The Drive & Control Company

Rexroth
Bosch Group

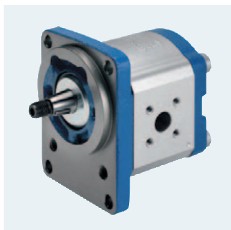
Product catalog Industrial hydraulics

Part 2: Motors

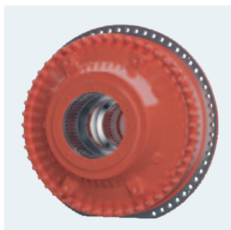










Product catalog Industrial hydraulics

Part 2: Motors

Product catalogs Industrial hydraulics of Bosch Rexroth at a glance:

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www.boschrexroth.com/contact

Contents

General

Installation, commissioning and maintenance of hydraulic systems

RE 07900/10.06
Replaces: 08.06

1. General

1.1 Long service life and functional reliability of hydraulic systems and their components depend on correct handling.

Ensure trouble-free operation by observing the following points:

– The specific installation and operating instructions for the relevant components

– Special instructions in individual cases

– Technical data in the data sheet.

In addition, we would like to draw your attention to the following regulations:

– German standard "Hydraulic systems" DIN 24346

– ISO standard ISO 4413

2. Installation

2.1 Preparatory work for the installation

– Sauberkeit der Anlage gewährleisten!

• For the surroundings:

Keep power units, line connections and components clean or clean them (e.g. pickling after, for example, processes have been carried out that involve heat, i.e. welding, hot bending, etc.)!

• For hydraulics fluids:

Take care of contamination and humidity; contamination from the environment must not enter the tanks! Fill oil tanks only through filters, preferably system filters or portable filter stations with fine filters.
Internal protective coatings, if any, must be resistant to the hydraulic fluid used!

• For parts taken from stock:

The storage of parts that were not filled or treated with anti-corrosion fluid can lead to the formation of resin. Solve the resin using a grease solvent and renew the lubricating film.

– Check to see that all of the parts required for the installation are available!

– Take note of any transport damage!

2.2 Carrying out the montage

– Use lifting lugs and transport facilities!

– Do not apply force to prevent transverse forces and tension on pipes and components. The valve mounting surfaces must be perfectly even. The fixing screws must be tightened evenly at the specified torque.

Take care that pipes are adequately fixed!

– When selecting pipes, hoses and fittings/flanges, observe the correct pressure stage (wall thickness, material). Use only seamless precision steel pipes.

- Do not use hemp or putty as sealing materials! This may cause contamination and thus malfunction.
- To prevent external leakage, observe the installation instructions of the pipe fittings' manufacturer. We recommend the use of fittings with elastic seals.
- Make sure that hoses are properly laid! Rubbing and abutting of the lines must be prevented.
- Provide the correct hydraulic fluids
  - Mineral oils:
    HLP hydraulic oils according to DIN 51524 part 2 are generally suitable for standard systems and components.
  - Fast bio-degradable hydraulic fluids:
    VDMA 24568.

    For these fluids, the system and components must be matched.
  - Hardly inflammable hydraulic fluids:
    VDMA 24317. For these fluids, the system and components must be matched. (Before filling in the special media, check, whether the system is compatible with the intended fluid.)

The following points must be observed in accordance with the relevant requirements:
- Viscosity of the hydraulic fluid
- Operating temperature range
- Type of seals used on the components fitted

3. Commissioning

When the installation has been carried out correctly, proceed with commissioning and functional testing.

3.1 Preparations for trial run
- Tank cleaned?
- Lines cleaned and properly installed?
- Fittings, flanges tightened?
- Lines and components correctly connected in line with installation drawings and circuit diagram?

Is the accumulator filled with nitrogen? Fill in nitrogen until the pre-charge pressure p0 as specified in the cicuit diagram is reached. (On the fluid side the system must be pressureless!). It is recommended that the gas pre-charge pressure is marked on the accumulator itself (e.g. self-adhesive label) and in the hydraulic circuit so that a comparative check is possible, if required.

⚠ **Caution!** Use only nitrogen as pre-charge gas!

Accumulators must comply with the safety regulations valid at the place of installation.
- Are the drive motor and pump properly installed and aligned?
- Is the drive motor correctly connected?
- Are filters with the prescribed filter rating used?
- Are filters fitted in the correct direction of flow?
- Has the specified hydraulic fluid filled up to the upper marking?

As the hydraulic fluids often do not comply with the required cleanliness, the fluids must be filled through a filter. The absolute filter rating of the filling filter should be at least that of the filters installed in the system.

3.2 Trial run
- For safety reasons, only personnel of the machine manufacturer and, if required, maintenance and operating personnel should be present.
- All pressure relief valves, pressure reducing valves, pressure controllers of pumps must be unloaded. An exemption to this are TÜV-set valves.
- Open isolator valves completely!
- Switch the system on briefly and check whether the direction of rotation of the drive motor matches the prescribed direction of rotation of the pump.
- Check the position of the directional valves and, if necessary, move the spool to the required position.
- Set the control spool to by-pass.
- Open suction valves of the pump. If required for design reasons, fill pump housing with hydraulic fluids to prevent bearings and parts of the rotary group from running dry.
- If a pilot oil pump is provided, commission it[1].
- Start up the pump, swivel it from its zero position and listen for any noises.
- Swivel the pump slightly out (ca. 5°)[1].
- Bleed the system
  Carefully loosen fittings or bleed screws at high points in the system. When the escaping fluid is free from bubbles, then the filling process is completed. Re-tighten fittings.
- Flush the system; if possible, short-circuit actuators. Flush the system until the filters remain clean; check the filters!
  With servo-systems, the servo-valves must be removed and replaced by flushing plates or direction valves of the same size. Short-circuit the actuators.
  During flushing, the hydraulic fluid in the complete hydraulic system should reach temperatures that are at least as high as later during operation. Change the filter elements as required.
  Flushing continues until the required minimum cleanliness is reached. This can only be achieved by continuous monitoring using a particle counter.
- Check the system functions under no-load conditions, if possible, by hand; cold-test the electrohydraulic control.
- When the operating temperature has been reached, test the system under load; slowly increase the pressure.
- Monitor control and instrumentation equipment!
- Check the housing temperature of hydraulic pumps and hydraulic motors.
- Listen for noises!
- Check the hydraulic fluid level; if required, top up!

[1] As far as possible with the control elements fitted; otherwise, start up at full displacement. In conjunction with combustion engines, start up at idle speed.

– Check the setting of pressure relief valves by loading or braking the system.
– Inspect the system for leaks.
– Switch off the drive.
– Retighten all fittings, even if there is no evidence of leakage.

⚠ **Caution!** Only tighten fittings when the system is depressurised!

– Is the pipe fixing adequate, even under changing pressure loads?
– Are the fixing points at the correct positions?
– Are the hoses laid so that they do not chamfer, even under pressure load?
– Check the fluid level.
– Test the system for all functions. Compare measured values with the permissible or specified data (pressure, velocity. Adjust further control components).
– Jerky movements indicate, amongst other things, the presence of air in the system. By briefly swivelling the pump in one or both directions with the actuator being loaded or braked, it is possible to eliminate certain air pockets. The system is completely bled when all functions are performed jerk-free and smoothly and the sur face of the hydraulic fluid level is free from foam. Experience has shown that foaming should have ceased one hour after start-up at the latest.
– Check the temperature.
– Switch off the drive.
– Remove filter elements (off-line and full-flow filters) and inspect them for residues. Clean filter elements or replace them, if required. Paper or glass fibre elements **cannot** be cleaned.
– If further contamination is found, additional flushing is required to prevent premature failure of the system components.
– All the adjustments made are to be recorded in an acceptance report.

3.3 Commissioning of fast running systems

Such system can often not be commissioning using the normal measuring instruments (such as pressure gauges, thermometers, electrical multimeters, etc.) and standard tools. Optimization is also not possible.
These systems include, for example, forging presses, plastics injection moulding machines, special machine tools, rolling tools, crane controls, machines with electro-hydraulic closed-loop control systems.
Commissioning and optimization of these systems often require more comprehensive measuring equipment to allow several measurements to be taken at a time (e.g. several pressures, electrical signals, travel, velocities, flows, etc.).

3.4 The most common faults occurring during commissioning

Apart from servicing, commissioning is very decisive for the service life and functional reliability of a hydraulic system.

For this reason, faults during commissioning must be avoided as far as possible.

The most common faults are:
– The fluid tank is not inspected.
– The hydraulic fluid is not filtered before being filled in.
– The installation is not checked before commissioning (subsequent conversion with loss of fluid!).
– System components are not bled.
– Pressure relief valves are set only slightly higher than the operating pressure (closing pressure differential is not observed).
– Pressure controllers of hydraulic pumps are set higher or to the same pressure as the pressure relief valve.
– The flushing time of servo systems is not adhered to.
– Abnormal pump noise is ignored (cavitation, leaking suction lines, too much air in the hydraulic fluid).
– Transversal loads on cylinder piston rods are not observed (installation error!).
– Hydraulic cylinders are not bled (damage to seals!)
– Limit switches are set too low.
– The switching hysteresis of pressure switches is not taken into account when settings are made.
– Hydraulic pump and hydraulic motor housings are not filled with hydraulic fluid prior to commissioning.
– Settings are not documented.
– Adjustment spindles are not secured or sealed.
– Unnecessary personnel present during commissioning of the system.

4. Maintenance

According to DIN 31 051 the term “maintenance” includes the following fields of activity:

– Inspection

Measures to recognise and assess the actual situation, i.e. recognise how and why the so-called wear reserve continues to decrease.

– Maintenance

Measures to preserve the nominal conditions, i.e. to take precautions in order that the reduction in the wear reserve during the useful life is kept as low as possible.

– Repair

Measures to restore the nominal condition, i.e. compensate for reduction in performance and restore the wear reserve.

Maintenance measures must be planned and taken in accordance with the operating time, the consequences of a failure and the required availability.

4.1 Inspection

The individual points to be inspected should be summarised for a specific system in so-called inspection lists in order that the inspections can be carried out adequately by employees with different qualification levels.

Important points of inspection are:
– Checking the hydraulic fluid level in the tank.
– Checking the heat exchanger (air, water) for effectiveness.

– Checking the system for external leakage (visual inspection).
– Checking the hydraulic fluid temperature during operation.
– Checking pressures
– Amount of leakage
– Checking the cleanliness of the hydraulic fluid

⚠ **Caution!**

Visual inspections can only give an approximation (clouding of the hydraulic fluid, darker appearance than at the time of filling, sediments in the fluid tank).

If conventional particle counting is impossible, the following three methods can be used for establishing the fluid cleanliness:

- Particle counts using electronic counting and sorting equipment.
- Microscopic examination.
- Gravimetric establishment of solids by means of finest filtration of a certain fluid volume (e.g. 100 ml) and weighing of the filter paper before and after the filtration process. This allows the establishment of the amount of solid particles in mg/l.

– Check the contamination of filters. A visual inspection of deep filters, which are widely used today, is **no** longer possible.
– Analyse the chemical properties of the hydraulic fluid.
– Check the temperature at points where bearings are located.
– Check the generation of noise.
– Test performance and velocity.
– Inspect pipes and hoses.

⚠ **Caution!**

Damaged pipes and hoses must be immediately replaced.

– Inspect accumulator stations.

4.2 Maintenance

In practice, inspection, maintenance and repair work is not as strictly separated as the definitions may suggest. Servicing is often done in conjunction with inspections.

For safety reason, pipe fittings, connections and components **must not** be loosened or removed as long as the system is pressurised.

Important service work is:

– Create a maintenance book

We recommend that a maintenance book is created to lay down the parts to be inspected.

– Check the hydraulic fluid level

- continuously during commissioning
- shortly after commissioning
- later, at weekly intervals

– Inspect filters

- during commissioning every two to three hours and, if necessary, replace them.
- daily during the first week and replace them as required.
- After one week, the filters should be cleaned as required.
- Maintenance of suction filters:

  Suction filters require particularly thorough servicing. After the running-in period, they must be inspected at least once a week and cleaned, if necessary.

– Service the system fluid

- Maintenance intervals depend on the following operating factors:

  - Hydraulic fluid condition (e.g. water in oil, strongly aged oil)
  - Operating temperature and oil fill

  We recommend that the fluid be changed in dependence upon an oil analysis. With systems whose oil is not analysed at regular intervals the fluid should be replaced every 2000 to 4000 operating hours at the latest.

- Drain the system fluid at operating temperature and change it.
- Severely aged or contaminated system fluid **cannot** be improved by adding new fluid!
- Only fill in oil via filters that have at least the same separation capacity as the filters installed in the system, or use a system filter.
- Take samples of the system fluid to have the type, size and amount of particles analysed in the lab. Record the results.

– Check the accumulator for its pre-charge pressure; for this, the accumulator must be depressurised on the fluid side.

⚠ **Caution!**

Work on systems that include accumulators may only be carried out after the fluid pressure was unloaded.

Welding or soldering work or any mechanical work on accumulators is not permitted.

Improper repairs can lead to severe accidents. Repairs on hydraulic accumulator may therefore only be carried out by Rexroth Service service personnel.

– The operating temperature must be measured. An increase in the operating temperature indicates increasing friction and leakage.
– Leakage in the pipework

Leakage, especially with underfloor piping, represents, apart from loss of fluid, a risk for equipment and concrete floors.

For safety reasons, sealing work on the pipes may only be carried out when the system is depressurised. Leakage at points that are sealed with soft seals (O-rings, form seal rings, etc.) **cannot** be eliminated by tightening as these sealing elements are either destroyed or hardened. Sealing can only be achieved by replacing the sealing elements.

– Check main and pilot pressure
  - Check interval: One week
  - Document pressure corrections in the maintenance book.
  - Frequent pressure adjustments indicate, among other things, wear of the pressure relief valve.

4.3 Repair

Locate and eliminate malfunction and damage.

– Fault localisation

A precondition for system repairs is successful, i.e. systematic fault search.

This requires in any case detailed knowledge of the structure and the operating principle of the individual components as well as of the entire system. The required documentation should be available and easily accessible.

The most important measuring instruments (thermometer, electrical multimeter, industrial stethoscope, stop watch, rpm counter, etc.) should also be available in the vicinity of the system, especially in the case of large systems.

– Fault correction

When carrying out any work, observe strictest cleanliness. Before loosening fittings, clean the surrounding area.

Generally, defective components should not be repaired on site, since for the proper repair, the required tooling and the required cleanliness are usually not given on site. On site, only complete components should be changed whenever possible, in order

- to keep the time for which the opened system is exposed to ambient influences to a minimum,
- to keep the fluid loss as low as possible,
- to ensure the shortest possible downtime through the use of overhauled and tested components.

After failed components are located, it is essential to check whether the entire system or parts of the system have been contaminated by broken parts or larger amounts of abraded metal.

4.4 Repair and major overhaul of hydraulic components

Generally, it can be said that only the component manufacturer can carry out major overhauls in the most efficiently and reliably (same quality standard, trained personnel, test facilities, warranty, etc.).

1

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Bosch Group

Installation, commissioning and servicing of hydraulic pumps and motors

(vane pumps, internal gear pumps, radial piston motors, internal gear pumps)

RE 07080/07.05
Replaces: 02.03

1. General

1.1 To ensure proper operation of pumps and motors, please observe the following information:

- Technical data in the data sheet
- General notes on commissioning of hydraulic systems
- The following notes on installation and operation

2. Installation

2.1 Flushing

- On pumps taken from stock, resin may have formed. This must be removed by means of solvents. Then, the lubricating film must be renewed. In the case of hardly inflammable fluids, no special measures have to be taken.

2.2 Installation

- Observe drawings and/or instructions
- Ensure stress-free installation
- In the case of prime movers, ensure that foundations are level

2.3 Lines and connections

2.3.1 Suction lines

- Design and assemble lines according to the manufacturer's instructions.
- Suction vacuum pressure or feed pressure must be within the limits specified by the manufacturer; filters and valves possibly installed must be taken into account.
- Take care that the suction lines are leak-free.
- The flow velocity in suction lines should not exceed 0.5 m/s.
- Cut the pipe ends at an angle of less than 45° and install them at a distance of at least 2.5 x the pipe diameter from the tank floor in order to prevent the aspiration of deposits from the tank floor.

2.3.2 Leakage drain lines

- Use sufficiently large nominal widths in order to keep the backpressure in the housing within the permissible limits.
- When installing the lines, make sure that the housing is completely filled with fluid, while taking care that a siphoning effect is avoided.
- Pressureless return flow to the tank
- Sufficient cooling and settling of the hydraulic fluid is achieved by directing the fluid to the tank wall.
- Ensure a sufficient distance to temperature switches.

2.3.3 Installation instructions

- All lines have to be submerged at least 2.5 x the pipe diameter below the lowest permissible fluid level, but at least 100 mm in order to prevent foaming.
- Install the leakage drain line higher than the suction line and take precautions that the returning oil cannot be directly re-aspired.
- The ends of the suction, return and leakage drain lines must therefore be installed with a distance of at least 200 mm from each other.
- We recommend seamless precision steel pipes to DIN 2391 and pipe connections that can be loosened.

2.4 Filters

- Whenever possible, use return line or pressure filters.
- Use suction filters only in conjunction with underpressure switches/clogging indicators.
- Depending on the pump type, the required filter rating is 25 µm to 40 µm.
  Recommendation: 10- µm filters prolong the service life under high load conditions.

2.5 Hydraulic media

2.5.1 Mineral oils

- When HL oils without wear-reducing additives are used, vane pumps (V3, V4, PV7, PVV, PVQ) may only be operated at reduced pressure.
- Oils containing polar additives (slide way oils) must not be used for pumps with plain bearings, as the additives precipitate at 70 °C and thus impair cooling and lubrication of the bearings.

2.5.2 HFC fluid (water glycol)

- Internal gear pumps of types PGF and PGH are suitable for operation with HFC fluids.

  Please note the information in the data sheets!

  When using hydraulic media, which are not listed in the technical data, please consult us.

3. Commissioning

3.1 Electrical open and closed-loop control elements

- Observe voltages and current intensity

3.2 Direction of rotation of drive/output shafts

- Observe the arrow of direction of rotation
- Testing of a unit filled with hydraulic fluid:
  Switching the unit briefly on and off prevents damage in the case of the wrong direction of rotation.

3.3 Filling

- Pump types V3, V4, PV7, PVV, PVQ are self-priming, the housings need not to be filled. Internal gear pumps must be filled prior to commissioning! For all other pumps, verify, whether the housing must be filled.

3.4 Start-up

- Observe specific component instructions.
- Set all valves, especially on the suction and supply side, to the free-flow position.
- Switch the motor briefly on and off several times in order to facilitate bleeding. Only operate the pump under full load when it runs properly and smoothly.
- During initial start-up, bleed the pressure line to allow complete filling of the pump.
  Exceptions to this are pump with automatic bleed valve.
- When the system starts up, the fluid level in the tank must not fall below the minimum suction level.

3.5 Pressure limitation / pressure control

- Always select the lowest settings for commissioning.
- Carefully increase the pressure to the required values, but do not set to unnecessarily high values.
- If required, secure settings against unwanted adjustment.

3.6 Temperature

- Check the fluid temperature under normal operating conditions.

4. Routine maintenance

4.1 Frequency

- Loads and operating conditions determine regular maintenance intervals.

4.2 Mounting

- Check the correct orientation of the pumps, motors, cylinders, further energy converters and lines at normal operating pressure and operating temperature.

4.3 Filters

- Observe clogging indicators and check suction filters for operability according to the operating instructions.

4.4 Servicing

- We recommend regular servicing of the complete system by Bosch Rexroth!

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Hydraulic fluids based on mineral oils and related hydrocarbons

RE 90220/05.12 1/16
Replaces: 05.10

Application notes and requirements for Rexroth hydraulic components

Hydraulic fluids

Title	**Hydraulic fluids based on mineral oils and related hydrocarbons**	Environmentally acceptable hydraulic fluids	Fire-resistant, water-free hydraulic fluids	Fire-resistant, water-containing hydraulic fluids
Standard	**DIN 51524**	ISO 15380	ISO 12922	ISO 12922
Data sheets	**RE 90220**	RE 90221	RE 90222	RE 90223 (in preparation)
Classification	**HL HLP HLPD HVLP HLPD and more**	HEPG HEES partially saturated HEES saturated HEPR HETG	HFDR HFDU (ester base) HFDU (glycol base) and more	HFC HFB HFAE HFAS

Contents

1 Basic information

1.1 General instructions

The hydraulic fluid is the common element in any hydraulic component and must be selected very carefully. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency and service life of a system.

Hydraulic fluids must conform, be selected and used in accordance with the generally acknowledged rules of technology and safety provisions. Reference is made to the country-specific standards and directives (in Germany the directive of the Employer's Liability Insurance Association BGR 137).

This data sheet includes recommendations and regulations concerning the selection, operation and disposal of hydraulic fluids based on mineral oils and related hydrocarbons in the application of Rexroth hydraulic components.

The individual selection of hydraulic fluid or the choice of classification are the responsibility of the operator.

It is the responsibility of the user to ensure that appropriate measures are taken for safety and health protection and to ensure compliance with statutory regulations. The recommendations of the lubricant manufacturer and the specifications given in the safety data sheet are to be observed when using hydraulic fluid.

This data sheet does not absolve the operator from verifying the conformity and suitability of the respective hydraulic fluid for his system. He is to ensure that the selected fluid meets the minimum requirements of the relevant fluid standard during the whole of the period of use.

Other regulations and legal provisions may also apply. The operator is responsible for their observance, e.g. EU directive 2004/35/EG and their national implementations. In Germany the Water Resources Act (WHG) is also to be observed.

We recommend that you maintain constant, close contact with lubricant manufacturers to support you in the selection, maintenance, care and analyses.

When disposing of used hydraulic fluids, apply the same care as during use.

1.2 Scope

This data sheet must be observed when using hydraulic fluids based on mineral oils and related hydrocarbons in Bosch Rexroth hydraulic components.

Please note that the specifications of this data sheet may be restricted further by the specifications given in the product data sheets for the individual components.

The use of the individual hydraulic fluids in accordance with the intended purpose can be found in the safety data sheets or other product description documents of the lubricant manufacturers. In addition, each use is to be individually considered.

Rexroth hydraulic components may only be operated with hydraulic fluids based on mineral oils and related hydrocarbons according to DIN 51524 if specified in the respective component data sheet or if Rexroth approval for use is furnished.

Notes:
In the market overview RE 90220-01, hydraulic fluid based on mineral oil are described which, according to the information of the lubricant manufacturer, feature the respective parameters of the current requirements standard DIN 51524 and other parameters which are of relevance for suitability in connection with Rexroth components.

These specifications are not checked or monitored by Bosch Rexroth. The list in the market overview does not therefore represent a recommendation on the part of Rexroth or approval of the respective hydraulic fluid for use with Rexroth components and does not release the operator from his responsibility regarding selection of the hydraulic fluid.

Bosch Rexroth will accept no liability for its components for any damage resulting from failure to comply with the notes below.

1.3 Safety instructions

Hydraulic fluids can constitute a risk for persons and the environment. These risks are described in the hydraulic fluid safety data sheets. The operator is to ensure that a current safety data sheet for the hydraulic fluid used is available and that the measures stipulated therein are complied with.

2 Solid particle contamination and cleanliness levels

Solid particle contamination is the major reason for faults occurring in hydraulic systems. It may lead to a number of effects in the hydraulic system. Firstly, single large solid particles may lead directly to a system malfunction, and secondly small particles cause continuous elevated wear.

For hydraulic fluids, the cleanliness level is given as a three-digit numerical code in accordance with ISO 4406. This numerical code denotes the number of particles present in a hydraulic fluid for a defined quantity. Moreover, foreign solid matter is not to exceed a mass of 50 mg/kg (gravimetric examination according to ISO 4405).

In general, compliance with a minimum cleanliness level of 20/18/15 in accordance with ISO 4406 or better is to be maintained in operation. Special servo valves demand improved cleanliness levels of at least 18/16/13. A reduction in cleanliness level by one level means half of the quantity of particles and thus greater cleanliness. Lower numbers in cleanliness levels should always be striven for and extend the service life of hydraulic components. The component with the highest cleanliness requirements determines the required cleanliness of the overall system. Please also observe the specifications in table 1: "Cleanliness levels according to ISO 4406" and in the respective data sheets of the various hydraulic components.

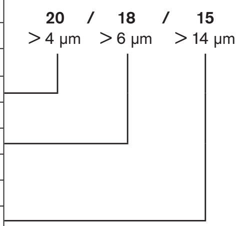
Hydraulic fluids frequently fail to meet these cleanliness requirements on delivery. Careful filtering is therefore required during operation and in particular, during filling in order to ensure the required cleanliness levels. Your lubricant manufacturer can tell you the cleanliness level of hydraulic fluids as delivered. To maintain the required cleanliness level over the operating period, you must use a reservoir breather filter. If the environment is humid, take appropriate measures, such as a breather filter with air drying or permanent off-line water separation.

Note: the specifications of the lubricant manufacturer relating to cleanliness levels are based on the time at which the container concerned is filled and not on the conditions during transport and storage.

Further information about contamination with solid matter and cleanliness levels can be found in brochure RE 08016.

Table 1: Cleanliness levels according to ISO 4406

Particles per 100 ml		Scale number
More than	Up to and including	
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64000	130,000	17
32000	64000	16
16000	32000	15
8000	16000	14
4000	8000	13
2000	4000	12
1000	2000	11
500	1000	10
250	500	9
130	250	8
64	130	7
32	64	6



3 Selection of the hydraulic fluid

The use of hydraulic fluids based on mineral oils for Rexroth hydraulic components is based on compliance with the minimum requirements of DIN 51524.

3.1 Selection criteria for the hydraulic fluid

The specified limit values for all components employed in the hydraulic system, for example viscosity and cleanliness level, must be observed with the hydraulic fluid used, taking into account the specified operating conditions.

Hydraulic fluid suitability depends, amongst others, on the following factors:

3.1.1 Viscosity

Viscosity is a basic property of hydraulic fluids. The permissible viscosity range of complete systems needs to be determined taking account of the permissible viscosity of all components and it is to be observed for each individual component.

The viscosity at operating temperature determines the response characteristics of closed control loops, stability and damping of systems, the efficiency factor and the degree of wear.

We recommend that the optimum operating viscosity range of each component be kept within the permissible temperature range. This usually requires either cooling or heating, or both. The permissible viscosity range and the necessary cleanliness level can be found in the product data sheet for the component concerned.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. In return, there will be lower internal leakage losses. If the pressure level is lower, lubrication gaps may not be filled up, which can lead to increased wear. For hydraulic pumps, the permitted suction pressure may not be reached, which may lead to cavitation damage.

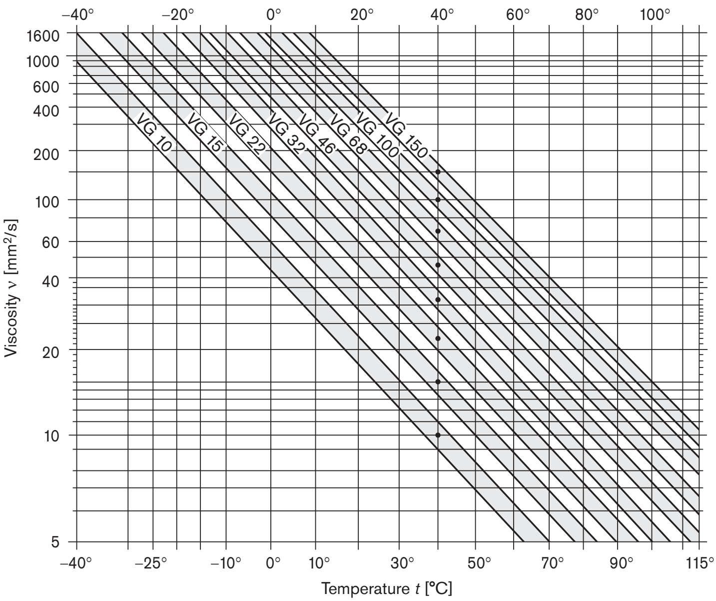
If the viscosity of a hydraulic fluid is below the permitted operating viscosity, increased leakage, wear, susceptibility to contamination and a shorter component life cycle will result.

3.1.2 Viscosity-temperature behavior

For hydraulic fluids, the viscosity temperature behavior (V-T behavior) is of particular importance. Viscosity is characterized in that it drops when the temperature increases and rises when the temperature drops; see Fig. 1 "Viscosity temperature chart for HL, HLP, HLPD (VI 100)". The interrelation between viscosity and temperature is described by the viscosity index (VI).

The viscosity temperature diagram in Fig. 1 is extrapolated in the < 40 °C range. This idealized diagram is for reference purposes only. Measured values can be obtained from your lubricant manufacturer and are to be preferred for design purposes.

Fig. 1: Viscosity-temperature chart for HL, HLP, HLPD (VI 100, double logarithmic representation)



3.1.3 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components. The wear protection capability is described in DIN 51524-2,-3 via test procedures "FZG gear test rig" (ISO 14635-1) and "Mechanical test in the vane pump" (ISO 20763). From ISO VG 32 DIN 51524-2,-3 prescribes a rating of at least 10 (FZG test). At present, the FZG test cannot be applied to viscosity classes < ISO VG 32.

3.1.4 Material compatibility

The hydraulic fluid must not negatively affect the materials used in the components. Compatibility with coatings, seals, hoses, metals and plastics is to be observed in particular. The fluid classifications specified in the respective component data sheets are tested by the manufacturer with regard to material compatibility. Parts and components not supplied by us are to be checked by the user.

Table 2: Known material incompatibilities

Classification	Incompatible with:
HLxx classifications	with EPDM seals
Zinc- and ash/free hydraulic fluids	with bronze-filled PTFE seals

3.1.5 Aging resistance

The way a hydraulic fluid ages depends on the thermal, chemical and mechanical stress to which it is subjected. Aging resistance can be greatly influenced by the chemical composition of the hydraulic fluids.

High fluid temperatures (e.g. over 80 °C) result in a approximate halving of the fluid service life for every 10 °C temperature increase and should therefore by avoided. The halving of the fluid service life results from the application of the Arrhenius equation (see Glossary).

Table 3: Reference values for temperature-dependent aging of the hydraulic fluid

Reservoir temperature	Fluid life cycle
80 °C	100 %
90 °C	50 %
100 °C	25 %

Hydraulic fluids based on mineral oils and related hydrocarbons are tested with 20% water additive during testing of aging resistance according to ISO 4263-1.

The calculated fluid service life is derived from the results of tests in which the long-term characteristics are simulated in a short period of time by applying more arduous conditions (condensed testing). This calculated fluid service life is not to be equated to the fluid service life in real-life applications.

Table 3 is a practical indicator for hydraulic fluids with water content < 0.1%, cf. chapter 4.10. "Water".

3.1.6 Air separation ability (ASA)

The air separation ability (ASA) describes the property of a hydraulic fluid to separate undissolved air. Hydraulic fluids contain approx. 7 to 13 percent by volume of dissolved air (with atmospheric pressure and 50 °C). Hydraulic fluids always contain dissolved air. During operation, dissolved air may be transformed into undissolved air, leading to cavitation damages. Fluid classification, fluid product, reservoir size and design must be coordinated to take into account the dwell time and ASA value of the hydraulic fluid. The air separation capacity depends on the viscosity, temperature, basic fluid and aging.
It cannot be improved by additives.

According to DIN 51524 for instance, an ASA value ≤ 10 minutes is required for viscosity class ISO VG 46, 6 minutes are typical, lower values are preferable.

3.1.7 Demulsifying ability and water solubility

The capacity of a hydraulic fluid to separate water at a defined temperature is known as the demulsifying ability. ISO 6614 defines the demulsifying properties of hydraulic fluids.

For larger systems with permanent monitoring, a demulsifying fluid with good water separation capability (WSC) is recommended. The water can be drained from the bottom of the reservoir. In smaller systems (e.g. in mobile machines), whose fluid is less closely monitored and where water contamination into the hydraulic fluid, for instance through air condensation, cannot be ruled out completely, an HLPD fluid is recommended.

The demulsifying ability up to ISO-VG 100 is given at 54 °C, and at 82 °C for fluids with higher viscosity.

Water emulsifying HLPD hydraulic fluids have no, or a very poor, demulsifying ability.

3.1.8 Filterability

Filterability describes the ability of a hydraulic fluid to pass through a filter, removing solid contaminants. The hydraulic fluids used require a good filterability, not just when new, but also during the whole of their service life. Depending on the basic fluid used and the additives (VI enhancers) there are great differences here.

The filterability is a basic prerequisite for cleanliness, servicing and filtration of hydraulic fluids. Filterability is tested with the new hydraulic fluid and after the addition of 0.2 % water. The underlying standard (ISO 13357-1/-2) stipulates that filterability must have no negative effects on the filters or the hydraulic fluid, see chapter 4 "Hydraulic fluids in operation".

3.1.9 Corrosion protection

Hydraulic fluids should not just prevent corrosion formation on steel components, they must also be compatible with non-ferrous metals and alloys. Corrosion protection tests on different metals and metal alloys are described in DIN 51524. Hydraulic fluids that are not compatible with the materials listed above must not be used, even if they are compliant with ISO 51524.

Rexroth components are usually tested with HLP hydraulic fluids or corrosion protection oils based on mineral oils before they are delivered.

3.1.10 Additivation

The properties described above can be modified with the help of suitable additives. A general distinction is made for fluids between heavy metal-free and heavy metal-containing (generally zinc) additive systems. Both additive systems are most often incompatible with each other. The mixing of these fluids must be avoided even if the mixing ratio is very low. See chapter 4, "Hydraulic fluids in operation".

Increasing additivation generally leads to deteriorated air separation ability (ASA) and water separation capability (WSC) of the hydraulic fluid. According to the present state of knowledge, all hydraulic fluids described in this document, independently of the actual additivation, can be filtered using all filter materials with all known filtration ratings ≥ 1 μm without filtering out effective additives at the same time.

Bosch Rexroth does not prescribe any specific additive system.

3.2 Classification and fields of application

Table 4: Classification and fields of application

Classification	Features	Typical field of application	Notes
HL fluids according to DIN 51524-1 VI = 100	Hydraulic fluids predominantly only with additives for oxidation and corrosion protection, but no specific additives for wear protection in case of mixed friction	HL fluids can be used in hydraulic systems that do not pose any requirements as to wear protection.	HL fluids may be used only for components whose product data sheet specifically allows HL fluids. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. Hydraulic fluids that only comply with the requirements of classes HL and HR in accordance with ISO 11158 without proving that DIN 51524-1 is also met may be used only with written approval of Bosch Rexroth AG. Observe restrictions as to pressure, rotation speed etc.
HLP fluids according to DIN 51524-2 VI = 100	Hydraulic fluid with corrosion, oxidation and verified wear protection additives	HLP fluids are suitable for most fields of application and components provided the temperature and viscosity provisions are observed.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. For the viscosity classes VG10, VG15 and VG22, DIN 51524 defines no requirements as to wear protection (DIN 51354 part 2 and DIN 51389 part 2). Beyond the requirements of DIN 51524 part 2, we require the same base oil type, identical refining procedure, identical additivation and identical additivation level across all viscosity classes.

Continued on page 8

Table 4: Classification and fields of application (continued from page 7)

Classification	Features	Typical field of application	Notes
HVLP fluids according to DIN 51524-3 VI > 140	HLP hydraulic fluid with additional improved viscosity temperature behavior	HVLP fluids are used in systems operated over a wide temperature range.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. The same notes and restrictions as defined for HLP fluids apply accordingly. The effect on Rexroth components (e.g. compatibility with material seals, wear resistance capacity) may differ when using related hydrocarbons instead of mineral oils, cf. Table 6, line 8. When using HVLP fluids, the viscosity may change on account of the shear of the long-chain VI enhancers. The viscosity index, high at the start, decreases during operation. This needs to be taken into account when selecting the hydraulic fluid. The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part 6. Please note that there are practical applications that create a much higher shear load on such fluids than can be achieved by this test. Up to VI < 160, we recommend a maximum permitted viscosity drop of 15 %, viscosity at 100 °C. The viscosity limits given by Bosch Rexroth for its components are to be observed for all operating conditions, even after the hydraulic fluids have sheared. HVLP fluids should be used only if required by the temperature ranges of the application.
HLPD fluids according to DIN 51524-2, HVLPD fluids in accordance with DIN 51524-3	HLP and HVLP hydraulic fluid with additional detergent and or dispersant additives	HLPD and HVLPD fluids are used in systems where deposits as well as solid or liquid contamination need to be kept temporarily suspended	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. Some of these fluids are able to absorb significant quantities of water (> 0.1 %). This may have negative implications for the wear protection and the aging properties of the fluid. The wetting ability of these fluids varies largely depending on the product. Therefore it is not correct to say that they are generally all very well able to prevent stick-slip. In individual cases where higher water contamination is to be expected (such as in steelworks or under humid conditions), the use of HLPD/HVLPD fluids cannot be recommended as the emulsified water does not settle in the reservoir but is evaporated in heavily loaded positions. For such cases, we recommend using HLP hydraulic fluids with particularly good demulsifying ability. The water collected at the reservoir bottom is to be drained regularly. If HLPD/HVLPD fluids are used, contamination does not settle. It rather remains suspended and needs to be filtered out or removed by appropriate draining systems. For this reason, the filter area must be increased. HLPD/HVLPD fluids may contain additives that in the long run are incompatible with plastics, elastomers and non-ferrous metals. Furthermore, these additives may lead to the premature clogging of hydraulic filters. Therefore, test the filterability and the selection of the filter material in consultation with the filter manufacturer.

4 Hydraulic fluids in operation

4.1 General

The properties of hydraulic fluids can change continually during storage and operation.

Please note that the fluid standard DIN 51524 merely describes minimum requirements for hydraulic fluids in new condition at the time of filling into the bins. The operator of a hydraulic system must ensure that the hydraulic fluid remains in a utilizable condition throughout its entire period of use.

Deviations from the characteristic values are to be clarified with the lubricant manufacturer, the test labs or Bosch Rexroth.

Please note the following aspects in operation.

4.2 Storage and handling

Hydraulic fluids must be stored correctly in accordance with the instructions of the lubricant manufacturer. Avoid exposing the containers to lengthy periods of direct heat. Containers are to be stored in such a way that the risk of any foreign liquid or solid matter (e.g. water, foreign fluids or dust) ingression into the inside of the container can be ruled out. After taking hydraulic fluids from the containers, these are immediately to be properly resealed.

Recommendation:

– Store containers in a dry, roofed place

– Store barrels on their sides

– Clean reservoir systems and machine reservoirs regularly

4.3 Filling of new systems

Usually, the cleanliness levels of the hydraulic fluids as delivered do not meet the requirements of our components. Hydraulic fluids must be filtered using an appropriate filter system to minimize solid particle contamination and water in the system.

As early as possible during test operation, new systems should be filled with the selected hydraulic fluid so as to reduce the risk of accidentally mixing the fluids (see chapter 4.5 "Mixing and compatibility of different hydraulic fluids"). Changing the hydraulic medium at a later point represents significant additional costs (see following chapter).

4.4 Hydraulic fluid changeover

Changeovers, in particular between hydraulic fluids with heavy metal-free and heavy metal-containing (generally zinc) additives, frequently lead to malfunctions, see chapter 3.1.10 "Additivation".

In the case of changeovers of the fluid in hydraulic systems, it is important to ensure compatibility of the new hydraulic fluid with the remainder of the previous hydraulic fluid. We recommend obtaining a written performance guarantee from the manufacturer or supplier of the new hydraulic fluid. The quantity of old fluid remaining should be minimized. Mixing hydraulic fluids should be avoided, see following chapter.

For information on changing over hydraulic fluids with different classifications please refer to VDMA 24314, VDMA 24569 and ISO 15380 appendix A.

Bosch Rexroth will not accept liability for any damage to its components resulting from inadequate hydraulic fluid change-overs!

4.5 Mixing and compatibility of different hydraulic fluids

If hydraulic fluids from different manufacturers or different types from the same manufacturer are mixed, gelling, silting and deposits may occur. These, in turn, may cause foaming, impaired air separation ability, malfunctions and damage to the hydraulic system.

If the fluid contains more than 2 % of another fluid then it is considered to be a mixture. Exceptions apply for water, see chapter 4.10 "Water".

Mixing with other hydraulic fluids is not generally permitted. This also includes hydraulic fluids with the same classification and from the market overview RE 90220-01. If individual lubricant manufacturers advertise miscibility and/or compatibility, this is entirely the responsibility of the lubricant manufacturer.

Bosch Rexroth customarily tests all components with mineral oil HLP before they are delivered.

Note: With connectible accessory units and mobile filtering systems, there is a considerable risk of non-permitted mixing of the hydraulic fluids!

Rexroth will not accept liability for any damage to its components resulting from mixing hydraulic fluids!

4.6 Re-additivation

Additives added at a later point in time such as colors, wear reducers, VI enhancers or anti-foam additives, may negatively affect the performance properties of the hydraulic fluid and the compatibility with our components and therefore are not permissible.

Rexroth will not accept liability for any damage to its components resulting from re-additivation!

4.7 Foaming behavior

Foam is created by rising air bubbles at the surface of hydraulic fluids in the reservoir. Foam that develops should collapse as quickly as possible.

Common hydraulic fluids in accordance with DIN 51524 are sufficiently inhibited against foam formation in new condition. On account of aging and adsorption onto surfaces, the defoamer concentration may decrease over time, leading to a stable foam.

Defoamers may be re-dosed only after consultation with the lubricant manufacturer and with his written approval.

Defoamers may affect the air separation ability.

4.8 Corrosion

The hydraulic fluid is to guarantee sufficient corrosion protection of components under all operating conditions, even in the event of impermissible water contamination.

During storage and operation, hydraulic fluid based on mineral oils with anti-corrosion additives protect components against water and "acidic" oil degradation products.

4.9 Air

Under atmospheric conditions, the hydraulic fluid contains dissolved air. In the negative pressure range, for instance in the suction pipe of the pump or downstream of control edges, this dissolved air may transform into undissolved air. The undissolved air content represents a risk of cavitation and of the diesel effect. This results in material erosion of components and increased hydraulic fluid aging.

With the correct measures, such as suction pipe and reservoir design, and an appropriate hydraulic fluid, air intake and separation can be positively influenced.

See also chapter 3.1.7 "Air separation ability (ASA)".

4.10 Water

Water contamination in hydraulic fluids can result from direct ingress or indirectly through condensation of water from the air due to temperature variations.

Water in the hydraulic fluid may result in wear or direct failure of hydraulic components. Furthermore, a high water content in the hydraulic fluid negatively affects aging and filterability and increases susceptibility to cavitation.

Undissolved water can be drained from the bottom of the reservoir. Dissolved water can be removed only by using appropriate measures. If the hydraulic system is used in humid conditions, preventive measures need to be taken, such as an air dehumidifier at the reservoir vent. During operation, the water content in all hydraulic fluids, determined according to the "Karl Fischer method" (see chapter 6 "Glossary") for all hydraulic fluids must constantly be kept below 0.1% (1000 ppm). To ensure a long service life of both hydraulic fluids and components, Bosch Rexroth recommends that values below 0.05% (500 ppm) are permanently maintained.

To ensure a long service life for the hydraulic fluids and the components, we recommend that values below 0.05 % (500 ppm) are permanently maintained. Detergent and or dispersant hydraulic fluids (HLPD / HVLPD) are able to absorb (and keep suspended) more water. Prior to using these hydraulic fluids, please contact the lubricant manufacturer.

4.11 Fluid servicing, fluid analysis and filtration

Air, water, operating temperature influences and solid matter contamination will change the performance characteristics of hydraulic fluids and cause them to age.

To preserve the usage properties and ensure a long service life for hydraulic fluid and components, the monitoring of the fluid condition and a filtration adapted to the application requirements (draining and degassing if required) are indispensable.

The effort is higher in the case of unfavorable usage conditions, increased stress for the hydraulic system or high expectations as to availability and service life, see chapter 2 "Solid particle contamination and cleanliness level".

When commissioning a system, please note that the required minimum cleanliness level can frequently be attained only by flushing the system. Due to severe start-up contamination, it may be possible that a fluid and/or filter replacement becomes necessary after a short operating period (< 50 operating hours).

The hydraulic fluid must be replaced in regular intervals and tested by the lubricant manufacturer or recognized, accredited test labs. **We recommend a reference analysis after commissioning.**

The minimum data to be tested for analyses are:

- Viscosity at 40 °C and 100 °C
- Neutralization number NN (acid number AN)
- Water content (Karl-Fischer method)
- Particle measurement with evaluation according to ISO 4406 or mass of solid foreign substances with evaluation to EN 12662
- Element analysis (RFA (EDX) / ICP, specify test method)
- Comparison with new product or available trend analyses
- Assessment / evaluation for further use
- Also recommended: IR spectrum

Compared to the pure unused hydraulic fluid, the changed neutralization number NN (acid number AN) indicates how many aging products are contained in the hydraulic fluid. This value must be kept as low as possible. As soon as the trend analysis notes a significant increase in the acid number, the lubricant manufacturer should be contacted.

In case of warranty, liability or guarantee claims to Bosch Rexroth, service verification and/or the results of fluid analyses are to be provided.

5 Disposal and environmental protection

Hydraulic fluids based on mineral oil and related hydrocarbons are hazardous for the environment. They are subject to a special disposal obligation.

The respective lubricant manufacturers provide specifications on environmentally acceptable handling and storage. Please ensure that spilt or splashed fluids are absorbed with appropriate adsorbents or by a technique that prevents it contaminating water courses, the ground or sewerage systems.

It is also not permitted to mix fluids when disposing of hydraulic fluids. Regulations governing the handing of used oils stipulate that used oils are not to mixed with other products, e.g. substances containing halogen. Non-compliance will increase disposal costs. Comply with the national legal provisions concerning the disposal of the corresponding hydraulic fluid. Comply with the local safety data sheet of the lubricant manufacturer for the country concerned.

6 Other hydraulic fluids based on mineral oil and related hydrocarbons

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
1	Hydraulic fluids with classification HL, HM, HV according to ISO 11158	– Can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see Table 4: "Hydraulic fluid classification". – Fluids **only** classified in accordance with ISO 11158 may be used only with prior written approval of Bosch Rexroth AG.
2	Hydraulic fluids with classification HH, HR, HS, HG according to ISO 11158	– May not be used.
3	Hydraulic fluids with classification HL, HLP, HLPD, HVLP, HVLPD to DIN 51502	– DIN 51502 merely describes how fluids are classified / designated on a national level. – It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids standardized according to DIN 51502 can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see Table 4: "Hydraulic fluid classification".
4	Hydraulic fluids with classification HH, HL, HM, HR, HV, HS, HG according to ISO 6743-4	– ISO 6743-4 merely describes how fluids are classified / designated on an international level. It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids standardized according to ISO 6743 -4 can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see table 4: "Classification and fields of application".
5	Lubricants and regulator fluids for turbines to DIN 51515-1 and -2	– Turbine oils can be used after confirmation and with limited performance data. – They usually offer lower wear protection than mineral oil HLP. Classification of turbine oils to DIN 51515-1 comparable to HL, turbine oils to DIN 51515-2 comparable to HLP. – Particular attention must be paid to material compatibility!
6	Lube oils C, CL, CLP in accordance with DIN 51517	– Lube oils in acc. with DIN 51517 can be used after confirmation and with limited performance data. They are mostly higher-viscosity fluids with low wear protection. Classification: CL similar to HL fluids and CLP similar to HLP fluids. – Particular attention must be paid to material compatibility, specifically with non-ferrous metals!
7	Fluids to be used in pharmaceutical and foodstuff industries, in acc. with FDA / USDA / NSF H1	– There are medical white oils and synthetic hydrocarbons (PAO). – Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – May be used only with FKM seals. – Other fluids used in pharmaceutical and foodstuff industries may be used only after confirmation. – Attention is to be paid to material compatibility in accordance with the applicable food law. **Caution!** Fluids used in pharmaceutical and foodstuff industries should not be confused with environmentally acceptable fluids!

Continued on page 13

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons
(continued from page 12)

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
8	Hydraulic fluids of classes HVLP and HVLPD based on related hydrocarbons	– Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – Lower pour point than HLP – Other wetting (polarity)
9	Automatic Transmission Fluids (ATF)	– ATF are operating fluids for automatic gearboxes in vehicles and machines. In special cases, ATFs are also used for certain synchronous gearboxes and hydraulic systems comprising gearboxes. – To be used only after confirmation! – Some of these fluids have poor air separation abilities and modified wear properties. – Check material compatibility and filterability!
10	Multi-purpose oil (MFO) – Industry	– Multi-purpose oils (industry) combine at least two requirements for a fluid, for instance metal machining and hydraulics. – To be used only after confirmation! – Please pay particular attention to air separation ability, modified wear properties and the reduced material life cycle. – Check material compatibility and filterability!
11	Multi-purpose oils (MFO) – Mobil UTTO, STOU	– Multi-purpose oils combine requirements for wet brakes, gearboxes, motor oil (STOU only) and hydraulics. – Fluids of the types: – UTTO (= universal tractor transmission oil) and – STOU (= Super Tractor super tractor universal oil) – To be used only after confirmation! – Please pay particular attention to shear stability, air separation ability and modified wear properties. – Check material compatibility and filterability!
12	Single-grade engine oils 10W, 20W, 30W	– To be used only after confirmation! – Please pay particular attention to the air separation ability and filtering ability.
13	Multi-grade engine oils 0Wx-30Wx	– To be used only after confirmation! – Please pay particular attention to air separation ability, changes in wear protection capability, viscosity changes during operation, material compatibility, dispersant and detergent properties and filterability. **Caution!** Multi-grade engine oils have been adapted to specific requirements in combustion engines and are suitable for use in hydraulic systems only to a limited extent.
14	Hydraulic fluids for military applications to MIL 13919 or H 540, MIL 46170 or H 544, MIL 5606 or H 515, MIL 83282 or H 537, MIL 87257	– To be used only after confirmation! – Please pay particular attention to air separation ability, changes in wear protection capability, viscosity changes during operation, material compatibility, water separation capability and filterability. **Caution!** Hydraulic fluids for military applications do not meet the current requirements for high-quality hydraulic fluids and are suitable for use only to a limited degree.
15	Motor vehicle transmission oils	– Motor vehicle transmission oil can be used after confirmation and with limited performance data. – Pay particular attention to wear protection, material compatibility, specifically with non-ferrous metals, as well as viscosity!

Continued on page 14

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons
(continued from page 13)

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
16	Diesel, test diesel in acc. with DIN 4113	– Diesel / test diesel has poorer wear protection capabilities and a very low viscosity ($< 3\ mm^2/s$). – May be used only with FKM seals – Please note their low flash point! – To be used only after confirmation and with limited performance data!
17	Hydraulic fluids for roller processes	– Hydraulic fluids for roller processes have lower wear protection capabilities than mineral oil HLP and a lower viscosity – Please note their low flash point! – Hydraulic fluids for roller processes with limited performance data can be used only after confirmation.
18	Fluids for power steering, hydro-pneumatic suspension, active chassis etc.	– Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – Please note the low viscosity! – In most cases they have poor water separation capability – Check the material compatibility!

7 Glossary

Additivation
Additives are chemical substances added to the basic fluids to achieve or improve specific properties.

Aging
Hydraulic fluids age due to oxidation (see chapter 3.1.5 "Aging resistance"). Liquid and solid contamination acts as a catalyzer for aging, meaning that it needs to be minimized as far as possible by careful filtration.

API classification
Classification of basic fluids by the **A**merican **P**etroleum **I**nstitute (API) – the largest association representing the US oil and gas industry.

Arrhenius equation
The quantitative relation between reaction rate and temperature is described by an exponential function, the Arrhenius equation. This function is usually visualized within the typical temperature range of the hydraulic system. For a practical example, see chapter 3.1.5 "Aging resistance".

Related hydrocarbons
Related hydrocarbons are hydrocarbon compounds that are not classified as API class 1, 2 or 5.

Basic fluids
In general, a hydraulic fluid is made up of a basic fluid, or base oil, and chemical substances, the so-called additives. The proportion of basic fluid is generally greater than 90%.

Demulsifying
Ability of a fluid to separate water contamination quickly; achieved with careful selection of base oil and additives.

Detergent
Ability of certain additives to emulsify part of the water contamination in the oil or to hold it in suspension until it has evaporated with increasing temperature. Larger water quantities, in contrast (above approx. 2 %), are separated immediately.

Dispersant
Ability of certain additives to keep insoluble liquid and solid contamination in suspension in the fluid.

Diesel effect
If hydraulic fluid that contains air bubbles is compressed quickly, the bubbles are heated to such a degree that a self-ignition of the air-gas mix may occur. The resultant temperature increase may lead to seal damage and increased aging of the hydraulic fluid.

Hydraulic fluids based on mineral oils
Hydraulic fluids based on mineral oils are made from petroleum (crude oil).

ICP (atomic emission spectroscopy)
The ICP procedure can be used to determine various wear metals, contamination types and additives. Practically all elements in the periodic system can be detected with this method.

Karl Fischer method
Method to determine the water content in fluids. Indirect coulometric determination procedure in accordance with DIN EN ISO 12937 in connection with DIN 51777-2. Only the combination of both standards will assure adequately accurate measured values.

Cavitation
Cavitation is the creation of cavities in fluids due to pressure reduction below the saturated vapour pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures and pressure may occur temporarily, which may damage the component surfaces.

Neutralization number (NN)
The neutralization number (NN) or acid number (AN) specifies the amount of caustic potash required to neutralize the acid contained in one gram of fluid.

Pour point
The lowest temperature at which the fluid still just flows when cooled down under set conditions. The pour point is specified in the lubricant manufacturers' technical data sheets as a reference value for achieving this flow limit.

RFA (wavelength dispersive x-ray fluorescence analysis)
Is a procedure to determine nearly all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast results.

Shearing/shear loss
Shearing of molecule chains during operation can change the viscosity of hydraulic fluids with long chain VI enhancers. The initially high viscosity index drops. This needs to be taken into account when selecting the hydraulic fluid.

The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part -6. Please note that there are practical applications that create a much higher shear load on such hydraulic fluids than can be achieved by this test.

Stick-slip effect (sliding)
Interaction between a resilient mass system involving friction (such as cylinder + oil column + load) and the pressure increase at very low sliding speeds. The static friction of the system is a decisive value here. The lower it is, the lower the speed that can still be maintained without sticking. Depending on the tribologic system, the stick-slip effect may lead to vibrations generated and sometimes also to significant noise emission. In many cases, the effect can be attenuated by replacing the lubricant.

Viscosity
Viscosity is the measure of the internal friction of a fluid to flow. It is defined as the property of a substance to flow under tension. Viscosity is the most important characteristic for describing the load-bearing capacity of a hydraulic fluid.

Kinematic viscosity is the ratio of the dynamic viscosity and the density of the fluid; the unit is mm^2/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

Viscosity index (VI)
Refers to the viscosity temperature behavior of a fluid.
The lower the change of viscosity in relation the temperature, the higher the VI.

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No statements concerning the suitability of a hydraulic fluid for a specific purpose can be derived from our information. The information given does not release the user from the obligation of own judgment and verification.

It must be remembered that our products are subject to a natural process of wear and aging.

Subject to change.

Rexroth
Bosch Group

Environmentally acceptable hydraulic fluids

RE 90221/05.12 1/14
Replaces: 05.10

Application notes and requirements for Rexroth hydraulic components

Hydraulic fluids

Title	Hydraulic fluids based on mineral oils and related hydrocarbons	**Environmentally acceptable hydraulic fluids**	Fire-resistant, water-free hydraulic fluids	Fire-resistant, water-containing hydraulic fluids
Standard	DIN 51524	**ISO 15380**	ISO 12922	ISO 12922
Data sheets	RE 90220	**RE 90221**	RE 90222	RE 90223 (in preparation)
Classification	HL HLP HLPD HVLP HLPD and more	**HEPG HEES partially saturated HEES saturated HEPR HETG**	HFDR HFDU (ester base) HFDU (glycol base) and more	HFC HFB HFAE HFAS

Contents

1 Basic information

1.1 General instructions

The hydraulic fluid is the common element in any hydraulic component and must be selected very carefully. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency and service life of a system.

Hydraulic fluids must conform, be selected and used in accordance with the generally acknowledged rules of technology and safety provisions. Reference is made to the country-specific standards and directives (in Germany the directive of the Employer's Liability Insurance Association BGR 137).

This data sheet includes recommendations and regulations concerning the selection, operation and disposal of environmentally compatible hydraulic fluids in the application of Rexroth hydraulic components.

The individual selection of hydraulic fluid or the choice of classification are the responsibility of the operator.

It is the responsibility of the user to ensure that appropriate measures are taken for safety and health protection and to ensure compliance with statutory regulations. The recommendations of the lubricant manufacturer and the specifications given in the safety data sheet are to be observed when using hydraulic fluid.

This data sheet does not absolve the operator from verifying the conformity and suitability of the respective hydraulic fluid for his system. He is to ensure that the selected fluid meets the minimum requirements of the relevant fluid standard during the whole of the period of use.

Other regulations and legal provisions may also apply. The operator is responsible for their observance, e.g. EU directive 2004/35/EG, 2005/360/EG and their national implementation. In Germany the Water Resources Act (WHG) is also to be observed.

We recommend that you maintain constant, close contact with lubricant manufacturers to support you in the selection, maintenance, care and analyses.

When disposing of used hydraulic fluids, apply the same care as during use.

Environmentally acceptable hydraulic fluids have been used successfully for many years. In some countries, the use of environmentally acceptable hydraulic fluids is already prescribed in ecologically sensitive areas (e.g. forestry, locks, weirs).

Environmentally acceptable hydraulic fluids may only be used in the pharmaceutical and food industry subject to required certification to FDA/USDA/NSF **H1**.

1.2 Environmental compatibility

There is no unambiguous legal definition for environmentally acceptable hydraulic fluids as different testing procedures can be applied for biological degradation and toxicity.

According to ISO 15380 the definition of "environmentally acceptable" is as follows: Humans, animals, plants, air and soil must not be endangered. With regard to hydraulic fluids in an unused condition in the bin this mainly means:

– biological degradation at least 60 % (according to ISO 14593 or ISO 9439)
– acute fish toxicity at least 100 mg/l (according to ISO 7346-2)
– acute daphnia toxicity at least 100 mg/l (according to ISO 5341)
– acute bacteria toxicity at least 100 mg/l (according to ISO 8192)

The same amount of care should be taken when handling environmentally acceptable hydraulic fluids as for mineral oils, leakage from the hydraulic system should be avoided. Environmentally acceptable hydraulic fluids are designed so that in the event of accidents and leakage,less permanent environmental damage is caused than by mineral oils, see also chapter 5 "Disposal and environmental protection".

In comparison to mineral oil HLP/HVLP , the biological degradation of environmentally acceptable hydraulic fluids may change fluid aging, see chapter 3.1.5 "Aging resistance", 3.1.6. "Biological degradation" and 4 "Hydraulic fluids in operation".

1

1.3 Scope

This data sheet must be applied when using environmentally acceptable hydraulic fluids with Rexroth hydraulic components. The specifications of this data sheet may be further restricted by the specification given in the data sheets for the individual components.

The use of the individual environmentally acceptable hydraulic fluids in accordance with the intended purpose can be found in the safety data sheets or other product description documents of the lubricant manufacturers. In addition, each use is to be individually considered.

Rexroth hydraulic components may only be operated with environmentally acceptable hydraulic fluids according to ISO 15380 if specified in the respective component data sheet or if a Rexroth approval for use is furnished.

The manufacturers of hydraulic systems must adjust their systems and operating instructions to the environmentally acceptable hydraulic fluids.

Notes:
In the market overview RE 90221-01, environmentally acceptable hydraulic fluids based on mineral oil are described which, according to the information of the lubricant manufacturer, feature the respective parameters of the current requirements standard ISO 15380 and other parameters which are of relevance for suitability in connection with Rexroth components.

These specifications are not checked or monitored by Bosch Rexroth. The list in the market overview does not therefore represent a recommendation on the part of Rexroth or approval of the respective hydraulic fluid for use with Rexroth components and does not release the operator from his responsibility regarding selection of the hydraulic fluid.

Bosch Rexroth will accept no liability for its components for any damage resulting from failure to comply with the notes below.

1.4 Safety instructions

Hydraulic fluids can constitute a risk for persons and the environment. These risks are described in the hydraulic fluid safety data sheets. The operator is to ensure that a current safety data sheet for the hydraulic fluid used is available and that the measures stipulated therein are complied with.

2 Solid particle contamination and cleanliness levels

Solid particle contamination is the major reason for faults occurring in hydraulic systems. It may lead to a number of effects in the hydraulic system. Firstly, single large solid particles may lead directly to a system malfunction, and secondly small particles cause continuous elevated wear.

For mineral oils, the cleanliness level of environmentally acceptable hydraulic fluids is given as a three-digit numerical code in accordance with ISO 4406. This numerical code denotes the number of particles present in a hydraulic fluid for a defined quantity. Moreover, foreign solid matter is not to exceed a mass of 50 mg/kg (gravimetric examination according to ISO 4405).

In general, compliance with a minimum cleanliness level of 20/18/15 in accordance with ISO 4406 or better is to be maintained in operation. Special servo valves demand improved cleanliness levels of at least 18/16/13. A reduction in cleanliness level by one level means half of the quantity of particles and thus greater cleanliness. Lower numbers in cleanliness levels should always be striven for and extend the service life of hydraulic components. The component with the highest cleanliness requirements determines the required cleanliness of the overall system. Please also observe the specifications in table 1: "Cleanliness levels according to ISO 4406" and in the respective data sheets of the various hydraulic components.

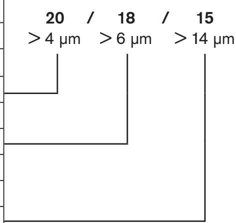
Hydraulic fluids frequently fail to meet these cleanliness requirements on delivery. Careful filtering is therefore required during operation and in particular, during filling in order to ensure the required cleanliness levels. Your lubricant manufacturer can tell you the cleanliness level of hydraulic fluids as delivered. To maintain the required cleanliness level over the operating period, you must use a reservoir breather filter. If the environment is humid, take appropriate measures, such as a breather filter with air drying or permanent off-line water separation.

Note: the specifications of the lubricant manufacturer relating to cleanliness levels are based on the time at which the container concerned is filled and not on the conditions during transport and storage.

Further information about contamination with solid matter and cleanliness levels can be found in brochure RE 08016.

Table 1: Cleanliness levels according to ISO 4406

Particles per 100 ml		Scale number
More than	Up to and including	
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64000	130,000	17
32000	64000	16
16000	32000	15
8000	16000	14
4000	8000	13
2000	4000	12
1000	2000	11
500	1000	10
250	500	9
130	250	8
64	130	7
32	64	6



3 Selection of the hydraulic fluid

Environmentally acceptable hydraulic fluids for Bosch Rexroth hydraulic components are assessed on the basis of their fulfillment of the minimum requirements of ISO 15380.

3.1 Selection criteria for the hydraulic fluid

The specified limit values for all components employed in the hydraulic system, for example viscosity and cleanliness level, must be observed with the hydraulic fluid used, taking into account the specified operating conditions.

Hydraulic fluid suitability depends, amongst others, on the following factors:

3.1.1 Viscosity

Viscosity is a basic property of hydraulic fluids. The permissible viscosity range of complete systems needs to be determined taking account of the permissible viscosity of all components and it is to be observed for each individual component.

The viscosity at operating temperature determines the response characteristics of closed control loops, stability and damping of systems, the efficiency factor and the degree of wear.

We recommend that the optimum operating viscosity range of each component be kept within the permissible temperature range. This usually requires either cooling or heating, or both. The permissible viscosity range and the necessary cleanliness level can be found in the product data sheet for the component concerned.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. In return, there will be lower internal leakage losses. If the pressure level is lower, lubrication gaps may not be filled up, which can lead to increased wear. For hydraulic pumps, the permitted suction pressure may not be reached, which may lead to cavitation damage.

If the viscosity of a hydraulic fluid is below the permitted operating viscosity, increased leakage, wear, susceptibility to contamination and a shorter life cycle will result.

Please ensure that the permissible temperature and viscosity limits are observed for the respective components. This usually requires either cooling or heating, or both.

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3.1.2 Viscosity-temperature behavior

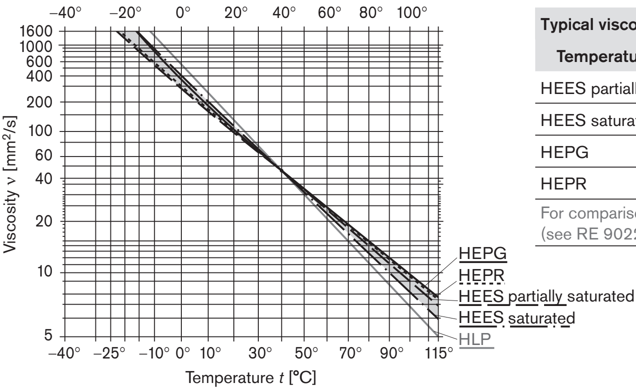
For hydraulic fluids, the viscosity temperature behavior (V-T behavior) is of particular importance. Viscosity is characterized in that it drops when the temperature increases and rises when the temperature drops. The interrelation between viscosity and temperature is described by the viscosity index (VI).

If exposed to the cold for several days, viscosity may rise significantly (HETG and HEES). After heating, the characteristic values as specified on the data sheet are restored. Please ask your lubricant manufacturer for the " Flow capacity after 7 days at low temperature" (ASTM D 2532) of fluid classifications HETG and partially saturated HEES.

All known environmentally acceptable hydraulic fluids have better viscosity temperature behavior than mineral oil HLP and generally feature greater shear stability than HVLP mineral oils. This should be taken into consideration when selecting hydraulic fluid for the required temperature range. A lower viscosity level can frequently be used to save any drive power during a cold start and avoid viscosity being too low at higher temperatures. The required viscosity and temperature limits in the product data sheets are to be observed in all operating conditions.

Depending on the basic fluid types/classes, VI indices can be achieved of 140–220, see Fig. 1: "Examples: V-T diagrams in comparison to HLP (reference values)" and Table 4: "Classification and fields of application of environmentally acceptable hydraulic fluids".

Fig. 1: Examples V-T diagrams in comparison to HLP (reference values, double-logarithmic representation)



Typical viscosity data [mm²/s]			
Temperature	–20 °C	40 °C	100 °C
HEES partially saturated	1250	46	9
HEES saturated	2500	46	8
HEPG	2500	46	10
HEPR	1400	46	10
For comparison HLP (see RE 90220)	4500	46	7

Detailed V-T diagrams may be obtained from your lubricant manufacturer for their specific products.

3.1.3 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components. The wear protection capability is described in ISO 15380 via test procedures"FZG gear test rig" (ISO 14635-1) and "Mechanical test in the vane pump" (ISO 20763). From ISO VG 32, ISO 15380 prescribes a rating of at least 10 (FZG test). At present, the FZG test cannot be applied to viscosity classes < ISO VG 32. The wear protection capability of environmentally acceptable hydraulic fluids in relation to the two test procedures is comparable to that of mineral oil HLP/HVLP.

3.1.4 Material compatibility

The hydraulic fluid must not negatively affect the materials used in the components. Compatibility with coatings, seals, hoses, metals and plastics is to be observed in particular. The fluid classifications specified in the respective component data sheets are tested by the manufacturer with regard to material compatibility. Parts and components not supplied by us are to be checked by the user.

Table 2: Known material incompatibilities

Classification	Incompatible with:
HE... general	One-component color coatings, lead, galvanized zinc coatings, some non-ferrous metals, seals made of NBR. In some cases, the latter show major increases in volume when impermissibly aged hydraulic fluids come into contact with the material. NBR is only permitted by prior consent, please observe the customary seal and tube replacement intervals. Do not use any hydrolysis/susceptible polyurethane qualities. **Note** Please check seals and coatings of control cabinets, outer coatings of hydraulic components and accessories (connectors, cables, control cabinets) for resistance to vapors issuing from hydraulic fluids.
HETG/HEES	Zinc, some non-ferrous alloys with zinc
HEPG	Steel/aluminum tribocontacts, paper filters, polymethylmethacrylate (PMMA), NBR **Note** Check plastics for resistance

The material incompatibilities mentioned here do not automatically result in function problems. However the elements of the materials are found in the hydraulic fluids after use. The biological degradation of hydraulic fluids is negatively influenced.

3.1.5 Aging resistance

The way an environmentally acceptable hydraulic fluids ages depends on the thermal, chemical and mechanical stress to which it is subjected. The influence of water, air, temperature and contamination may be significantly greater than for mineral oils HLP/HVLP. Aging resistance can be greatly influenced by the chemical composition of the hydraulic fluids .

High fluid temperatures (e.g. over 80 °C) result in a approximate halving of the fluid service life for every 10 °C temperature increase and should therefore by avoided. The halving of the fluid service life results from the application of the Arrhenius equation (see Glossary).

Table 3: Reference values for temperature-dependent aging of the hydraulic fluid

Reservoir temperature	Fluid life cycle
80 °C	100 %
90 °C	50 %
100 °C	25 %

A modified aging test (without adding water) is prescribed for fluid classifications HETG and HEES. Hydraulic fluids with HEPG and HEPR classification are subjected to the identical test procedure as mineral oils (with 20 % water added). The calculated fluid service life is derived from the results of tests in which the long-term characteristics are simulated in a short period of time by applying more arduous conditions (condensed testing). This calculated fluid service life is not to be equated to the fluid service life in real-life applications.

Table 3 is a practical indicator for hydraulic fluids with water content < 0.1%, cf. chapter 4.10. "Water".

3.1.6 Biological degradation

Environmentally acceptable hydraulic fluids are ones which degrade biologically much faster than mineral oils. Biological degradation is a biochemical transformation effected by micro-organisms resulting in mineralization. For environmentally acceptable hydraulic fluids that make reference to ISO 15380, biological degradation according to ISO 14593 or ISO 9439 must be verified. 60% minimum degradation is defined as limit value. Proof of biological degradation is furnished for the new, unmixed, ready-formulated hydraulic fluids. Aged or mixed hydraulic fluids are less able to degrade biologically. Biological degradation outside the defined test procedure is subject to a variety of natural influences. The key factors are temperature, humidity, contamination, fluid concentration, type and quantity of micro-organisms. Environmentally acceptable hydraulic fluids require no extended maintenance in comparison to mineral oils, please observe chapter 4 "Hydraulic fluids in operation".

3.1.7 Air separation ability (ASA)

The air separation ability (ASA) describes the property of a hydraulic fluid to separate undissolved air. Hydraulic fluids always contain dissolved air. During operation, dissolved air may be transformed into undissolved air, leading to cavitation damages. Fluid classification, fluid product, reservoir size and design must be coordinated to take into account the dwell time and ASA value of the hydraulic fluid. The air separation capacity depends on the viscosity, temperature, basic fluid and aging. It cannot be improved by additives.

According to ISO 15380, for instance, an ASA value ≤ 10 minutes is required for viscosity class ISO VG 46, 6 minutes are typical, lower values are preferable.

3.1.8 Demulsifying ability and water solubility

The capacity of a hydraulic fluid to separate water at a defined temperature is known as the demulsifying ability. ISO 6614 defines the demulsifying properties of hydraulic fluids.

Fluids classified HETG, HEES and HEPR separate from water. HETG and HEES hydraulic fluids have a different water separation ability to mineral oil HLP/HVLP. At 20 °C, in comparison to mineral oil HLP/HVLP, a multiple (> factor 3) of water can separate in the hydraulic fluid. Water solubility is also more temperature-dependent than for mineral oils. With regard to water solubility, HEPR hydraulic fluids behave like HVLP hydraulic fluids (see RE 90220). In the majority of cases, HEPG-classified fluids HEPG dissolve water completely , see chapter "4.10 Water".

3.1.9 Filterability

Filterability describes the ability of a hydraulic fluid to pass through a filter, removing solid contaminants. The hydraulic fluids used require a good filterability, not just when new, but also during the whole of their service life. Depending on the different basic fluids (glycols, saturated and partially saturated ester oils, hydrocrack oils, polyalpha olefins, triglycerides) and additives (VI enhancers), there are great differences here.

The filterability is a basic prerequisite for cleanliness, servicing and filtration of hydraulic fluids. Rexroth therefore requires the same degree of filterability of environmentally acceptable hydraulic fluids as for mineral oils HLP/HVLP to DIN 51524. As ISO 15380 does not comment on the filterability of hydraulic fluids, filterability comparable to that of mineral oils HLP/HVLP must be requested of lubricant manufacturers.

Filterability is tested with the new hydraulic fluid and after the addition of 0.2 % water. The underlying standard (ISO 13357-1/-2) stipulates that filterability must have no negative effects on the filters or the hydraulic fluid, see chapter 4 "Hydraulic fluids in operation".

3.1.10 Corrosion protection

Hydraulic fluids should not just prevent corrosion formation on steel components, they must also be compatible with non-ferrous metals and alloys. Corrosion protection tests on different metals and metal alloys are described in ISO 15380. Hydraulic fluids that are not compatible with the materials listed above must not be used, even if they are compliant with ISO 15380.

Rexroth components are usually tested with HLP hydraulic fluids or corrosion protection oils based on mineral oils before they are delivered.

3.1.11 Additivation

The properties described above can be modified with the help of suitable additives. Environmentally acceptable hydraulic fluids should never contain heavy metals. According to the present state of knowledge, all hydraulic fluids, regardless of additivation, can be filtered with all customary filter materials in all known filtration ratings (≥ 0.8 μm), without filtering out effective additives at the same time.

Bosch Rexroth does not prescribe any specific additive system.

3.2 Classification and fields of application

Table 4: Classification and fields of application

Classification	Features	Typical field of application	Notes
HEPG according to ISO 15380 Density at 15 °C: typically > 0.97 kg/dm³ VI: typical > 170	Basic fluid, glycols	Systems on exposed water courses (locks, weirs, dredgers)	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Very good viscosity/temperature characteristics, shear stability – Resistant to aging – Incompatible with mineral oil (exceptions must be confirmed by the lubricant manufacturer) – Can be water-soluble – Can be mixed with water – Very good wear protection properties – A higher implementation temperature with the same viscosity in comparison to mineral oil is to be expected – Due to the higher density in comparison to HLP, lower suction pressures are to be anticipated for pumps. Reduce the maximum speed as required and optimize suction conditions. – Classified as insignificantly water-endangering (water hazard class WGK 1) – Prior to commissioning, contact the lubricant manufacturer, as the components are tested with mineral oil HLP/corrosion protection oil.
HEES partially saturated according to ISO 15380 Density at 15 °C: typically 0.90–0.93 kg/dm³ VI: typical > 160 Iodine count < 90	Basic fluid: Ester based on renewable raw materials, synthetic esters, mixtures of various esters, mixtures with polyalphaolefines (< 30%)	Suitable for most fields of application and components.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Preferred use of FKM seals. Please enquire for shaft seal rings and implementation temperatures under –15 °C. – In operation, a higher temperature in comparison to mineral oil HLP/HVLP is to be expected given identical design and viscosity – Limit lower (depending on viscosity class) and upper implementation temperatures (maximum 80 °C due to aging) – Good viscosity/temperature characteristics, shear stability. – Good corrosion protection, if correspondingly additivized – Mostly classed as insignificantly water-endangering (water hazard class WGK 1), in some cases as not water-endangering – High dirt dissolving capacity on fluid changeovers – In unfavorable operating conditions (high water content, high temperature), HEES on ester basis have a tendency to hydrolysis. The acidic organic decomposition products can chemically attack materials and components.

Continued on page 9

Table 4: Classification and fields of application (continued from page 8)

Classification	Features	Typical field of application	Notes
HEES saturated according to ISO 15380 Density at 15 °C: typically 0.90–0.93 kg/dm³ VI: typical 140–160 Iodine count <15	Basic fluid: Ester based on renewable raw materials, synthetic esters, mixtures of various esters, mixtures with polyalphaolefines (< 30%)	Suitable for most fields of application and components. Saturated HEES should be preferred over partially saturated HEES and HETG for components and systems exposed to high stress levels.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Preferred use of FKM seals. Please enquire for shaft seal rings and implementation temperatures under –15 °C. – In operation, a higher temperature in comparison to mineral oil HLP/HVLP is to be expected given identical design and viscosity – Good viscosity/temperature characteristics, shear stability – Good corrosion protection, if correspondingly additivized – Mostly classed as insignificantly water-endangering (water hazard class WGK 1), in the case of low viscosity classes (up to ISO VG 32) also classed as not water-endangering – High dirt dissolving capacity on fluid changeovers
HEPR according to ISO 15380 Density at 15 °C: typically 0.87 kg/dm³ VI : typical 140–160	Basic fluid: synthetically manufactured hydrocarbons (polyalpha olefins PAO) partly mixed with esters (< 30 %)	Suitable for most fields of application and components. HEPR should be preferred over partially saturated HEES and HETG for components and systems exposed to high stress levels.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Behaves similarly to HVLP- hydraulic fluids, individual products comply with ISO 15380 HEPR and DIN 51524-3 HVLP – Preferred use of FKM seals. Please enquire for shaft seal rings and implementation temperatures under –15 °C. – Good viscosity-temperature behavior – Classified as insignificantly water-endangering (water hazard class WGK 1) **Note:** Note shear stability (see chapter 4.11 "Fluid servicing, fluid analysis and filtration" and chapter 6 "Glossary")
HETG according to ISO 15380 Density at 15 °C: typically 0.90-0.93 kg/dm³ VI: typical > 200 Iodine count > 90	Basic fluid: vegetable oils and triglycerides	Not recommended for Rexroth components!	Practical requirements are frequently not fulfilled by hydraulic fluids in this classification. Use only permissible after consultation. – Viscosity is not stable over time – Very fast fluid aging, very hydrolysis-susceptible (please observe neutralization number) – Tendency to gumming, gelling and setting. – Limit the lower (depending on viscosity class) and upper implementation temperatures (see chapter 3.1.5) – Only limited material compatibility – Filterability problems at water ingress – High dirt dissolving capacity on fluid changeovers – Mostly classed as not water-endangering

4 Hydraulic fluids in operation

4.1 General

The properties of hydraulic fluids can change continually during storage and operation.

Please note that the fluid standard ISO 15380 merely describes minimum requirements for hydraulic fluids in new condition at the time of filling into the bins. The operator of a hydraulic system must ensure that the hydraulic fluid remains in a utilizable condition throughout its entire period of use.

Deviations from the characteristic values are to be clarified with the lubricant manufacturer, the test labs or Bosch Rexroth.

Bosch Rexroth will accept no liability for damage to its components within the framework of the applicable liability legislation insofar as the latter is due to non-observance of the following instructions.

Please note the following aspects in operation.

4.2 Storage and handling

Hydraulic fluids must be stored correctly in accordance with the instructions of the lubricant manufacturer. Avoid exposing the containers to lengthy periods of direct heat. Containers are to be stored in such a way that the risk of any foreign liquid or solid matter (e.g. water, foreign fluids or dust) ingression into the inside of the container can be ruled out. After taking hydraulic fluids from the containers, these are immediately to be properly resealed.

Recommendation:

– Store containers in a dry, roofed place

– Store barrels on their sides

– Clean reservoir systems and machine reservoirs regularly

4.3 Filling of new systems

Usually, the cleanliness levels of the hydraulic fluids as delivered do not meet the requirements of our components. Hydraulic fluids must be filtered using an appropriate filter system to minimize solid particle contamination and water in the system.

As early as possible during test operation, new systems should be filled with the selected hydraulic fluid so as to reduce the risk of accidentally mixing fluids (see chapter 4.5 "Mixing and compatibility of different hydraulic fluids"). Changing the hydraulic medium at a later point represents significant additional costs (see following chapter).

4.4 Hydraulic fluid changeover

In particular with the changeover from mineral oils to environmentally acceptable hydraulic fluids, but also from one environmentally acceptable hydraulic fluids to another, there may be interference (e.g. incompatibility in the form of gelling, silting, stable foam or reduced filterability or filter blockage).

In the case of changeovers of the fluid in hydraulic systems, it is important to ensure compatibility of the new hydraulic fluid with the remains of the previous hydraulic fluid. Bosch Rexroth recommends obtaining verification of compatibility from the manufacturer or supplier of the new hydraulic fluid. The quantity of old fluid remaining should be minimized. Mixing hydraulic fluids should be avoided, see following chapter.

For information on changing over hydraulic fluids with different classifications, please refer to VDMA 24314, VDMA 24569 and ISO 15380 appendix A.

Bosch Rexroth will not accept liability for any damage to its components resulting from inadequate hydraulic fluid changeovers!

4.5 Mixing and compatibility of different hydraulic fluids

If hydraulic fluids from different manufacturers or different types from the same manufacturer are mixed, gelling, silting and deposits may occur. These, in turn, may cause foaming, impaired air separation ability, malfunctions and damage to the hydraulic system.

If the fluid contains more than 2 % of another fluid then it is considered to be a mixture. Exceptions apply for water, see chapter 4.10 "Water".

Mixing with other hydraulic fluids is not generally permitted. This also includes hydraulic fluids with the same classification and from the market overview RE 90221-01. If individual lubricant manufacturers advertise miscibility and/or compatibility, this is entirely the responsibility of the lubricant manufacturer.

Bosch Rexroth customarily tests all components with mineral oil HLP before they are delivered.

Note: With connectible accessory units and mobile filtering systems, there is a considerable risk of non-permitted mixing of the hydraulic fluids!

Rexroth will not accept liability for any damage to its components resulting from mixing hydraulic fluids!

4.6 Re-additivation

Additives added at a later point in time such as colors, wear reducers, VI enhancers or anti-foam additives, may negatively affect the performance properties of the hydraulic fluid and the compatibility with our components and therefore are not permissible.

Rexroth will not accept liability for any damage to its components resulting from re-additivation!

4.7 Foaming behavior

Foam is created by rising air bubbles at the surface of hydraulic fluids in the reservoir. Foam that develops should collapse as quickly as possible.

Common hydraulic fluids in accordance with ISO 15380 are sufficiently inhibited against foam formation in new condition. On account of aging and adsorption onto surfaces, the defoamer concentration may decrease over time, leading to a stable foam.

Defoamers may be re-dosed only after consultation with the lubricant manufacturer and with his written approval.

Defoamers may affect the air separation ability.

4.8 Corrosion

The hydraulic fluid is to guarantee sufficient corrosion protection of components under all operating conditions, even in the event of impermissible water contamination.

Environmentally acceptable hydraulic fluids are tested for corrosion protection in the same way as mineral oil HLP/HVLP. When used in practice other corrosion mechanisms are revealed in detail and in individual cases, for the most part in contact with non-ferrous and white alloys.

4.9 Air

Under atmospheric conditions the hydraulic fluid contains dissolved air. In the negative pressure range, for instance in the suction pipe of the pump or downstream of control edges, this dissolved air may transform into undissolved air. The undissolved air content represents a risk of cavitation and of the diesel effect. This results in material erosion of components and increased hydraulic fluid aging.

With the correct measures, such as suction pipe and reservoir design, and an appropriate hydraulic fluid, air intake and separation can be positively influenced.

See also chapter 3.1.7 "Air separation ability (ASA)".

4.10 Water

Water contamination in hydraulic fluids can result from direct ingress or indirectly through condensation of water from the air due to temperature variations.

HEPG dissolves water completely. This means that any water that has ingressed into the system cannot be drained off in the sump of the reservoir.

In the case of hydraulic fluids classed HETG, HEES and HEPR undissolved water can be drained off from the reservoir sump, the remaining water content is however too high to ensure that the maximum permissible water limit values are observed in the long term.

Water in the hydraulic fluid can result in wear or direct failure of hydraulic components. Furthermore, a high water content in the hydraulic fluid negatively affects aging and filterability and increases susceptibility to cavitation. During operation, the water content in all hydraulic fluids, determined according to the "Karl Fischer method" (see chapter 6 "Glossary") for all environmentally acceptable hydraulic fluids must constantly be kept below 0.1% (1000 ppm). To ensure a long service life of both hydraulic fluids and components, Bosch Rexroth recommends that values below 0.05% (500 ppm) are permanently maintained.

Due to the higher water solubility (except for HEPR) in comparison to mineral oil HLP/HVLP it is urgently advised that precautions be taken when using environmentally acceptable hydraulic fluids, such as a dehumidifier on the reservoir ventilation.

Water content has an affect particularly in the case of HETG and partially saturated HEES in that it accelerates aging (hydrolysis) of the hydraulic fluid and biological degradation, see chapter 4.11 "Fluid servicing, fluid analysis and filtration".

4.11 Fluid servicing, fluid analysis and filtration

Air, water, operating temperature influences and solid matter contamination will change the performance characteristics of hydraulic fluids and cause them to age.

To preserve the usage properties and ensure a long service life for hydraulic fluid and components, the monitoring of the fluid condition and a filtration adapted to the application requirements (draining and degassing if required) are indispensable.

The effort is higher in the case of unfavorable usage conditions, increased stress for the hydraulic system or high expectations as to availability and service life, see chapter 2 "Solid particle contamination and cleanliness levels".

When commissioning a system, please note that the required minimum cleanliness level can frequently be attained only by flushing the system. Due to severe start-up contamination, it may be possible that a fluid and/or filter replacement becomes necessary after a short operating period ($<$ 50 operating hours).

The hydraulic fluid must be replaced at regular intervals and tested by the lubricant manufacturer or recognized accredited test labs. **We recommend a reference analysis after commissioning.**

The minimum data to be tested for analyses are:

- Viscosity at 40 °C and 100 °C
- Neutralization number NN (acid number AN)
- Water content (Karl-Fischer method)
- Particle measurement with evaluation according to ISO 4406 or mass of solid foreign substances with evaluation to EN 12662
- Element analysis (RFA (EDX) / ICP, specify test method)
- Comparison with new product or available trend analyses
- Assessment / evaluation for further use
- Also recommended: IR spectrum"

Differences in the maintenance and upkeep of environmentally acceptable hydraulic fluids with the corresponding suitability characteristics (as required in market overview RE 90221-01) in comparison to mineral oil HLP/HVLP are not necessary. Attention is however drawn to the note in chapter 1.3.

After changing over hydraulic fluids it is recommended that the filters be replaced again after 50 operating hours as fluid aging products may have detached themselves ("self-cleaning effect").

Compared to the pure unused hydraulic fluid the changed neutralization number NN (acid number AN) indicates how many aging products are contained in the hydraulic fluid. This difference must be kept as low as possible. As soon as the trend analysis notes a significant increase in the values, the lubricant manufacturer should be contacted.

A higher viscosity than that of new materials indicates that the hydraulic fluid has aged. Evaluation by the test lab or lubricant manufacturers is however authoritative, whose recommendation should be urgently observed.

On systems where the possibility of water contamination cannot be completely ruled out (also condensation), it should be ensured via the hydraulic system circuit that fluid aging products are not accumulating in individual areas of the hydraulic system, but are being removed from the system in a controlled manner via the filtration system. This should be ensured via suitable hydraulic circuits (e.g. flushing circuit) or system manufacturer's operating instructions/specifications.

In case of warranty, liability or guarantee claims to Bosch Rexroth, service verification and/or the results of fluid analyses are to be provided.

5 Disposal and environmental protection

All environmentally acceptable hydraulic fluids, are like mineral oil-based hydraulic fluids, subject to special disposal obligations.

The respective lubricant manufacturers provide specifications on environmentally acceptable handling and storage. Please ensure that spilt or splashed fluids are absorbed with appropriate adsorbents or by a technique that prevents it contaminating water courses, the ground or sewerage systems.

It is also not permitted to mix fluids when disposing of hydraulic fluids. Regulations governing the handing of used oils stipulate that used oils are not to mixed with other products, e.g. substances containing halogen. Non-compliance will increase disposal costs. Comply with the national legal provisions concerning the disposal of the corresponding hydraulic fluid. Comply with the local safety data sheet of the lubricant manufacturer for the country concerned.

6 Glossary

Additivation
Additives are chemical substances added to the basic fluids to achieve or improve specific properties.

Aging
Hydraulic fluids age due to oxidation (see chapter 3.1.5 "Aging resistance"). Liquid and solid contamination acts as a catalyzer for aging, meaning that it needs to be minimized as far as possible by careful filtration. Please refer to Hydrolysis.

Arrhenius equation
The quantitative relation between reaction rate and temperature is described by an exponential function, the Arrhenius equation. This function is usually visualized within the typical temperature range of the hydraulic system. For a practical example, see chapter 3.1.5 "Aging resistance".

Basic fluids
In general, a hydraulic fluid is made up of a basic fluid, or base oil, and chemical substances, the so-called additives. The proportion of basic fluid is generally greater than 90%.

Diesel effect
If hydraulic fluid that contains air bubbles is compressed quickly, the bubbles are heated to such a degree that a self-ignition of the air-gas mix may occur. The resultant temperature increase may lead to seal damage and increased aging of the hydraulic fluid.

Saturated esters
Esters differ by the number of C atoms (chain length) and position of the bonds between the C atoms. Saturated esters do not have double/multiple bonds between C atoms and are therefore more resistant to aging than partially saturated esters.

Partially saturated esters
In contrast to saturated esters, partially saturated esters have double/multiple bonds between C atoms. Rexroth defines partially saturated esters as unsaturated bonds and mixtures of esters with unsaturated and saturated bonds. Esters with unsaturated bonds are produced on the basis of renewable raw materials.

Depending on their number and position, these unsaturated bonds between the C atoms are instable. These bonds can detach themselves and form new bonds, thus changing the properties of those liquids (an aging mechanism). One of the underlying requirements for inclusion in the market overview RE 90221-01 is an aging stability characteristic. Attention is however drawn to the note in chapter 1.3.

Hydrolysis
Hydrolysis is the splitting of a chemical bond through the reaction with water under the influence of temperature.

ICP (atomic emission spectroscopy)
The ICP procedure can be used to determine various wear metals, contamination types and additives. Practically all elements in the periodic system can be detected with this method..

Iodine count
The iodine count is a yardstick for the quantity of single and multiple unsaturated bonds between C atoms in the basic fluid. A low iodine count indicates that the hydraulic fluid contains few unsaturated bonds and is thus considerably more resistant to aging than a hydraulic fluid with a high iodine count. A statement about the position at which these multiple bonds are located and about how "stable" they are against influencing factors cannot be derived simply by stating the iodine count.

Karl Fischer method
Method to determine the water content in fluids. Indirect coulometric determination procedure in accordance with DIN EN ISO 12937 in connection with DIN 51777-2. Only the combination of both standards will assure adequately accurate measured values. For hydraulic fluids based on glycol, DIN EN ISO 12937 is to be applied in conjunction with DIN 51777-1.

Cavitation
Cavitation is the creation of cavities in fluids due to pressure reduction below the saturated vapour pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures and pressure may occur temporarily, which may damage the component surfaces.

Neutralization number (NN)
The neutralization number (NN) or acid number (AN) specifies the amount of caustic potash required to neutralize the acid contained in one gram of fluid.

Pour point
The lowest temperature at which the fluid still just flows when cooled down under set conditions. The pour point is specified in the lubricant manufacturers' technical data sheets as a reference value for achieving this flow limit.

RFA (wavelength dispersive x-ray fluorescence analysis)
Is a procedure to determine nearly all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast results.

Shearing/shear loss
Shearing of molecule chains during operation can change the viscosity of hydraulic fluids with long chain VI enhancers. The initially high viscosity index drops. This needs to be taken into account when selecting the hydraulic fluid.

The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part -6. Please note that there are practical applications that create a much higher shear load on such hydraulic fluids than can be achieved by this test.

Stick-slip
Interaction between a resilient mass system involving friction (such as cylinder + oil column + load) and the pressure increase at very low sliding speeds. The static friction of the system is a decisive value here. The lower it is, the lower the speed that can still be maintained without sticking. Depending on the tribologic system, the stick-slip effect may lead to vibrations generated and sometimes also to significant noise emission. In many cases, the effect can be attenuated by replacing the lubricant.

Viscosity
Viscosity is the measure of the internal friction of a fluid to flow. It is defined as the property of a substance to flow under tension. Viscosity is the most important characteristic for describing the load-bearing capacity of a hydraulic fluid.

Kinematic viscosity is the ratio of the dynamic viscosity and the density of the fluid; the unit is mm^2/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

Viscosity index (VI)
Refers to the viscosity temperature behavior of a fluid. The lower the change of viscosity in relation the temperature, the higher the VI.

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Rexroth
Bosch Group

Fire-resistant, water-free hydraulic fluids (HFDR/HFDU)

Application notes and requirements for Rexroth hydraulic components

Hydraulic fluids

Title	Hydraulic fluids based on mineral oils and related hydrocarbons	Environmentally acceptable hydraulic fluids	**Fire-resistant, water-free hydraulic fluids**	Fire-resistant, water-containing hydraulic fluids
Standard	DIN 51524	ISO 15380	**ISO 12922**	ISO 12922
Data sheets	RE 90220	RE 90221	**RE 90222**	RE 90223 (in preparation)
Classification	HL HLP HLPD HVLP HLPD and more	HEPG HEES partially saturated HEES saturated HEPR HETG	**HFDR HFDU (ester base) HFDU (glycol base) and more**	HFC HFB HFAE HFAS

Contents

1 Basic information

1.1 General instructions

The hydraulic fluid is the common element in any hydraulic component and must be selected very carefully. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency and service life of a system.

Hydraulic fluids must conform, be selected and used in accordance with the generally acknowledged rules of technology and safety provisions. Reference is made to the country-specific standards and directives (in Germany the directive of the Employer's Liability Insurance Association BGR 137).

This data sheet includes recommendations and regulations concerning the selection, operation and disposal of fire-resistant, water-free hydraulic fluids in the application of Rexroth hydraulic components.

The individual selection of hydraulic fluid or the choice of classification are the responsibility of the operator.

It is the responsibility of the user to ensure that appropriate measures are taken for safety and health protection and to ensure compliance with statutory regulations. The recommendations of the lubricant manufacturer and the specifications given in the safety data sheet are to be observed when using hydraulic fluid.

This data sheet does not absolve the operator from verifying the conformity and suitability of the respective hydraulic fluid for his system. He is to ensure that the selected fluid meets the minimum requirements of the relevant hydraulic fluid standard during the whole of the period of use.

The currently valid standard for fire-resistant hydraulic fluids is the ISO 12922. In addition, other, more detailed documents, guidelines, specifications and legislation may also be valid. The operator is responsible for ensuring that such regulations are observed, for example:

– 7th Luxembourg Report: Luxembourg, April 1994, Doc. No. 4746/10/91 EN "Requirements and tests applicable to fire-resistant hydraulic fluids for hydrostatic and hydrokinetic power transmission and control"
– VDMA 24314 (1981-11): "Changing hydraulic fluids – guidelines"
– VDMA 24317 (2005-11): "Fire-resistant hydraulic fluids – minimum technical requirements"
– FM Approval Standard 6930 (2009-04): "Flammability Classification of Industrial Fluids" (only available in English)
– DIN Technical Report CEN/TR 14489 (2006-01): "Selection guidelines for protecting safety, health and the environment"

We recommend that you maintain constant, close contact with lubricant manufacturers to support you in the selection, maintenance, care and analyses.

When disposing of used hydraulic fluids, apply the same care as during use.

1.2 Fire resistance

There is no clear legal definition of fire-resistant hydraulic fluids. There are great differences regarding fire resistance. The selection is the sole responsibility of the system operator with respect to requirements (application, construction and design of the system, hottest source in the system, necessary fire protection).

Different test procedures are applied for evaluating fire resistance.

Fire resistance test procedure according to ISO 12922:

– Ignition properties of spray according to ISO 15029-1 (Spray flame persistence – hollow-cone nozzle method)
– Ignition properties of spray according to ISO 15029-2 (Stabilized flame heat release)
– Wick flame persistence of fluids according to ISO 14935 (average flame persistence)
– Determination of the flammability characteristics of fluids in contact with hot surfaces, ignition process according to ISO 20823 (ignition temperature, flame spread)

In general, fire-resistant hydraulic fluids are distinguished between **water-containing** fire-resistant and **water-free** fire-resistant hydraulic fluids. Water-containing fire-resistant hydraulic fluids are described in RE 90223.

Water-free, fire-resistant hydraulic fluid means hydraulic fluids with a water-proportion of 0.1% by volume ("Karl Fischer method", see chapter 6 "Glossary"), measured at the time of filling in the transport container.

In Europe water-free, fire-resistant hydraulic fluids are not approved for use in underground coal mining. The classification HFDU is no longer included in the VDMA 24317: 2005.

Note
In contrast to water-containing fluids, all water-free, fire-resistant hydraulic fluids have a flash point and a fire point. Specific parameters for flash point and fire point can be found in the technical and/or safety data sheet for the hydraulic fluid concerned.

Just as much care should be taken when working with fire-resistant hydraulic fluids are with other hydraulic fluids, e.g. mineral oils. A leak from the hydraulic system must be avoided. The best and most cost-effective protection against fire and explosion is to prevent leakage with meticulous service, maintenance and care of the hydraulic system.

1.3 Scope

This data sheet must be applied when using water-free, fire-resistant hydraulic fluids with Rexroth hydraulic components. The specifications of this data sheet may be further restricted by the specifications given in data sheets for the individual components concerned.

The use of the individual water-free, fire-resistant hydraulic fluids in accordance with the intended purpose can be found in the safety data sheets or other product description documents of the lubricant manufacturers. In addition, each use is to be individually considered.

Rexroth hydraulic components may only be operated with water-free, fire-resistant hydraulic fluids according to ISO 12922 if specified in the respective component data sheet or if a Rexroth approval for use is furnished.

The manufacturers of hydraulic systems must adjust their systems and operating instructions to the water-free, fire-resistant hydraulic fluids.

Bosch Rexroth will accept no liability for its components for any damage resulting from failure to comply with the notes below.

1.4 Safety instructions

Hydraulic fluids can constitute a risk for persons and the environment. These risks are described in the hydraulic fluid safety data sheets. The operator is to ensure that a current safety data sheet for the hydraulic fluid used is available and that the measures stipulated therein are complied with.

2 Solid particle contamination and cleanliness levels

Solid particle contamination is the major reason for faults occurring in hydraulic systems. It may lead to a number of effects in the hydraulic system. Firstly, single large solid particles may lead directly to a system malfunction, and secondly small particles cause continuous elevated wear.

For mineral oils, the cleanliness level of water-free, fire-resistant hydraulic fluids is given as a three-digit numerical code in accordance with ISO 4406. This numerical code denotes the number of particles present in a hydraulic fluid for a defined quantity. Moreover, foreign solid matter is not to exceed a mass of 50 mg/kg (gravimetric examination according to ISO 4405).

In general, compliance with a minimum cleanliness level of 20/18/15 in accordance with ISO 4406 or better is to be maintained in operation. Special servo valves demand improved cleanliness levels of at least 18/16/13. A reduction in cleanliness level by one level means half of the quantity of particles and thus greater cleanliness. Lower numbers in cleanliness levels should always be striven for and extend the service life of hydraulic components. The component with the highest cleanliness requirements determines the required cleanliness of the overall system. Please also observe the specifications in table 1: "Cleanliness levels according to ISO 4406" and in the respective data sheets of the various hydraulic components.

Hydraulic fluids frequently fail to meet these cleanliness requirements on delivery. Careful filtering is therefore required during operation and in particular, during filling in order to ensure the required cleanliness levels. Your lubricant manufacturer can tell you the cleanliness level of hydraulic fluids as delivered. To maintain the required cleanliness level over the operating period, you must use a reservoir breather filter. If the environment is humid, take appropriate measures, such as a breather filter with air drying or permanent off-line water separation.

Note: the specifications of the lubricant manufacturer relating to cleanliness levels are based on the time at which the container concerned is filled and not on the conditions during transport and storage.

Further information about contamination with solid matter and cleanliness levels can be found in brochure RE 08016.

1

Table 1: Cleanliness levels according to ISO 4406

Particles per 100 ml		Scale number
More than	Up to and including	
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64000	130,000	17
32000	64000	16
16000	32000	15
8000	16000	14
4000	8000	13
2000	4000	12
1000	2000	11
500	1000	10
250	500	9
130	250	8
64	130	7
32	64	6

20 / **18** / **15**
> 4 µm > 6 µm > 14 µm

3 Selection of the hydraulic fluid

Water-free, fire-resistant hydraulic fluids for Bosch Rexroth hydraulic components are assessed on the basis of their fulfillment of the minimum requirements of ISO 12922.

3.1 Selection criteria for the hydraulic fluid

The specified limit values for all components employed in the hydraulic system, for example viscosity and cleanliness level, must be observed with the hydraulic fluid used, taking into account the specified operating conditions.

Hydraulic fluid suitability depends, amongst others, on the following factors:

3.1.1 Viscosity

Viscosity is a basic property of hydraulic fluids. The permissible viscosity range of complete systems needs to be determined taking account of the permissible viscosity of all components and it is to be observed for each individual component.

The viscosity at operating temperature determines the response characteristics of closed control loops, stability and damping of systems, the efficiency factor and the degree of wear.

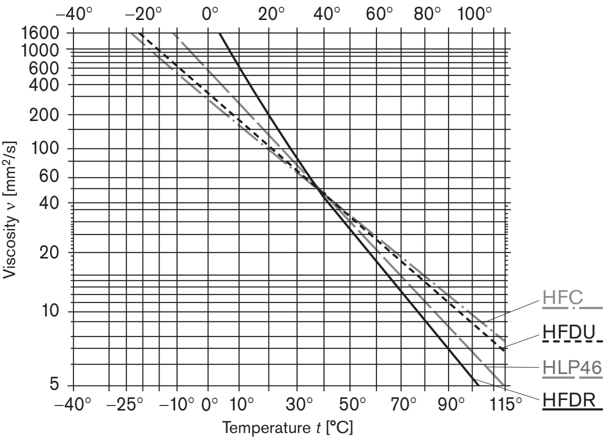
We recommend that the optimum operating viscosity range of each component be kept within the permissible temperature range. This usually requires either cooling or heating, or both. The permissible viscosity range and the necessary cleanliness level can be found in the product data sheet for the component concerned.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. In return, there will be lower internal leakage losses. If the pressure level is lower, lubrication gaps may not be filled up, which can lead to increased wear. For hydraulic pumps, the permitted suction pressure may not be reached, which may lead to cavitation damage.

If the viscosity of a hydraulic fluid is below the permitted operating viscosity, increased leakage, wear, susceptibility to contamination and a shorter component life cycle will result.

Please ensure that the permissible temperature and viscosity limits are observed for the respective components. This usually requires either cooling or heating, or both.

Fig. 1: Examples V-T diagrams for water-free, fire-resistant hydraulic fluids in comparison to HLP and HFC (reference values, double-logarithmic representation)



Typical viscosity data [mm²/s]			
at temperature	**0 °C**	**40 °C**	**100 °C**
HFDR	2500	43	5,3
HFDU (ester base)	330	46	9,2
HFDU (glycol base)	350	46	8,7
For comparison HLP (see RE 90220)	610	46	7
For comparison HFC (see RE 90223)	280	46	

Detailed V-T diagrams may be obtained from your lubricant manufacturer for their specific products. Descriptions of the individual classifications can be found in chapter 3.2 and in Table 4.

3.1.2 Viscosity-temperature behavior

For hydraulic fluids, the viscosity temperature behavior (V-T behavior) is of particular importance. Viscosity is characterized in that it drops when the temperature increases and rises when the temperature drops. The interrelation between viscosity and temperature is described by the viscosity index (VI).

For cold testing over a period of several days, the viscosity of ester-based HFDU can increase greatly. After heating, the characteristic values as specified on the data sheet are restored. Please ask your lubricant manufacturer for the "Flow capacity after seven days at low temperature" (ASTM D 2532) for the fluid classification ester-based HFDU .

HFDU fluid based on ester and glycol have better viscosity/temperature characteristics than mineral oil HLP (see Fig. 1). This should be taken into consideration when selecting hydraulic fluid for the required temperature range. The viscosity and temperature limits required in the product data sheets are to be observed in all operating conditions.

Note
For ambient temperatures below 0 °C, fire-resistant, **water-containing** hydraulic fluids of classification HFC are to be preferred because they observe the component-related viscosity ranges and because the have better pour points (see RE 90223).

3.1.3 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components. The wear protection capability is described in ISO 12922 via test procedures"FZG gear test rig" (ISO 14635-1) and "Mechanical test in the vane pump" (ISO 20763). The wear protection capability of water-free, fire-resistant hydraulic fluids in relation to the two test procedures is comparable to that of mineral oil HLP/HVLP.

3.1.4 Material compatibility

The hydraulic fluid must not negatively affect the materials used in the components. Compatibility with coatings, seals, hoses, metals and plastics is to be observed in particular. The fluid classifications specified in the respective component data sheets are tested by the manufacturer with regard to material compatibility. Parts and components not supplied by us are to be checked by the user.

Table 2: Known material incompatibilities

Classification	Incompatible with:
HFD in general	Seals, plastics and coatings of control cabinets, outer coatings of hydraulic components and accessory components (connectors, wiring harnesses, control cabinets) are to be tested for stability. **Note:** hydraulic fluid vapors can also lead to incompatibility!
HFDR	Individual component color coating, lead, galvanic zinc-plating, in part non-ferrous metals with zinc, tin and aluminum in a tribological system. Sealing elements made of NBR. In some cases, the latter show major increases in volume when impermissibly aged hydraulic fluids come into contact with the material. Do not use any hydrolysis/susceptible polyurethane qualities.
HFDU based on ester	Single-component color coatings, lead, galvanized zinc coatings, in part non-ferrous metals with zinc, tin, seals made of NBR. In some cases, the latter show major increases in volume when impermissibly aged hydraulic fluids come into contact with the material. Do not use any hydrolysis/susceptible polyurethane qualities.
HFDU based on glycol	Single-component color coatings, steel/aluminum tribocontacts, paper filters, polymethylmethacrylate (PMMA). The compatibility of NBR is to be examined for individual case.

The material incompatibilities mentioned here do not automatically result in function problems. However the elements of the materials are found in the hydraulic fluids after use. The material incompatibilities described here may lead to accelerated aging of the hydraulic fluid and to reduced fire resistance.

3.1.5 Aging resistance

The way a water-free, fire-resistant hydraulic fluid ages depends on the thermal, chemical and mechanical stress to which it is subjected. The influence of water, air, temperature and contamination may be significantly greater than for mineral oils HLP/HVLP. Aging resistance can be greatly influenced by the chemical composition of the hydraulic fluids.

High fluid temperatures (e.g. over 80 °C) result in a approximate halving of the fluid service life for every 10 °C temperature increase and should therefore by avoided. The halving of the fluid service life results from the application of the Arrhenius equation (see Glossary).

Table 3: Reference values for temperature-dependent aging of the hydraulic fluid

Reservoir temperature	Fluid life cycle
80 °C	100 %
90 °C	50 %
100 °C	25 %

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A modified aging test (ISO 4263-3 or ASTM D943 – without the addition of water) is specified for fluid classification HFDU. Fluid classification HFDR is described with a special procedure with respect to oxidation stability (EN 14832) and oxidation service life (ISO 4263-3). The calculated fluid service life is derived from the results of tests in which the long-term characteristics are simulated in a short period of time by applying more arduous conditions (condensed testing). This calculated fluid service life is not to be equated to the fluid service life in real-life applications.

Table 3 is a practical indicator for hydraulic fluids with water content < 0.1%, cf. chapter 4.10. "Water".

3.1.6 Environmentally acceptable

HFDU fluids based on ester and glycol are hydraulic fluids which may also be classified as environmentally acceptable. The main criteria for fire-resistant, water-free hydraulic fluids are the leak-free, technically problem-free use and the necessary fire resistance. Environmentally acceptable is merely a supplementary criterion. Notes on environmentally compatible hydraulic fluids can be found in RE 90221.

3.1.7 Air separation ability (ASA)

The air separation ability (ASA) describes the property of a hydraulic fluid to separate undissolved air. Hydraulic fluids always contain dissolved air. During operation, dissolved air may be transformed into undissolved air, leading to cavitation damages. Fluid classification, fluid product, reservoir size and design must be coordinated to take into account the dwell time and ASA value of the hydraulic fluid. The air separation capacity depends on the viscosity, temperature, basic fluid and aging. It cannot be improved by additives.

According to ISO 12922 for instance, an ASA value ≤ 15 minutes is required for viscosity class ISO VG 46, practical values on delivery are < 10 minutes, lower values are preferable.

3.1.8 Demulsifying ability and water solubility

The capacity of a hydraulic fluid to separate water at a defined temperature is known as the demulsifying ability. ISO 6614 defines the demulsifying properties of hydraulic fluids.

The fluid classifications HFDU based on ester and HFDR separate water, but HFD hydraulic fluids have a different water separation ability to mineral oil HLP/HVLP. At 20 °C, in comparison to mineral oil HLP/HVLP, a multiple (> factor 3) of water can separate in the hydraulic fluid. Water solubility is also more temperature-dependent than for mineral oils. The fluid classification HFDU based on glycol usually dissolves water completely, see chapter "4.10 Water".

3.1.9 Filterability

Filterability describes the ability of a hydraulic fluid to pass through a filter, removing solid contaminants. The hydraulic fluids used require a good filterability, not just when new, but also during the whole of their service life. This can differ greatly depending on the different basic fluids (glycols, esters) and additives (VI enhancers, anti-fogging additives).

The filterability is a basic prerequisite for cleanliness, servicing and filtration of hydraulic fluids. Rexroth therefore requires the same degree of filterability of water-free, fire-resistant hydraulic fluids as for mineral oils HLP/HVLP to DIN 51524.
As ISO 12922 does not comment on the filterability of hydraulic fluids, filterability comparable to that of mineral oils HLP/HVLP must be requested of lubricant manufacturers.

Filterability is tested with the new hydraulic fluid and after the addition of 0.2 % water. The underlying standard (ISO 13357-1/-2) stipulates that filterability must have no negative effects on the filters or the hydraulic fluid, see chapter 4 "Hydraulic fluids in operation".

3.1.10 Corrosion protection

Hydraulic fluids should not just prevent corrosion formation on steel components, they must also be compatible with non-ferrous metals and alloys. Corrosion protection tests on different metals and metal alloys are described in ISO 12922.

Rexroth components are usually tested with HLP hydraulic fluids or corrosion protection oils based on mineral oils before they are delivered.

3.1.11 Additivation

The properties described above can be modified with the help of suitable additives.
Bosch Rexroth does not prescribe any specific additive system.

3.2 Classification and fields of application

Table 4: Classification and fields of application

Classification	Features	Typical field of application	Notes
HFDU (glycol-based) according to ISO 12922 Density at 15 °C: typically > 0.97 kg/dm^3 VI: typical > 170 The classification "HFDU" is no longer listed in the current standard sheet VDMA 24317.	Base fluid: Glycols	Mobile systems with high thermal loading	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Very good viscosity/temperature characteristics, shear stability – Resistant to aging – Can be water-soluble – Can be mixed with water – Very good wear protection properties – A higher implementation temperature with the same viscosity in comparison to mineral oil is to be expected – Due to the higher density in comparison to HLP, lower suction pressures are to be anticipated for pumps. Reduce the maximum speed as required and optimize suction conditions. – Prior to commissioning, contact the lubricant manufacturer, as the components are tested with mineral oil HLP/corrosion protection oil. – Incompatible with mineral oil (exceptions must be confirmed by the lubricant manufacturer).
HFDU (ester-based) according to ISO 12922 Density at 15 °C: typically 0.90-0.93 kg/dm^3 VI: typical > 160 Iodine count < 90 The classification "HFDU" is no longer listed in the current standard sheet VDMA 24317.	Base fluid: Ester based on regenerative raw materials, synthetic ester and mixtures of different esters Because of the fire resistance, HFDU hydraulic fluids based on ester are usually partially saturated esters	Suitable for most fields of application and components.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Preferred use of FKM seals. Please enquire about shaft seal rings and implementation temperatures under –15 °C. – Note shear stability (see chapter 4.11 "Fluid servicing, fluid analysis and filtration" and chapter 6 "Glossary") – Fire resistance is not stable over time – In operation, a higher temperature in comparison to mineral oil HLP/HVLP is to be expected given identical design and viscosity. Please check ATEX approvals for hydraulic components. – Limit the lower (see chapter 3.1.2) and upper implementation temperatures (see chapter 3.1.5) – Good viscosity-temperature behavior – Usually classified as insignificantly water-endangering (water hazard class WGK 1) – High dirt dissolving capacity on fluid changeovers – In unfavorable operating conditions (high water content, high temperature), HFDU on ester basis have a tendency to hydrolysis. The acidic organic decomposition products can chemically attack materials and components.

Classification	Features	Typical field of application	Notes
HFDR according to ISO 12922 Density at 15 °C: typically 1.1 kg/dm³ VI : typical 140–160	Base fluid: phosphoric acid ester	Turbine control systems	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. – Classified as hazardous materials (for transportation and storage) – Hazardous working material – Water-endangering (Water hazard class 2 – WGK2) – Develops toxic vapors in case of fire – Preferred use of FKM, and possibly PTFE seals. Please enquire for shaft seal rings and implementation temperatures under –15 °C. – In operation, a higher temperature in comparison to mineral oil HLP/HVLP is to be expected given identical design and viscosity – Phosphoric acid esters display a tendency to hydrolysis when they come into contact with moisture. Under the influence of water/moisture, they become unstable or form highly aggressive, acidic components which could damage the hydraulic fluid and component beyond repair. – Poor viscosity/temperature characteristics – Due to the higher density in comparison to HLP, lower suction pressures are to be anticipated for pumps. Reduce the maximum speed as required and optimize suction conditions. – In unfavorable operating conditions (high water content, high temperature), HFDR have a tendency to hydrolysis. The acidic inorganic decomposition products chemically attack materials and components.
HFDU (continued)	Based on triglycerides, mineral oils or related hydrocarbons	Not recommended for Rexroth components!	Hydraulic fluids based on polyalphaolefines are not recommended on account of their poor fire resistance. This classification can usually be identified from: density < 0.89; VI < 140 to 160 Hydraulic fluids based on triglycerides are not recommended on account of their aging resistance. This classification can usually be identified from: density > 0.92; VI > 190; iodine count > 90 Consult your lubricant manufacturer or your Bosch Rexroth sales partner if the classification of a hydraulic fluid is not clear.
HFDS HFDT	Based on halogenated hydrocarbons or mixtures with halogenated hydrocarbons	Not approved for Rexroth components!	HFDS and HFDT have not been permitted to be manufactured or used since 1989 for environmental reasons.

4 Hydraulic fluids in operation

4.1 General

The properties of hydraulic fluids can change continually during storage and operation.

Please note that the fluid standard ISO 12922 merely describes minimum requirements for hydraulic fluids in new condition at the time of filling into the bins. The operator of a hydraulic system must ensure that the hydraulic fluid remains in a utilizable condition throughout its entire period of use.

Deviations from the characteristic values are to be clarified with the lubricant manufacturer, the test labs or Bosch Rexroth.

Bosch Rexroth will accept no liability for damage to its components within the framework of the applicable liability legislation insofar as the latter is due to non-observance of the following instructions.

Please note the following aspects in operation.

4.2 Storage and handling

Hydraulic fluids must be stored correctly in accordance with the instructions of the lubricant manufacturer. Avoid exposing the containers to lengthy periods of direct heat. Containers are to be stored in such a way that the risk of any foreign liquid or solid matter (e.g. water, foreign fluids or dust) ingression into the inside of the container can be ruled out. After taking hydraulic fluids from the containers, these are immediately to be properly resealed.

Recommendation:

- Store containers in a dry, roofed place
- Store barrels on their sides
- Clean reservoir systems and machine reservoirs regularly

4.3 Filling of new systems

Usually, the cleanliness levels of the hydraulic fluids as delivered do not meet the requirements of our components. Hydraulic fluids must be filtered using an appropriate filter system to minimize solid particle contamination and water in the system.

As early as possible during test operation, new systems should be filled with the selected hydraulic fluid so as to reduce the risk of accidentally mixing fluids (see chapter 4.5 "Mixing and compatibility of different hydraulic fluids"). Changing the hydraulic medium at a later point represents significant additional costs (see following chapter).

4.4 Hydraulic fluid changeover

Problems may be encountered in particular when changing over from water-containing, fire-resistant hydraulic fluid or mineral oils to water-free, fire-resistant hydraulic fluids (e.g. incompatibilities in the form of gelling, silting, stable foam, reduced filterability or filter blockage). This may also happen when changing products within the same classification.

In the case of changeovers of the fluid in hydraulic systems, it is important to ensure compatibility of the new hydraulic fluid with the remains of the previous hydraulic fluid. Bosch Rexroth recommends obtaining verification of compatibility from the manufacturer or supplier of the new hydraulic fluid. The quantity of old fluid remaining should be minimized. Mixing hydraulic fluids should be avoided, see following chapter.

Information about changing to a hydraulic fluid of a different classification can be found, for example, in VDMA 24314 and in ISO 7745. In addition, the information given in chapter 3.1.4 "Material compatibility" is also to be observed.

Bosch Rexroth will not accept liability for any damage to its components resulting from inadequate hydraulic fluid changeovers!

4.5 Mixing and compatibility of different hydraulic fluids

If hydraulic fluids from different manufacturers or different types from the same manufacturer are mixed, gelling, silting and deposits may occur. These, in turn, may cause foaming, impaired air separation ability, malfunctions and damage to the hydraulic system.

If the fluid contains more than 2 % of another fluid then it is considered to be a mixture. Exceptions apply for water, see chapter 4.10 "Water".

Mixing with other hydraulic fluids is not generally permitted. This includes hydraulic fluids with the same classification. If individual lubricant manufacturers advertise miscibility and/or compatibility, this is entirely the responsibility of the lubricant manufacturer.

Bosch Rexroth customarily tests all components with mineral oil HLP before they are delivered.

Note: With connectible accessory units and mobile filtering systems, there is a considerable risk of non-permitted mixing of the hydraulic fluids!

Rexroth will not accept liability for any damage to its components resulting from mixing hydraulic fluids!

4.6 Re-additivation

Additives added at a later point in time such as colors, wear reducers, VI enhancers or anti-foam additives, may negatively affect the performance properties of the hydraulic fluid and the compatibility with our components and therefore are not permissible.

Rexroth will not accept liability for any damage to its components resulting from re-additivation!

4.7 Foaming behavior

Foam is created by rising air bubbles at the surface of hydraulic fluids in the reservoir. Foam that develops should collapse as quickly as possible.

Common hydraulic fluids in accordance with ISO 12922 are sufficiently inhibited against foam formation in new condition. On account of aging and adsorption onto surfaces, the defoamer concentration may decrease over time, leading to a stable foam.

Defoamers may be re-dosed only after consultation with the lubricant manufacturer and with his written approval.

Defoamers may affect the air separation ability.

4.8 Corrosion

The hydraulic fluid is to guarantee sufficient corrosion protection of components under all operating conditions, even in the event of impermissible water contamination.

Water-free, fire-resistant hydraulic fluids are tested for corrosion protection in the same way as mineral oil HLP/HVLP. When used in practice other corrosion mechanisms are revealed in detail and in individual cases, for the most part in contact with non-ferrous and white alloys.

4.9 Air

Under atmospheric conditions the hydraulic fluid contains dissolved air. In the negative pressure range, for instance in the suction pipe of the pump or downstream of control edges, this dissolved air may transform into undissolved air. The undissolved air content represents a risk of cavitation and of the diesel effect. This results in material erosion of components and increased hydraulic fluid aging.

With the correct measures, such as suction pipe and reservoir design, and an appropriate hydraulic fluid, air intake and separation can be positively influenced.

See also chapter 3.1.7 "Air separation ability (ASA)".

4.10 Water

Water contamination in hydraulic fluids can result from direct ingress or indirectly through condensation of water from the air due to temperature variations.

HFDU hydraulic fluids on glycol basis are water-soluble or can be mixed with water. This means that any water that has ingressed into the system cannot be drained off in the sump of the reservoir.

In the case of HDFU hydraulic fluids on ester basis, undissolved water can be drained off from the reservoir sump, the remaining water content is however too high to ensure that the maximum permissible water limit values are observed in the long term.

With the fluid classification HFDR, the greater density of the ester means that the any water that has ingressed will be on the surface of the hydraulic fluid. This means that any water that has ingressed into the system cannot be drained off in the sump of the reservoir.

Water in the hydraulic fluid can result in wear or direct failure of hydraulic components. Furthermore, a high water content in the hydraulic fluid negatively affects aging and filterability and increases susceptibility to cavitation. During operation, the water content in all hydraulic fluids, determined according to the "Karl Fischer method" (see chapter 6 "Glossary") for all water-free, fire-resistant hydraulic fluids must constantly be kept below 0.1% (1000 ppm). To ensure a long service life of both hydraulic fluids and components, Bosch Rexroth recommends that values below 0.05% (500 ppm) are permanently maintained.

Due to the higher water solubility in comparison to mineral oil HLP/HVLP it is urgently advised that precautions be taken when using water-free, fire-resistant hydraulic fluids, such as a dehumidifier on the reservoir ventilation.

Water content has an affect particularly in the case of HEDU hydraulic fluid on ester basis and HFDR in that it accelerates aging (hydrolysis) of the hydraulic fluid and biological degradation, see chapter 4.11 "Fluid servicing, fluid analysis and filtration".

4.11 Fluid servicing, fluid analysis and filtration

Air, water, operating temperature influences and solid matter contamination will change the performance characteristics of hydraulic fluids and cause them to age.

To preserve the usage properties and ensure a long service life for hydraulic fluid and components, the monitoring of the fluid condition and a filtration adapted to the application requirements (draining and degassing if required) are indispensable.

The effort is higher in the case of unfavorable usage conditions, increased stress for the hydraulic system or high expectations as to availability and service life, see chapter 2 "Solid particle contamination and cleanliness levels".

When commissioning a system, please note that the required minimum cleanliness level can frequently be attained only by flushing the system. Due to severe start-up contamination, it may be possible that a fluid and/or filter replacement becomes necessary after a short operating period (< 50 operating hours).

The hydraulic fluid must be replaced at regular intervals and tested by the lubricant manufacturer or recognized accredited test labs. **We recommend a reference analysis after commissioning.**

The minimum data to be tested for analyses are:

– Viscosity at 40 °C and 100 °C
– Neutralization number NN (acid number AN)
– Water content (Karl-Fischer method)
– Particle measurement with evaluation according to ISO 4406 or mass of solid foreign substances with evaluation to EN 12662
– Element analysis (RFA (EDX) / ICP, specify test method)
– Comparison with new product or available trend analyses
– Assessment / evaluation for further use
– Also recommended: IR spectrum

No differences are needed in the maintenance and care of water-free, fire-resistant hydraulic fluids with the appropriate suitability parameters compared to HLP/HVLP mineral oils. Attention is however drawn to the note in chapter 1.3.

After changing over hydraulic fluids it is recommended that the filters be replaced again after 50 operating hours as fluid aging products may have detached themselves ("self-cleaning effect").

Compared to the pure unused hydraulic fluid the changed neutralization number NN (acid number AN) indicates how many aging products are contained in the hydraulic fluid.
This difference must be kept as small as possible. The lubricant manufacturer should be contacted as soon as the trend analysis notes a significant increase in values.

A higher viscosity than that of new materials indicates that the hydraulic fluid has aged. Evaluation by the test lab or lubricant manufacturers is however authoritative, whose recommendation should be urgently observed.

On systems where the possibility of water contamination cannot be completely ruled out (also condensation), it should be ensured via the hydraulic system circuit that fluid aging products are not accumulating in individual areas of the hydraulic system, but are being removed from the system in a controlled manner via the filtration system. This should be ensured via suitable hydraulic circuits (e.g. flushing circuit) or system manufacturer's operating instructions/specifications.

In case of warranty, liability or guarantee claims to Bosch Rexroth, service verification and/or the results of fluid analyses are to be provided.

5 Disposal and environmental protection

All water-free, fire-resistant hydraulic fluids, are, like mineral oil-based hydraulic fluids, subject to special disposal obligations.

The respective lubricant manufacturers provide specifications on environmentally acceptable handling and storage. Please ensure that spilt or splashed fluids are absorbed with appropriate adsorbents or by a technique that prevents it contaminating water courses, the ground or sewerage systems.

It is also not permitted to mix fluids when disposing of hydraulic fluids. Regulations governing the handing of used oils stipulate that used oils are not to mixed with other products, e.g. substances containing halogen. Non-compliance will increase disposal costs. Comply with the national legal provisions concerning the disposal of the corresponding hydraulic fluid. Comply with the local safety data sheet of the lubricant manufacturer for the country concerned.

6 Glossary

Additivation
Additives are chemical substances added to the basic fluids to achieve or improve specific properties.

Aging
Hydraulic fluids age due to oxidation (see chapter 3.1.5 "Aging resistance"). Liquid and solid contamination acts as a catalyzer for aging, meaning that it needs to be minimized as far as possible by careful filtration. Please refer to Hydrolysis.

Arrhenius equation
The quantitative relation between reaction rate and temperature is described by an exponential function, the Arrhenius equation. This function is usually visualized within the typical temperature range of the hydraulic system. For a practical example, see chapter 3.1.5 "Aging resistance".

Basic fluids
In general, a hydraulic fluid is made up of a basic fluid, or base oil, and chemical substances, the so-called additives. The proportion of basic fluid is generally greater than 90%.

Diesel effect

If hydraulic fluid that contains air bubbles is compressed quickly, the bubbles are heated to such a degree that a self-ignition of the air-gas mix may occur. The resultant temperature increase may lead to seal damage and increased aging of the hydraulic fluid.

Partially saturated esters
In contrast to saturated esters, partially saturated esters have double/multiple bonds between C atoms. Rexroth defines partially saturated esters as unsaturated bonds and mixtures of esters with unsaturated and saturated bonds. Esters with unsaturated bonds are produced on the basis of renewable raw materials.

Depending on their number and position, these unsaturated bonds between the C atoms are instable. These bonds can detach themselves and form new bonds, thus changing the properties of those liquids (an aging mechanism). Attention is however drawn to the note in chapter 1.3.

Hydrolysis
Hydrolysis is the splitting of a chemical bond through the reaction with water under the influence of temperature.

ICP (atomic emission spectroscopy)
The ICP procedure can be used to determine various wear metals, contamination types and additives. Practically all elements in the periodic system can be detected with this method.

Iodine count
The iodine count is a yardstick for the quantity of single and multiple unsaturated bonds between C atoms in the basic fluid. A low iodine count indicates that the hydraulic fluid contains few unsaturated bonds and is thus considerably more resistant to aging than a hydraulic fluid with a high iodine count. A statement about the position at which these multiple bonds are located and about how "stable" they are against influencing factors cannot be derived simply by stating the iodine count.

Karl Fischer method
Method to determine the water content in fluids. Indirect coulometric determination procedure in accordance with DIN EN ISO 12937 in connection with DIN 51777-2. Only the combination of both standards will assure adequately accurate measured values. For hydraulic fluids based on glycol, DIN EN ISO 12937 is to be applied in conjunction with DIN 51777-1.

Cavitation
Cavitation is the creation of cavities in fluids due to pressure reduction below the saturated vapour pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures and pressure may occur temporarily, which may damage the component surfaces.

Neutralization number (NN)
The neutralization number (NN) or acid number (AN) specifies the amount of caustic potash required to neutralize the acid contained in one gram of fluid.

Pour point
The lowest temperature at which the fluid still just flows when cooled down under set conditions. The pour point is specified in the lubricant manufacturers' technical data sheets as a reference value for achieving this flow limit.

RFA (wavelength dispersive x-ray fluorescence analysis)
Is a procedure to determine nearly all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast results.

Shearing/shear loss
Shearing of molecule chains during operation can change the viscosity of hydraulic fluids with long chain VI enhancers and anti-fogging additives. The initially high viscosity index drops. This needs to be taken into account when selecting the hydraulic fluid.

The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part -6. Please note that there are practical applications that create a much higher shear load on such hydraulic fluids than can be achieved by this test.

Viscosity
Viscosity is the measure of the internal friction of a fluid to flow. It is defined as the property of a substance to flow under tension. Viscosity is the most important characteristic for describing the load-bearing capacity of a hydraulic fluid.

Kinematic viscosity is the ratio of the dynamic viscosity and the density of the fluid; the unit is mm^2/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

Viscosity index (VI)
Refers to the viscosity temperature behavior of a fluid. The lower the change of viscosity in relation the temperature, the higher the VI.

1

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Rating of hydraulic fluids for Rexroth hydraulic components (pumps and motors)

RE 90235
Edition: 01.2013

Bosch Rexroth offers the rating of hydraulic fluids as service – inclusive assistance and consulting of experienced engineers.

Hydraulic fluids

Title	Hydraulic fluids based on mineral oils and related hydrocarbons	Environmentally acceptable hydraulic fluids	Fire-resistant, water-free hydraulic fluids	Fire-resistant, water-containing hydraulic fluids
Standard	DIN 51524	ISO 15380	ISO 12922	ISO 12922
Data sheets	90220	90221	90222	90223 (in preparation)
Classification	HL HLP HLP(D) HVLP HVLP(D) and more	HEPG HEES partially saturated HEES saturated HEPR HETG	HFDR HFDU (ester base) HFDU (glycol base) and more	HFC HFB HFAE HFAS

The safe and reliable operation of industrial and mobile equipment is only possible if the hydraulic fluid used is selected with respect to the application. The main tasks of the hydraulic fluid are e.g. transmission of power, lubrication of the components, reduction of friction, corrosion prevention and heat dissipation. Unfortunately the common element "hydraulic fluid" is often disregarded during conceptual design.
Increased requirements on machines and equipment constantly raise the quality requirements on the hydraulic fluid used. For using a suitable hydraulic fluid, adequate knowledge and experience of this are necessary.
Therefore Bosch Rexroth offers the rating of hydraulic fluids for Rexroth hydraulic components as service.
Bosch Rexroth defines hydraulic fluids on the basis of the illustration on page 1. Application notes and requirements for Rexroth hydraulic components can be taken out of the data sheets mentioned in this illlustration on page 1.

1 Description

Minimum requirements
At present the DIN/ISO conformity for the minimum requirement on fluids is defined in our Bosch Rexroth component data sheets. The fluid manufacturers' technical data sheets have to include that the specific standard is met. The plausibility and correctness of the fluid data is not reviewed by Bosch Rexroth.

Basic Level
Fluid data of the manufacturer has to be according to DIN / ISO and Bosch Rexroth requirements (tightened data of standards, further Bosch Rexroth requirements). Bosch Rexroth demands the data to be confirmed in writing. The plausibility and correctness of the fluid data is reviewed by Bosch Rexroth.
Furthermore retained samples (finished fluid, base oils) are stored.
No special Rexroth fluid test with Rexroth hydraulic components will be done.

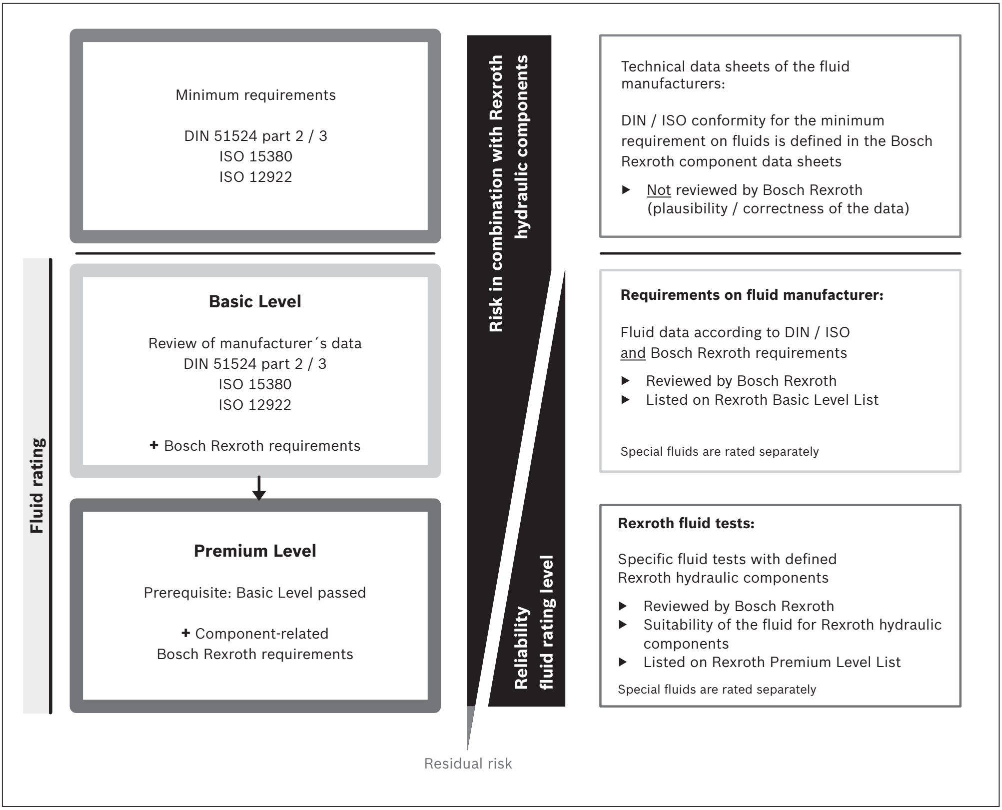
When the requirements are fulfilled the corresponding hydraulic fluids will be listed on the following Bosch Rexroth documents:
- 90240: Rexroth Basic Level List (HLP/HLP(D)/HVLP/HVLP(D))

in preparation:
- 90241: Rexroth Basic Level List (HExx)
- 90242: Rexroth Basic Level List (HFDx)
- 90243: Rexroth Basic Level List (HFxx)

Premium Level
It is a precondition for the Premium Level to meet the Basic Level.
The Premium Level contains specific fluid tests which show the suitability of the hydraulic fluid with defined Rexroth components. According to the Rexroth components used the corresponding test has to be passed with respect to the oil category.

When the requirements are fulfilled the corresponding hydraulic fluids will be listed on the following Bosch Rexroth document:
- 90245: Rexroth Premium Level List

Note
The fluid tests carried out in the Premium Level can not cover all machine and system-dependent conditions (see residual risk on rating scheme on page 3). Only single Rexroth components (type of pumps/motors used for the fluid test) can be examined.
Premium Level testing does not cover all systems and applications. Releases for special applications are excluded from the fluid rating.
The responsibility for selection of the hydraulic fluid remains with the equipment/machinery operator and the lubricant manufacturer.
By means of the fluid test contained in the Premium Level the risk in combination with Rexroth hydraulic components can be considerably reduced and the reliability significantly increased.


Minimum requirements
DIN 51524 part 2 / 3
ISO 15380
ISO 12922
Risk in combination with Rexroth hydraulic components
Technical data sheets of the fluid manufacturers:
DIN / ISO conformity for the minimum requirement on fluids is defined in the Bosch Rexroth component data sheets
▶ Not reviewed by Bosch Rexroth (plausibility / correctness of the data)
Fluid rating
Basic Level
Review of manufacturer´s data
DIN 51524 part 2 / 3
ISO 15380
ISO 12922
+ Bosch Rexroth requirements
Requirements on fluid manufacturer:
Fluid data according to DIN / ISO and Bosch Rexroth requirements
▶ Reviewed by Bosch Rexroth
▶ Listed on Rexroth Basic Level List
Special fluids are rated separately
Premium Level
Prerequisite: Basic Level passed
+ Component-related Bosch Rexroth requirements
Reliability fluid rating level
Rexroth fluid tests:
Specific fluid tests with defined Rexroth hydraulic components
▶ Reviewed by Bosch Rexroth
▶ Suitability of the fluid for Rexroth hydraulic components
▶ Listed on Rexroth Premium Level List
Special fluids are rated separately
Residual risk

2 Process

The process of a fluid rating includes the following steps:

Process fluid rating

Basic Level

(BR*	Contacting fluid manufacturer)
FM**	Registration for “fluid rating” on website of Bosch Rexroth (www.boschrexroth.com/fluidrating)
BR	Reviewing registration data of the fluid manufacturer for plausibility
BR	Assignation of registration number to fluid manufacturer Activating of fluid manufacturer´s access to download area of “fluid rating” on the website of Bosch Rexroth
BR	Information to fluid manufacturer: 1) Registration number (=user name for login download area “fluid rating“) 2) Activating for download area is done
FM	Download of all documents (conditions, applications) necessary for “fluid rating” (Basic Level)
FM	Submitting of all documents and retained samples necessary for “fluid rating” (Basic Level) to Bosch Rexroth
BR	Reviewing of the manufacturer´s data, testing of specific fluid data, storing of retained samples
BR	when the requirements are fulfilled - hydraulic fluid will be listed on the Rexroth Basic Level List (HLP/HLP(D)/HVLP/HVLP(D): 90240, lists for other fluid categories in preparation) → **rated@Rexroth4Basic.HLP** → **rated@Rexroth4Basic.HVLP** validity period: → **rated@Rexroth4Basic.HLP(D)** → **rated@Rexroth4Basic.HVLP(D)** 3 years

Premium Level

FM	Request for quotation for fluid test by Bosch Rexroth			
FM	Commissioning of fluid test, supply of fluid for fluid test			
BR	Implementation of specific fluid test using defined Rexroth components	**RFT-APU-CL** Rexroth Fluid Test - Axial Piston Unit - Closed Loop	**RFT-APU-OL-HFC** Rexroth Fluid Test - Axial Piston Unit - Open Loop-HFC	further fluid tests in preparation
BR	when the requirements are fulfilled - hydraulic fluid will be listed on the Rexroth Premium Level List 90245 → **rated@Rexroth4Premium.RFT-APU-CL** → **rated@Rexroth4Premium.RFT-APU-OL-HFC**			

*BR: Bosch Rexroth **FM: fluid manufacturer

1

3 Fluid tests

3.1 Rexroth fluid test RFT-APU-CL

(**R**exroth **F**luid **T**est **A**xial **P**iston **U**nit **C**losed **L**oop)

Fluid test for closed loops using a combination unit existing of a hydraulic pump A4VG045EP and a hydraulic motor A6VM060EP. This fluid test represents the requirements on a hydrostatic transmission.

Features of the fluid test

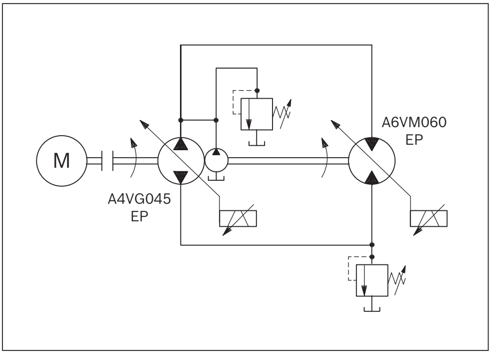
The suitability of the hydraulic fluid is tested at high stress under laboratory conditions. The fluid test consists of a break-in test, swivel cycle test and a corner power test.

Rating criteria

- Examination of the interaction fluid to component
  - Measurement of the component weight change respectively dimensional change
  - Material compatibility
  - Visual inspection of components/component surfaces
  - Oil analysis (SOT, during test, EOT)
- Evidence of endurance performance
- Determination of efficiency (SOT, EOT)

Test bench

▼ **Schematical hydraulic circuit diagram of the RFT-APU-CL**



Technical data of the test components

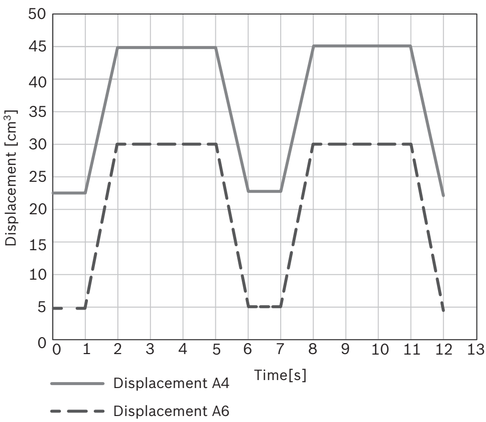
Type	A4VG045EP	A6VM060EP
Data sheet	92004	91610
Operation mode	pump	motor
Nominal volume	45 cm^3	62 cm^3
Maximum speed (at $V_{g\,max}$)	4300 min^{-1}	4450 min^{-1}
Maximum pressure	500 bar	500 bar
Control	electric (EP)	electric (EP)

Operating data

1. Break-in test	
Speed	2000 min^{-1}
Operating pressure	250 bar
Viscosity	10 to 15 mm^2/s
Operating time	10 h

2. Swivel cycle test	
Speed	4000 min^{-1}
Operating pressure	450 bar
Viscosity	5 to 7 mm^2/s
Operating time	300 h

▼ **Swivel cycle (schematic diagram)**



3. Corner power test	
Speed	4000 min^{-1}
Operating pressure	500 bar
Viscosity	5 to 7 mm^2/s
Operating time	200 h

3.2 Rexroth fluid test RFT-APU-OL-HFC
(**R**exroth **F**luid **T**est **A**xial **P**iston **U**nit **O**pen **L**oop-**HFC**)

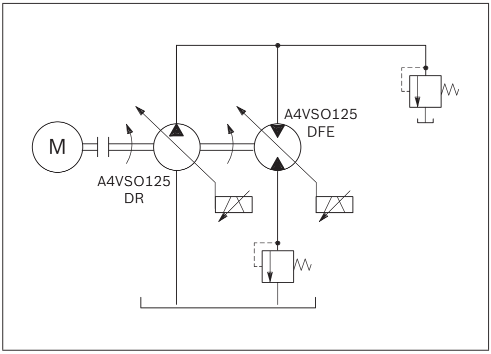
Fluid test for open loops using a A4VSO swashplate axial piston combination unit (hydraulic pump and hydraulic motor). This fluid test represents the requirements on applications demanding water-containing, fire-resistant hydraulic fluids of the classification HFC.

Features of the fluid test
The suitability of the hydraulic fluid is tested at high stress under laboratory conditions. The fluid test consists of a constant and swivel cycle test.

Rating criteria
- Examination of the interaction fluid to component
  - Wear and cavitation behaviour
  - Material compatibility
  - Visual inspection of components/component surfaces
  - Measuring records of functional relevant component surfaces
  - Oil analysis (SOT, during test, EOT)
- Evidence of endurance performance

Test bench

▼ **Schematical hydraulic circuit diagram of the RFT-APU-OL-HFC**



Technical data of the test components

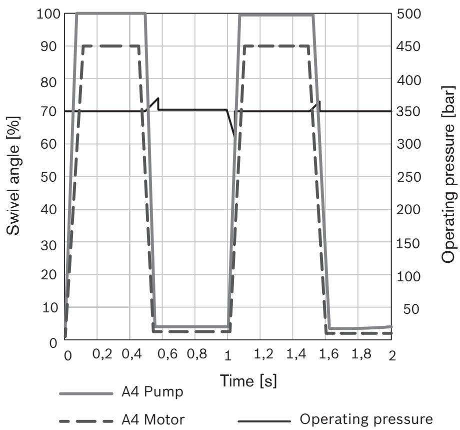
Type	A4VSO125DR	A4VSO125DFE
Data sheet	92053	92053
Operation mode	pump, self-priming	motor
Nominal volume	125 cm^3	125 cm^3
Maximum speed	2200 min^{-1}	2200 min^{-1}
Maximum pressure	400 bar	400 bar

Operating data

1. Constant test	
Speed	1800 min^{-1}
Operating pressure	350 bar
Displacement	$V_{g\,max}$, $V_{g\,min}$
Temperature	40°C
Operating time	200 h

2. Swivel cycle test	
Speed	1800 min^{-1}
Operating pressure	350 bar
Displacement	0,5 sec $V_{g\,min}$ / 0,5 sec $V_{g\,max}$
Temperature	40/50 °C
Operating time	800 h

▼ **Swivel cycle (schematic diagram)**



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Motors

Axial piston motors
Axial piston motors are available in swash plate or bent axis design for medium and high pressure applications.
Our hydrostatic drives for stationary applications stand out due to their robustness, reliability, long life cycles, low noise emissions and high efficiency as well as high cost-effectiveness.

Radial piston motors
Radial piston motors fulfill high requirements in industrial applications regarding high efficiency at low speeds or broad speed ranges.

External gear motors
External gear motors are a cost-effective alternative for rotary drives up to approximately 50 kW. The direction of rotation is either in one direction or reversible. In fan drives, constant motors and motors with proportional bypass control are used.

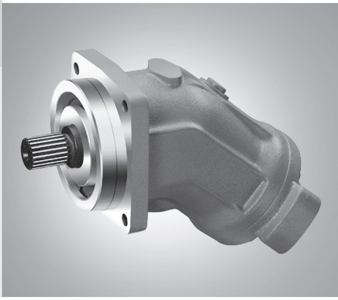
Axial piston motors

Rexroth
Bosch Group

Axial Piston Fixed Motor A2FM

RE 91001/06.2012
Replaces: 09.07

Data sheet



Series 6

Size	Nominal pressure/Maximum pressure
5	315/350 bar
10 to 200	400/450 bar
250 to 1000	350/400 bar

Open and closed circuits

Contents

Features

- Fixed motor with axial tapered piston rotary group of bent-axis design, for hydrostatic drives in open and closed circuits
- For use in mobile and stationary applications
- The output speed is dependent on the flow of the pump and the displacement of the motor.
- The output torque increases with the pressure differential between the high-pressure and the low-pressure side.
- Finely graduated sizes permit far-reaching adaptation to the drive case
- High power density
- Small dimensions
- High total efficiency
- Good starting characteristics
- Economical design
- One-piece tapered piston with piston rings for sealing

Ordering code for standard program

	A2F		M		/	6		W	–	V						
01	02	03	04	05		06	07	08		09	10	11	12	13	14	15

Hydraulic fluid

01	Mineral oil and HFD. HFD for sizes 250 to 1000 only in combination with long-life bearings "L" (without code)		
	HFB, HFC hydraulic fluid	Sizes 5 to 200 (without code)	
		Sizes 250 to 1000 (only in combination with long-life bearings "L")	E-

Axial piston unit

02	Bent-axis design, fixed	A2F

Drive shaft bearing

		5 to 200	250 to 500	710 to 1000	
03	Standard bearing (without code)	●	●	–	
	Long-life bearing	–	●	●	L

Operating mode

04	Motor (plug-in motor A2FE, see RE 91008)	M

Size (NG)

05	Geometric displacement, see table of values on page 7																				
		5	10	12	16	23	28	32	45	56	63	80	90	107	125	160	180	200	250	355	500	710	1000

Series

06		6

Index

07	NG10 to 180	1
	NG200	3
	NG5 and 250 to 1000	0

Direction of rotation

08	Viewed on drive shaft, bidirectional	W

Seals

09	FKM (fluor-caoutchouc)	V

Drive shafts

		5	10	12	16	23	28	32	45	56	63	80	90	107	125	160	180	200	250 to 1000	
10	Splined shaft DIN 5480	–	●	●	●	●	●	●	–	●	●	●	●	●	●	●	●	●	–	A
		–	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	Z
	Parallel keyed shaft DIN 6885	●	●	●	●	●	●	●	–	●	●	●	●	●	●	●	●	●	–	B
		–	●	●	–	●	●	–	●	●	–	●	–	●	–	●	–	–	●	P
	Conical shaft[1]	●	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	C

Mounting flanges

			5 to 250	355 to 1000	
11	ISO 3019-2	4-hole	●	–	B
		8-hole	–	●	H

● = Available ❍ = On request – = Not available ▭ = Preferred program

1) Conical shaft with threaded pin and woodruff key (DIN 6888). The torque must be transmitted via the tapered press fit.

Ordering code for standard program

	A2F		M		/	6		W	–	V						
01	02	03	04	05		06	07	08		09	10	11	12	13	14	15

Port plates for service lines[2)]

				5	10-16	23	28, 32	45	56,63	80,90	107-125	160-180	200	250	355-500	1000	
12	SAE flange ports A and B at rear	01	0	–	–	●	●	●	●	●	●	●	●	●	●	●	010
			7	–	–	–	–	–	–	–	–	–	–	–	●	–	017
	SAE flange ports A and B at side, opposite	02	0	–	–	●	●	●	●	●	●	●	–	●	–	–	020
			7	–	–	–	–	●	▲	▲	●	●	–	●	–	–	027
			9	–	–	–	–	–	●	●	–	–	–	–	–	–	029
	Threaded ports A and B at side, opposite	03	0	●	●	●	●	–	–	–	–	–	–	–	–	–	030
	Threaded ports A and B at side and rear[3)]	04	0	–	●	●	●	●	●	–	–	–	–	❍	–	–	040
	SAE flange ports A and B at bottom (same side)	10	0	–	–	–	●	●	●	●	●	●	–	–	❍	–	100
	Port plate with 1-level pressure-relief valves for mounting a counterbalance valve[5)] BVD	17	1	–	–	–	–	–	–	–	●	–					171 178
	BVD	18	8	–	–	–	●	●	●	●	●	●	–	–	–	–	181 188
	BVE	18		–	–	–	–	–	–	–	●	●	–	–[4)]	–	–	
	Port plate with pressure-relief valves	19	1	–	–	–	●	●	●	●	●	●	–	–	–	–	191
			2	–	–	–	●	●	●	●	●	●	–	–	–	–	192

Valves (see pages 34 to 41)

Without valve	0
Pressure-relief valve (without pressure boost facility)	1
Pressure-relief valve (with pressure boost facility)	2
Flushing and boost pressure valve, mounted	7
Counterbalance valve BVD/BVE mounted[5)6)]	8
Flushing and boost pressure valve, integrated	9

Speed sensors (see pages 42 and 43)

		5 to 16	23 to 180	200	250 to 500	710 to 1000[4)]	
13	Without speed sensor (without code)	●	●	●	●	●	
	Prepared for HDD speed sensor	–	▲	▲	●	–	F
	HDD speed sensor mounted[7)]	–	▲	▲	●	–	H
	Prepared for DSA speed sensor	–	❍	❍	❍	–	U
	DSA speed sensor mounted[7)]	–	❍	❍	❍	–	V

Special version

14	Standard version (without code)	
	Special version for slew drives (standard with port plate 19)	J

Standard / special version

15	Standard version (without code)	
	Standard version with installation variants, e. g. T ports against standard open or closed	–Y
	Special version	-S

● = Available ❍ = On request – = Not available ▲ = Not for new projects (grey box) = Preferred program

2) Fastening thread or threaded ports, metric
3) Threaded ports at the sides (sizes 10 to 63) plugged with threaded plugs
4) Please contact us.
5) Note the restrictions on page 39.
6) Specify ordering code of counterbalance valve according to data sheet (BVD – RE 95522, BVE – RE 95525) separately.
7) Specify ordering code of sensor according to data sheet (DSA – RE 95133, HDD – RE 95135) separately and observe the requirements on the electronics

2

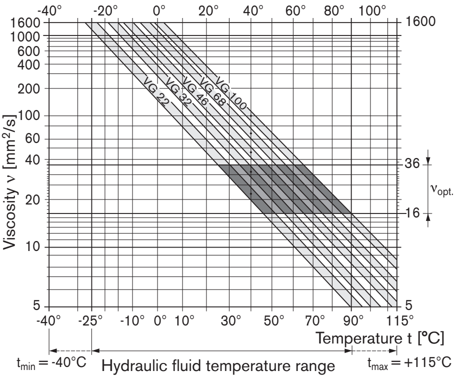
Technical data

Hydraulic fluid

Before starting project planning, please refer to our data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids), RE 90222 (HFD hydraulic fluids) and RE 90223 (HFA, HFB, HFC hydraulic fluids) for detailed information regarding the choice of hydraulic fluid and application conditions.

The fixed motor A2FM is not suitable for operation with HFA hydraulic fluid. If HFB, HFC or HFD or environmentally acceptable hydraulic fluids are used, the limitations regarding technical data or other seals must be observed.

Selection diagram



Details regarding the choice of hydraulic fluid

The correct choice of hydraulic fluid requires knowledge of the operating temperature in relation to the ambient temperature: in a closed circuit, the circuit temperature, in an open circuit, the reservoir temperature.

The hydraulic fluid should be chosen so that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt} see shaded area of the selection diagram). We recommended that the higher viscosity class be selected in each case.

Example: At an ambient temperature of X °C, an operating temperature of 60 °C is set in the circuit. In the optimum operating viscosity range ($\nu_{opt.}$, shaded area), this corresponds to the viscosity classes VG 46 or VG 68; to be selected: VG 68.

Note

The case drain temperature, which is affected by pressure and speed, can be higher than the circuit temperature or reservoir temperature. At no point of the component may the temperature be higher than 115 °C. The temperature difference specified below is to be taken into account when determining the viscosity in the bearing.

If the above conditions cannot be maintained due to extreme operating parameters, we recommend flushing the case at port U (sizes 250 to 1000) or using a flushing and boost pressure valve (see pages 34).

Viscosity and temperature of hydraulic fluid

	Viscosity [mm²/s]	Temperature	Comment
Transport and storage at ambient temperature		$T_{min} \geq$ -50 °C T_{opt} = +5 °C to +20 °C	factory preservation: up to 12 months with standard, up to 24 months with long-term
(Cold) start-up[1]	ν_{max} = 1600	$T_{St} \geq$ -40 °C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1000 rpm (for sizes 5 to 200), n ≤ 0.25 • n_{nom} (for sizes 250 to 1000)
Permissible temperature difference		ΔT ≤ 25 K	between axial piston unit and hydraulic fluid
Warm-up phase	ν < 1600 to 400	T = -40 °C to -25 °C	at p ≤ 0.7 • p_{nom}, n ≤ 0.5 • n_{nom} and t ≤ 15 min
Operating phase			
Temperature difference		ΔT = approx. 12 K	between hydraulic fluid in the bearing and at port T.
Maximum temperature		115 °C	in the bearing
		103 °C	measured at port T
Continuous operation	ν = 400 to 10 ν_{opt} = 36 to 16	T = -25 °C to +90 °C	measured at port T, no restriction within the permissible data
Short-term operation[2]	$\nu_{min} \geq 7$	T_{max} = +103 °C	measured at port T, t < 3 min, p < 0.3 • p_{nom}
FKM shaft seal[1]		T ≤ +115 °C	see page 5

1) At temperatures below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).
2) Sizes 250 to 1000, please contact us.

Technical data

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.

To ensure the functional reliability of the axial piston unit, a gravimetric analysis of the hydraulic fluid is necessary to determine the amount of solid contaminant and to determine the cleanliness level according to ISO 4406. A cleanliness level of at least 20/18/15 is to be maintained.

At very high hydraulic fluid temperatures (90 °C to maximum 115 °C), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

If the above classes cannot be achieved, please contact us.

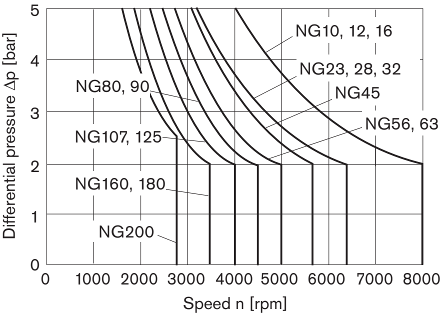
Shaft seal

Permissible pressure loading

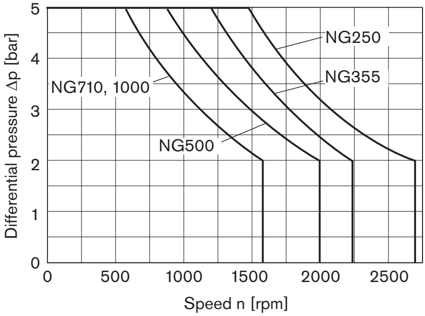
The service life of the shaft seal is influenced by the speed of the axial piston unit and the case drain pressure (case pressure). The mean differential pressure of 2 bar between the case and the ambient pressure may not be enduringly exceeded at normal operating temperature. For a higher differential pressure at reduced speed, see diagram. Momentary pressure spikes ($t < 0.1$ s) of up to 10 bar are permitted. The service life of the shaft seal decreases with an increase in the frequency of pressure spikes.

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

Sizes 10 to 200



Sizes 250 to 1000



The values are valid for an ambient pressure $p_{abs} = 1$ bar.

Temperature range

The FKM shaft seal may be used for case drain temperatures from -25 °C to +115 °C.

Note
For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C). State NBR shaft seal in plain text when ordering.
Please contact us.

2

Direction of flow

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

Speed range

No limit to minimum speed n_{min}. If uniformity of motion is required, speed n_{min} must not be less than 50 rpm. See table of values on page 7 for maximum speed.

Long-life bearing

Sizes 250 to 1000
For long service life and use with HF hydraulic fluids. Identical external dimensions as motor with standard bearings. Subsequent conversion to long-life bearings is possible. Bearing and case flushing via port U is recommended.

Flushing flow (recommended)

NG	250	355	500	710	1000
$q_{v\ flush}$ (L/min)	10	16	16	16	16

Technical data

Operating pressure range

(operating with mineral oil)

Pressure at service line port A or B

Size 5

Nominal pressure p_{nom} ________ 315 bar absolute

Maximum pressure p_{max} ________ 350 bar absolute
Single operating period ________ 10 s
Total operating period ________ 300 h

Summation pressure (pressure A + pressure B) p_{Su} 630 bar

Sizes 10 to 200

Nominal pressure p_{nom} ________ 400 bar absolute

Maximum pressure p_{max} ________ 450 bar absolute
Single operating period ________ 10 s
Total operating period ________ 300 h

Summation pressure (pressure A + pressure B) p_{Su} _ 700 bar

Sizes 250 to 1000

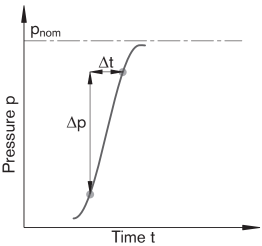
Nominal pressure p_{nom} ________ 350 bar absolute

Maximum pressure p_{max} ________ 400 bar absolute
Single operating period ________ 10 s
Total operating period ________ 300 h

Summation pressure (pressure A + pressure B) p_{Su} _ 700 bar

Minimum pressure (high-pressure side) ___25 bar absolute

Rate of pressure change $R_{A\ max}$
with integrated pressure-relief valve________ 9000 bar/s
without pressure-relief valve ________ 16000 bar/s

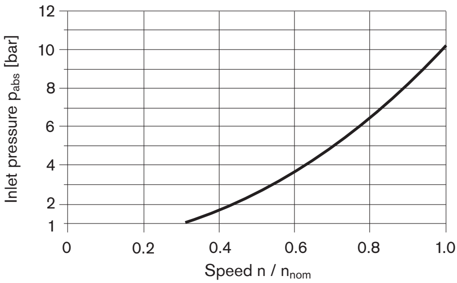


Note

Values for other hydraulic fluids, please contact us.

Minimum pressure – pump mode (inlet)

To prevent damage to the axial piston motor in pump operating mode (change of high-pressure side with unchanged direction of rotation, e. g. when braking), a minimum pressure must be guaranteed at the service line port (inlet). The minimum pressure depends on the speed of the axial piston unit (see characteristic curve below).



This diagram is valid only for the optimum viscosity range from ν_{opt} = 36 to 16 mm²/s.
Please contact us if these conditions cannot be satisfied.

Definition

Nominal pressure p_{nom}

The nominal pressure corresponds to the maximum design pressure.

Maximum pressure p_{max}

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.

Minimum pressure (high-pressure side)

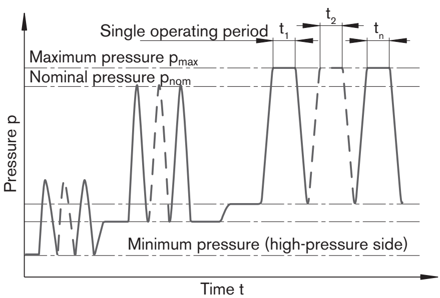
Minimum pressure at the high-pressure side (A or B) which is required in order to prevent damage to the axial piston unit.

Summation pressure p_{Su}

The summation pressure is the sum of the pressures at both service line ports (A and B).

Rate of pressure change R_A

Maximum permissible rate of pressure rise and reduction during a pressure change over the entire pressure range.



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

Technical data

Table of values (theoretical values, without efficiency and tolerances; values rounded)

Size	NG		5	10	12	16	23	28	32	45	56	63	80
Displacement geometric, per revolution	V_g	cm^3	4.93	10.3	12	16	22.9	28.1	32	45.6	56.1	63	80.4
Speed maximum[1]	n_{nom}	rpm	10000	8000	8000	8000	6300	6300	6300	5600	5000	5000	4500
	n_{max}[2]	rpm	11000	8800	8800	8800	6900	6900	6900	6200	5500	5500	5000
Input flow[3]													
at n_{nom} and V_g	q_V	L/min	49	82	96	128	144	177	202	255	281	315	362
Torque[4]													
at V_g and $\Delta p = 350$ bar	T	Nm	24.7[5]	57	67	89	128	157	178	254	313	351	448
$\Delta p = 400$ bar	T	Nm	–	66	76	102	146	179	204	290	357	401	512
Rotary stiffness	c	kNm/rad	0.63	0.92	1.25	1.59	2.56	2.93	3.12	4.18	5.94	6.25	8.73
Moment of inertia for rotary group	J_{GR}	kgm^2	0.00006	0.0004	0.0004	0.0004	0.0012	0.0012	0.0012	0.0024	0.0042	0.0042	0.0072
Maximum angular acceleration	α	rad/s^2	5000	5000	5000	5000	6500	6500	6500	14600	7500	7500	6000
Case volume	V	L		0.17	0.17	0.17	0.20	0.20	0.20	0.33	0.45	0.45	0.55
Mass (approx.)	m	kg	2.5	5.4	5.4	5.4	9.5	9.5	9.5	13.5	18	18	23

Size	NG		90	107	125	160	180	200	250	355	500	710	1000
Displacement geometric, per revolution	V_g	cm^3	90	106.7	125	160.4	180	200	250	355	500	710	1000
Speed maximum[1]	n_{nom}	rpm	4500	4000	4000	3600	3600	2750	2700	2240	2000	1600	1600
	n_{max}[2]	rpm	5000	4400	4400	4000	4000	3000	–	–	–	–	–
Input flow[3]													
at n_{nom} and V_g	q_V	L/min	405	427	500	577	648	550	675	795	1000	1136	1600
Torque[4]													
at V_g and $\Delta p = 350$ bar	T	Nm	501	594	696	893	1003	1114	1393	1978	2785	3955	5570
$\Delta p = 400$ bar	T	Nm	573	679	796	1021	1146	1273	–	–	–	–	–
Rotary stiffness	c	kNm/rad	9.14	11.2	11.9	17.4	18.2	57.3	73.1	96.1	144	270	324
Moment of inertia for rotary group	J_{GR}	kgm^2	0.0072	0.0116	0.0116	0.0220	0.0220	0.0353	0.061	0.102	0.178	0.55	0.55
Maximum angular acceleration	α	rad/s^2	6000	4500	4500	3500	3500	11000	10000	8300	5500	4300	4500
Case volume	V	L	0.55	0.8	0.8	1.1	1.1	2.7	2.5	3.5	4.2	8	8
Mass (approx.)	m	kg	23	32	32	45	45	66	73	110	155	325	336

1) The values are valid:
- for the optimum viscosity range from $\nu_{opt} = 36$ to 16 mm^2/s
- with hydraulic fluid based on mineral oils

2) Intermittent maximum speed: overspeed for unload and overhauling processes, $t < 5$ s and $\Delta p < 150$ bar
3) Restriction of input flow with counterbalance valve, see page 39
4) Torque without radial force, with radial force see page 8
5) Torque at $\Delta p = 315$ bar

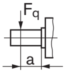
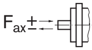
Note
Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Other permissible limit values, with respect to speed variation, reduced angular acceleration as a function of the frequency and the permissible start up angular acceleration (lower than the maximum angular acceleration) can be found in data sheet RE 90261.

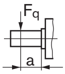
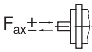
2

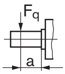
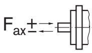
Technical data

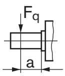
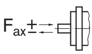
Permissible radial and axial forces of the drive shafts

(splined shaft and parallel keyed shaft)

Size	NG		5	5[3)]	10	10	12	12	16	23	23
Drive shaft	ø	mm	12	12	20	25	20	25	25	25	30
Maximum radial force[1)] at distance a (from shaft collar) 	$F_{q\,max}$	kN	1.6	1.6	3.0	3.2	3.0	3.2	3.2	5.7	5.4
	a	mm	12	12	16	16	16	16	16	16	16
with permissible torque	T_{max}	Nm	24.7	24.7	66	66	76	76	102	146	146
≙ permissible pressure Δp	Δp_{perm}	bar	315	315	400	400	400	400	400	400	400
Maximum axial force[2)] 	$+F_{ax\,max}$	N	180	180	320	320	320	320	320	500	500
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	1.5	1.5	3.0	3.0	3.0	3.0	3.0	5.2	5.2

Size	NG		28	28	32	45	56	56[4)]	56	63	80
Drive shaft	ø	mm	25	30	30	30	30	30	35	35	35
Maximum radial force[1)] at distance a (from shaft collar) 	$F_{q\,max}$	kN	5.7	5.4	5.4	7.6	9.5	7.8	9.1	9.1	11.6
	a	mm	16	16	16	18	18	18	18	18	20
with permissible torque	T_{max}	Nm	179	179	204	290	357	294	357	401	512
≙ permissible pressure Δp	Δp_{perm}	bar	400	400	400	400	400	330	400	400	400
Maximum axial force[2)] 	$+F_{ax\,max}$	N	500	500	500	630	800	800	800	800	1000
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	5.2	5.2	5.2	7.0	8.7	8.7	8.7	8.7	10.6

Size	NG		80[4)]	80	90	107	107	125	160	160	180
Drive shaft	ø	mm	35	40	40	40	45	45	45	50	50
Maximum radial force[1)] at distance a (from shaft collar) 	$F_{q\,max}$	kN	11.1	11.4	11.4	13.6	14.1	14.1	18.1	18.3	18.3
	a	mm	20	20	20	20	20	20	25	25	25
with permissible torque	T_{max}	Nm	488	512	573	679	679	796	1021	1021	1146
≙ permissible pressure Δp	Δp_{perm}	bar	380	400	400	400	400	400	400	400	400
Maximum axial force[2)] 	$+F_{ax\,max}$	N	1000	1000	1000	1250	1250	1250	1600	1600	1600
	$-F_{ax\,max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	10.6	10.6	10.6	12.9	12.9	12.9	16.7	16.7	16.7

Size	NG		200	250	355	500	710	1000
Drive shaft	ø	mm	50	50	60	70	90	90
Maximum radial force[1)] at distance a (from shaft collar) 	$F_{q\,max}$	kN	20.3	1.2[6)]	1.5[6)]	1.9[6)]	3.0[6)]	2.6[6)]
	a	mm	25	41	52.5	52.5	67.5	67.5
with permissible torque	T_{max}	Nm	1273	[5)]	[5)]	[5)]	[5)]	[5)]
≙ permissible pressure Δp	Δp_{perm}	bar	400	[5)]	[5)]	[5)]	[5)]	[5)]
Maximum axial force[2)] 	$+F_{ax\,max}$	N	1600	2000	2500	3000	4400	4400
	$-F_{ax\,max}$	N	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$\pm F_{ax\,perm/bar}$	N/bar	16.7	[5)]	[5)]	[5)]	[5)]	[5)]

1) With intermittent operation
2) Maximum permissible axial force during standstill or when the axial piston unit is operating in non-pressurized condition.
3) Conical shaft with threaded pin and woodruff key (DIN 6888)
4) Restricted technical data only for splined shaft
5) Please contact us.
6) When at a standstill or when axial piston unit operating in non-pressurized conditions. Higher forces are permissible when under pressure, please contact us.

Note

Influence of the direction of the permissible axial force:

$+F_{ax\,max}$ = Increase in service life of bearings

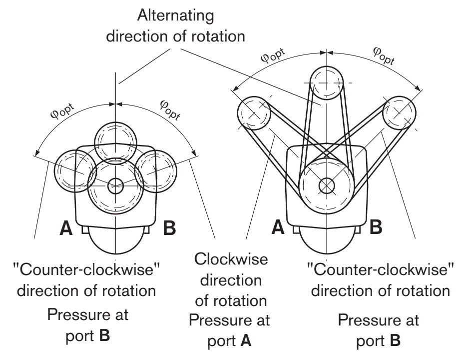
$-F_{ax\,max}$ = Reduction in service life of bearings (avoid)

Technical data

Effect of radial force F_q on the service life of bearings

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

	Toothed gear drive	V-belt output
NG	φ_{opt}	φ_{opt}
5 to 180	± 70°	± 45°
200 to 1000	± 45°	± 70°



Determining the operating characteristics

Input flow $q_v = \dfrac{V_g \cdot n}{1000 \cdot \eta_v}$ [L/min]

Speed $n = \dfrac{q_V \cdot 1000 \cdot \eta_v}{V_g}$ [min^{-1}]

Torque $T = \dfrac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$ [Nm]

Power $P = \dfrac{2\,\pi \cdot T \cdot n}{60000} = \dfrac{q_v \cdot \Delta p \cdot \eta_t}{600}$ [kW]

V_g = Displacement per revolution in cm^3

Δp = Differential pressure in bar

n = Speed in rpm

η_v = Volumetric efficiency

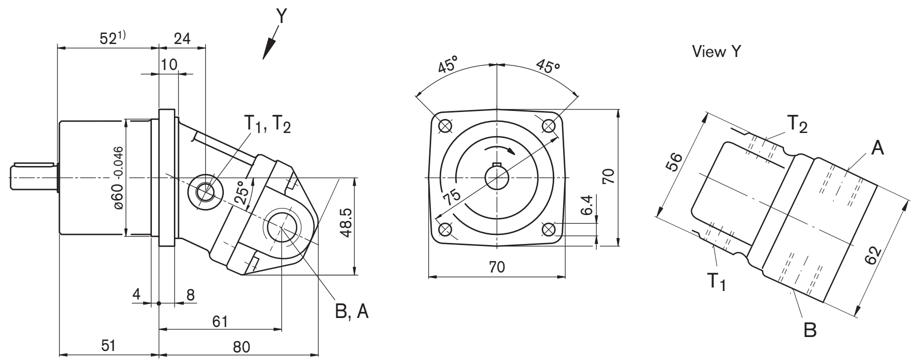
η_{mh} = Mechanical-hydraulic efficiency

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

2

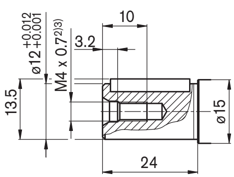
Dimensions size 5

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

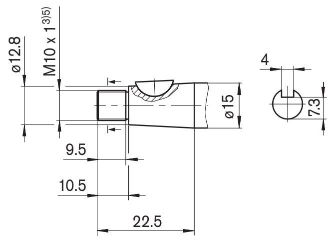


Drive shafts

B Parallel keyed shaft DIN 6885, A4x4x20



C Conical shaft with threaded pin and woodruff key, 3x5 (DIN 6888), (tapering 1:10)



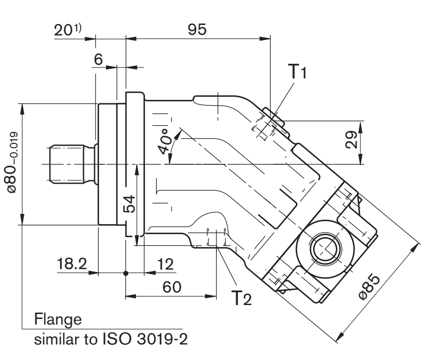
Ports

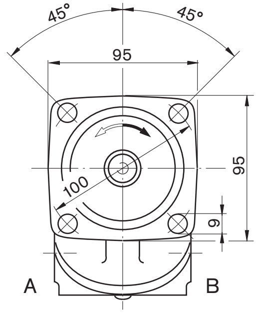
Designation	Port for	Standard[6)]	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line	DIN 3852	M18 x 1.5; 12 deep	350	O
T_1	Drain line	DIN 3852	M10 x 1; 8 deep	3	O
T_2	Drain line	DIN 3852	M10 x 1; 8 deep	3	O

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Thread according to DIN 3852, maximum tightening torque: 30 Nm
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)

Dimensions sizes 10, 12, 16

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

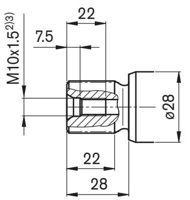




Drive shafts

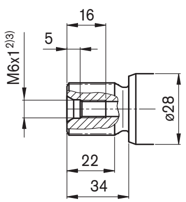
Sizes 10, 12, 16

A Splined shaft DIN 5480 W25x1.25x18x9g



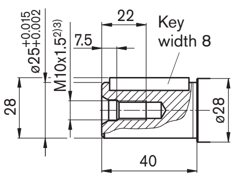
Sizes 10, 12

Z Splined shaft DIN 5480 W20x1.25x14x9g



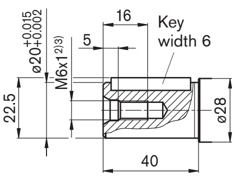
Sizes 10, 12, 16

B Parallel keyed shaft DIN 6885, AS8x7x32



Sizes 10, 12

P Parallel keyed shaft DIN 6885, AS6x6x32



Ports

Designation	Port for	Standard	Size3)	Maximum pressure [bar]4)	State7)
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852 6)	M12 x 1.5; 12 deep	3	X5)
T_2	Drain line	DIN 3852 6)	M12 x 1.5; 12 deep	3	O5)

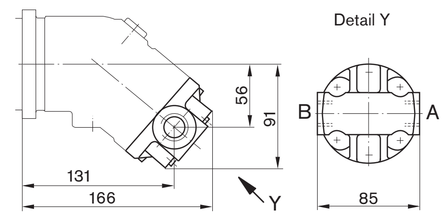
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 10, 12, 16

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

03 – Threaded ports at side, opposite



04 – Threaded ports at side and rear

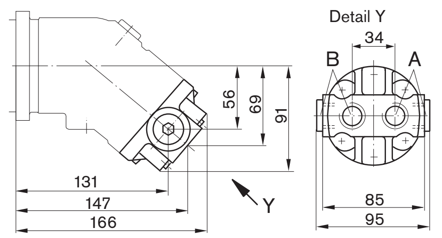


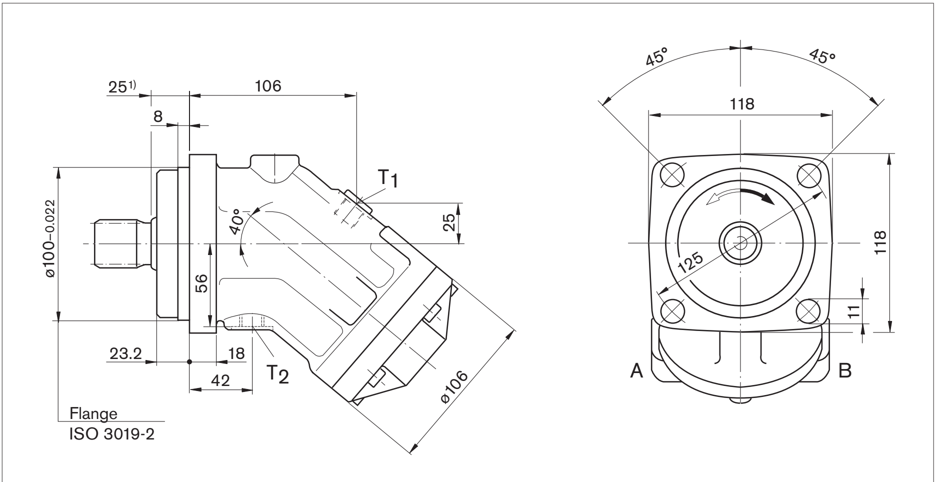
Plate	Designation	Port for	Standard[3]	Size[1]	Maximum pressure [bar][2]	State[4]
03	A, B	Service line	DIN 3852	M22 x 1.5; 14 deep	450	O
04		Service line	DIN 3852	M22 x 1.5; 14 deep	450	1x O each

1) Observe the general instructions on page 46 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) The spot face can be deeper than specified in the appropriate standard.
4) O = Must be connected (plugged on delivery)

2

Dimensions sizes 23, 28, 32

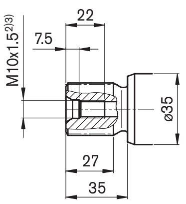
Before finalizing your design, request a binding installation drawing. Dimensions in mm.



Drive shafts

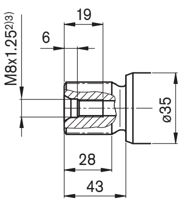
Sizes 23, 28, 32

A Splined shaft DIN 5480 W30x2x14x9g



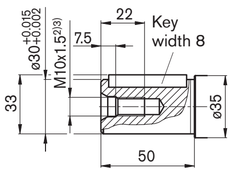
Sizes 23, 28

Z Splined shaft DIN 5480 W25x1.25x18x9g



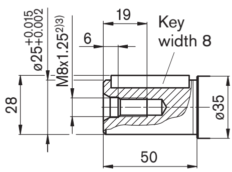
Sizes 23, 28, 32

B Parallel keyed shaft DIN 6885, AS8x7x40



Sizes 23, 28

P Parallel keyed shaft DIN 6885, AS8x7x40



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6)]	M16 x 1.5; 12 deep	3	X[5)]
T_2	Drain line	DIN 3852[6)]	M16 x 1.5; 12 deep	3	O[5)]

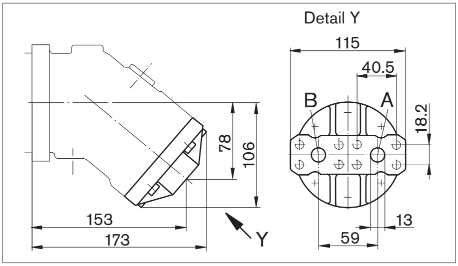
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 23, 28, 32

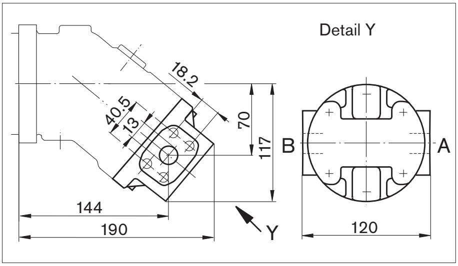
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

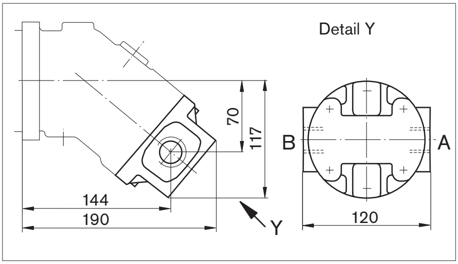
01 – SAE flange ports at rear



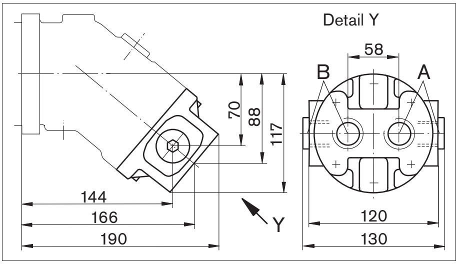
02 – SAE flange ports at side, opposite



03 – Threaded ports at side, opposite



04 – Threaded ports at side and rear



10 – SAE flange ports at bottom (same side)[4)]

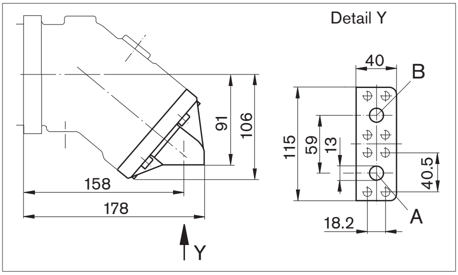


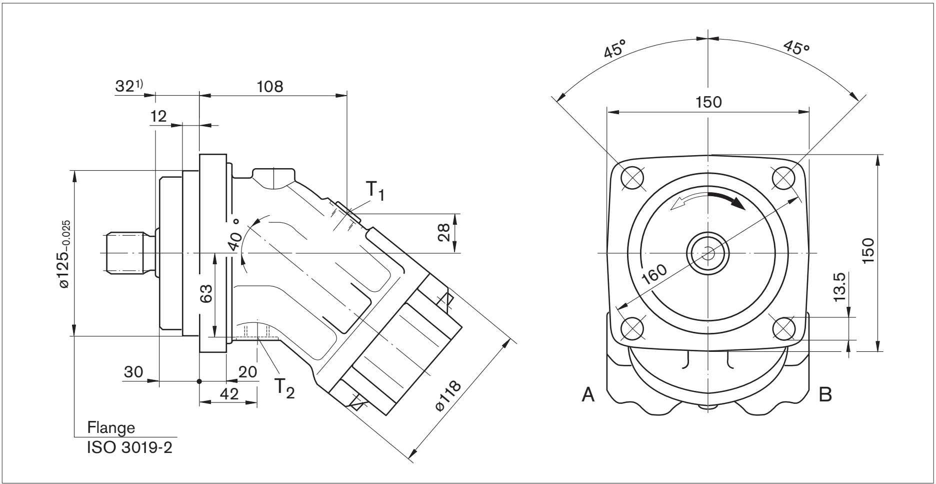
Plate	Designation	Port for	Standard	Size[1)]	Maximum pressure [bar][2)]	State[6)]
01, 02, 10	A, B	Service line Fastening thread A/B	SAE J518[3)] DIN 13	1/2 in M8 x 1.25; 15 deep	450	O
03		Service line	DIN 3852[5)]	M27 x 2; 16 deep	450	O
04		Service line	DIN 3852[5)]	M27 x 2; 16 deep	450	1x O each

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard
4) Only sizes 28 and 32
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)

Note
Port plates 18 and 19: see pages 37 and 40

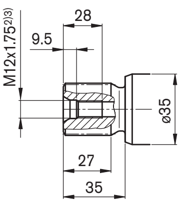
Dimensions size 45

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

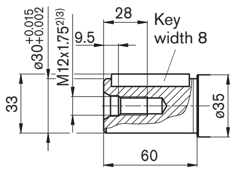


Drive shafts

Z Splined shaft DIN 5480 W30x2x14x9g



P Parallel keyed shaft DIN 6885, AS8x7x50



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[5)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[5)]

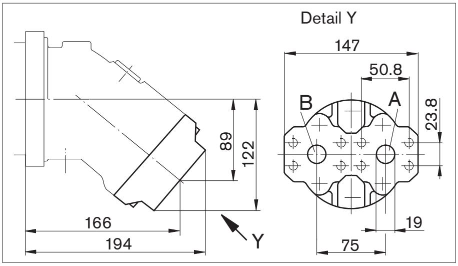
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 45

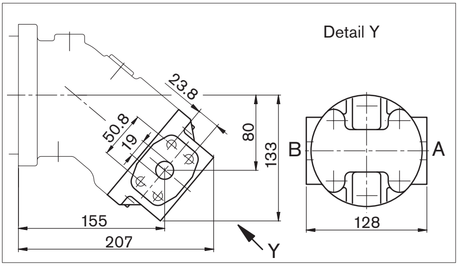
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

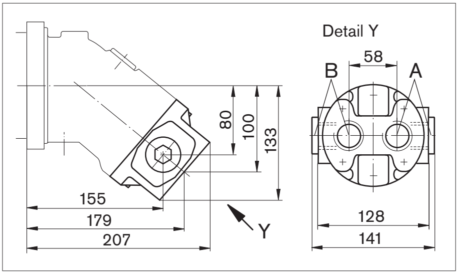
01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite



04 – Threaded ports at side and rear



10 – SAE flange ports at bottom (same side)

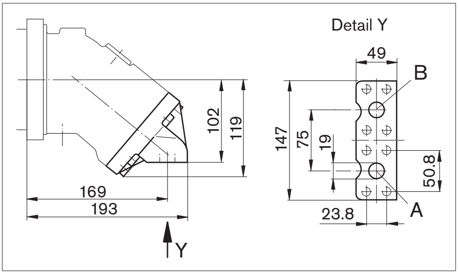


Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[5]
01, 02, 10	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
04		Service line	DIN 3852[4]	M33 x 2; 18 deep	450	1x O each

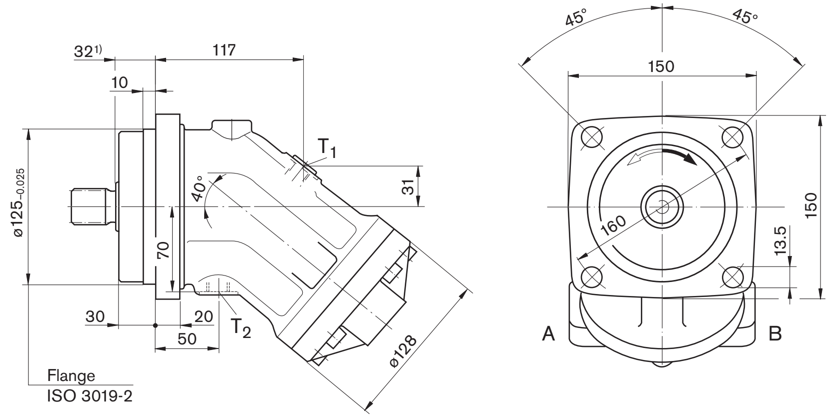
1) Observe the general instructions on page 46 for the maximum tightening torques
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) The spot face can be deeper than specified in the appropriate standard.
5) O = Must be connected (plugged on delivery)

Note

Port plates 18 and 19: see pages 37 and 40

Dimensions sizes 56, 63

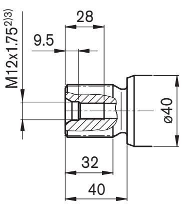
Before finalizing your design, request a binding installation drawing. Dimensions in mm.



Drive shafts

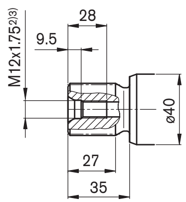
NG56, 63

A Splined shaft DIN 5480 W35x2x16x9g



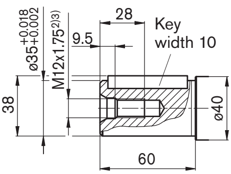
NG56

Z Splined shaft DIN 5480 W30x2x14x9g



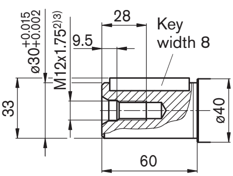
NG56, 63

B Parallel keyed shaft DIN 6885, AS10x8x50



NG56

P Parallel keyed shaft DIN 6885, AS8x7x50



Ports

Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[7]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6]	M18 x 1.5; 12 deep	3	X[5]
T_2	Drain line	DIN 3852[6]	M18 x 1.5; 12 deep	3	O[5]

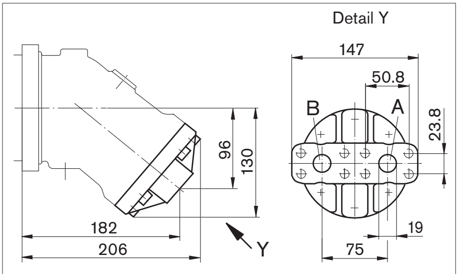
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 56, 63

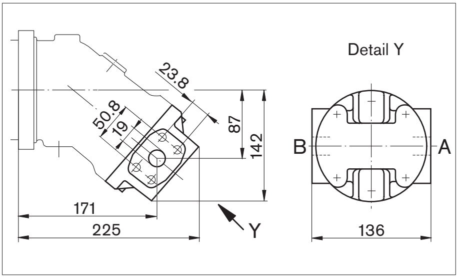
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

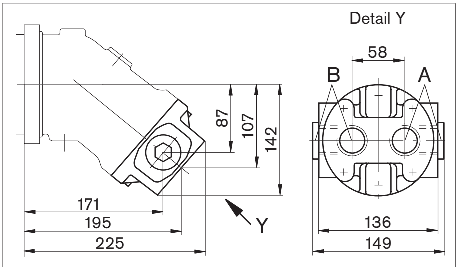
01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite



04 – Threaded ports at side and rear



10 – SAE flange ports at bottom (same side)

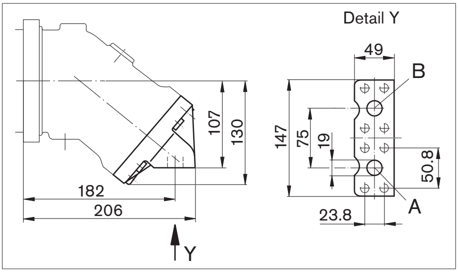


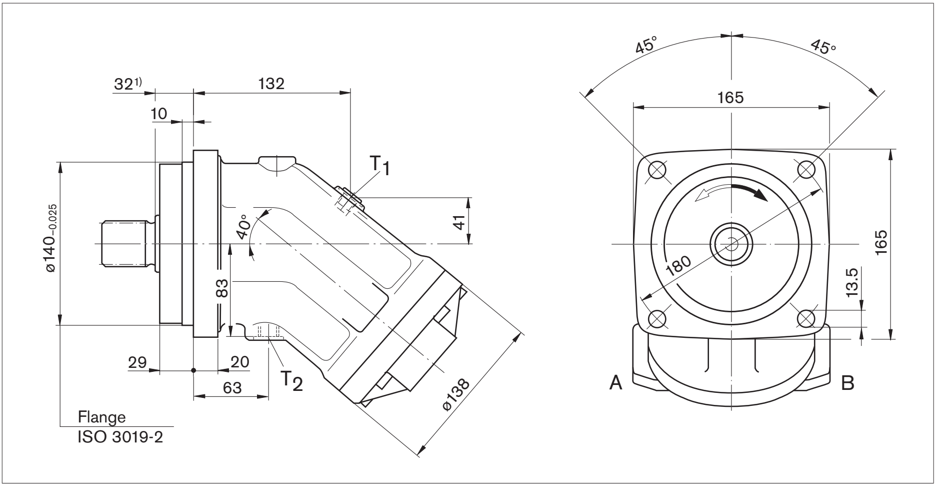
Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[5]
01, 02, 10	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
04		Service line	DIN 3852[4]	M33 x 2; 18 deep	450	1x O each

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) The spot face can be deeper than specified in the appropriate standard.
5) O = Must be connected (plugged on delivery)

Note
Port plates 18 and 19: see pages 37 and 40

Dimensions sizes 80, 90

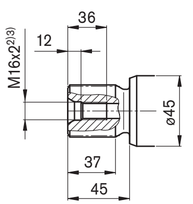
Before finalizing your design, request a binding installation drawing. Dimensions in mm.



Drive shafts

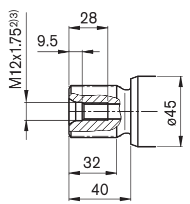
NG80, 90

A Splined shaft DIN 5480 W40x2x18x9g



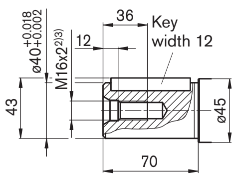
NG80

Z Splined shaft DIN 5480 W35x2x16x9g



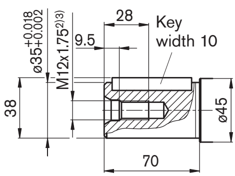
NG80, 90

B Parallel keyed shaft DIN 6885, AS12x8x56



NG80

P Parallel keyed shaft DIN 6885, AS10x8x56



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[5)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[5)]

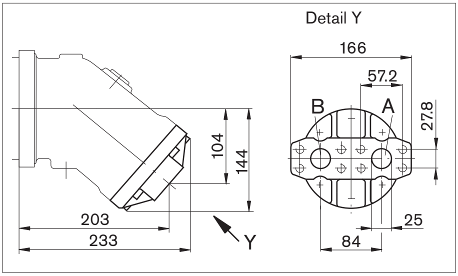
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 80, 90

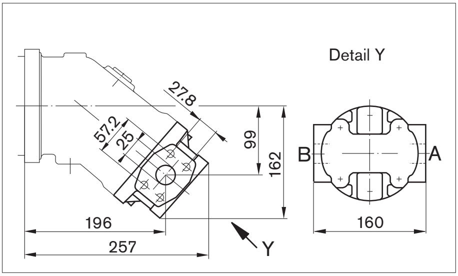
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite



10 – SAE flange ports at bottom (same side)

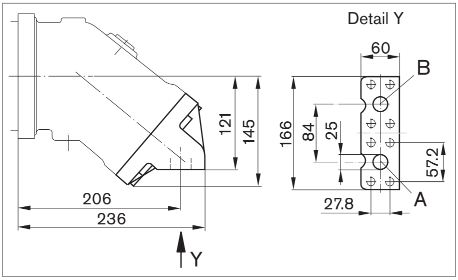


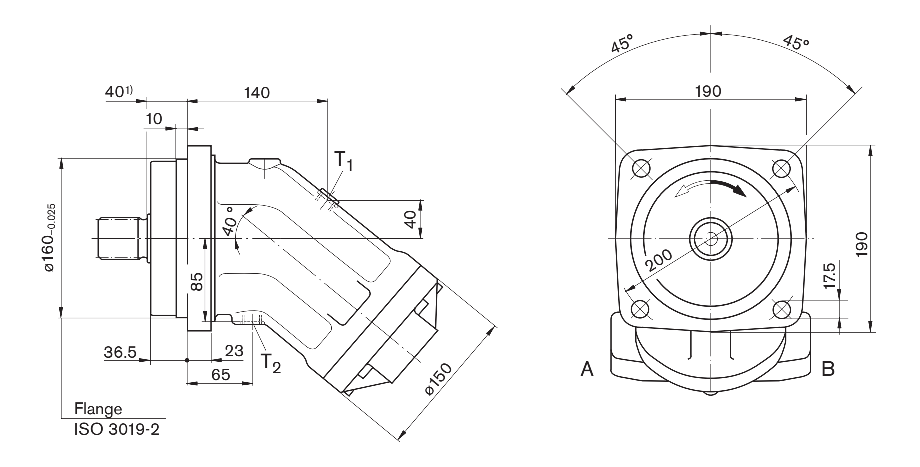
Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[4]
01, 02, 10	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	450	O

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) O = Must be connected (plugged on delivery)

Note
Port plates 18 and 19: see pages 37 and 40

Dimensions sizes 107, 125

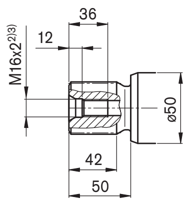
Before finalizing your design, request a binding installation drawing. Dimensions in mm.



Drive shafts

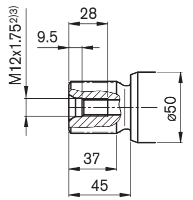
NG107, 125

A Splined shaft DIN 5480 W45x2x21x9g



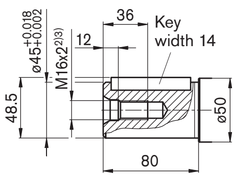
NG107

Z Splined shaft DIN 5480 W40x2x18x9g



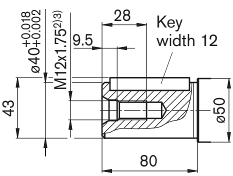
NG107, 125

B Parallel keyed shaft DIN 6885, AS14x9x63



NG107

P Parallel keyed shaft DIN 6885, AS12x8x63



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	X[5)]
T_2	Drain line	DIN 3852[6)]	M18 x 1.5; 12 deep	3	O[5)]

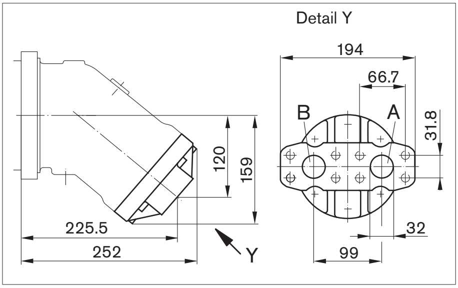
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 107, 125

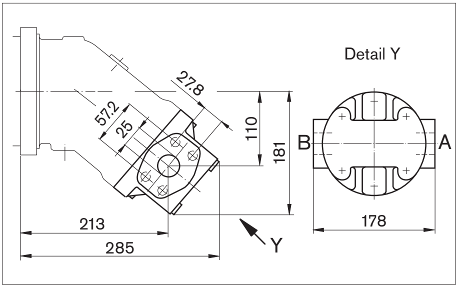
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

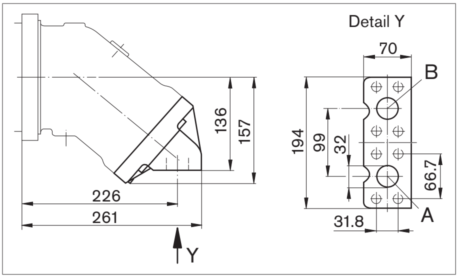
01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite (size 107)



10 – SAE flange ports at bottom (same side)



02 – SAE flange ports at side, opposite (size 125)

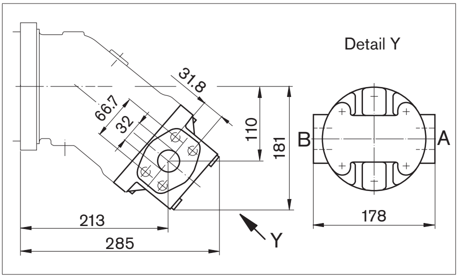


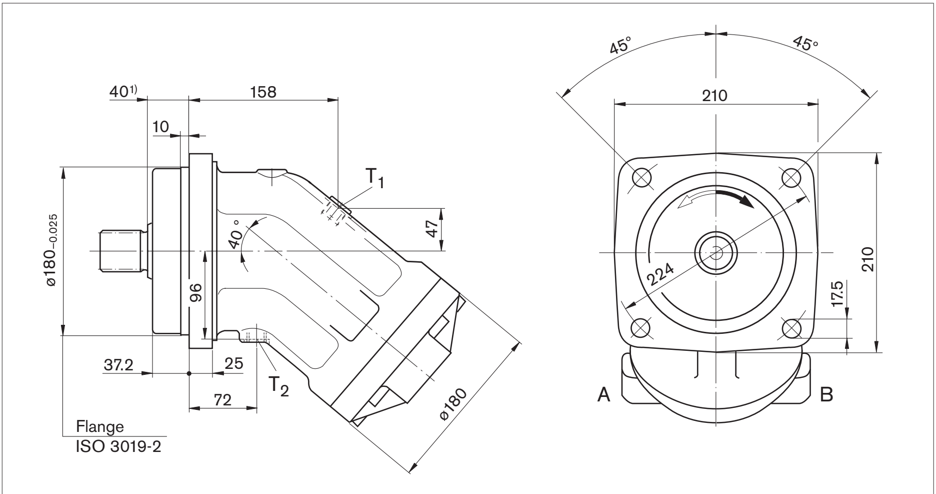
Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[4]
01, 10	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
02 (size 107)		Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	450	O
02 (size 125)		Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) O = Must be connected (plugged on delivery)

Note
Port plates 17, 18 and 19: see pages 37 and 40

Dimensions sizes 160, 180

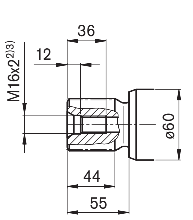
Before finalizing your design, request a binding installation drawing. Dimensions in mm.



Drive shafts

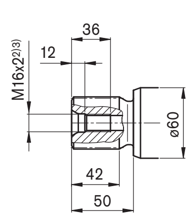
NG160, 180

A Splined shaft DIN 5480 W50x2x24x9g



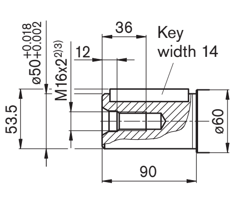
NG160

Z Splined shaft DIN 5480 W45x2x21x9g



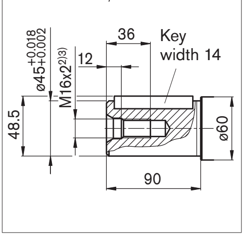
NG160, 180

B Parallel keyed shaft DIN 6885, AS14x9x70



NG160

P Parallel keyed shaft DIN 6885, AS14x9x70



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			450	
T_1	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	X[5)]
T_2	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	O[5)]

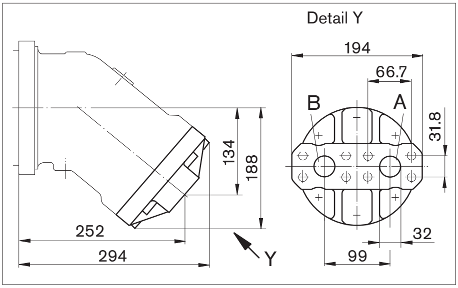
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions sizes 160, 180

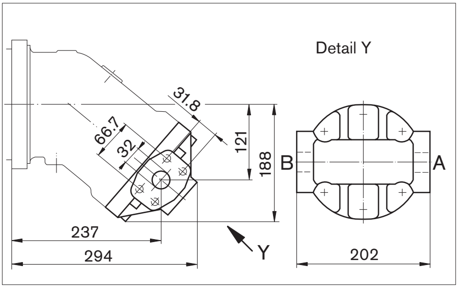
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite



10 – SAE flange ports at bottom (same side)

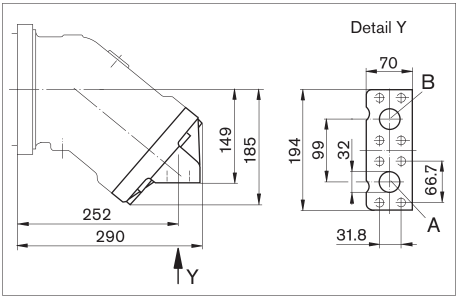


Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[4]
01, 02, 10	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) O = Must be connected (plugged on delivery)

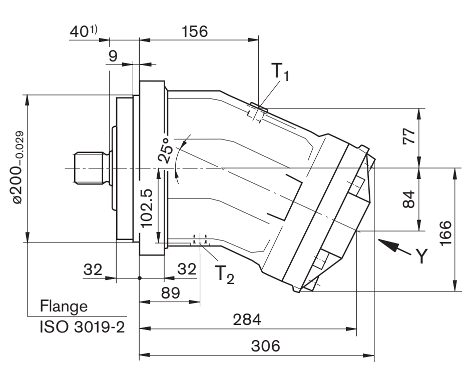
Note

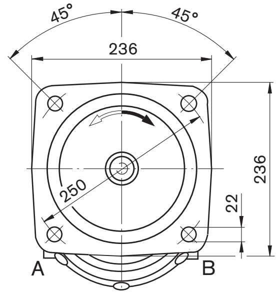
Port plates 18 and 19: see pages 37 and 40

Dimensions size 200

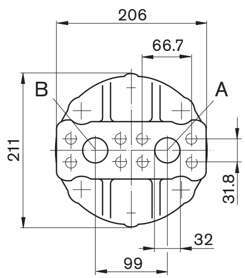
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 01 – SAE flange ports at rear



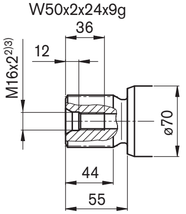


Detail Y

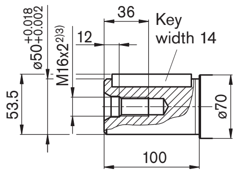


Drive shafts

A Splined shaft DIN 5480 W50x2x24x9g



B Parallel keyed shaft DIN 6885, AS14x9x80



Ports

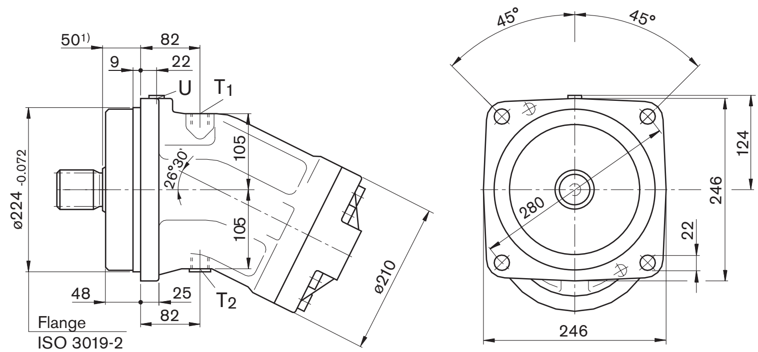
Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[8)]
A, B	Service line Fastening thread A/B	SAE J518[5)] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
T_1	Drain line	DIN 3852[7)]	M22 x 1.5; 14 deep	3	X[6)]
T_2	Drain line	DIN 3852[7)]	M22 x 1.5; 14 deep	3	O[6)]

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Notes

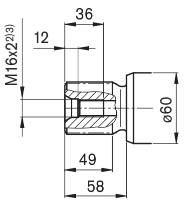
Dimensions size 250

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

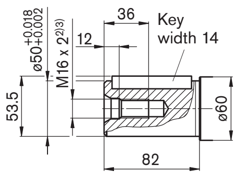


Drive shafts

Z Splined shaft DIN 5480 W50x2x24x9g



P Parallel keyed shaft DIN 6885, AS14x9x80



Ports

Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[7)]
A, B	Service line (see port plates)			400	
T_1	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	O[5)]
T_2	Drain line	DIN 3852[6)]	M22 x 1.5; 14 deep	3	X[5)]
U	Bearing flushing	DIN 3852[6)]	M14 x 1.5; 12 deep	3	X

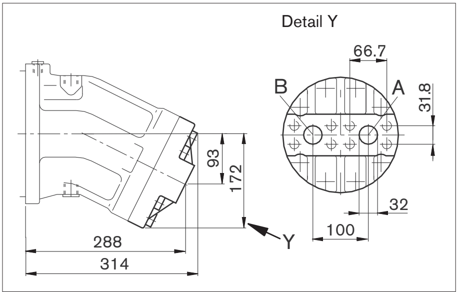
1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
6) The spot face can be deeper than specified in the appropriate standard.
7) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 250

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Location of the service line ports on the port plates

01 – SAE flange ports at rear



02 – SAE flange ports at side, opposite

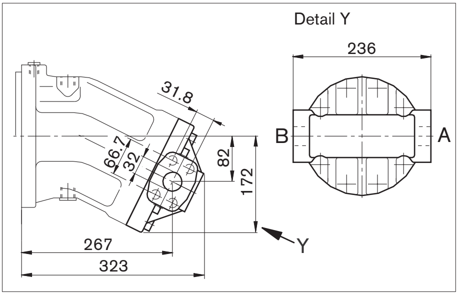


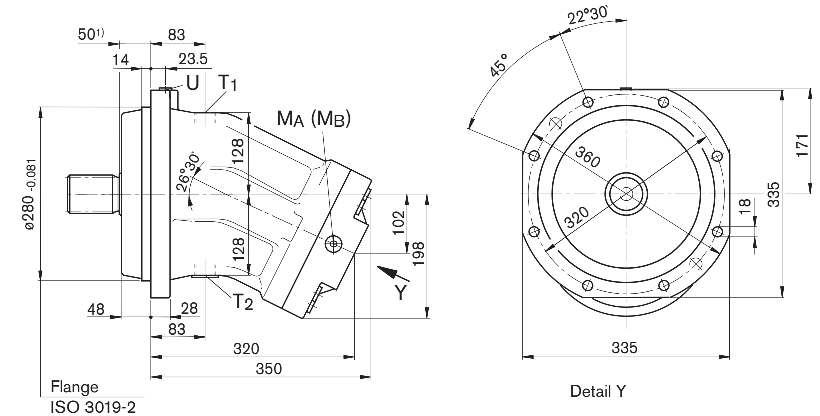
Plate	Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[4]
01, 02	A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	400	O

1) Observe the general instructions on page 46 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) O = Must be connected (plugged on delivery)

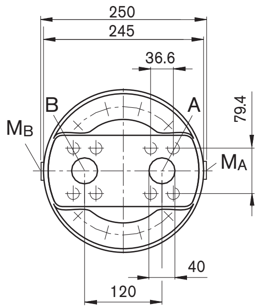
Dimensions size 355

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 01 – SAE flange ports at rear

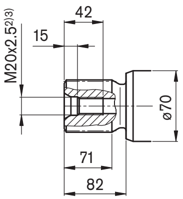


Detail Y

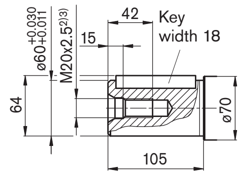


Drive shafts

Z Splined shaft DIN 5480 W60x2x28x9g



P Parallel keyed shaft DIN 6885, AS18x11x100



Ports

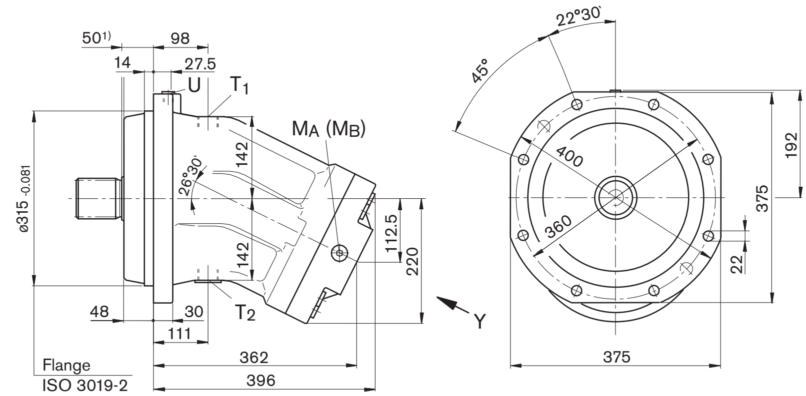
Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[8]
A, B	Service line Fastening thread A/B	SAE J518[5] DIN 13	1 1/2 in M16 x 2; 21 deep	400	O
T_1	Drain line	DIN 3852[7]	M33 x 2; 18 deep	3	O[6]
T_2	Drain line	DIN 3852[7]	M33 x 2; 18 deep	3	X[6]
U	Bearing flushing	DIN 3852[7]	M14 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7]	M14 x 1.5; 12 deep	400	X

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

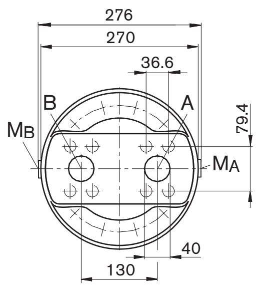
Dimensions size 500

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 01 – SAE flange ports at rear

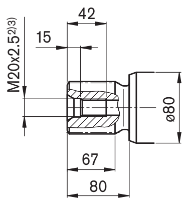


Detail Y

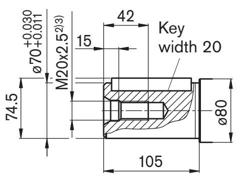


Drive shafts

Z Splined shaft DIN 5480 W70x3x22x9g



P Parallel keyed shaft DIN 6885, AS20x12x100



Ports

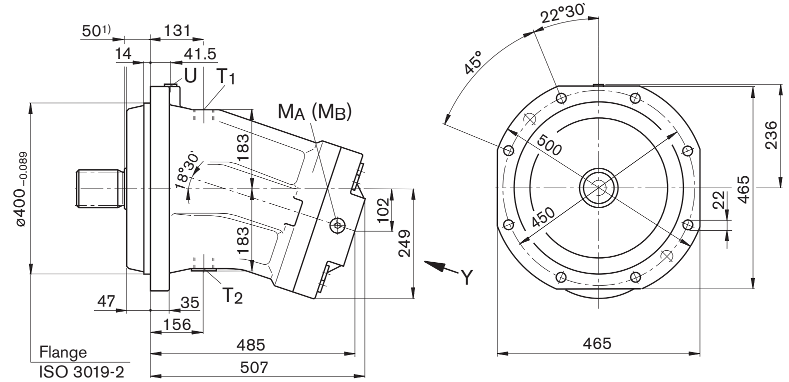
Designation	Port for	Standard	Size[3)]	Maximum pressure [bar][4)]	State[8)]
A, B	Service line Fastening thread A/B	SAE J518[5)] DIN 13	1 1/2 in M16 x 2; 21 deep	400	O
T_1	Drain line	DIN 3852[7)]	M33 x 2; 18 deep	3	O[6)]
T_2	Drain line	DIN 3852[7)]	M33 x 2; 18 deep	3	X[6)]
U	Bearing flushing	DIN 3852[7)]	M18 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7)]	M14 x 1.5; 12 deep	400	X

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

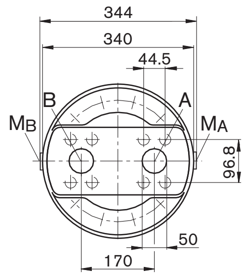
Dimensions size 710

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 01 – SAE flange ports at rear

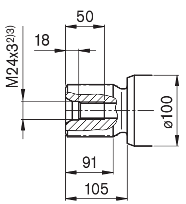


Detail Y

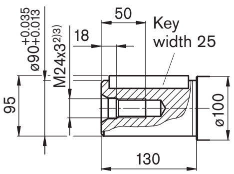


Drive shafts

Z Splined shaft DIN 5480 W90x3x28x9g



P Parallel keyed shaft DIN 6885, AS25x14x125



Ports

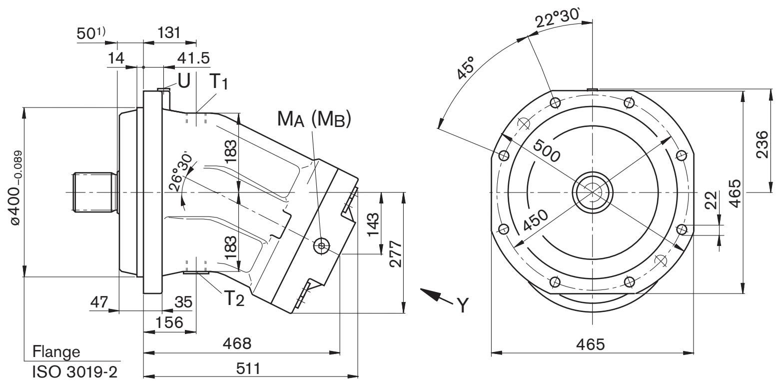
Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[8]
A, B	Service line Fastening thread A/B	SAE J518[5] DIN 13	2 in M20 x 2.5; 30 deep	400	O
T_1	Drain line	DIN 3852[7]	M42 x 2; 20 deep	3	O[6]
T_2	Drain line	DIN 3852[7]	M42 x 2; 20 deep	3	X[6]
U	Bearing flushing	DIN 3852[7]	M18 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7]	M14 x 1.5; 12 deep	400	X

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

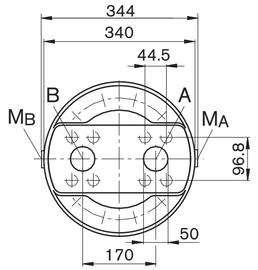
Dimensions size 1000

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Port plate 01 – SAE flange ports at rear

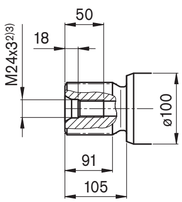


Detail Y

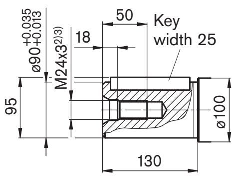


Drive shafts

Z Splined shaft DIN 5480 W90x3x28x9g



P Parallel keyed shaft DIN 6885, AS25x14x125



Ports

Designation	Port for	Standard	Size[3]	Maximum pressure [bar][4]	State[8]
A, B	Service line Fastening thread A/B	SAE J518[5] DIN 13	2 in M20 x 2.5; 30 deep	400	O
T_1	Drain line	DIN 3852[7]	M42 x 2; 20 deep	3	O[6]
T_2	Drain line	DIN 3852[7]	M42 x 2; 20 deep	3	X[6]
U	Bearing flushing	DIN 3852[7]	M18 x 1.5; 12 deep	3	X
M_A, M_B	Measuring operating pressure	DIN 3852[7]	M14 x 1.5; 12 deep	400	X

1) To shaft collar
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Observe the general instructions on page 46 for the maximum tightening torques.
4) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
6) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 44).
7) The spot face can be deeper than specified in the appropriate standard.
8) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Flushing and boost pressure valve

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

In an open circuit, it is used only for flushing the housing.

In a closed circuit, it ensures a minimum boost pressure level in addition to the case flushing.

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

With port plate 027, the valve is mounted directly on the fixed motor (sizes 45 to 180, 250); with port plate 017 (sizes 355 and 500) on a plate.

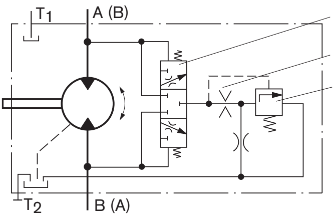
Cracking pressure of pressure retaining valve
(observe when setting the primary valve)
Sizes 45 to 500, fixed setting ______ 16 bar

Switching pressure of flushing piston Δp
Sizes 45 to 500 ______ 8±1 bar

Flushing flow q_v

Orifice (throttles with integrated valve) can be used to set the flushing flows as required.
Following parameters are based on:
$\Delta p_{ND} = p_{ND} - p_G = 25$ bar and $\nu = 10$ mm^2/s
(p_{ND} = low pressure, p_G = case pressure)

Schematic



Standard flushing flows

Flushing and boost pressure valve, mounted (code 7)

Size	Flushing flow q_v [L/min]	ø [mm]	Mat. No. of orifice
45	3.5	1.2	R909651766
107, 125	8	1.8	R909419696
160, 180	10	2.0	R909419697
250	10	2.0	R909419697
355, 500	16	2.5	R910803019

With sizes 45 to 180, orifices can be supplied for flushing flows from 3.5 to 10 L/min. For other flushing flows, please state the required flushing flow when ordering. The flushing flow without orifice is approx. 12 to 14 L at low pressure $\Delta p_{ND} = 25$ bar.

Flushing and boost pressure valve, integrated (code 9)

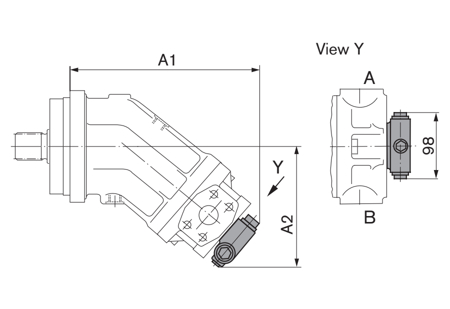
Size	Throttle ø [mm]	q_v [L/min]
56, 63, 80, 90	1.5	6
	1.8	7.3

Flushing and boost pressure valve

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

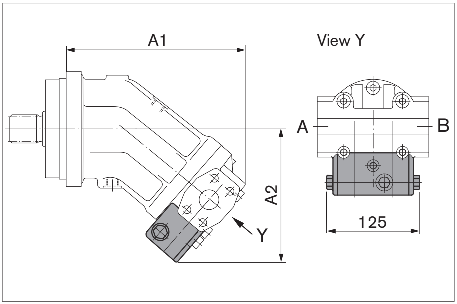
Dimensions

Port plate 027 – SAE flange ports at side



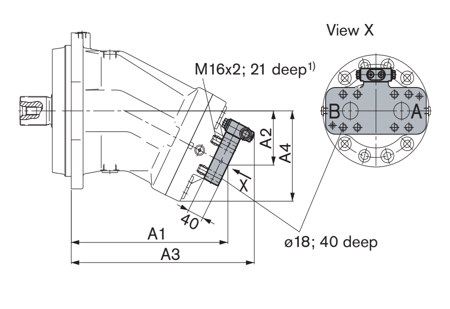
Size	A1	A2
45	223	151
107, 125	294	192
160, 180	315	201
250	344	172

Port plate 029 – SAE flange ports at side



Size	A1	A2
56, 63	225	176
80, 90	257	186.7

Port plate 017 – SAE flange ports at rear



Size	A1	A2	A3	A4
355	356	120	421	198
500	397	130	464	220

1) DIN 13, observe the general instructions on page 46 for the maximum tightening torques

2

Pressure-relief valve

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

The MHDB pressure-relief valves (see RE 64642) protect the hydraulic motor from overload. As soon as the set cracking pressure is reached, the hydraulic fluid flows from the high-pressure side to the low-pressure side.

The pressure-relief valves are only available in combination with port plates 181, 191 or 192 (counterbalance valve for mounting to port plate 181: see next page).

Cracking pressure setting range ____________ 50 to 420 bar

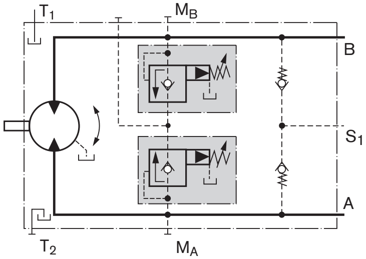
With the version "with pressure boost facility" (192), a higher pressure setting can be realized by applying an external pilot pressure of 25 to 30 bar to port P_{St}.

When ordering, please state in plain text:

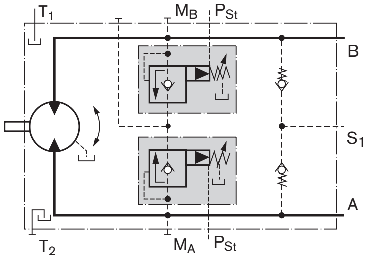
– Cracking pressure of pressure-relief valve

– Cracking pressure with pilot pressure applied to P_{St} (only with version 192)

Version without pressure boost facility "191"



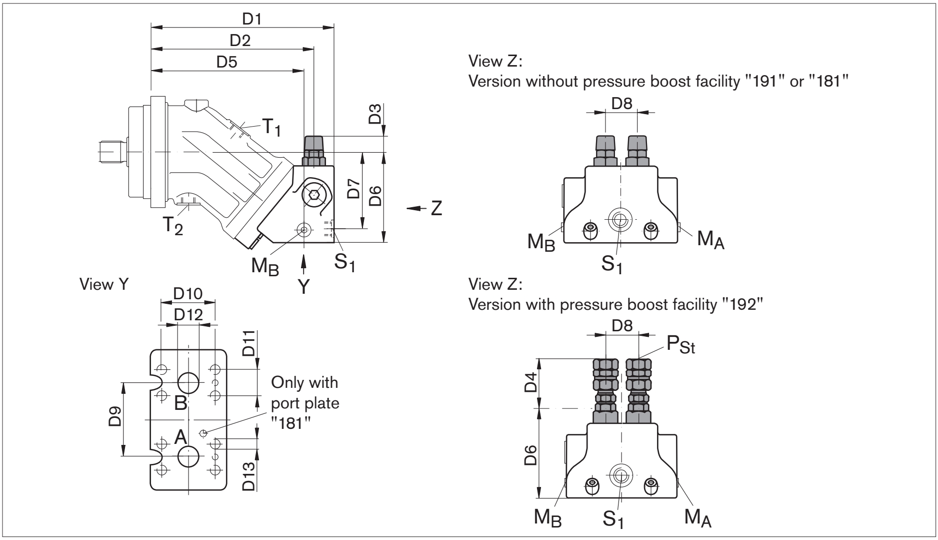
Version with pressure boost facility "192"



Pressure-relief valve

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Dimensions



Size		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13[2)]
28, 32	MHDB.**16**	209	186	25	68	174	102	87	36	66	50.8	23.8	ø19	M10; 17 deep
45	MHDB.**16**	222	198	22	65	187	113	98	36	66	50.8	23.8	ø19	M10; 17 deep
56, 63	MHDB.**22**	250	222	19	61	208	124	105	42	75	50.8	23.8	ø19	M10; 13 deep
80, 90	MHDB.**22**	271	243	17.5	59	229	134	114	42	75	57.2	27.8	ø25	M12; 18 deep
107, 125	MHDB.**32**	298	266	10	52	250	149.5	130	53	84	66.7	31.8	ø32	M14; 19 deep
160, 180	MHDB.**32**	332	301	5	47	285	170	149	53	84	66.7	31.8	ø32	M14; 19 deep

Size	A, B	S_1[1)]	M_A, M_B[1)]	P_{St}[1)]
28, 32	3/4 in	M22 x 1.5; 14 deep	M20 x 1.5; 14 deep	G 1/4
45	3/4 in	M22 x 1.5; 14 deep	M20 x 1.5; 14 deep	G 1/4
56, 63	3/4 in	M26 x 1.5; 16 deep	M26 x 1.5; 16 deep	G 1/4
80, 90	1 in	M26 x 1.5; 16 deep	M26 x 1.5; 16 deep	G 1/4
107, 125	1 1/4 in	M26 x 1.5; 16 deep	M26 x 1.5; 16 deep	G 1/4
160, 180	1 1/4 in	M26 x 1.5; 16 deep	M30 x 1.5; 16 deep	G 1/4

Assembly instructions for port plate with pressure boost facility "192":
The lock nut must be counterheld when installing the hydraulic line at the p_{st} port!

Ports

Designation	Port for	Standard	Size	Maximum pressure [bar][2)]	State[3)]
A, B	Service line	SAE J518	See above	450	O
S_1	Supply (only with port plate 191/192)	DIN 3852	See above	5	O
M_A, M_B	Measuring operating pressure	DIN 3852	See above	450	X
P_{St}	Pilot pressure (only with port plate 192)	DIN ISO 228	See above	30	O

1) Observe the general instructions on page 46 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) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Function

Travel drive/winch counterbalance valves are designed to reduce the danger of overspeeding and cavitation of axial piston motors in open circuits. Cavitation occurs if the motor speed is greater than it should be for the given input flow while braking, travelling downhill, or lowering a load.

If the inlet pressure drops, the counterbalance spool throttles the return flow and brakes the motor until the inlet pressure returns to approx. 20 bar.

Note

– BVD available for sizes 28 to 180 and BVE available for sizes 107 to 180.

– The counterbalance valve must be ordered additionally. We recommend ordering the counterbalance valve and the motor as a set. Ordering example: A2FM90/61W–VAB**188** + BVD20F27S/41B–V03K16D0400S12

– The counterbalance valve does not replace the mechanical service brake and park brake.

– Observe the detailed notes on the BVD counterbalance valve in RE 95522 and BVE counterbalance valve in RE 95525!

– For the design of the brake release valve, we must know for the mechanical park brake:

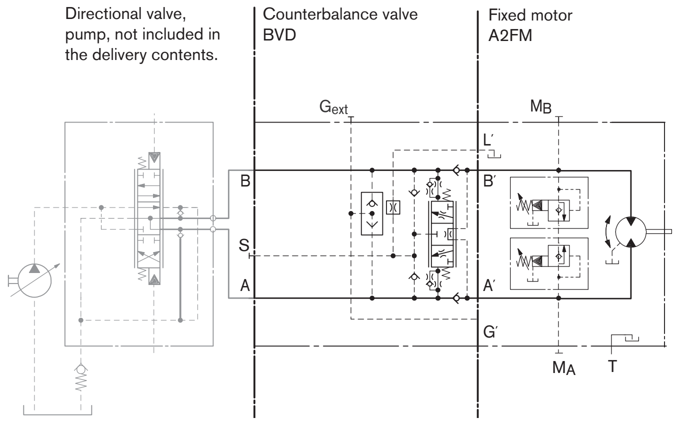
- the pressure at the start of opening
- the volume of the counterbalance spool between minimum stroke (brake closed) and maximum stroke (brake released with 21 bar)
- the required closing time for a warm device (oil viscosity approx. 15 mm²/s)

Travel drive counterbalance valve BVD...F

Application option

– Travel drive on wheeled excavators

Example schematic for travel drive on wheeled excavators
A2FM090/61W-VAB188 + BVD20F27S/41B–V03K16D0400S12



Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

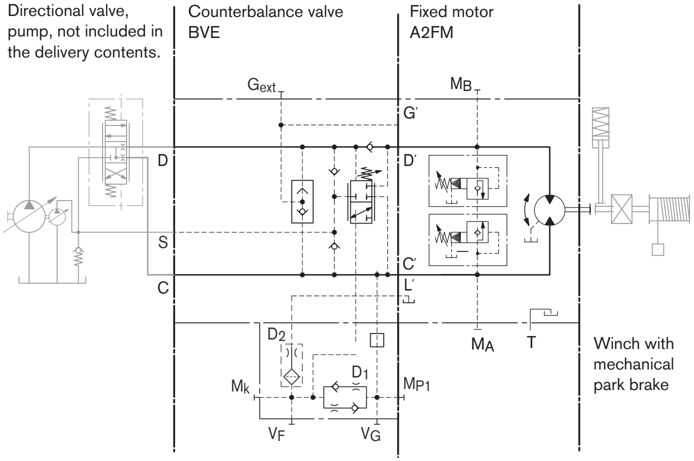
Winch counterbalance valve BVD...W and BVE

Application options

– Winch drive in cranes (BVD and BVE)

– Track drive in excavator crawlers (BVD)

Example schematic for winch drive in cranes
A2FM090/61W-VAB188 + BVE25W385/51ND-V100K00D4599T30S00-0



Permissible input flow or pressure in operation with DBV and BVD/BVE

Motor	Without valve		Restricted values in operation with DBV and BVD/BVE							
			DBV				BVD/BVE			
NG	p_{nom}/p_{max} [bar]	$q_{V\,max}$ [L/min]	NG	p_{nom}/p_{max} [bar]	q_V [L/min]	Code	NG	p_{nom}/p_{max} [bar]	q_V [L/min]	Code
28	400/450	176	16	350/420	100	181 191, 192	20 (BVD)	350/420	100	188
32		201								
45		255								
56		280	22		240				220	
63		315								
80		360								
90		405								
107		427				171 191, 192				178
125		500								
107		427	32		400	181 191, 192	25 (BVD/BVE)		320	188
125		500								
160		577								
180		648								

DBV ______________________________ pressure-relief valve

BVD ________________counterbalance valve, double-acting

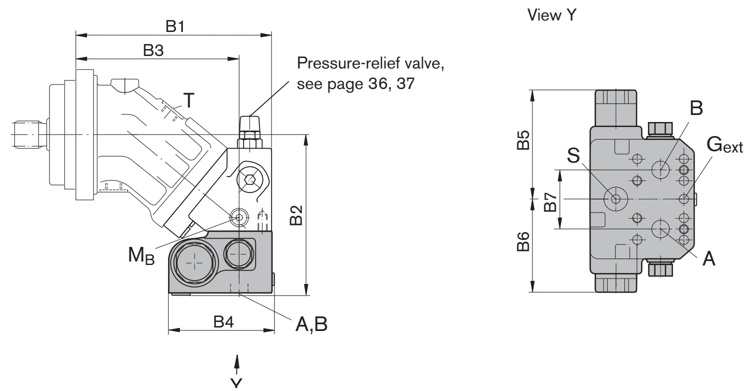
BVE ___________________counterbalance valve, one-sided

2

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Dimensions



A2FM Size	Counterbalance valve Type	Ports A, B	Dimensions B1	B2	B3	B4 (S)	B4 (L)	B5	B6	B7
28, 32	BVD**20**..16	3/4 in	209	175	174	142	147	139	98	66
45	BVD**20**..16	3/4 in	222	196	187	142	147	139	98	66
56, 63	BVD**20**..17	3/4 in	250	197	208	142	147	139	98	75
80, 90	BVD**20**..27	1 in	271	207	229	142	147	139	98	75
107, 125	BVD**20**..28	1 in	298	238	251	142	147	139	98	84
107, 125	BVD**25**..38	1 1/4 in	298	239	251	158	163	175	120.5	84
160, 180	BVD**25**..38	1 1/4 in	332	260	285	158	163	175	120.5	84
107, 125	BVE**25**..38	1 1/4 in	298	240	251	167	172	214	137	84
160, 180	BVE**25**..38	1 1/4 in	332	260	285	167	172	214	137	84
250	On request									

Ports

Designation	Port for	Version	Standard	Size1)	Maximum pressure [bar]2)	State4)
A, B	Service line		SAE J518	see table above	420	O
S	Infeed	BVD20	DIN 3852 3)	M22 x 1.5; 14 deep	30	X
		BVD25, BVE25	DIN 3852 3)	M27 x 2; 16 deep	30	X
Br	Brake release, reduced high pressure	L	DIN 3852 3)	M12 x 1.5; 12.5 deep	30	O
G_{ext}	Brake release, high pressure	S	DIN 3852 3)	M12 x 1.5; 12.5 deep	420	X
M_A, M_B	Measuring pressure A and B		ISO 6149 3)	M12 x 1.5; 12 deep	420	X

1) Observe the general instructions on page 46 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) The spot face can be deeper than specified in the appropriate standard.
4) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Mounting the counterbalance valve

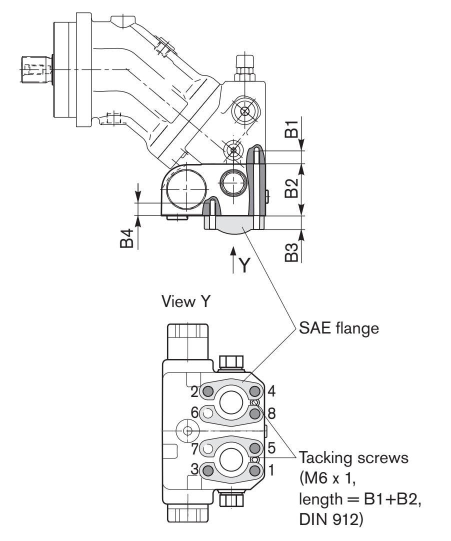
When delivered, the counterbalance valve is mounted to the motor with two tacking screws (transport protection). The tacking screws may not be removed while mounting the service lines. If the counterbalance valve and motor are delivered separately, the counterbalance valve must first be mounted to the motor port plate using the provided tacking screws. The counterbalance valve is finally mounted to the motor by screwing on the SAE flange with the following screws:

6 screws (**1, 2, 3, 4, 5, 8**) ______________ length B1+B2+B3
2 screws (**6, 7**) __________________________ length B3+B4

Tighten the screws in two steps in the specified sequence from 1 to 8 (see following scheme).

In the first step, the screws must be tightened with half the tightening torque, and in the second step with the maximum tightening torque (see following table).

Thread	Strength class	Tightening torque [Nm]
M6 x 1 (tacking screw)	10.9	15.5
M10	10.9	75
M12	10.9	130
M14	10.9	205



2

Size	28, 32, 45	56, 63	80, 90	107, 125, 160, 180	107, 125
Port plate	18				17
B1[1]	M10 x 1.5; 17 deep	M10 x 1.5; 17 deep	M12 x 1.75; 18 deep	M14 x 2; 19 deep	M12 x 1.75; 17 deep
B2	78[2]	68	68	85	68
B3	customer-specific				
B4	M10 x 1.5; 15 deep	M10 x 1.5; 15 deep	M12 x 1.75; 16 deep	M14 x 2; 19 deep	M12 x 1.75; 17 deep

1) Minimum required thread reach 1 x ø-thread
2) Including sandwich plate

Speed sensors

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

The versions A2FM...U and A2FM...F ("prepared for speed sensor", i.e. without sensor) is equipped with a toothed ring on the rotary group.

On deliveries "prepared for speed sensor", the port is plugged with a pressure-resistant cover.

With the DSA or HDD speed sensor mounted a signal proportional to motor speed can be generated.
The sensors measures the speed and direction of rotation.

Ordering code, technical data, dimensions and details on the connector, plus safety information about the sensor can be found in the relevant data sheet.

DSA ________________________________ RE 95133

HDD ________________________________ RE 35135

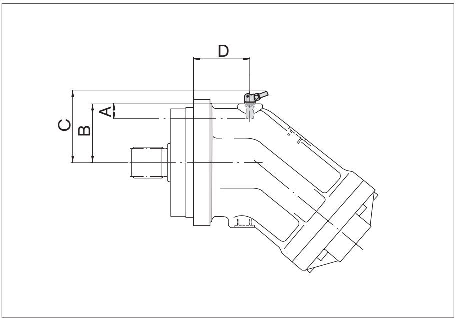
The sensor is mounted at the specially provided port D as follows:

DSA ________________________ with one mounting bolt

HDD ________________________ with two mounting bolts

We recommend ordering the A2FM fixed motor complete with sensor mounted.

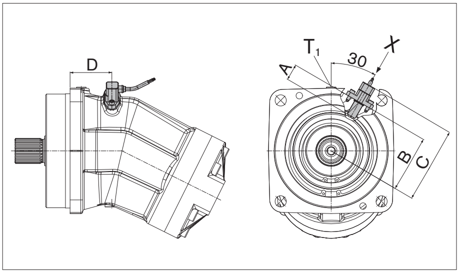
Version "V"
Sizes 23 to 200 with DSA sensor



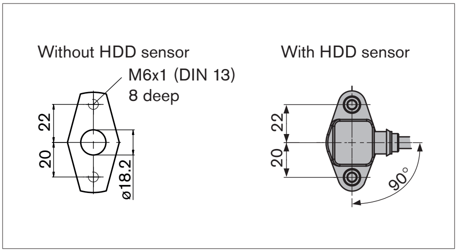
Version "V"
Sizes 250 to 500 with DSA sensor

On request

Version "H"
Sizes 250 to 500 with HDD sensor



View X



Speed sensors

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Size			23, 28, 32	45	56, 63	80, 90	107, 125
Number of teeth			38	45	47	53	59
DSA	A	Insertion depth (tolerance ± 0.1)	18.4	18.4	18.4	18.4	18.4
	B	Contact surface	57.9	64.9	69.9	74.9	79.9
	C		74.5	81.5	86.5	91.5	96.5
	D		54.7	54.3	61.5	72.5	76.8

Size			160, 180	200	250	355	500
Number of teeth			67	80	78	90	99
HDD	A	Insertion depth (tolerance ± 0.1)	–	–	32	32	32
	B	Contact surface	–	–	110.5	122.5	132.5
	C		–	–	149	161	171
	D		–	–	82	93	113
DSA	A	Insertion depth (tolerance ± 0.1)	18.4	18.4	32	32	32
	B	Contact surface	87.4	100.9	–	–	–
	C		104	117.5	–	–	–
	D		86.8	97.5			

Installation instructions

General

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

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

The case drain fluid in the motor housing must be directed to the reservoir via the highest available drain port (T_1, T_2).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the 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 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.

Installation position

See the following examples 1 to 8.
Further installation positions are possible upon request.

Recommended installation positions: 1 and 2.

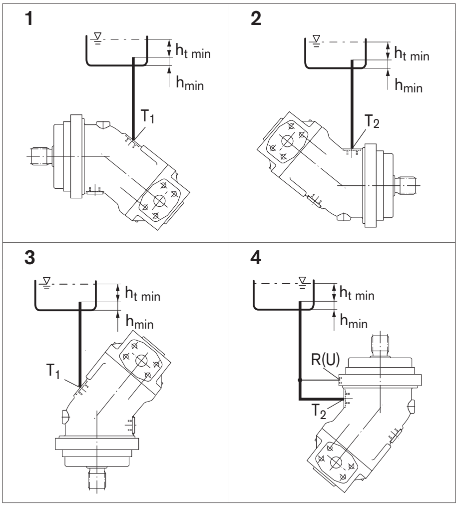
Note
With sizes 10 to 200 with installation position "shaft upward", an air-bleed port R is required (state in plain text when ordering - special version). With sizes 250 to 1000, port U is provided as standard in the area near the bearings for air bleeding.

Installation position	Air bleed	Filling
1	–	T_1
2	–	T_2
3	–	T_1
4	R (U)	T_2
5	L_1	T_1 (L_1)
6	L_1	T_2 (L_1)
7	L_1	T_1 (L_1)
8	R (U)	T_2 (L_1)

L_1 Filling / air bleed
R Air bleed port (special version)
U Bearing flushing / air bleed port
T_1, T_2 Drain port
$h_{t\,min}$ Minimum required immersion depth (200 mm)
h_{min} Minimum required spacing to reservoir bottom (100 mm)

Below-reservoir installation (standard)

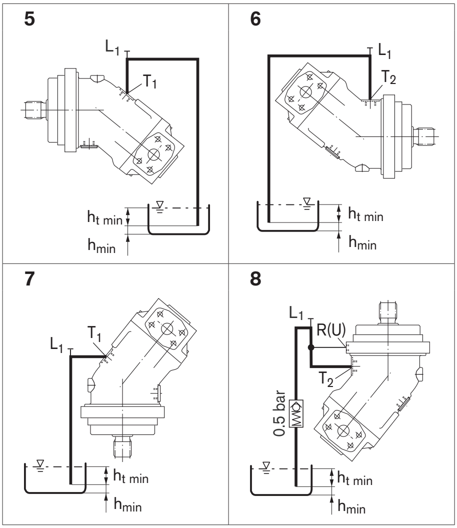
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.



Above-reservoir installation

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

Recommendation for installation position 8 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) can prevent draining of the motor housing.



2

General instructions

– The motor A2FM is designed to be used in open and closed circuits.

– The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified personnel.

– Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these can be requested from Bosch Rexroth.

– During and shortly after operation, there is a risk of burns on the axial piston unit. 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.

– The product is not approved as a component for the safety concept of a general machine according to ISO 13849.

– The following tightening torques apply:

  - Fittings:
    Observe the manufacturer's instructions regarding tightening torques of the fittings used.

  - Mounting bolts:
    For mounting bolts with metric ISO thread according to DIN 13 or with thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

  - Female threads in the axial piston unit:
    The maximum permissible tightening torques $M_{G\,max}$ are maximum values for 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**	**Size of thread**	**Maximum permissible tightening torque of the female threads $M_{G\,max}$**	**Required tightening torque of the threaded plugs M_V**[1]	**WAF hexagon socket of the threaded plugs**
DIN 3852[1]	M10 x 1	30 Nm	15 Nm[2]	5 mm
	M12 x 1.5	50 Nm	25 Nm[2]	6 mm
	M14 x 1.5	80 Nm	35 Nm	6 mm
	M16 x 1.5	100 Nm	50 Nm	8 mm
	M18 x 1.5	140 Nm	60 Nm	8 mm
	M20 x 1.5	170 Nm	80 Nm	10 mm
	M22 x 1.5	210 Nm	80 Nm	10 mm
	M26 x 1.5	230 Nm	120 Nm	12 mm
	M27 x 2	330 Nm	135 Nm	12 mm
	M30 x 2	420 Nm	215 Nm	17 mm
	M33 x 2	540 Nm	225 Nm	17 mm
	M42 x 2	720 Nm	360 Nm	22 mm
DIN ISO 228	G 1/4	40 Nm	–	–

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 10 Nm for M10 x 1 and 17 Nm for M12 x 1.5.

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Glockeraustrasse 4
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An den Kelterwiesen 14
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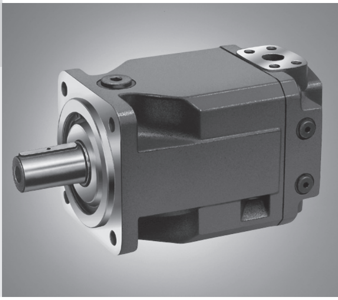
Rexroth
Bosch Group

Fixed Displacement Motor A4FM

RE 91 120/04.00
replaces: 03.95
and RE 91 100

for open and closed circuits



Sizes 22...500
Series 1, Series 3
Nominal pressure up to 400 bar
Peak pressure up to 450 bar

Index

Features

- Axial Piston Fixed Displacement Motor A4FM of swashplate design is used in open and closed loop circuits for hydrostatic drives.
- Output speed is proportional to input flow and inversely proportional to motor displacement.
- Output torque increases with the pressure drop across the motor between the high and low pressure sides.
- Long service life, optimum efficiencies
- Compact design for special applications where A2FM cannot be applied
- Proven rotary group in swashplate-technology

Ordering Code

	A4F	M		/			W	–				

Hydraulic fluid

Mineral oil, HFD (no code)	
HFA, HFB, HFC-Hydraulic fluid (only sizes 71...500)	E-

Axial piston unit

Swashplate design, fixed displacement	A4F

Mode of operation

Motor	M

Size

	22	28	40	56	71	125	250	500
≙ Displacement V_g (cm³)	●	●	●	●	●	●	●	○

Series

Sizes 22...56, 125...500	3
Size 71	1

Index

Sizes 22...56	2
Sizes 71...500	0

Direction of rotation

Viewed on shaft end	alternating	W

Seals

NBR (Nitril-caoutchouc), shaft sealing in FKM (Fluor-caoutchouc)	Sizes 22...56	N
	Sizes 71...500	P
FKM (Fluor-caoutchouc)	Sizes 71...500	V

Shaft end

Shaft end	22	28	40	56	71	125	250	500	
Splined shaft SAE	○	○	–	–	–	–	–	–	S
Splined shaft SAE	●	●	–	–	–	–	–	–	T
Splined shaft DIN 5480	–	–	●	●	●	●	●	○	Z
Parallel with key DIN 6885	–	–	–	–	●	●	●	○	P

Mounting flange

Mounting flange	22	28	40	56	71	125	250	500	
SAE 2-hole	●	●	●	●	–	–	–	–	C
ISO 4-hole	–	–	–	–	●	●	●	–	B
ISO 8-hole	–	–	–	–	–	–	–	○	H

Service line connections

Service line connections	22...40	56	71...500	
Ports A, B: SAE at rear (with metric fixing screws)	–	●	●	01
Ports A, B: SAE at side (on opposite sides) (with metric fixing screws)	●	–	●	02

● = available
○ = available on enquiry
– = not available

Technical Data

Fluid

We request that before starting a project detailed information about the choice of pressure fluids and application conditions are taken from our catalogue sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90223 (fire resistance fluids, HF).

When using HF- or environmentally acceptable hydraulic fluids possible limitations for the technical data have to be taken into consideration. If necessary please consult our technical department (please indicate type of the hydraulic fluid used for your application on the order sheet).

The sizes 22..56 are not suitable for operation with HFA, HFB and HFC.

Operation viscosity range

In order to obtain optimum efficiency and service life, we recommend that the operating viscosity (at operating temperature) be selected from within the range:

ν_{opt} = operating viscosity 16...36 mm²/s

referred to the loop temperature (closed circuit) or tank temperature (open circuit).

Viscosity limits

The limiting values for viscosity are as follows:

Size 22...56

ν_{min} = 5 mm²/s, short term at a max. permissible temp. of t_{max}= 115°C
ν_{max}= 1600 mm²/s, short term on cold start (t_{min} = -40°C)

Size 71...500

ν_{min} = 10 mm²/s, short term at a max. permissible drain temp. t_{max} = 90°C
ν_{max} = 1000 mm²/s, short term on cold start (t_{min} = -25°C)

Please note that the max. fluid temperature is also not exceeded in certain areas (for instance bearing area).

At temperature of -25°C up to -40°C special measures may be required for certain installation positions, please contact us.

Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the loop (closed circuit) or the tank temperature (open circuit) in relation to the ambient temperature.

The hydraulic fluid should be selected so that within the operating temperature range, the operating viscosity lies within the optimum range (ν_{opt}) (see shaded section of the selection diagram). We recommend that the highest possible viscosity range should be chosen in each case.

Example: At an ambient temperature of X°C the operating temperature is 60°C. Within the operating viscosity range (ν_{opt}; shaded area), this corresponds to viscosity ranges VG 46 or VG 68. VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and motor speed and is always higher than the circuit temperature. However, at no point in the circuit may the temperature exceed 115°C for sizes 22...56 or 90°C for sizes 71...500.

If it is not possible to comply with the above condition because of extreme operating parameters or high ambient temperatures we recommend housing flushing. Please consult us.

2

Filtration

The finer the filtration the better the achieved purity grade of the pressure fluid and the longer the life of the axial piston unit. To ensure the functioning of the axial piston unit a minimum purity grade of:

9 to NAS 1638

18/15 to ISO/DIS 4406 is necessary.

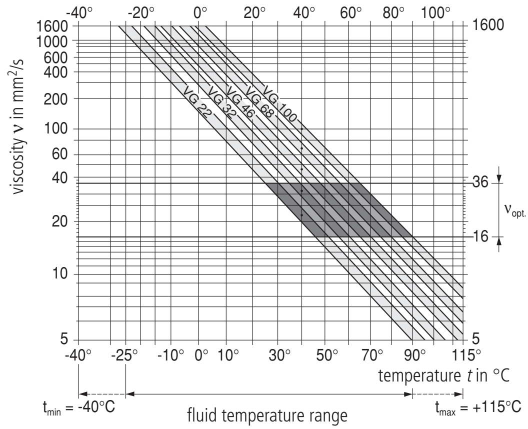
At very high temperatures of the hydraulic fluid (90°C to max. 115°C, not permissible for sizes 71...500) at least cleanless class

8 to NAS 1638

17/14 to ISO/DIS 4406 is necessary.

If above mentioned grades cannot be maintained please consult supplier.

Selection diagram



Technical Data

valid for operation with mineral oils

Flushing of the bearings (Sizes 125...500)

operating conditions, flushing quantities and notes on bearing flushing see RE 92 050 (A4VSO).

Operating pressure range

Maximum pressure at port A or B (Pressure data to DIN 24312)

Size		22...56	71...500
Nominal pressure p_N	*bar*	400 [1])	350
Peak pressure p_{max}	*bar*	450 [1])	400

[1]) Size 28 with S-shaft: 315/350 bar

The summ of the pressures at ports A and B may not exceed 700 bar.

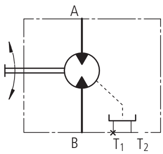
Direction of flow

clockwise rotation	anti-clockwise rotation
A to **B**	**B** to **A**

Symbol

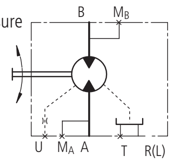
Size 22...56

A, B Service line ports
T_1, T_2 Case drain (1 port plugged)



Size 71...500

A, B Service line ports
M_A,M_B Pressure gauge, working pressure
T, R(L) Case drain, Air bleed (1port plugged)
U Flushing port (Sizes71...500)



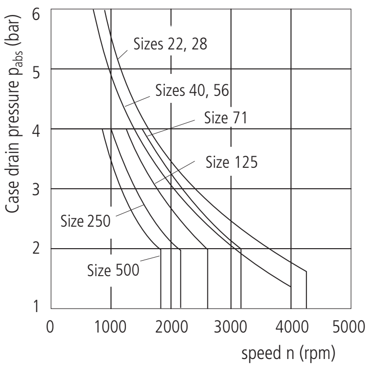
Case drain pressure

The max. permissible leakage pressure (housing pressure) is dependent on speed (see diagram). The pressure in the housing must be equal to or greater than the external pressure on the shaft sealing ring.

Max. leakage pressure (housing pressure)

$p_{abs.\ max.}$ ______________________________ 6 bar (sizes 22...56)
______________________________ 4 bar(sizes71...500)

A leakage line to the tank is necessary.



Installation and Commissioning Guidelines

General

At start-up and during operation the motor housing has imperatively to be filled up with hydraulic fluid (filling of the case chamber). Start-up has to be carried out at low speed and without load till the system is completely bleeded.

At a longer standstill the case may discharge via operating line. At new start-up a sufficient filling of the housing has to be granted.

The leakage oil in the housing has to be discharged to the tank via highest positioned case drain port.

Installation position

- Sizes 22...56: Shaft horizontal or shaft down
- Sizes 71 (series1): Shaft horizontal, vertical installation position as to agreement
- Sizes 125...500: Optional, at vertical installation position bearing flushing is recommended at port U (as to RD 9205)

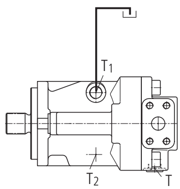
Installation below tank level

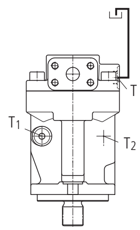
Motor below min. oil level in the tank (standard)

➔ Fill up axial piston motor before start-up via highest positioned case drain port

➔ Operate motor at low speed till motor system is completely filled up

➔ Minimum immerson depth of the drain line in the tank: 200mm (relative to the min. oil level in the tank).



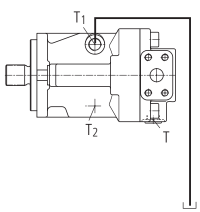


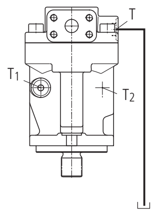
Installation on top of tank level

Motor on top of min. oil level in the tank

➔ Actions as installation below tank level

➔ Note: installation position "drive shaft up" for sizes 22...56 not permissible





Technical Data

valid for operation with mineral oil

Table of values (theoretical values, without considering η_{mh} and η_v; values rounded)

Size			22	28	40	56	71	125	250	500
Displacement	V_g	cm³	22	28	40	56	71	125	250	500
Max. speed	$n_{max\ continuous}$	rpm	4250	4250	4000	3600	3200	2600	2200	1800
	$n_{max\ interm.}$ ¹)	rpm	5000	5000	5000	4500	–	–	–	–
Max. flow (at n_{max})	$q_{V\ max}$	L/min	93	119	160	202	227	325	550	900
Torque constants	T_K	Nm/bar	0,35	0,445	0,64	0,89	1,13	1,99	3,97	7,95
Torque (at Δp = 400 bar)	T_{max}	Nm	140	178	255	356	395²)	696²)	1391²)	2783²)
Filling volume		L	0,3	0,3	0,4	0,5	2,0	3,0	7,0	11,0
Moment of inertia about drive axis	J	kgm²	0,0015	0,0015	0,0043	0,0085	0,0121	0,0300	0,0959	0,3325
Actual starting torque at n = 0 rpm (Δp = 350 bar)		Nm (approx.)					320	564	1127	
Weight (approx.)	m	kg	11	11	15	21	34	61	120	

¹) Intermittent max. speed at overspeed: Δp = 70…150 bar ²) Δp = 350 bar

2

Calculation of size

Flow $q_v = \dfrac{V_g \bullet n}{1000 \bullet \eta_v}$ in L/min

Output speed $n = \dfrac{q_V \bullet 1000 \bullet \eta_V}{V_g}$

Output torque $T = \dfrac{V_g \bullet \Delta p \bullet \eta_{mh}}{20 \bullet \pi}$ in Nm

$= T_K \bullet \Delta p \bullet \eta_{mh}$

Output power $P = \dfrac{T \bullet n}{9549} = \dfrac{2\,\pi \bullet T \bullet n}{60\,000}$ in kW

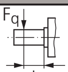
$= \dfrac{q_v \bullet \Delta p \bullet \eta_t}{600}$

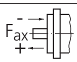
V_g = geometric displacement per rev. in cm³
Δp = pressure differential in bar
n = speed in rpm
η_v = volumetric efficiency
η_{mh} = mech.-hyd. efficiency
η_t = overall efficiency

Output drive

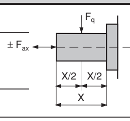
permissible axial and radial loading on drive shaft

Size				22	28	40	56
Distance of F_q (from shaft shoulder)		a	mm	17,5	17,5	17,5	17,5
		b	mm	30	30	30	30
		c	mm	42,5	42,5	42,5	42,5
Max. permissible radial force at distance	a	$F_{q\ max}$	N	2500	2050	3600	5000
	b	$F_{q\ max}$	N	1400	1150	2890	4046
	c	$F_{q\ max}$	N	1000	830	2416	3398
Max. permissible axial load		$-F_{ax\ max}$	N	1557	1557	2120	2910
		$+F_{ax\ max}$	N	417	417	880	1490



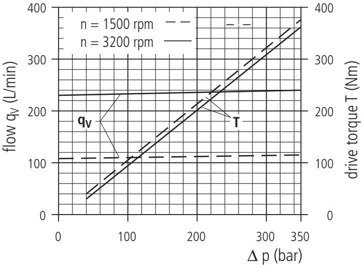


Size			71	125	250	500
Max. axial force at housing pressure p_{max} 1 bar abs.	$\pm F_{ax\ max}$	N	1400	1900	3000	4000
Max. axial force at housing pressure p_{max} 4 bar abs.	$+F_{ax\ max}$	N	810	1050	1850	2500
	$-F_{ax\ max}$	N	1990	2750	4150	5500
Max. radial force	$F_{q\ max}$	N	1700	2500	4000	5000

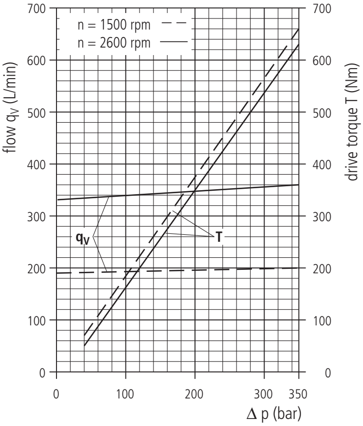


Flow and Drive Torque

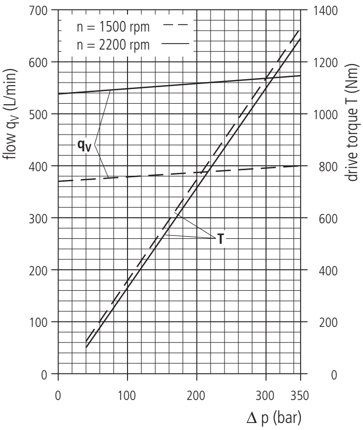
Size 71



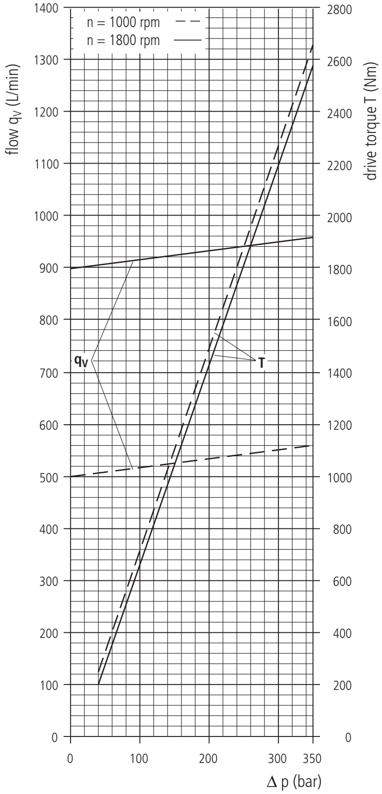
Size 125



Size 250



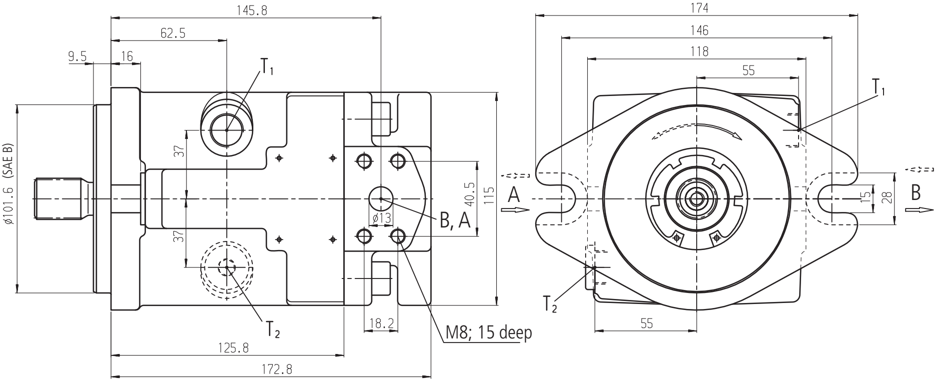
Size 500



(Fluid: Hydraulic oil ISO VG 46 DIN 51519, t = 50°C)

Unit Dimensions, Size 22, 28

Before finalising your design, please request a certified drawing.



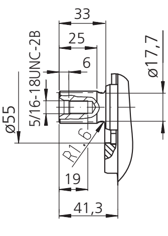
Connections

A, B	Service line ports	SAE 1/2" 420 bar (6000 psi) high pressure series
T_1, T_2	Leakage port / oil filling port	M18x1,5; 12 deep

Shaft ends

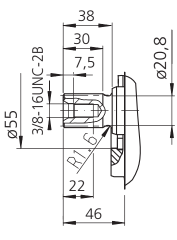
S

Splined shaft SAE 7/8",
30° pressure angle,
13 teeth, 16/32 pitch,
flat root, side fit,
tolerance class 5
ANSI B92.1a-1976



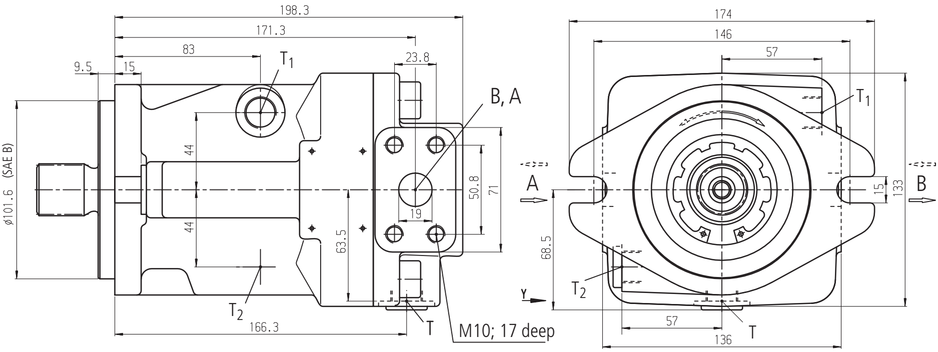
T

Splined shaft SAE 1"
30° pressure angle,
15 teeth, 16/32 pitch,
flat root, side fit,
tolerance class 5
ANSI B92.1a-1976



Unit Dimensions, Size 40

Before finalising your design, please request a certified drawing.



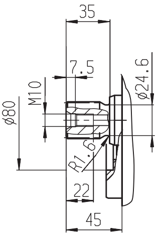
Connections

A, B	Service line ports	SAE $^3/_4$" 420 bar (6000 psi) high pressure serie
T, T_1, T_2	Leakage port / oil filling port	M18x1,5; 15 deep

Shaft ends

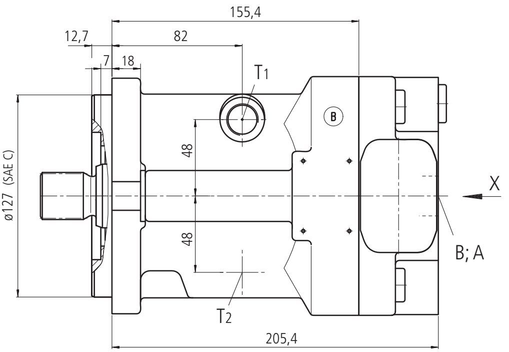
Z

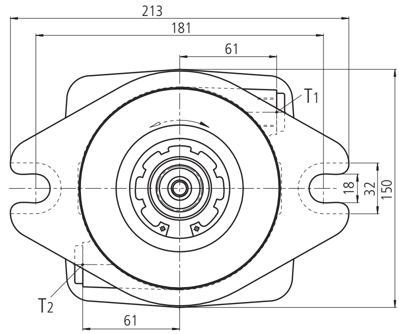
Splined shaft
W 30x2x30x14x9g
DIN 5480



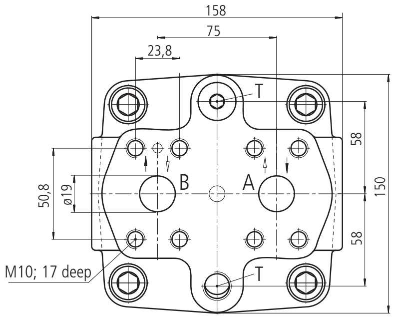
Unit Dimensions, Size 56

Before finalising your design, please request a certified drawing.





View X



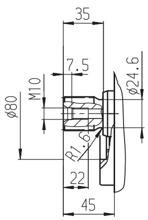
Connections

A, B	Service line ports	SAE $^3/_4$" 420 bar (6000 psi) high pressure serie
T, T_1, T_2	Leakage port / oil filling port	M 18x1,5 ; 12 deep

Shaft ends

Z

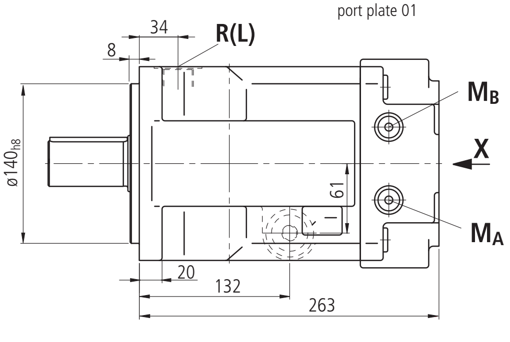
Splined shaft
W 30x2x30x14x9g
DIN 5480

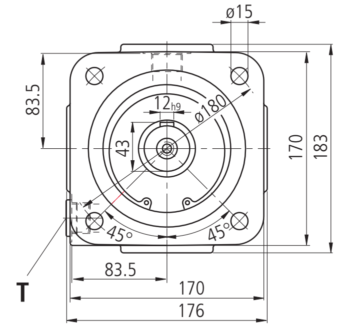


Unit Dimensions, Size 71

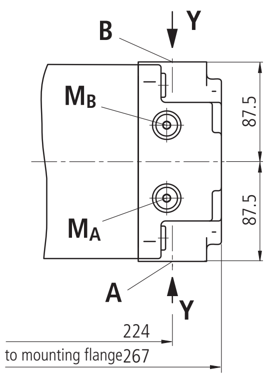
Before finalising your design, please request a certified drawing.

port plate 01

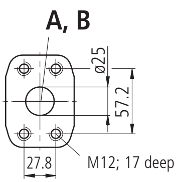




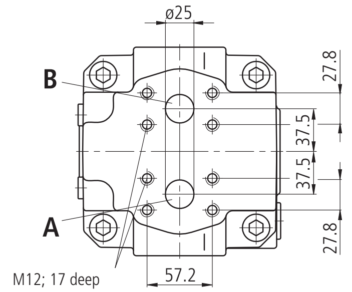
port plate 02



View Y



port plate 01
View X



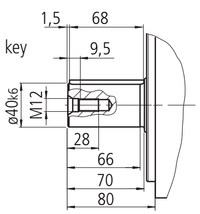
Connections

A, B	service line ports	SAE 1" (high pressure series)
R (L)	oil filling and bleed	M27x2
T	oil drain (plugged)	M27x2
M_A, M_B	measuring port for pressure (plugged)	M14x1,5

Shaft end

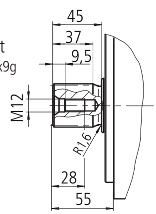
P

Parallel shaft with key
AS 12x8x68
DIN 6885



Z

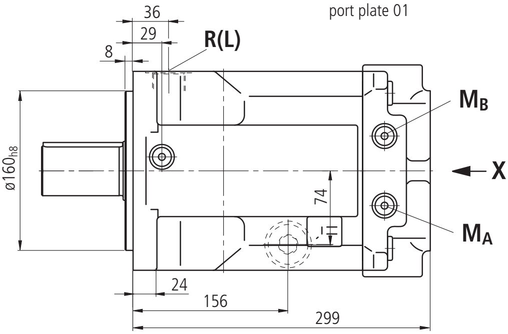
Splined shaft
W40x2x30x18x9g
DIN 5480

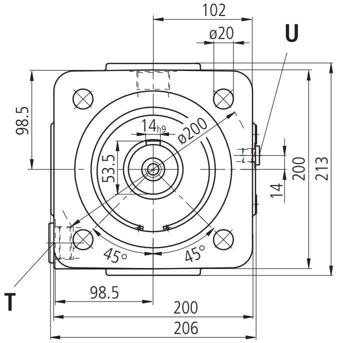


Unit Dimensions, Size 125

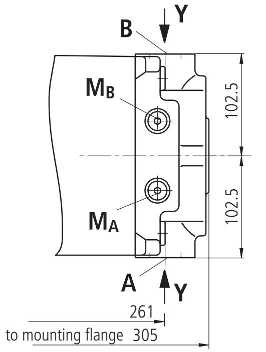
Before finalising your design, please request a certified drawing.

port plate 01

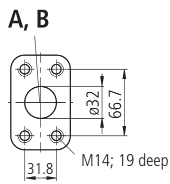




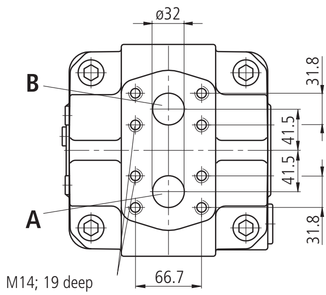
port plate 02



View Y



port plate 01
View X



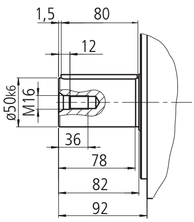
Connections

A, B	service line ports	SAE 1 1/4" (high pressure series)
R (L)	oil filling and bleed	M33x2
T	oil drain (plugged)	M33x2
M_A, M_B	measuring port for pressure (plugged)	M14x1,5
U	Flushing port, flushing of the bearings (plugged)	M14x1,5

Shaft end

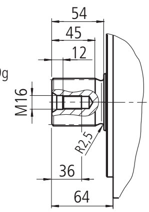
P

Parallel shaft with key
14x9x80
DIN 6885



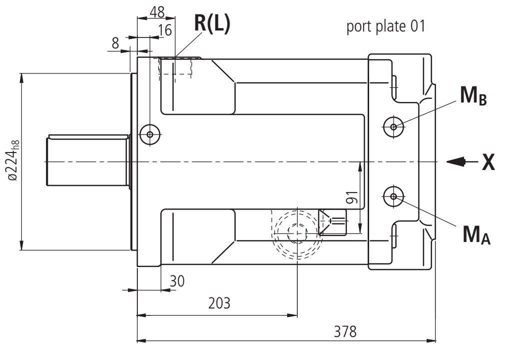
Z

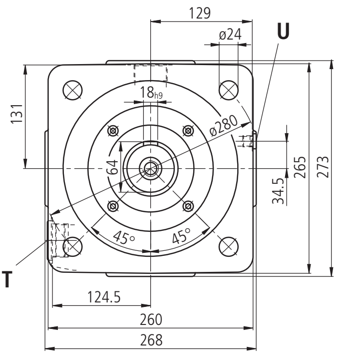
Splined shaft
W50x2x30x24x9g
DIN 5480



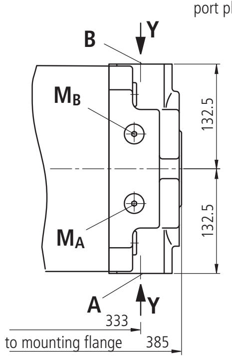
Unit Dimensions, Size 250

Before finalising your design, please request a certified drawing.

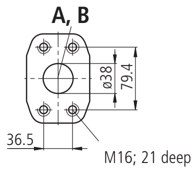




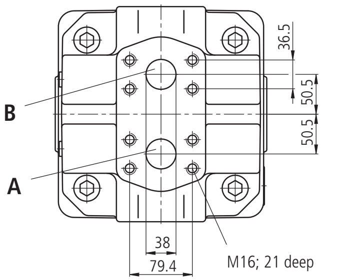
port plate 02



View Y



port plate 01
View X



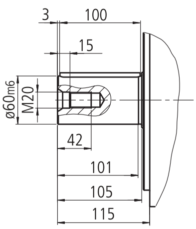
Connections

A, B	service line ports	SAE 1 1/2" (high pressure series)
R (L)	oil filling and bleed	M42x2
T	oil drain (plugged)	M42x2
M_A, M_B	measuring port for pressure (plugged)	M14x1,5
U	Flushing port, flushing of the bearings (plugged)	M14x1,5

Shaft end

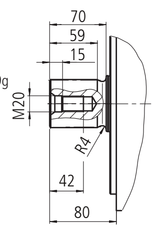
P

Parallel shaft with key
AS 18x11x100
DIN 6885



Z

Splined shaft
W60x2x30x28x9g
DIN 5480



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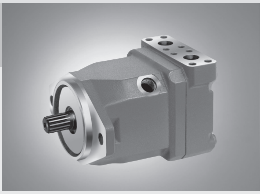
Rexroth
Bosch Group

Fixed displacement motor
Axial piston design
A10FM / A10FE

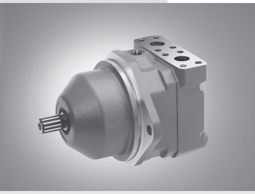
RE 91172/02.12
Replaces: 11.10

Data sheet

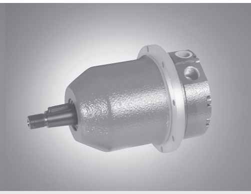
Series 52
Sizes 10 to 63
Nominal pressure 280 bar
Maximum pressure 350 bar
Open and closed circuit



A10FM 23...63



A10FE 10...45
(2-hole-flange)



A10FE 11...18
(8-hole-flange)

Contents

Features

- Fixed displacement motor in axial piston swashplate design for hydrostatic drives in open and closed circuit operation
- The output speed is proportional to the inlet flow
- The output torque increases with the pressure differential between the high and low pressure sides
- For use in mobile and industrial applications
- Long service life
- High permissible output speeds
- Well proven A10-rotary group technology
- High power to weight ratio – compact design
- Plug-in version for space saving installation
- Low noise level
- Mechanical and hydraulic connections also acc. to SAE standards
- Speed sensor optional
- Integrated anti cavitation valve optional, i.e. for fan drives

Ordering code for standard program

A10F	M		/	52		–	V		C			
01	02	03		04	05		06	07	08	09	10	11

Axial piston unit

01	Swashplate design, fixed displacement, nominal pressure 280 bar, maximum pressure 350 bar	**A10F**

Operating mode

02	Motor, open and closed circuit	**M**

Size (NG)

03	Theoretical displacement see page 6	**018**	**023**	**028**	**037**	**045**	**058**	**063**

Series

04	Series 5, Index 2	**52**

Direction of rotation

05	Viewed on drive shaft	clockwise	**R**[1]
		counter clockwise	**L**[1]
		bidirectional	**W**

Seals

06	FKM (Fluoro-rubber)	**V**

	Drive shaft	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
07	Splined shaft to ISO 3019-1 (SAE J744)	❍	●	●	●	●	●	●	**R**
	Splined shaft to ISO 3019-1 (SAE J744)	–	❍	❍	●	●	●	●	**W**
	Tapered with woodruff key and threaded end	❍	●	●	●	●	●	●	**C**

	Mounting flange	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
08	SAE 2-hole	❍	●	●	●	●	●	●	**C**

	Ports for service lines	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
09	SAE-flange ports A and B on side, same side Mounting bolts metric	–	●	●	●	●	●	●	**10N00**
	Threaded ports A and B,metric, on side, same side	❍	●	●	●	●	●	●	**16N00**

	Ventile	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
10	Without valves	❍	●	●	●	●	●	●	**0**
	With integrated flushing valve	–	●	●	●	●	●	●	**7**
	With integrated anti cavitation valve	❍	●	●	●	●	●	●	**2**

	Speed sensor	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
11	Without speed sensor	❍	●	●	●	●	●	●	
	Prepared for speed sensor (for inductive speed sensor ID)	❍	●	●	●	●	❍	❍	**D**

● = available ❍ = on request – = not available

1) Only necessary in conjunction with valve configuration „2“ (integrated anti cavitation valve)

Ordering code for standard program

A10F	E		/	52		–	V					
01	02	03		04	05		06	07	08	09	10	11

Axial piston unit

01	Swashplate design, fixed displacement, nominal pressure 280 bar, maximum pressure 350 bar	**A10F**

Operating mode

02	Motor, open and closed circuit	**E**

Size (NG)

03	Theoretical displacement see page 6	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**

Series

04	Series 5, Index 2	**52**

Direction of rotation

05	Viewed on drive shaft	clockwise	**R**[1]
		counter clockwise	**L**[1]
		bidirectional	**W**

Seals

06	FKM (Fluoro-rubber)	**V**

	Drive shaft	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
07	Splined shaft to ISO 3019-1 (SAE J744)	❍	●	●	●	●	●	●	●	●	●	●	**R**
	Splined shaft to ISO 3019-1 (SAE J744)	–	–	–	–	–	❍	❍	●	●	●	●	**W**
	Tapered with woodruff key and threaded end	●	●	●	●	●	●	●	●	●	●	●	**C**

	Mounting flange	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
08	SAE 2-hole	●	●	●	●	●	–	–	–	–	–	–	**C**[2]
	Special 2-hole	–	–	–	–	–	●	●	●	●	●	●	**F**
	Special 8-hole	–	●	●	●	●	–	–	–	–	–	–	**H**

	Ports for service lines	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
09	SAE-flange ports A and B, on side, same side mounting bolts metric	–	–	–	–	–	●	●	●	●	●	●	**10N00**
	Threaded ports A and B, metric, on side, same side	●	●	●	●	●	●	●	●	●	●	●	**16N00**

	Valves	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
10	Without valves	❍	●	❍	●	●	●	●	●	●	●	●	**0**
	With integrated flushing valve	–	–	–	–	–	●	●	●	●	●	●	**7**
	With integrated anti cavitation valve	●	●	●	●	●	●	●	●	●	●	●	**2**

	Speed sensor	**010**	**011**	**014**	**016**	**018**	**023**	**028**	**037**	**045**	**058**	**063**	
11	Without speed sensor	●	●	●	●	●	●	●	●	●	●	●	
	Prepared for speed sensor (for inductive speed sensor ID)	–	–	–	–	❍	●	●	●	●	❍	❍	**D**

● = available ❍ = on request – = not available

1) Only necessary in conjunction with valve configuration „2“ (integrated anti cavitation valve)

2) R-shaft with C-flange on sizes 10 to 18 in preparation

2

Technical data

Fluids

Prior to project design, please see our technical data sheets RE 90220 (mineral oil) and RE 90221 (environmentally acceptable fluis) for detailed information on fluids and operating conditions.

For operation on environmentally acceptable fluids please consult us (when ordering, please state in clear text the fluid to be used).

Operating viscosity range

To achieve optimum values for efficiency and service life we recommend an operation viscosity (at operating temperature) within the range,

ν_{opt} = opt. operating viscosity 16 ... 36 mm²/s

referred to the tank temperature (open circuit).

Limit of viscosity range

For critical operation conditions the following values apply:

ν_{min} = 5 mm²/s (closed circuit)
10 mm²/s (open circuit)
for short periods ($t \leq 1$ min)
at a max. perm. temperature of 115 °C.

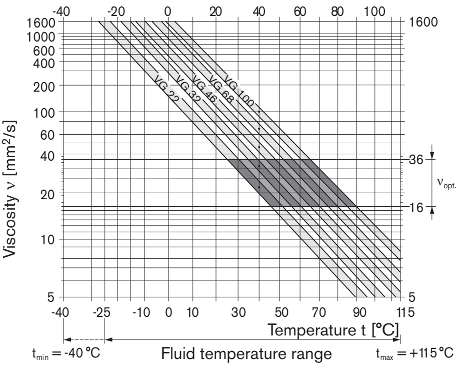
Please note that the max. leakage fluid temperature of 115 °C is also not exceeded in certain areas (for instance bearing area).The fluid temperature in the bearing area is approx. 5 K higher than the average leakage fluid temperature

ν_{max} = 1600 mm²/s
for short periods ($t \leq 1$ min)
on cold start
(t_{min} = $p \leq 30$ bar, $n \leq 1000$ min⁻¹, –25 °C).

At temperatures between -40 °C and -25 °C special measures are required, please consult us for further information.

For detailed information on operation with low temperatures see data sheet RE 90300-03-B.

Selection diagram



Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the tank (open circuit) in relation to the ambient temperature.

The fluid should be selected so that witin the operating temperature range, the viscosity lies within the optimum range (ν_{opt}), see shaded section of the selection diagram. We recommend to select the higher viscosity grade in each case.

Example: at an ambient temperature of X °C the operating temperature in the tank is 60 °C. In the optimum viscosity range (ν_{opt}; shaded area) this corresponds to viscosity grades VG 46 resp. VG 68; VG 68 should be selected.

Important: The leakage oil (case drain oil) temperature is influenced by pressure and input speed and is always higher than the tank temperature. However, at no point of the component may the temperature exceed 115 °C.

If it is not possible to comply with the above conditions because of extreme operating parameters please consult us.

Filtration of the hydraulic fluid

Filtration improves the cleanliness level of the hydraulic fluid, which, in turn, increases the service life of the axial piston unit.

To ensure the functional reliability of the axial piston unit, a gravimetric evaluation is necessary for the hydraulic fluid to determine the amount of contamination by solid matter and to determine the cleanliness level according to ISO 4406.
A cleanliness level of at least 20/18/15 to ISO 4406 is to be maintained.

If above requirements cannot be maintained please consult us.

Technical data

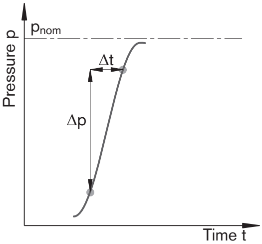
Operating pressure range

Pressure at service line port (pressure port) A or B

Nominal pressure p_{nom} ________ 280 bar absolute

Maximum pressure p_{max} ________ 350 bar absolute
Single operating period ________ 2,5 ms
Total operating period ________ 300 h
Minimum pressure (high pressure side) ________ 10 bar[2)]

Rate of pressure change $R_{A\ max}$ ________ 16000 bar/s



Outlet pressure

at n_{max}
Minimum pressure at low pressure side $p_{abs\ max}$ ________ 18 bar

Case drain pressure

Maximum permissible case drain pressure
(at port L, L_1):

$p_{max\ abs}$ motor operation in open circuit ________ 4 bar $_{abs}$
$p_{max\ abs}$ motor operation in closed circuit ________ 4 bar $_{abs}$
$p_{max\ abs}$ pump/motor operation in open circuit ________ 2 bar $_{abs}$

Direction of flow

viewed on drive shaft	
clockwise rotation	**counter clockwise rotation**
A to **B**	**B** to **A**

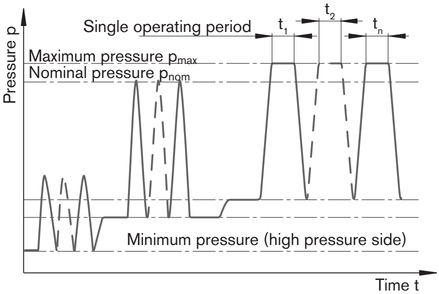
Definitions

Nominal pressure p_{nom}
The nominal pressure corresponds to the maximum design pressure.

Maximum pressure p_{max}
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.

Minimum pressure (high-pressure side)
Minimum pressure at the high pressure side (A or B) which is required in order to prevent damage to the axial piston unit.

Rate of pressure change R_A
Maximum permissible rate of pressure rise and pressure reduction during a pressure change, over the entire pressure range.



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

1) Other values on request

2) Lower pressures time dependent, please consult us.

2

Technical data

Table of values (theoretical values, without efficiency and tolerances: valuea rounded)

Size		NG		010	011	014	016	018	023
Displacement		$V_{g\ max}$	cm³	10.6	11.5	14.1	16.1	18	23.5
Speed [1)] at $V_{g\ max}$		n_{nom}	rpm	5000	4200	4200	4200	4200	4900
Input flow at n_{nom}		$q_{v\ max}$	L/min	53	48	59	68	76	115
Power at n_{nom}, $\Delta p = 280$ bar		P_{max}	kW	24.7	22.5	27.6	31.6	35.3	53.6
Actual starting torque at n= 0 rpm, $\Delta p = 280$ bar			Nm	37.5	30	45	53	67.5	75
Torque at $V_{g\ max}$	$\Delta p = 280$ bar	T_{max}	Nm	47	51	63	72	80	105
Torsional stiffness Drive shaft	R	c	Nm/rad	–	–	–	–	14835	28478
	W	c	Nm/rad	–	–	–	–	–	–
	C	c	Nm/rad	15084	18662	18662	18662	18662	30017
Moment of inertia rotary group		J_{TW}	kgm²	0.0006	0.00093	0.00093	0.00093	0.00093	0.0017
Maximum angular acceleration		α	rad/s²	8000	6800	6800	6800	6800	5500
Case volume		V	L	0.1	0.15	0.15	0.15	0.15	0.6
Weight approx.		m	kg	5	6.5	6.5	6.5	6.5	12

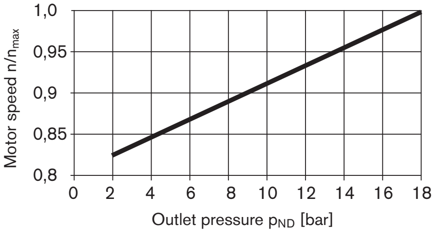
Size		NG		028	037	045	058	063
Displacement		$V_{g\ max}$	cm³	28.5	36.7	44.5	58	63.1
Speed [1)] at $V_{g\ max}$		n_{nom}	rpm	4700	4200	4000	3600	3400
Input flow at n_{nom}		$q_{v\ max}$	L/min	134	154	178	209	215
Power at n_{nom} , $\Delta p = 280$ bar		P_{max}	kW	62.5	71.8	83.1	97.4	100.1
Actual starting torque at n= 0 min^{-1} , $\Delta p = 280$ bar			Nm	105	125	170	205	230
Torque at $V_{g\ max}$	$\Delta p = 280$ bar	T_{max}	Nm	127	163	198	258	281
Torsional stiffness Drive shaft	R	c	Nm/rad	28478	46859	46859	80590	80590
	W	c	Nm/rad	–	38489	38489	60907	60907
	C	c	Nm/rad	30017	46546	46546	87667	87667
Moment of inertia rotary group		J_{TW}	kgm²	0.0017	0.0033	0.0033	0.0056	0.0056
Maximum angular acceleration		α	rad/s²	5500	4000	4000	3300	3300
Case volume		V	L	0.6	0.7	0.7	0.8	0.8
Weight approx.		m	kg	12	17	17	22	22

1) for maximum speed an outlet pressure (in low pressure side) of 18 bar is required (see diagram on page 7)

Note
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 testing the loads by means of experiment or calculation / simulation and comparison with the permissible values.

Technical data

Permissible motor speed in relation to outlet pressure



Determination of motor size (NG)

Input flow $q_v = \dfrac{V_g \cdot n}{1000 \cdot \eta_v}$ [L/min]

Torque $T = \dfrac{1{,}59 \cdot V_g \cdot \Delta p \cdot \eta_{mh}}{100}$ [Nm]

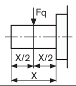
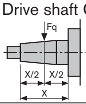
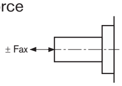
or $T = T_k \cdot \Delta p \cdot \eta_{mh}$

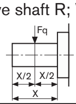
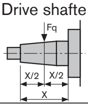
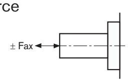
Power $P = \dfrac{2\,\pi \cdot T \cdot n}{60000} = \dfrac{q_v \cdot \Delta p \cdot \eta_t}{600}$ [kW]

Output speed $n = \dfrac{q_v \cdot 1000 \cdot \eta_v}{V_g}$ [rpm]

V_g = Displacement per revolution in cm^3
Δp = Differential pressure in bar
n = Speed in rpm
η_v = Volumetric efficiency
η_{mh} = Mechanical-hydraulic efficiency
η_t = Overall efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)
T_k = Torque constant

Permissible radial and axial forces on the drive shaft

Size			NG		10	11	14	16	18	23
Max. radial force at X/2	Drive shaft R; W 	Drive shaft C 	$F_{q\,max}$	N	250	350	350	350	350	1200
Maximum axial force			$\pm F_{ax\,max}$	N	400	700	700	700	700	1000

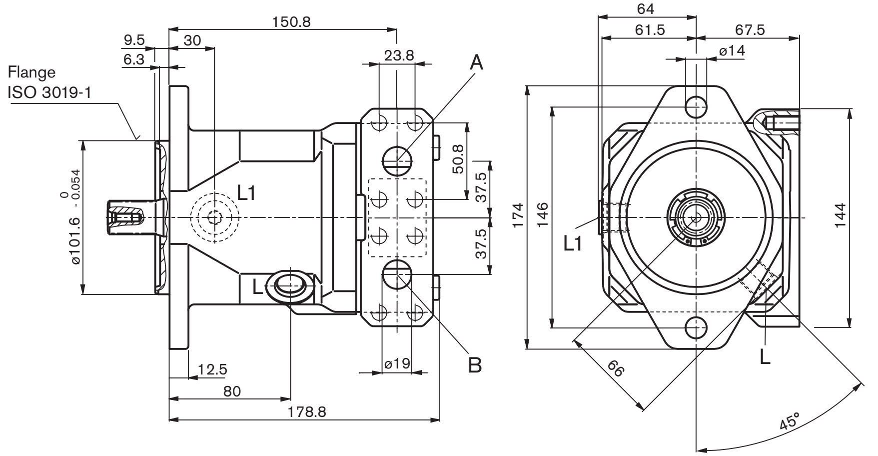
Size			NG		28	37	45	58	63
Max. radial force at X/2	Drive shaft R; W 	Drive shafte C 	$F_{q\,max}$	N	1200	1500	1500	1700	1700
Maximum axial force			$\pm F_{ax\,max}$	N	1000	1500	1500	2000	2000

Dimensions A10FM size 23 - 28

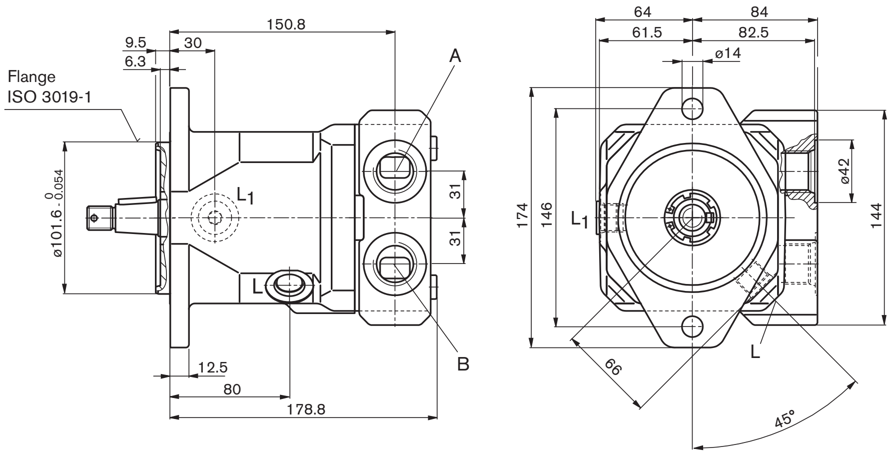
Before finalising your design request a certified installation drawing. Dimensions in mm.

A10FM 23-28/52W-VxCxxN000

Port plate 10



Port plate 16

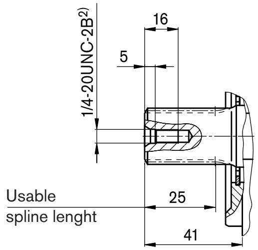


Dimensions A10FM size 23 - 28

Before finalising your design request a certified installation drawing. Maße in mm.

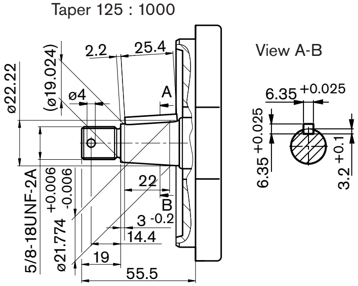
Drive shafts

R Splined shaft 7/8 in 13T 16/32DP[1] (SAE J744; 22-4(B))



C Tapered with woodruff key and threaded end (SAE J744; 22-3(B))

Taper 125 : 1000



Ports

Designation	Port for	Standard	Size[2]	Max. pressure [bar][3]	State
A, B	Service line (high pressure series)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17 deep		
A, B Port plate 16	Service line	DIN 3852	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5]	3/4-16 UNF-2B; 11 deep	4	O[4]
L_1	Case drain	ISO 11926[5]	3/4-16 UNF-2B; 11 deep	4	X[4]

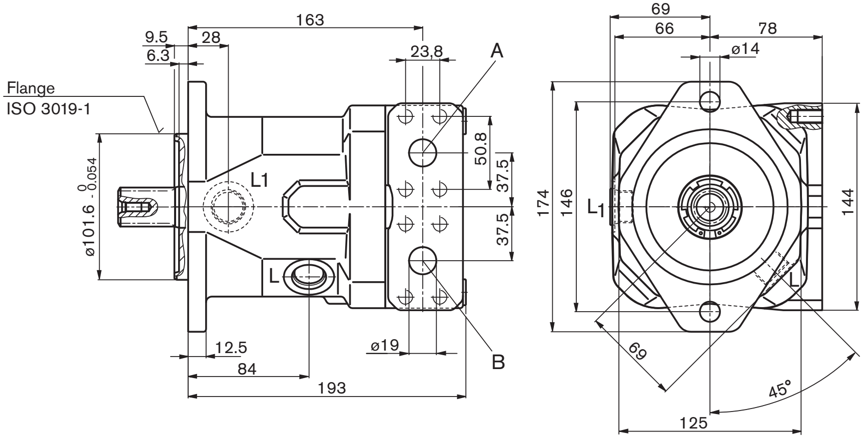
[1] ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
[2] Observe the general instructions on page 28 for the maximum tightening torques.
[3] Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut
[4] Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
[5] The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10FM size 37 - 45

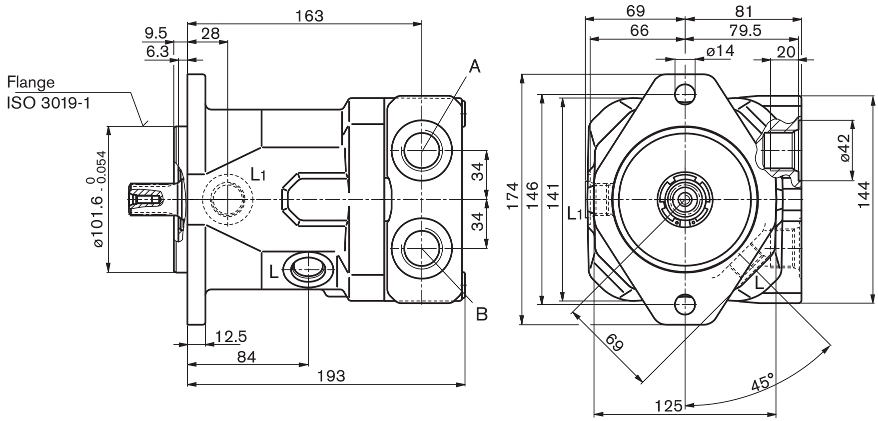
Before finalising your design request a certified installation drawing. Dimensions in mm.

A10FM 37-45/52W-VxCxxN000

Port plate 10



Port plate16

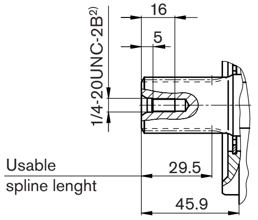


Dimensions A10FM size 37 - 45

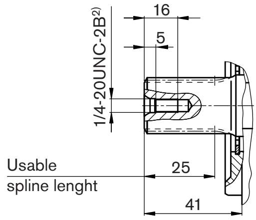
Before finalising your design request a certified installation drawing. Dimensions in mm.

Drive shafts

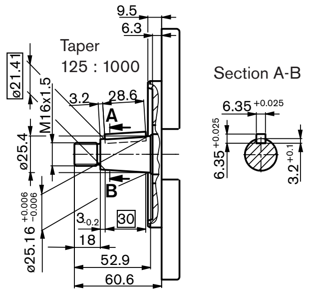
R Splined shaft 1 in 15T 16/32DP[1] (SAE J744; 25-4(B-B))



W Splined shaft 7/8 in 13T 16/32DP[1] (SAE J744; 22-4(B))



C Tapered with woodruff key and threaded end (SAE J744; 22-3(B))



Ports

Designation	Port for	Standard	Size[2]	Max. pressure [bar][3]	State
A, B	Service line (high pressure series)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17 deep		
A, B Port plate 16	Service line	DIN 3852-1	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5]	7/8-14 UNF-2B; 13 deep	4	O[4]
L_1	Case drain	ISO 11926[5]	7/8-14 UNF-2B; 13 deep	4	X[4]

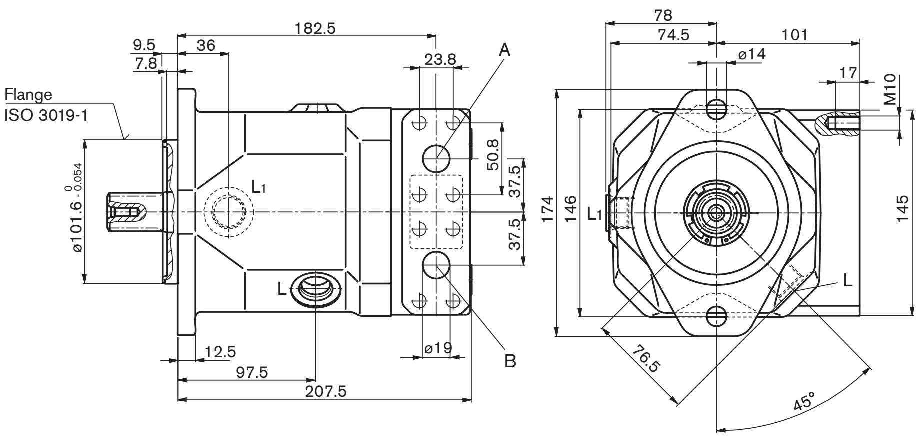
1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
5) The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10FM size 58 - 63

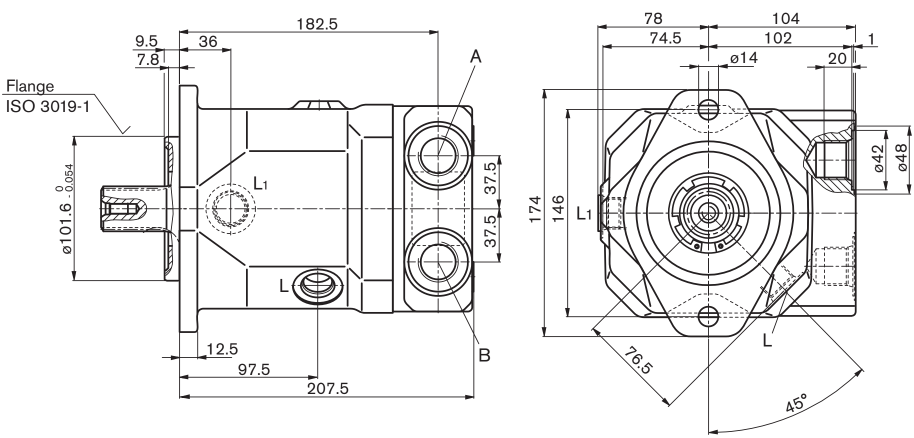
Before finalising your design request a certified installation drawing. Dimensions in mm.

A10FM 58-63/52W-VxCxxN000

Port plate 10



Port plate 16

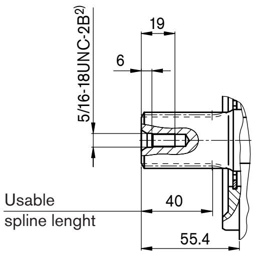


Dimensions A10FM size 58 - 63

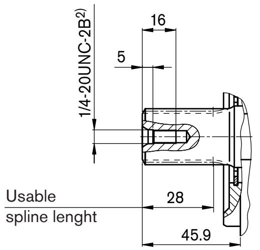
Before finalising your design request a certified installation drawing. Dimensions in mm

Drive shafts

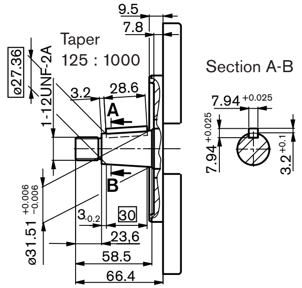
R Drive shaft 1 1/4 in 14T 12/24DP[1)] (SAE J744; 32-4(C))



W Drive shaft 1 in 15T 16/32DP[1)] (SAE J744; 25-4(B-B))



C Tapered with woodruff key and threaded end (SAE J744; 32-3(C))



Ports

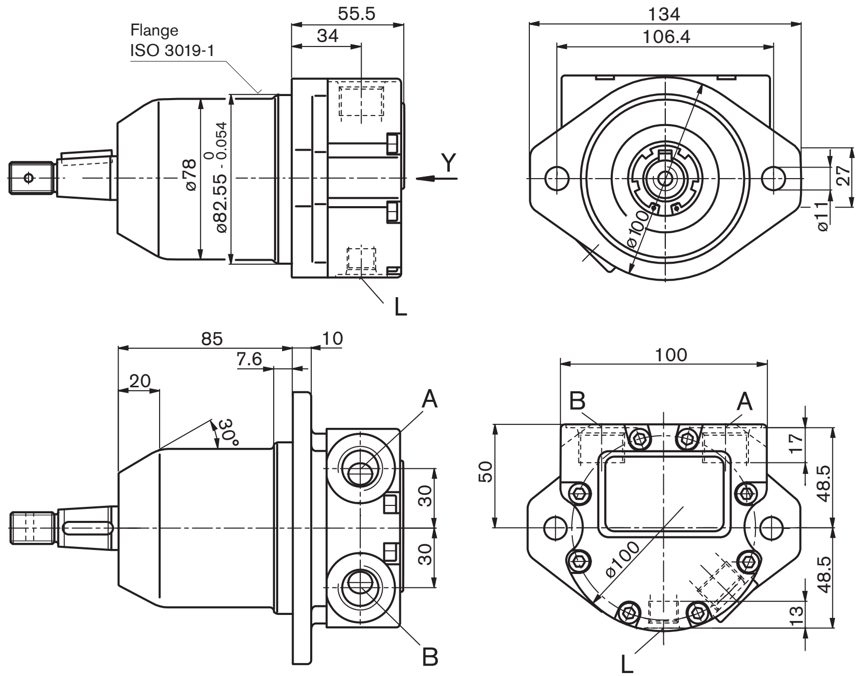
Designation	Port for	Standard	Size[2)]	Max. press. [bar][3)]	State
A, B	Service line (high pressure series)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17deep		
A, B Port plate 16	Service line	DIN 3852-1	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	O[4)]
L_1	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	X[4)]

1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
5) The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10FE size 10

Before finalising your design request a certified installation drawing. Dimensions in mm

A10FE 10/52W-VxC16N000

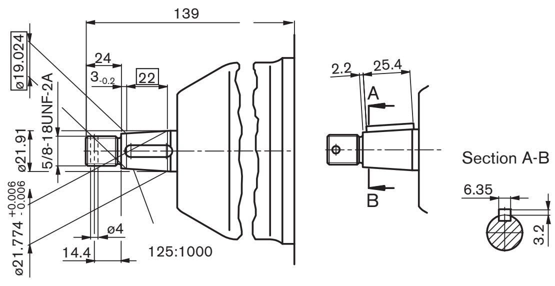


Dimensions A10FE size 10

Before finalising your design request a certified installation drawing. Dimensions in mm.

Drive shaft

C Tapered shaft with woodruff key and threaded end (SAE J744; 22-3(B))



Ports

Designation	Port for	Standard	Size[2)]	Max. pressure [bar][3)]	State
A, B	Service line	DIN 3852-1	M18 x 1.5; 17 deep	350	O
L	Case drain	DIN 3852-1	M14 x 1.5; 13 deep	4	O[4)]

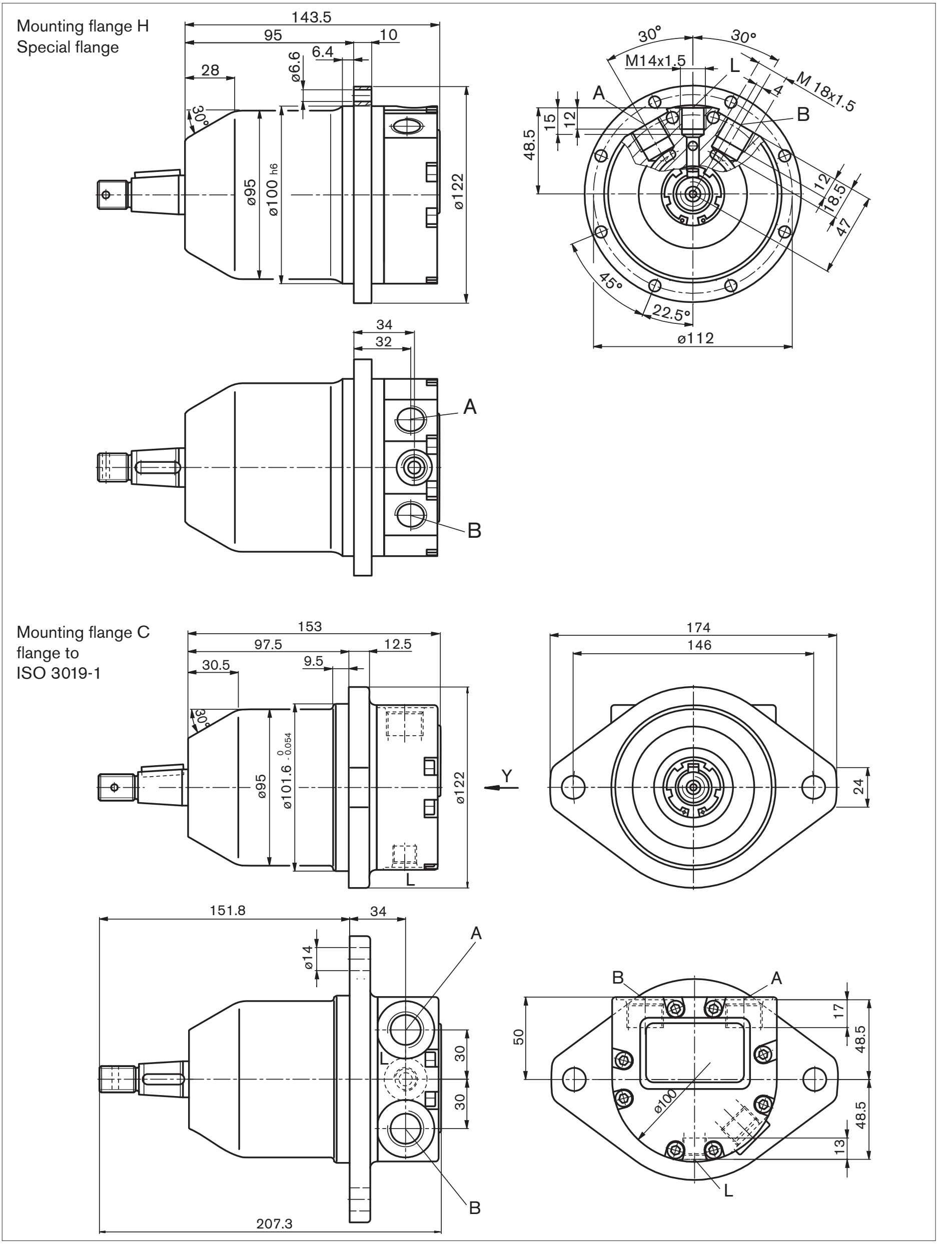
1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

2

Dimensions A10FE size 11 - 18

Before finalising your design request a certified installation drawing. Dimensions in mm.

A10FE 11-18/52W-Vxx16N000

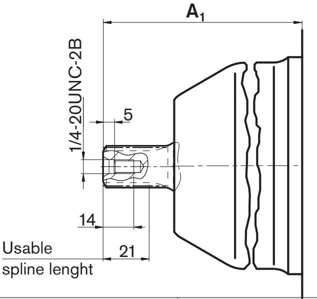


Dimensions A10FE size 11 - 18

Before finalising your design request a certified installation drawing. Dimensions in mm

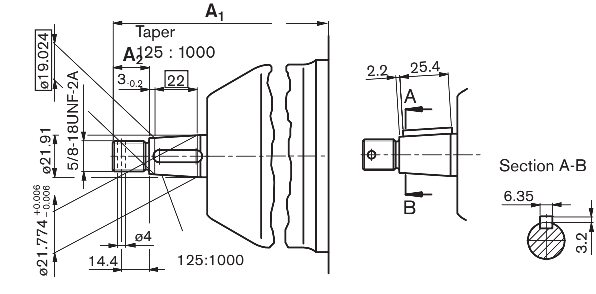
Drive shafts

R[5)] Splined shaft 3/4 in 11T 16/32DP[1)] (SAE J744; 19-4(A-B))



Mounting flange	A_1
H	126,6
C	–

C Tapered with woodruff key and threaded end (SAE J744; 22-3(B))



Mounting flange	A_1	A_2
H	**144.2**	**19**
C	**151.8**	**24**

2

Ports

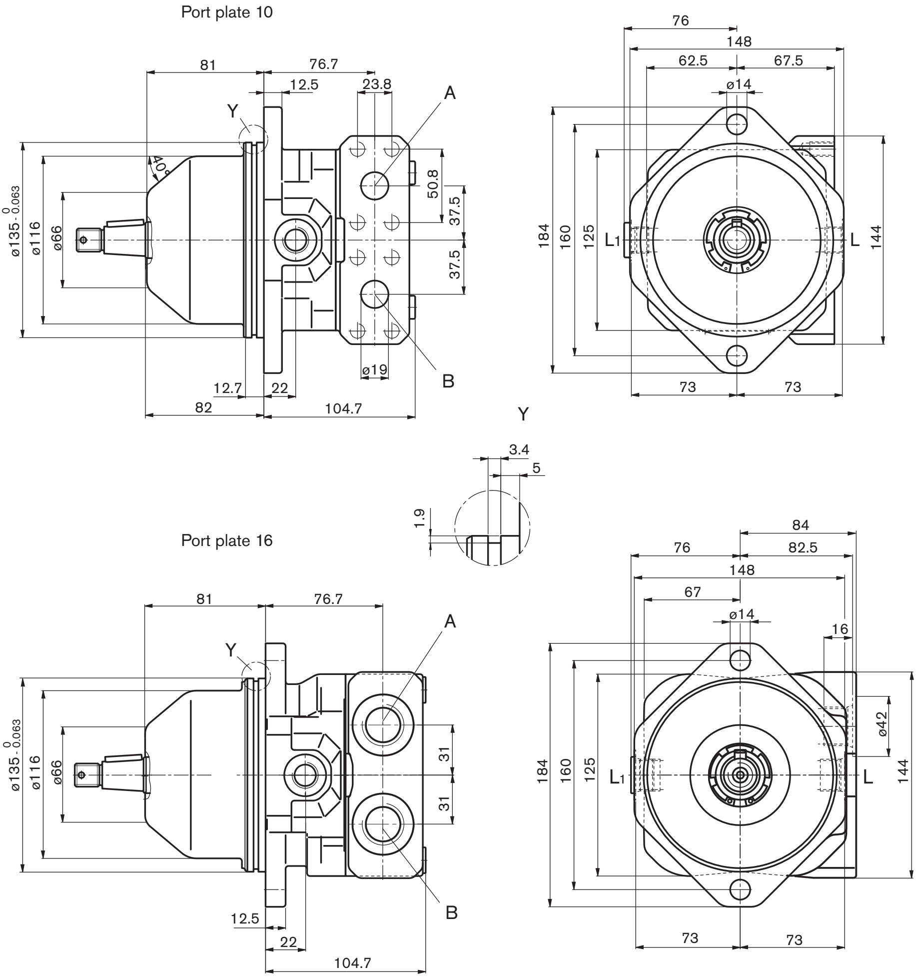
Designation	Port for	Standard	Size[2)]	Max. pressure [bar][3)]	State
A, B	Service line	DIN 3852-1	M18 x 1.5; 12 deep	350	O
L	Case drain	DIN 3852-1	M14 x 1.5; 12 deep	4	O[4)]
L_1	Case drain	DIN 3852-1	M14 x 1.5; 12 deep	4	X[4)]

1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
5) R-shaft with C-flange for size 10 resp. 11 to 18 in preparation.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10FE size 23 - 28

Before finalising your design request a certified installation drawing. Dimensions in mm

A10FE 23-28/52W-VxFxxN000

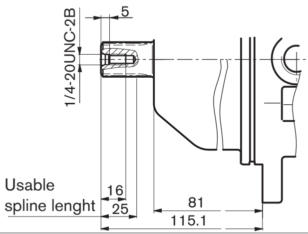


Dimensions A10FE size 23 - 28

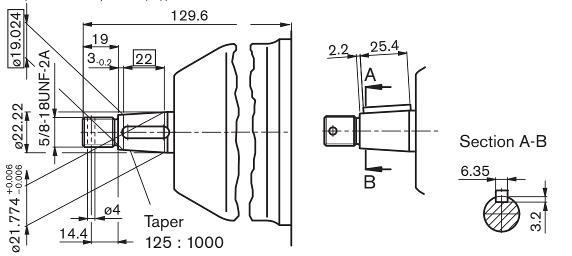
Before finalising your design request a certified installation drawing. Dimensions in mm

Drive shafts

R Drive shaft 7/8 in 13T 16/32DP[1]
(SAE J744; 22-4(B))



C Tapered with woodruff key and threaded end
(SAE J744; 22-3(B))



Ports

Designation	Port for	Standard	Size[2]	Max. pressure [bar][3]	State
A, B	Service line (high pressure series)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17 deep		
A, B Port plate 16	Service line	DIN 3852-1	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5]	3/4-16 UNF-2B; 11 deep	4	O[4]
L_1	Case drain	ISO 11926[5]	3/4-16 UNF-2B; 11 deep	4	X[4]

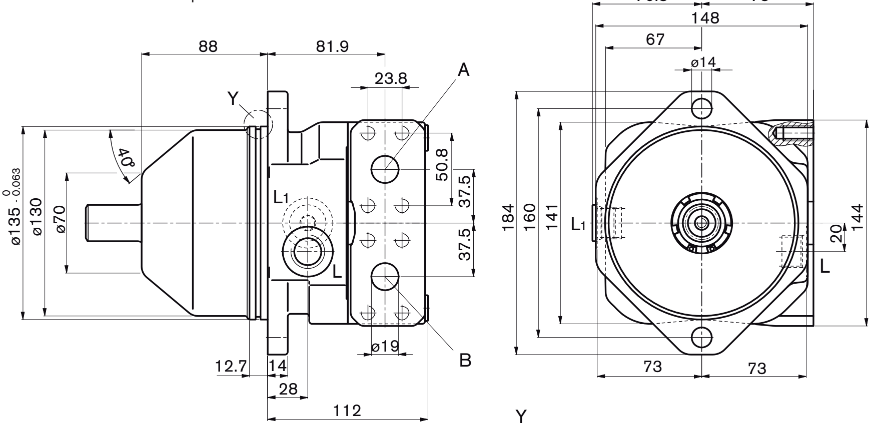
1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
5) The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

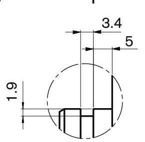
Dimensions A10FE size 37 - 45

Before finalising your design request a certified installation drawing. Dimensions in mm

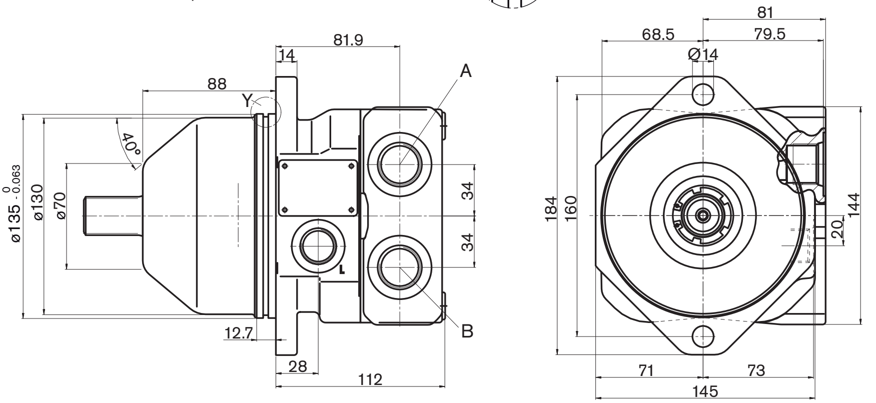
A10FE 37-45/52W-VxFxxN000

Port plate 10





Port plate 16

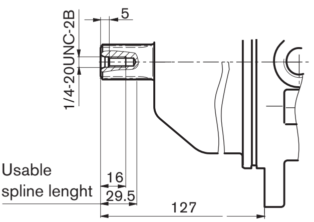


Dimensions A10FE size 37 - 45

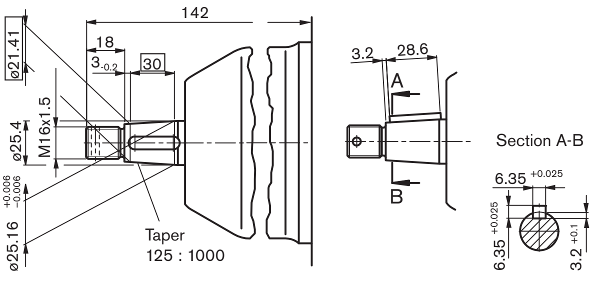
Before finalising your design request a certified installation drawing. Dimensions in mm.

Drive shafts

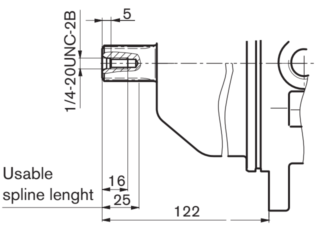
R Splined shaft 1 in 15T 16/32DP[1)] (SAE J744; 25-4(B-B))



C Tapered with woodruff key and threaded end (SAE J744; 25-3(B-B))



W Splined shaft 7/8 in 13T 16/32DP[1)] (SAE J744; 22-4(B))



2

Ports

Designation	Port for	Standard	Size[2)]	Max. pressure [bar][3)]	State
A, B	Service line (high pressure range)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17 deep		
A, B Port plate 16	Service line	DIN 3852-1	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	O[4)]
L_1	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	X[4)]

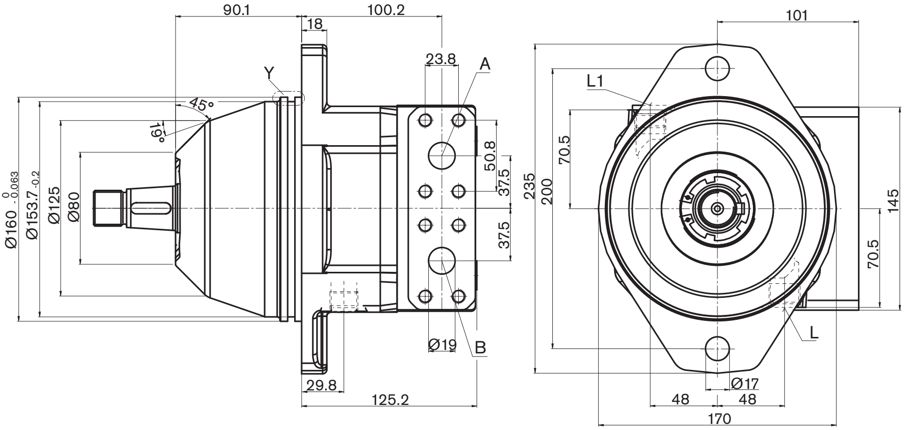
1) ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
2) Observe the general instructions on page 28 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
4) Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
5) The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10FE size 58 - 63

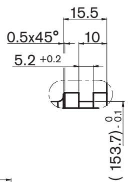
Before finalising your design request a certified installation drawing. Dimensions in mm.

A10FE 58-63/52W-VxFxxN000

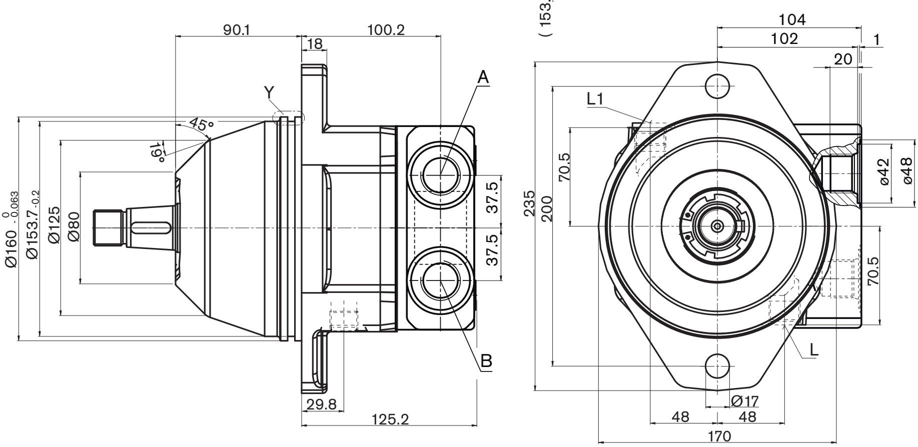
Port plate 10



View Y 2:1



Port plate 16

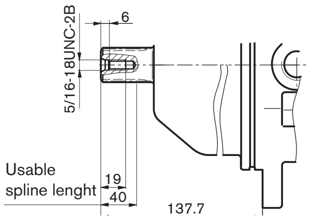


Dimensions A10FE size 58 - 63

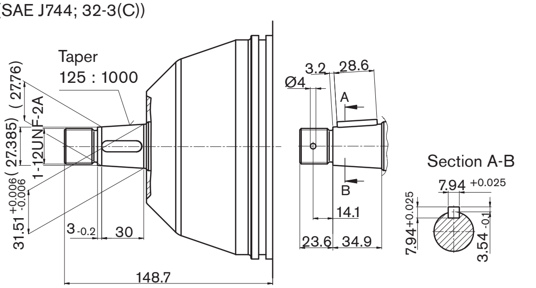
Before finalising your design request a certified installation drawing. Dimensions in mm.

Drive shafts

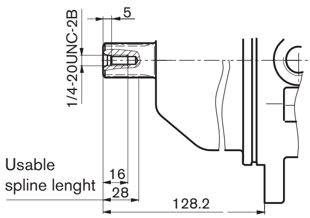
R Splined shaft 1 1/4 in 14T 12/24DP[1)]
(SAE J744; 32-4(C))



C Tapered with woodruff key and threaded end
(SAE J744; 32-3(C))



W Splined shaft 1 in 15T 16/32DP[1)]
(SAE J744; 25-4(B-B))



2

Ports

Designation	Port for	Standard	Size[2)]	Max. pressure [bar][3)]	State
A, B	Service line (high pressure range)	SAE J518	3/4 in	350	O
Port plate 10	Mounting bolts	DIN 13	M10 x 1.5; 17 deep		
A, B Port plate 16	Service line	DIN 3852-1	M27 x 2; 16 deep	350	O
L	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	O[4)]
L_1	Case drain	ISO 11926[5)]	7/8-14 UNF-2B; 13 deep	4	X[4)]

[1)] ANSI B92.1a-1996, 30° pressure angle, flat base, flank centering, tolerance class 5
[2)] Observe the general instructions on page 28 for the maximum tightening torques.
[3)] Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings. Pressure data in bar absolut.
[4)] Depending on the installation position, L or L_1 must be connected (see also page 26 - 27).
[5)] The counterbore can be deeper than stipulated in the standard.
O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Flushing and boost pressure valve

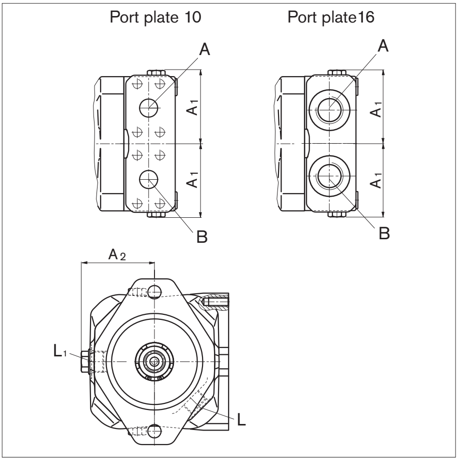
Before finalising your design request a certified installation drawing. Dimensions in mm.

Ordering Option N007

This valve assembly is used to flush an unacceptable heat load out of the closed loop circuit, and to maintain the necessary minimum boost pressure (16 bar, fixed setting). The valve is integrated into the port plate.

A built-in fixed orifice determines the flushing flow, which is taken out of the low pressure side of the loop and directed into the motor housing. It leaves the housing together with the case drain flow. This combined flow is replenished with fresh oil by means of the boost pump.

Dimensions A10FM / A10FE



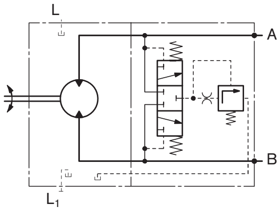
Standard flushing flow

With low press. side p_{ND} = 20 bar and an orifice dia. 1,6 mm: 5,5 L/min (sizes 23 - 63). Other orifice diameters are available, please state in clear text.

Further flushing flows for sizes 23 - 63 see table:

Flushing flow [L/min]	Orifice ø [mm]
3.5	1.2
5.5	1.6
9	2

Schematic



	Port for
A; B	Service line
L, L_1	Case drain (L_1 plugged)

Size (NG)	A_1	A_2
23/28	72	72
37/45	77	77
58/63	77	82

Anti cavitation valve

Ordering option N002

When stopping a system with a relatively large mass (i.e. fan drive) the anti-cavitation valve provides fluid to the motor inlet during the coasting time.

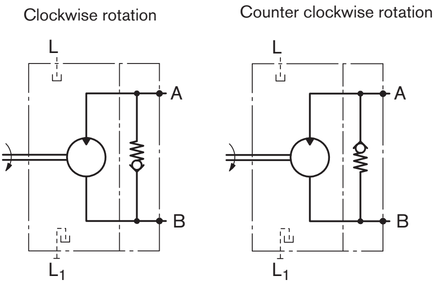
The valve assembly is integrated inside the port plate.

Important

It is necessary **to specify a direction of rotation (clockwise or counter clockwise)** looking at the shaft end of the motor.

The outside dimensions are identical to the standard units except the A10FE 11 - 18 with the 8-hole mounting flange, for the difference in lenght see unit dimensions.

Schematic



	Port for
A; B	Service line
L, L_1	Case drain (L_1 plugged)

Speed sensor

Ordering option D

The version A10FM...D comprises gearing around the rotary unit (prepared for speed pickup).

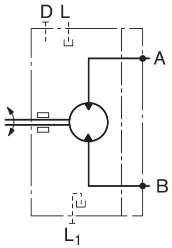
In this case, the rotating cylinder barrel can provide a speed dependent signal, which can be picked up by a suitable sensor and processed for further evaluation. Sensor port (D) will be closed for delivery.

A motor, prepared for speed sensing will be delivered without the necessary accessory parts which must be ordered separately.

Inductive speed sensor ID R 18/20-L250 (see RE 95130) and mounting parts (spacer and 2 seals per kit) can be ordered separately with the following part numbers:

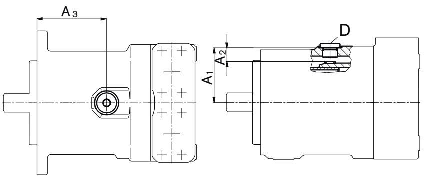
Size (NG)	Ordering Nr.	Nr. of teeth
23/28	R902428802	48
37/45	R902433368	48
58/63	in preparation	9

Schematic



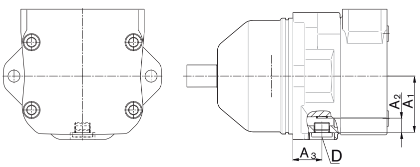
	Port for
A; B	Service line
L, L_1	Case drain (L_1 plugged)

Dimensions



A10FM....D

Size (NG)	A1	A2	A3	Port „D" (plugged)
23/28	61	15.5	101.8	M18 x 1.5
37/45	66	17	84.2	M18 x 1.5
58/63	69	14.8	128.5	M18 x 1.5



A10FE.....D

Size (NG)	A1	A2	A3	Port „D" (plugged)
23/28	61	15.5	27.7	M18 x 1.5
37/45	66	17	33.9	M18 x 1.5
58/63	69	14.8	46.1	M18 x 1.5

Installation instructions

General

At all times, the axial piston unit must be filled with fluid and air bled during commissioning and operation. This must also be observed after a prolonged period of standstill as the system may drain back to the reservoir via the hydraulic lines.

The case drain fluid in the motor housing must be directed to tank via the highest available tank port and must drain the fluid below the minimum fluid level in the reservoir.

Installation position

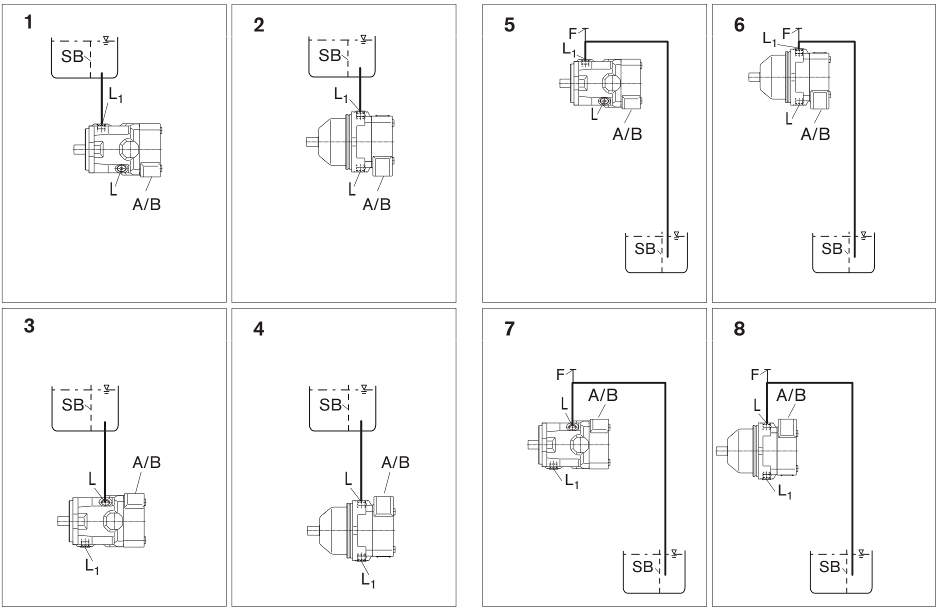
See following examples 1 to 8.
Recommended installation positions: 1 and 3 resp. 2 and 4.
Additional installation positions are available on request.

Below reservoir installation (standard)

Below reservoir installation means, that the motor is mounted below the minimum fluid level.

Above reservoir installation

Above reservoir installation means, that the motor is mounted above the minimum fluid level. A check valve in the case drain line is only permissible under certain conditions; please consult us.



Install. position	Air bleed	Filling
1, 2	–	L_1
3, 4	–	L

Install. position	Air bleed	Filling
5, 6	F	L_1 (F)
7, 8	F	L (F)

L/L_1 = Case drain port, F = Air bleed resp. filling port, , SB = Baffle.

Notes

General instructions

– The motor A10FM and A10FE has been designed to be used in open and closed circuits.

– Project planning, assembly and commissioning of the axial piston unit require the involvement of qualified personnel.

– Before operating the axial piston unit read the relevant operating manual thoroughly and completely. If needed request this information from 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).

- Pressure 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 operating conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.

– The service line ports and function ports are only designed to accommodate hydraulic lines.

– The data and notes contained herein must be adhered to.

– The product is not approved as a component for the safety concept of a general machine according to DIN 13849.

– The following tightening torques apply:

- Fittings:
  Observe the manufacturer's instructions regarding the tightening torques of the fittings used.

- Mounting bolts:
  For fixing screws with metric ISO thread according to DIN 13 or thread according to ASME B1.1, we recommend checking the tightening torque individually according to VDI 2230.

- Mounting bolts threads and threaded ports in the axial piston unit:
  The maximum permissible tightening torques $M_{G\,max}$ are maximum values for the female threads and must not be exceeded. For values, see the following table.

- Threaded plugs:
  For the threaded plugs, supplied with the axial piston unit, the required tightening torques M_V apply. For values, see the following table.

Ports Standard	Thread sizes	Maximum permissible tightening torque for the female threads $M_{G\,max}$	Required tightening torque for the threaded plugs M_V	WAF hexagon socket of the threaded plugs
DIN 3852	M14 x 1.5	80 Nm	35 Nm 1)	6 mm
	M18 x 1.5	140 Nm	60 Nm 1)	8 mm
	M27 x 2	330 Nm	135 Nm 1)	12 mm
ISO 11926	3/4-16 UNF-2B	160 Nm	62 Nm	5/16 in
	7/8-14 UNF-2B	240 Nm	110 Nm	3/8 in

1) The tightening torques apply for screws in the "dry" state as received on delivery and in the "lightly oiled" state for installation.

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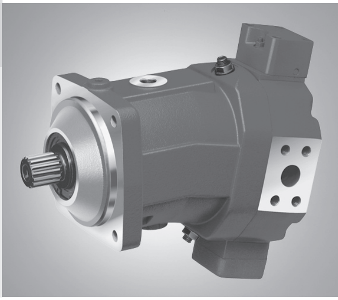
Rexroth
Bosch Group

Axial Piston Variable Motor A6VM

Data sheet



Series 63

Size	Nominal pressure
28 to 200	400 bar/450 bar
250 to 1000	350 bar/400 bar

Open and closed circuits

Contents

Features

- Variable motor with axial tapered piston rotary group of bent-axis design, for hydrostatic drives in open and closed circuits
- For use in mobile and stationary applications
- The wide control range enables the variable motor to satisfy the requirement for high speed and high torque.
- The displacement can be infinitely changed from $V_{g\,max}$ to $V_{g\,min} = 0$.
- The output speed is dependent on the flow of the pump and the displacement of the motor.
- The output torque increases with the pressure differential between the high-pressure and low-pressure side and with increasing displacement.
- Wide control range with hydrostatic transmissions
- Wide selection of control devices
- Cost savings through elimination of gear shifts and possibility of using smaller pumps
- Compact, robust motor with long service life
- High power density
- Good starting characteristics
- Small swing torque

Ordering code for standard program

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

Hydraulic fluid

01	Mineral oil and HFD. HFD for sizes 250 to 1000 only in combination with long-life bearings "L" (without code)		
	HFB, HFC hydraulic fluid	Sizes 28 to 200 (without code)	
		Sizes 250 to 1000 (only in combination with long-life bearings "L")	E

Axial piston unit

02	Bent-axis design, variable	A6V

Drive shaft bearing

		28...200	250	355	500	1000	
03	Standard bearing (without code)	●	●	●	●	–	
	Long-life bearing	–	●	●	●	●	L

Operating mode

04	Motor (plug-in motor A6VE, see RE 91606)	M

Sizes (NG)

05	Geometric displacement, see table of values on page 8	28	55	80	107	140	160	200	250	355	500	1000

Control devices

				28	55	80	107	140	160	200	250	355	500	1000	
06	Proportional control hydraulic		Δp = 10 bar	●	●	●	●	●	●	●	●	●	●	●	HD1
			Δp = 25 bar	●	●	●	●	●	●	●	●	●	●	●	HD2
			Δp = 35 bar	–	–	–	–	–	–	–	●	●	●	●	HD3
	Two-point control hydraulic			–	–	–	–	–	–	–	●	●	●	●	HZ
				●	–	–	–	●	●	●	–	–	–	–	HZ1
				–	●	●	●	–	–	–	–	–	–	–	HZ3
	Proportional control electric		12 V	●	●	●	●	●	●	●	●	●	●	●	EP1
			24 V	●	●	●	●	●	●	●	●	●	●	●	EP2
	Two-point control electric		12 V	●	–	–	–	●	●	●	●	●	●	●	EZ1
			24 V	●	–	–	–	●	●	●	●	●	●	●	EZ2
			12 V	–	●	●	●	–	–	–	–	–	–	–	EZ3
			24 V	–	●	●	●	–	–	–	–	–	–	–	EZ4
	Automatic control high-pressure related	with minimum pressure increase Δp ≤ approx. 10 bar		●	●	●	●	●	●	●	●	●	●	●	HA1
		with pressure increase Δp = 100 bar		●	●	●	●	●	●	●	●	●	●	●	HA2
	Automatic control speed-related p_{St}/p_{HD} = 3/100	hydraulic travel direction valve		–	–	–	–	–	–	–	●	●	●	❍	DA
	p_{St}/p_{HD} = 5/100	hydraulic travel direction valve		●	●	●	●	●	●	●	–	–	–	–	DA1
		electric travel direction valve + electric $V_{g\ max}$-circuit	12 V	●	●	●	●	●	●	●	–	–	–	–	DA2
			24 V	●	●	●	●	●	●	●	–	–	–	–	DA3
	p_{St}/p_{HD} = 8/100	hydraulic travel direction valve		●	●	●	●	●	●	●	–	–	–	–	DA4
		electric travel direction valve + electric $V_{g\ max}$-circuit	12 V	●	●	●	●	●	●	●	–	–	–	–	DA5
			24 V	●	●	●	●	●	●	●	–	–	–	–	DA6

Pressure control (only for HD, EP)

			28	55	80	107	140	160	200	250	355	500	1000	
07	Without pressure control (without code)		●	●	●	●	●	●	●	●	●	●	●	
	Pressure control	fixed setting	●	●	●	●	●	●	●	●	●	●	●	D
		hydraulic override, two-point	●	●	●	●	●	●	●	1)	1)	1)	1)	E
		hydraulic remote control, proportional	–	–	–	–	–	–	–	●	●	●	●	G

● = Available ❍ = On request ▲ = Not for new projects – = Not available ▭ = Preferred program

1) Fitted as standard with version D (sizes 250 to 1000)

Ordering code for standard program

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

Overrides for controls HA1 and HA2

			28	55	80	107	140	160	200	250	355	500	1000	
08	Without override (without code)		●	●	●	●	●	●	●	●	●	●	●	
	Hydraulic override, remote control, proportional		●	●	●	●	●	●	●	●	●	●	●	T
	Electric override, two-point	12 V	●	●	●	●	●	●	●	–	–	–	–	U1
		24 V	●	●	●	●	●	●	●	–	–	–	–	U2
	Electric override + electric travel direction valve	12 V	●	●	●	●	●	●	●	–	–	–	–	R1
		24 V	●	●	●	●	●	●	●	–	–	–	–	R2

Series

09	Series 6, index 3	63

Direction of rotation

10	Viewed on drive shaft, bidirectional	W

Setting ranges for displacement[2]

			28	55	80	107	140	160	200	250	355	500	1000	
11	$V_{g\,min} = 0$ to $0.7\ V_{g\,max}$ (without code)		●	●	●	●	●	●	●	–	–	–	–	
	$V_{g\,min} = 0$ to $0.4\ V_{g\,max}$	$V_{g\,max} = V_{g\,max}$ to $0.8\ V_{g\,max}$	–	–	–	–	–	–	–	●	●	●	●	1
	$V_{g\,min} > 0.4\ V_{g\,max}$ to $0.8\ V_{g\,max}$	$V_{g\,max} = V_{g\,max}$ to $0.8\ V_{g\,max}$	–	–	–	–	–	–	–	●	●	●	●	2

Seals

12	FKM (fluor-caoutchouc)	V

Drive shafts

		28	55	80	107	140	160	200	250	355	500	1000	
13	Splined shaft DIN 5480	●	●	●	●	–	●	●	–	–	–	–	A
		●	●	●	●	●	●	–	●	●	●	●	Z
	Parallel keyed shaft DIN 6885	–	–	–	–	–	–	–	●	●	●	●	P

Mounting flanges

			28	55	80	107	140	160	200	250	355	500	1000	
14	ISO 3019-2	4-hole	●	●	●	●	●	●	●	●	–	–	–	B
		8-hole	–	–	–	–	–	–	–	–	●	●	●	H

Port plates for service lines[3]

					28	55	80	107	140	160	200	250	355	500	1000	
15	SAE flange ports A and B at rear		01	0	●	●	●	●	●	●	●	●	●	●	●	010
				7	●	●	●	●	●	●	●	●	●	●	●	017
	SAE flange ports A and B at side, opposite		02	0	●	●	●	●	●	●	●	●	●	●	●	020
				7	●	●	●	●	●	●	●	●	●	●	●	027
	SAE flange ports A and B at side, opposite + rear		15	0	–	–	–	–	–	–	–	●	●	●	●	150
	Port plate with 1-level pressure-relief valves for mounting a counterbalance valve[4]	BVD	37	0	–	–	–	●	–	–	–	–	–	–	–	370 378
			38	8	–	●	●	●	●	●	●	●[6]	–	–	–	380
		BVE	38		–	–	–	●	●	●	●	–[6]	–	–	–	388

Valves (see pages 71 to 76)

Without valve	0
Flushing and boost pressure valve mounted	7
Counterbalance valve mounted[5]	8

● = Available ❍ = On request ▲ = Not for new projects – = Not available ▭ = Preferred program

2) Specify exact settings for $V_{g\,min}$ and $V_{g\,max}$ in plain text when ordering: $V_{g\,min} = ...\ cm^3$, $V_{g\,max} = ...\ cm^3$
3) Metric fastening thread
4) Only possible in combination with HD, EP and HA control. Note the restrictions on page 74.
5) Specify ordering code of counterbalance valve according to data sheet (BVD – RE 95522, BVE – RE 95525) separately. Note the restrictions on page 74.
6) Counterbalance valve MHB32, please contact us.

2

Ordering code for standard program

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

	Speed sensors (see page 78)	28	55	80	107	140	160	200	250	355	500	1000[7]	
16	Without speed sensor	●	●	●	●	●	●	●	●	●	●	●	0
	Prepared for HDD speed sensor	–	▲	▲	▲	▲	▲	▲	▲	●	●	–	F
	HDD speed sensor mounted[8]	–	▲	▲	▲	▲	▲	▲	▲	●	●	–	H
	Prepared for DSA speed sensor	●	●	●	●	●	●	●	❍	❍	❍	–	U
	DSA speed sensor mounted[8]	●	●	●	●	●	●	●	❍	❍	❍	–	V

	Swivel angle sensor (see page 77)	28	55	80	107	140	160	200	250	355	500	1000	
17	Without swivel angle sensor (without code)	●	●	●	●	●	●	●	●	●	●	–	
	Optical swivel angle sensor	–	–	–	–	–	–	–	●	●	●	●	V
	Electric swivel angle sensor	–	–	–	–	–	–	–	●	●	●	●	E

	Connector for solenoids (see page 70)	28 to 200	250 to 1000	
18	Without connector (without solenoid, only with hydraulic controls)	●	–	0
	(size 250 to 1000 without code)	–	●	
	DEUTSCH – molded connector, 2-pin – without suppressor diode	●	–	P
	HIRSCHMANN connector – without suppressor diode (without code)	–	●	

	Beginning of control	28	55	80	107	140	160	200	250	355	500	1000	
19	At $V_{g\,min}$ (standard for HA)	●	●	●	●	●	●	●	●	●	●	●	A
	At $V_{g\,max}$ (standard for HD, HZ, EP, EZ, DA)	●	●	●	●	●	●	●	●	●	●	●	B

	Standard / special version	
20	Standard version (without code)	
	Standard version with installation variants, e. g. T ports against standard open or closed	–Y
	Special version	-S

● = Available ❍ = On request ▲ = Not for new projects – = Not available [grey box] = Preferred program

7) Please contact us.

8) Specify ordering code of sensor according to data sheet (DSA – RE 95133, HDD – RE 95135) separately and observe the requirements on the electronics.

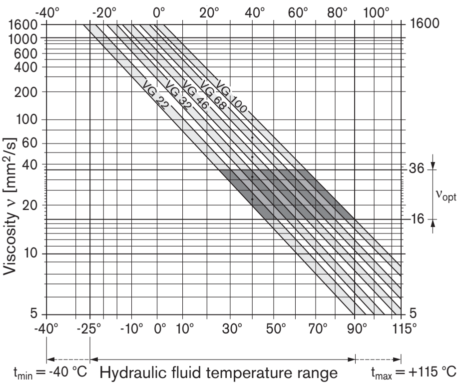
Technical data

Hydraulic fluid

Before starting project planning, please refer to our data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids), RE 90222 (HFD hydraulic fluids) and RE 90223 (HFA, HFB, HFC hydraulic fluids) for detailed information regarding the choice of hydraulic fluid and application conditions.

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

Selection diagram



Details regarding the choice of hydraulic fluid

The correct choice of hydraulic fluid requires knowledge of the operating temperature in relation to the ambient temperature: in a closed circuit, the circuit temperature, in an open circuit, the reservoir temperature.

The hydraulic fluid should be chosen so that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt} see shaded area of the selection diagram). We recommended that the higher viscosity class be selected in each case.

Example: At an ambient temperature of X °C, an operating temperature of 60 °C is set in the circuit. In the optimum viscosity range ($\nu_{opt.}$, shaded area), this corresponds to the viscosity classes VG 46 or VG 68; to be selected: VG 68.

Note

The case drain temperature, which is affected by pressure and speed, can be higher than the circuit temperature or reservoir temperature. At no point of the component may the temperature be higher than 115 °C. The temperature difference specified below is to be taken into account when determining the viscosity in the bearing.

If the above conditions cannot be maintained due to extreme operating parameters, we recommend flushing the case at port U or using a flushing and boost pressure valve (see pages 71 and 72).

Viscosity and temperature of hydraulic fluid

	Viscosity [mm²/s]	Temperature	Comment
Transport and storage at ambient temperature		$T_{min} \geq$ -50 °C T_{opt} = +5 °C to +20 °C	factory preservation: up to 12 months with standard, up to 24 months with long-term
(Cold) start-up[1]	ν_{max} = 1600	$T_{St} \geq$ -40 °C	$t \leq 3$ min, without load ($p \leq 50$ bar), $n \leq 1000$ rpm (sizes 28 to 200), $n \leq 0.25 \cdot n_{nom}$ (sizes 250 to 1000)
Permissible temperature difference		$\Delta T \leq 25$ K	between axial piston unit and hydraulic fluid
Warm-up phase	$\nu <$ 1600 to 400	T = -40 °C to -25 °C	At $p \leq 0.7 \cdot p_{nom}$, $n \leq 0.5 \cdot n_{nom}$ and $t \leq 15$ min
Operating phase			
Temperature difference		ΔT = approx. 12 K	between hydraulic fluid in the bearing and at port T. The bearing temperature can be reduced by flushing via port U.
Maximum temperature		115 °C	in the bearing
		103 °C	measured at port T
Continuous operation	ν = 400 to 10 ν_{opt} = 36 to 16	T = -25 °C to +90 °C	measured at port T, no restriction within the permissible data
Short-term operation[2]	$\nu_{min} \geq 7$	T_{max} = +103 °C	measured at port T, $t < 3$ min, $p < 0.3 \cdot p_{nom}$
FKM shaft seal[1]		$T \leq$ +115 °C	see page 6

1) At temperatures below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).
2) Sizes 250 to 1000, please contact us.

Technical data

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.

To ensure the functional reliability of the axial piston unit, a gravimetric analysis of the hydraulic fluid is necessary to determine the amount of solid contaminant and to determine the cleanliness level according to ISO 4406. A cleanliness level of at least 20/18/15 is to be maintained.

At very high hydraulic fluid temperatures (90 °C to maximum 115 °C), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

If the above classes cannot be achieved, please contact us.

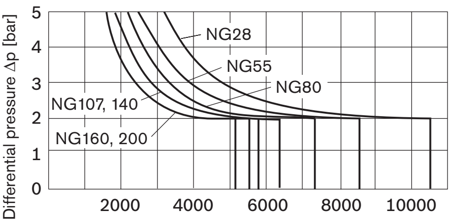
Shaft seal

Permissible pressure loading

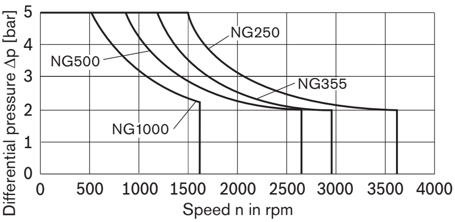
The service life of the shaft seal is influenced by the speed of the axial piston unit and the case drain pressure (case pressure). The mean differential pressure of 2 bar between the case and the ambient pressure may not be enduringly exceeded at normal operating temperature. For a higher differential pressure at reduced speed, see diagram. Momentary pressure spikes ($t < 0.1$ s) of up to 10 bar are permitted. The service life of the shaft seal decreases with an increase in the frequency of pressure spikes.

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

Sizes 28 to 200



Sizes 250 to 1000



The values are valid for an ambient pressure $p_{abs} = 1$ bar.

Temperature range

The FKM shaft seal may be used for case drain temperatures from -25 °C to +115 °C.

Note
For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range: -40 °C to +90 °C).
State NBR shaft seal in plain text when ordering.
Please contact us.

Influence of case pressure on beginning of control

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

HD, HA.T (sizes 28 to 200) ____________ increase
HD, EP, HA, HA.T (sizes 250 to 1000) ____________ increase
DA ____________ decrease

With the following controls, an increase in the case pressure has no influence on the beginning of control:
EP, HA, HA.R, HA.U (sizes 28 to 200)

The factory settings for the beginning of control are made at $p_{abs} = 2$ bar (sizes 28 to 200) and $p_{abs} = 1$ bar (sizes 250 to 1000) case pressure.

Direction of flow

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

Long-life bearings

Sizes 250 to 1000

For long service life and use with HF hydraulic fluids. Identical external dimensions as motor with standard bearings. Subsequent conversion to long-life bearings is possible. Bearings and case flushing via port U is recommended.

Flushing flow (recommended)

NG	250	355	500	1000
$q_{v\ flush}$ (L/min)	10	16	16	16

Technical data

Operating pressure range

(operating with mineral oil)

Pressure at service line port A or B

Sizes 28 to 200

Nominal pressure p_{nom} ______ 400 bar absolute

Maximum pressure p_{max} ______ 450 bar absolute
Single operating period ______ 10 s
Total operating period at ______ 300 h

Sizes 250 to 1000

Nominal pressure p_{nom} ______ 350 bar absolute

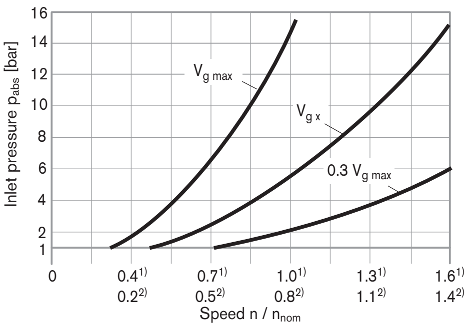
Maximum pressure p_{max} ______ 400 bar absolute
Single operating period ______ 10 s
Total operating period ______ 300 h

Minimum pressure (high-pressure side) ___25 bar absolute

Summation pressure (pressure A + pressure B) p_{Su} _ 700 bar

Rate of pressure change $R_{A\,max}$
with integrated pressure-relief valve ______ 9000 bar/s
without pressure-relief valve ______ 16000 bar/s

Minimum pressure – pump mode (inlet)
To prevent damage to the axial piston motor in pump operating mode (change of high-pressure side with unchanged direction of rotation, e. g. when braking), a minimum pressure must be guaranteed at the service line port (inlet). This minimum pressure is dependent on the speed and displacement of the axial piston unit (see characteristic curve below).



[1] For sizes 28 to 200
[2] For sizes 250 to 1000

This diagram is valid only for the optimum viscosity range from ν_{opt} = 36 to 16 mm²/s.
Please contact us if the above conditions cannot be satisfied.

Note
Values for other hydraulic fluids, please contact us.

Definition

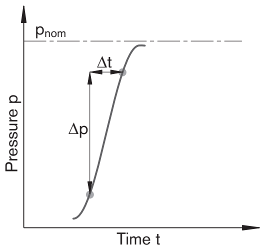
Nominal pressure p_{nom}
The nominal pressure corresponds to the maximum design pressure.

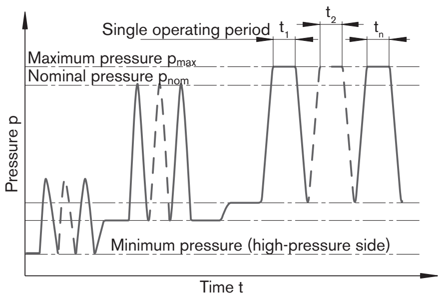
Maximum pressure p_{max}
The maximum pressure corresponds to the maximum operating pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.

Minimum pressure (high-pressure side)
Minimum pressure at the high-pressure side (A or B) which is required in order to prevent damage to the axial piston unit.

Summation pressure p_{Su}
The summation pressure is the sum of the pressures at both service line ports (A and B).

Rate of pressure change R_A
Maximum permissible rate of pressure rise and reduction during a pressure change over the entire pressure range.





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

2

Technical data

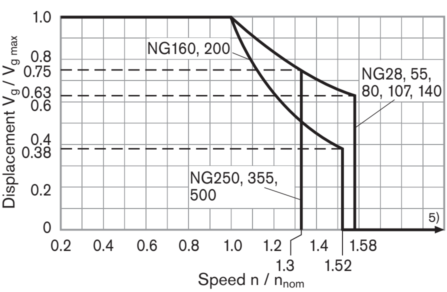
Table of values (theoretical values, without efficiency and tolerances; values rounded)

Size	NG		28	55	80	107	140	160	200	250	355	500	1000
Displacement geometric[1], per revolution	$V_{g\,max}$	cm^3	28.1	54.8	80	107	140	160	200	250	355	500	1000
	$V_{g\,min}$	cm^3	0	0	0	0	0	0	0	0	0	0	0
	$V_{g\,x}$	cm^3	18	35	51	68	88	61	76	188	270	377	762
Speed maximum[2] (while adhering to the maximum permissible input flow)													
at $V_{g\,max}$	n_{nom}	rpm	5550	4450	3900	3550	3250	3100	2900	2700	2240	2000	1600
at $V_g < V_{g\,x}$ (see diagram below)	n_{max}	rpm	8750	7000	6150	5600	5150	4900	4600	3600	2950	2650	1600
at $V_{g\,0}$	n_{max}	rpm	10450	8350	7350	6300	5750	5500	5100	3600	2950	2650	1600
Input flow[3] at n_{nom} and $V_{g\,max}$	$q_{V\,max}$	L/min	156	244	312	380	455	496	580	675	795	1000	1600
Torque[4] at $V_{g\,max}$ and $\Delta p = 400$ bar	T	Nm	179	349	509	681	891	1019	1273	–	–	–	–
at $V_{g\,max}$ and $\Delta p = 350$ bar	T	Nm	157	305	446	596	778	891	1114	1391	1978	2785	5571
Rotary stiffness $V_{g\,max}$ to $V_g/2$	c_{min}	KNm/rad	6	10	16	21	34	35	44	60	75	115	281
$V_g/2$ to 0 (interpolated)	c_{max}	KNm/rad	18	32	48	65	93	105	130	181	262	391	820
Moment of inertia for rotary group	J_{GR}	kgm^2	0.0014	0.0042	0.008	0.0127	0.0207	0.0253	0.0353	0.061	0.102	0.178	0.55
Maximum angular acceleration	α	rad/s^2	47000	31500	24000	19000	11000	11000	11000	10000	8300	5500	4000
Case volume	V	L	0.5	0.75	1.2	1.5	1.8	2.4	2.7	3.0	5.0	7.0	16.0
Mass (approx.)	m	kg	16	26	34	47	60	64	80	100	170	210	430

1) The minimum and maximum displacement are infinitely adjustable, see ordering code, page 3.
(standard setting for sizes 250 to 1000 if not specified in the order: $V_{g\,min} = 0.2 \cdot V_{g\,max}$, $V_{g\,max} = V_{g\,max}$).
2) The values are valid:
- for the optimum viscosity range from $\nu_{opt} = 36$ to $16\ mm^2/s$
- with hydraulic fluid based on mineral oils
3) Restriction of input flow with counterbalance valve, see page 74
4) Torque without radial force, with radial force see page 9

Note
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, with respect to speed variation, reduced angular acceleration as a function of the frequency and the permissible startup angular acceleration (lower than the maximum angular acceleration) can be found in data sheet 90261.

Permissible displacement in relation to speed



5) Values in this range on request

Determining the operating characteristics

Input flow $q_v = \dfrac{V_g \cdot n}{1000 \cdot \eta_v}$ [L/min]

Speed $n = \dfrac{q_V \cdot 1000 \cdot \eta_v}{V_g}$ [min^{-1}]

Torque $T = \dfrac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$ [Nm]

Power $P = \dfrac{2\,\pi \cdot T \cdot n}{60000} = \dfrac{q_v \cdot \Delta p \cdot \eta_t}{600}$ [kW]

V_g = Displacement per revolution in cm^3

Δp = Differential pressure in bar

n = Speed in rpm

η_v = Volumetric efficiency

η_{mh} = Mechanical-hydraulic efficiency

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

Technical data

Permissible radial and axial forces of the drive shafts

Size	NG		28	28	55	55	80	80	107	107	140
Drive shaft	ø	mm	30	25	35	30	40	35	45	40	45
Maximum radial force[1)] at distance a (from shaft collar)	$F_{q\ max}$	N	4838	6436	8069	7581	10283	10266	12215	13758	15982
	a	mm	17.5	14	20	17.5	22.5	20	25	22.5	25
with permissible torque	T_{max}	Nm	179	179	349	281	509	444	681	681	891
≙ Permissible pressure Δp at $V_{g\ max}$	$p_{nom\ perm.}$	bar	400	400	400	322	400	349	400	400	400
Maximum axial force[2)]	$+F_{ax\ max}$	N	315	315	500	500	710	710	900	900	1030
	$-F_{ax\ max}$	N	0	0	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$F_{ax\ perm./bar}$	N/bar	4.6	4.6	7.5	7.5	9.6	9.6	11.3	11.3	13.3

Size	NG		160	160	200	250	355	500	1000
Drive shaft	ø	mm	50	45	50	50	60	70	90
Maximum radial force[1)] at distance a (from shaft collar)	$F_{q\ max}$	N	16435	18278	20532	1200[3)]	1500[3)]	1900[3)]	2600[3)]
	a	mm	27.5	25	27.5	41	52.5	52.5	67.5
with permissible torque	T_{max}	Nm	1019	1019	1273	[4)]	[4)]	[4)]	[4)]
≙ Permissible pressure Δp at $V_{g\ max}$	$p_{nom\ perm.}$	bar	400	400	400	[4)]	[4)]	[4)]	[4)]
Maximum axial force[2)]	$+F_{ax\ max}$	N	1120	1120	1250	1200	1500	1900	2600
	$-F_{ax\ max}$	N	0	0	0	0	0	0	0
Permissible axial force per bar operating pressure	$F_{ax\ perm./bar}$	N/bar	15.1	15.1	17.0	[4)]	[4)]	[4)]	[4)]

1) With intermittent operation.
2) Maximum permissible axial force during standstill or when the axial piston unit is operating in non-pressurized condition.
3) When at a standstill or when axial piston unit operating in non-pressurized conditions. Higher forces are permissible when under pressure, please contact us.
4) Please contact us.

Note

Influence of the direction of the permissible axial force:

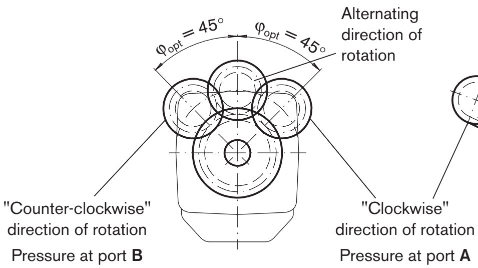
$+F_{ax\ max}$ = Increase in service life of bearings

$-F_{ax\ max}$ = Reduction in service life of bearings (avoid)

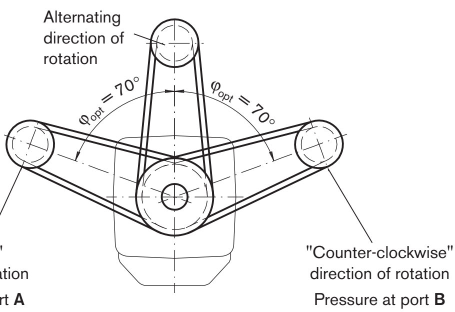
Effect of radial force F_q on the service life of bearings

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

Toothed gear drive



V-belt drive



HD – Proportional control hydraulic

The proportional hydraulic control provides infinite setting of the displacement, proportional to the pilot pressure applied to port X.

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

Note

- Maximum permissible pilot pressure: p_{St} = 100 bar
- The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
  Please note that pressures up to 450 bar can occur at port G.
- Please state the desired beginning of control in plain text when ordering, e. g.: beginning of control at 10 bar.
- The beginning of control and the HD characteristic are influenced by the case pressure. An increase in case pressure causes an increase in the beginning of control (see page 6) and thus a parallel shift of the characteristic.
- A leakage flow of maximum 0.3 L/min can escape at port X due to internal leakage (operating pressure > pilot pressure). The control is to be suitably configured to avoid an independent build-up of pilot pressure.

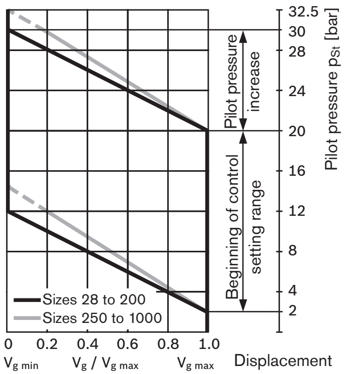
HD1
Pilot pressure increase Δp_{St} = 10 bar

A pilot pressure increase of 10 bar at port X results in a decrease in displacement from $V_{g\ max}$ to 0 cm³ (sizes 28 to 200) or from $V_{g\ max}$ to 0.2 $V_{g\ max}$ (sizes 250 to 1000).

Beginning of control, setting range ______________2 to 20 bar

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

HD1 characteristic



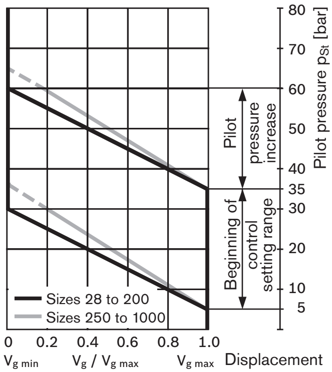
HD2
Pilot pressure increase Δp_{St} = 25 bar

A pilot pressure increase of 25 bar at port X results in a decrease in displacement from $V_{g\ max}$ to 0 cm³ (sizes 28 to 200) or from $V_{g\ max}$ to 0.2 $V_{g\ max}$ (sizes 250 to 1000).

Beginning of control, setting range ______________5 to 35 bar

Standard setting:
Beginning of control at 10 bar (end of control at 35 bar)

HD2 characteristic



HD3
Pilot pressure increase Δp_{St} = 35 bar

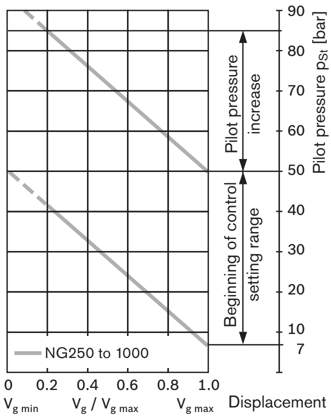
(sizes 250 to 1000)

A pilot pressure increase of 35 bar at port X results in a decrease in displacement from $V_{g\ max}$ to 0.2 $V_{g\ max}$.

Beginning of control, setting range ______________7 to 50 bar

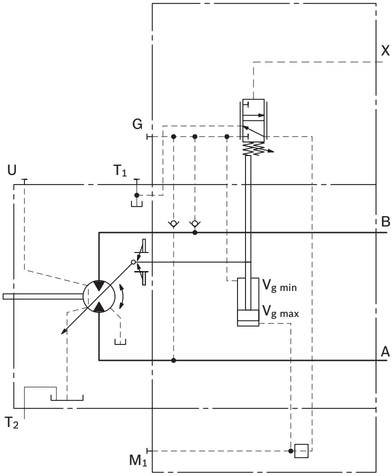
Standard setting:
Beginning of control at 10 bar (end of control at 45 bar)

HDR3 characteristic

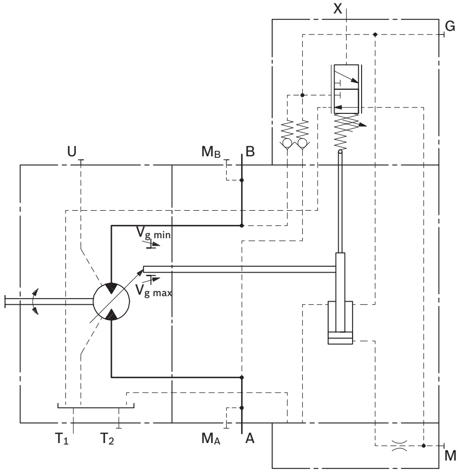


HD – Proportional control hydraulic

Schematic HD1, HD2, HD3
Sizes 28 to 200



Schematic HD1, HD2, HD3
Sizes 250 to 1000



Note

The spring return feature in the control part is not a safety device

The control part can stick in an undefined position by internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the control will no longer respond correctly to the operator's commands.

Check whether the application on your machine requires additional safety measures, in order to bring the driven actuator into a controlled and safe position (immediate stop). If necessary, make sure these are properly implemented.

HD – Proportional control hydraulic

HD.D
Pressure control, fixed setting

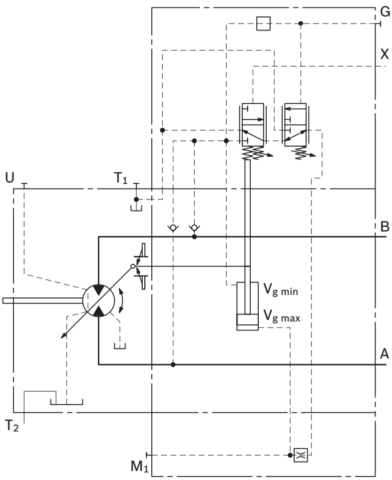
The pressure control overrides the HD control function. If the load torque or a reduction in motor swivel angle causes the system pressure to reach the setpoint of the pressure control, the motor will swivel towards a larger displacement.

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

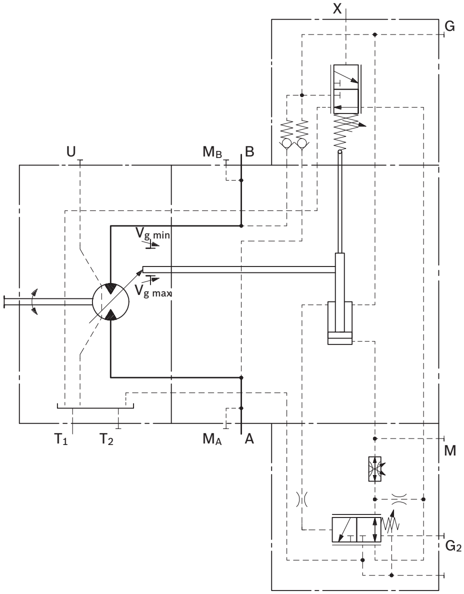
Setting range of the pressure control valve

Sizes 28 to 200	80 to 400 bar
Sizes 250 to 1000	80 to 350 bar

Schematic HD.D
Sizes 28 to 200



Schematic HD.D
Sizes 250 to 1000



HD – Proportional control hydraulic

HD.E
Pressure control, hydraulic override, two-point

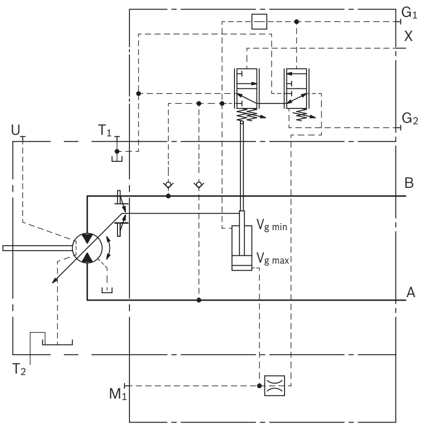
Sizes 28 to 200

The pressure control setting can be overridden by applying an external pilot pressure at port G_2, realizing a 2nd pressure setting.

Required pilot pressure at port G_2:
p_{St} = 20 to 50 bar

Please state the 2nd pressure setting in plain text when ordering.

Schematic HD.E



Sizes 250 to 1000 (HD.D)

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

The pressure control setting can be overridden by applying an external pilot pressure at port G_2, realizing a 2nd pressure setting.

Required pilot pressure at port G_2:
$p_{St} \geq 100$ bar

Please state the 2nd pressure setting in plain text when ordering.

HD.G
Pressure control, remote control

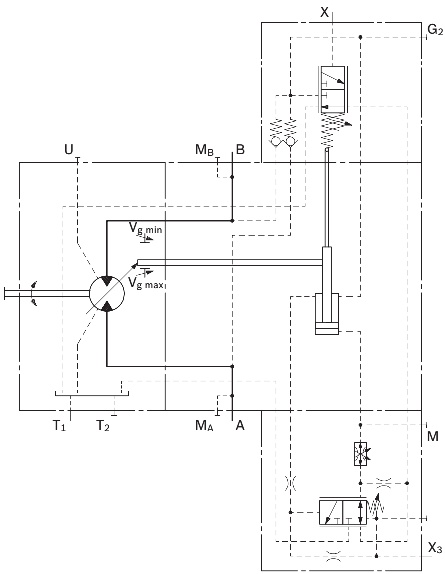
Sizes 250 to 1000

When the set pressure value is reached, the remote control pressure control continually regulates the motor to maximum displacement $V_{g\ max}$. A pressure-relief valve (not included in the delivery contents), which is located separately from the motor and which is connected to port X_3, assumes the task of controlling the internal pressure cut-off valve.
So long as the target pressure value has not been reached, pressure is evenly applied to the valve from both sides in addition to the force of the spring, and the valve remains closed.
The target pressure value is between 80 bar and 350 bar.
When the target pressure value is reached at the separate pressure-relief valve, this will open, reliving the pressure on the spring side to the reservoir. The internal control valve switches and the motor swivels to maximum displacement $V_{g\ max}$.
The differential pressure at the control valve is set as standard to 25 bar. As a separate pressure-relief valve, we recommend:

DBD 6 (hydraulic) as per RE 25402

The maximum line length should not exceed 2 m.

Schematic HD.G



2

EP – Proportional control electric

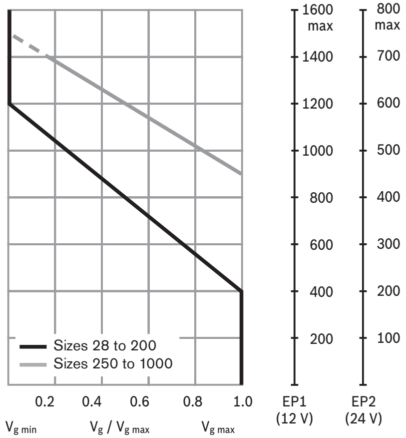
The proportional electric control provides infinite setting of the displacement, proportional to the control current applied to the solenoid (sizes 28 to 200) or proportional valve (sizes 250 to 1000).

For sizes 250 to 1000, the pilot oil supply at port P requires an external pressure of $p_{min} = 30$ bar ($p_{max} = 100$ bar).

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

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

Characteristic



Note
The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
Please note that pressures up to 450 bar can occur at port G.

The following only needs to be noted for sizes 250 to 1000:

– The beginning of control and the EP characteristic are influenced by the case pressure. An increase in case pressure causes an increase in the beginning of control (see page 6) and thus a parallel shift of the characteristic.

Technical data, solenoid
Sizes 28 to 200

	EP1	EP2
Voltage	12 V (±20 %)	24 V (±20 %)
Control current		
Beginning of control	400 mA	200 mA
End of control	1200 mA	600 mA
Limiting current	1.54 A	0.77 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 design page 70		

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

– BODAS controller RC
  Series 20 ____ RE 95200
  Series 21 ____ RE 95201
  Series 22 ____ RE 95202
  Series 30 ____ RE 95203, RE 95204
  and application software

– Analog amplifier RA ____ RE 95230

– Electric amplifier VT 2000, series 5X (see RE 29904) (for stationary application)

Further information can also be found on the Internet at www.boschrexroth.com/mobile-electronics

Technical data, proportional valve
Sizes 250 to 1000

	EP1	EP2
Voltage	12 V (±20 %)	24 V (±20 %)
Beginning of control at $V_{g\ max}$	900 mA	450 mA
End of control at $V_{g\ min}$	1400 mA	700 mA
Limiting current	2.2 A	1.0 A
Nominal resistance (at 20 °C)	2.4 Ω	12 Ω
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

See also proportional pressure-reducing valve DRE 4K (RE 29181).

Note

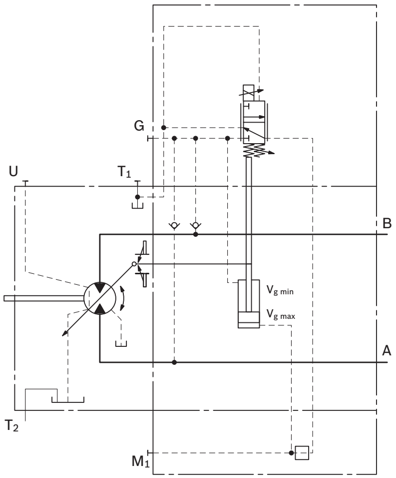
The spring return feature in the control part is not a safety device

The control part can stick in an undefined position by internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the control will no longer respond correctly to the operator's commands.

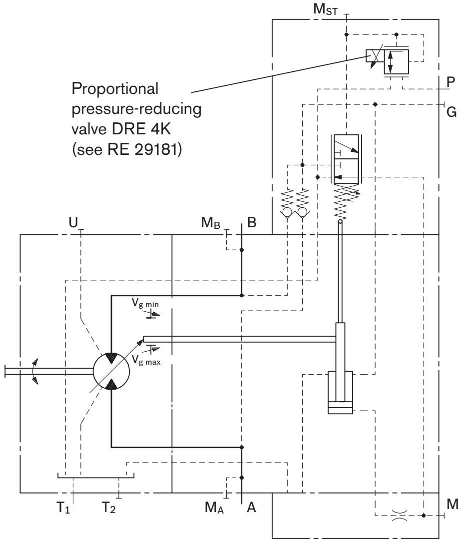
Check whether the application on your machine requires additional safety measures, in order to bring the driven actuator into a controlled and safe position (immediate stop). If necessary, make sure these are properly implemented.

EP – Proportional control electric

Schematic EP1, EP2
Sizes 28 to 200



Schematic EP1, EP2
Sizes 250 to 1000



EP – Proportional control electric

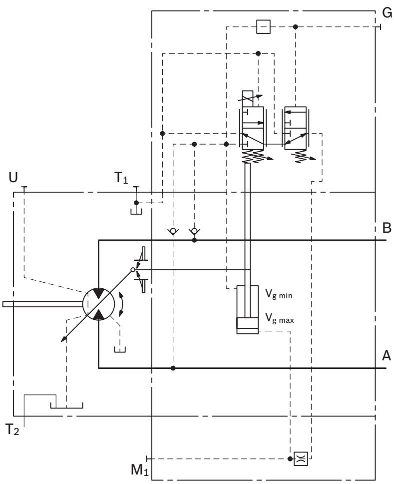
EP.D
Pressure control, fixed setting

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

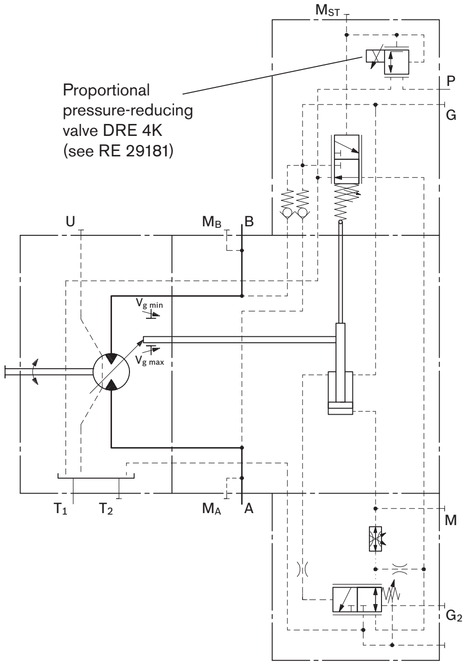
The increase in the displacement and the resulting reduction in pressure cause the control deviation to decrease. With the increase in displacement the motor develops more torque, while the pressure remains constant.

Setting range of the pressure control valve:
Sizes 28 to 200 ________________________ 80 to 400 bar
Sizes 250 to 1000 ______________________ 80 to 350 bar

Schematic EP.D
Sizes 28 to 200



Schematic EP.D
Sizes 250 to 1000



EP – Proportional control electric

EP.E
Pressure control, hydraulic override, two-point

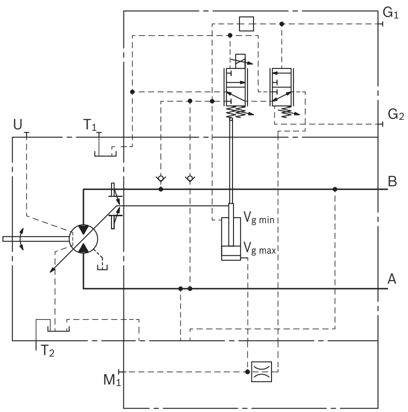
Sizes 28 to 200

The pressure control setting can be overridden by applying an external pilot pressure at port G_2, realizing a 2nd pressure setting.

Required pilot pressure at port G_2:
$p_{St} = 20$ to 50 bar

Please state the 2nd pressure setting in plain text when ordering.

Schematic EP.E



Sizes 250 to 1000 (EP.D)

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

The pressure control setting can be overridden by applying an external pilot pressure at port G_2, realizing a 2nd pressure setting.

Required pilot pressure at port G_2:
$p_{St} \geq 100$ bar

Please state the 2nd pressure setting in plain text when ordering.

EP.G
Pressure control, remote control

Sizes 250 to 1000

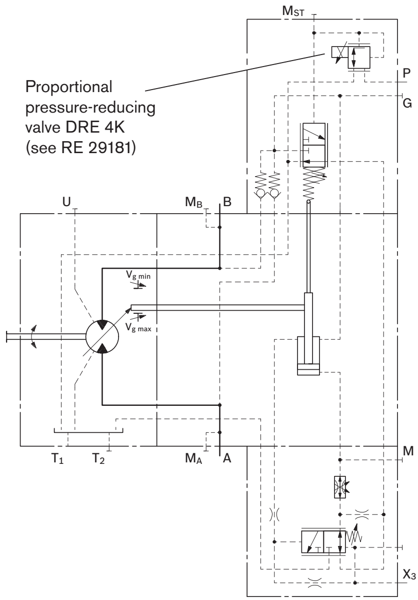
When the set pressure value is reached, the remote control pressure control continually regulates the motor to maximum displacement $V_{g\ max}$. A pressure-relief valve (not included in the delivery contents), which is located separately from the motor and which is connected to port X_3, assumes the task of controlling the internal pressure cut-off valve.

So long as the target pressure value has not been reached, pressure is evenly applied to the valve from both sides in addition to the force of the spring, and the valve remains closed. The target pressure value is between 80 bar and 350 bar. When the target pressure value is reached at the separate pressure-relief valve, this will open, reliving the pressure on the spring side to the reservoir. The internal control valve switches and the motor swivels to maximum displacement $V_{g\ max}$.
The differential pressure at the control valve is set as standard to 25 bar. As a separate pressure-relief valve, we recommend:

DBD 6 (hydraulic) as per RE 25402

The maximum line length should not exceed 2 m.

Schematic EP.G



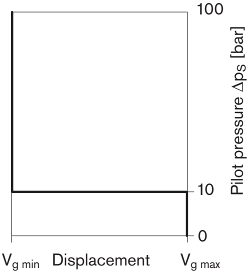
2

HZ – Two-point control hydraulic

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

- Position at $V_{g\ max}$ (without pilot pressure, maximum torque, minimum speed)
- Position at $V_{g\ min}$ (with pilot pressure > 10 bar activated, minimum torque, maximum permissible speed)

Characteristic HZ

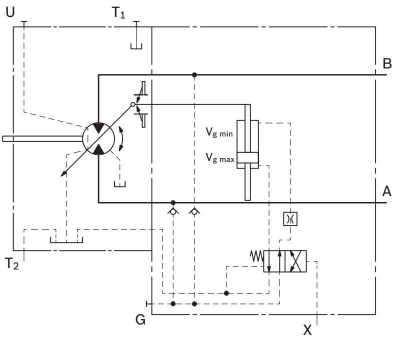


Note

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

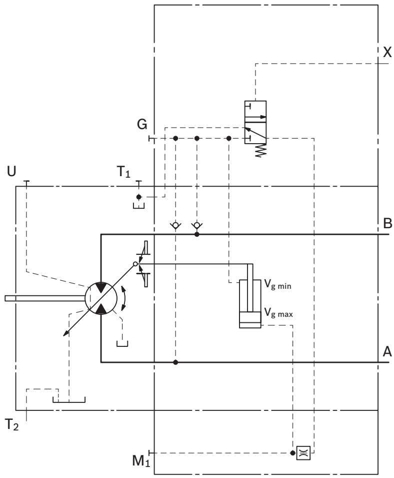
Schematic HZ3

Sizes 55 to 107



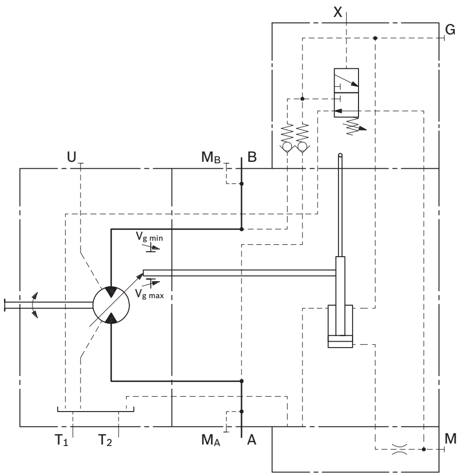
Schematic HZ1

Sizes 28, 140, 160, 200



Schematic HZ

Sizes 250 to 1000



EZ – Two-point control electric

The two-point electric control with switching solenoid (sizes 28 to 200) or control valve (sizes 250 to 1000) allows the displacement to be set to either $V_{g\,min}$ or $V_{g\,max}$ by switching the electric current at the switching solenoid or control valve on or off.

Note

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

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

Technical data, solenoid with Ø37

Sizes 28, 140, 160, 200

	EZ1	EZ2
Voltage	12 V (±20 %)	24 V (±20 %)
Displacement $V_{g\,max}$	de-energized	de-energized
Displacement $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum required current	1.32 A	0.67 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

Technical data, solenoid with Ø45

Sizes 55 to 107

	EZ3	EZ4
Voltage	12 V (±20 %)	24 V (±20 %)
Displacement $V_{g\,max}$	de-energized	de-energized
Displacement $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

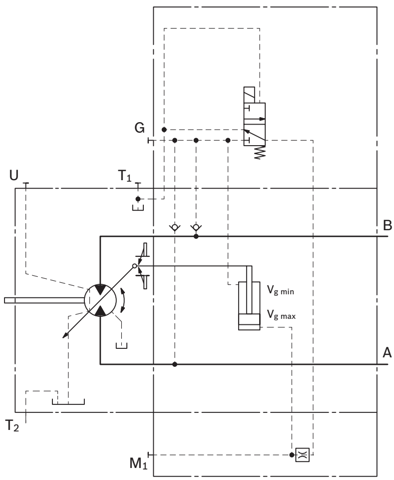
Technical data, control valve

Sizes 250 to 1000

	EZ1	EZ2
Voltage	12 V (±20 %)	24 V (±20 %)
Displacement $V_{g\,max}$	de-energized	de-energized
Displacement $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	6 Ω	23 Ω
Nominal power	26 W	26W
Minimum required current	2 A	1.04 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

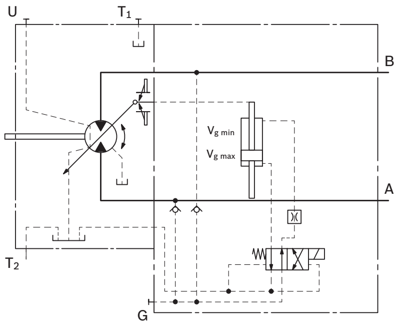
Schematic EZ1, EZ2

Sizes 28, 140, 160, 200



Schematic EZ3, EZ4

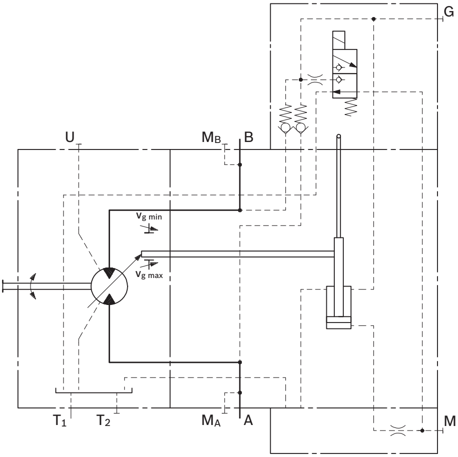
Sizes 55 to 107



2

EZ – Two-point control electric

Schematic EZ1, EZ2
Sizes 250 to 1000



HA – Automatic control high-pressure related

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

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

– Beginning of control at $V_{g\,min}$ (minimum torque, maximum speed)

– End of control at $V_{g\,max}$ (maximum torque, minimum speed)

Note

– For safety reasons, winch drives are not permissible with beginning of control at $V_{g\,min}$ (standard for HA).

– The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
Please note that pressures up to 450 bar can occur at port G.

– The beginning of control and the HA characteristic are influenced by the case pressure. An increase in case pressure causes an increase in the beginning of control (see page 7) and thus a parallel shift of the characteristic. Only for HA1T (sizes 28 to 200) and HA1, HA2, HA.T, (sizes 250 to 1000).

– A leakage flow of maximum 0.3 L/min is present at port X (operating pressure > pilot pressure). To avoid a build-up of pilot pressure, pressure is to be relieved from port X to the reservoir. **Only for control HA.T**.

2

HA – Automatic control high-pressure related

HA1
With minimum pressure increase

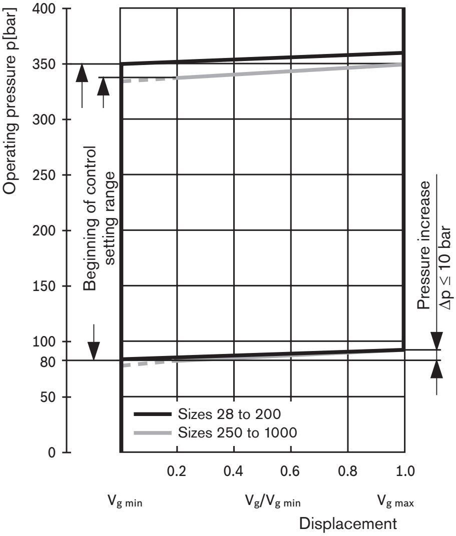
An operating pressure increase of Δp ≤ approx. 10 bar results in an increase in displacement from 0 cm³ to $V_{g\ max}$ (sizes 28 to 200) or from 0.2 $V_{g\ max}$ to $V_{g\ max}$ (sizes 250 to 1000).

Beginning of control, setting range

Sizes 28 to 200	80 to 350 bar
Sizes 250 to 1000	80 to 340 bar

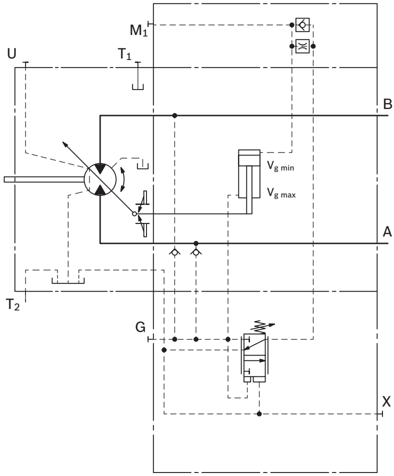
Please state the desired beginning of control in plain text when ordering, e. g.: beginning of control at 300 bar.

Characteristic HA1

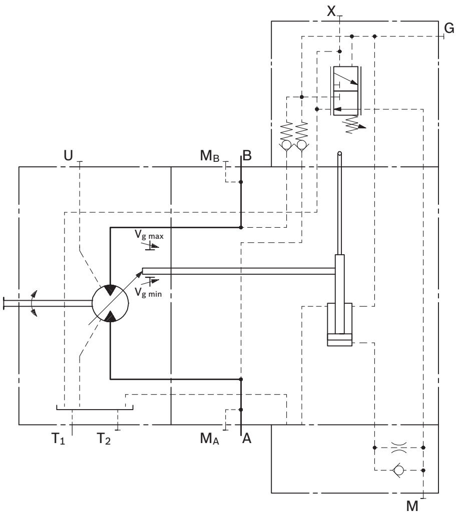


Schematic HA1

Sizes 28 to 200



Sizes 250 to 1000



HA – Automatic high-pressure related control

HA2
With pressure increase

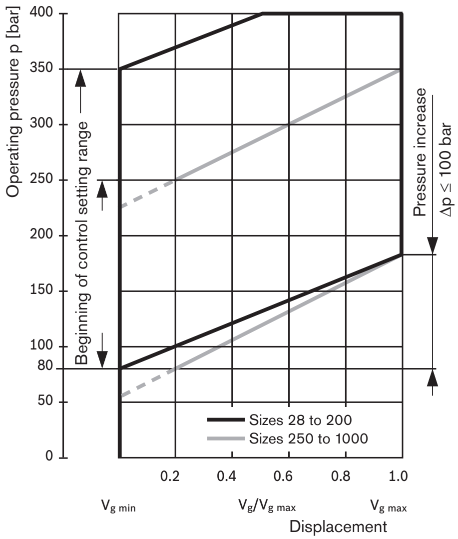
An operating pressure increase of Δp = approx. 100 bar results in an increase in displacement from 0 cm^3 to $V_{g\,max}$ (sizes 28 to 200) or from 0.2 $V_{g\,max}$ to $V_{g\,max}$ (sizes 250 to 1000).

Beginning of control, setting range

Sizes 28 to 200	80 to 350 bar
Sizes 250 to 1000	80 to 250 bar

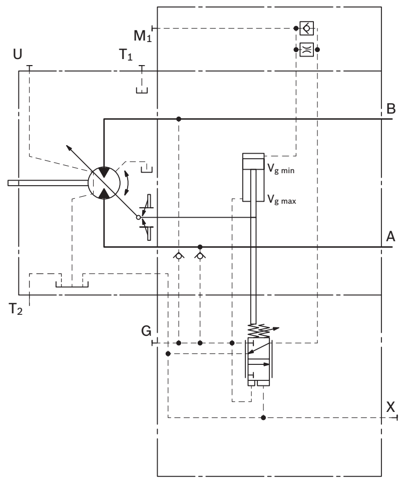
Please state the desired beginning of control in plain text when ordering, e. g.: beginning of control at 200 bar.

Characteristic HA2

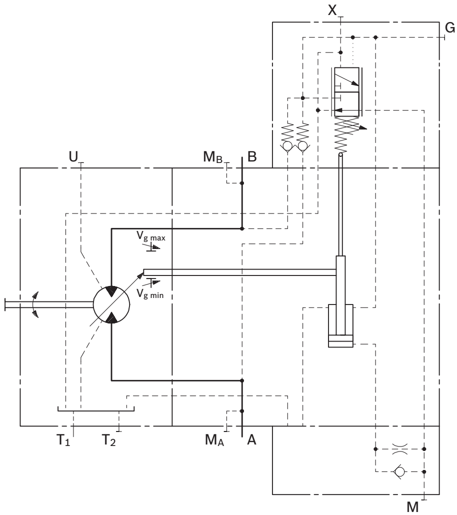


Schematic HA2

Sizes 28 to 200



Sizes 250 to 1000



2

HA – Automatic control high-pressure related

HA.T
Override hydraulic remote control, proportional

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

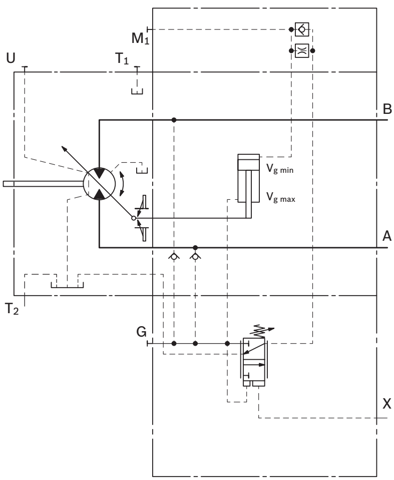
For each 1 bar of pilot pressure increase, the beginning of control is reduced by 17 bar (sizes 28 to 200) or 8 bar (sizes 250 to 1000).

Example (sizes 28 to 200):

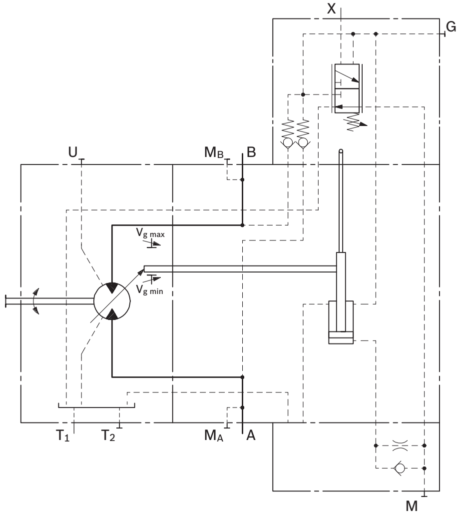
Beginning of control setting	300 bar	300 bar
Pilot pressure at port X	0 bar	10 bar
Beginning of control at	300 bar	130 bar

Note
Maximum permissible pilot pressure 100 bar.

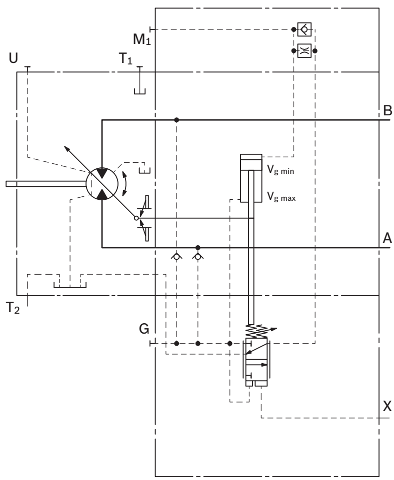
Schematic HA1.T
Sizes 28 to 200



Schematic HA1.T
Sizes 250 to 1000



Schematic HA2.T
Sizes 28 to 200



HA – Automatic control high-pressure related

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

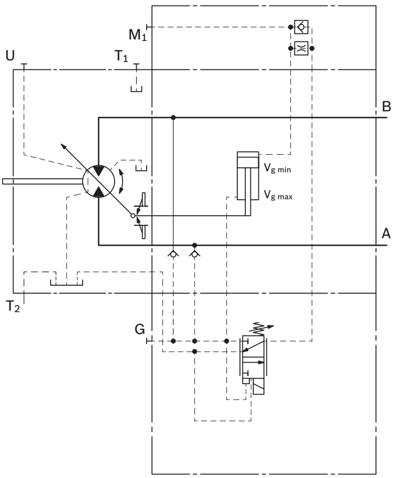
Sizes 28 to 200

With the HA.U1 or HA.U2 control, the beginning of control can be overridden by an electric signal to a switching solenoid. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position. The beginning of control is adjustable between 80 and 300 bar (specify required setting in plain text when ordering).

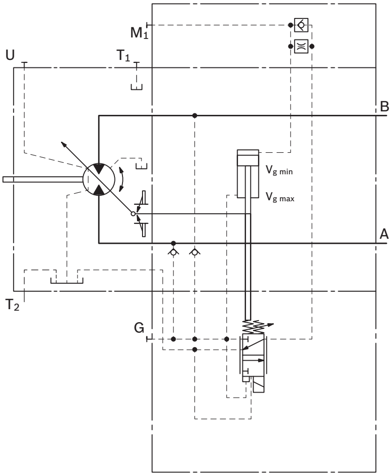
Technical data, solenoid with Ø45

	U1	U2
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30 W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

Schematic HA1U1, HA1U2



Schematic HA2U1, HA2U2



2

HA – Automatic control high-pressure related

HA.**R1**, HA.**R2** **Override electric, travel direction valve electric** (see page 29)

(see page 29)

Sizes 28 to 200

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

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

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the pressure spring or the switching solenoid a (see page 29 for further details).

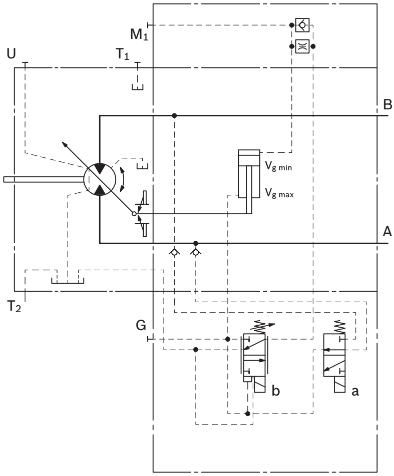
Technical data, solenoid a with Ø37
(travel direction valve)

		R1	R2
Voltage		12 V (±20 %)	24 V (±20 %)
No override		de-energized	de-energized
Direction of rotation	Operating pressure in		
ccw	B	energized	energized
cw	A	de-energized	de-energized
Nominal resistance (at 20 °C)		5.5 Ω	21.7 Ω
Nominal power		26.2 W	26.5 W
Minimum required current		1.32 A	0.67 A
Duty cycle		100 %	100 %
Type of protection see connector design page 70			

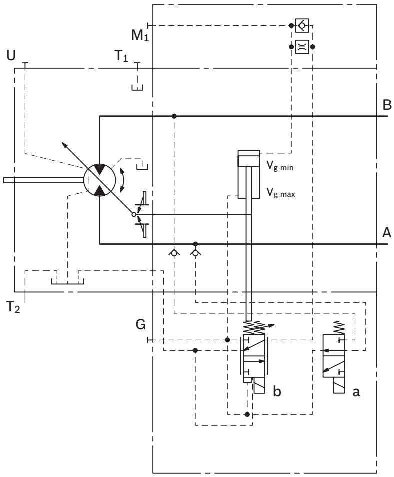
Technical data, solenoid b with Ø45
(electric override)

	R1	R2
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30 W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

Schematic HA1R1, HA1R2



Schematic HA2R1, HA2R2



DA – Automatic control speed-related

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

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

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

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

Pressure ratio p_{St}/p_{HD}: 3/100, 5/100, 8/100

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

Detailed information is available from our sales department and on the Internet at www.boschrexroth.com/da-control.

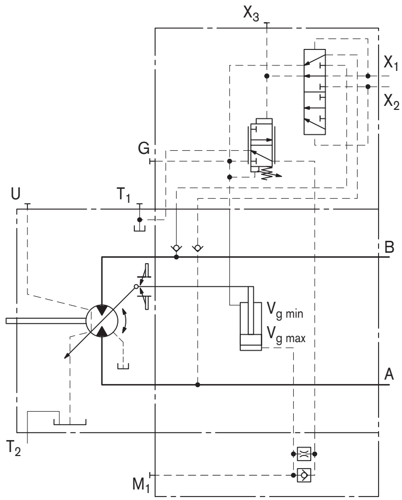
Note
The beginning of control and the DA characteristic are influenced by case pressure. An increase in case pressure causes a decrease in the beginning of control (see page 6) and thus a parallel shift of the characteristic.

DA, DA1, DA4
Hydraulic travel direction valve

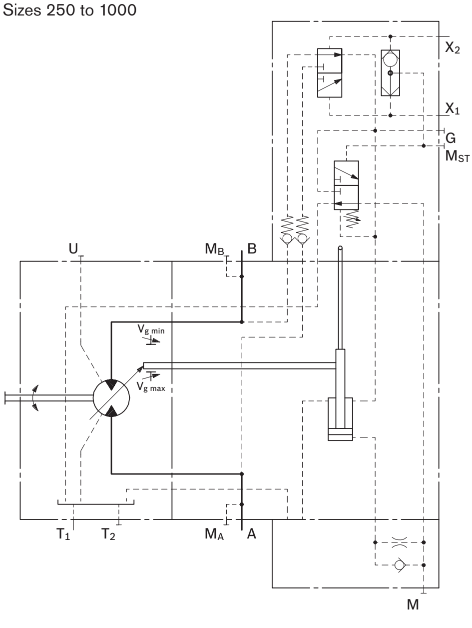
Dependent on the direction of rotation (travel direction), the travel direction valve is switched by using pilot pressures connections X_1 or X_2.

Direction of rotation	Operating pressure in	Pilot pressure in
cw	A	X_1
ccw	B	X_2

Schematic DA1, DA4
Sizes 28 to 200



Schematic DA
Sizes 250 to 1000



2

DA – Automatic control speed-related

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

The travel direction valve is either spring offset or switched by energizing switching solenoid a, depending on the direction of rotation (travel direction).

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

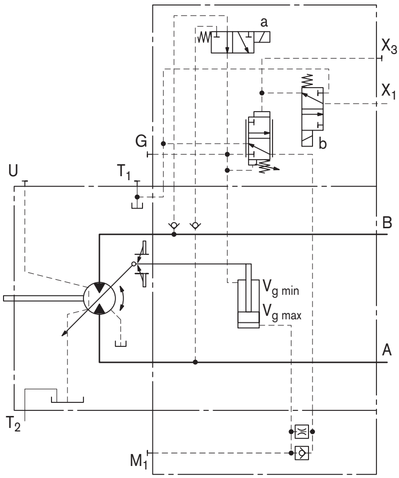
Technical data, solenoid a with Ø37
(travel direction valve)

		DA2, DA5	DA3, DA6
Voltage		12 V (±20 %)	24 V (±20 %)
Direction of rotation	Operating pressure in		
ccw	B	de-energized	de-energized
cw	A	energized	energized
Nominal resistance (at 20 °C)		5.5 Ω	21.7 Ω
Nominal power		26.2 W	26.5 W
Minimum required current		1.32 A	0.67 A
Duty cycle		100 %	100 %
Type of protection see connector design page 70			

Technical data, solenoid b with Ø37
(electric override)

	DA2, DA5	DA3, DA6
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\,max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum required current	1.32 A	0.67 A
Duty cycle	100 %	100 %
Type of protection see connector design page 70		

Schematic DA2, DA3, DA5, DA6
Sizes 28 to 200



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

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

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

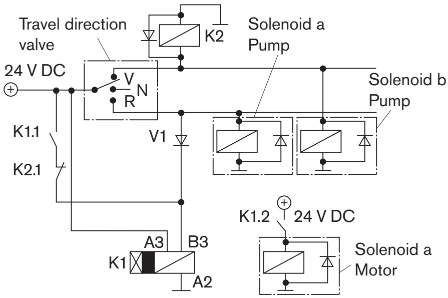
When the travel direction valve of the pump (e. g. 4/3-directional valve of the DA-control) is switched to

– the neutral position,
  the electric circuitry causes the previous signal on the travel direction valve on the motor to be retained.

– reversing,
  the electric circuitry causes the travel direction valve on the motor to switch to the other travel direction following a time delay (approx. 0.8 s) with respect to the pump.

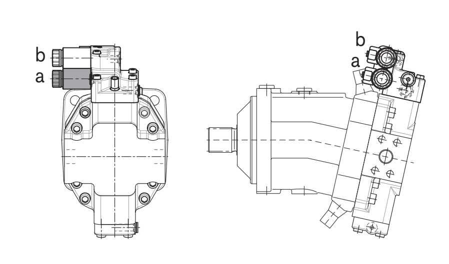
As a result, jerky deceleration or braking is prevented in both cases.

Schematic – electric travel direction valve

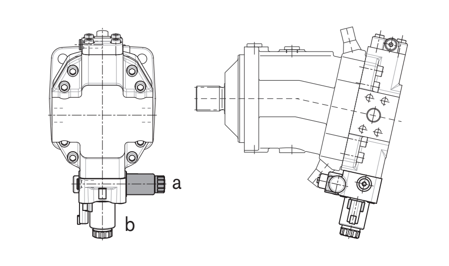


Note
The shown diodes and relays are not included in the delivery of the motor.

DA2, DA3, DA5, DA6 control (see page 28)



HA1R., HA2R. control (see page 26)



Switching solenoid a on the travel direction valve

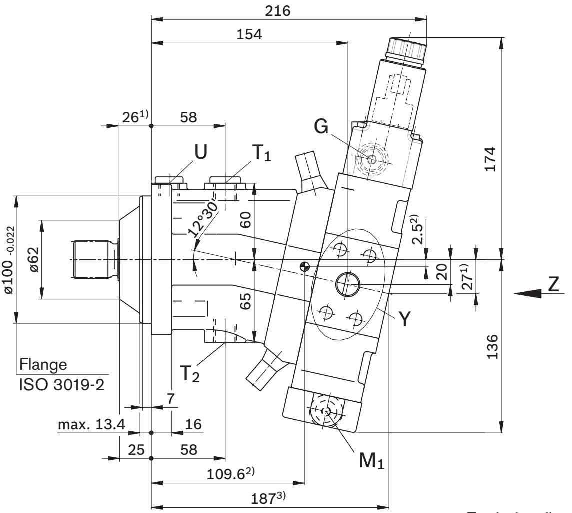
2

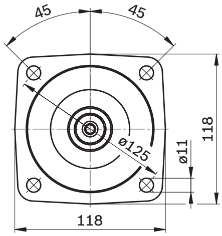
Dimensions size 28

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

Port plate 02 – SAE flange ports A and B at side, opposite

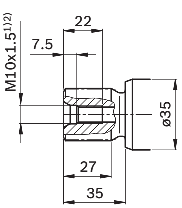




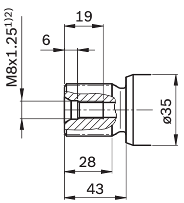
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Drive shafts

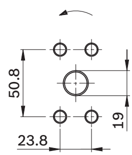
A Splined shaft DIN 5480 W30x2x14x9g



Z Splined shaft DIN 5480 W25x1.25x18x9g



Service line port (detail Y)



1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

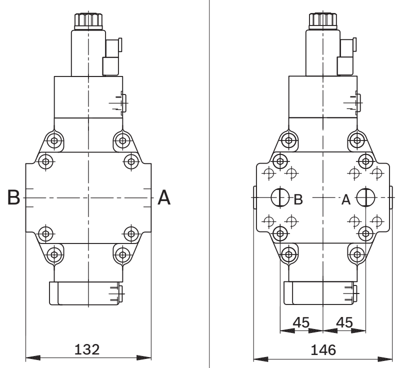
Dimensions size 28

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

02 SAE flange ports A and B at side, opposite

01 SAE flange ports A and B at rear



Ports

Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
T_1	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M16 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

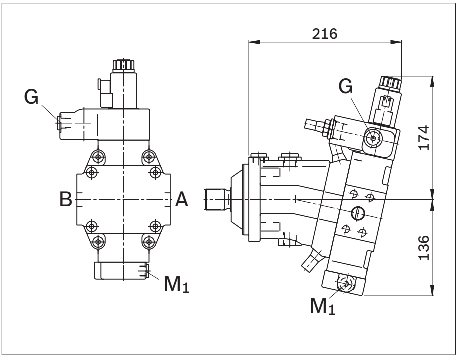
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

2

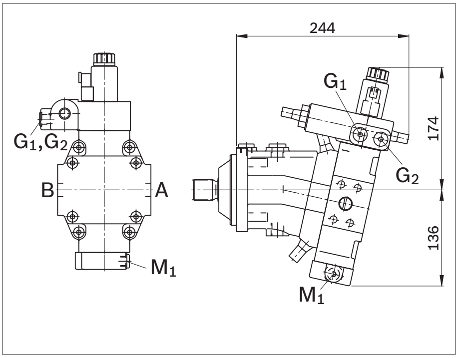
Dimensions size 28

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

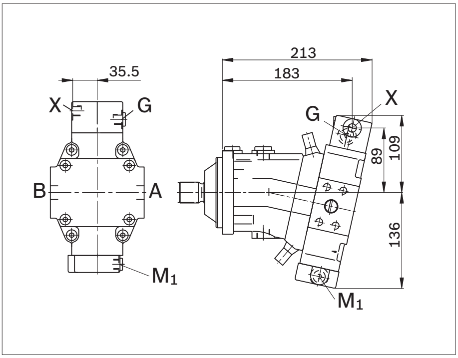
EP.D
Proportional control electric,
with pressure control fixed setting



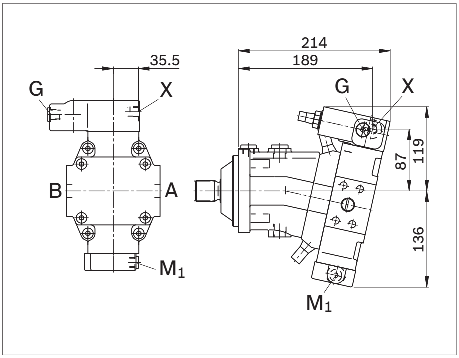
EP.E
Proportional control electric,
with pressure control hydraulic override, two-point



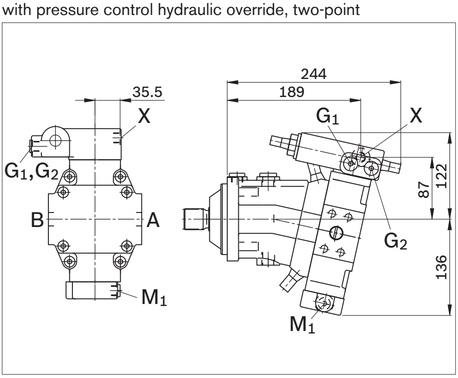
HD1, HD2
Proportional control hydraulic



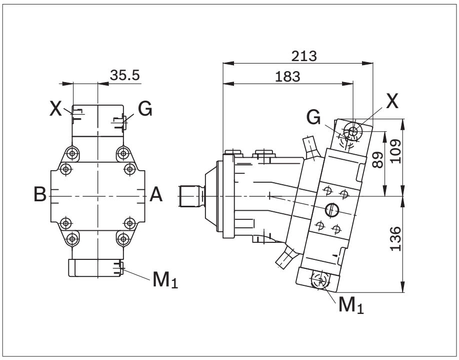
HD.D
Proportional control hydraulic,
with pressure control fixed setting



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



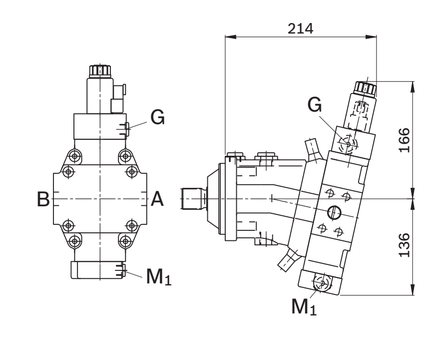
HZ1
Two-point control hydraulic



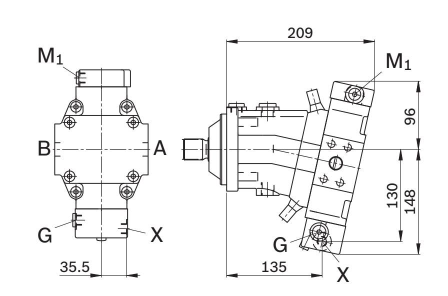
Dimensions size 28

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EZ1, EZ2
Two-point control electric

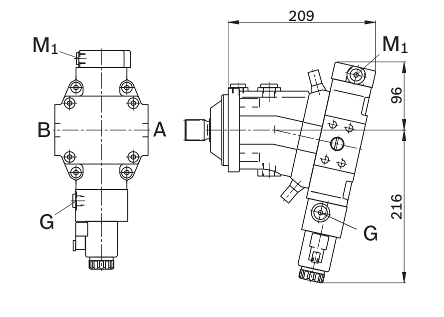


HA1, HA2 / HA1T, HA2T
Automatic control high-pressure related,
with override hydraulic remote control, proportional

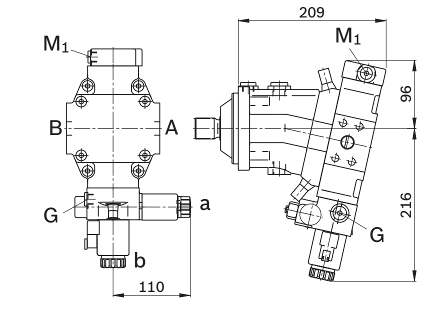


HA1 and HA2, X plugged
HA1T and HA2T, X open

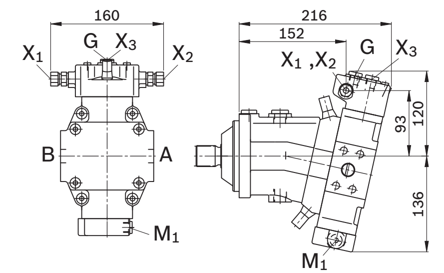
HA1U1, HA2U2
Automatic control high-pressure related,
with override electric, two-point



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

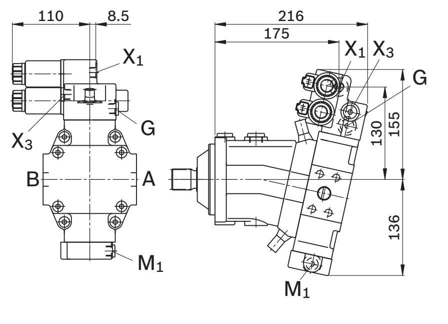


DA1, DA4
Automatic control speed related,
with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6
Automatic control speed related,
with electric travel direction valve and electric $V_{g\ max}$-circuit

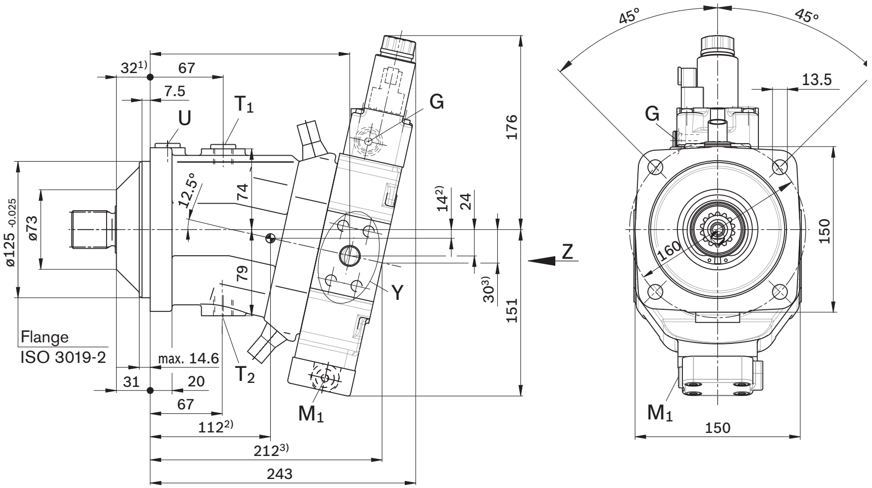


Dimensions size 55

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

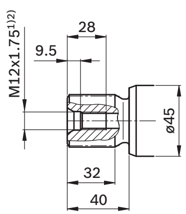
Port plate 02 – SAE flange ports A and B at side, opposite

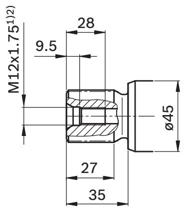


1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

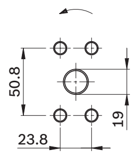
Drive shafts

A	Splined shaft DIN 5480 W35x2x16x9g	Z	Splined shaft DIN 5480 W30x2x14x9g





Service line port (detail Y)



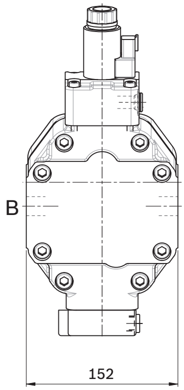
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 55

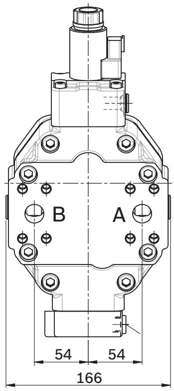
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

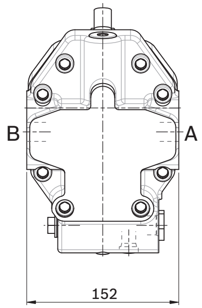
02 SAE flange ports A and B at side, opposite



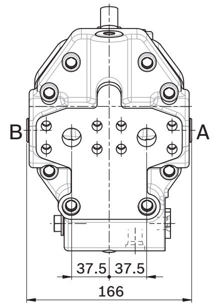
01 SAE flange ports A and B at rear



02 SAE flange port A and B at side, opposite only HZ3, EZ3, EZ4



01 SAE flange port A and B at rear only HZ3, EZ4, EZ4



Ports

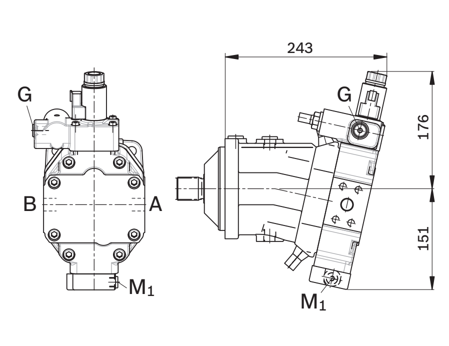
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	3/4 in M10 x 1.5; 17 deep	450	O
T_1	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M18 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

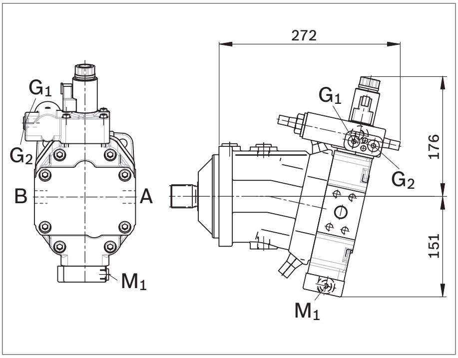
Dimensions size 55

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

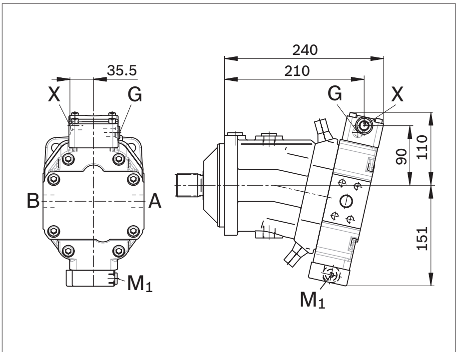
EP.D
Proportional control electric, with pressure control fixed setting



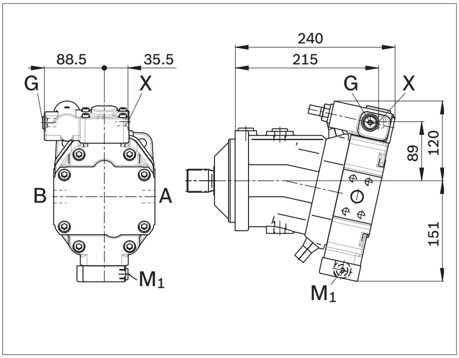
EP.E
Proportional control electric, with pressure control hydraulic override, two-point



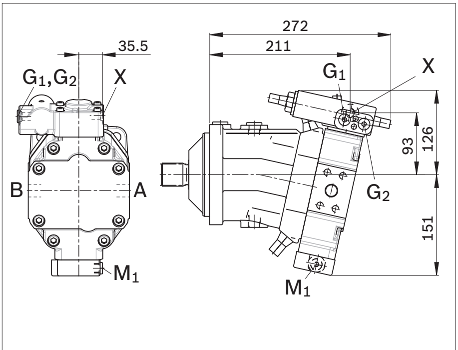
HD1, HD2
Proportional control hydraulic



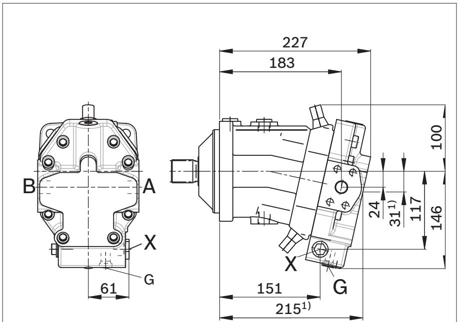
HD.D
Proportional control hydraulic, with pressure control fixed setting



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



HZ3
Two-point control hydraulic

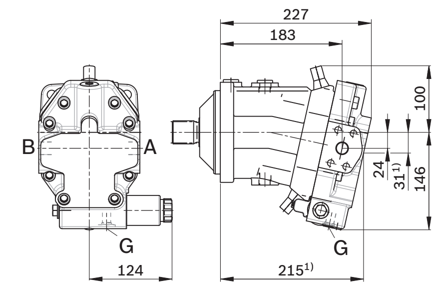


1) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 55

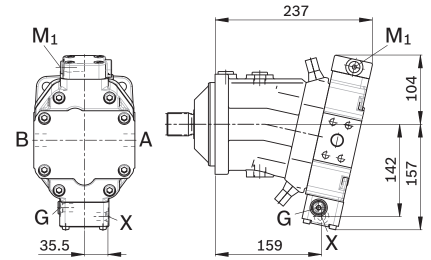
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EZ3, EZ4
Two-point control electric



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

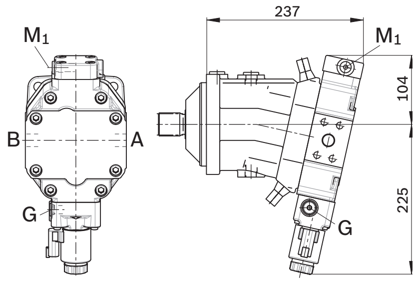
HA1, HA2 / HA1T, HA2T
Automatic control high-pressure related, with override hydraulic remote control, proportional



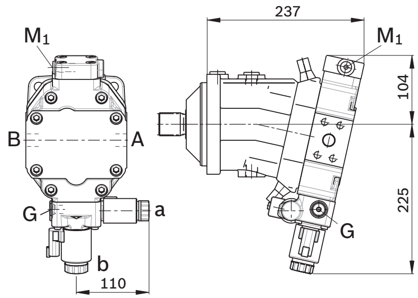
HA1 and HA2, X plugged
HA1T and HA2T, X open

2

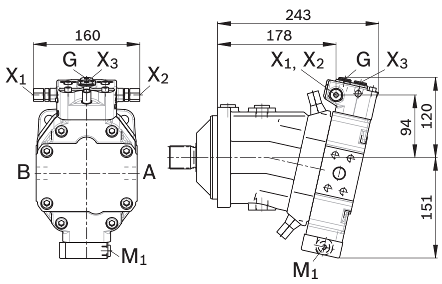
HA1U1, HA2U2
Automatic control high-pressure related, with override electric, two-point



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

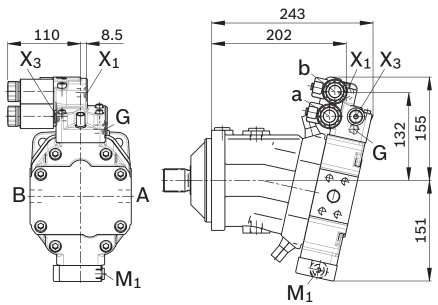


DA1, DA4
Automatic control speed related, with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6
Automatic control speed related, with electric travel direction valve and electric $V_{g\,max}$-circuit

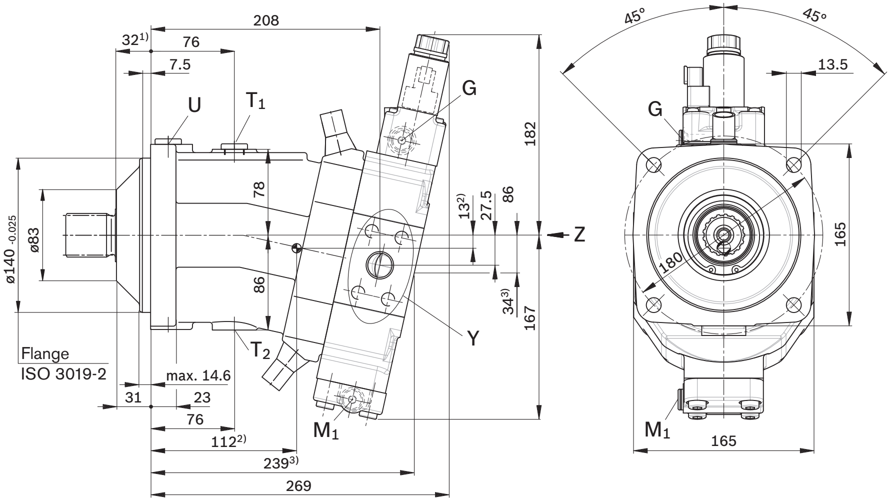


Dimensions size 80

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

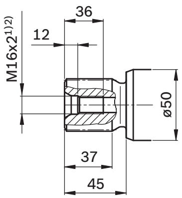
Port plate 02 – SAE flange ports A and B at side, opposite



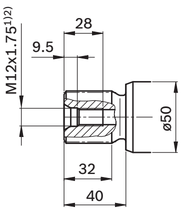
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Drive shafts

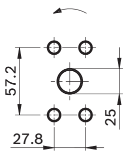
A Splined shaft DIN 5480 W40x2x18x9g



Z Splined shaft DIN 5480 W35x2x16x9g



Service line port (detail Y)



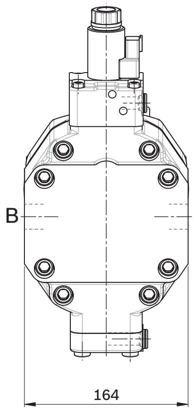
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 80

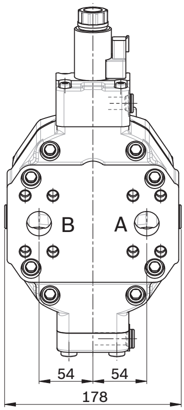
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

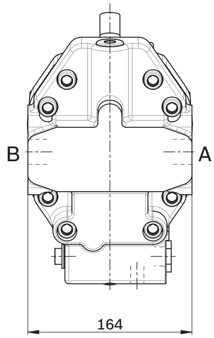
02 SAE flange ports A and B at side, opposite



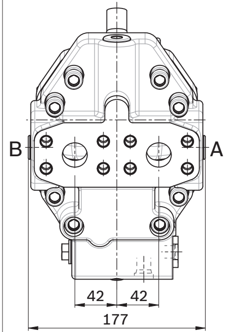
01 SAE flange ports A and B at rear



02 SAE flange port A and B at side, opposite only HZ3, EZ3, EZ4



01 SAE flange port A and B at rear only HZ3, EZ3, EZ4



2

Ports

Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	450	O
T_1	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M18 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

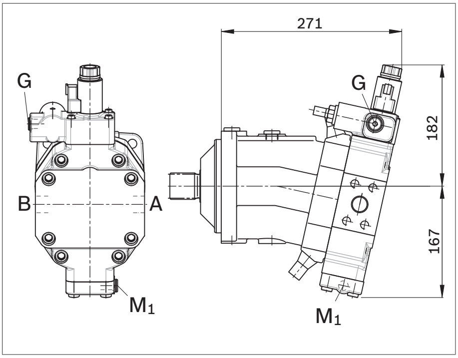
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 80

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

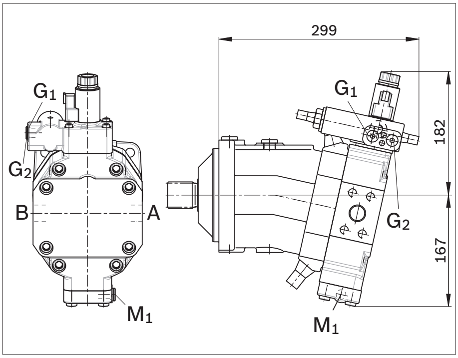
EP.D

Proportional control electric,
with pressure control fixed setting



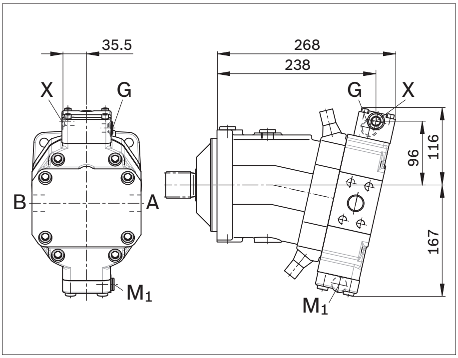
EP.E

Proportional control electric,
with pressure control hydraulic override, two-point



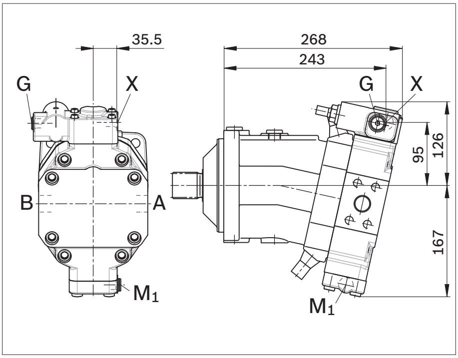
HD1, HD2

Proportional control hydraulic



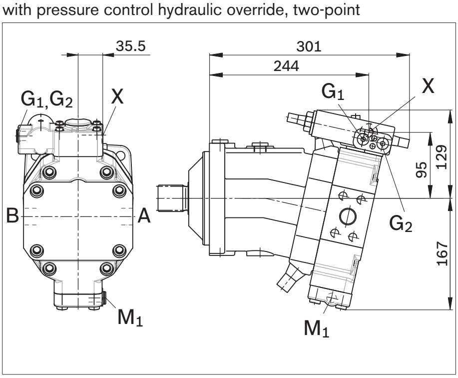
HD.D

Proportional control hydraulic,
with pressure control fixed setting



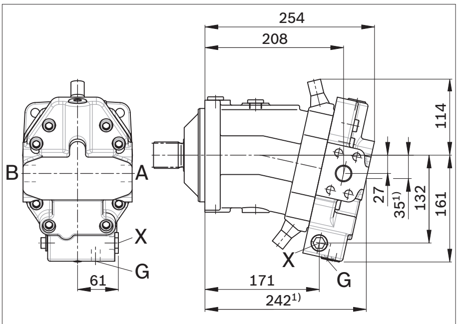
HD.E

Proportional control hydraulic,
with pressure control hydraulic override, two-point



HZ3

Two-point control hydraulic

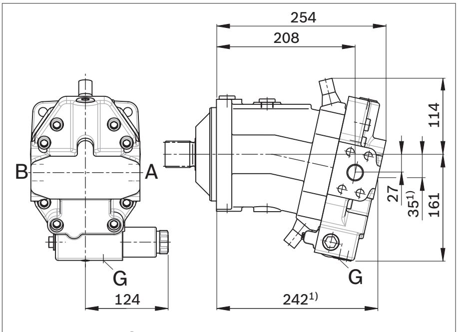


1) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 80

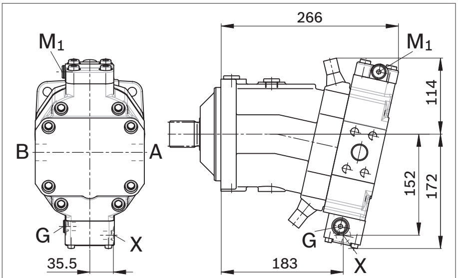
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EZ3, EZ4
Two-point control electric



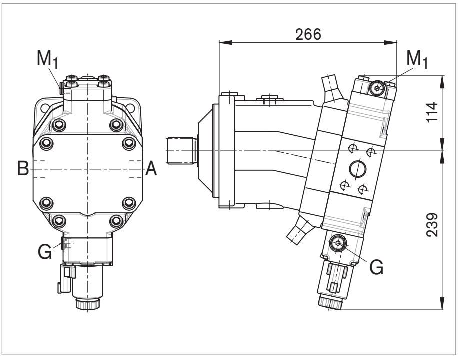
1) Port plate 1 – SAE flange ports A and B at rear

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

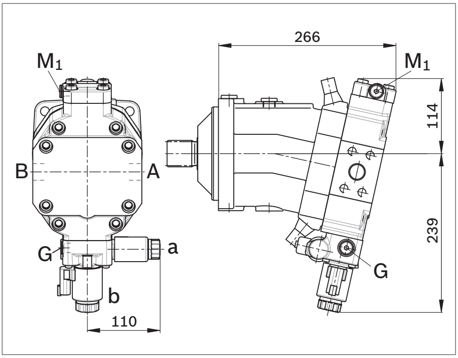


HA1 and HA2, X plugged
HA1T and HA2T, X open

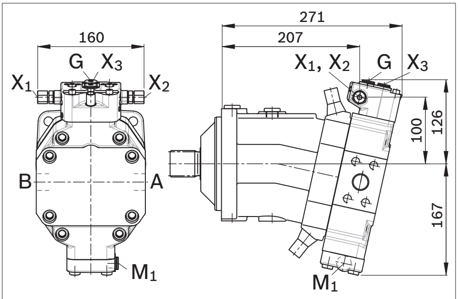
HA1U1, HA2U2
Automatic control high-pressure related,
with override electric, two-point



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

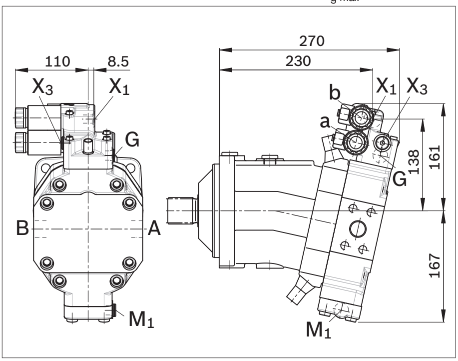


DA1, DA4
Automatic control speed related,
with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6
Automatic control speed related,
with electric travel direction valve and electric $V_{g\ max}$-circuit

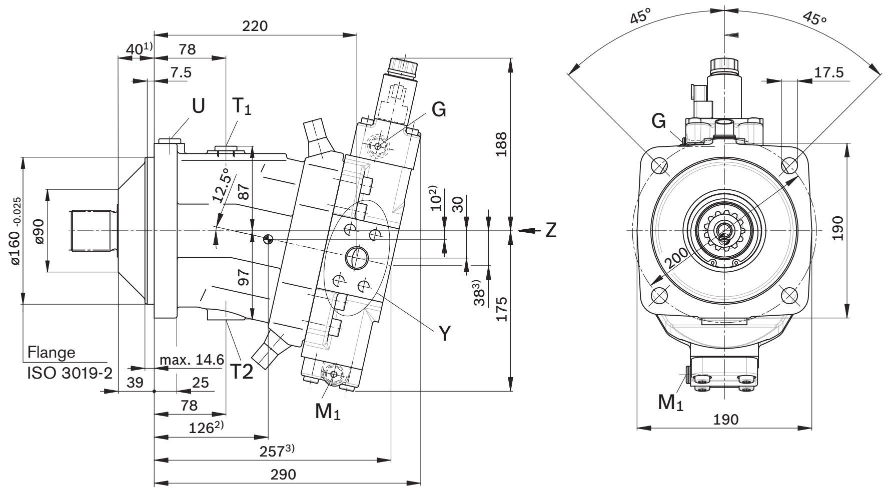


Dimensions size 107

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

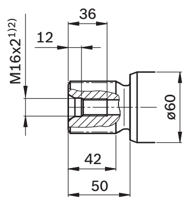
Port plate 02 – SAE-SAE flange ports A and B at side, opposite



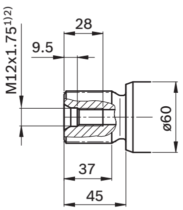
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Drive shafts

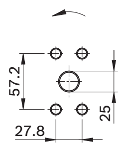
A Splined shaft DIN 5480 W45x2x21x9g



Z Splined shaft DIN 5480 W40x2x18x9g



Service line port (detail Y)



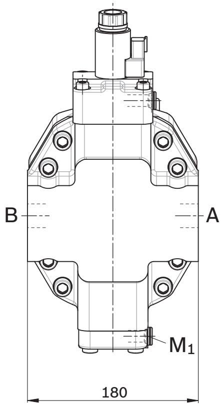
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 107

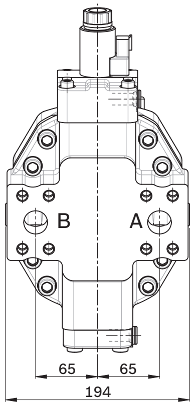
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

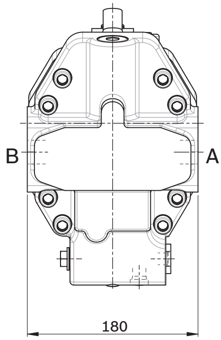
02 SAE flange ports A and B at side, opposite



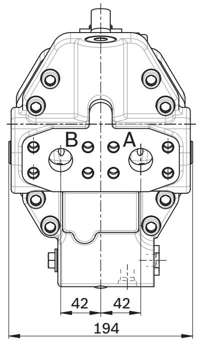
01 SAE flange ports A and B at rear



02 SAE flange port A and B at side, opposite only HZ3, EZ3, EZ4



01 SAE flange port A and B at rear only HZ3, EZ3, EZ4



Ports

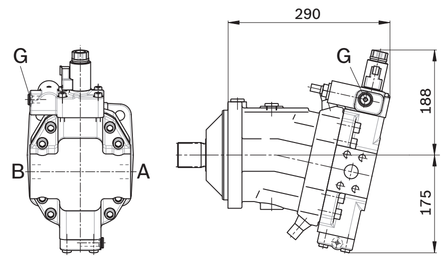
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	450	O
T_1	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M18 x 1.5; 12 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M18 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

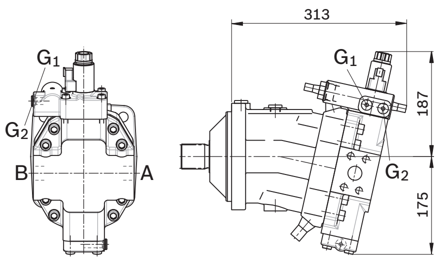
Dimensions size 107

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

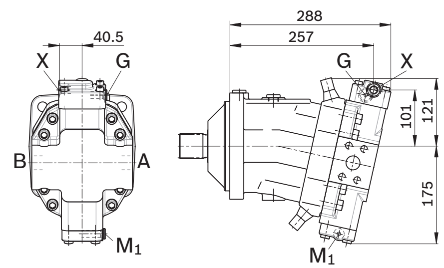
EP.D
Proportional control electric,
with pressure control fixed setting



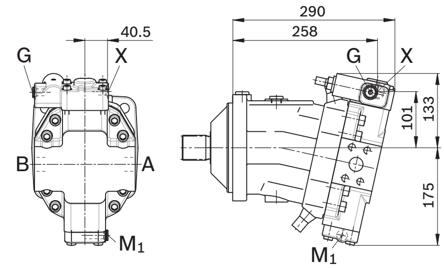
EP.E
Proportional control electric,
with pressure control hydraulic override, two-point



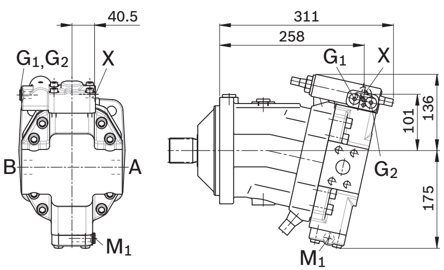
HD1, HD2
Proportional control hydraulic



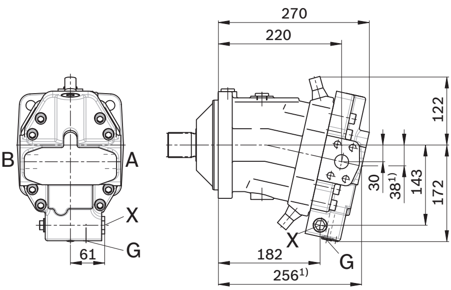
HD.D
Proportional control hydraulic,
with pressure control fixed setting



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



HZ3
Two-point control hydraulic



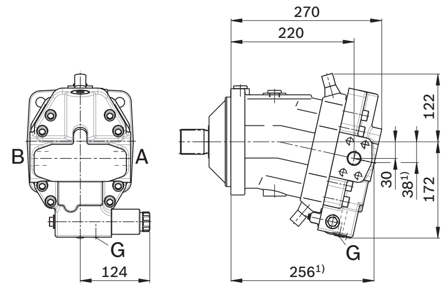
1) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 107

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EZ3, EZ4

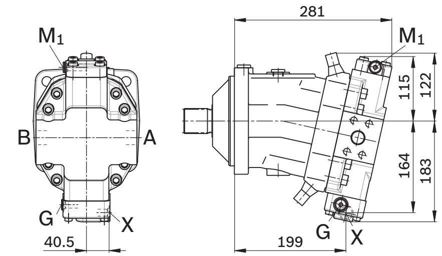
Two-point control electric



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

HA1, HA2 / HA1T, HA2T

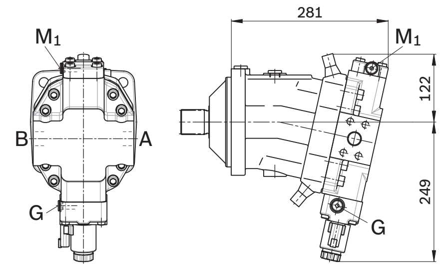
Automatic control high-pressure related,
with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

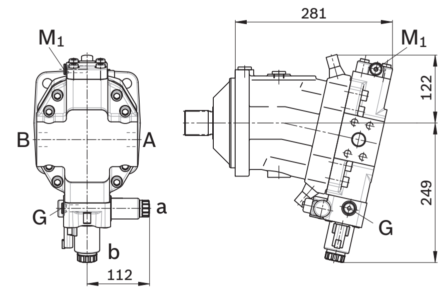
HA1U1, HA2U2

Automatic control high-pressure related,
with override electric, two-point



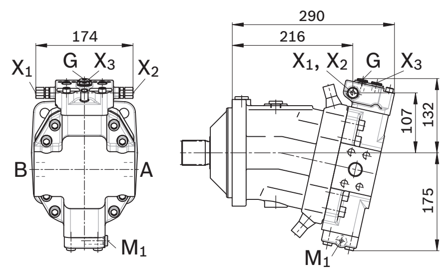
HA1R1, HA2R2

Automatic control high-pressure related,
with override electric and travel direction valve electric



DA1, DA4

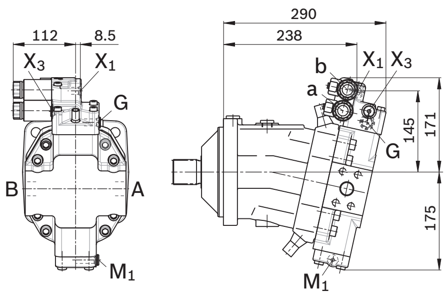
Automatic control speed related,
with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6

Automatic control speed related,
with electric travel direction valve and electric $V_{g\,max}$-circuit

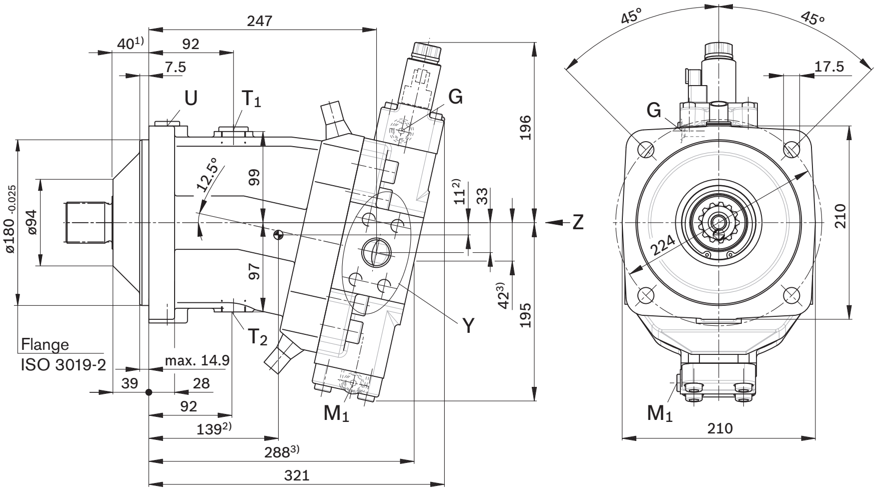


Dimensions size 140

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

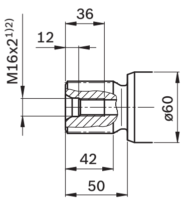
Port plate 02 – SAE flange ports A and B at side, opposite



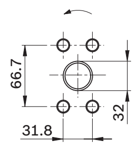
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Drive shaft

Z Splined shaft DIN 5480 W45x2x21x9g



Service line port (detail Y)



1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

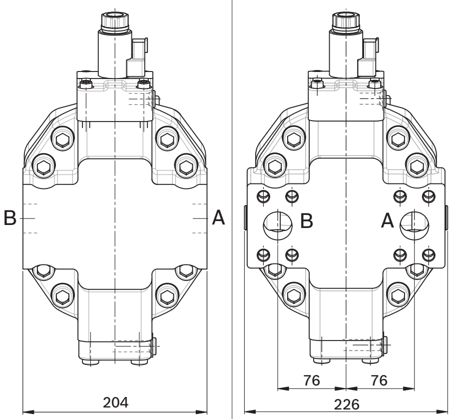
Dimensions size 140

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

02 SAE flange ports A and B at side, opposite

01 SAE flange ports A and B at rear



Ports

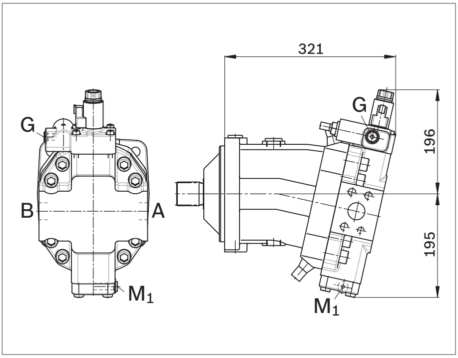
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
T_1	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M22 x 1.5; 14 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

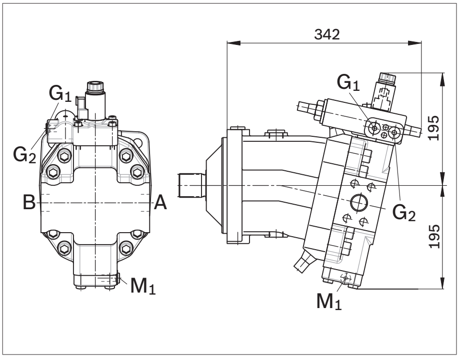
Dimensions size 140

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

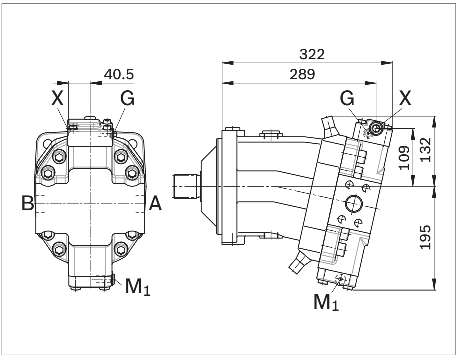
EP.D
Proportional control electric,
with pressure control fixed setting



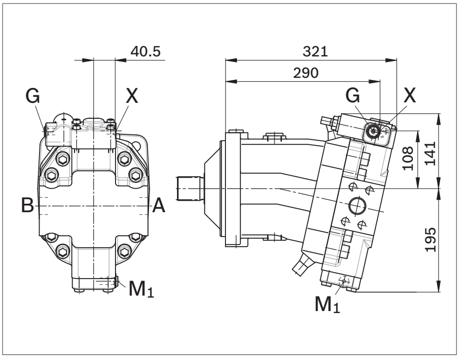
EP.E
Proportional control electric,
with pressure control hydraulic override, two-point



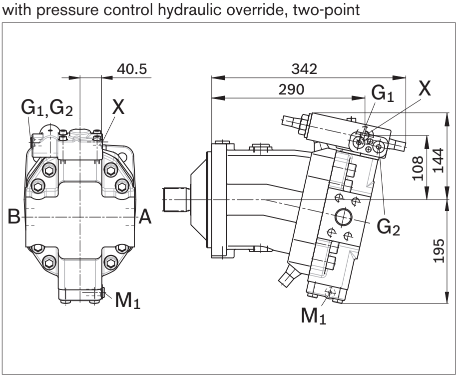
HD1, HD2
Proportional control hydraulic



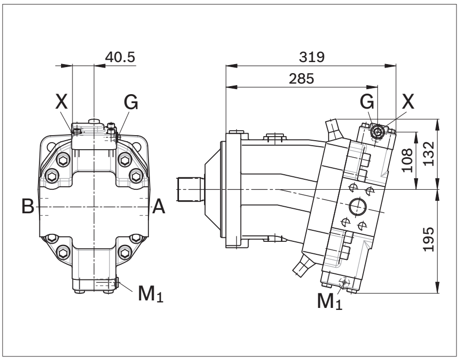
HD.D
Proportional control hydraulic,
with pressure control fixed setting



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



HZ1
Two-point control hydraulic

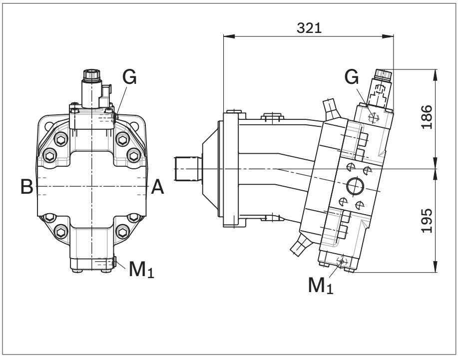


Dimensions size 140

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

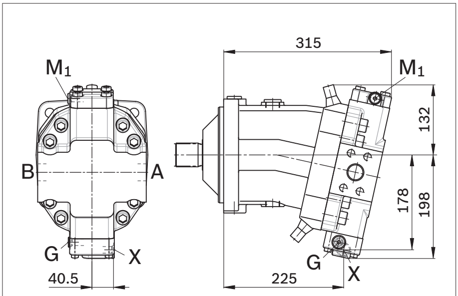
EZ1, EZ2

Two-point control electric



HA1, HA2 / HA1T, HA2T

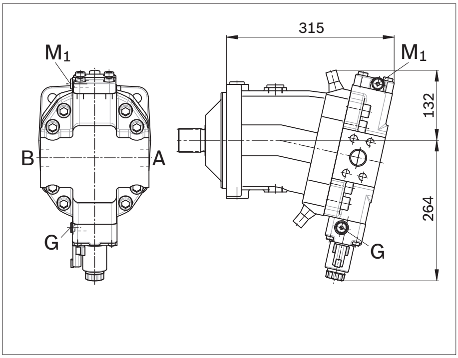
Automatic control high-pressure related, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

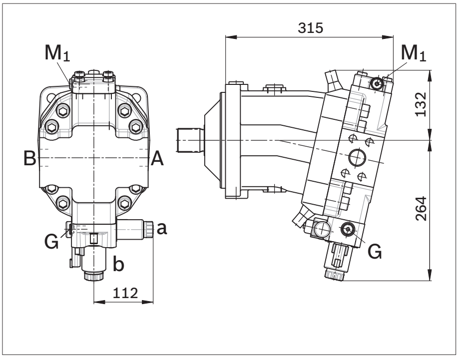
HA1U1, HA2U2

Automatic control high-pressure related, with override electric, two-point



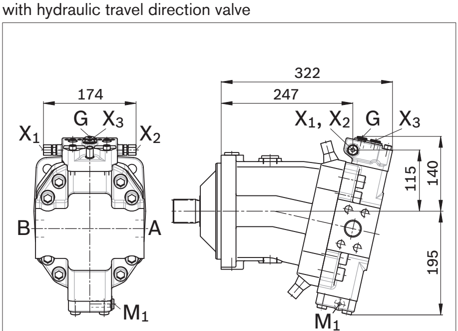
HA1R1, HA2R2

Automatic control high-pressure related, with override electric and travel direction valve electric



DA1, DA4

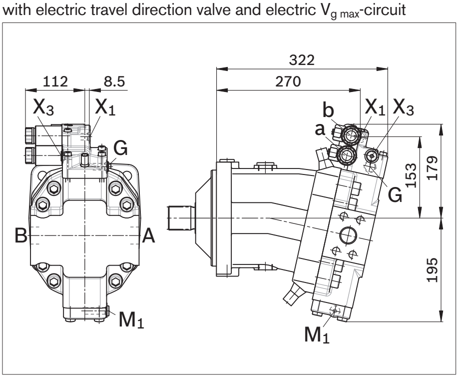
Automatic control speed related, with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6

Automatic control speed related, with electric travel direction valve and electric $V_{g\,max}$-circuit

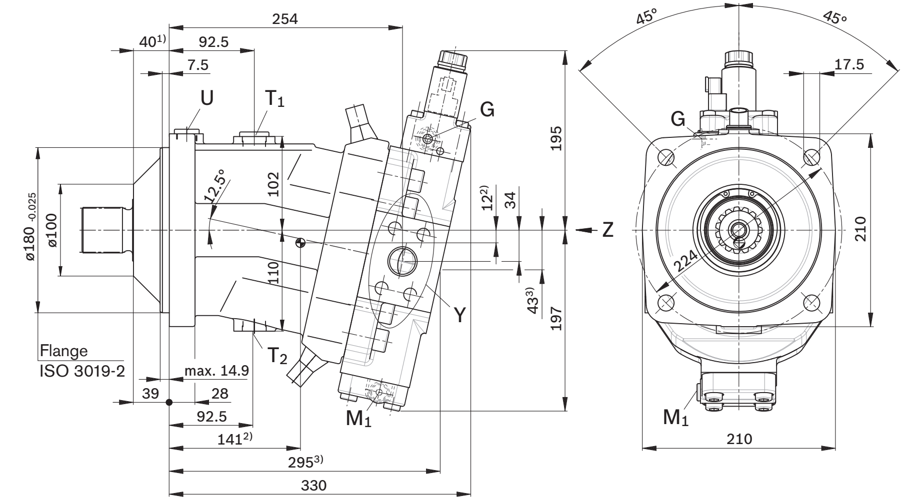


Dimensions size 160

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

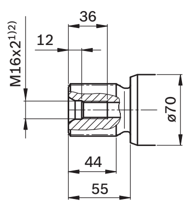
Port plate 02 – SAE-SAE flange ports A and B at side, opposite

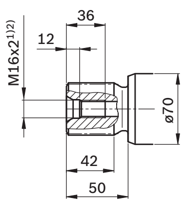


1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

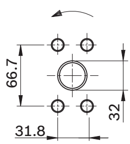
Drive shafts

A	Splined shaft DIN 5480 W50x2x24x9g	Z	Splined shaft DIN 5480 W45x2x21x9g





Service line port (detail Y)



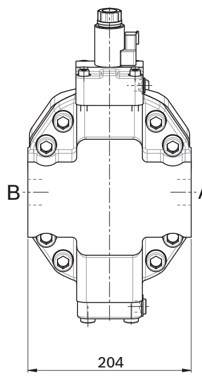
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 160

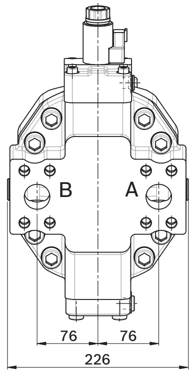
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

02 SAE flange ports A and B at side, opposite



01 SAE flange ports A and B at rear



2

Ports

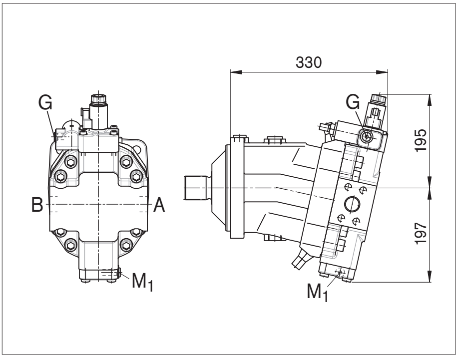
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
T_1	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M22 x 1.5; 14 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

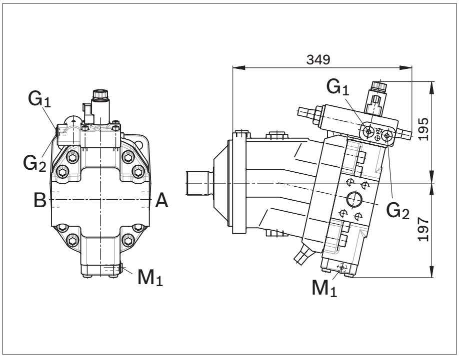
Dimensions size 160

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

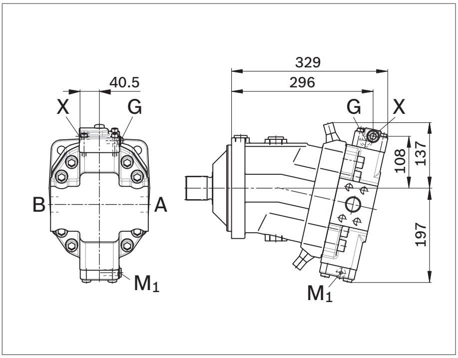
EP.D
Proportional control electric,
with pressure control fixed setting



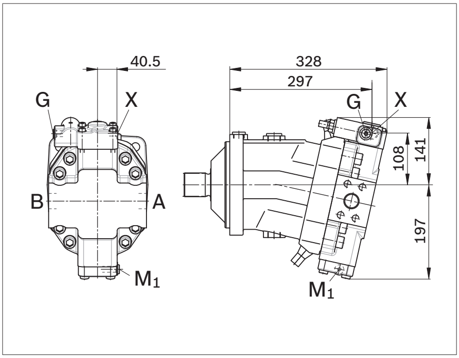
EP.E
Proportional control electric,
with pressure control hydraulic override, two-point



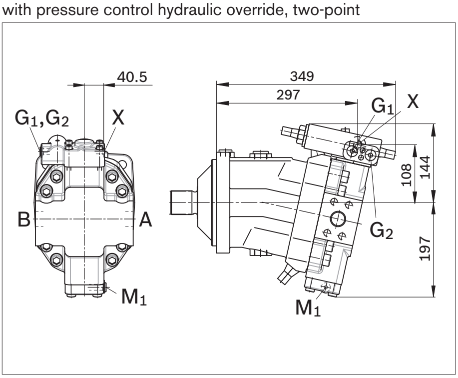
HD1, HD2
Proportional control hydraulic



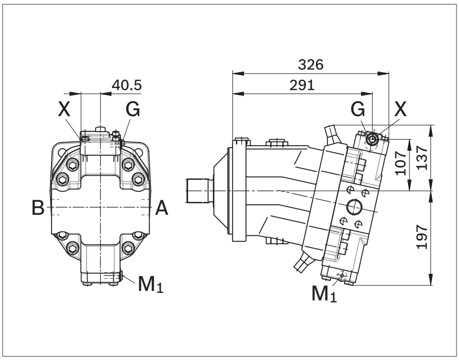
HD.D
Proportional control hydraulic,
with pressure control fixed setting



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



HZ1
Two-point control hydraulic

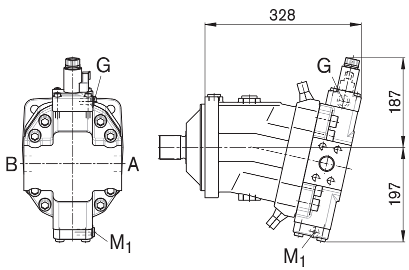


Dimensions size 160

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

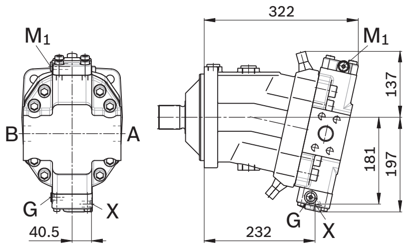
EZ1, EZ2

Two-point control electric



HA1, HA2 / HA1T, HA2T

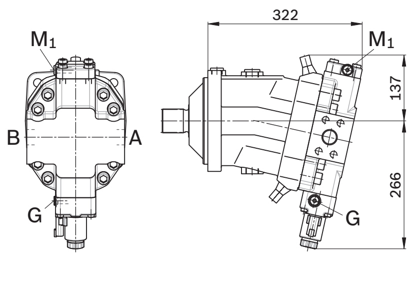
Automatic control high-pressure related, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

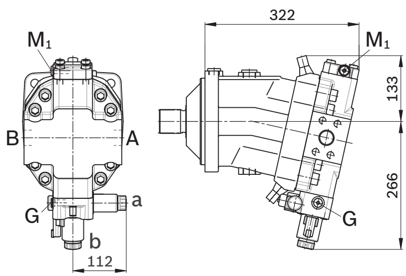
HA1U1, HA2U2

Automatic control high-pressure related, with override electric, two-point



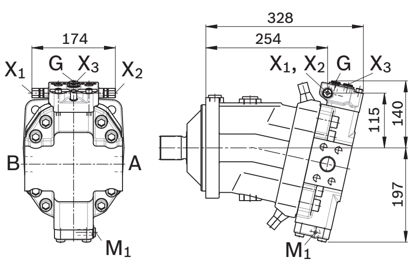
HA1R1, HA2R2

Automatic control high-pressure related, with override electric and travel direction valve electric



DA1, DA4

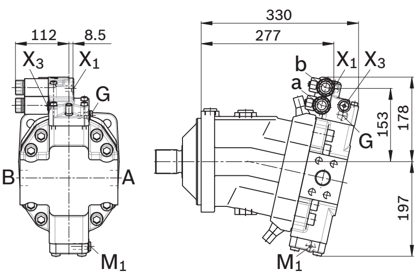
Automatic control speed related, with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6

Automatic control speed related, with electric travel direction valve and electric $V_{g\ max}$-circuit

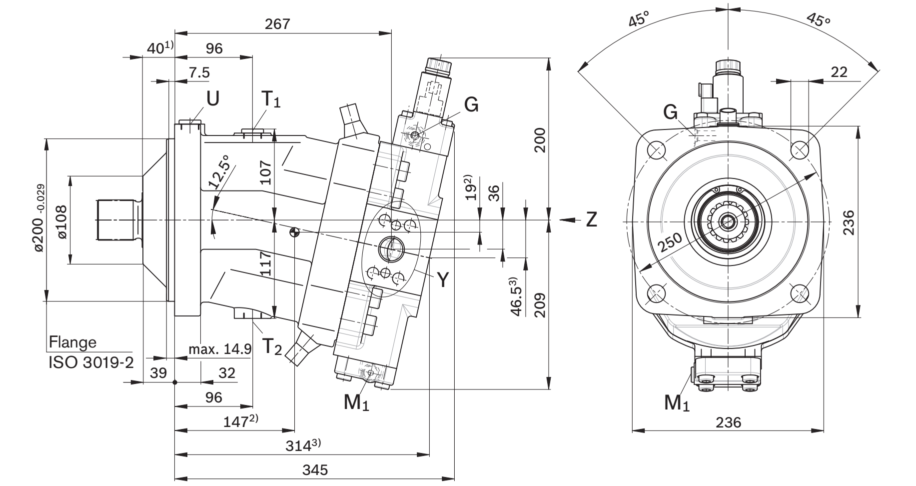


Dimensions size 200

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP1, EP2 – Proportional control electric

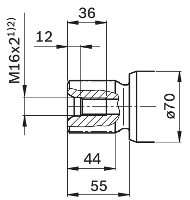
Port plate 02 – SAE-SAE flange ports A and B at side, opposite



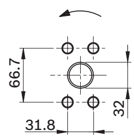
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Drive shaft

A Splined shaft DIN 5480 W50x2x24x9g



Service line port (detail Y)



1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

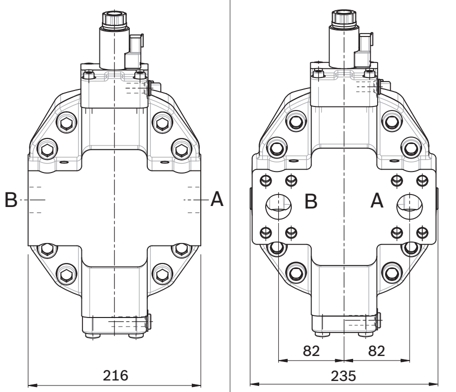
Dimensions size 200

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

02 SAE flange ports A and B at side, opposite

01 SAE flange ports A and B at rear



2

Ports

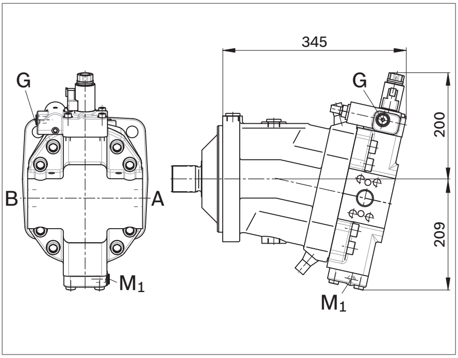
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	450	O
T_1	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M26 x 1.5; 16 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	450	X
G_2	2nd pressure setting (HD.E, EP.E)	DIN 3852[5]	M14 x 1.5; 12 deep	100	X
U	Bearing flushing	DIN 3852[5]	M22 x 1.5; 14 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA1, DA4)	DIN 2353-CL	8B-ST	40	O
X_1	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	O
X_3	Pilot signal (DA2, DA3, DA5, DA6)	DIN 3852[5]	M14 x 1.5; 12 deep	40	X
M_1	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	450	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

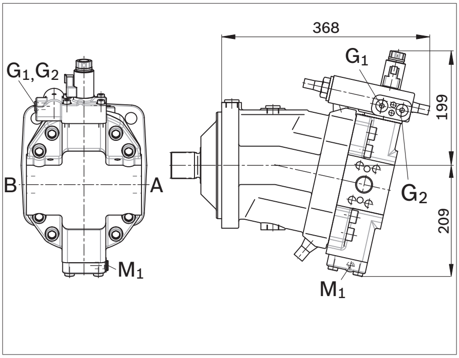
Dimensions size 200

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

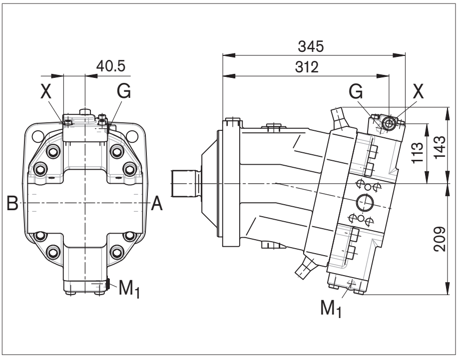
EP.D
Proportional control electric,
with pressure control fixed setting



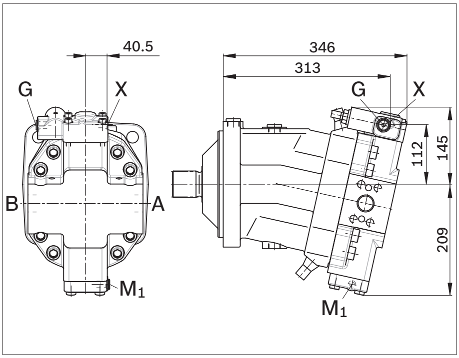
EP.E
Proportional control electric,
with pressure control hydraulic override, two-point



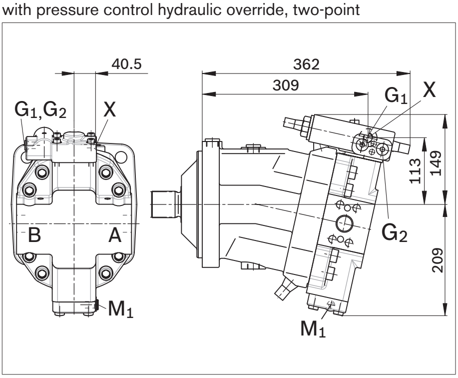
HD1, HD2
Proportional control hydraulic



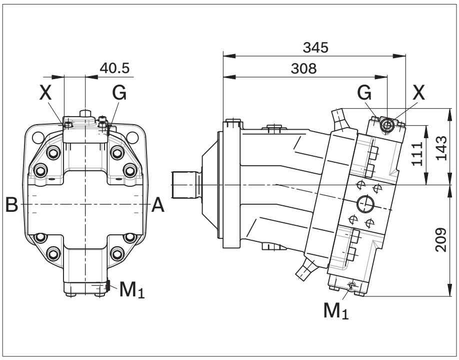
HD.D
Proportional control hydraulic,
with pressure control fixed setting



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



HZ1
Two-point control hydraulic

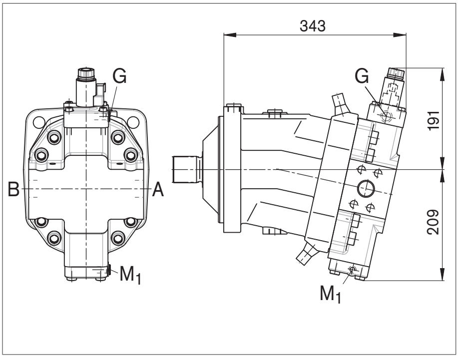


Dimensions size 200

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

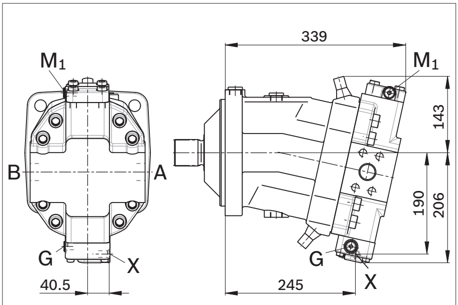
EZ1, EZ2

Two-point control electric



HA1, HA2 / HA1T, HA2T

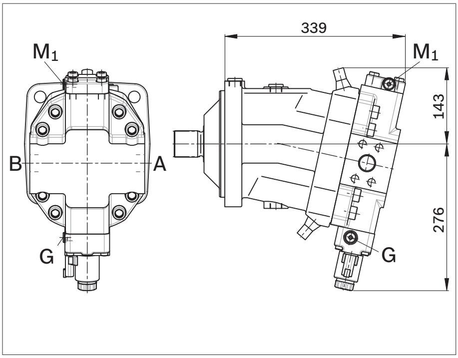
Automatic control high-pressure related, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

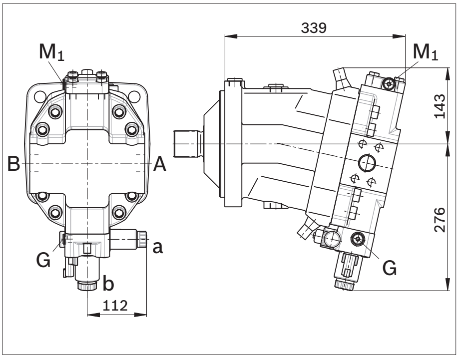
HA1U1, HA2U2

Automatic control high-pressure related, with override electric, two-point



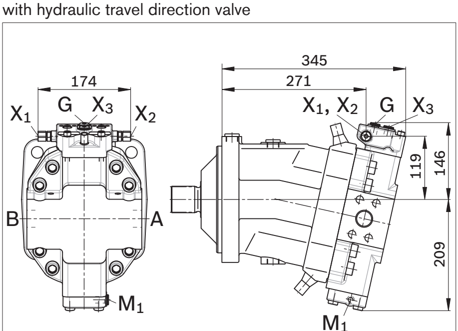
HA1R1, HA2R2

Automatic control high-pressure related, with override electric and travel direction valve electric



DA1, DA4

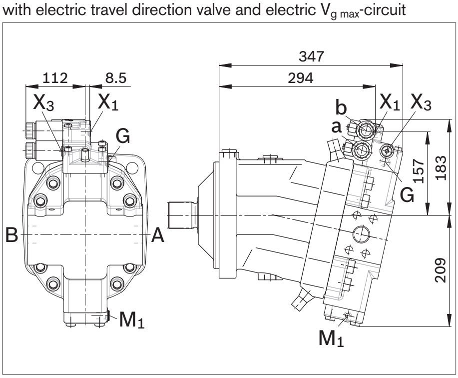
Automatic control speed related, with hydraulic travel direction valve



X_1, X_2 pipe fitting 8B-ST according to DIN 2353-CL
Use installed fittings!

DA2, DA3, DA5, DA6

Automatic control speed related, with electric travel direction valve and electric $V_{g\ max}$-circuit

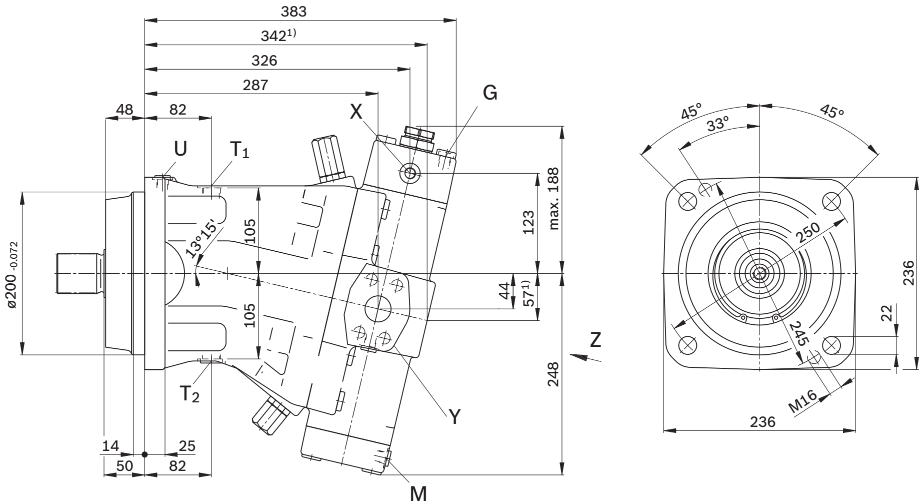


Dimensions size 250

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

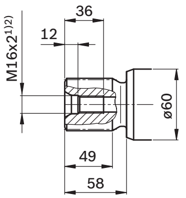
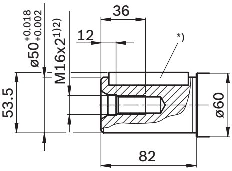
HD1, HD2 – Proportional control hydraulic
HZ – Two-point control hydraulic

Port plate 02 – SAE flange ports A and B at side, opposite



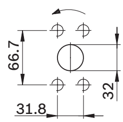
1) Port plate 01/15 – SAE flange ports A and B at rear

Drive shafts

Z	Splined shaft DIN 5480 W50x2x24x9g	P	Cyl. shaft with key AS14x9x80 (DIN 6885)
			

*) Key width 14

Service line port (detail Y)



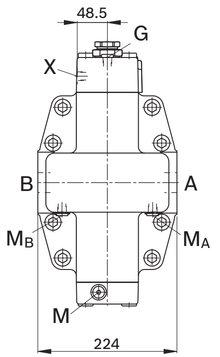
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 250

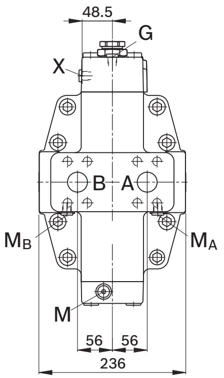
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

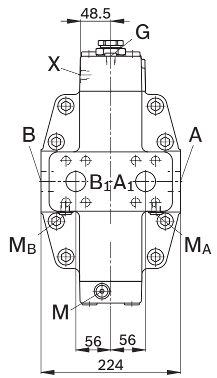
02 SAE flange ports A and B at side, opposite



01 SAE flange ports A and B at rear



15 SAE flange port A and B at side, opposite, A_1 and B_1 at rear



2

Ports

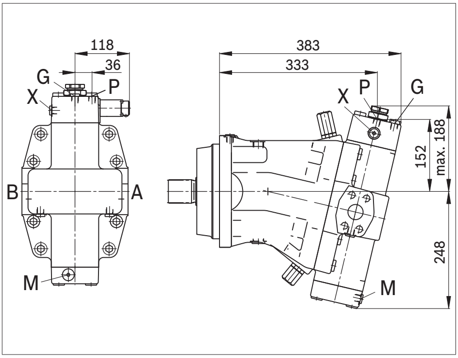
Designation	Port for	Standard	Size[1)]	Maximum pressure [bar][2)]	State[6)]
A, B	Service line Fastening thread A/B	SAE J518[3)] DIN 13	1 1/4 in M14 x 2; 19 deep	400	O
A_1, B_1	Additional service line for plate 15 Fastening thread A_1/B_1	SAE J518[3)] DIN 13	1 1/4 in M14 x 2; 19 deep	400	O
T_1	Drain line	DIN 3852[5)]	M22 x 1.5; 14 deep	3	X[4)]
T_2	Drain line	DIN 3852[5)]	M22 x 1.5; 14 deep	3	O[4)]
G	Synchronous control	DIN 3852[5)]	M14 x 1.5; 12 deep	400	X
G_2	2nd pressure setting (HD.D, EP.D)	DIN 3852[5)]	M14 x 1.5; 12 deep	400	X
P	Pilot oil supply (EP)	DIN 3852[5)]	M14 x 1.5; 12 deep	100	O
U	Bearing flushing	DIN 3852[5)]	M14 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5)]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5)]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA)	DIN 2353-CL	8B-ST	40	O
X_3	Remote control valve (HD.G, EP.G)	DIN 3852[5)]	M14 x 1.5; 12 deep	400	O
M	Measuring stroking chamber	DIN 3852[5)]	M14 x 1.5; 12 deep	400	X
M_A, M_B	Measuring pressure A/B	DIN 3852[5)]	M14 x 1.5; 12 deep	400	X
M_{St}	Measuring pilot pressure	DIN 3852[5)]	M14 x 1.5; 12 deep	400	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

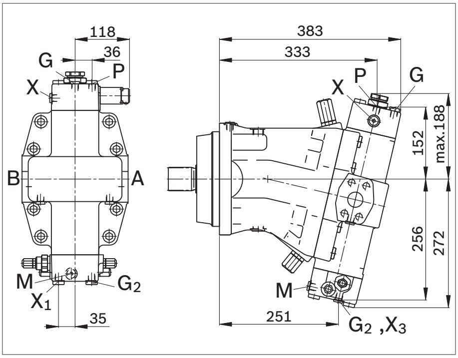
Dimensions size 250

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

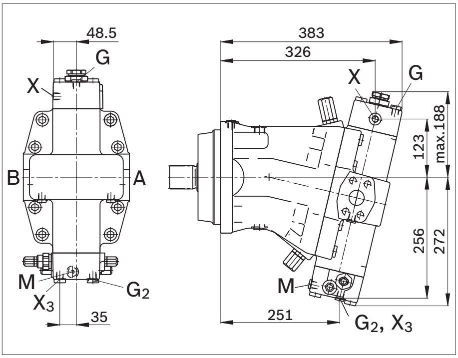
EP1, EP2
Proportional control electric



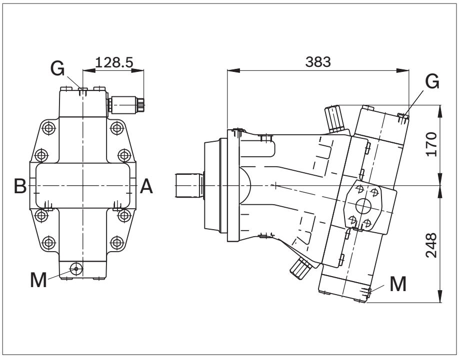
EP.D, EP.G
Proportional control electric,
with pressure control fixed setting; remote control (EP.G)



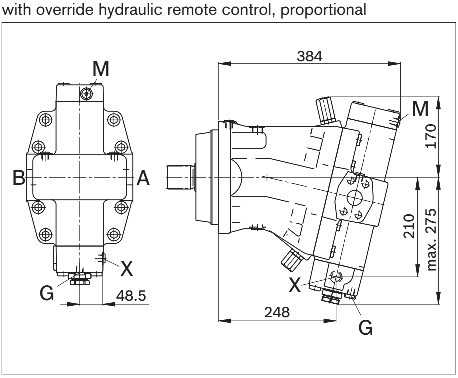
HD.D, HD.G
Proportional control hydraulic,
with pressure control fixed setting; remote control (EP.G)



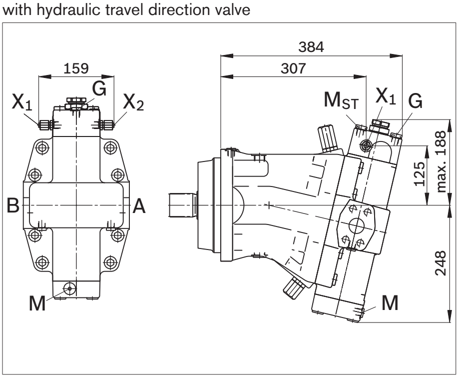
EZ1, EZ2
Two-point control electric



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



DA
Automatic control speed related,
with hydraulic travel direction valve

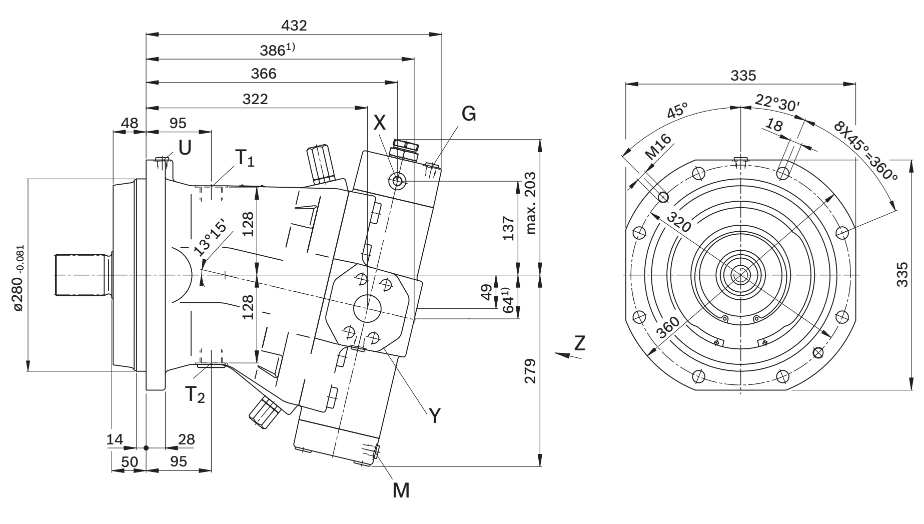


Dimensions size 355

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HD1, HD2 – Proportional control hydraulic
HZ – Two-point control hydraulic

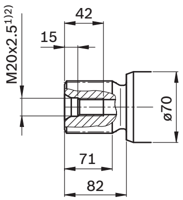
Port plate 02 – SAE flange ports A and B at side, opposite



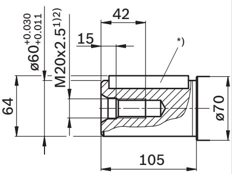
1) Port plate 01/15 – SAE flange ports A and B at rear

Drive shafts

Z Splined shaft DIN 5480 W60x2x28x9g

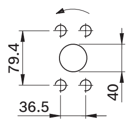


P Cyl. shaft with key AS18x11x100 (DIN 6885)



*) Key width 18

Service line port (detail Y)



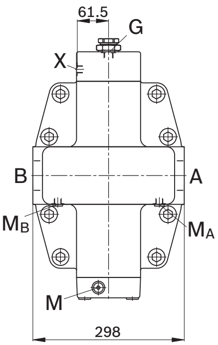
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 355

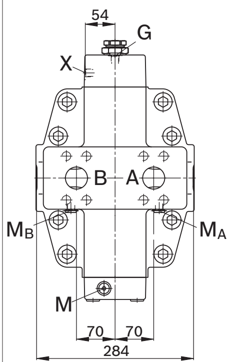
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

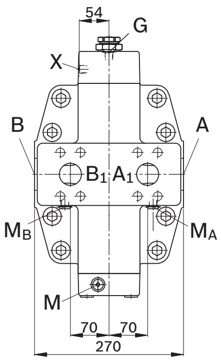
02 SAE flange ports A and B at side, opposite



01 SAE flange ports A and B at rear



15 SAE flange port A and B at side, opposite, A_1 and B_1 at rear



Ports

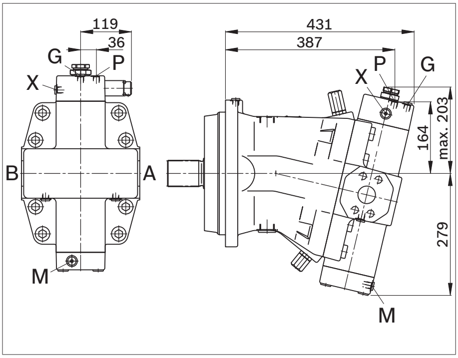
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/2 in M16 x 2; 24 deep	400	O
A_1, B_1	Additional service line for plate 15 Fastening thread A_1/B_1	SAE J518[3] DIN 13	1 1/2 in M16 x 2; 24 deep	400	O
T_1	Drain line	DIN 3852[5]	M33 x 2; 18 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M33 x 2; 18 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
G_2	2nd pressure setting (HD.D, EP.D)	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
P	Pilot oil supply (EP)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
U	Bearing flushing	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA)	DIN 2353-CL	8B-ST	40	O
X_3	Remote control valve (HD.G, EP.G)	DIN 3852[5]	M14 x 1.5; 12 deep	400	O
M	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_A, M_B	Measuring pressure A/B	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_{St}	Measuring pilot pressure	DIN 3852[5]	M14 x 1.5; 12 deep	400	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

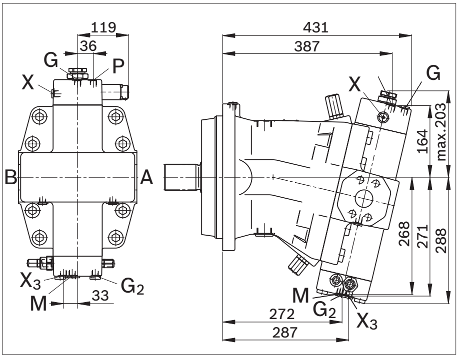
Dimensions size 355

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

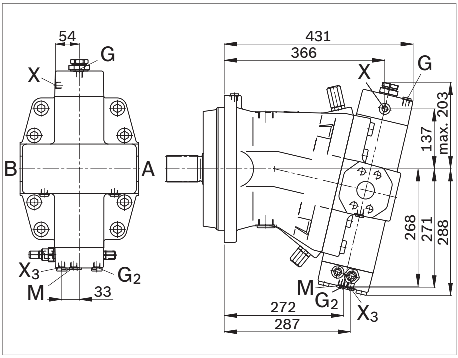
EP1, EP2
Proportional control electric



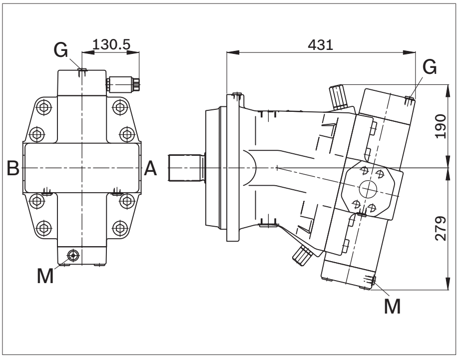
EP.D, EP.G
Proportional control electric,
with pressure control fixed setting; remote control (EP.G)



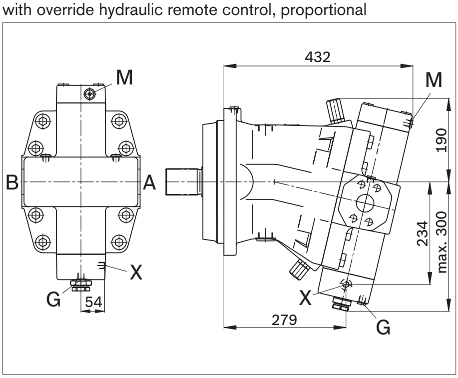
HD.D, HD.G
Proportional control hydraulic,
with pressure control fixed setting; remote control (EP.G)



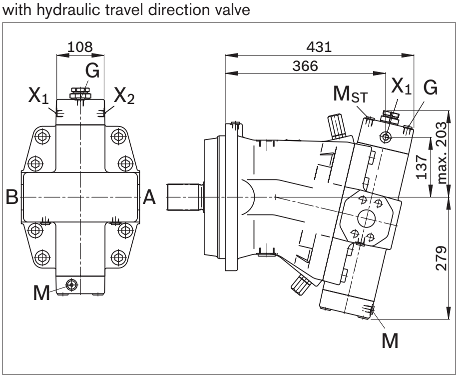
EZ1, EZ2
Two-point control electric



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



DA
Automatic control speed related,
with hydraulic travel direction valve

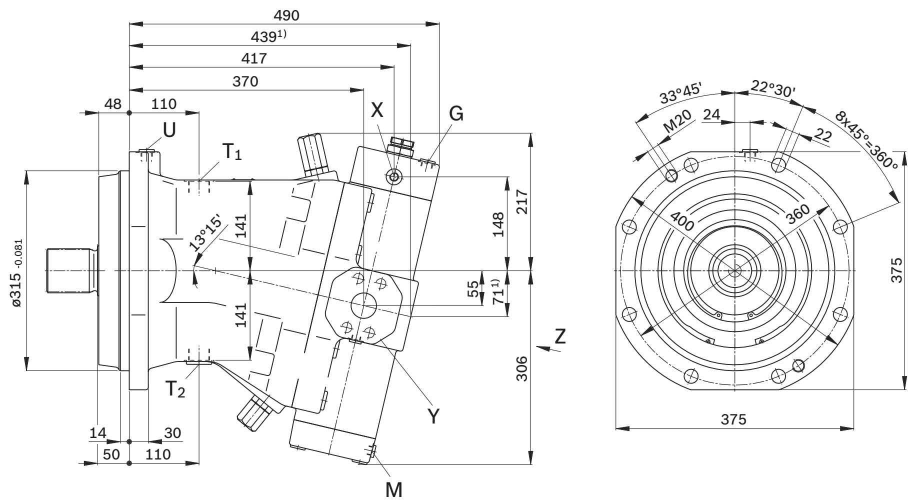


Dimensions size 500

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HD1, HD2 – Proportional control hydraulic
HZ – Two-point control hydraulic

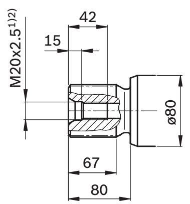
Port plate 02 – SAE flange ports A and B at side, opposite



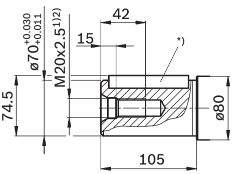
1) Port plate 01/15 – SAE flange ports A and B at rear

Drive shafts

Z Splined shaft DIN 5480 W70x3x22x9g

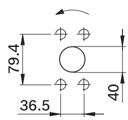


P Cyl. shaft with key AS20x12x100 (DIN 6885)



*) Key width 20

Service line port (detail Y)



1) Observe the general instructions on page 80 for the maximum tightening torques.

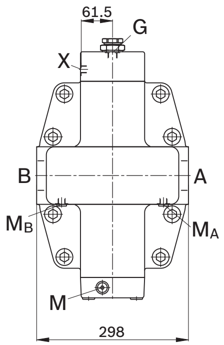
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 500

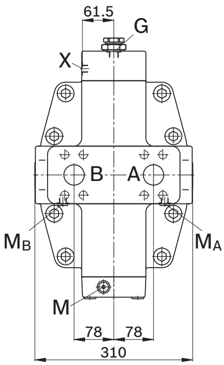
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

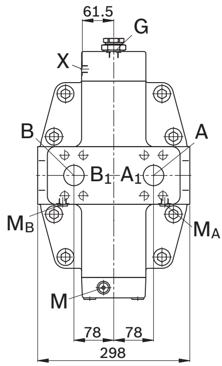
02 SAE flange ports A and B at side, opposite



01 SAE flange ports A and B at rear



15 SAE flange port A and B at side, opposite, A_1 and B_1 at rear



Ports

Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/2 in M16 x 2; 24 deep	400	O
A_1, B_1	Additional service line for plate 15 Fastening thread A_1/B_1	SAE J518[3] DIN 13	1 1/2 in M16 x 2; 24 deep	400	O
T_1	Drain line	DIN 3852[5]	M33 x 2; 18 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M33 x 2; 18 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M18 x 1.5; 12 deep	400	X
G_2	2nd pressure setting (HD.D, EP.D)	DIN 3852[5]	M18 x 1.5; 12 deep	400	X
P	Pilot oil supply (EP)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
U	Bearing flushing	DIN 3852[5]	M18 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_1, X_2	Pilot signal (DA)	DIN 2353-CL	8B-ST	40	O
X_3	Remote control valve (HD.G, EP.G)	DIN 3852[5]	M14 x 1.5; 12 deep	400	O
M	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_A, M_B	Measuring pressure A/B	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_{St}	Measuring pilot pressure	DIN 3852[5]	M14 x 1.5; 12 deep	400	X

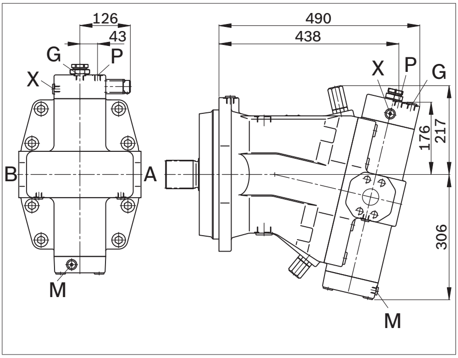
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

2

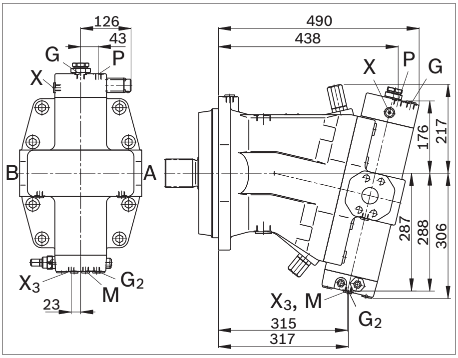
Dimensions size 500

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

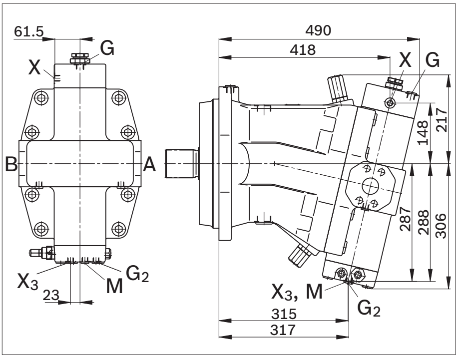
EP1, EP2
Proportional control electric



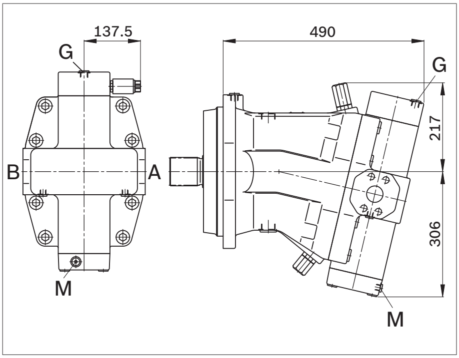
EP.D, EP.G
Proportional control electric,
with pressure control fixed setting; remote control (EP.G)



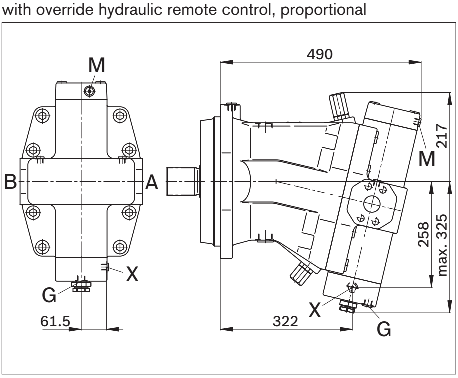
HD.D, HD.G
Proportional control hydraulic,
with pressure control fixed setting; remote control (EP.G)



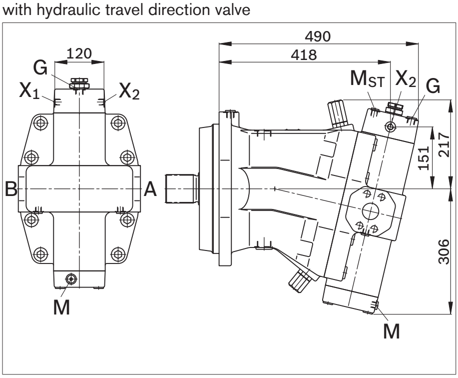
EZ1, EZ2
Two-point control electric



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



DA
Automatic control speed related,
with hydraulic travel direction valve

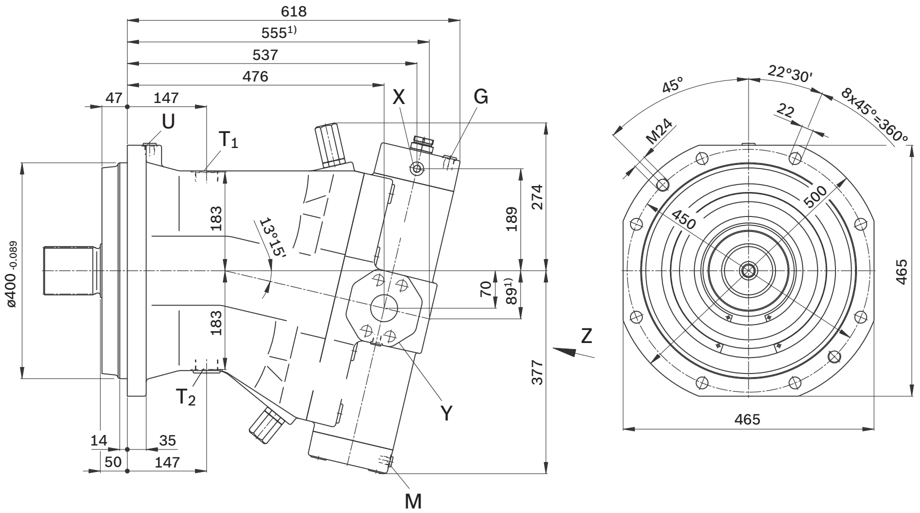


Dimensions size 1000

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HD1, HD2 – Proportional control hydraulic
HZ – Two-point control hydraulic

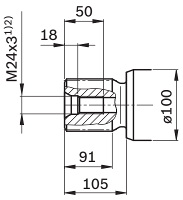
Port plate 02 – SAE-SAE flange ports A and B at side, opposite



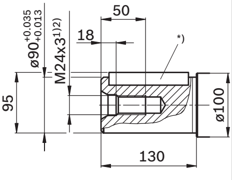
1) Port plate 01/15 – SAE flange ports A and B at rear

Drive shafts

A Splined shaft DIN 5480 W90x3x28x9g

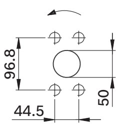


P Cyl. shaft with key AS25x14x125 (DIN 6885)



*) Key width 25

Service line port (detail Y)



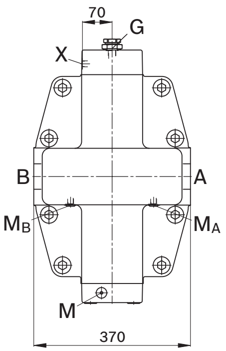
1) Observe the general instructions on page 80 for the maximum tightening torques.
2) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 1000

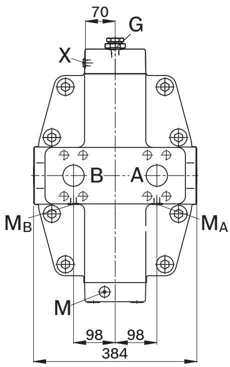
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

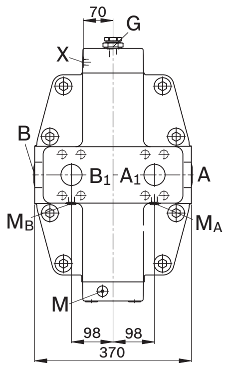
02 SAE flange ports A and B at side, opposite



01 SAE flange ports A and B at rear



15 SAE flange port A and B at side, opposite, A_1 and B_1 at rear



Ports

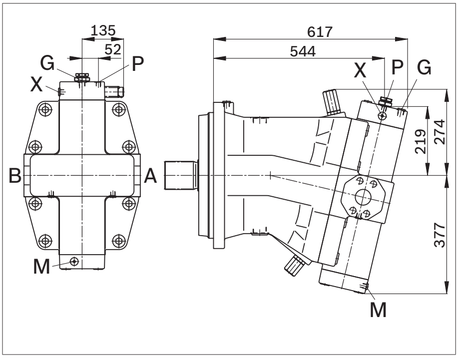
Designation	Port for	Standard	Size[1]	Maximum pressure [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	2 in M20 x 2.5; 24 deep	400	O
A_1, B_1	Additional service line for plate 15 Fastening thread A_1/B_1	SAE J518[3] DIN 13	2 in M20 x 2.5; 24 deep	400	O
T_1	Drain line	DIN 3852[5]	M42 x 2; 20 deep	3	X[4]
T_2	Drain line	DIN 3852[5]	M42 x 2; 20 deep	3	O[4]
G	Synchronous control	DIN 3852[5]	M18 x 1.5; 12 deep	400	X
G_2	2nd pressure setting (HD.D, EP.D)	DIN 3852[5]	M18 x 1.5; 12 deep	400	X
P	Pilot oil supply (EP)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
U	Bearing flushing	DIN 3852[5]	M18 x 1.5; 12 deep	3	X
X	Pilot signal (HD, HZ, HA1T/HA2T)	DIN 3852[5]	M14 x 1.5; 12 deep	100	O
X	Pilot signal (HA1 and HA2)	DIN 3852[5]	M14 x 1.5; 12 deep	3	X
X_3	Remote control valve (HD.G, EP.G)	DIN 3852[5]	M14 x 1.5; 12 deep	400	O
M	Measuring stroking chamber	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_A, M_B	Measuring pressure A/B	DIN 3852[5]	M14 x 1.5; 12 deep	400	X
M_{St}	Measuring pilot pressure	DIN 3852[5]	M14 x 1.5; 12 deep	400	X

1) Observe the general instructions on page 80 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on page 79).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

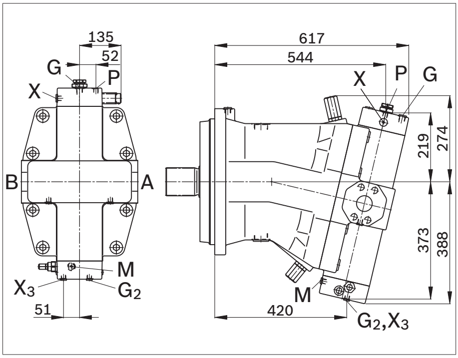
Dimensions size 1000

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

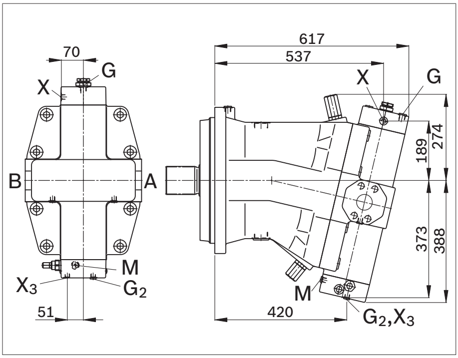
EP1, EP2
Proportional control electric



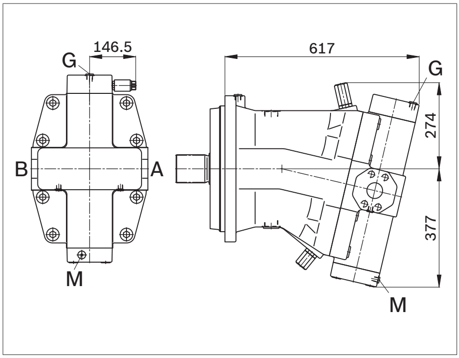
EP.D, EP.G
Proportional control electric,
with pressure control fixed setting; remote control (EP.G)



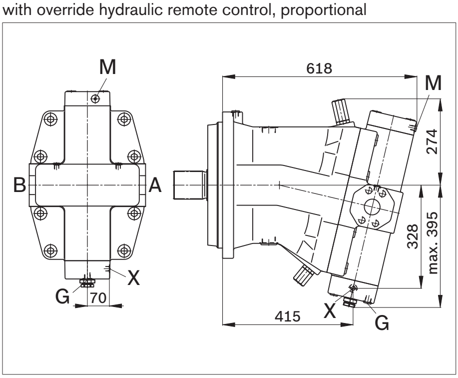
HD.D, HD.G
Proportional control hydraulic,
with pressure control fixed setting; remote control (EP.G)



EZ1, EZ2
Two-point control electric



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



Connector for solenoids

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DEUTSCH DT04-2P-EP04

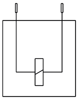
Sizes 28 to 200

Molded, 2-pin, without bidirectional suppressor diode

There is the following type of protection with mounted mating connector:
IP67 ______________________________ DIN/EN 60529

and IP69K ____________________________ DIN 40050-9

Circuit symbol



Mating connector

DEUTSCH DT06-2S-EP04
Bosch Rexroth Mat. No. R902601804

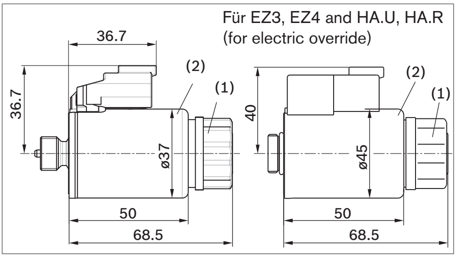
Consisting of: DT designation

– 1 housing _________________________ DT06-2S-EP04

– 1 wedge ________________________________ W2S

– 2 sockets ________________________ 0462-201-16141

The mating connector is not included in the delivery contents. This can be supplied by Bosch Rexroth on request.



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

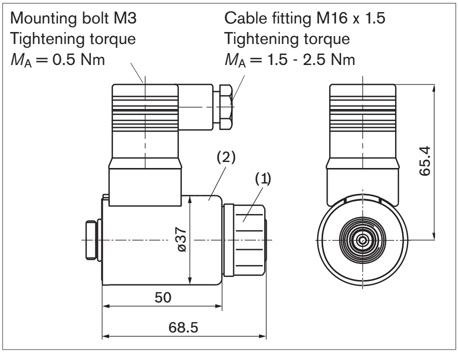
Sizes 250 to 1000

Without bidirectional suppressor diode

There is the following type of protection with mounted mating connector:
IP65 _____________________________DIN/EN 60529

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

The HIRSCHMANN connector is included in the delivery contents of the motor.



Changing connector orientation

If necessary, you can change the connector orientation by turning the solenoid housing.

To do this, proceed as follows:

1. Loosen the mounting nut (1) of the solenoid. To do this, turn the mounting nut (1) one turn counter-clockwise.
2. Turn the solenoid body (2) to the desired orientation.
3. Retighten the mounting nut. Tightening torque: 5+1 Nm. (WAF26, 12-sided DIN 3124)

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

Flushing and boost pressure valve

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

In an open circuit, it is used only for flushing the housing.

In a closed circuit, it ensures a minimum boost pressure level in addition to the case flushing.

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

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

Cracking pressure of pressure retaining valve
(observe when setting the primary valve)
fixed setting ________________________________ 16 bar

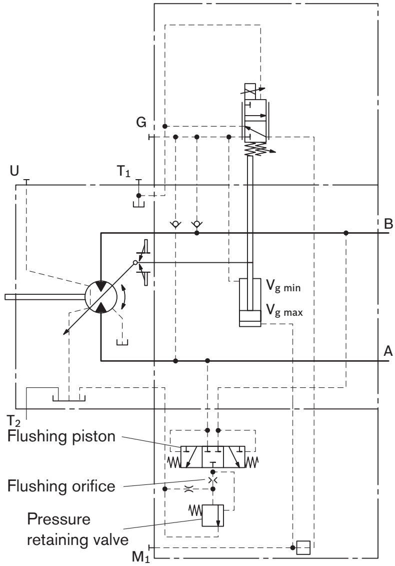
Switching pressure of flushing piston Δp________ 8±1 bar

Flushing flow q_v
Orifices can be used to set the flushing flows as required. Following parameters are based on:
$\Delta p_{ND} = p_{ND} - p_G = 25$ bar and $\nu = 10$ mm²/s
(p_{ND} = low pressure, p_G = case pressure)

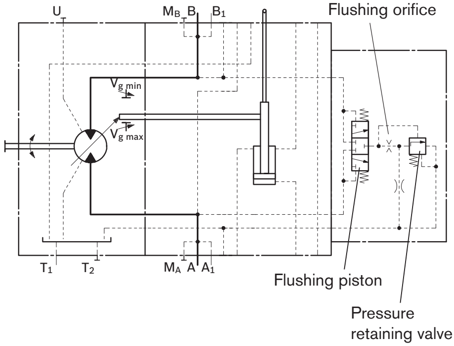
Size	Flushing flow q_V [L/min]	Mat. No. of orifice
28, 55	3.5	R909651766
80	5	R909419695
107	8	R909419696
140, 160, 200	10	R909419697
250	10	R909419697
355, 500, 1000	16	R910803019

With sizes 28 to 200, orifices can be supplied for flushing flows from 3.5 to - 10 L/min. For other flushing flows, please state the required flushing flow when ordering. The flushing flow without orifice is approx. 12 to 14 L at low pressure Δp_{ND} = 25 bar.

Schematic EP
Sizes 28 to 200



Schematic
Sizes 250 to 1000



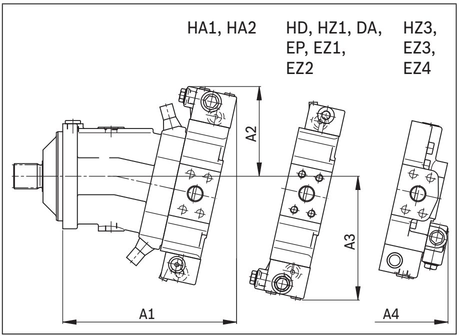
2

Flushing and boost pressure valve

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

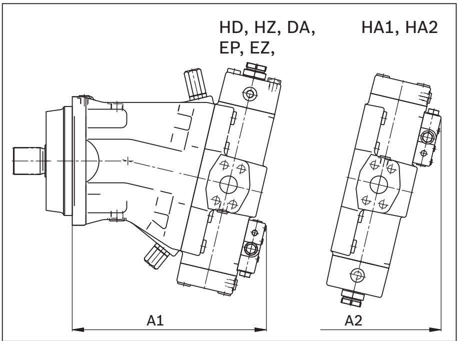
Dimensions

Sizes 28 to 200



NG	A1	A2	A3	A4
28	214	125	161	–
55	243	133	176	236
80	273	142	193	254
107	288	144	200	269
140	321	154	218	–
160	328	154	220	–
200	345	160	231	–

Sizes 250 to 1000



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

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Function

Travel drive/winch counterbalance valves are designed to reduce the danger of overspeeding and cavitation of axial piston motors in open circuits. Cavitation occurs if the motor speed is greater than it should be for the given input flow while braking, travelling downhill, or lowering a load.

If the inlet pressure drops, the counterbalance spool throttles the return flow and brakes the motor until the inlet pressure returns to approx. 20 bar.

Note

- BVD available for sizes 55 to 200 and BVE available for sizes 107 to 200.
- The counterbalance valve must be ordered additionally. We recommend ordering the counterbalance valve and the motor as a set. Ordering example: A6VM80HA1T/63W–VAB38800A + BVD20F27S/41B–V03K16D0400S12
- For safety reasons, controls with beginning of control at $V_{g\ min}$ (e. g. HA) are not permissible for winch drives!
- The counterbalance valve does not replace the mechanical service brake and park brake.
- Observe the detailed notes on the BVD counterbalance valve in RE 95522 and BVE counterbalance valve in RE 95525.
- For the design of the brake release valve, we must know for the mechanical park brake:
  - the pressure at the start of opening
  - the volume of the counterbalance spool between minimum stroke (brake closed) and maximum stroke (brake released with 21 bar)
  - the required closing time for a warm device (oil viscosity approx. 15 mm²/s)

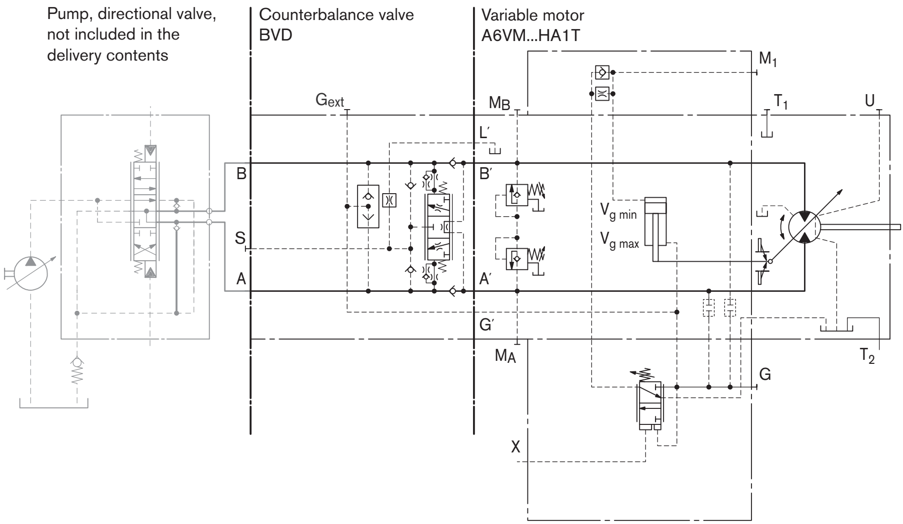
2

Travel drive counterbalance valve BVD...F

Application option

- Travel drive on wheeled excavators

Example schematic for travel drive for wheeled excavators
A6VM80HA1T/63W–VAB38800A + BVD20F27S/41B–V03K16D0400S12



Counterbalance valve BVD and BVE

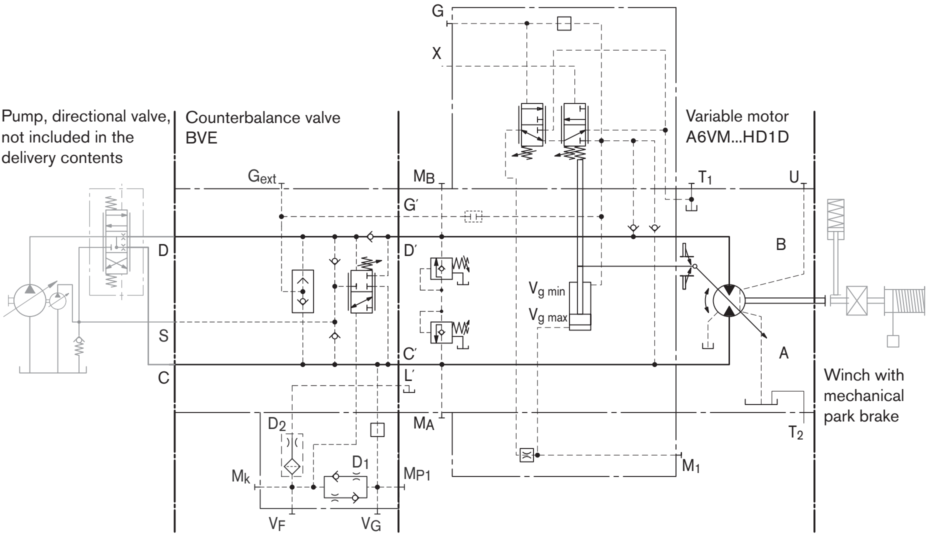
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Winch counterbalance valve BVD...W and BVE

Application options

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

Example schematic for winch drive in cranes
A6VM80HD1D/63W–VAB38800B + BVE25W38S/51ND-V100K00D4599T30S00-0



Permissible input flow or pressure in operation with DBV and BVD/BVE

Motor NG	Without valve p_{nom}/p_{max} [bar]	Without valve $q_{V\,max}$ [L/min]	DBV NG	DBV p_{nom}/p_{max} [bar]	DBV q_V [L/min]	DBV Code	BVD/BVE NG	BVD/BVE p_{nom}/p_{max} [bar]	BVD/BVE q_V [L/min]	BVD/BVE Code
55	400/450	244	22	350/420	240	380	20 (BVD)	350/420	220	388
80		312								
107		380	32		400	370				378
107		380				380	25 (BVD/BVE)		320	388
140		455								
160		496								
200		580	On request							
250	350/400	675	On request							

DBV ____________________ pressure-relief valve

BVD ______________ counterbalance valve, double-acting

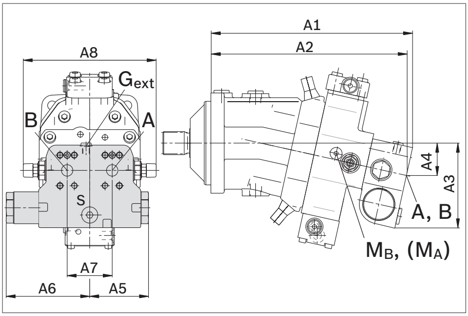
BVE ________________ counterbalance valve, one-sided

Counterbalance valve BVD and BVE

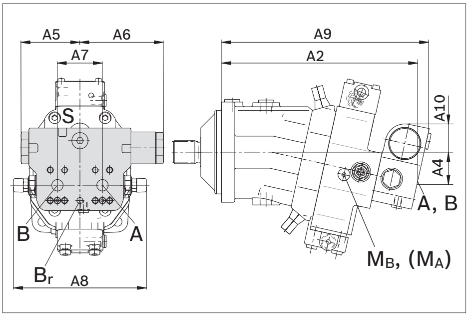
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Dimensions

A6VM...HA



A6VM...HD or EP[1)]



A6VM NG...plate	Counterbalance valve Type	Ports A, B	Dimensions A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
55...38	BVD20...17	3/4 in	311	302	143	50	98	139	75	222	326	50
80...38	BVD20...27	1 in	340	331	148	55	98	139	75	222	355	46
107...37	BVD20...28	1 in	362	353	152	59	98	139	84	234	377	41
107...38	BVD25...38	1 1/4 in	380	370	165	63	120.5	175	84	238	395	56
140...38	BVD25...38	1 1/4 in	411	401	168	67	120.5	175	84	238	426	53
160...38	BVD25...38	1 1/4 in	417	407	170	68	120.5	175	84	238	432	51
200...38	BVD25...38	1 1/4 in	448	438	176	74	120.5	175	84	299	463	46
107...38	BVE25...38	1 1/4 in	380	370	171	63	137	214	84	238	397	63
140...38	BVE25...38	1 1/4 in	411	401	175	67	137	214	84	238	423	59
160...38	BVE25...38	1 1/4 in	417	407	176	68	137	214	84	238	432	59
200...38	BVE25...38	1 1/4 in	448	438	182	74	137	214	84	299	463	52

Ports

Designation	Port for	Version	A6VM Plate	Standard	Size[2)]	Maximum pressure [bar][3)]	State[5)]
A, B	Service line			SAE J518	see table above	420	O
S	Infeed	BVD20		DIN 3852[4)]	M22 x 1.5; 14 deep	30	X
		BVD25, BVE25		DIN 3852[4)]	M27 x 2; 16 deep	30	X
Br	Brake release, reduced high-pressure	L	7	DIN 3852[4)]	M12 x 1.5; 12.5 deep	30	O
			8	DIN 3852[4)]	M12 x 1.5; 12 deep	30	O
G_{ext}	Brake release, high-pressure	S		DIN 3852[4)]	M12 x 1.5; 12.5 deep	420	X
M_A, M_B	Measuring pressure A and B			ISO 6149[4)]	M18 x 1.5; 14.5 deep	420	X

1) At the mounting version for the controls HD and EP, the cast-in port designations A and B on the counterbalance valve BVD do not correspond with the connection drawing of the A6VM motor.
The designation of the ports on the installation drawing of the motor is binding!
2) Observe the general instructions on page 80 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) The spot face can be deeper than specified in the appropriate standard.
5) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Mounting the counterbalance valve

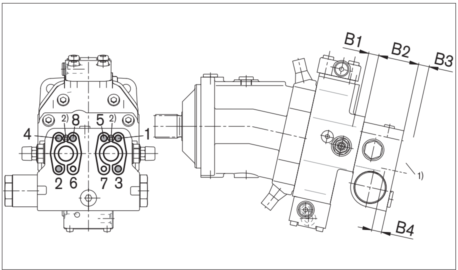
When delivered, the counterbalance valve is mounted to the motor with two tacking screws (transport protection). The tacking screws may not be removed while mounting the service lines. If the counterbalance valve and motor are delivered separately, the counterbalance valve must first be mounted to the motor port plate using the provided tacking screws. The counterbalance valve is finally mounted to the motor by screwing on the SAE flange with the following screws:

6 screws (**1, 2, 3, 4, 5, 8**) ____________ length B1+B2+B3
2 screws (**6, 7**) ______________________ length B3+B4

Tighten the screws in two steps in the specified sequence from 1 to 8 (see following scheme).

In the first step, the screws must be tightened with half the tightening torque, and in the second step with the maximum tightening torque (see following table).

Thread	Strength class	Tightening torque [Nm]
M6 x 1 (tacking screw)	10.9	15.5
M10	10.9	75
M12	10.9	130
M14	10.9	205



1) SAE flange
2) Tacking screw (M6 x 1, length = B1 + B2, DIN 912)

NG...plate	55...38	80...38, 107...37	107, 140, 160, 200...38
B1[3]	M10 x 1.5 17 deep	M12 x 1.75 15 deep	M14 x 2 19 deep
B2	68	68	85
B3	customer-specific		
B4	M10 x 1.5 15 deep	M12 x 1.75 16 deep	M14 x 2 19 deep

3) Minimum required thread reach 1 x Ø-thread

Swivel angle indicator (sizes 250 to 1000)

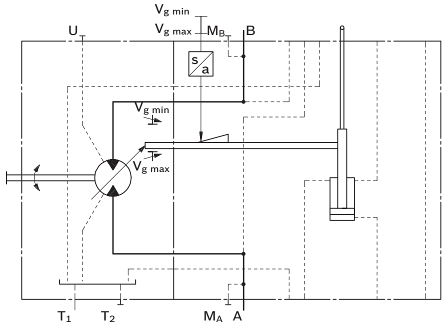
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

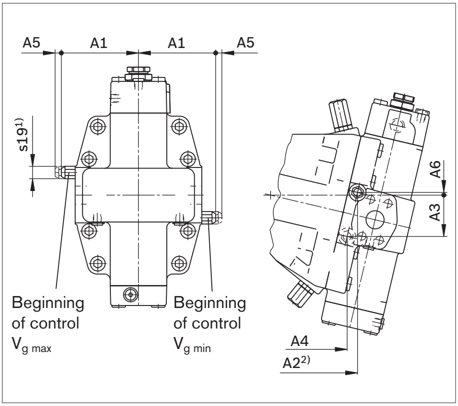
Optical swivel angle indicator (V)

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

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

Example: beginning of control at $V_{g\ max}$





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

1) Size
2) Dimension to mounting flange
3) Required clearance for removal of cap nut

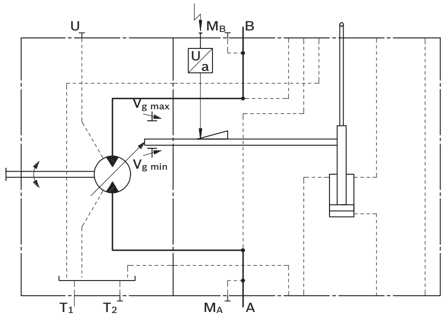
Electric swivel angle indicator (E)

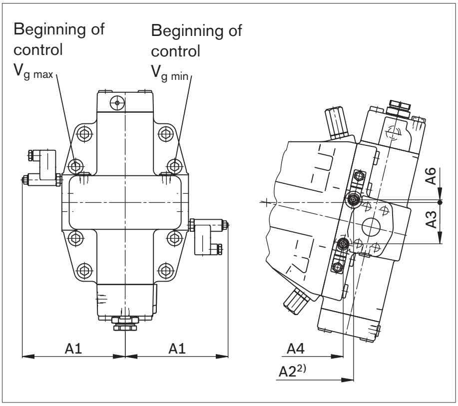
The motor position is measured by an inductive position transducer. This converts the stroke of the control device into an electric signal.

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

Inductive position transducer, type IW9–03–01
type of protection according to DIN/EN 60529: IP65

Example: beginning of control at $V_{g\ min}$





NG	A1	A2 [2]	A3	A4	A6
250	182	256	73	238	5
355	205	288	84	266	8
500	218	331	89	309	3
1000	254	430	114	402	3

Speed sensors

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Version A6VM...U and A6VM...F ("prepared for speed sensor", i.e. without sensor) is quipped with a toothed ring on the rotary group.

On deliveries "prepared for speed sensor", the port is plugged with a pressure-resistant cover.

With the speed sensor DSA or HDD mounted, a signal proportional to the motor speed can be generated. The sensors measure the speed and direction of rotation.

Ordering code, technical data, dimensions and details on the connector, plus safety information about the sensor can be found in the relevant data sheet.

DSA ______________________________ RE 95133

HDD ______________________________ RE 95135

Version "V" (sizes 28 to 200)

Suitable for mounting the DSA speed sensor. The sensor is fastened at the upper reservoir port T_1.

Note

With speed measuring, only port T_2 can be used to drain the case drain.

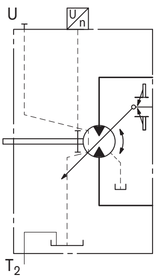
Version "H" (sizes 355 and 500)

Suitable for mounting the HDD speed sensor. The sensor is flanged onto the port provided for this purpose with two mounting bolts.

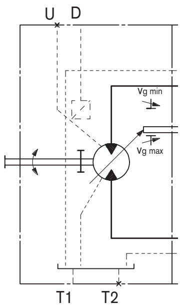
We recommend ordering the A6VM variable motor complete with installed sensor.

Schematic

Sizes 28 to 200

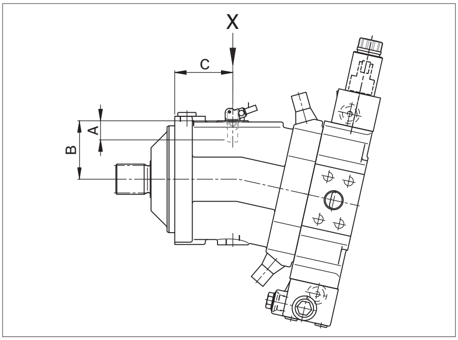


Sizes 250 to 1000



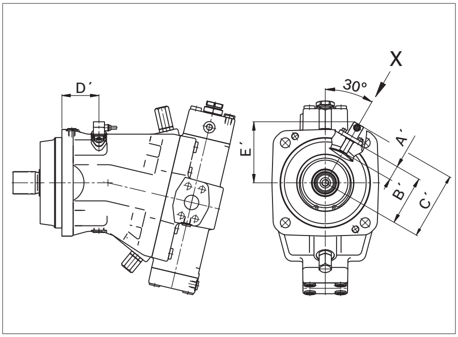
Dimensions

Version "V" with DSA sensor (sizes 28 to 200)

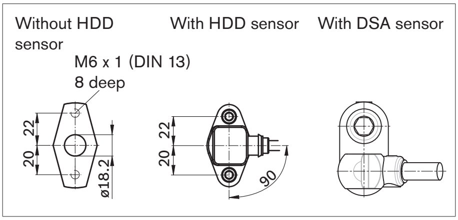


Dimensions

Version "H" with HDD sensor (sizes 355 and 500)



View X



Size			55	80	107	140	160	200	250	355	500
Number of teeth			54	58	67	72	75	80	78	90	99
DSA	A	Insertion depth (tolerance -0.25)	18.4	18.4	18.4	18.4	18.4	18.4	On request	-	-
	B	Contact surface	75	79	88	93	96	101		-	-
	C		66.2	75.2	77.2	91.2	91.7	95.2		-	-
HDD	A‘	Insertion depth (tolerance ± 0.1)	-	-	-	-	-	-	-	32.5	32.5
	B‘	Contact surface	-	-	-	-	-	-	-	122.5	132.5
	C‘		-	-	-	-	-	-	-	161	171
	D‘		-	-	-	-	-	-	-	93	113
	E‘		-	-	-	-	-	-	-	145	154

Installation instructions

General

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

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

The case drain fluid in the motor housing must be directed to the reservoir via the highest available drain port (T_1, T_2).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the 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 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.

Installation position

See the following examples 1 to 8.
Further installation positions are possible upon request.

Recommended installation positions: 1 and 2.

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

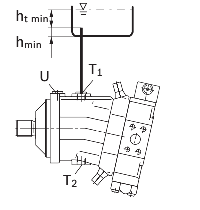
Installation position	Air bleed	Filling
1	–	T_1
2	–	T_2
3	–	T_1
4	U	T_1
5	U (L_1)	T_1 (L_1)
6	L_1	T_2 (L_1)
7	L_1	T_1 (L_1)
8	U	T_1 (L_1)

L_1	Filling / air bleed
U	Bearing flushing / air bleed port
T_1, T_2	Drain port
$h_{t\,min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required spacing to reservoir bottom (100 mm)

Below-reservoir installation (standard)

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

1



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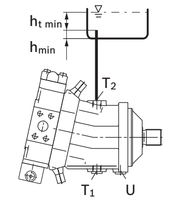

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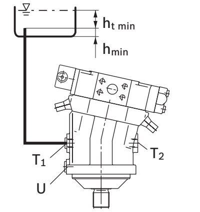

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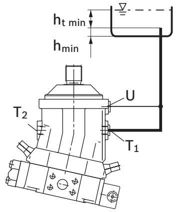
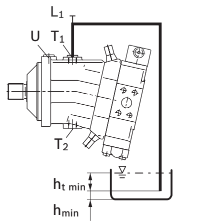


Above-reservoir installation

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

Recommendation for installation position 8 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) can prevent draining of the motor housing.

5



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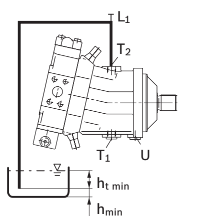

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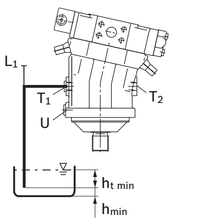
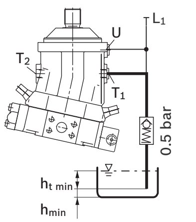


8



General instructions

– The motor A6VM is designed to be used in open and closed circuits.

– The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified personnel.

– Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these can be requested from Bosch Rexroth.

– 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.

– The product is not approved as a component for the safety concept of a general machine according to ISO 13849.

– The following tightening torques apply:

- Fittings:
Observe the manufacturer's instruction regarding tightening torques for the fittings used.

- Mounting bolts:
For mounting bolts with metric ISO thread according to DIN 13 or thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

- Female threads in the axial piston unit:
The maximum permissible tightening torques $M_{G\,max}$ are maximum values for 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	Size of thread	Maximum permissible tightening torque of the female threads $M_{G\,max}$	Required tightening torque of the threaded plugs M_V 1)	WAF hexagon socket of the threaded plugs
DIN 3852	M12 x 1.5	50 Nm	25 Nm 2)	6 mm
	M14 x 1.5	80 Nm	35 Nm	6 mm
	M16 x 1.5	100 Nm	50 Nm	8 mm
	M18 x 1.5	140 Nm	60 Nm	8 mm
	M22 x 1.5	210 Nm	80 Nm	10 mm
	M26 x 1.5	230 Nm	120 Nm	12 mm
	M27 x 2	330 Nm	135 Nm	12 mm
	M33 x 2	540 Nm	225 Nm	17 mm
	M42 x 2	720 Nm	360 Nm	22 mm

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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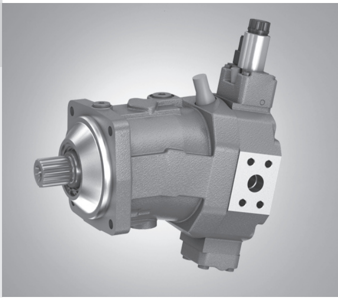
Rexroth
Bosch Group

Axial Piston Variable Motor A6VM

Replaces: 06.12

Data sheet



Series 71
Sizes 60 to 215
Nominal pressure 450 bar
Maximum pressure 500 bar
Open and closed circuits

Contents

Features

- Variable motor with axial tapered piston rotary group of bent-axis design, for hydrostatic drives in open and closed circuits
- For use in mobile and stationary applications
- The wide control range enables the variable motor to satisfy the requirement for high speed and high torque.
- The displacement can be infinitely changed from $V_{g\ max}$ to $V_{g\ min} = 0$.
- The output speed is dependent on the flow of the pump and the displacement of the motor.
- The output torque increases with the pressure differential between the high-pressure and low-pressure side and with increasing displacement.
- Wide control range with hydrostatic transmissions
- Wide selection of control devices
- Cost savings through elimination of gear shifts and possibility of using smaller pumps
- Compact, robust motor with long service life
- High power density
- Good starting characteristics
- Version with 9-piston rotary group
- Good low speed characteristics
- High uniformity

Ordering code for standard program

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

Axial piston unit

01	Bent-axis design, variable, nominal pressure 450 bar, maximum pressure 500 bar	**A6V**

Operating mode

02	Motor	**M**

Sizes (NG)

03	Geometric displacement, see table of values on page 8	**060**	**085**	**115**	**150**	**170**	**215**

Control devices

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

Pressure control/overrides

				060	085	115	150	170	215	
05	Without pressure control/override			●	●	●	●	●	●	**00**
	Pressure control fixed setting, only for HP5, HP6, EP5 and EP6			●	●	●	●	●	●	**D1**
	Override of the HA1 and HA2 controls	hydraulic remote control, proportional		●	●	●	●	●	●	**T3**
		electric, two-point	U = 12 V DC	●	●	●	●	●	●	**U1**
			U = 24 V DC	●	●	●	●	●	●	**U2**
		electric and travel direction valve, electric	U = 12 V DC	●	●	●	●	●	●	**R1**
			U = 24 V DC	●	●	●	●	●	●	**R2**

Connector for solenoids[1] (see page 61)

06	Without connector (without solenoid, only with hydraulic controls)	**0**
	DEUTSCH - molded connector, 2-pin, without suppressor diode	**P**

● = Available ❍ = On request – = Not available

1) Connectors for other electric components can deviate.

Ordering code for standard program

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

Additional function 1

07	Without additional function	0

Additional function 2

08	Without additional function	0

Response time damping (for selection, see control)

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

Setting ranges for displacement[2)]

	$V_{g\,max}$-adjusting screw	$V_{g\,min}$-adjusting screw	060	085	115	150	170	215	
10	Without adjusting screw	short (0-adjustable)	●	●	●	●	●	●	A
		medium	●	●	●	●	●	●	B
		long	●	●	●	●	●	●	C
		extra long	–	–	●	●	●	●	D
	Short	short (0-adjustable)	●	●	●	●	●	●	E
		medium	●	●	●	●	●	●	F
		long	●	●	●	●	●	●	G
		extra long	–	–	●	●	●	●	H
	Medium	short (0-adjustable)	●	●	●	●	●	●	J
		medium	●	●	●	●	●	●	K
		long	●	●	●	●	●	●	L
		extra long	–	–	●	●	●	●	M

Series

11	Series 7, index 1	71

Configuration of ports and fastening threads

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

Direction of rotation

13	Viewed on drive shaft, bidirectional	W

Seals

14	FKM (fluor-caoutchouc)	V

Drive shaft bearing

15	Standard bearing	0

Mounting flanges

			060	085	115	150	170	215	
16	ISO 3019-2	125-4	●	–	–	–	–	–	M4
		140-4	–	●	–	–	–	–	N4
		160-4	–	–	●	–	–	–	P4
		180-4	–	–	–	●	●	–	R4
		200-4	–	–	–	–	–	●	S4

● = Available ❍ = On request – = Not available

2) The settings for the adjusting screws can be found in the table (page 69 and 70).

2

Ordering code for standard program

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

Drive shafts

			060	085	115	150	170	215	
17	Splined shaft ANSI B92.1a	1 1/4 in 14T 12/24DP	●	–	–	–	–	–	S7
		1 1/2 in 17T 12/24DP	–	●	–	–	–	–	S9
		1 3/4 in 13T 8/16DP	–	–	●	●	–	–	T1
		2 in 15T 8/16DP	–	–	–	❍	●	●	T2
	Splined shaft DIN 5480	W35x2x16x9g	●	–	–	–	–	–	Z8
		W40x2x18x9g	–	●	●	–	–	–	Z9
		W45x2x21x9g	–	–	–	●	●	–	A1
		W50x2x24x9g	–	–	–	–	–	●	A2

Port plates for service lines

			060	085	115	150	170	215	
18	SAE flange ports A and B at rear		●	●	●	●	●	●	1
	SAE flange ports A and B at side, opposite		●	●	●	●	●	●	2
	Port plate with 1-level pressure-relief valves for mounting a counterbalance valve[3)]	BVD20	●	●	●	–	–	–	7
		BVD25, BVE25	–	–	●	●	●	●	8

Valves (see page 62 to 67)

			060	085	115	150	170	215	
19	Without valve		●	●	●	●	●	●	0
	Counterbalance valve BVD/BVE mounted[4)]		●	●	●	●	●	●	W
	Flushing and boost pressure valve mounted, flushing on both sides Flushing flow with: $\Delta p = p_{ND} - p_G = 25$ bar and $\nu = 10$ mm²/s (p_{ND} = low pressure, p_G = case pressure) Only possible with port plates 1 and 2	**Flushing flow q_v [L/min]**							
		3.5	●	●	●	–	–	–	A
		5	●	●	●	–	–	–	B
		8	●	●	●	●	●	●	C
		10	●	●	●	●	●	●	D
		14	●	●	●	–	–	–	F
		17	–	–	–	●	●	●	G
		20	–	–	●[5)]	●	●	●	H
		25	–	–	●[5)]	●	●	●	J
		30	–	–	●[5)]	●	●	●	K
		35	–	–	–	●	●	●	L
		40	–	–	–	●	●	●	M

Speed sensors (see page 68)

		060	085	115	150	170	215	
20	Without speed sensor	●	●	●	●	●	●	0
	Prepared for DSM speed sensor	●	●	●	●	●	●	U
	DSM speed sensor mounted[6)]	●	●	●	●	●	●	V

Standard / special version

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

● = Available ❍ = On request – = Not available

3) Only possible in combination with HP, EP and HA control. Note the restrictions on page 65.
4) Specify ordering code of counterbalance valve acc. to data sheet (BVD – RE 95522, BVE – RE 95525) separately. Note the restrictions on page 65.
5) Not for EZ7, EZ8 and HZ7
6) DSA on request. Specify ordering code of DSM acc. to data sheet RE 95132 separately and observe the requirements on the electronics.

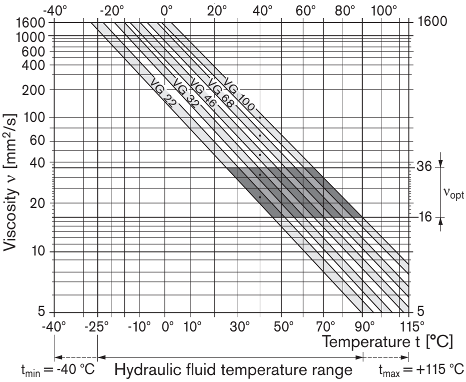
Technical data

Hydraulic fluid

Before starting project planning, please refer to our data sheets RE 90220 (mineral oil), RE 90221 (environmentally acceptable hydraulic fluids) and RE 90222 (HFD hydraulic fluids) for detailed information regarding the choice of hydraulic fluid and application conditions.

The variable motor A6VM is not suitable for operation with HFA hydraulic fluid. If HFB, HFC or HFD or environmentally acceptable hydraulic fluids are used, the limitations regarding technical data or other seals must be observed.
Please contact us.

Selection diagram



Details regarding the choice of hydraulic fluid

The correct choice of hydraulic fluid requires knowledge of the operating temperature in relation to the ambient temperature: in a closed circuit, the circuit temperature; in an open circuit, the reservoir temperature.

The hydraulic fluid should be chosen so that the operating viscosity in the operating temperature range is within the optimum range (ν_{opt} see shaded area of the selection diagram). We recommended that the higher viscosity class be selected in each case.

Example: At an ambient temperature of X °C, an operating temperature of 60 °C is set in the circuit. In the optimum operating viscosity range ($\nu_{opt.}$, shaded area), this corresponds to the viscosity classes VG 46 or VG 68; to be selected: VG 68.

Note
The case drain temperature, which is affected by pressure and speed, can be higher than the circuit temperature or reservoir temperature. At no point of the component may the temperature be higher than 115 °C. The temperature difference specified below is to be taken into account when determining the viscosity in the bearing.

If the above conditions cannot be maintained due to extreme operating parameters, we recommend flushing the case at port U or using a flushing and boost pressure valve (see pages 62 and 63).

2

Viscosity and temperature of hydraulic fluid

	Viscosity [mm²/s]	Temperature	Comment
Transport and storage at ambient temperature		$T_{min} \geq$ -50 °C T_{opt} = +5 °C to +20 °C	factory preservation: up to 12 months with standard, up to 24 months with long-term
(Cold) start-up[1]	ν_{max} = 1600	$T_{St} \geq$ -40 °C	t ≤ 3 min, without load (p ≤ 50 bar), n ≤ 1000 rpm
Permissible temperature difference		ΔT ≤ 25 K	between axial piston unit and hydraulic fluid
Warm-up phase	ν < 1600 to 400	T = -40 °C to -25 °C	at p ≤ 0.7 • p_{nom}, n ≤ 0.5 • n_{nom} and t ≤ 15 min
Operating phase			
Temperature difference		ΔT = approx. 12 K	between hydraulic fluid in the bearing and at port T. The bearing temperature can be reduced by flushing via port U.
Maximum temperature		115 °C	in the bearing
		103 °C	measured at port T
Continuous operation	ν = 400 to 10 ν_{opt} = 36 to 16	T = -25 °C to +90 °C	measured at port T, no restriction within the permissible data
Short-term operation	$\nu_{min} \geq 7$	T_{max} = +103 °C	measured at port T, t < 3 min, p < 0.3 • p_{nom}
FKM shaft seal[1]		T ≤ +115 °C	see page 6

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

Technical data

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.

To ensure the functional reliability of the axial piston unit, a gravimetric analysis of the hydraulic fluid is necessary to determine the amount of solid contaminant and to determine the cleanliness level according to ISO 4406. A cleanliness level of at least 20/18/15 is to be maintained.

At very high hydraulic fluid temperatures (90 °C to maximum 115 °C), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

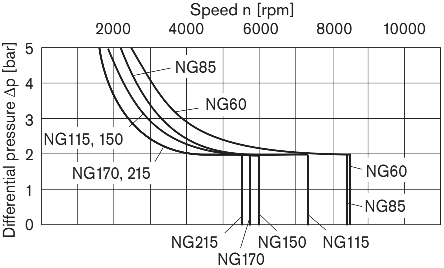
If the above classes cannot be achieved, please contact us.

Shaft seal

Permissible pressure loading

The service life of the shaft seal is influenced by the speed of the axial piston unit and the case drain pressure (case pressure). The mean differential pressure of 2 bar between the case and the ambient pressure may not be enduringly exceeded at normal operating temperature. For a higher differential pressure at reduced speed, see diagram. Momentary pressure spikes ($t < 0.1$ s) of up to 10 bar are permitted. The service life of the shaft seal decreases with an increase in the frequency of pressure spikes.

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



The values are valid for an ambient pressure $p_{abs} = 1$ bar.

Temperature range

The FKM shaft seal may be used for case drain temperatures from -25 °C to +115 °C.

Note
For application cases below -25 °C, an NBR shaft seal is required (permissible temperature range -40 °C to +90 °C). State NBR shaft seal in plain text when ordering.
Please contact us.

Influence of case pressure on beginning of control

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

HP, HA.T3 ________________ increase
DA ________________ decrease

With the following controls, an increase in the case pressure has no influence on the beginning of control:
HA.R and HA.U, EP, HA

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

Direction of flow

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

Technical data

Operating pressure range

(operating with mineral oil)

Pressure at service line port A or B

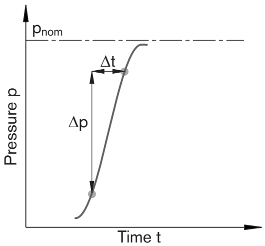
Nominal pressure p_{nom} ________________ 450 bar absolute

Maximum pressure p_{max} ________________ 500 bar absolute
Single operating period____________________________ 10 s
Total operating period ____________________________ 300 h

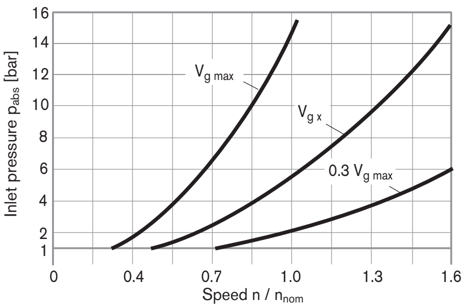
Minimum pressure (high-pressure side) ___25 bar absolute

Summation pressure (pressure A + pressure B) p_{Su} __ 700 bar

Rate of pressure change $R_{A\,max}$
with integrated pressure-relief valve____________ 9000 bar/s
without pressure-relief valve _________________ 16000 bar/s



Minimum pressure – pump mode (inlet)
To prevent damage to the axial piston motor in pump operating mode (change of high-pressure side with unchanged direction of rotation, e. g. when braking), a minimum pressure must be guaranteed at the service line port (inlet). This minimum pressure is dependent on the speed and displacement of the axial piston unit (see characteristic curve below).



This diagram is valid only for the optimum viscosity range from ν_{opt} = 36 to 16 mm²/s.
Please contact us if the above conditions cannot be satisfied.

Note
Values for other hydraulic fluids, please contact us.

Definition

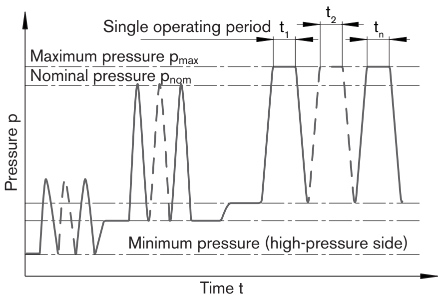
Nominal pressure p_{nom}
The nominal pressure corresponds to the maximum design pressure.

Maximum pressure p_{max}
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.

Minimum pressure (high-pressure side)
Minimum pressure at the high-pressure side (A or B) which is required in order to prevent damage to the axial piston unit.

Summation pressure p_{Su}
The summation pressure is the sum of the pressures at both service line ports (A and B).

Rate of pressure change R_A
Maximum permissible rate of pressure rise and reduction during a pressure change over the entire pressure range.



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

2

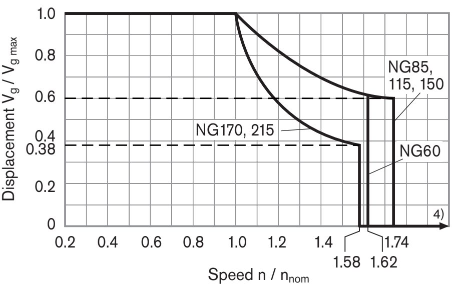
Technical data

Table of values (theoretical values, without efficiency and tolerances; values rounded)

Nenngröße	NG		60	85	115	150	170	215
Displacement geometric, per revolution	$V_{g\,max}$	cm³	62.0	85.2	115.6	152.1	171.8	216.5
	$V_{g\,min}$	cm³	0	0	0	0	0	0
	$V_{g\,x}$	cm³	37	51	69	91	65	82
Speed maximum[1] (while adhering to the maximum permissible input flow)								
at $V_{g\,max}$	n_{nom}	rpm	4450	3900	3550	3250	3100	2900
at $V_g < V_{g\,x}$ (see diagram below)	n_{max}	rpm	7200	6800	6150	5600	4900	4600
at $V_{g\,0}$	n_{max}	rpm	8400	8350	7350	6000	5750	5500
Input flow[2]								
at n_{nom} and $V_{g\,max}$	$q_{V\,max}$	L/min	276	332	410	494	533	628
Torque[3]								
at $V_{g\,max}$ and $\Delta p = 450$ bar	T	Nm	444	610	828	1089	1230	1550
Rotary stiffness								
$V_{g\,max}$ to $V_g/2$	c_{min}	kNm/rad	15	22	37	44	52	70
$V_g/2$ to 0 (interpolated)	c_{max}	kNm/rad	45	68	104	124	156	196
Moment of inertia for rotary group	J_{GR}	kgm²	0.0043	0.0072	0.0110	0.0181	0.0213	0.0303
Maximum angular acceleration	α	rad/s²	21000	17500	15500	11000	11000	10000
Case volume	V	L	0.8	1.0	1.5	1.7	2.3	2.8
Weight (approx.)	m	kg	28	36	46	61	62	78

Note
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, with respect to speed variation, reduced angular acceleration as a function of the frequency and the permissible start up angular acceleration (lower than the maximum angular acceleration) can be found in data sheet RE 90261.

Permissible displacement in relation to speed



1) The values are valid:
- for the optimum viscosity range from $\nu_{opt} = 36$ to 16 mm²/s
- with hydraulic fluid based on mineral oils

2) Restriction of input flow with counterbalance valve, see page 65

3) Torque without radial force, with radial force see page 10

4) Values in this range on request

Determining the operating characteristics

Input flow $$q_v = \frac{V_g \cdot n}{1000 \cdot \eta_v}$$ [L/min]

Speed $$n = \frac{q_V \cdot 1000 \cdot \eta_v}{V_g}$$ [min⁻¹]

Torque $$T = \frac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$$ [Nm]

Power $$P = \frac{2\,\pi \cdot T \cdot n}{60000} = \frac{q_v \cdot \Delta p \cdot \eta_t}{600}$$ [kW]

V_g = Displacement per revolution in cm³
Δp = Differential pressure in bar
n = Speed in rpm
η_v = Volumetric efficiency
η_{mh} = Mechanical-hydraulic efficiency
η_t = Total efficiency ($\eta_t = \eta_v \cdot \eta_{mh}$)

Technical data

Permissible radial and axial forces of the drive shafts

Size		NG	60	85	115	150	150	170	215
Drive shaft		in	1 1/4	1 1/2	1 3/4	1 3/4	2	2	2
Maximum radial force[1)] at distance a (from shaft collar)	$F_{q\,max}$	N	7620	12463	14902	15948	17424	19370	22602
	a	mm	24.0	27.0	33.5	33.5	33.5	33.5	33.5
with permissible torque	T_{max}	Nm	310	595	828	890	1089	1230	1445
≙ permissible pressure Δp at $V_{g\,max}$	$p_{nom\,perm.}$	bar	315	440	450	370	450	450	420
Maximum axial force[2)]	$+F_{ax\,max}$	N	0	0	0	0	0	0	0
	$-F_{ax\,max}$	N	500	710	900	1030	1030	1120	1250
Permissible axial force per bar operating pressure	$+F_{ax\,perm./bar}$	N/bar	7.5	9.6	11.3	13.3	13.3	15.1	17.0

Size		NG	60	85	115	150		170	215
Drive shaft		mm	W35	W40	W40	W45		W45	W50
Maximum radial force[1)] at distance a (from shaft collar)	$F_{q\,max}$	N	10266	12323	16727	19534		21220	25016
	a	mm	20.0	22.5	22.5	25.0		25.0	27.5
Permissible nominal pressure at $V_{g\,max}$	$p_{nom\,perm.}$	bar	450	450	450	450		440	450
Permissible torque	T_{max}	Nm	444	610	828	1089		1200	1550
Maximum axial force[2)]	$+F_{ax\,max}$	N	0	0	0	0		0	0
	$-F_{ax\,max}$	N	500	710	900	1030		1120	1250
Permissible axial force per bar operating pressure	$+F_{ax\,perm./bar}$	N/bar	7.5	9.6	11.3	13.3		15.1	17.0

1) With intermittent operation.
2) Maximum permissible axial force during standstill or when the axial piston unit is operating in non-pressurized condition.

2

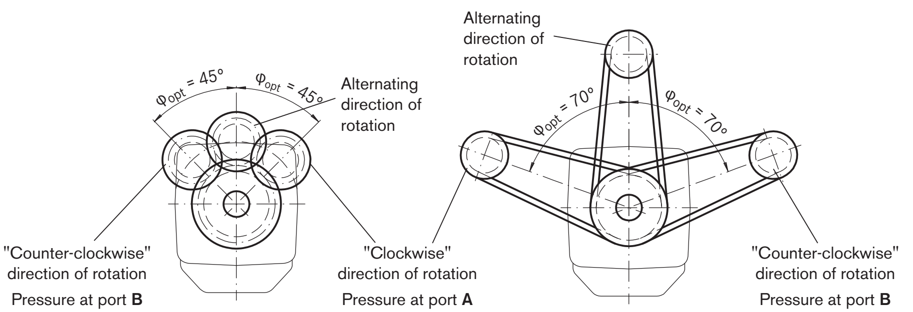
Note
Influence of the direction of the permissible axial force:

$+F_{ax\,max}$ = Increase in service life of bearings
$-F_{ax\,max}$ = Reduction in service life of bearings (avoid)

Effect of radial force F_q on the service life of bearings

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

Toothed gear drive **V-belt drive**



HP – Proportional control hydraulic

The proportional hydraulic control provides infinite setting of the displacement, proportional to the pilot pressure applied to port X.

HP1, HP2 positive control

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

HP5, HP6 negative control

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

Note

- Maximum permissible pilot pressure: p_{St} = 100 bar
- The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
  Please note that pressures up to 500 bar can occur at port G.
- Please state the desired beginning of control in plain text when ordering, e. g.: beginning of control at 10 bar.
- The beginning of control and the HP characteristic are influenced by the case pressure. An increase in the case pressure causes an increase in the beginning of control (see page 6) and thus a parallel shift of the characteristic.

HP1, HP5 pilot pressure increase Δp_{St} = 10 bar

HP1 positive control

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

HP5 negative control

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

Beginning of control, setting range ______________2 to 20 bar

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

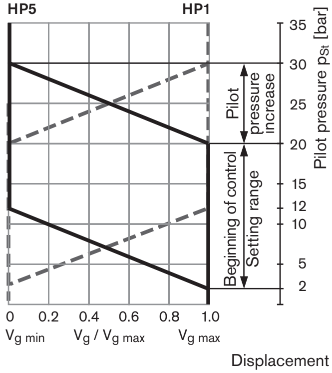
Note

The spring return feature in the control part is not a safety device

The control part can stick in an undefined position by internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the control will no longer respond correctly to the operator's commands.

Check whether the application on your machine requires additional safety measures, in order to bring the driven actuator into a controlled and safe position (immediate stop). If necessary, make sure these are properly implemented.

Characteristic



HP2, HP6 pilot pressure increase Δp_{St} = 25 bar

HP2 positive control

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

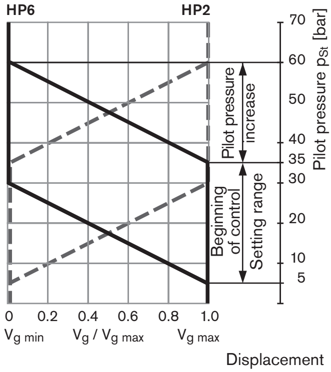
HP6 negative control

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

Beginning of control, setting range ______________5 to 35 bar

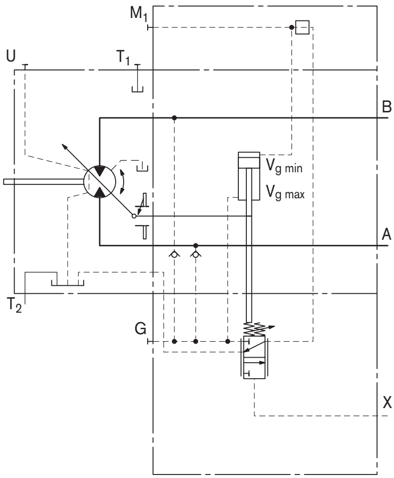
Standard setting:
Beginning of control at 10 bar (end of control at 35 bar)

Characteristic

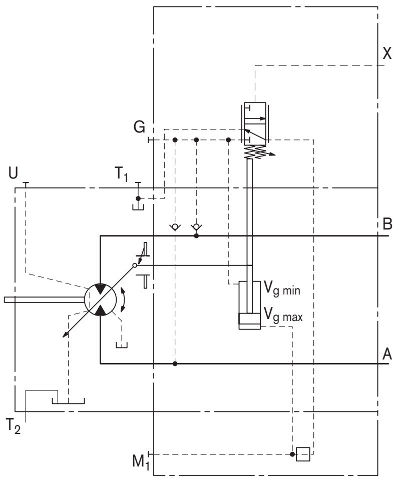


HP – Proportional control hydraulic

Schematic HP1, HP2: positive control



Schematic HP5, HP6: negative control



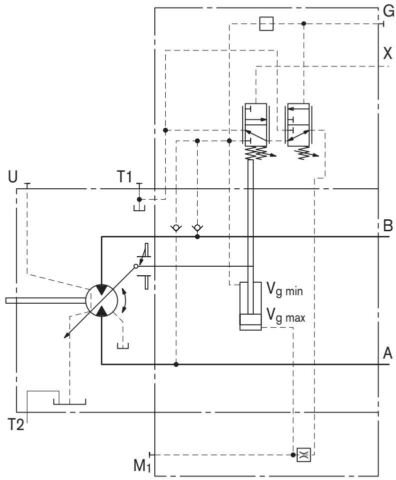
HP5D1, HP6D1
Pressure control, fixed setting

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

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

Setting range of the pressure control valve_____ 80 to 450 bar

Schematic HP5D1, HP6D1: negative control



EP – Proportional control electric

The proportional electric control provides infinite setting of the displacement, proportional to the control current applied to the solenoid.

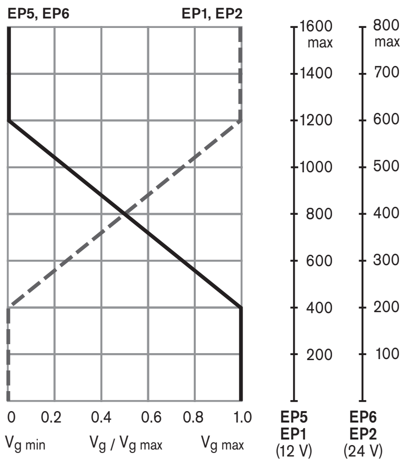
EP1, EP2 positive control

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

EP5, EP6 negative control

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

Characteristic



Note

The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
Please note that pressures up to 500 bar can occur at port G.

Technical data, solenoid

	EP1, EP5	EP2, EP6
Voltage	12 V (±20 %)	24 V (±20 %)
Control current		
Beginning of control	400 mA	200 mA
End of control	1200 mA	600 mA
Limiting current	1.54 A	0.77 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 design page 61		

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

- BODAS controller RC
  Series 20 ______ RE 95200
  Series 21 ______ RE 95201
  Series 22 ______ RE 95202
  Series 30 ______ RE 95203, RE 95204
  and application software
- Analog amplifier RA ______ RE 95230
- Electric amplifier VT 2000, series 5X (see RE 29904) (for stationary application)

Further information can also be found on the Internet at www.boschrexroth.com/mobile-electronics

Note

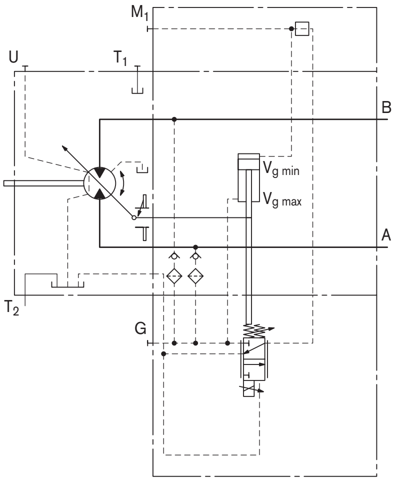
The spring return feature in the control part is not a safety device

The control part can stick in an undefined position by internal contamination (contaminated hydraulic fluid, abrasion or residual contamination from system components). As a result, the control will no longer respond correctly to the operator's commands.

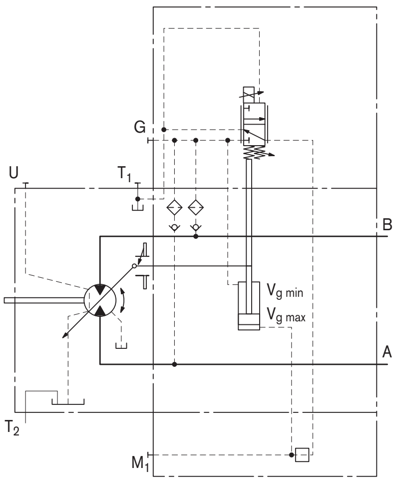
Check whether the application on your machine requires additional safety measures, in order to bring the driven actuator into a controlled and safe position (immediate stop). If necessary, make sure these are properly implemented.

EP – Proportional control electric

Schematic EP1, EP2: positive control



Schematic EP5, EP6: negative control



EP – Proportional control electric

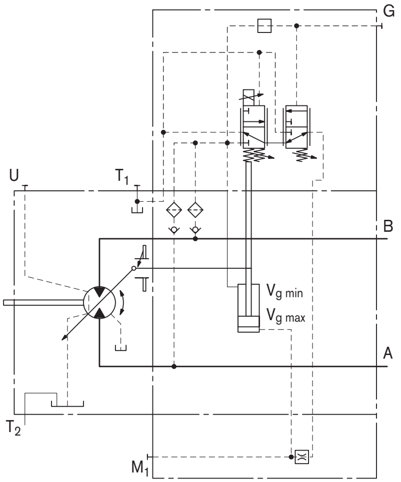
EP5**D1**, EP6**D1**
Pressure control, fixed setting

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

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

Setting range of the pressure control valve ____ 80 to 450 bar

Schematic EP5D1, EP6D1: negative control



HZ – Two-point control hydraulic

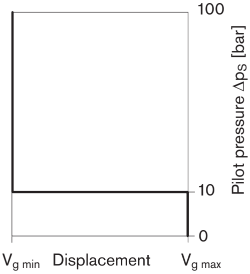
The two-point hydraulic control allows the displacement to be set to either $V_{g\,min}$ or $V_{g\,max}$ by switching the pilot pressure at port X on or off.

HZ5, HZ7 negative control

– Position at $V_{g\,max}$ (without pilot pressure, maximum torque, minimum speed)

– Position at $V_{g\,min}$ (with pilot pressure > 10 bar activated, minimum torque, maximum permissible speed)

Characteristic HZ5, HZ7



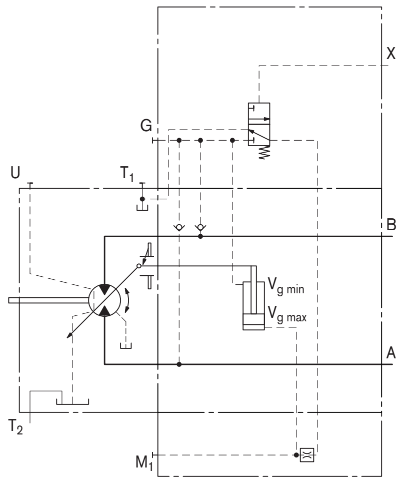
Note

– Maximum permissible pilot pressure: 100 bar

– The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
Please note that pressures up to 500 bar can occur at port G.

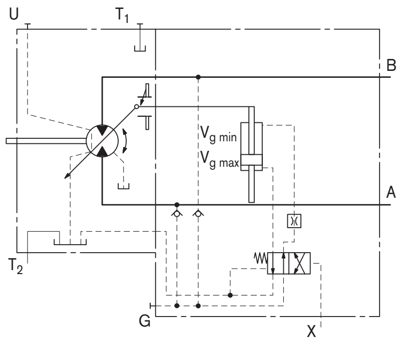
Schematic HZ5: negative control

Sizes 150 to 215



Schematic HZ7: negative control

Sizes 60 to 115



EZ – Two-point control electric

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

Note

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

Please note that pressures up to 500 bar can occur at port G.

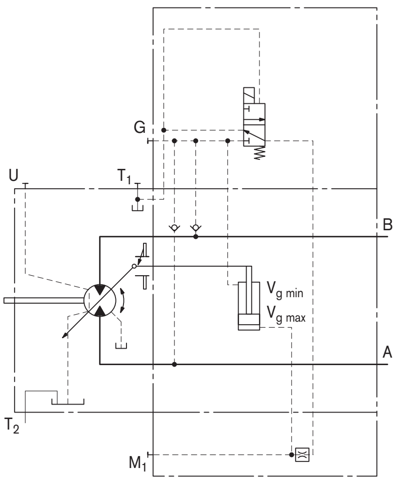
Technical data, solenoid with Ø37

Sizes 150 to 215

	EZ5	EZ6
Voltage	12 V (±20 %)	24 V (±20 %)
Displacement $V_{g\,max}$	de-energized	de-energized
Displacement $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum required current	1.32 A	0.67 A
Duty cycle	100 %	100 %
Type of protection see connector design page 61		

Schematic EZ5, EZ6: negative control

Sizes 150 to 215



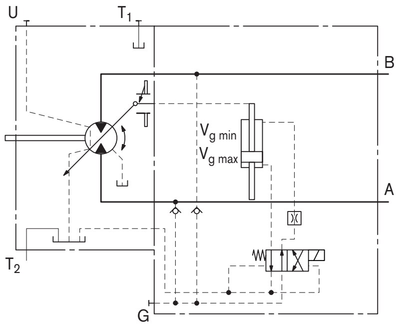
Technical data, solenoid with Ø45

Sizes 60 to 115

	EZ7	EZ8
Voltage	12 V (±20 %)	24 V (±20 %)
Displacement $V_{g\,max}$	de-energized	de-energized
Displacement $V_{g\,min}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 61		

Schematic EZ7, EZ8: negative control

Sizes 60 to 115



HA – Automatic control high-pressure related

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

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

HA1, HA2 positive control

– Beginning of control at $V_{g\,min}$ (minimum torque, maximum speed)

– End of control at $V_{g\,max}$ (maximum torque, minimum speed)

Note

– For safety reasons, winch drives are not permissible with beginning of control at $V_{g\,min}$ (standard for HA).

– The control oil is internally taken out of the high-pressure side of the motor (A or B). For reliable control, an operating pressure of at least 30 bar is required in A (B). If a control operation is performed at an operating pressure < 30 bar, an auxiliary pressure of at least 30 bar must be applied at port G via an external check valve. For lower pressures, please contact us.
Please note that pressures up to 500 bar can occur at port G.

– The beginning of control and the HA.T3 characteristic are influenced by case pressure. An increase in case pressure causes an increase in the beginning of control (see page 6) and thus a parallel shift of the characteristic.

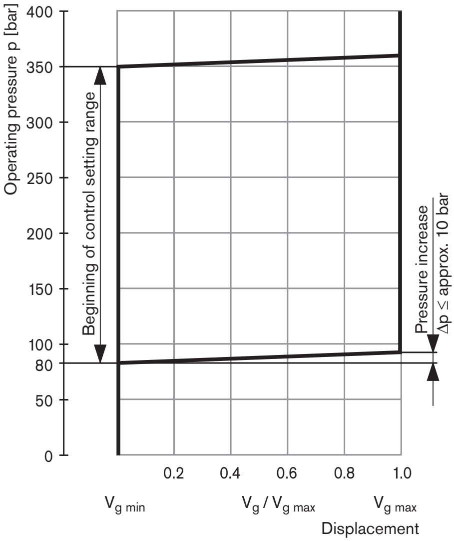
HA1
With minimum pressure increase, positive control

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

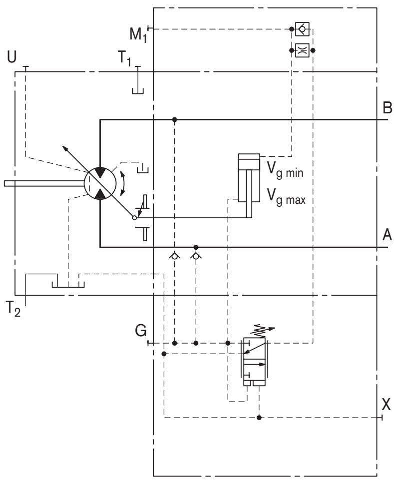
Beginning of control, setting range __________ 80 to 350 bar

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

Characteristic HA1



Schematic HA1



HA – Automatic control high-pressure related

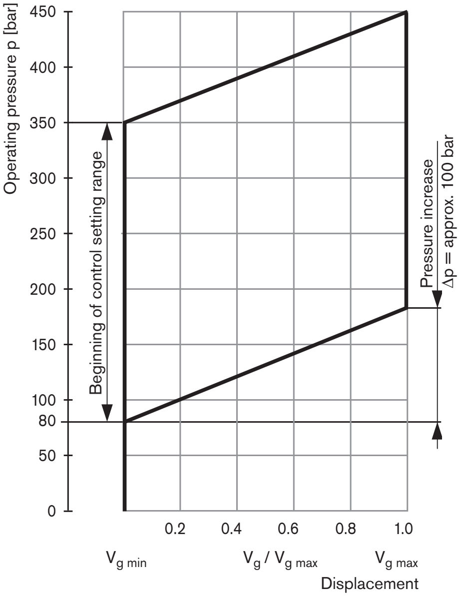
HA2
With pressure increase, positive control

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

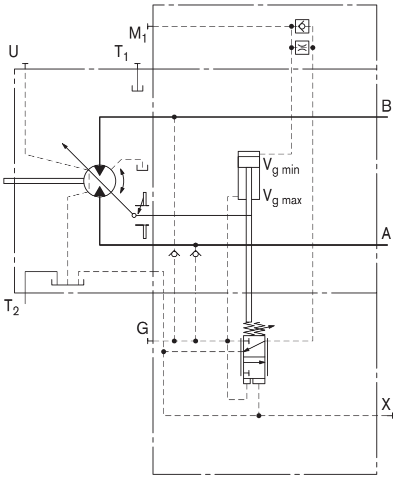
Beginning of control, setting range ___________ 80 to 350 bar

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

Characteristic HA2



Schematic HA2



HA – Automatic control high-pressure related

HA.T3
Override hydraulic remote control, proportional

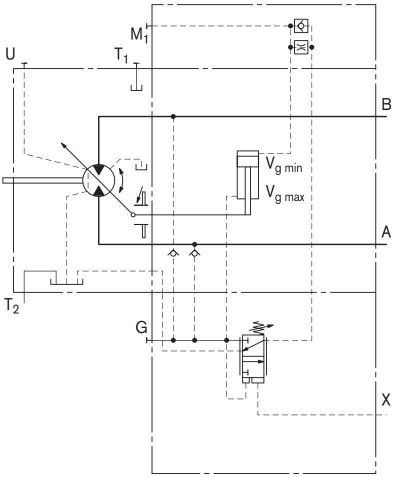
With the HA.T3 control, the beginning of control can be influenced by applying a pilot pressure to port X.

For each 1 bar of pilot pressure increase, the beginning of control is reduced by 17 bar.

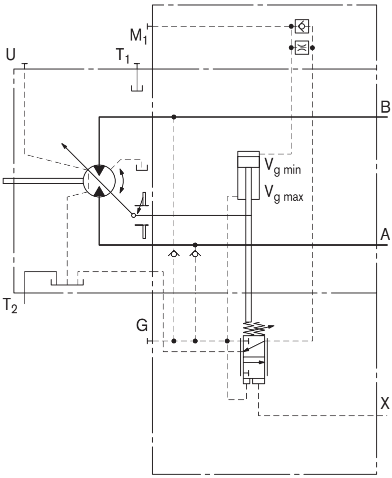
Beginning of control setting	300 bar	300 bar
Pilot pressure at port X	0 bar	10 bar
Beginning of control at	300 bar	130 bar

Note
Maximum permissible pilot pressure 100 bar.

Schematic HA1.T3



Schematic HA2.T3



HA – Automatic control high-pressure related

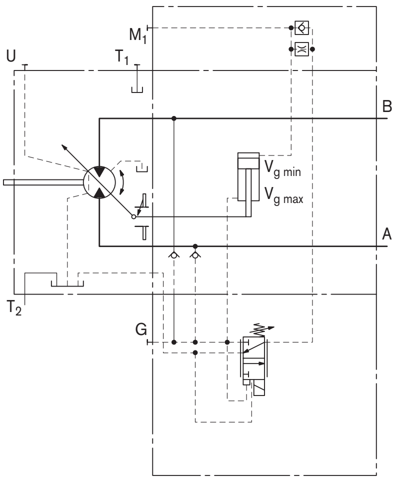
HA.**U1**, HA.**U2**
Override electric, two-point

With the HA.U1 or HA.U2 control, the beginning of control can be overridden by an electric signal to a switching solenoid. When the override solenoid is energized, the variable motor swivels to maximum swivel angle, without intermediate position. The beginning of control is adjustable between 80 and 300 bar (specify required setting in plain text when ordering).

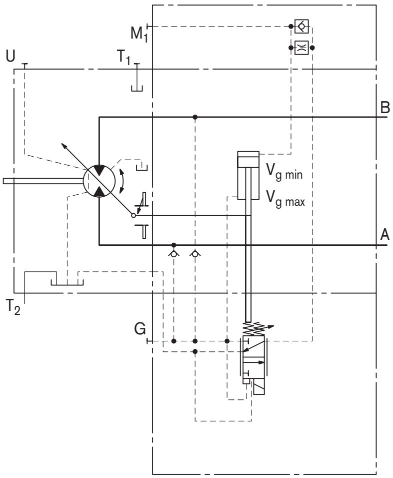
Technical data, solenoid with Ø45

	U1	U2
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30 W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 61		

Schematic HA1U1, HA1U2



Schematic HA2U1, HA2U2



HA – Automatic control high-pressure related

HA.**R1**, HA.**R2**
Override electric,
travel direction valve electric (see page 24)

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

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

Depending on the direction of rotation (direction of travel), the travel direction valve is actuated through the pressure spring or the switching solenoid a (see page 24 for further details).

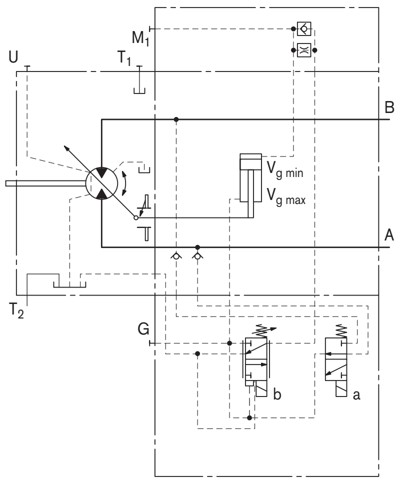
Technical data, solenoid a with Ø37
(travel direction valve)

		R1	R2
Voltage		12 V (±20 %)	24 V (±20 %)
No override		de-energized	de-energized
Direction of rotation	Operating pressure in		
ccw	B	energized	energized
cw	A	de-energized	de-energized
Nominal resistance (at 20 °C)		5.5 Ω	21.7 Ω
Nominal power		26.2 W	26.5 W
Minimum required current		1.32 A	0.67 A
Duty cycle		100 %	100 %
Type of protection see connector design page 61			

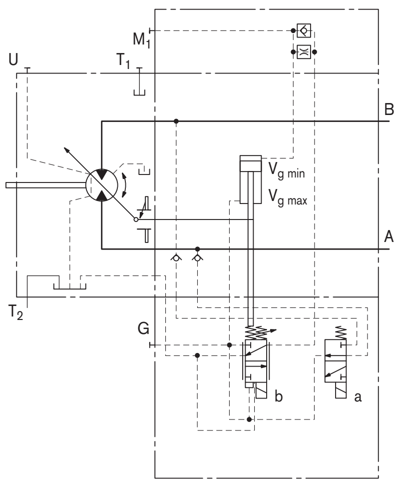
Technical data, solenoid b with Ø45
(electric override)

	R1	R2
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	4.8 Ω	19.2 Ω
Nominal power	30 W	30 W
Minimum required current	1.5 A	0.75 A
Duty cycle	100 %	100 %
Type of protection see connector design page 61		

Schematic HA1R1, HA1R2



Schematic HA2R1, HA2R2



2

DA – Automatic control speed-related

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

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

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

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

Pressure ratio p_{St}/p_{HD} ____________ 5/100

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

Detailed information is available from our sales department and on the Internet at www.boschrexroth.com/da-control.

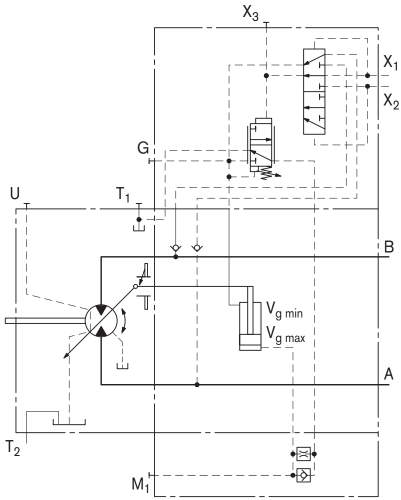
Note
The beginning of control and the DA characteristic are influenced by case pressure. An increase in case pressure causes a decrease in the beginning of control (see page 6) and thus a parallel shift of the characteristic.

DA0
Hydraulic travel direction valve, negative control

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

Direction of rotation	Operating pressure in	Pilot pressure in
cw	A	X_1
ccw	B	X_2

Schematic DA0



DA – Automatic control speed-related

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

The travel direction valve is either spring offset or switched by energizing switching solenoid a, depending on the direction of rotation (travel direction).

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

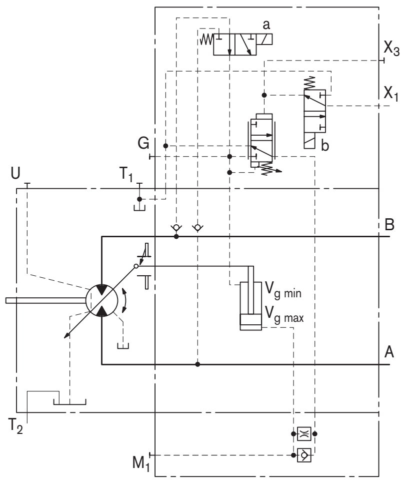
Technical data, solenoid a with Ø37
(travel direction valve)

		DA1	DA2
Voltage		12 V (±20 %)	24 V (±20 %)
Direction of rotation	Operating pressure in		
ccw	B	de-energized	de-energized
cw	A	energized	energized
Nominal resistance (at 20 °C)		5.5 Ω	21.7 Ω
Nominal power		26.2 W	26.5 W
Minimum required current		1.32 A	0.67 A
Duty cycle		100 %	100 %
Type of protection see connector design page 61			

Technical data, solenoid b with Ø37
(electric override)

	DA1	DA2
Voltage	12 V (±20 %)	24 V (±20 %)
No override	de-energized	de-energized
Displacement $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum required current	1.32 A	0.67 A
Duty cycle	100 %	100 %
Type of protection see connector design page 61		

Schematic DA1, DA2



2

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

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

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

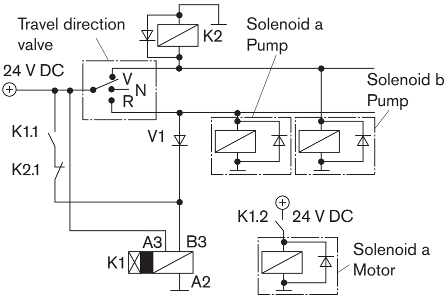
When the travel direction valve of the pump (e. g. 4/3-directional valve of the DA-control) is switched to

– the neutral position,
  the electric circuitry causes the previous signal on the travel direction valve on the motor to be retained.

– reversing,
  the electric circuitry causes the travel direction valve on the motor to switch to the other travel direction following a time delay (approx. 0.8 s) with respect to the pump.

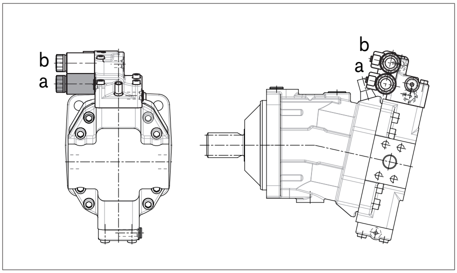
As a result, jerky deceleration or braking is prevented in both cases.

Schematic - electric travel direction valve

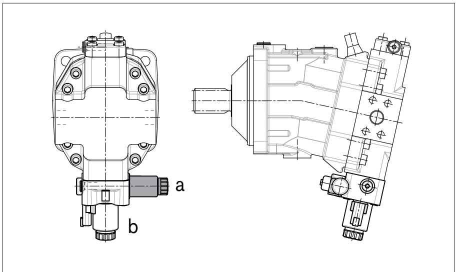


Note
The shown diodes and relays are not included in the delivery of the motor.

DA1, DA2 control (see page 23)



HA1R., HA2R. control (see page 21)



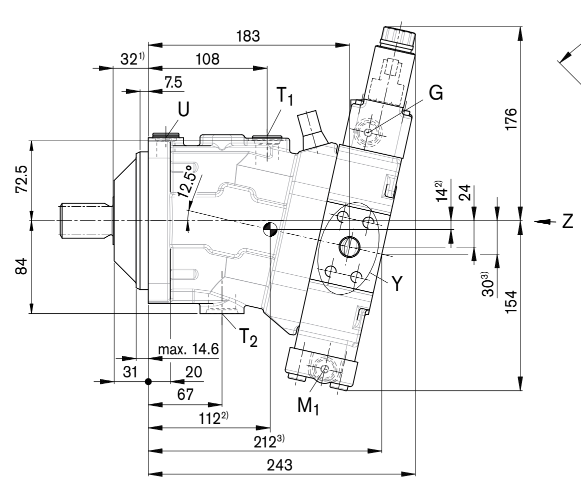
Switching solenoid a on the travel direction valve

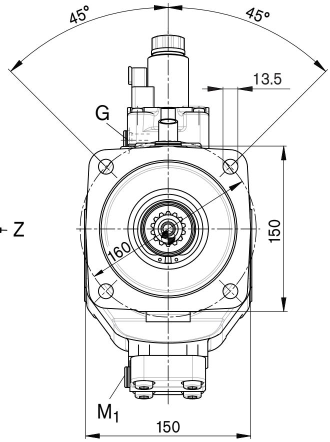
Dimensions size 60

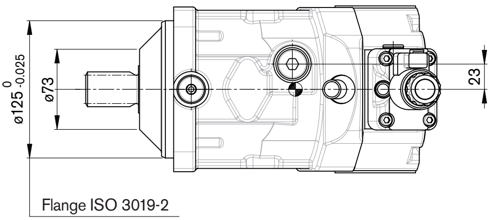
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP5, EP6 – Proportional control electric, negative control

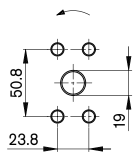
Port plate 2 – SAE flange ports A and B at side, opposite

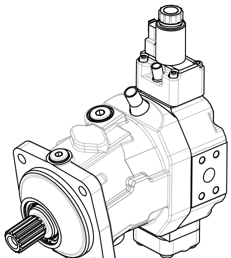






View Y





2

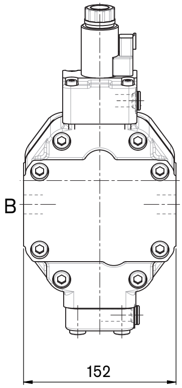
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 60

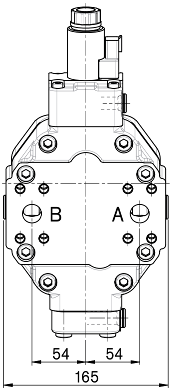
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

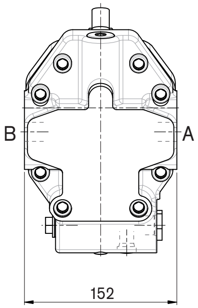
2 SAE flange ports A and B at side, opposite



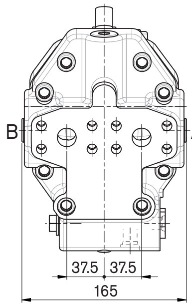
1 SAE flange ports A and B at rear



2 SAE flange ports A and B at side, opposite only HZ7, EZ7/8

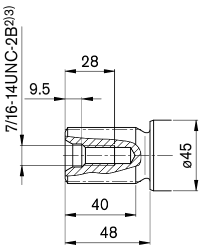


1 SAE flange ports A and B at rear only HZ7, EZ7/8

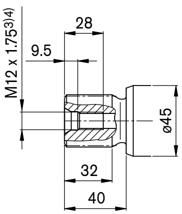


Drive shafts

S7 Splined shaft 1 1/4 in 14 T 12/24DP[1)]



Z8 Splined shaft DIN 5480 W35x2x16x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 60

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	3/4 in M10 x 1.5; 17 deep	500	O
T_1	Drain line	ISO 6149[5]	M22 x 1.5; 15.5 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M27 x 2; 19 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M18 x 1.5; 14.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X

1) Observe the general instructions on pages 72 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

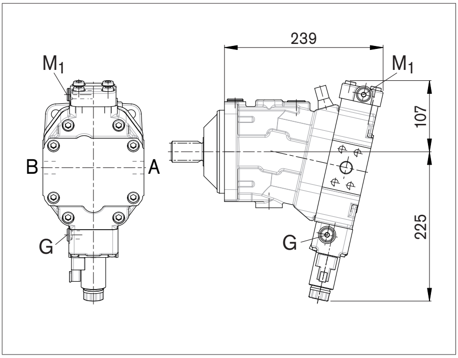
2

Dimensions size 60

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

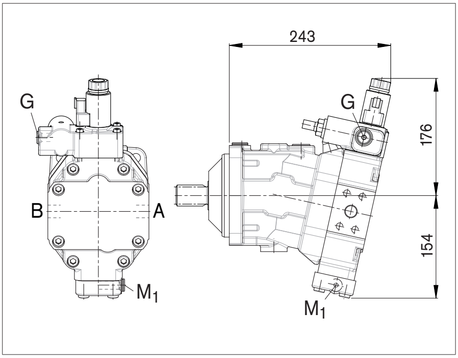
EP1, EP2

Proportional control electric, positive control



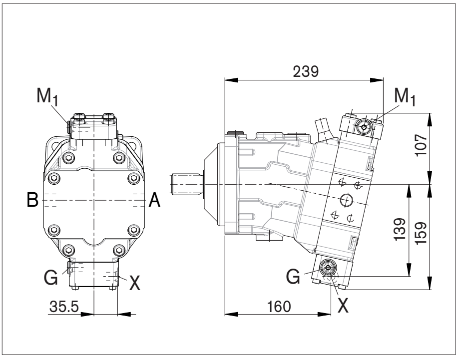
EP5D1, EP6D1

Proportional control electric, negative control, with pressure control fixed setting



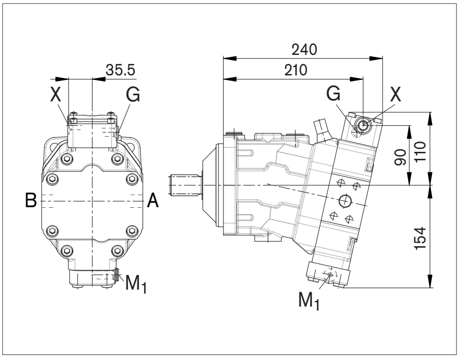
HP1, HP2

Proportional control hydraulic, positive control



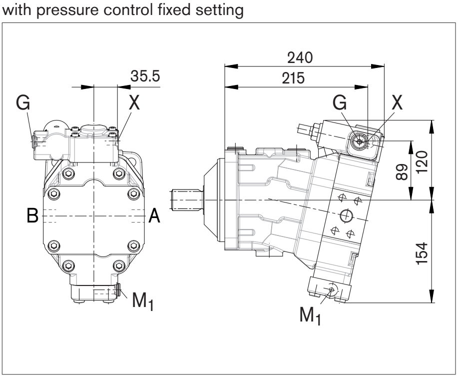
HP5, HP6

Proportional control hydraulic, negative control



HP5D1, HP6D1

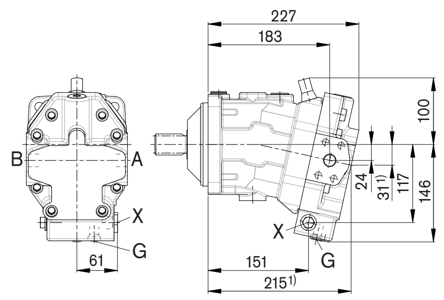
Proportional control hydraulic, negative control, with pressure control fixed setting



Dimensions size 60

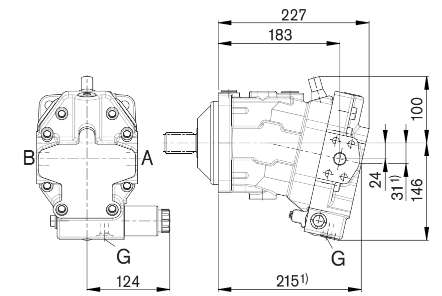
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HZ7
Two-point control hydraulic, negative control



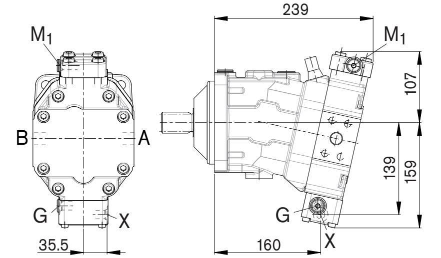
1) Port plate 1 – SAE flange ports A and B at rear

EZ7, EZ8
Two-point control electric, negative control



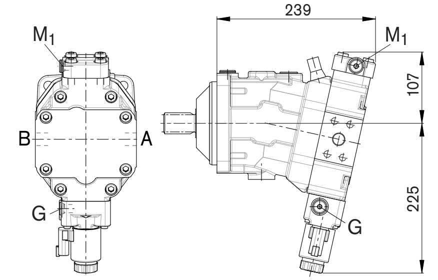
1) Port plate 1 – SAE flange ports A and B at rear

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

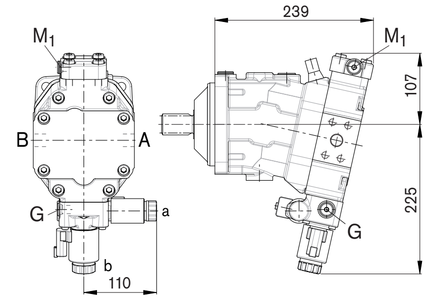


HA1 and HA2, X plugged
HA1T and HA2T, X open

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



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



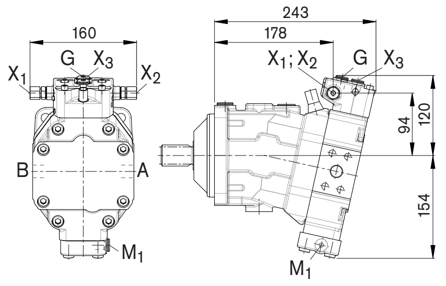
2

Dimensions size 60

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

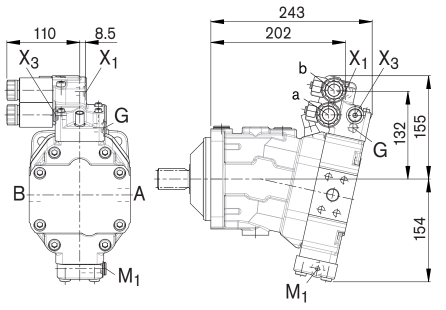
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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

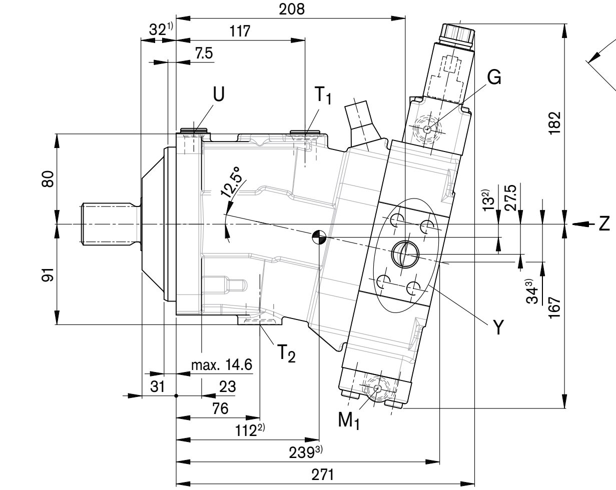


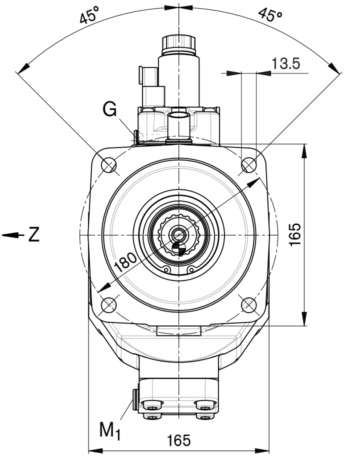
Dimensions size 85

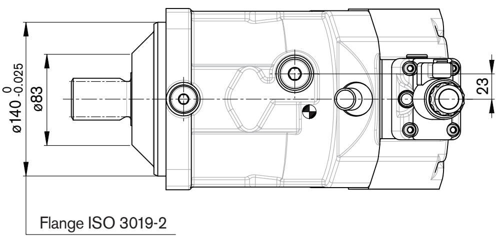
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

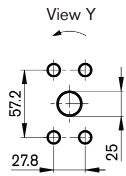
EP5, EP6 – Proportional control electric, negative control

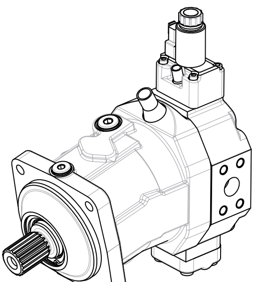
Port plate 2 – SAE flange ports A and B at side, opposite











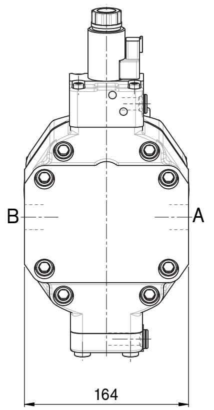
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 85

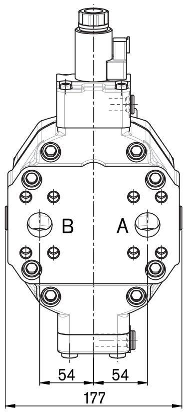
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

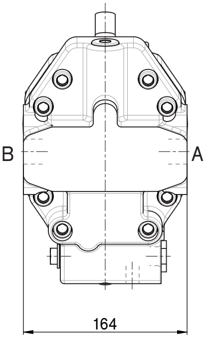
2 SAE flange ports A and B at side, opposite



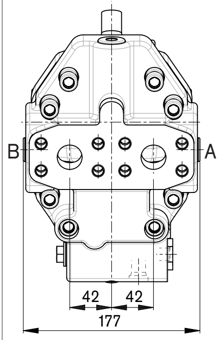
1 SAE flange ports A and B at rear



2 SAE flange ports A and B at side, opposite only HZ7, EZ7/8

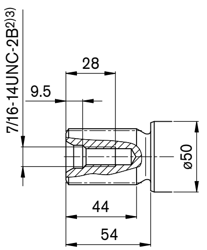


1 SAE flange ports A and B at rear only HZ7, EZ7/8

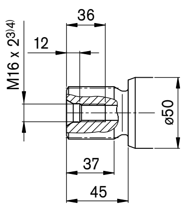


Drive shafts

S9 Splined shaft 1 1/2 in 17 T 12/24DP[1]



Z9 Splined shaft DIN 5480 W40x2x18x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 85

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	500	O
T_1	Drain line	ISO 6149[5]	M22 x 1.5; 15.5 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M27 x 2; 19 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M18 x 1.5; 14.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X

1) Observe the general instructions on pages 72 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

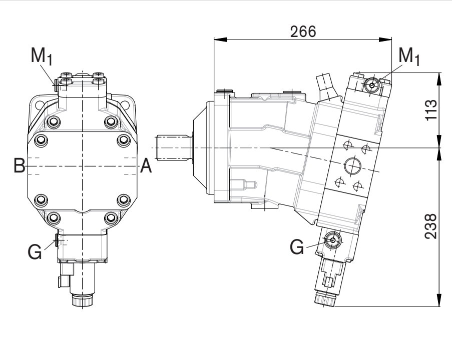
2

Dimensions size 85

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

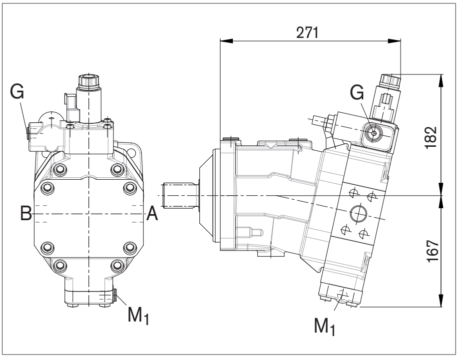
EP1, EP2

Proportional control electric, positive control



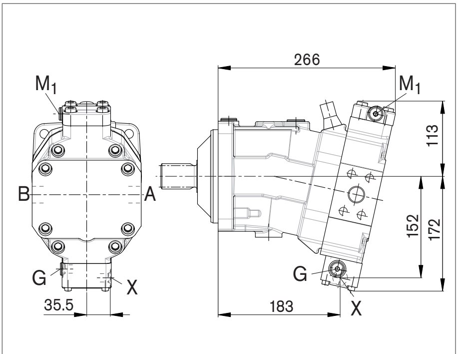
EP5D1, EP6D1

Proportional control electric, negative control, with pressure control fixed setting



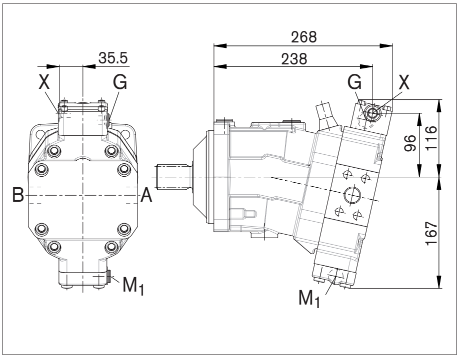
HP1, HP2

Proportional control hydraulic, positive control



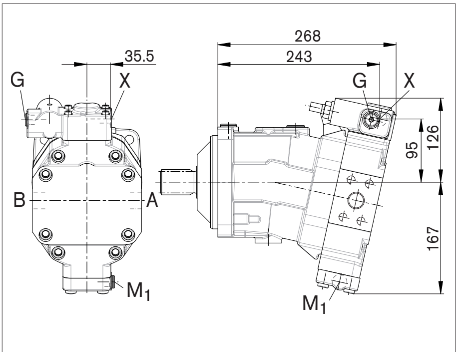
HP5, HP6

Proportional control hydraulic, negative control



HP5D1, HP6D1

Proportional control hydraulic, negative control, with pressure control fixed setting

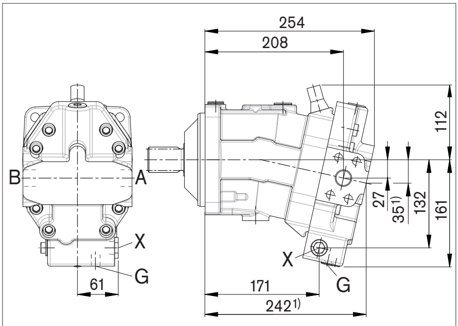


Dimensions size 85

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HZ7

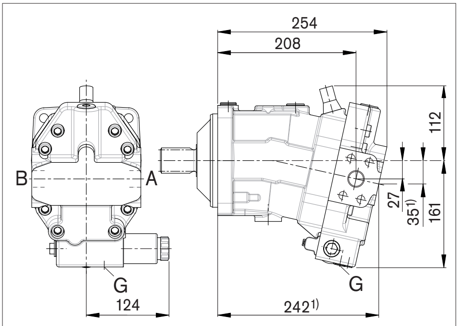
Two-point control hydraulic, negative control



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

EZ7, EZ8

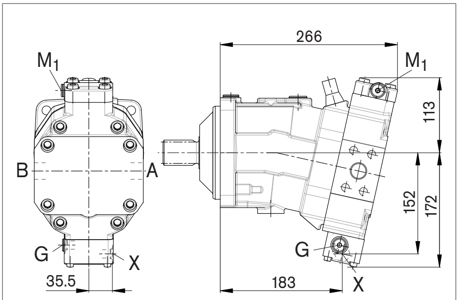
Two-point control electric, negative control



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

HA1, HA2 / HA1T3, HA2T3

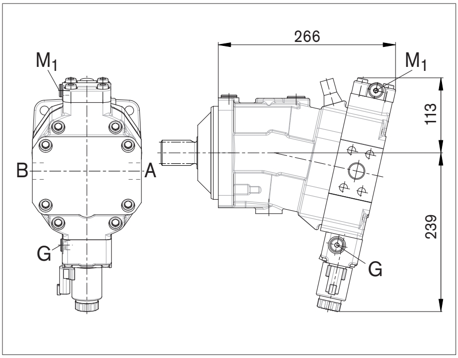
Automatic control high-pressure related, positive control, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

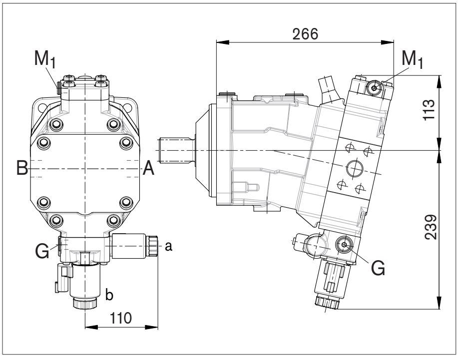
HA1U1, HA2U2

Automatic control high-pressure related, positive control, with override electric, two-point



HA1R1, HA2R2

Automatic control high-pressure related, positive control, with override electric and travel direction valve electric



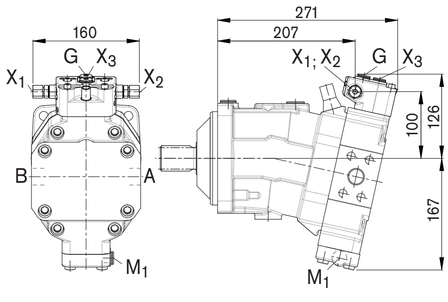
2

Dimensions size 85

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

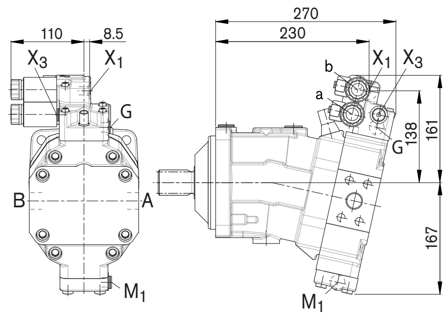
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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

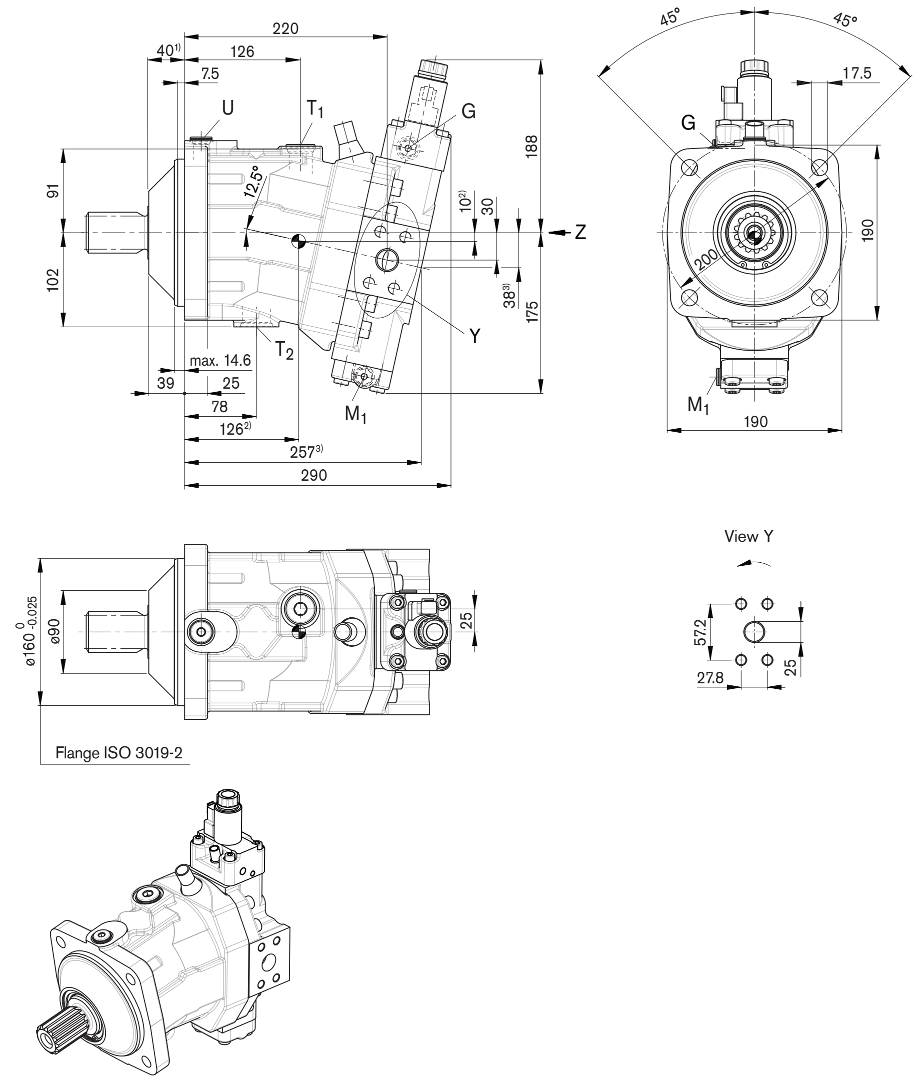


Dimensions size 115

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

EP5, EP6 – Proportional control electric, negative control

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



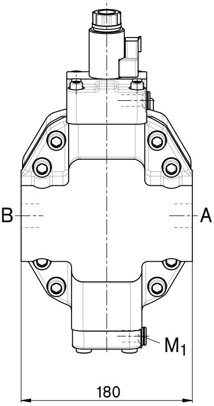
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 115

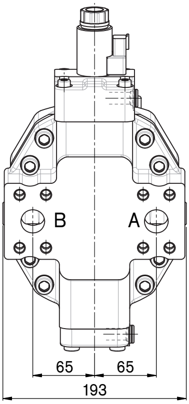
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

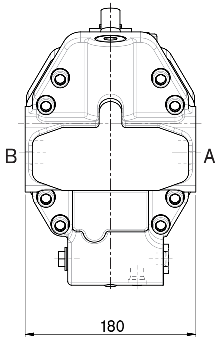
2 SAE flange ports A and B at side, opposite



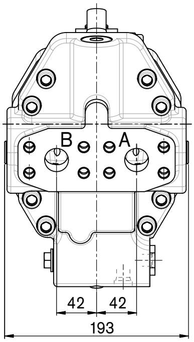
1 SAE flange ports A and B at rear



2 SAE flange ports A and B at side, opposite only HZ7, EZ7/8

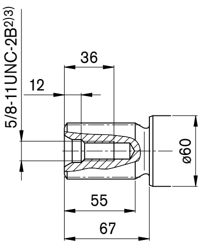


1 SAE flange ports A and B at rear only HZ7, EZ7/8

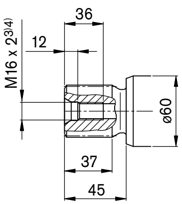


Drive shafts

T1 Splined shaft 1 3/4 in 13 T 8/16DP[1]



Z9 Splined shaft DIN 5480 W40x2x18x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 115

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 in M12 x 1.75; 17 deep	500	O
T_1	Drain line	ISO 6149[5]	M27 x 2; 19 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M33 x 2; 19 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M18 x 1.5; 14.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X

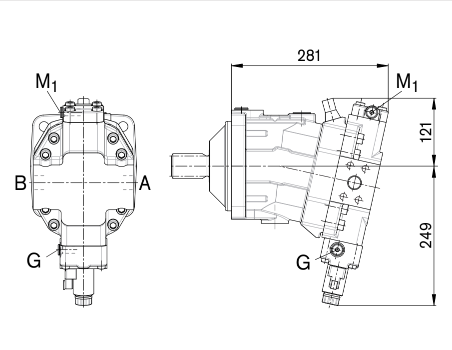
1) Observe the general instructions on pages 72 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

2

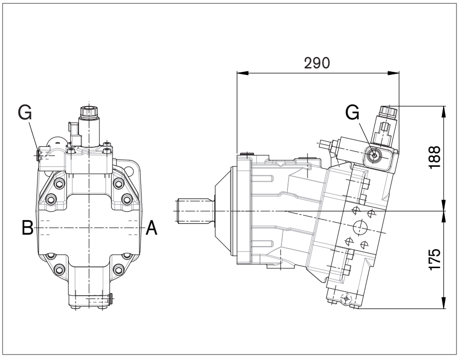
Dimensions size 115

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

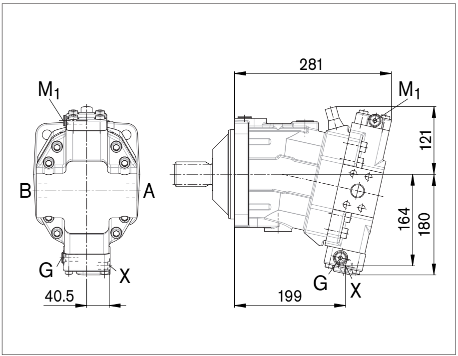
EP1, EP2
Proportional control electric, positive control



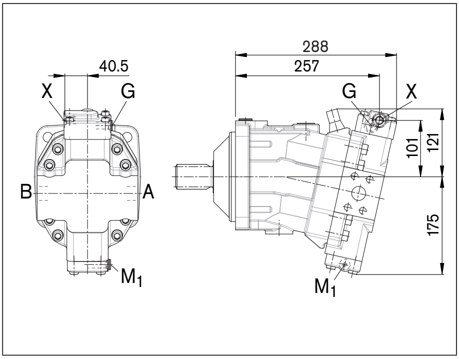
EP5D1, EP6D1
Proportional control electric, negative control, with pressure control fixed setting



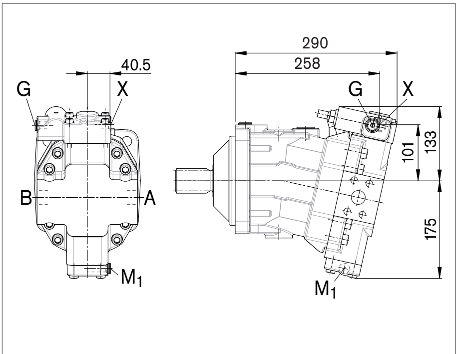
HP1, HP2
Proportional control hydraulic, positive control



HP5, HP6
Proportional control hydraulic, negative control



HP5D1, HP6D1
Proportional control hydraulic, negative control, with pressure control fixed setting

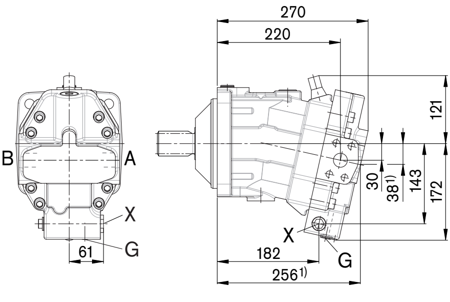


Dimensions size 115

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

HZ7

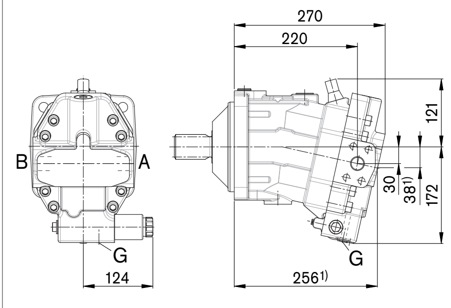
Two-point control hydraulic, negative control



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

EZ7, EZ8

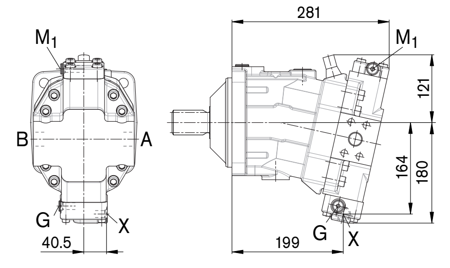
Two-point control electric, negative control



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

HA1, HA2 / HA1T3, HA2T3

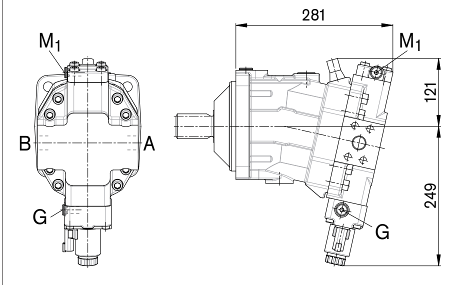
Automatic control high-pressure related, positive control, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

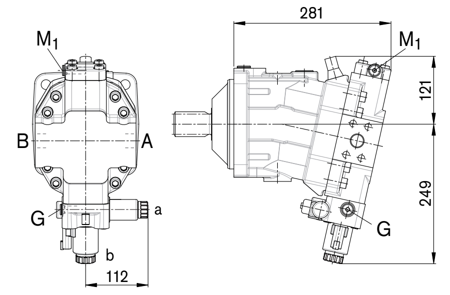
HA1U1, HA2U2

Automatic control high-pressure related, positive control, with override electric, two-point



HA1R1, HA2R2

Automatic control high-pressure related, positive control, with override electric and travel direction valve electric

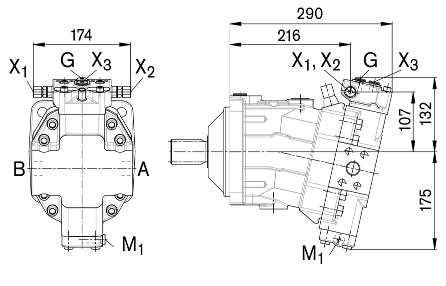


Dimensions size 115

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

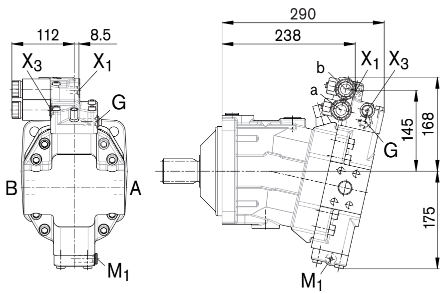
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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

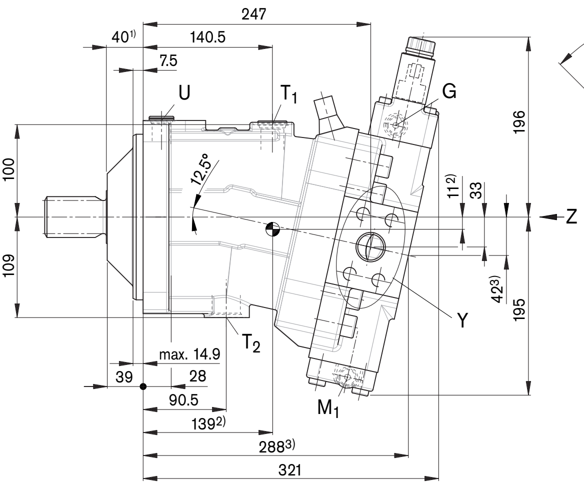


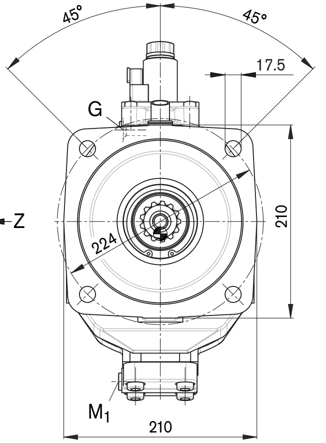
Dimensions size 150

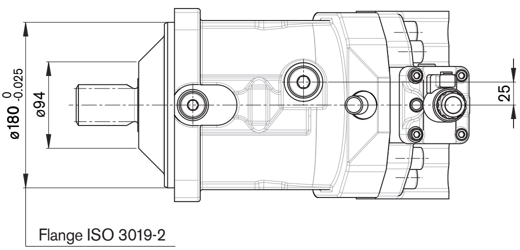
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

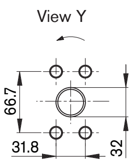
EP5, EP6 – Proportional control electric, negative control

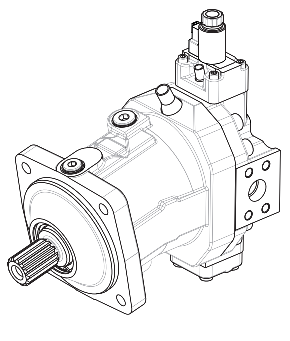
Port plate 2 – SAE flange ports A and B at side, opposite











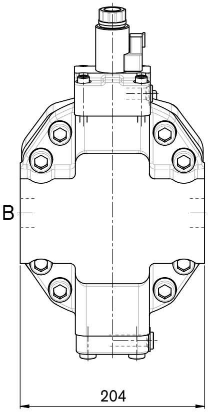
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 150

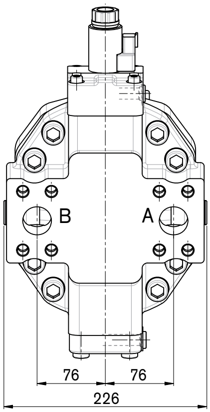
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

2 SAE flange ports A and B at side, opposite

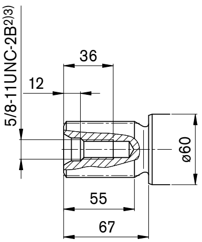


1 SAE flange ports A and B at rear

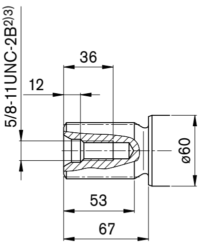


Drive shafts

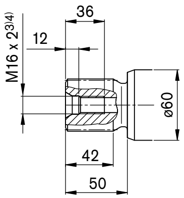
T1 Splined shaft 1 3/4 in 13 T 8/16DP[1)]



T2 Splined shaft 2 in 15 T 8/16DP[1)]



A1 Splined shaft DIN 5480 W45x2x21x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 150

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	500	O
T_1	Drain line	ISO 6149[5]	M27 x 2; 19 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M33 x 2; 19 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M22 x 1.5; 15.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x1.5; 11.5 deep	500	X

1) Observe the general instructions on pages 72 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

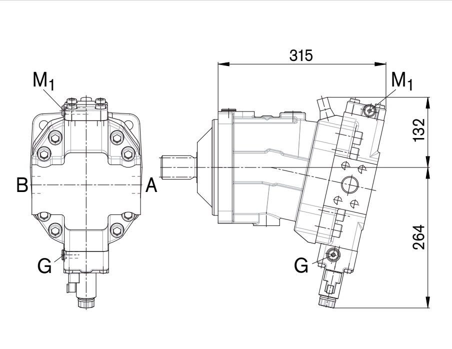
2

Dimensions size 150

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

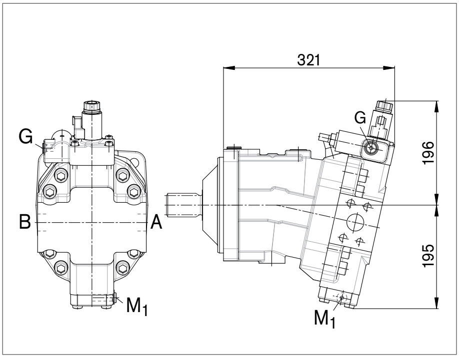
EP1, EP2

Proportional control electric, positive control



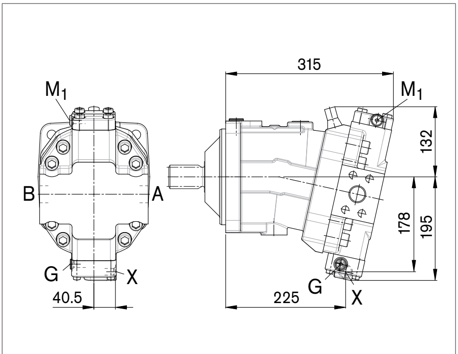
EP5D1, EP6D1

Proportional control electric, negative control, with pressure control fixed setting



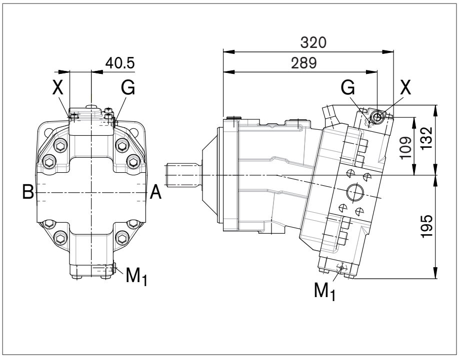
HP1, HP2

Proportional control hydraulic, positive control



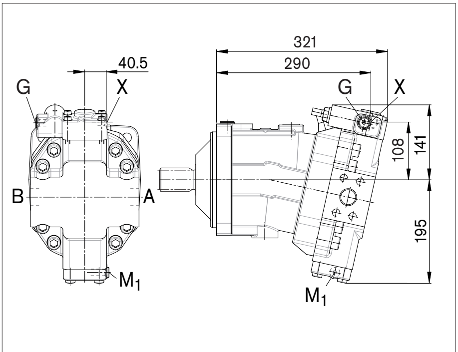
HP5, HP6

Proportional control hydraulic, negative control



HP5D1, HP6D1

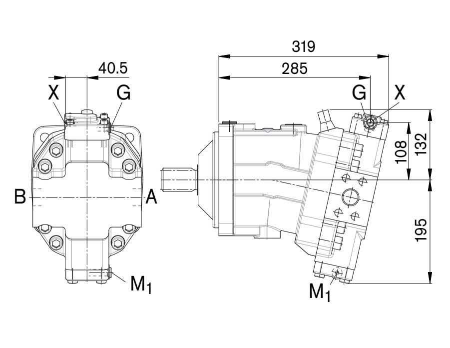
Proportional control hydraulic, negative control, with pressure control fixed setting



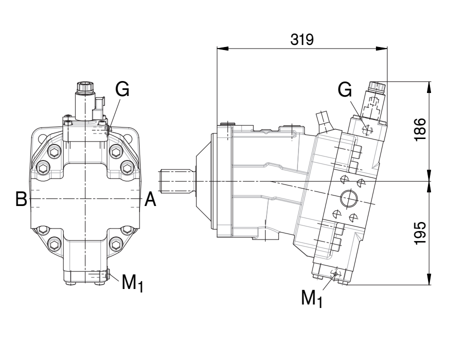
Dimensions size 150

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

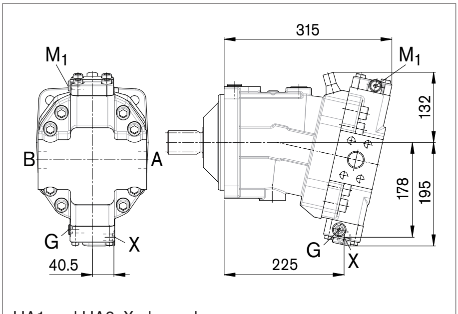
HZ5
Two-point control hydraulic, negative control



EZ5, EZ6
Two-point control electric, negative control

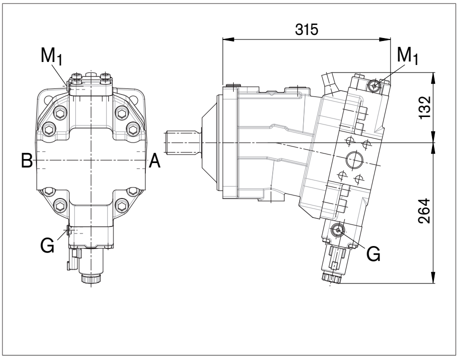


HA1, HA2 / HA1T3, HA2T3
Automatic control high-pressure related, positive control, with override hydraulic remote control, proportional

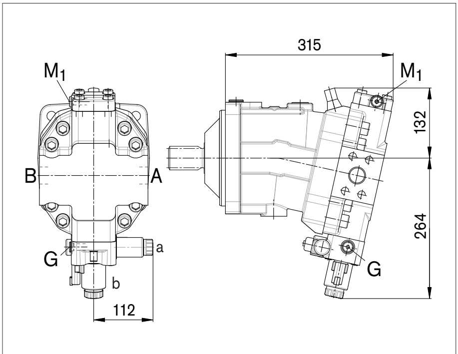


HA1 and HA2, X plugged
HA1T and HA2T, X open

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



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

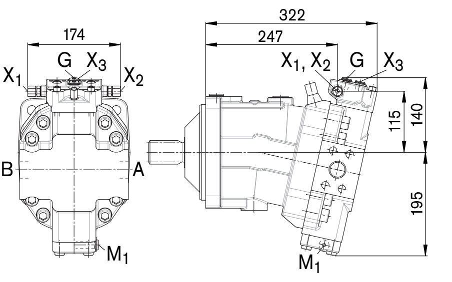


Dimensions size 150

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

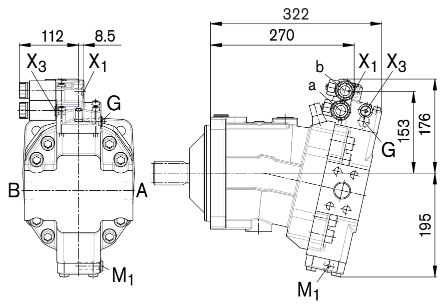
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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

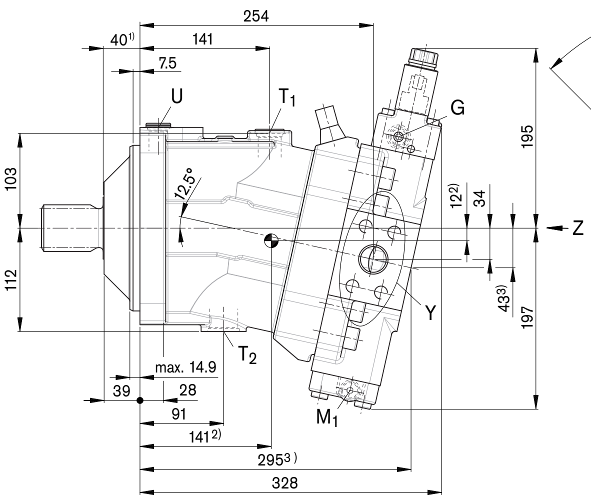


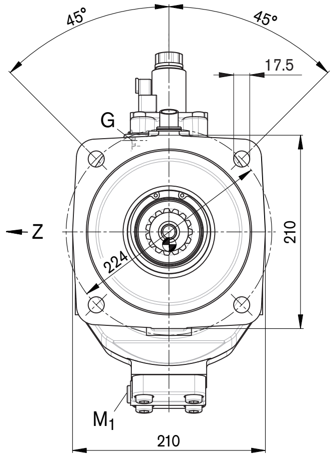
Dimensions size 170

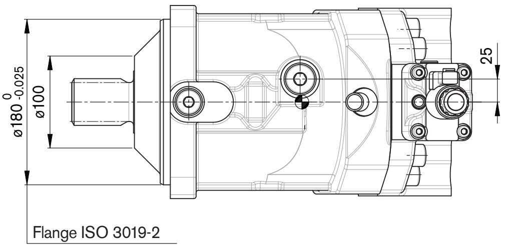
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

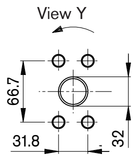
EP5, EP6 – Proportional control electric, negative control

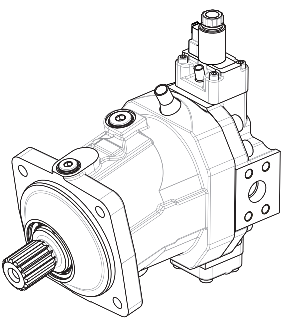
Port plate 2 – SAE flange ports A and B at side, opposite











1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

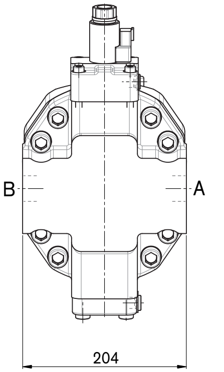
2

Dimensions size 170

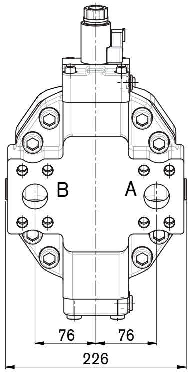
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

2 SAE flange ports A and B at side, opposite

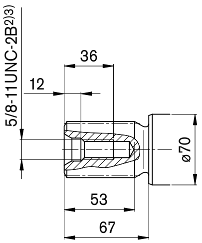


1 SAE flange ports A and B at rear

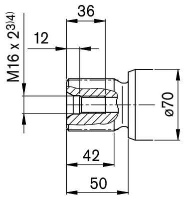


Drive shafts

T2 Splined shaft 2 in 15 T 8/16DP[1]



A1 Splined shaft DIN 5480 W45x2x21x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 170

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	500	O
T_1	Drain line	ISO 6149[5]	M27 x 2; 19 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M33 x 2; 19 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M22 x 1.5; 15.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X

1) Observe the general instructions on pages 72 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) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

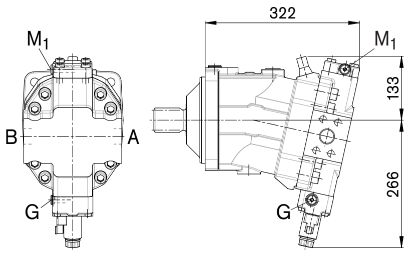
2

Dimensions size 170

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

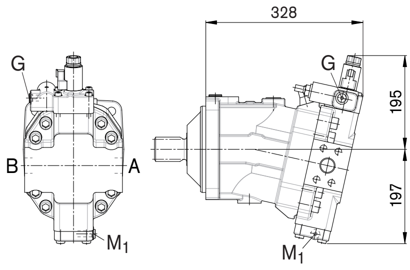
EP1, EP2

Proportional control electric, positive control



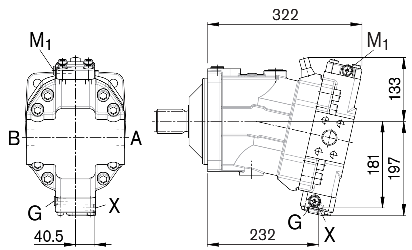
EP5D1, EP6D1

Proportional control electric, negative control, with pressure control fixed setting



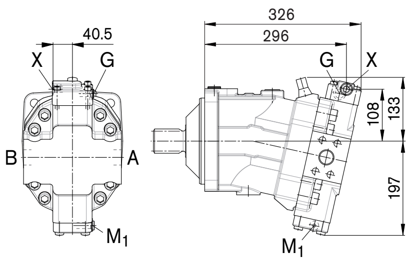
HP1, HP2

Proportional control hydraulic, positive control



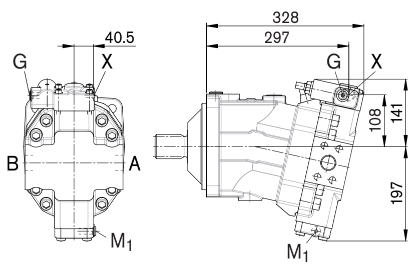
HP5, HP6

Proportional control hydraulic, negative control



HP5D1, HP6D1

Proportional control hydraulic, negative control, with pressure control fixed setting

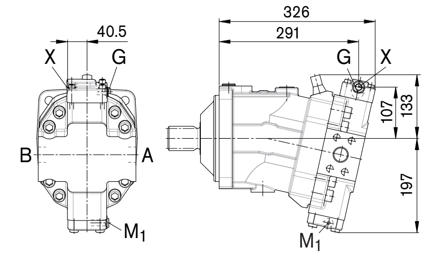


Dimensions size 170

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

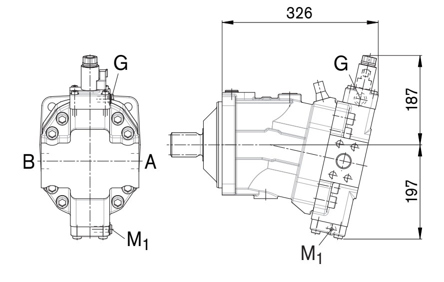
HZ5

Two-point control hydraulic, negative control



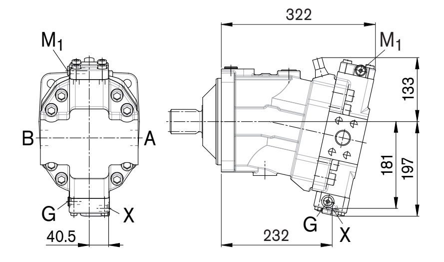
EZ5, EZ6

Two-point control electric, negative control



HA1, HA2 / HA1T3, HA2T3

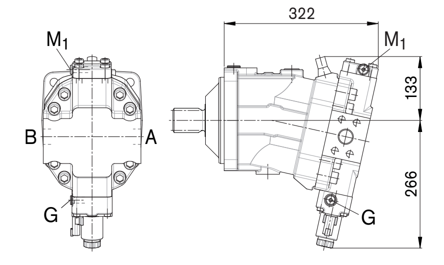
Automatic control high-pressure related, positive control, with override hydraulic remote control, proportional



HA1 and HA2, X plugged
HA1T and HA2T, X open

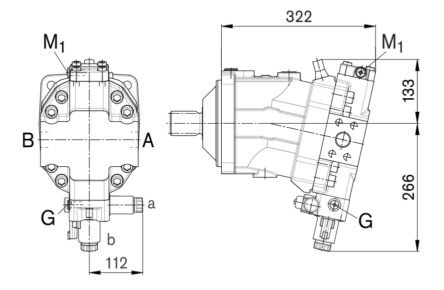
HA1U1, HA2U2

Automatic control high-pressure related, positive control, with override electric, two-point



HA1R1, HA2R2

Automatic control high-pressure related, positive control, with override electric and travel direction valve electric

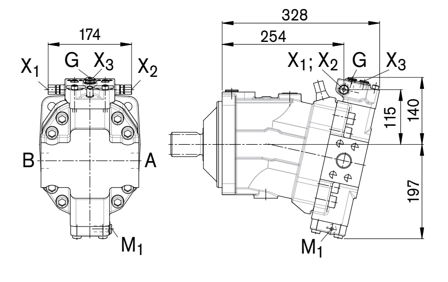


Dimensions size 170

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

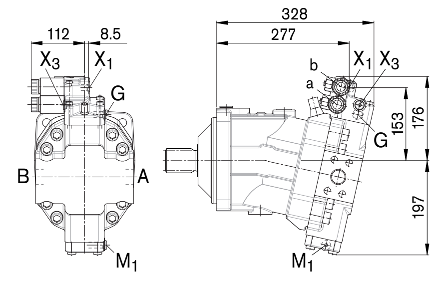
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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

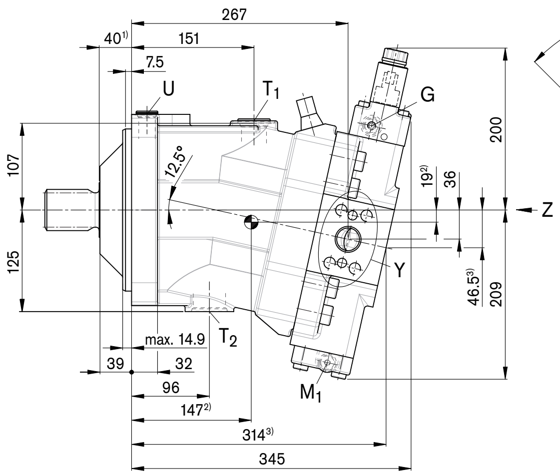


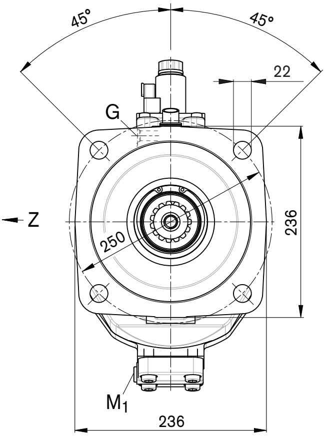
Dimensions size 215

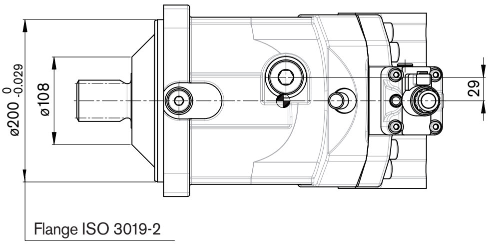
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

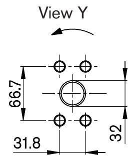
EP5, EP6 – Proportional control electric, negative control

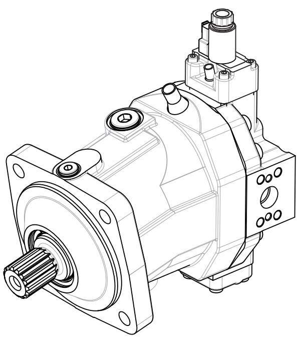
Port plate 2 – SAE flange ports A and B at side, opposite











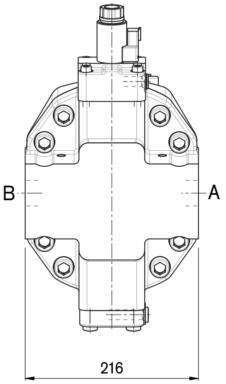
1) To shaft collar
2) Center of gravity
3) Port plate 1 – SAE flange ports A and B at rear

Dimensions size 215

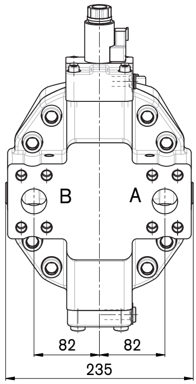
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

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

2 SAE flange ports A and B at side, opposite

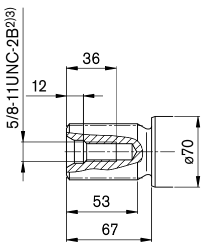


1 SAE flange ports A and B at rear

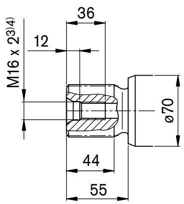


Drive shafts

T2 Splined shaft 2 in 15 T 8/16DP[1]



A2 Splined shaft DIN 5480 W50x2x24x9g



1) ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to ASME B1.1
3) Observe the general instructions on pages 72 for the maximum tightening torques.
4) Center bore according to DIN 332 (thread according to DIN 13)

Dimensions size 215

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Ports

Designation	Port for	Standard	Size[1]	P_{max} [bar][2]	State[6]
A, B	Service line Fastening thread A/B	SAE J518[3] DIN 13	1 1/4 in M14 x 2; 19 deep	500	O
T_1	Drain line	ISO 6149[5]	M33 x 2; 19 deep	3	X[4]
T_2	Drain line	ISO 6149[5]	M42 x 2; 19.5 deep	3	O[4]
G	Synchronous control	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X
U	Bearing flushing	ISO 6149[5]	M22 x 1.5; 15.5 deep	3	X
X	Pilot signal (HP, HZ, HA1T/HA2T)	ISO 6149[5]	M14 x 1.5; 11.5 deep	100	O
X	Pilot signal (HA1 and HA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	3	X
X_1, X_2	Pilot signal (DA0)	ISO 8434-1	SDSC–L8xM12–F	40	O
X_1	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	O
X_3	Pilot signal (DA1, DA2)	ISO 6149[5]	M14 x 1.5; 11.5 deep	40	X
M_1	Measuring stroking chamber	ISO 6149[5]	M14 x 1.5; 11.5 deep	500	X

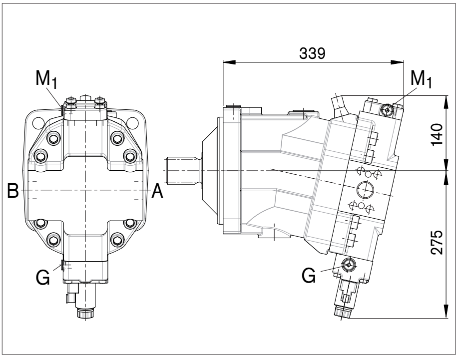
1) Observe the general instructions on pages 72 for the maximum tightening torques.
2) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
3) Only dimensions according to SAE J518, metric fastening thread is a deviation from standard.
4) Depending on installation position, T_1 or T_2 must be connected (see also installation instructions on pages 71).
5) The spot face can be deeper than specified in the appropriate standard.
6) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions size 215

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

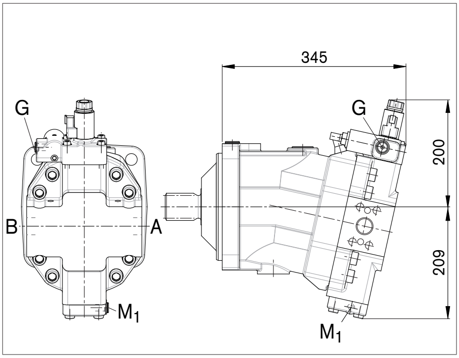
EP1, EP2

Proportional control electric, positive control



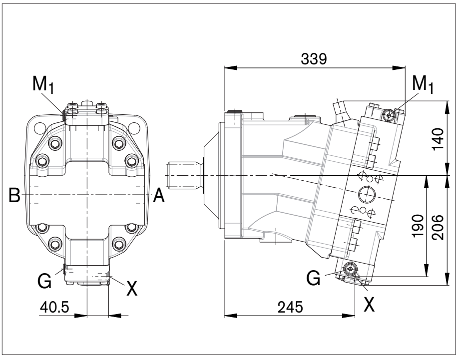
EP5D1, EP6D1

Proportional control electric, negative control, with pressure control fixed setting



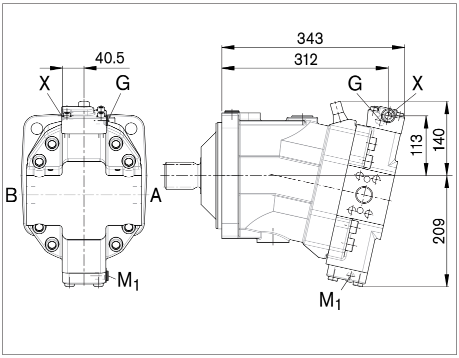
HP1, HP2

Proportional control hydraulic, positive control



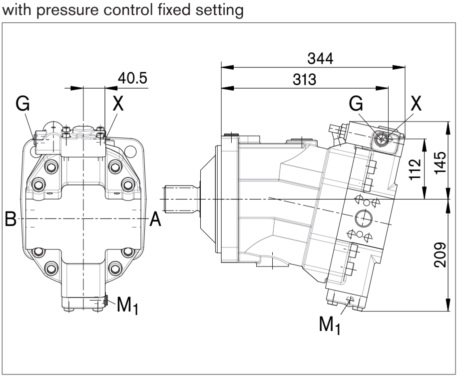
HP5, HP6

Proportional control hydraulic, negative control



HP5D1, HP6D1

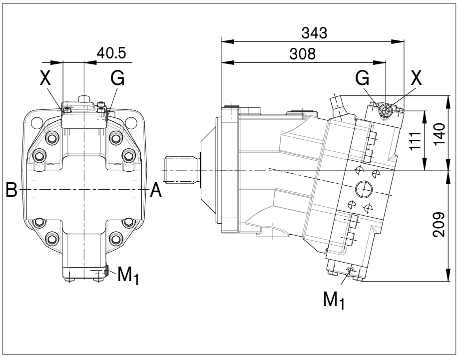
Proportional control hydraulic, negative control, with pressure control fixed setting



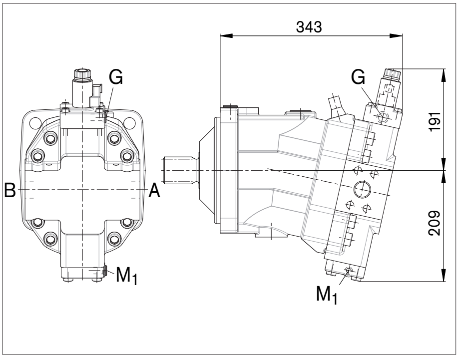
Dimensions size 215

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

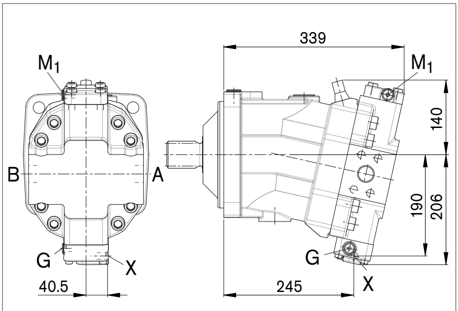
HZ5
Two-point control hydraulic, negative control



EZ5, EZ6
Two-point control electric, negative control

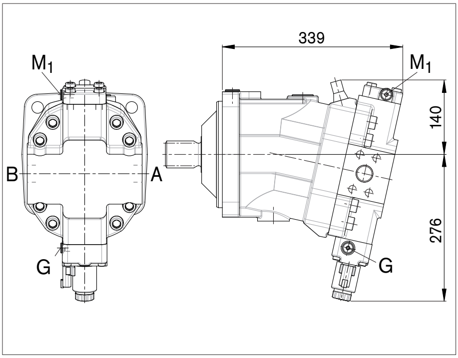


HA1, HA2 / HA1T3, HA2T3
Automatic control high-pressure related, positive control, with override hydraulic remote control, proportional

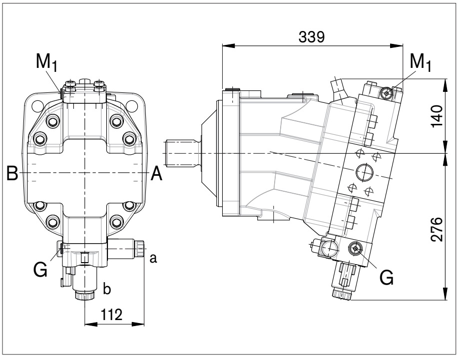


HA1 and HA2, X plugged
HA1T and HA2T, X open

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



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

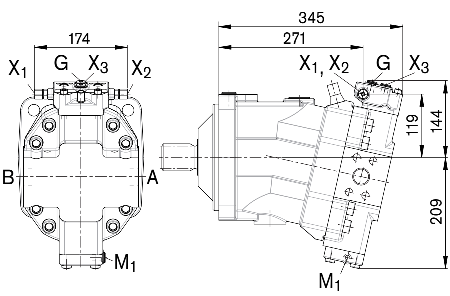


Dimensions size 215

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

DA0

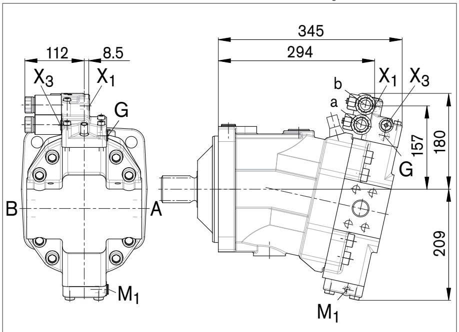
Automatic control speed related, negative control, with hydraulic travel direction valve



X_1, X_2 Pipe fitting SDSC – L8xM12 – F acc. to ISO 8434-1
Use assembled fitting!

DA1, DA2

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



Connector for solenoids

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

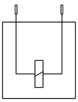
DEUTSCH DT04-2P-EP04

Molded, 2-pin, without bidirectional suppressor diode

There is the following type of protection with mounted mating connector:
IP67 ________________ DIN/EN 60529

and IP69K ________________ DIN 40050-9

Circuit symbol



Mating connector

DEUTSCH DT06-2S-EP04
Bosch Rexroth Mat. No. R902601804

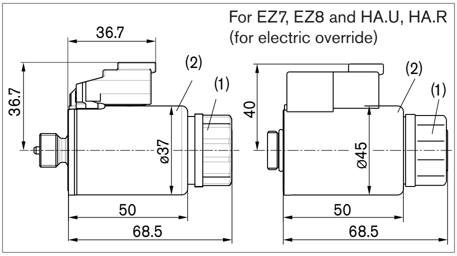
Consisting of: DT designation

– 1 housing ________________ DT06-2S-EP04

– 1 wedge ________________ W2S

– 2 sockets ________________ 0462-201-16141

The mating connector is not included in the delivery contents. This can be supplied by Bosch Rexroth on request.



Changing connector orientation

If necessary, you can change the connector orientation by turning the solenoid housing.

To do this, proceed as follows:

1. Loosen the mounting nut (1) of the solenoid. To do this, turn the mounting nut (1) one turn counter-clockwise.
2. Turn the solenoid body (2) to the desired orientation.
3. Retighten the mounting nut. Tightening torque: 5+1 Nm. (WAF26, 12-sided DIN 3124)

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

2

Flushing and boost pressure valve

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

In an open circuit, it is used only for flushing the housing.

In a closed circuit, it ensures a minimum boost pressure level in addition to the case flushing.

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

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

Cracking pressure of pressure retaining valve
(observe when setting the primary valve)
Sizes 60 to 215, fixed setting ______ 16 bar

Switching pressure of flushing piston Δp
Sizes 60 to 115 (small flushing valve) ______ 8±1 bar
Sizes 115 to 215 (medium and large flushing valve) 17.5±1.5 bar

Flushing flow q_v
Orifices can be used to set the flushing flows as required.
Following parameters are based on:
$\Delta p_{ND} = p_{ND} - p_G = 25$ bar und $\nu = 10$ mm²/s
(p_{ND} = low pressure, p_G = case pressure)

Small flushing valve for sizes 60 to 115

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

Medium flushing valve for size 115

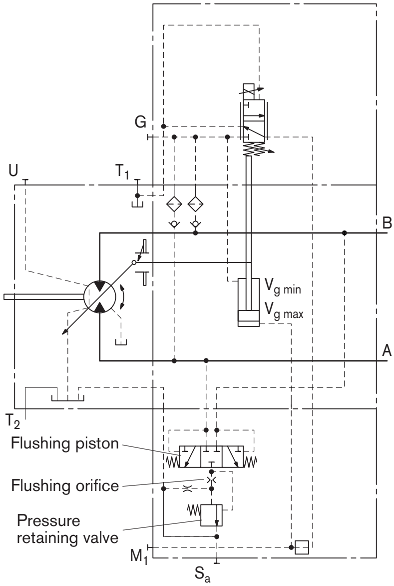
Material number of orifice	ø [mm]	q_v [L/min]	Code
R909431310	2.8	20	H
R909435172	3.5	25	J
R909449967	5.0	30	K

Large flushing valve for sizes 150 to 215

Material number of orifice	ø [mm]	q_v [L/min]	Code
R909449998	1.8	8	C
R909431308	2.0	10	D
R909431309	2.5	17	G
R909431310	2.8	20	H
R902138235	3.1	25	J
R909435172	3.5	30	K
R909436622	4.0	35	L
R909449967	5.0	40	M

For a flushing flow greater than 35 L/min, it is recommended that port S_a be connected in order to prevent an increase in case pressure. An increased case pressure reduces the flushing flow.

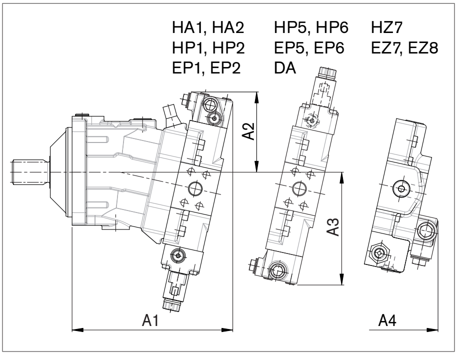
Schematic EP
Port S_a only for sizes 150 to 215



Flushing and boost pressure valve

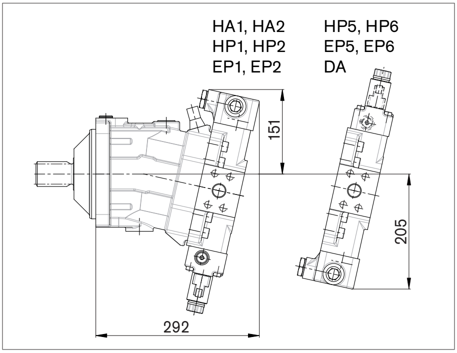
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Dimensions of sizes 60 to 115 (small flushing valve)



NG	A1	A2	A3	A4
060	243	133	176	236
085	273	142	194	254
115	287	143	202	269

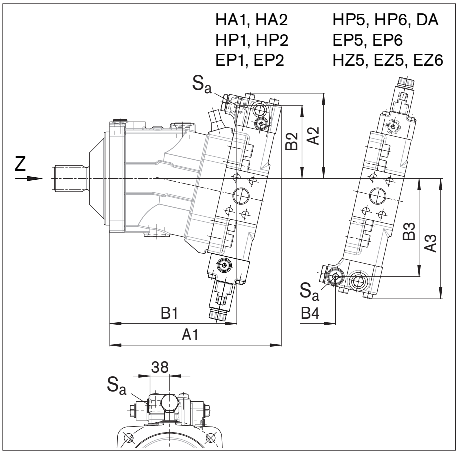
Dimensions of size 115 (medium flushing valve)



NG	S_a [1]
150	M22 x 1.5; 15.5 deep
170	M22 x 1.5; 15.5 deep
215	M22 x 1.5; 15.5 deep

1) ISO 6149, ports plugged (in normal operation)
Observe the general instructions on pages 72 for the maximum tightening torques.
The spot face can be deeper than specified in the appropriate standard.

Dimensions for sizes 150 to 215 (large flushing valve)



NG	A1	B1	A2	B2	A3	B3	B4
150	325	239	165	142	230	187	166
170	332	246	165	142	233	190	172
215	349	263	172	148	244	201	185

2

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Function

Travel drive/winch counterbalance valves are designed to reduce the danger of overspeeding and cavitation of axial piston motors in open circuits. Cavitation occurs if the motor speed is greater than it should be for the given input flow while braking, travelling downhill, or lowering a load.

If the inlet pressure drops, the counterbalance spool throttles the return flow and brakes the motor until the inlet pressure returns to approx. 20 bar.

Note

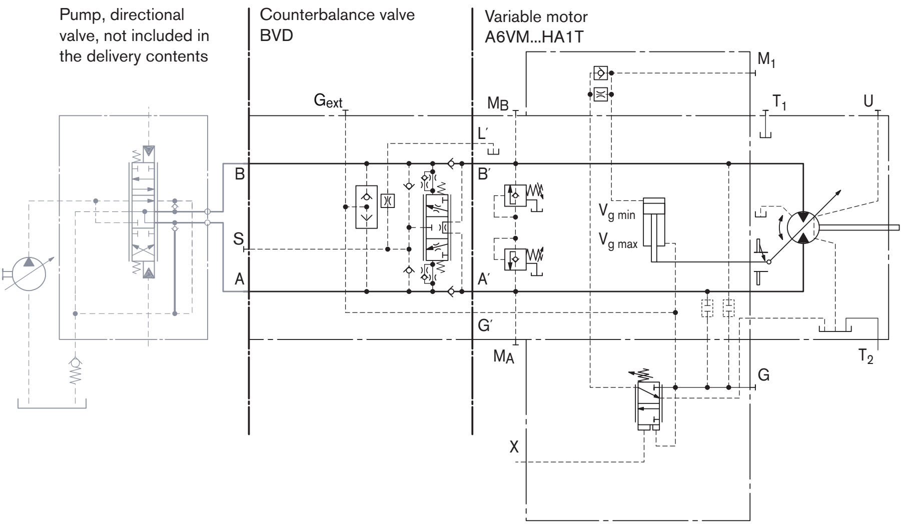
- BVD available for sizes 60 to 215 and BVE available for sizes 115 to 215.
- The counterbalance valve must be ordered additionally. We recommend ordering the counterbalance valve and the motor as a set. Ordering example: A6VM085HA1T30004A/71MWV0N4S97W0-0 + BVD20F27S/41B–V03K16D0400S12
- For safety reasons, controls with beginning of control at $V_{g\ min}$ (e. g. HA) are not permissible for winch drives!
- The counterbalance valve does not replace the mechanical service brake and park brake.
- Observe the detailed notes on the BVD counterbalance valve in RE 95522 and BVE counterbalance valve in RE 95525!
- For the design of the brake release valve, we must know for the mechanical park brake:
  - the pressure at the start of opening
  - the volume of the brake piston between minimum stroke (brake closed) and maximum stroke (brake released with 21 bar)
  - the required closing time for a warm device (oil viscosity approx. 15 mm^2/s)

Travel drive counterbalance valve BVD...F

Application option

- Travel drive on wheeled excavators

Example schematic for travel drive on wheeled excavators
A6VM085HA1T30004A/71MWV0N4S97W0-0 + BVD20F27S/41B–V03K16D0400S12



Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

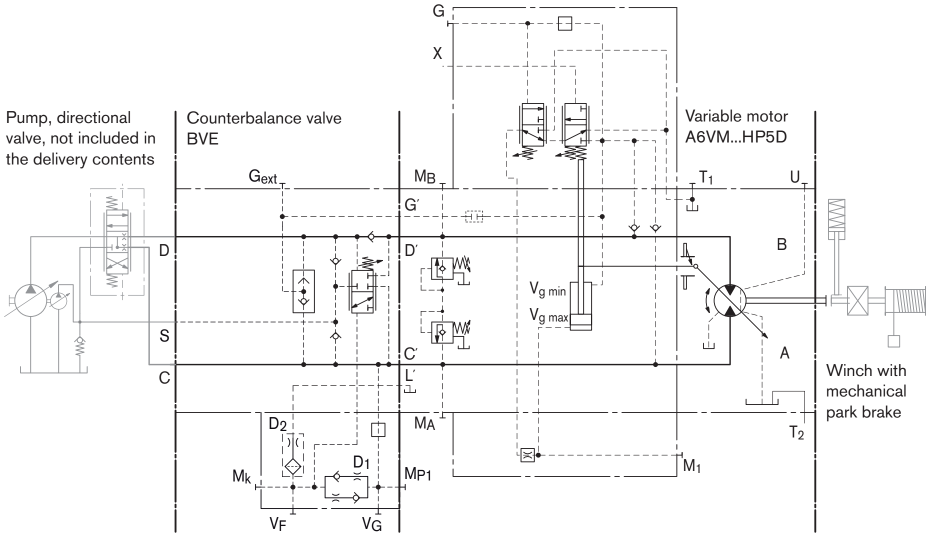
Winch counterbalance valve BVD...W and BVE

Application options

– Winch drive in cranes (BVD and BVE)

– Track drive in excavator crawlers (BVD)

Example schematic for winch drive in cranes
A6VM085HP5D10001A/71MWV0N4S97W0-0 + BVE25W38S/51ND-V100K00D4599T30S00-0



Permissible input flow or pressure in operation with DBV and BVD/BVE

Motor NG	Without valve p_{nom}/p_{max} [bar]	$q_{V\,max}$ [L/min]	Restricted values in operation with DBV and BVD/BVE: DBV NG	p_{nom}/p_{max} [bar]	q_V [L/min]	Code	BVD/BVE NG	p_{nom}/p_{max} [bar]	q_V [L/min]	Code
60	450/500	276	22	350/420	240	7	20 (BVD)	350/420	220	7W
85		332								
115		410	32		400					
115		410				8	25 (BVD/BVE)		320	8W
150		494								
170		533								
215		628	On request							

DBV ______________________________ pressure-relief valve

BVD _________________counterbalance valve, double-acting

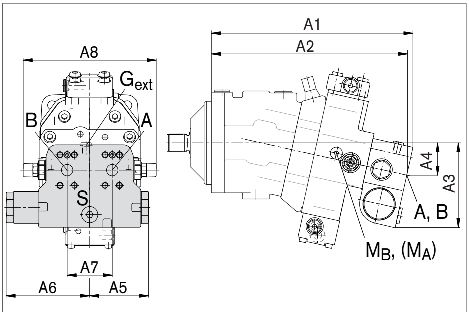
BVE ____________________counterbalance valve, one-sided

Counterbalance valve BVD and BVE

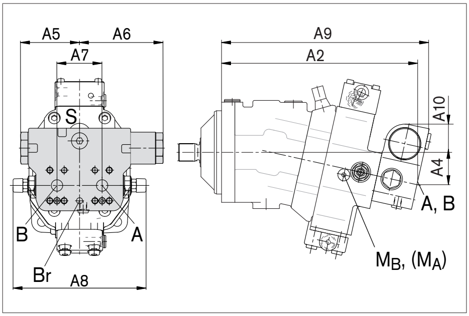
Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Dimensions

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



A6VM...HP5, HP6 and EP5, EP6[1)]



A6VM	Counterbalance valve											
NG...plate	Type	Ports	Dimensions									
		A, B	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
60...7	BVD20...17	3/4 in	311	302	143	50	98	139	75	222	326	50
85...7	BVD20...27	1 in	340	331	148	55	98	139	75	222	355	46
115...7	BVD20...28	1 in	362	353	152	59	98	139	84	234	377	41
115...8	BVD25...38	1 1/4 in	380	370	165	63	120.5	175	84	238	395	56
150...8	BVD25...38	1 1/4 in	411	401	168	67	120.5	175	84	238	426	53
170...8	BVD25...38	1 1/4 in	417	407	170	68	120.5	175	84	238	432	51
215...8	BVD25...38	1 1/4 in	448	438	176	74	120.5	175	84	299	463	46
115...8	BVE25...38	1 1/4 in	380	370	171	63	137	214	84	238	397	63
150...8	BVE25...38	1 1/4 in	411	401	175	67	137	214	84	238	423	59
170...8	BVE25...38	1 1/4 in	417	407	176	68	137	214	84	238	432	59
215...8	BVE25...38	1 1/4 in	448	438	182	74	137	214	84	299	463	52

Ports

Designation	Port for	Version	A6VM plate	Standard	Size[2)]	P_{max} [bar][2)]	State[5)]
A, B	Service line			SAE J518	see table above	420	O
S	Infeed	BVD20		DIN 3852[4)]	M22 x 1.5; 14 deep	30	X
		BVD25, BVE25		DIN 3852[4)]	M27 x 2; 16 deep	30	X
Br	Brake release, reduced high pressure	L	7	DIN 3852[4)]	M12 x 1.5; 12.5 deep	30	O
			8	DIN 3852[4)]	M12 x 1.5; 12 deep	30	O
G_{ext}	Brake release, high pressure	S		DIN 3852[4)]	M12 x 1.5; 12.5 deep	420	X
M_A, M_B	Measuring pressure A and B			ISO 6149[4)]	M18 x 1.5; 14.5 deep	420	X

1) At the mounting version for the controls HP5, HP6 and EP5, EP6, the cast-in port designations A and B on the counterbalance valve BVD do not correspond with the connection drawing of the A6VM motor.
The designation of the ports on the installation drawing of the motor is binding!
2) Observe the general instructions on pages 72 for the maximum tightening torques.
3) Momentary pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) The spot face can be deeper than specified in the appropriate standard.
5) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)

Counterbalance valve BVD and BVE

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Mounting the counterbalance valve

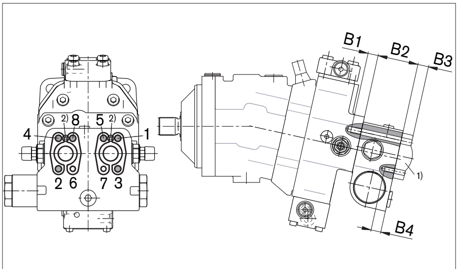
When delivered, the counterbalance valve is mounted to the motor with two tacking screws (transport protection). The tacking screws may not be removed while mounting the service lines. If the counterbalance valve and motor are delivered separately, the counterbalance valve must first be mounted to the motor port plate using the provided tacking screws. The counterbalance valve is finally mounted to the motor by screwing on the SAE flange with the following screws:

6 screws (**1, 2, 3, 4, 5, 8**) ____________ length B1+B2+B3
2 screws (**6, 7**) ______________________ length B3+B4

Tighten the screws in two steps in the specified sequence from 1 to 8 (see following scheme).

In the first step, the screws must be tightened with half the tightening torque, and in the second step with the maximum tightening torque (see following table).

Thread	Strength class	Tightening torque [Nm]
M6 x 1 (tacking screw)	10.9	15.5
M10	10.9	75
M12	10.9	130
M14	10.9	205



1) SAE flange
2) Tacking screw (M6 x 1, length = B1 + B2, DIN 912)

NG...plate	60...7	85...7 115...7	115...8, 150...8, 170...8
B1[3]	M10 x 1.5 17 deep	M12 x 1.75 15 deep	M14 x 2 19 deep
B2	68	68	85
B3	customer-specific		
B4	M10 x 1.5 15 deep	M12 x 1.75 16 deep	M14 x 2 19 deep

3) Minimum required thread reach 1 x Ø-thread

2

Speed sensor

Before finalizing your design, request a binding installation drawing. Dimensions in mm.

Version A6VM...U ("prepared for speed sensor", i.e. without sensor) is equipped with a toothed ring on the rotary group.

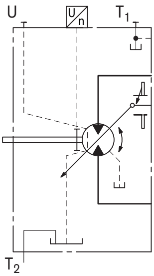
With the speed sensor DSM mounted, a signal proportional to motor speed can be generated. The DSM sensor measures the speed and direction of rotation.

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

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

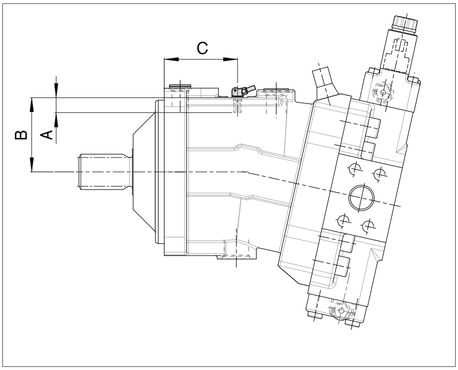
We recommend ordering the A6VM variable motor complete with sensor mounted.

Schematic



Dimensions

Version "V" with mounted speed sensor



Size		60	85	115	150	170	215
Number of teeth		54	58	67	72	75	80
A	Insertion depth (tolerance -0.25)	18.4	18.4	18.4	18.4	18.4	18.4
B	Contact surface	75	79	88	93	96	101
C		66.2	75.2	77.2	91.2	91.7	95.2

Setting range for displacement

	60				85				115				150			
	$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)		$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)		$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)		$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)	
	from	to	from	to	from	to	from	to	from	to	from	to	from	to	from	to
A	62.0	62.0	0.0	15.0	85.2	85.2	0.0	31.5	115.6	115.6	0.0	24.0	152.1	152.1	0.0	44.0
	without screw		M10 x 60 R909154690		without screw		M12 x 70 R909085976		without screw		M12 x 70 R909085976		without screw		M12 x 80 R909153075	
B	62.0	62.0	> 15.0	30.5	85.2	85.2	> 31.5	52.0	115.6	115.6	> 24.0	47.5	152.1	152.1	> 44.0	69.0
	without screw		M10 x 70 R909153779		without screw		M12 x 80 R909153075		without screw		M12 x 80 R909153075		without screw		M12 x 90 R909154041	
C	62.0	62.0	> 30.5	43.0	85.2	85.2	> 52.0	59.0	115.6	115.6	> 47.5	71.0	152.1	152.1	> 69.0	99.0
	without screw		M10 x 80 R909154058		without screw		M12 x 90 R909154041		without screw		M12 x 90 R909154041		without screw		M12 x 100 R909153975	
D	x		x		x		x		115.6	115.6	> 71.0	80.0	152.1	152.1	> 99.0	106.0
									without screw		M12 x 100 R909153975		without screw		M12 x 110 R909154212	
E	< 62.0	47.5	0.0	15.0	< 85.2	55.5	0.0	31.5	< 115.6	93.5	0.0	24.0	< 152.1	111.0	0.0	44.0
	M10 x 60 R909154690		M10 x 60 R909154690		M12 x 70 R909085976		M12 x 70 R909085976		M12 x 70 R909085976		M12 x 70 R909085976		M12 x 80 R909153075		M12 x 80 R909153075	
F	< 62.0	47.5	> 15.0	30.5	< 85.2	55.5	> 31.5	52.0	< 115.6	93.5	> 24.0	47.5	< 152.1	111.0	> 44.0	69.0
	M10 x 60 R909154690		M10 x 70 R909153779		M12 x 70 R909085976		M12 x 80 R909153075		M12 x 70 R909085976		M12 x 80 R909153075		M12 x 80 R909153075		M12 x 90 R909154041	
G	< 62.0	47.5	> 30.5	43.0	< 85.2	55.5	> 52.0	59.0	< 115.6	93.5	> 47.5	71	< 152.1	111.0	> 69.0	99.0
	M10 x 60 R909154690		M10 x 80 R909154058		M12 x 70 R909085976		M12 x 90 R909154041		M12 x 70 R909085976		M12 x 90 R909154041		M12 x 80 R909153075		M12 x 100 R909153975	
H	x		x		x		x		< 115.6	93.5	> 71.0	80.0	< 152.1	111.0	> 99.0	106.0
									M12 x 70 R909085976		M12 x 100 R909153975		M12 x 80 R909153075		M12 x 110 R909154212	
J	< 47.5	33.0	0.0	15.0	< 55.5	35.0	0.0	31.5	< 93.5	71.0	0.0	24.0	< 111.0	87.0	0.0	44.0
	M10 x 70 R909153779		M10 x 60 R909154690		M12 x 80 R909153075		M12 x 70 R909085976		M12 x 80 R909153075		M12 x 70 R909085976		M12 x 90 R909154041		M12 x 80 R909153075	
K	< 47.5	33.0	> 15.0	30.5	< 55.5	35.0	> 31.5	52.0	< 93.5	71.0	> 24.0	47.5	< 111.0	87.0	> 44.0	69.0
	M10 x 70 R909153779		M10 x 70 R909153779		M12 x 80 R909153075		M12 x 80 R909153075		M12 x 80 R909153075		M12 x 80 R909153075		M12 x 90 R909154041		M12 x 90 R909154041	
L	< 47.5	33.0	> 30.5	43.0	< 55.5	35.0	> 52.0	59.0	< 93.5	71.0	> 47.5	71.0	< 111.0	87.0	> 69.0	99.0
	M10 x 70 R909153779		M10 x 80 R909154058		M12 x 80 R909153075		M12 x 90 R909154041		M12 x 80 R909153075		M12 x 90 R909154041		M12 x 90 R909154041		M12 x 100 R909153975	
M	x		x		x		x		< 93.5	71.0	> 71.0	80.0	< 111.0	87.0	> 99.0	106.0
									M12 x 80 R909153075		M12 x 100 R909153975		M12 x 90 R909154041		M12 x 110 R909154212	

Specify exact settings for $V_{g\,min}$ and $V_{g\,max}$ in plain text when ordering:
$V_{g\,min}$ = ... cm^3, $V_{g\,max}$ = ... cm^3

Theoretical, maximum setting:
for $V_{g\,min} = 0.7 \cdot V_{g\,max}$
for $V_{g\,max} = 0.3 \cdot V_{g\,max}$

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

Setting range for displacement

	170				215			
	$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)		$V_{g\,max}$ (cm^3/rev)		$V_{g\,min}$ (cm^3/rev)	
	from	to	from	to	from	to	from	to
A	171.8	171.8	0.0	35.0	216.5	216.5	0.0	44.5
	without screw		M12 x 80 R909153075		without screw		M12 x 80 R909153075	
B	171.8	171.8	> 35.0	63.5	216.5	216.5	> 44.5	80.0
	without screw		M12 x 90 R909154041		without screw		M12 x 90 R909154041	
C	171.8	171.8	> 63.5	98.0	216.5	216.5	> 80.0	115.0
	without screw		M12 x 100 R909153975		without screw		M12 x 100 R909153975	
D	171.8	171.8	> 98.0	120.0	216.5	216.5	> 115.0	150.0
	without screw		M12 x 110 R909154212		without screw		M12 x 110 R909154212	
E	< 171.8	139.0	0.0	35.0	< 216.5	175.0	0.0	44.5
	M12 x 80 R909153075		M10 x 80 R909153075		M12 x 80 R909153075		M12 x 80 R909153075	
F	< 171.8	139.0	> 35.0	63.5	< 216.5	175.0	> 44.5	80.0
	M12 x 80 R909153075		M12 x 90 R909154041		M12 x 80 R909153075		M12 x 90 R909154041	
G	< 171.8	139.0	> 63.5	98.0	< 216.5	175.0	> 80.0	115.0
	M12 x 80 R909153075		M12 x 100 R909153975		M12 x 80 R909153075		M12 x 100 R909153975	
H	< 171.8	139.0	> 98.0	120.0	< 216.5	175.0	> 115.0	150.0
	M12 x 80 R909153075		M12 x 110 R909154212		M12 x 80 R909153075		M12 x 110 R909154212	
J	< 139.0	112.0	0.0	35.0	< 175.0	141.0	0.0	44.5
	M12 x 90 R909154041		M12 x 80 R909153075		M12 x 90 R909154041		M12 x 80 R909153075	
K	< 139.0	112.0	> 35.0	63.5	< 175.0	141.0	> 44.5	80.0
	M12 x 90 R909154041		M12 x 90 R909154041		M12 x 90 R909154041		M12 x 90 R909154041	
L	< 139.0	112.0	> 63.5	98.0	< 175.0	141.0	> 80.0	115.0
	M12 x 90 R909154041		M12 x 100 R909153975		M12 x 90 R909154041		M12 x 100 R909153975	
M	< 139.0	112.0	> 98.0	120.0	< 175.0	141.0	> 115.0	150.0
	M12 x 90 R909154041		M12 x 110 R909154212		M12 x 90 R909154041		M12 x 110 R909154212	

Specify exact settings for $V_{g\,min}$ and $V_{g\,max}$ in plain text when ordering:
$V_{g\,min}$ = ... cm^3, $V_{g\,max}$ = ... cm^3

Theoretical, maximum setting:
for $V_{g\,min} = 0.7 \cdot V_{g\,max}$
for $V_{g\,max} = 0.3 \cdot V_{g\,max}$

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

Installation instructions

General

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

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

The case drain fluid in the motor housing must be directed to the reservoir via the highest available drain port (T_1, T_2).

For combinations of multiple units, make sure that the respective case pressure in each unit is not exceeded. In the event of pressure differences at the drain ports of the units, the shared drain line must be changed so that the 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 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.

Installation position

See the following examples 1 to 8.
Further installation positions are possible upon request.

Recommended installation position: 1 and 2.

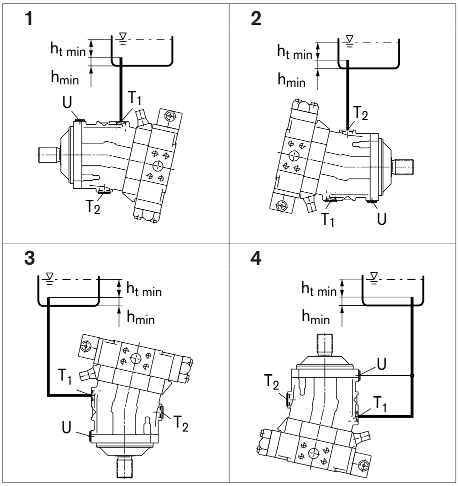
Note
In certain installation positions, an influence on the control characteristics can be expected. Gravity, dead weight and case pressure can cause minor shifts in control characteristics and changes in response time.

Installation position	Air bleed	Filling
1	–	T_1
2	–	T_2
3	–	T_1
4	U	T_1
5	U (L_1)	T_1 (L_1)
6	L_1	T_2 (L_1)
7	L_1	T_1 (L_1)
8	U	T_1 (L_1)

L_1 Filling / air bleed
U Bearing flushing / air bleed port
T_1, T_2 Drain port
$h_{t\,min}$ Minimum required immersion depth (200 mm)
h_{min} Minimum required spacing to reservoir bottom (100 mm)

Below-reservoir installation (standard)

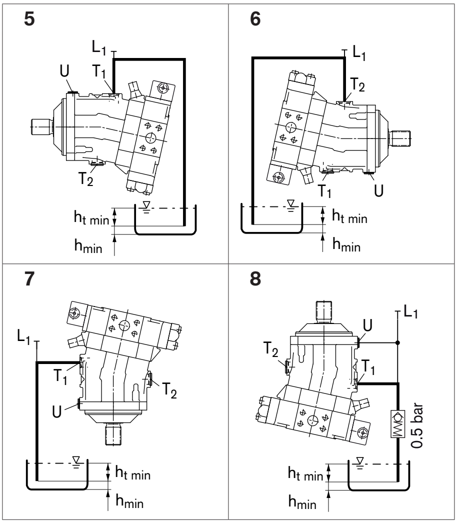
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir below the minimum fluid level.



Above-reservoir installation

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

Recommendation for installation position 8 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) can prevent draining of the motor housing.



2

General instructions

– The motor A6VM is designed to be used in open and closed circuits.

– The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified personnel.

– Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these can be requested from Bosch Rexroth.

– 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.

– Not all versions of the product are approved for use in a safety function pursuant to ISO 13849. If you require characteristic values relating to reliability (e. g. $MTTF_d$) for functional safety, please consult the responsible contact person at Bosch Rexroth.

– The following tightening torques apply:

- Fittings:
Observe the manufacturer's instructions regarding the tightening torques of the fittings used.

- Mounting bolts:
For mounting bolts with metric ISO thread according to DIN 13 or thread according to ASME B1.1, we recommend checking the tightening torque in individual cases in accordance with VDI 2230.

- Female threads in 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	Size of thread	Maximum permissible tightening torque of the female threads $M_{G\ max}$	Required tightening torque of the threaded plugs M_V	WAF hexagon socket of the threaded plugs
ISO 6149	M10 x 1	30 Nm	15 Nm	5 mm
	M12 x 1.5	50 Nm	25 Nm	6 mm
	M14 x 1.5	80 Nm	45 Nm	6 mm
	M16 x 1.5	100 Nm	55 Nm	8 mm
	M18 x 1.5	140 Nm	70 Nm	8 mm
	M22 x 1.5	210 Nm	100 Nm	10 mm
	M27 x 2	330 Nm	170 Nm	12 mm
	M33 x 2	540 Nm	310 Nm	17 mm
	M42 x 2	720 Nm	330 Nm	22 mm
DIN 3852	M12 x 1.5	50 Nm	25 Nm[1)2)]	6 mm
	M22 x 1.5	210 Nm	80 Nm[1)]	10 mm
	M27 x 2	330 Nm	135 Nm[1)]	12 mm

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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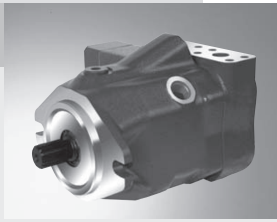
Axial piston variable motor A10VM Plug-in version A10VE

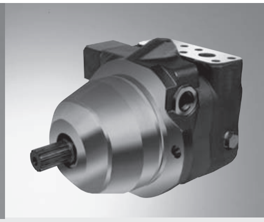
RE 91703/03.10
Replaces: 06.09

Data sheet

Series 52
Size 28 to 85
Nominal pressure 280 bar
Maximum pressure 350 bar
Open and closed circuit



A10VM



A10VE

Contents

Features

- Dual displacement motor, axial piston swashplate design, for hydrostatic transmissions in open and closed circuits
- Output speed is directly proportional to inlet flow and inversely proportional to motor displacement
- Output torque increases proportional to the pressure difference between high and low pressure sides and increasing displacement
- Heavy duty bearings for long service life
- High permissible output speed
- Well proven A10-rotary unit technology
- High power/weight ratio – compact dimensions
- Cost effective
- Low noise
- External control pressure supply possible
- Minimum displacement can be set externally
- SAE-2-bolt mounting flange on A10VM
- Special 2-bolt mounting flange on A10VE

Ordering code for standard program

A10V	M			/	52	W		–	V		C				
01	02	03	04		05	06	07		08	09	10	11	12	13	14

Axial piston unit

01	Swash plate design, variable, nominal pressure 280 bar, maximum pressure 350 bar	**A10V**

Operating Mode

02	Motor, open and closed circuit	**M**

Size (NG)

03	Displacement $V_{g\,max}$ in cm^3	**028**	**045**	**063**	**085**

Control devices

					028	045	063	085	
04	Two point control	Directly operated, external control supply, without pilot valve			●	●	●	●	**DG**
		Hydraulically operated	Stroking time orifice	without	●	●	●	❍	**HZ**
				with	●	●	●	❍	**HZ6**
		Electricaly with solenoid valve control voltage **12V**	Stroking time orifice	without	●	●	●	●	**EZ1**
				with	●	●	●	●	**EZ6**
		Electricaly with solenoid valve control voltage **24V**	Stroking time orifice	without	●	●	●	❍	**EZ2**
				with	●	●	●	❍	**EZ7**

Series

05	Series 5, Index 2	**52**

Direction of rotation

06	Viewed on shaft end	Bi-directional	**W**

Minimum displacement

			028	045	063	085	
07	$V_{g\,min}$ (in cm^3) steplessly adjustable	from/to	8/28	12/25	16/38	22/50	**1**
	Adjustment state in clear text	from/to	–	26/45	40/62	48/85	**2**

Seals

08	FKM (flour-rubber)	**V**

Drive shaft

		028	045	063	085	
09	Splined shaft, ANSI B92.1a-1976, for higher drive torque	●	●	●	●	**R**
	Splined shaft, ANSI B92.1a-1976, for reduced drive torque	–	●	●	●	**W**

Mounting flange

10	SAE J744 2-bolt	**C**

Ports for service lines

11	SAE flanges , at side-same side, metric fixing screws	●	●	●	●	**10N00**
	SAE flanges at rear, metric fixing screws	❍	●	❍	❍	**11N00**
	Threaded ports on side, same side, metric thread	●	●	●	❍	**16N00**

Valves

12	Without valves	●	●	●	●	**0**
	Integrated flushing valve, only with side ports (10N00 and 16N00)	●	●	●	●	**7**

Speed pickup

13	Without speed pickup	●	●	●	●	**–**
	Prepared for inductive type of speed pickup ID R	●	●	●	❍	**D**

Connector for solenoids

14	HIRSCHMANN - connector – without suppressor diod	▲	▲	▲	▲	**H**
	DEUTSCH - connector, molded, 2-pin – without suppressor diod	●	●	●	●	**P**

● = available ❍ = in preparation – = not available ▲ = not for new projects

Ordering code for standard program

A10V	E			/	52	W		–	V		F				
01	02	03	04		05	06	07		08	09	10	11	12	13	14

Axial piston unit

01	Swash plate design, variable, nominal pressure 280 bar, maximum pressure 350 bar	A10V

Operating mode

02	Motor, plug in type, open and closed circuit	E

Size (NG)

03	Displacement $V_{g\ max}$ in cm^3	028	045	063

Control devices

					028	045	063	
04	Two point control	Directly operated, external control supply, without pilot valve			●	●	❍	DG
		Hydraulically	Stroking time orifice	without	●	●	●	HZ
				with	●	●	●	HZ6
		Electricaly with solenoid valve control voltage **12V**	Stroking time orifice	without	●	●	●	EZ1
				with	●	●	●	EZ6
		Electricaly with solenoid valve control voltage **24V**	Stroking time orifice	without	●	●	●	EZ2
				with	●	●	●	EZ7

Series

05	Series 5, Index 2	52

Direction of rotation

06	Viewed on shaft end	Bi-directional	W

Minimum displacement

			028	045	063	
07	$V_{g\ min}$ (in cm^3) stepples adjustable	from/to	10/28	12/25	16/38	1
	Adjustment please state in clear text	from/to	–	26/45	40/62	2

Seals

08	FKM (flour-rubber)	V

Drive shaft

		028	045	063	
09	Splined shaft, ANSI B92.1a-1976, for higher drive torque	●	●	●	R
	Splined shaft, ANSI B92.1a-1976, for reduced drive torque	–	●	●	W

Mounting flange

10	Special 2-bolt	F

Ports for service line

11	SAE flanges at side-same side, metric fixing screws	●	●	●	10N00
	SAE flanges at rear, metric fixing screws	❍	●	❍	11N00
	Threaded ports on side , same side, metric thread	●	●	●	16N00

Valves

12	Without valves	●	●	●	0
	Integrated flushing valve, only with side ports (10N00 and 16N00)	●	●	●	7

Speed pickup

13	Without speed pickup	●	●	●	–
	Prepared for inductive type of speed pickup ID R	❍	●	❍	D

Connector for solenoids

14	HIRSCHMANN - connector – without suppressor diod	▲	▲	▲	H
	DEUTSCH - connector, molded, 2-pin – without suppressor diod	●	●	●	P

● = available ❍ = in preparation – = not available ▲ = not for new projects

2

Technical data

Fluid

Prior to project design please see our data sheets RE 90220 (mineral oil), RE 90221 (ecologically acceptable fluids) and RE90223 (HF-fluids) for detailed information on fluids and application conditions.

When operating on ecologically acceptable fluids, limitations to the techical data may be necessary.

Please contact us and state the fluid used in clear text when ordering.

Operating viscosity range

For optimum efficiency and service life we recommend an operating viscosity (at operating temperature) in the range

ν_{opt} = opt. operating viscosity 16...36 mm²/s

referred to circuit temperature in closed circuits or tank temperature in open circuits.

The following limits are valid for extreme operating conditions:

ν_{min} = 5 mm²/s (closed circuit)
ν_{min} = 10 mm²/s (open circuit)

briefly (t ≤ 1 min) at max. permissible temperature of 115 °C.

Please note, that the max. fluid temperature of 115 °C may also not be exceeded in certain areas (for instance bearing area) The temperature in the bearing area is approx. 5 K higher than the average fluid temperature.

ν_{max} = 1600 mm²/s
briefly (t ≤ 1 min)
on cold start (t_{min} = -25°C, p ≤ 30 bar, n ≤ 1000 rpm).

At temperatures between –25 °C and –40 °C special measures may be required for certain installation positions. Please consult us for further information

For detailed information on operation at very low temperatures see RE 90300-03-B.

Notes on the selection of the hydraulic fluid

In order to select the correct fluid, it is necessary to know the operating temperature in the tank (open circuit), circuit temperature (closed circuits), in relation to the ambient temperature.

The fluid should be selected, so that within the operating temperatue range, the viscosity lies within the optimum range (ν_{opt}), see shaded section of the selection diagram. We recommend to select the higher viscosity grade in each case.

Example: at an ambient temperature of X °C the operating temperature in the tank is 60 °C. In the optimum viscosity range (ν_{opt}; shaded area) this corresponds to viscosity grades VG 46 resp. VG 68; select VG 68.

Important: The leakage fluid (case drain fluid) temperature is influenced by pressure and motor speed and is always higher than the tank temperature. However, at no point in the circuit may the temperature exceed 115 °C.

If it is not possible to comply with the above conditions because of extreme operating parameters or high ambient temperatures please consult us

Filtration of fluid

The finer the filtration the better the achieved cleanliness of the fluid and the longer the life of the axial piston unit.

To ensure a reliable functioning of the axial piston unit, a minimum cleanliness of

20/18/15 to ISO 4406 is necessary.

At very high fluid temperatures (90 °C to max. 115 °C) the minimum cleanliness has to be at least

19/17/14 to ISO 4406.

If above cleanliness classes cannot be met please consult us.

Operating pressure range

Pressure at port A or B

(Pressure data to DIN 24312)

Nominal pressure pN 280 bar [1]
Maximum pressure p_{max} 350 bar
With motors connected in series please consult us.

Case drain pressure

Max. permissible pressure at leakage port L

p_{abs} max operation as a motor in open circuit 4 bar abs
p_{abs} max operation as a motor in closed circuit 4 bar abs
p_{abs} max motor/pump operation in open circuit 2 bar abs

Direction of rotation

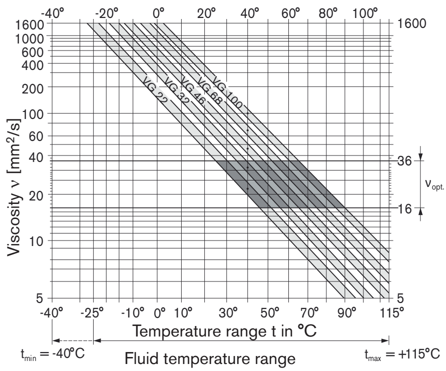
Direction of rotation, viewed on shaft end	
clockwise	counter-clockwise
B to **A**	**A** to **B**

Adjustment of displacement

The minimum displacement is steplessly adjustable within the range of the screw lenghts 1 or 2 (see ordering code).

Please state minimum displacement in clear text when ordering.

Selection diagram



Technical data

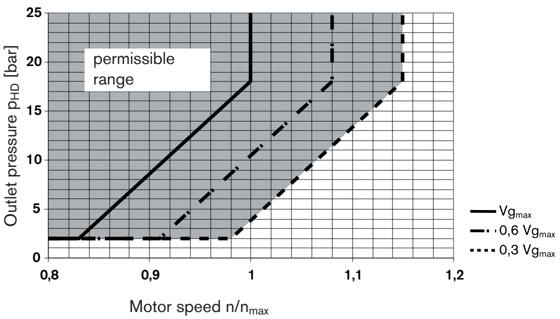
Table of values (theoretical values, without efficiency levels and tolerances; values rounded)

Size				28	45	63	85
Displacement		$V_{g\ max}$	cm^3	28	45	62	87
		$V_{g\ min}$	cm^3	8 (VM)/10(VE)	12	16	22
Speed[1]							
max. at $V_{g\ max}$		$n_{0\ max}$	min^{-1}	4700	4000	3300	3100
max. at $V_{g\ min}$		$n_{0\ max\ zul}$	min^{-1}	5400	4600	3900	3560
Min. speed in cont. operation		$n_{0\ min}$	min^{-1}	250	250	250	250
Inlet flow							
bei $n_{0\ max}$ and $V_{g\ max}$		$q_{V0\ max}$	L/min	131,6	180	205	270
Torque constant[2] at $V_{g\ max}$		T_K	Nm/bar	0,445	0,716	1,002	1,35
Torque							
at $V_{g\ max}$	p_N= 280 bar	T_{max}	Nm	125	200	276	387
Actual starting torque							
at n = 0 min^{-1}	p_N = 280 bar	T	Nm ca.	92	149	205	253
Rotary stiffness	Shaft R	c	Nm/rad	26000	41000	69400	152900
	Shaft W	c	Nm/rad	19800	34400	54000	117900
Mass moment of inertia (about output shaft)		J	kgm^2	0,0017	0,0033	0,0056	0,012
Filling volume		V	L	0,6	0,7	0,8	1,0
Weight approx.		m	kg	14	18	26	34

1) At maximal speed in closed circuit operation make sure that motor outlet pressure is at least ≥ 18 bar.
2) In open circuit Δp 280bar at $p_{boostpress.}$ 2bar
In closed circuit Δp 260bar at $p_{boostpress.}$ 20bar

2

Minimum required outlet pressure (low pressure) at port A (B) depending on motor speed



Technical data

Calculating size

Flow $$q_V = \frac{V_g \cdot n}{1000 \cdot \eta_V} \quad \text{[L/min]}$$

Torque $$T = \frac{1{,}59 \cdot V_g \cdot \Delta p \cdot \eta_{mh}}{100} \quad \text{[Nm]}$$

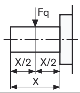
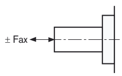
or $$T = T_K \cdot \Delta p \cdot \eta_{mh}$$

Output power $$P = \frac{2\pi \cdot T \cdot n}{60000} = \frac{q_V \cdot \Delta p \cdot \eta_t}{600} \quad \text{[kW]}$$

Output speed $$n = \frac{q_v \cdot 1000 \cdot \eta_v}{V_g} \quad \text{[min}^{-1}\text{]}$$

V_g = Displacement per rev. in cm^3
Δp = Differential pressure in bar
n = speed in rpm
η_V = Volumetric efficiency
η_{mh} = Mechanical-hydraulic efficiency
η_t = Total efficiency ($\eta_t = \eta_V \cdot \eta_{mh}$)
T_K = Torque constant

Permissible radial and axial forces on drive shaft

Size					28	45	63	85
Max. radial force		at X/2	$F_{q\,max}$	N	1200	1500	1700	2000
Max. axial force			F_{ax}	N	1000	1500	2000	3000

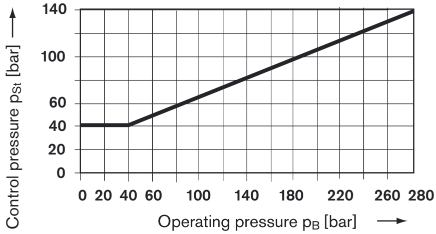
Two-point direct control DG

Normally the motor is at max. displacement. By applying an external pressure to port G, the control piston is directly pressurized and the motor swivels back to min. displacement

The minimum required control pressure is $p_{St} \geq 40$ bar

Please note, that this minimum required control pressure at port G depends directly on the operating pressure p_B in port A or B. (Pressure in A or B),see control pressure diagram below. With a control pressure above this minimum required pressure level the motor will destroke properly.

Control pressure diagram



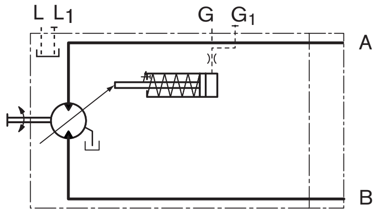
Control pressure = 0 bar ≙ $V_{g\ max}$

Control pressure ≥ 40 bar ≙ $V_{g\ min}$ (see circuit diagram)

The max. permissible control pressure is p_{St} = 280 bar.

V_{gmin} adjustment please state in clear text with order

Circuit diagram



Ports for	
A, B	Pressure
L, L_1	Caise drain (L_1 plugged)
G, G_1	For external control pressure (G_1 plugged)

2

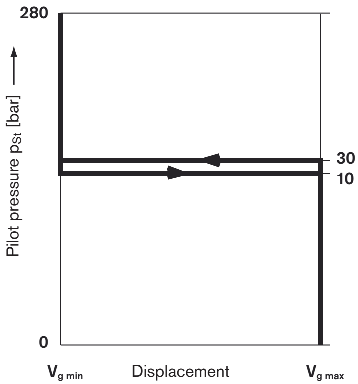
Two-point control, hydraulically operated HZ/HZ6

Normally the motor is at max. displacement. By applying a pilot pressure p_X to port X the pilot valve shifts and the control piston is pressurized causing the motor to swivel to min. displacement ($p_X \geq 30$bar).

The necessary control pressure is via a shuttle valve taken out of the motor pressure side A or B. A minimum pressure difference of $\Delta p_{A,B} \geq 20$ bar between the motor pressure sides is required.

Only $V_{g\,max}$ or $V_{g\,min}$ are possible.

$V_{g\,min}$ - adjustment please state in clear text when ordering.



Pilot pressure p_X = 0 bar ≙ $V_{g\,max}$

Pilot pressure p_X ≥ 30 bar ≙ $V_{g\,min}$

Techn. data HZ/HZ6	
Minimum pilot pressure	30 bar
Maximum permissible pilot pressure	280 bar

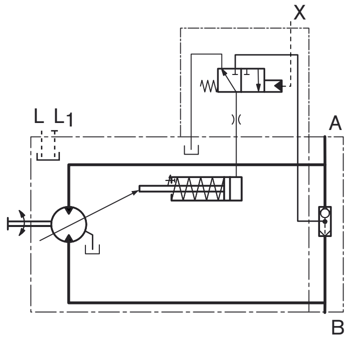
Version HZ6 with stroking time shuttle orifice

Slow down of swivel action by means of shuttle orifice.

This enables a smooth swivel action.

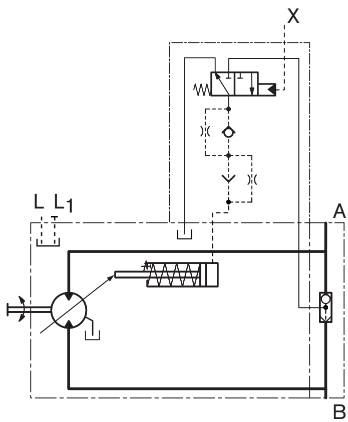
Standard orifice size = 0.21 mm; other sizes on request.

Circuit diagram HZ



Ports for	
A, B	Pressure
L, L_1	Caise drain (L_1 plugged)
X	Pilot pressure (plugged)

Circuit diagram HZ6



Ports for	
A, B	Pressure
L, L_1	Caise drain (L_1 plugged)
X	Pilot pressure (plugged)

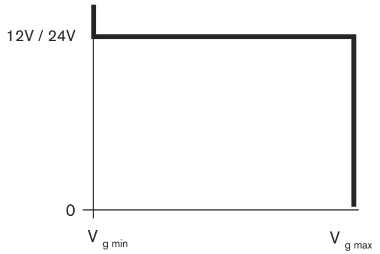
Two-point control, electrically operated EZ[1)]

Normally the motor is at maximum displacement. By energizing the solenoid of the control valve, the control piston is pressurized and the motor swivels to minimum displacement.

The control pressure is via a shuttle valve taken out of the motor pressure side A or B. A minimum pressure difference of $\Delta p_{A,B} \geq 20$ bar between the pressure sides is required.

The motor can only swivel between $V_{g\,max}$ or $V_{g\,min}$.

$V_{g\,min}$ - adjustment please state in clear text when ordering.



De-energized ≙ $V_{g\,max}$

Energized ≙ $V_{g\,min}$

Techn. data EZ		
Version	EZ 1/6	EZ 2/7
Supply voltage	12V DC	24V DC
Nom. current at 20°C	1.5 A	0.8 A
Duty cycler	100% ED	100% ED
Plug protection class to DIN 43650	IP 65	IP 65

Ambient temperature range -20°C to +60°C.
If the above temperature range cannot be met please consult us

Features

– with spring return at solenoid

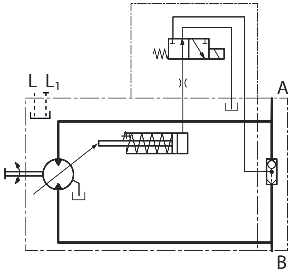
– Solenoid plug can be turned 4 x 90°

Version EZ6/7 with stroking time shuttle orifice.

Slow down of swivel action by means of shuttle orifice.
This enables a smooth swivel action.
Standard orifice size = 0.21 mm; other sizes on request.

More information see page 25

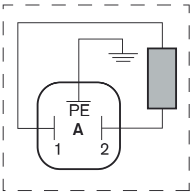
Circuit diagram EZ1/2



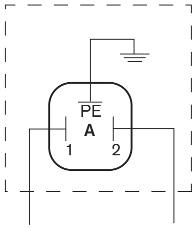
Ports for	
A, B	Pressure
L, L1	Caise drain (L1 plugged)

2

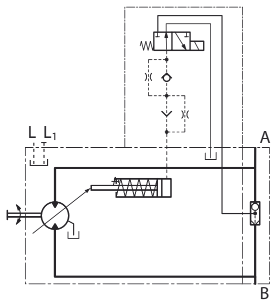
Connection to solenoid according to DIN 43650



Plug connection to DIN EN 175301-803-A Cable screw joint M 16x1.5



Circuit diagram EZ6/7



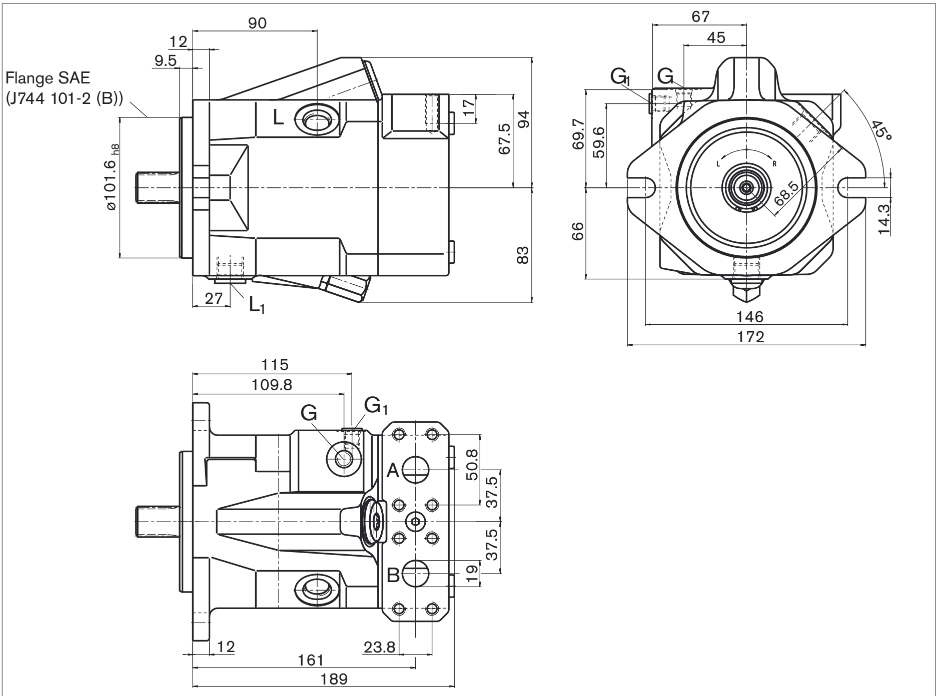
Ports for	
A, B	Pressure
L, L1	Caise drain (L1 plugged)

1) Shown in the unit dimensions: DIN connector from HIRSCHMANN;
Preferred for mobile applications (other dimensions): DEUTSCH connector molded, 2-pin – without suppressor diode

Dimensions A10VM size28

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VM 28**DG**/52WX-VXC**10**N000



Ports

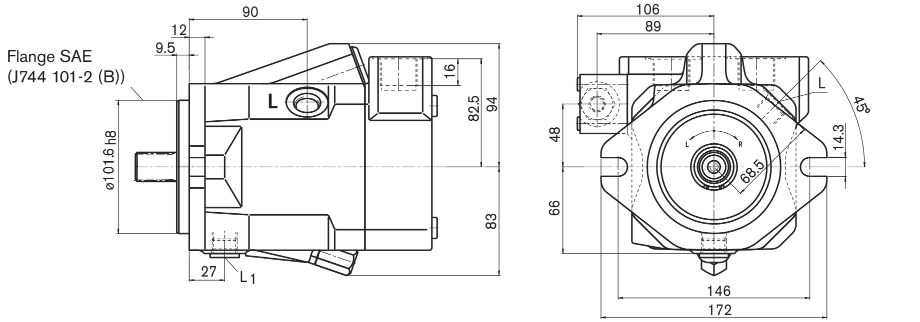
Designation	Port for	Standard	Size[2)	Max. press. [bar][3)	State
A, B	Pressure (High presure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5)	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5)	3/4-16UNF-2B	4	O[4)
L_1	Case drain	ISO 11926[5)	3/4-16UNF-2B	4	X[4)
G	External control pressure	ISO 11926[5)	7/16-20 UNF-2B; 12 deep	350	O
G_1	External control pressure	ISO 11926[5)	7/16-20 UNF-2B; 12 deep	350	X
X	Pilot pressure	ISO 11926[5)	7/16-20UNF-2B; 10 deep	350	O

1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.
O = must be connected (plugged on delivery)
X = Plugged (in normal operation)

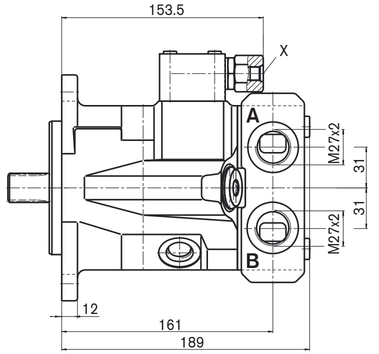
Dimensions A10VM size 28

Before finalising your design please request a certifified installation drawing.
Dimensions in mm

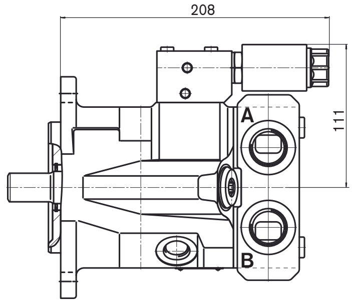
A10VM 28**HZX(EZX)**/52WX-VXC**16**N000



A10VM 28**HZX**/52WX-VXC**16**N000

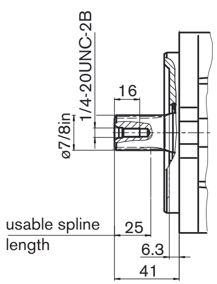


A10VM 28**EZX**/52WX-VXC**16**N000



Drive shaft

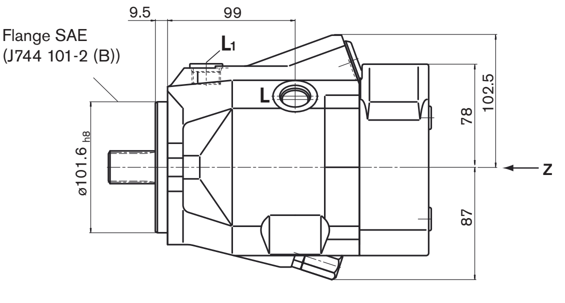
R Splined 7/8 in 13T 16/32DP[1)]
(SAE J744 - 22-4 (B))

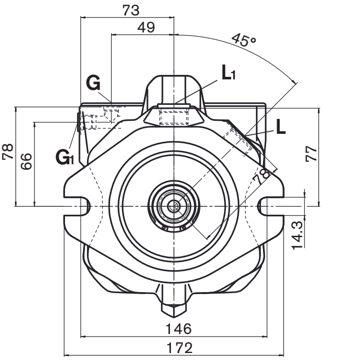


Dimensions A10VM size 45

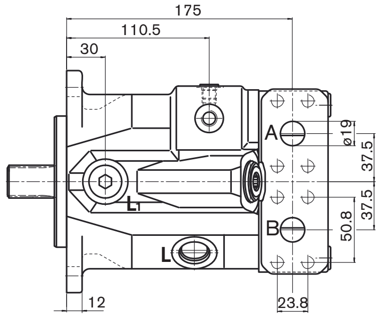
Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VM 45**DG**/52WX-VXC**10(11)**N000

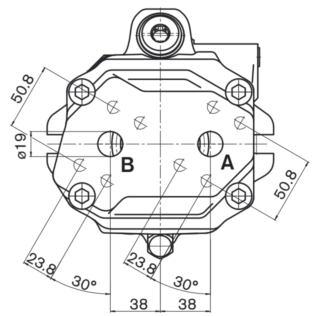




Port plate 10



View Z
Port plate 11



Ports

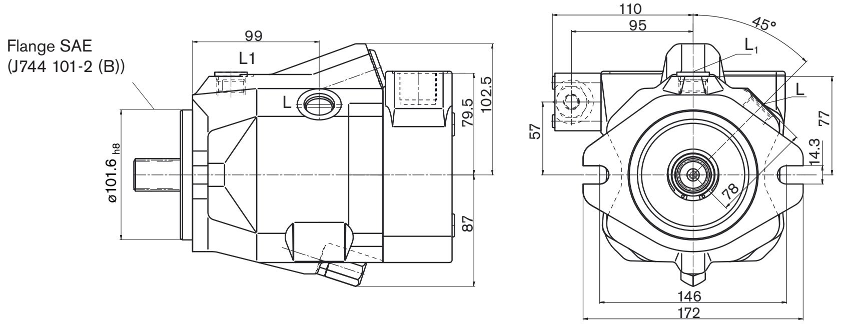
Designation	Port for	Standard	Size[2]	Max. press. [bar][3]	State
A, B	Pressure (high pressure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5]	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	O[4]
L_1	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	X[4]
G	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	O
G_1	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	X
X	Pilot pressure	ISO 11926[5]	7/16-20UNF-2B; 10 deep	350	O

1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.
O = must be connected (plugged on delivery)
X = Plugged (in normal operation)

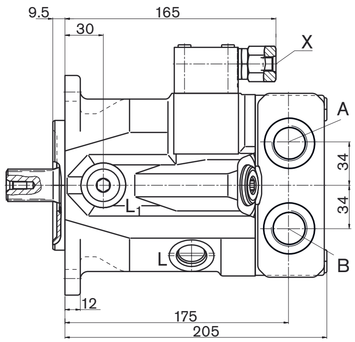
Dimensions A10VM size 45

Before finalising your design please request a certified installation drawing.
Dimensions in mm

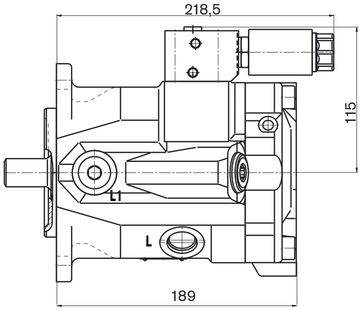
A10VM 45**HZX(EZX)**/52WX-VXC**11(16)**N000



A10VM 45**HZX**/52WX-VXC**16**N000

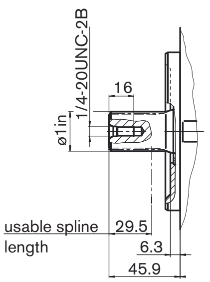


A10VM 45**EZX**/52WX-VXC**11**N000

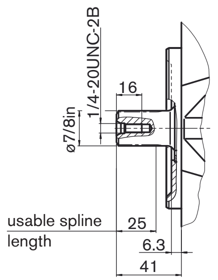


Drive shaft

R Splined 1 in 15T 16/32DP[1)] (SAE J744 - 25-4 (B-B))



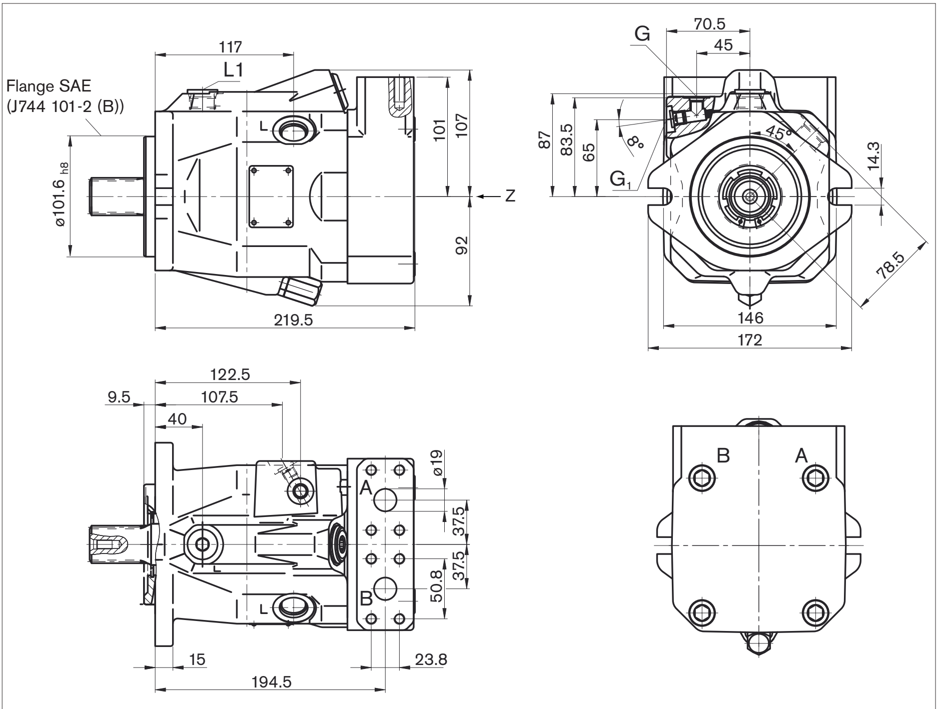
W Splined 7/8 in 13T 16/32DP[1)] (SAE J744 - 22-4 (B))



Dimensions A10VM size 63

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VM 63**DG**/52WX-VXC**10**N000



Ports

Designation	Port for	Standard	Size[2]	Max. press. [bar][3]	State
A, B	Pressure (high pressure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5]	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	O[4]
L_1	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	X[4]
G	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	O
G_1	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	X
X	Pilot pressure	ISO 11926[5]	7/16-20UNF-2B; 10 deep	350	O

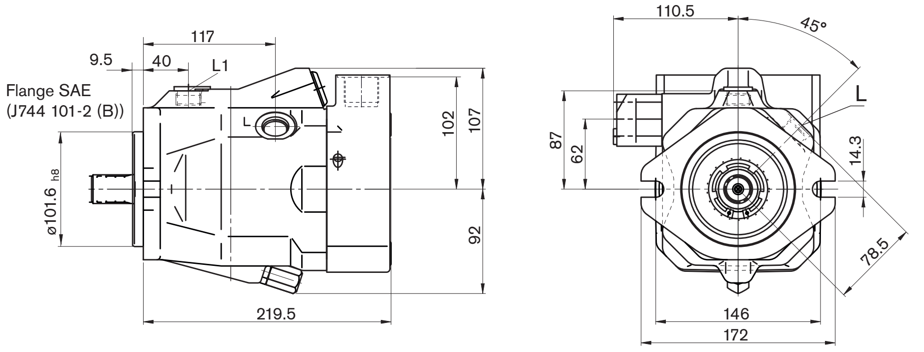
1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must bee connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.

O = must bee connected (plugged on delivery)
X = Plugged (in normal operation)

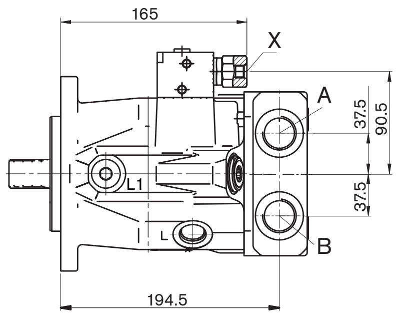
Dimensions A10VM size 63

Before finalising your design please request a certifified installation drawing.
Dimensions in mm

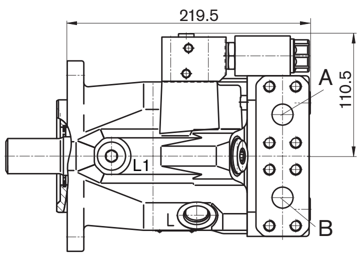
A10VM 63**HZX(EZX)**/52WX-VXC**10(16)**N000



A10VM 63**HZX**/52WX-VXC**16**N000

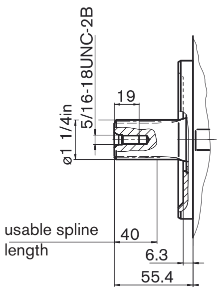


A10VM 63**EZX**/52WX-VXC**10**N000

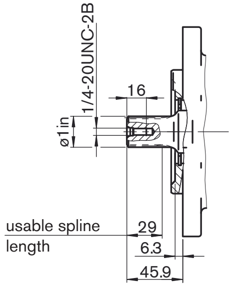


Drive shaft

R Splined 1 1/4 in 14T 12/24DP[1)]
(SAE J744 - 32-4 (C))



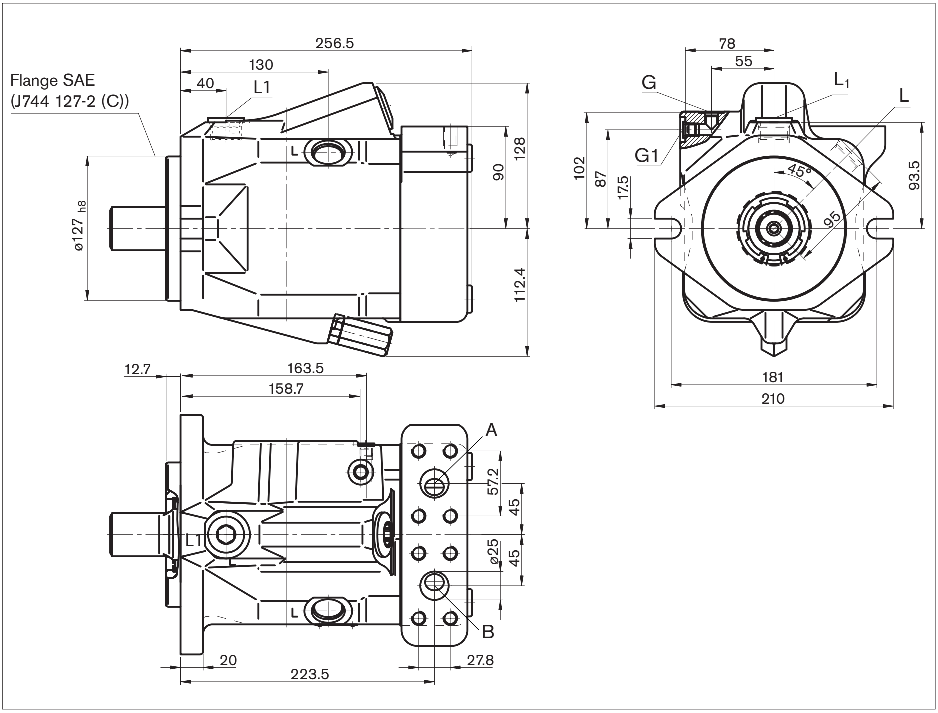
W Splined 1 in 15T 16/32DP[1)]
(SAE J744 - 25-4 (B-B))



Dimensions A10VM size 85

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VM 85**DG**/52WX-VXC**10**N000



Ports

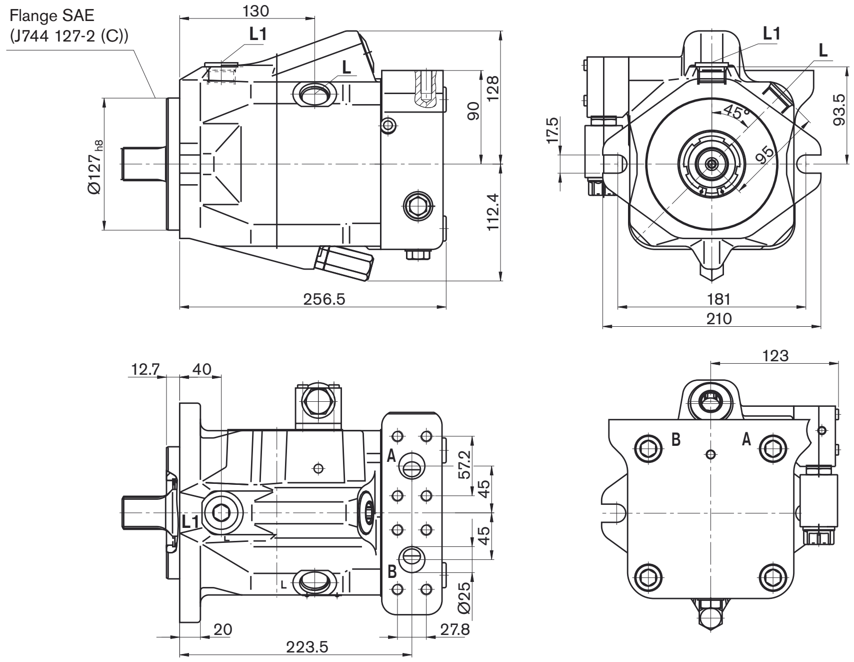
Designation	Port for	Standard	Size2)	Max. press. [bar]3)	State
A, B	Pressure (high pressure sereis, code 62)	SAE J518C	1 in	350	O
	Fixing thread (port plate 10)	DIN 13	M12; 17 deep		O
L	Case drain	ISO 11926 5)	1 1/16-12UN-2B	4	O 4)
L_1	Case drain	ISO 11926 5)	1 1/16-12UN-2B	4	X 4)
G	external control pressure	ISO 11926 5)	7/16-20 UNF-2B; 12 deep	350	O
G_1	external control pressure	ISO 11926 5)	7/16-20 UNF-2B; 12 deep	350	X

1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.
O = must be connected (plugged on delivery)
X = Plugged (in normal operation)

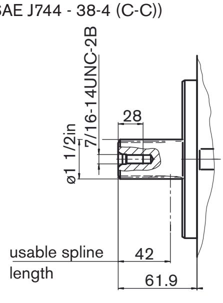
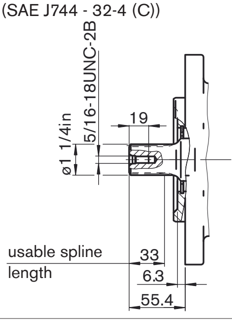
Dimensions A10VM size 85

Before finalising your design please request a certifified installation drawing.
Dimensions in mm

A10VM 85**EZX**/52WX-VXC**10**N000



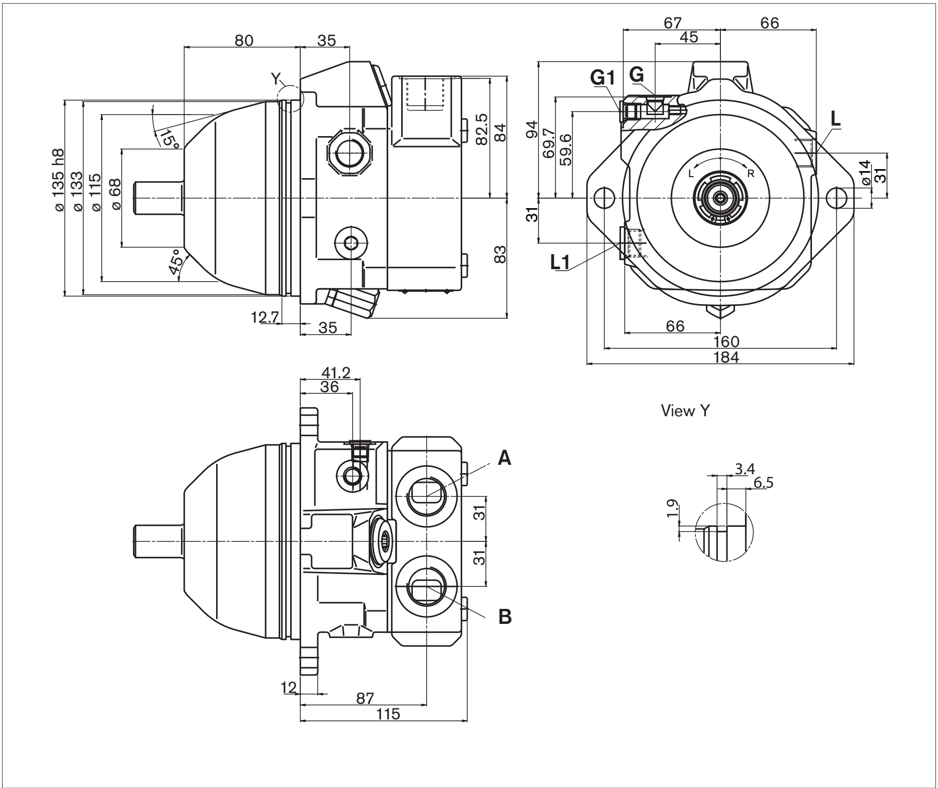
Drive shaft

R	Splined 1 1/2 in 17T 12/24DP[1)] (SAE J744 - 38-4 (C-C))	W	Splined 1 1/4 in 14T 12/24DP[1)] (SAE J744 - 32-4 (C))
			

Dimensions A10VE size 28

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VE 28**DG**/52WX-VXF**16**N000



Ports

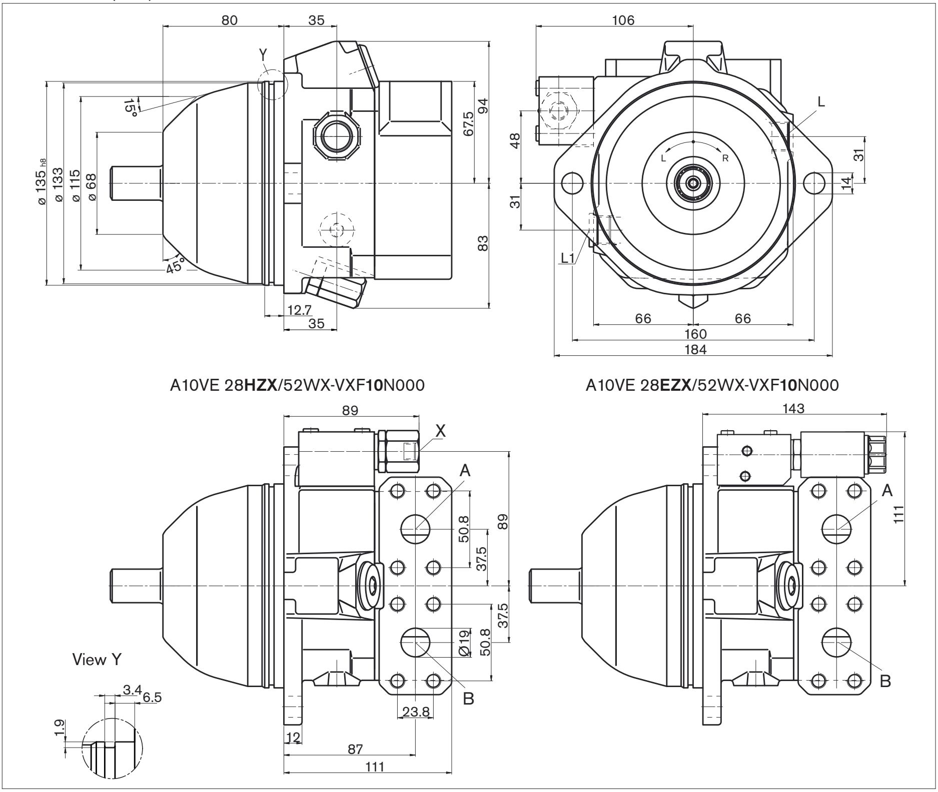
Designation	Port for	Standard	Size[2]	Max. press. [bar][3]	State
A, B	Pressure (high pressure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5]	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5]	3/4-16UNF-2B	4	O[4]
L_1	Case drain	ISO 11926[5]	3/4-16UNF-2B	4	X[4]
G	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	O
G_1	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	X
X	Pilot pressure	ISO 11926[5]	7/16-20UNF-2B; 10 deep	350	O

1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.
O = must be connected (plugged on delivery)
X = Plugged (in normal operation)

Dimensions A10VE size 28

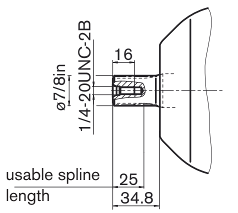
Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VE 28**HZX(EZX)**/52WX-VXF**10**N000



Drive shaft

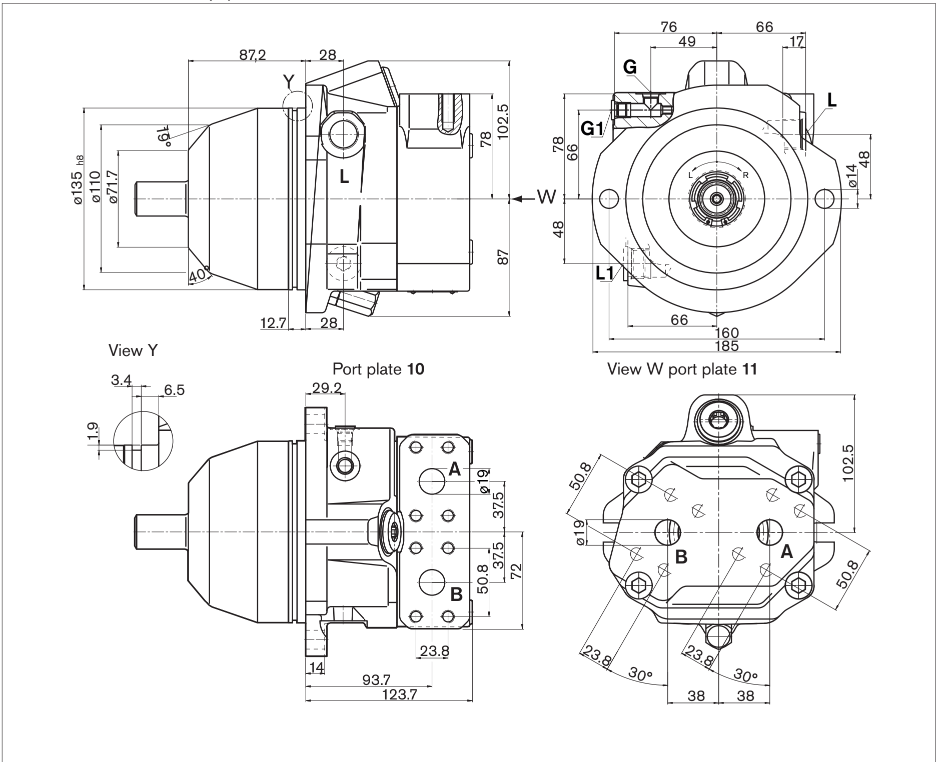
R Splined 7/8 in 13T 16/32DP[1)]
(SAE J744 - 22-4 (B))



Dimensions A10VE size 45

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VE 45**DG**/52WX-VXF**10(11)**N000



Ports

Designation	Port for	Standard	Size[2]	Max. press. [bar][3]	State
A, B	Pressure (high pressure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10, 11)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5]	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	O[4]
L_1	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	X[4]
G	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	O
G_1	External control pressure	ISO 11926[5]	7/16-20 UNF-2B; 12 deep	350	X
X	Pilot pressure	ISO 11926[5]	7/16-20UNF-2B; 10 deep	350	O

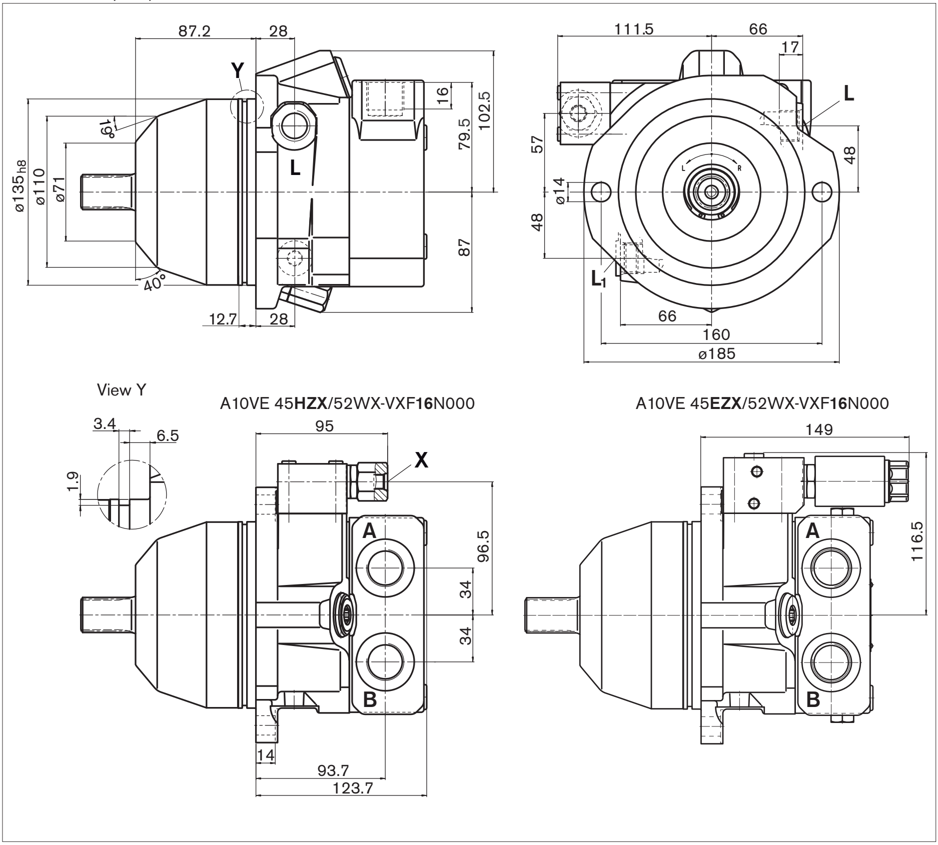
1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.

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

Dimensions A10VE size 45

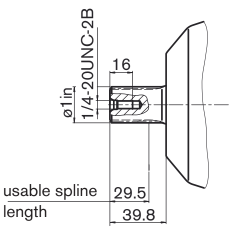
Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VE 45**HZX(EZX)**/52WX-VXF**16**N000

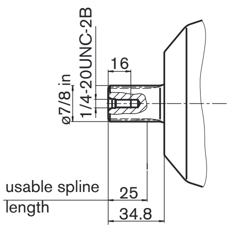


Drive shaft

R Splined 1 in 15T 16/32DP[1] (SAE J744 - 25-4 (B-B))



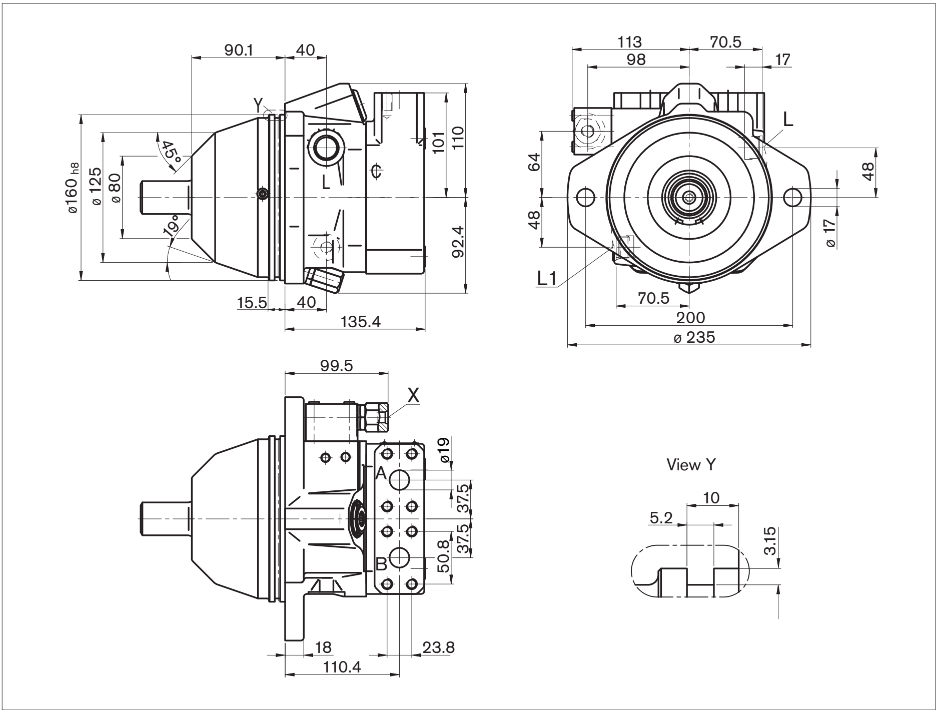
W Splined 7/8 in 13T 16/32DP[1] (SAE J744 - 22-4 (B))



Dimensions A10VE size 63

Before finalising your design please request a certified installation drawing.
Dimensions in mm

A10VE 63**HZ**/52WX-VXF**10**N000



Ports

Designation	Port for	Standard	Size[2]	Max. press. [bar][3]	State
A, B	Pressure (high pressure series, code 62)	SAE J518	3/4 in	350	O
	Fixing thread (port plate 10)	DIN 13	M10; 17 deep		O
A, B	Pressure (port plate 16)	DIN 3852-1[5]	M27x2; 16 deep	350	O
L	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	O[4]
L_1	Case drain	ISO 11926[5]	7/8-14UNF-2B	4	X[4]
X	External control pressure	ISO 11926[5]	7/16-20UNF-2B; 10 deep	350	O

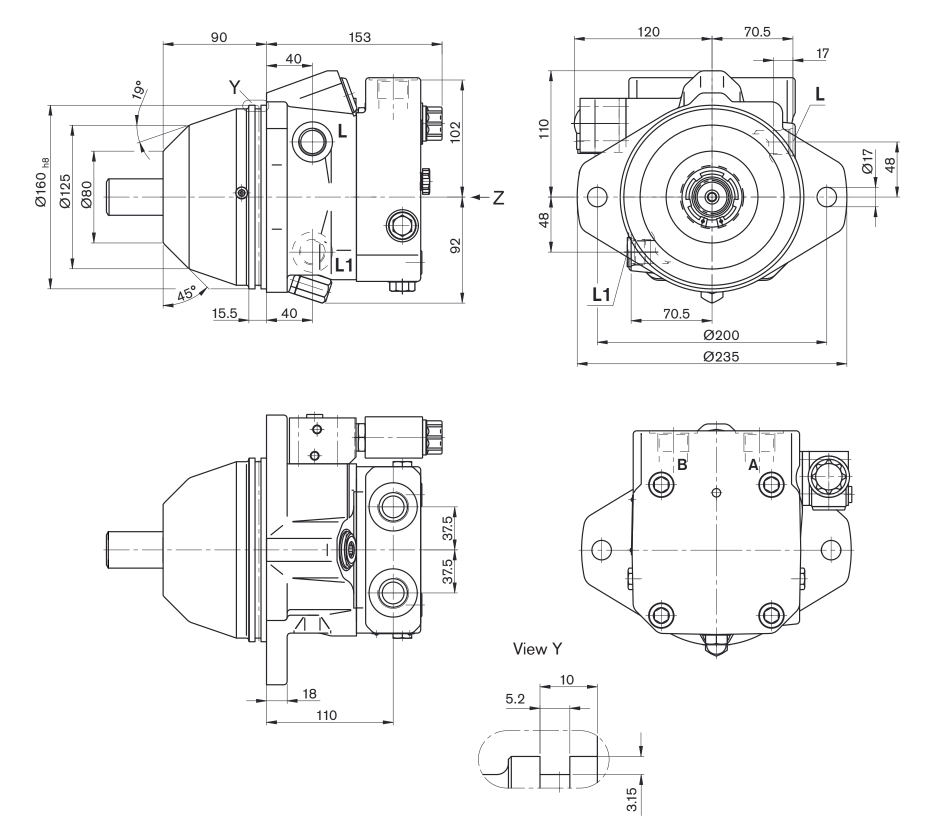
1) ANSI B92.1a-1976, 30° pressure angle, flat root, side fit, tolerance class 5
2) Observe the general instruction on page 28 for the maximum tightening torques.
3) Short-term pressure spikes may occur depending on the application. Keep this in mind when selecting measuring devices and fittings.
4) Depending on installation position L oder L_1 must be connected (see also page 27).
5) The spot face can be deeper than specified in the appropriate standard.

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

Dimensions A10VE size 63

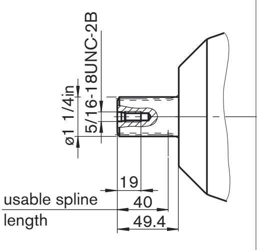
Before finalising your design please request a certifified installation drawing.
Dimensions in mm

A10VE 63**EZX**/52WX-VXF**16**N000

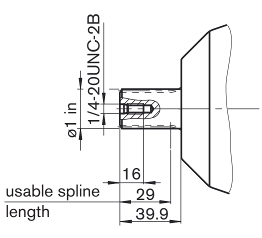


Drive shaft

R Splined 1 1/4 in 14T 12/24DP1) (SAE J744 - 32-4 (C))



W Splined 1 in 15T 16/32DP1) (SAE J744 - 25-4 (B-B))



Integrated flushing and boost press. relief valve, N007

The flushing and boost pressure relief valve is used in closed circuits to flush an unacceptable heat load out of the circuit and to maintain a minimum boost pressure level (fixed setting). The valve is integrated into the port plate.

A built-in fixed orifice determines the flushing flow, which is taken out of the low pressure side of the loop and directed into the motor housing. It leaves the housing together with the case drain flow. This combined flow must be replenished with fresh, cool fluid by means of the boost pump.

Standard flushing flow

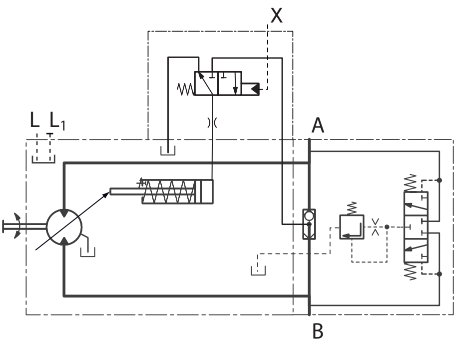
With a pressure of p_{ND} = 20 bar in the low pressure side of the circuit and an orifice dia. of ø1.6 mm the flushing flow amounts to 5.5 L/min (Size 28 - 85).
Other orifice diameters can be ordered in clear text.

Further flushing flows for sizes 28 - 85 see table:

Flushing flow (L/min)	Orifice dia. in mm
3.5	1.2
5.5	1.6
7.2	1.8

Circuit diagram

e.g. A10VO..HZ/...N007



Ports for	
A, B	pressure
L, L_1	case drain (L_1 plugged)
X	pilot pressure

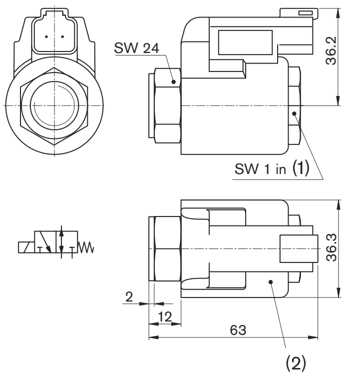
Connector for solenoids

DEUTSCH WKM08130D-01-C-V-XXDN, 2-pin

Molded, without bidirectionale suppressor diode
(Standard) ____ P

Rexroth part-No. R902650409 ____________________ 12V
R902650408 ____________________ 24V

Technical data of electric	
Voltage	Cocurrent flow
Supply voltage	12 or 24 V
Nominal current	1.5 A
Voltage tolerance	-15 % bis +15 %
Operating period	100 %
Protection class	IP 65
Technical data of hydraulic	
Nominal pressure	maximum 350 bar
Flow	maximum 25 L/min
Sealing	FKM (flour-rubber)
Operating temperature of fluid	-20 °C to +120 °C
Viskosity range	10 mm^2/s to 420 mm^2/s
Function	D



The female connector is not part of the scope of supply.
This can be supplied by Rexroth on request.

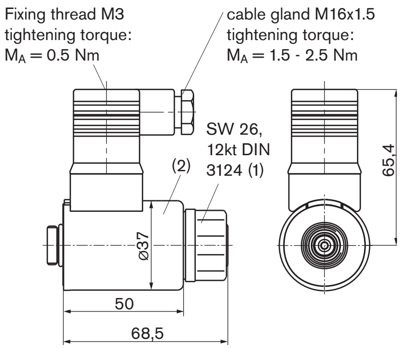
HIRSCHMANN DIN EN 175 301-803-A /ISO 4400
(not for new projects)

without bidirectional suppressor diode ________________ H

Degree of protection to DIN/EN 60529: IP65

The sealing ring in the cable gland (M16x1,5) is suitable for cables 4.5 mm to 10 mm in diameter.

The HIRSCHMANN-connector is part of the scope of supply of the motor.



Note for round solenoids:

The position of the connector can be changed by turning the solenoid body.

Proceed as follows:

– 1. Loosen fixing nut (1)

– 2. Turn the solenoid body (2) to the desired position.

– 3. Tighten the fixing nut

Tightening torque of fixing nut: 5+1 Nm

Electronic controls

Control	Electronic function	Electronics		Further information
Electric pressure control	Regulated current outout	RA	analogue	RD 95 230
		VT2000	analogue	RD 29 904
		RC2-2/21 [1]	digital	RD 95 201

[1] Current outputs for 2 valves, sparately controllable

2

Speed pickup

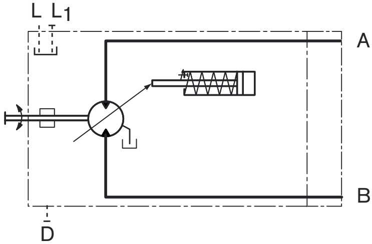
Before finalising your design please request a certified installation drawing.
Dimensions in mm

The version A10VM/E...D („prepared for speed pickup“) comprises gearing around the rotary unit.

In this case, the rotating cylinder barrel can provide a speed dependent signal, which can be picked up by a suitable sensor and processed for further evaluation. The sensor port will be plugged for delivery.
This preparation for speed pickup does not include the necessary working parts. They must be ordered separately as a kit with a corresponding part number.
Inductive speed sensor ID R 18/20-L250 (see RE 95130) and mounting parts (spacer and 2 seals per kit) can be ordered separately under the following part numbers:

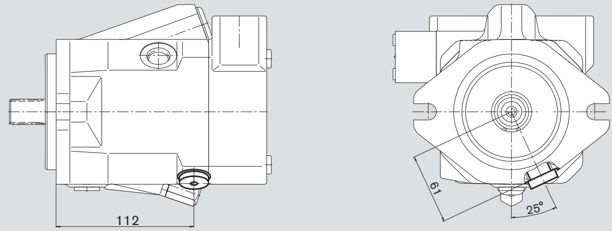
Size	Part Nr.	Number of teeth
28	R902428802	48
45	R902437557	48
63	R902428802	56
85	in preparation	

Circuit diagram



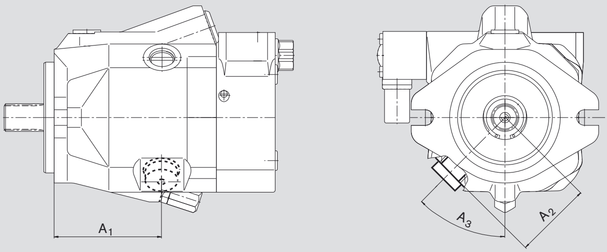
Dimension port D

A10VM 28

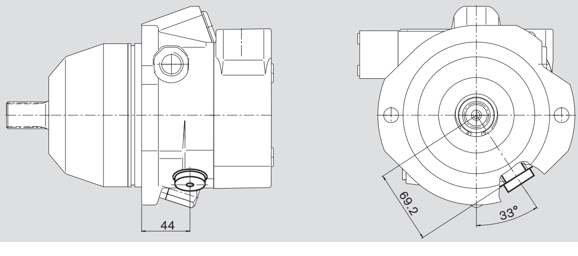


A10VM 45, 63 and 85

Size	A1	A2	A3
45	96	69.2	45°
63	140.5	71	57.5°
85	130	91.3	45°



A10VE 45



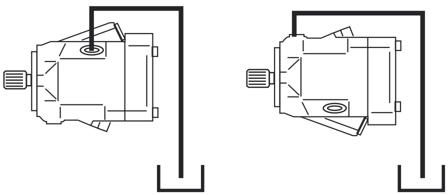
Mounting position

The motor housing must be filled during start up and operation. The drain line must be arranged, so that the housing cannot empty itself when the motor is at standstill. The end of the drain line must enter the tank below the minimum fluid level.

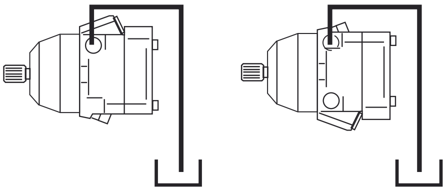
In all installation positions the highest case drain port must be used to fill the housing and to connect the drain line.

In case of a vertical installation please consult us.

A10VM



A10VE



General instructions

– The A10VM/VE is designed for operation in open and closed circuits

– Systems design, installation and commissioning requires trained technicians or tradesmen.

– Be sure to read the entire operating instructions throughly and completely befor using the axial piston unit. If necessary, request them at Rexroth.

– All hydraulic ports can only be used for the fastening of hydraulic service lines.

– During and shortly after operation of a axial piston unit the housing and especially a solenoid can be extremely hot, avoid being burned; take suitable safety measures (wear protective clothing).

– Dependent on the operating conditions of the axial piston unit (operating pressure, fluid temperature) deviations in the performance curves can occur.

– Pressure ports:
All materials and port threads are selected and designed in such a manner, that they can withstand the maximum pressure.
The machine and system manufacturer must ensure, that all connecting elements and hydraulic lines are suitable for the actual operating pressures.

– Pressure cut off and pressure control are not suitable for providing system protection against excessive pressures. A suitable overall main line relief valve must be incorporated.

– All given data and information must be adhered to.

– The following tightening torques are valid:

- Female threads in the axial piston unit:
the maximum permissible tightening torques M_{GMax} are maximum values for the female threads in the pump casting and may not be exceeded. Value see table below.

- Fittings:
please comply with the manufacturer‘s information regarding the max. permissible tightening torques for the used fittings.

- Fastening bolts:
for fastening bolts to ISO 68 we recommend to check the permissible tightening torques in each individual case to VDI 2230.

- Plugs:
for the metal plugs, supplied with the axial piston unit the following min. required tightening torques M_V apply (see table).

Threaded port sizes		Maximum permissible tightening torque of the threaded holes $M_{G\ max}$	Requiered tightening torque of the locking screws M_V	WAF hexagon socket of the locking screws
7/8-14 UNF-2B	ISO 11926	240 Nm	127 Nm	3/8 in
7/16-20UNF-2B	ISO 11926	40 Nm	15 Nm	3/16 in
3/4-16 UNF-2B	ISO 11936	160 Nm	62 Nm	5/16 in
1 1/16-12 UNF-2B	ISO 11926	360 Nm	147 Nm	9/16 in
M14x1,5	DIN 3852	80 Nm	35 Nm	6 mm
M16x1,5	DIN 3852	100 Nm	50 Nm	8 mm
M18x1,5	DIN 3852	140 Nm	60 Nm	8 mm
M22x1,5	DIN 3852	210 Nm	80 Nm	10 mm
M27x2	DIN 3852	330 Nm	135 Nm	12 mm

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Telephon +49 (0) 74 51 92-0
Fax +49 (0) 74 51 82 21
info.brm-ak@boschrexroth.de
www.boschrexroth.com/axial-piston-motors

External gear motors

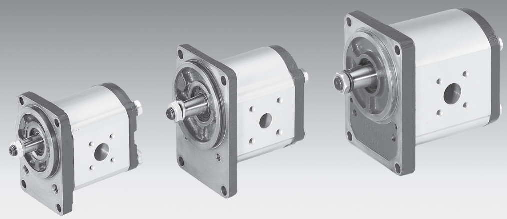
Designation	**Type**	**Size**	**Component series**	p_{max} in bar	**Data sheet**	**Page**
External gear motors	AZMF, AZMN, AZMG	8 ... 45	1X		14026	339

External Gear Motors

RE 14 026/05.09
Replaces:
RE 14 026/01.05

AZMF ..., AZMN ..., AZMG ...

Model F = 8 ... 22.5 cm³/rev
N = 25 und 28 cm³/rev
G = 22.5 ... 45 cm³/rev



Contents

General

Rexroth external gear motors are produced in 3 different models, with different displacements being produced by means of gears of differing widths.
Different versions of motors are achieved by the use of different flanges, shafts, valves and integrated speed sensors.

Features

- High pressures combined with small size and low weight
- Large speed ranges
- Broad viscosity and temperature ranges
- Reversible motors for 2- and 4-quadrant operation

Fields of application

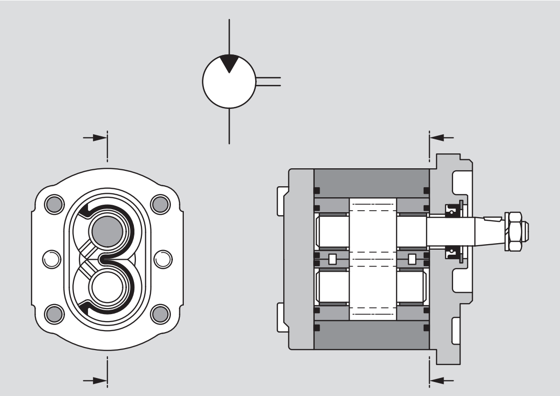
- Road construction machines as road rollers and pavers
- Agricultural machines and forestry technology as harvesters and forestry machines
- Street vehicles such as busses, trucks and special vehicles and above all in hydrostatic fan drives.

Function

If pressurized oil is fed into the motor, a torque can be obtained from the shaft leading out of the housing. Here, a distinction is made between motors that rotate on one direction and reversible motors.

External gear motors that rotate in one direction

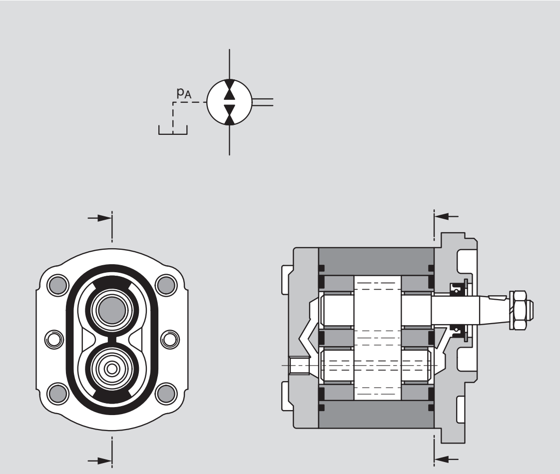
These are of asymmetrical design, i.e. the high and low pressure sides are defined and not interchangeable at will. In this case, reversible operation is not possible. In order to ensure a high efficiency level, a special running-in method is used for motors. Leakage oil is discharged internally to the outlet side. Pressure loading of the outlet is limited by the shaft seal.



Reversible external gear motors

The displacement method in external gear motors is the reverse of the pump process. Reversible motors have a special feature, however. Their symmetrical construction means that the high or low pressure chambers are separate from the bearing and shaft seal chamber. The resulting leakage oil is routed through a separate oil drain gland in the housing cover. This oil drainage enables the motor to be subjected to load via the return line, which in turn allows the use of series connections. Due to the connection between the shaft seal and the low-pressure end, however, standard motors and pumps can only withstand a pressure of up to approx. 3 bar.

The figure shows a reversible gear motor for 4-quadrant operation, i.e. both output and input torque in both directions. (Hydraulic motor becomes a pump if load reversal occurs.)



Product overview “Model F” preferential range

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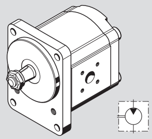
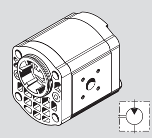
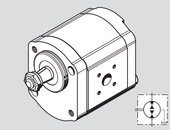
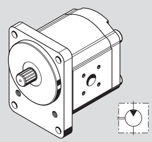
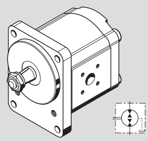
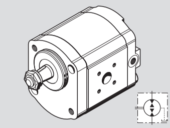
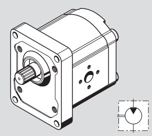
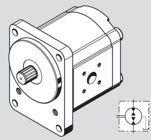
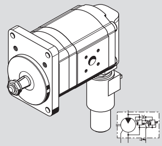
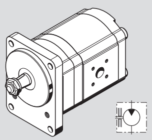
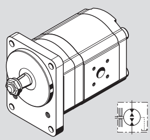
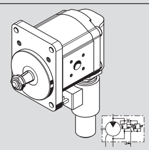
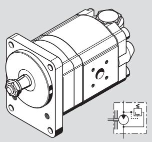
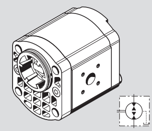
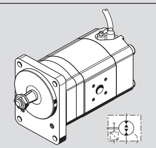
	19		24		29
	20		25		30
	21		26		31
	22		27		32
	23		28		34

Product overview “Model N” preferential range

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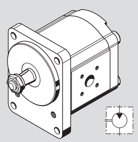
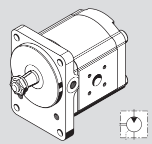
	35		36

Product overview “Model G” preferential range

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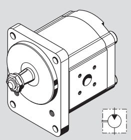
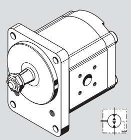
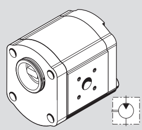
	37		38		39

3

Ordering code

External Gear Motors Model “F”

AZ	M	F	–	1x	–	022	R	C	B	20	M	B	200xx	–	S0001

Function

M = Motor

Series

1x = Standard bearing

Size (F)

8.0 cm³/rev	= **008**
11.0 cm³/rev	= **011**
14.0 cm³/rev	= **014**
16.0 cm³/rev	= **016**
19.0 cm³/rev	= **019**
22.5 cm³/rev	= **022**

Direction of rotation

Right	= **R**
Left	= **L**
Universal	= **U**

*) The special equipments partly contained on the pages 20–35, are not considered in the representation of the ordering code.

Special design*)

Valve adjustment

PRV 200 bar	= **200 xx**
PRV	= **180 xx**

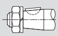
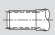
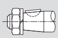
Rear cover

Standard	= **B**
PRV	= **G**
drain oil line connection (axial)	= **L**
PRV excess flow internal	= **D**

Seals

NBR	= **M**
FPM	= **P**
NBR, WDR in FPM	= **K**

Drive shafts

			suitable front cover
C	Tapered keyed shaft 1 : 5		B, P
N	Tang drive		T
F	Spline shaft DIN 5482 B 17 x 14		B, P
S	Tapered keyed shaft 1 : 5 for flange A		A

Front cover

B	Square flange Centring Ø 80 mm	
P	2-bolt mounting Centring Ø 50 mm	
O	Square flange Centring Ø 36.47 mm	
A	Outboard bearing Ø 80 mm, Type 1	
N	2-bolt mounting Centring Ø 50 mm	
T	4-bolt mounting Ø 52 mm, with O-ring	

Port connections

20	Rectangular flange	
30	Rectangular flange	

Ordering code

External Gear Motors Model "N"

AZ	M	N	–	1x	–	020	R	C	B	20	M	B		–	S0001

Function
M = Motor

Series
1x = Standard bearing

Size (N)
25.0 cm³/rev = **025**
28.0 cm³/rev = **028**

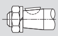
Direction of rotation
Right = **R**
Left = **L**

Special design

Rear cover
Standard = **B**
Special design = **X**

Seals
NBR = **M**
FPM = **P**

Drive shafts (suitable front cover)

C	Tapered keyed shaft 1 : 5		**B**

Front cover

B	Square flange Centring Ø 100 mm	

Port connections

20	Rectangular flange	

External Gear Motors Model "G"

AZ	M	G	–	1x	–	022	R	C	B	20	M	B		–	S0001

Function
M = Motor

Model
G = 22.5...56 cm³/rev

Size (G)
22.5 cm³/rev = **022**
28.0 cm³/rev = **028**
32.0 cm³/rev = **032**
45.0 cm³/rev = **045**

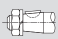
Direction of rotation
Right = **R**
Left = **L**
Universal = **U**

Special design

Rear cover
Standard = **B**
Special design = **X**

Seals
NBR = **M**
NBR, WDR in FPM = **K**

Drive shafts (suitable front cover)

C	Tapered keyed shaft 1 : 5		**B**
N	Tang drive		**M**

Front cover

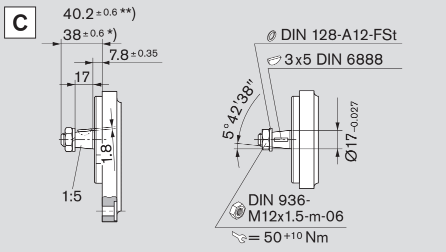
B	Square flange Centring Ø 105 mm	
M	2-bolt mounting Ø 52 mm, with O-ring	

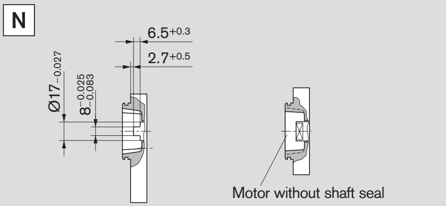
Port connections

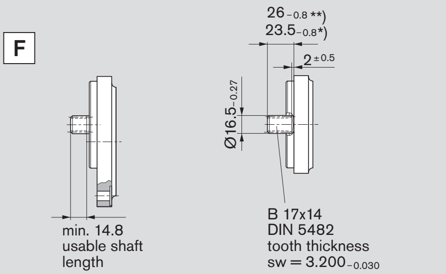
20	Rectangular flange	

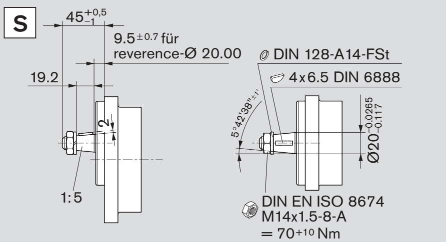
3

Drive shaft model "F"

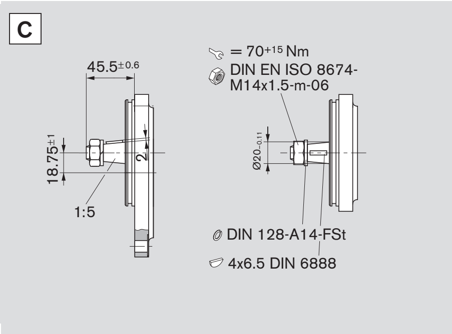








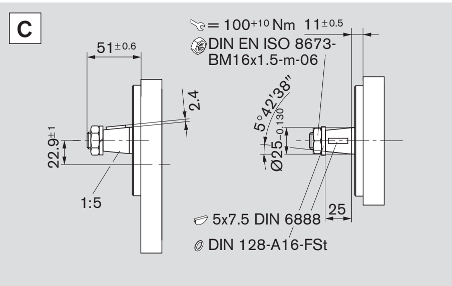
Drive shaft model "N"

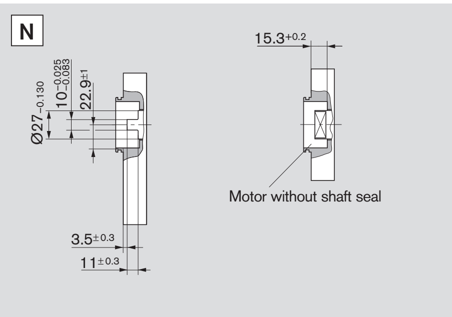


*) in combination with front cover B

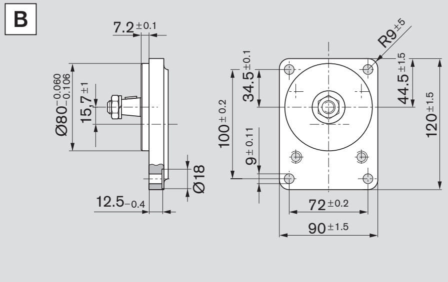
**) in combination with front cover P

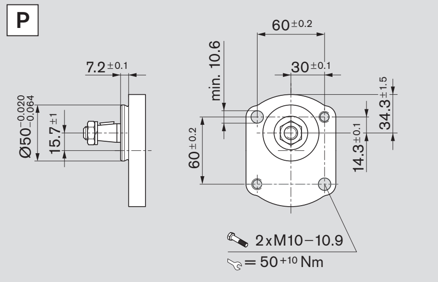
Drive shaft model "G"

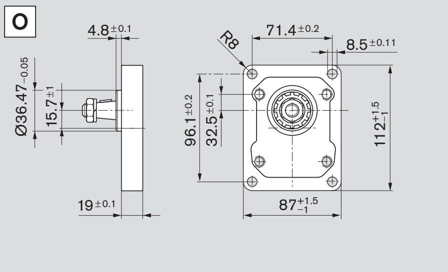


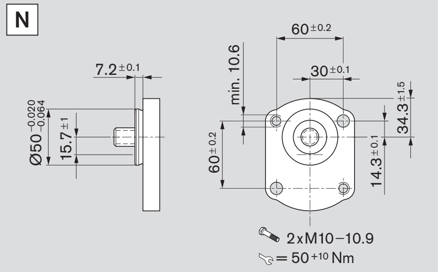


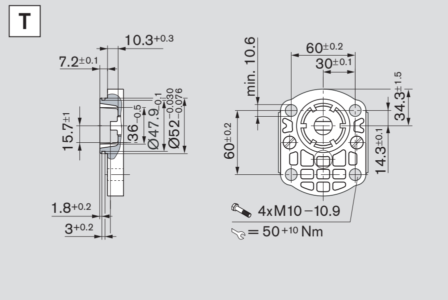
Front cover model "F"

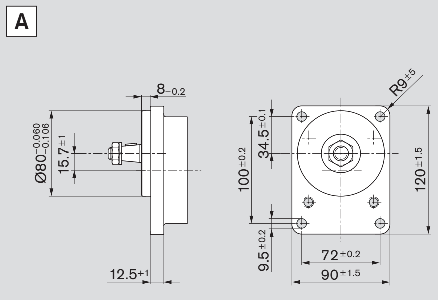




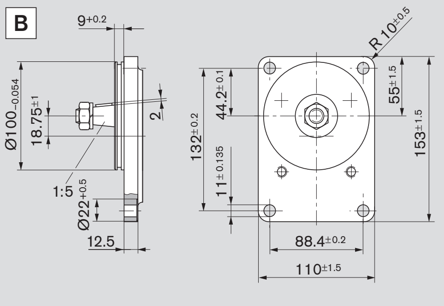




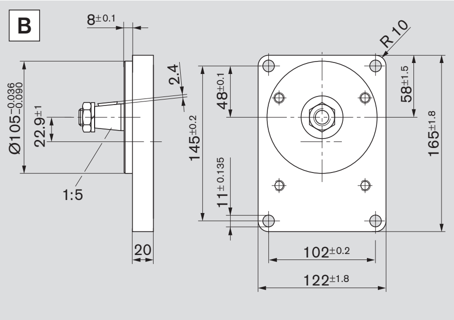


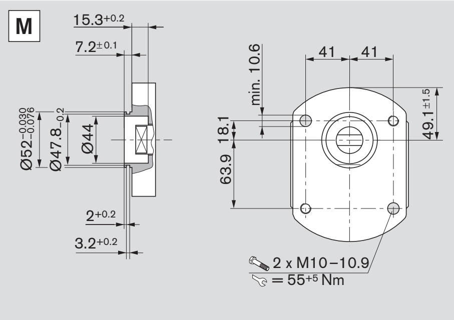


Front cover model "N"

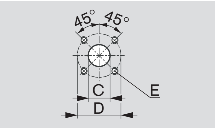


Front cover model "G"





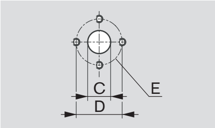
Port connections



20 **Rectangular flange**

Synopsis of Type	Size	Inlet side			Outlet side		
		C	D	E	C	D	E
20	8.0 ... 22.5 cm³	15	35	M6 utilizable depth 13	20	40	M6 utilizable depth 13
	22.5 ... 45.0 cm³	18	55	M8 utilizable depth 13	26	55	M8 utilizable depth 13

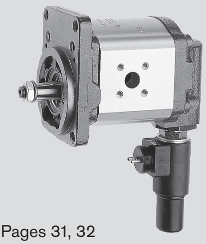
Synopsis of Type	Size	**Port connections** (direction of rotation universal)		
		C	D	E
20	8.0 ... 22.5 cm³	15	35	M6 utilizable depth 13
	22.5 ... 45.0 cm³	18	55	M8 utilizable depth 13

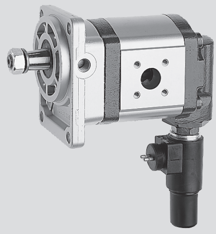


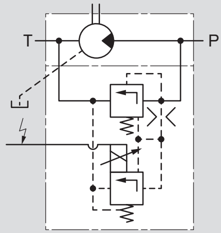
30 **Rectangular flange**

Synopsis of Type	Size	Inlet side			Outlet side		
		C	D	E C	D	E	
30	4 ... 8 cm³	13.5	30.2	M6 utilizable depth 13	13.5	30.2	M6 utilizable depth 13
	11 ... 28 cm³				20.0	39.7	M8 utilizable depth 13

External gear motors with integrated valves, sensors







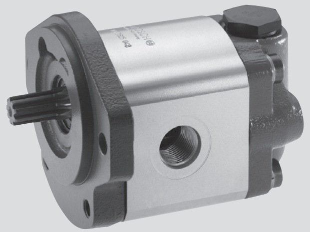
Pages 31, 32

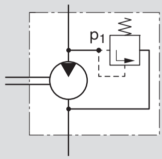
Gear motor with integrated, pilot-operated proportional pressure relief valve and rotary shaft seal relieved of load thanks to the three-chamber design.
The use of gear motors without this relief of the rotary shaft seal is not recommended due to the loads from the oil return line, particularly when the oil is cold. The basis of this drive unit is a motor model “F”. The pilot proportional pressure relief valve is integrated in the rear end cover. This unit has the following advantages:

- No pipework necessary for the functioning of the prop. pressure relief valve
- Integrated pressure relief
- Fail-safe function in the event of power loss
- Drag speed virtually zero
- Motor speed prop. controllable
- Unaffected by pressure loads from the outlet

Additional information see:
Hydrostatic fan drives 1 987 761 700
http://www.boschrexroth.com/brm

External gear motors with pressure relief valve

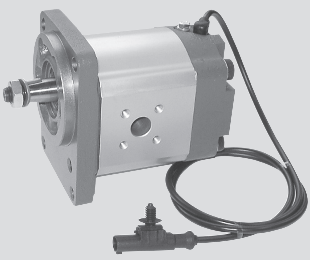




return port pressure < 3 bar (10 bar at starting)

Page 23

External gear motors with integrated speed sensor



Page 34

The DSM1-10 Hall-effect speed sensor was specially developed for tough use in mobile work machines. The sensor detects the speed signal of ferromagnetic gear wheels. In this process, as an active sensor, it supplies a signal with constant amplitude independent of the rotational speed.
Due to its compact, sturdy design, the gear motor with integrated sensor is suitable for the applications such as

- In fan drives for buses, trucks and construction machinery from 7 to 20 kW
- As a vibration drive for road rollers and road construction machinery

For additional information see: **Speed Sensor DSM RE 95 132**
http://www.boschrexroth.com/brm

Design calculations for motors

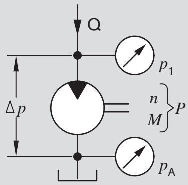
The design calculations for motors are based on the following parameters:

V	[cm³/rev]	Displacement
Q	[l/min]	Inlet flow rate
p	[bar]	Pressure (p_1, p_A)
M	[Nm]	Output torque
n	[rev/min]	Output speed
P	[kW]	Output power

It is also necessary to allow for different efficiencies such as:

η_v Volumetric efficiency
η_{hm} Mechanical-hydraulic efficiency
η_t Total efficiency

The following formulas describe the various relationships. They include correction factors for adapting the parameters to the usual units encountered in practice.
Note: Diagrams providing approximate selection data can be found on subsequent pages. These graphs contain the levels of efficiency in each case.



$$Q = \frac{V \cdot n}{\eta_v} \cdot 10^{-1} \qquad V = \frac{Q \cdot \eta_v}{n} \cdot 10 \qquad n = \frac{Q \cdot \eta_v}{V} \cdot 10$$

$$\Delta p = \frac{M}{1.59 \cdot V \cdot \eta_{hm}} \cdot 10^4 \qquad V = 1.59 \cdot \frac{M}{\Delta p \cdot \eta_{hm}} \cdot 10^4 \qquad M = 1.59 \cdot V \cdot \Delta p \cdot \eta_{hm} \cdot 10^{-4}$$

$$P = \frac{Q \cdot \Delta p \cdot \eta_t}{6} \cdot 10^{-4}$$

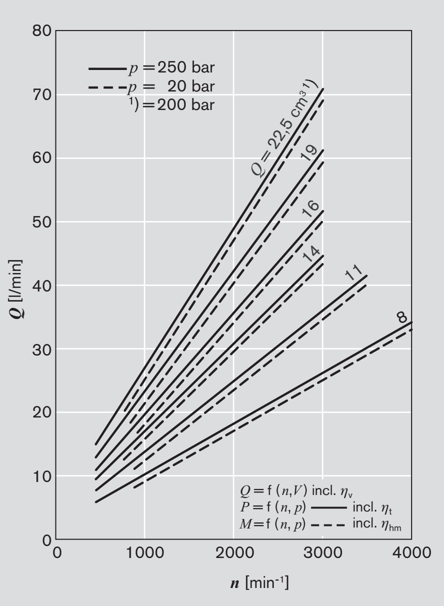
	[%]	
Q	—— η_v ⟶	n
Δp	—— η_{hm} ⟶	M
$\Delta p \cdot Q$	—— η_t ⟶	P

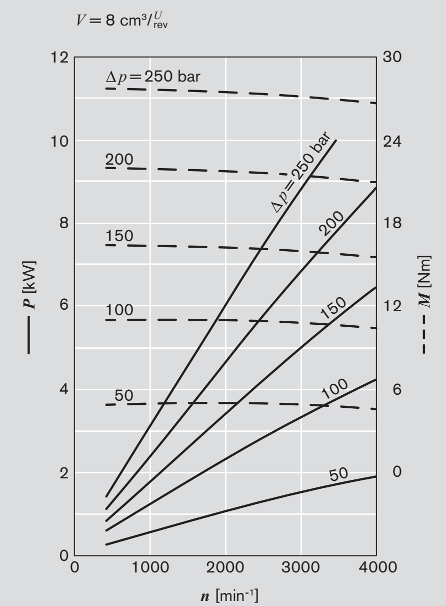
V [cm³/rev] Q [l/min] Δp [bar] **Note:** η [%]

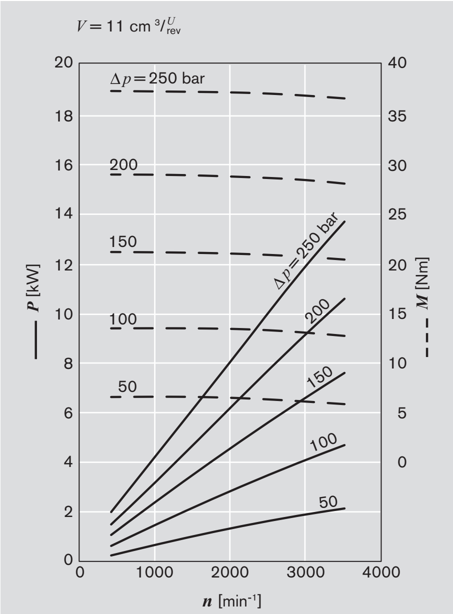
n [rev/min] P [kW] M [Nm]

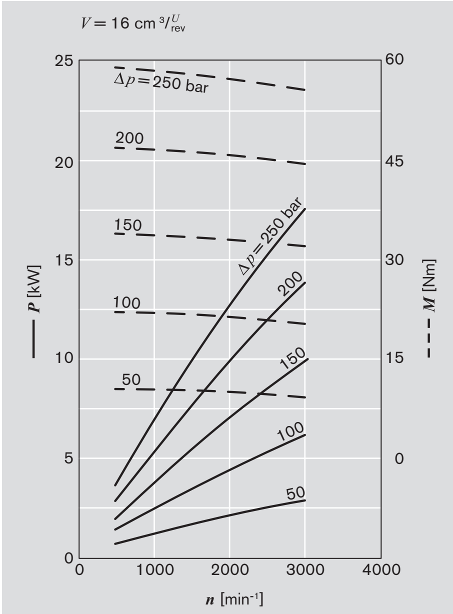
Diagrams Model “F”

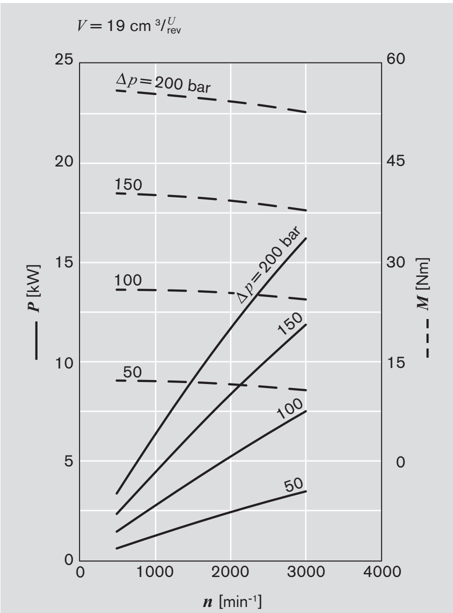
$v = 35$ mm²/s, $T = 50$ °C

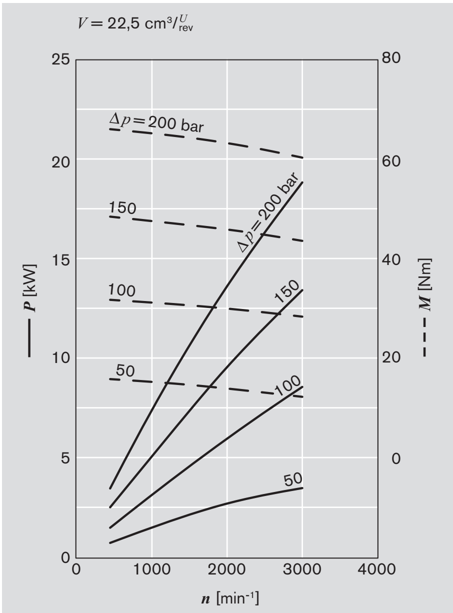





V = 11 cm³/U rev
Δp = 250 bar
200
150
100
50
Δp = 250 bar
200
150
100
50
P [kW]
M [Nm]
n [min⁻¹]


V = 16 cm³/U rev
Δp = 250 bar
200
150
100
50
Δp = 250 bar
200
150
100
50
P [kW]
M [Nm]
n [min⁻¹]

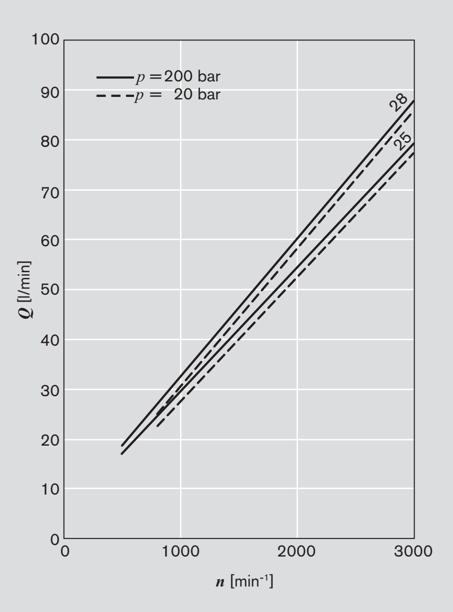

V = 19 cm³/U rev
Δp = 200 bar
150
100
50
Δp = 200 bar
150
100
50
P [kW]
M [Nm]
n [min⁻¹]


V = 22,5 cm³/U rev
Δp = 200 bar
150
100
50
Δp = 200 bar
150
100
50
P [kW]
M [Nm]
n [min⁻¹]

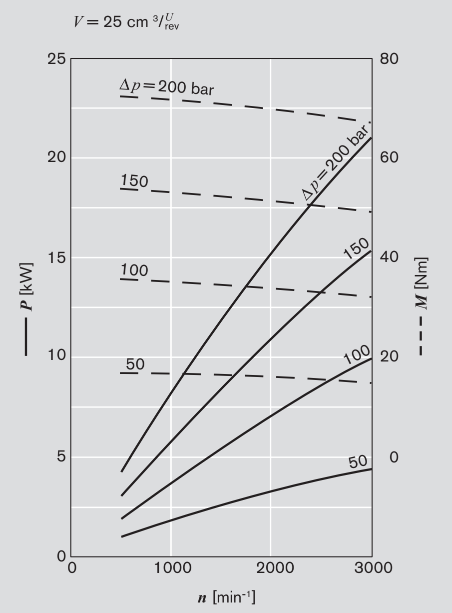
3

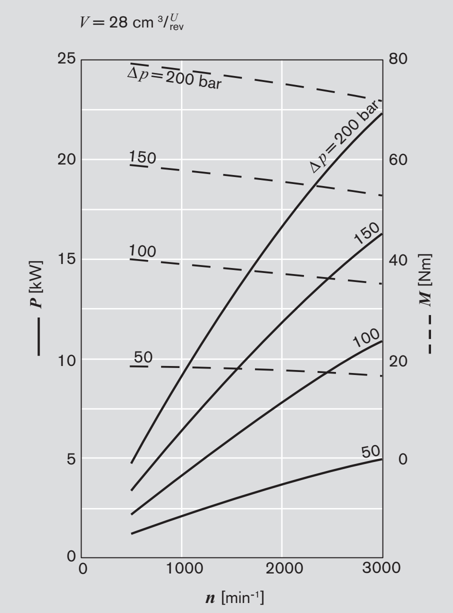
Diagrams Model "N"

$\upsilon = 35$ mm²/s, $T = 50$ °C



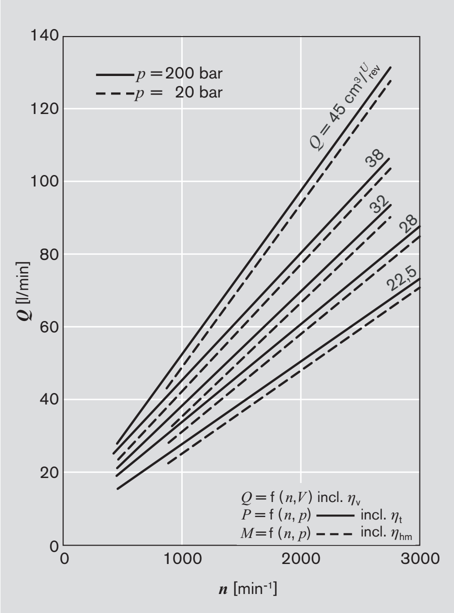
$Q = f(n, V)$ incl. η_v
$P = f(n, p)$ ——— incl. η_t
$M = f(n, p)$ – – – incl. η_{hm}

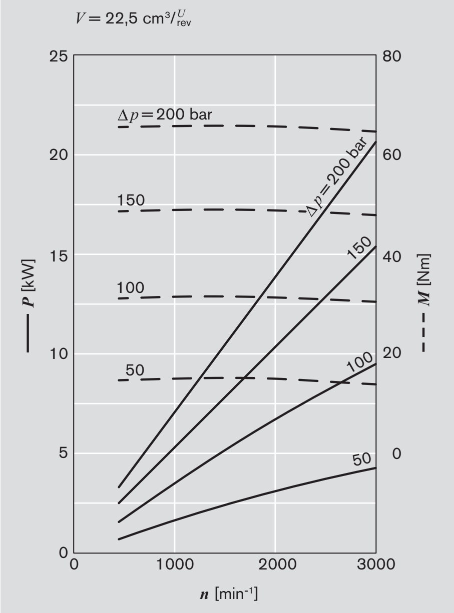


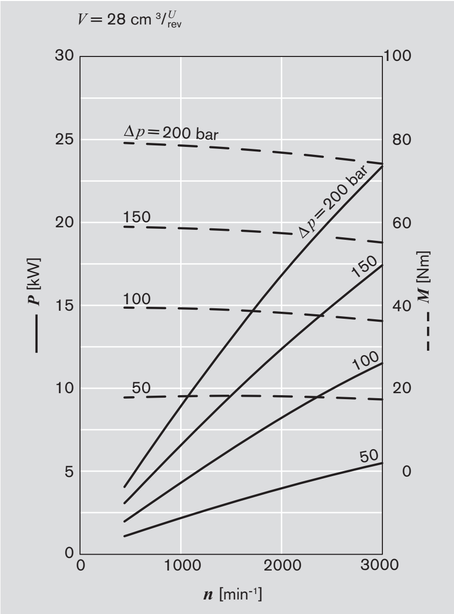


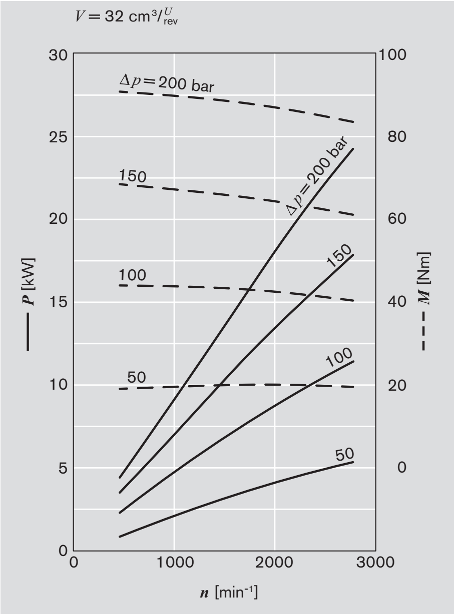
Diagrams Model "G"

$\upsilon = 35$ mm²/s, $T = 50$ °C

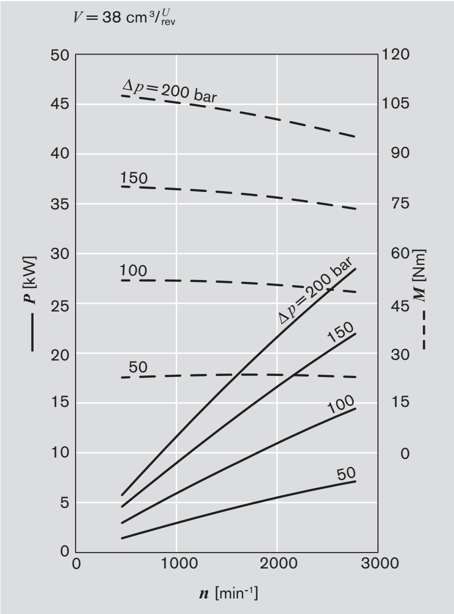


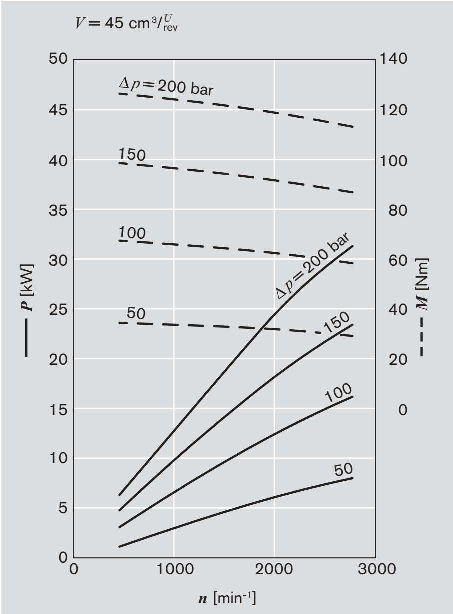






3





Specifications

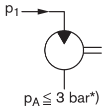
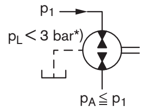
General	
Construction	external gear motor
Mounting	Flange or through-bolting with spigot
Port connections	screw, flange
Direction of rotation (looking on shaft)	One direction of rotation or reversible
Mounting position	any
Load on shaft	radial and axial forces after consulting
Ambient temperature range	–30 °C...+80 °C with NBR seals*) –20 °C...+110 °C with FPM seals**)
Fluids	mineral oil-based hydraulic fluids to DIN/ISO, other fluids upon request
Viscosity	12…800 mm²/s permitted range 20…100 mm²/s recommended range …2,000 mm²/s permitted for starting
Fluid temperature range	max. +80 °C with NBR seals*) max. 110 °C with FPM seals**)
Filter ***)	contamination at least class 19/16 according to ISO 4406 to be obtained with filter b20 = 75. For higher lifespan demands we recommend a corre spondingly higher filter class.

*) NBR = Perbunan®
**) FPM = Viton®
***) During the application of control systems or devices with critical counter-reaction, such as steering and brake valves, the type of filtration selected must be adapted to the sensitivity of these devices/systems.

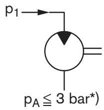
Safety requirements pertaining to the whole systems are to be observed.

In the case of applications with frequent load cycles please consult us.

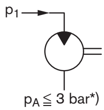
Model F

Displacement	cm³/rev	**5.5** [1])	**8**	**11**	**14**	**16**	**19**	**22.5**
max. continuous pressure p_1	bar	250					180	
max. starting pressure p_2		280					210	
min. rotational speed	min⁻¹	500						
max. rotational speed p_1		4,000		3,500	3,000			
Motor outlet pressure p_A Leakage-oil line pressure p_L	bar							

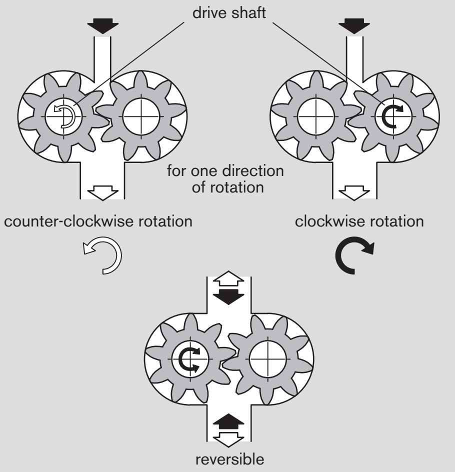
Model N

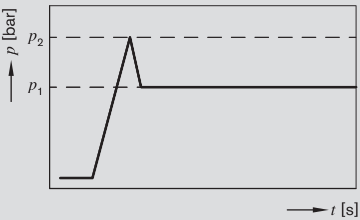
Displacement	cm³/rev	**25**	**28**
max. continuous pressure p_1	bar	210	200
max. starting pressure p_2		240	230
min. rotational speed	min⁻¹	500	
max. rotational speed p_1		3,000	
Motor outlet pressure p_A Leakage-oil line pressure p_L	bar		

Model G

Displacement	cm³/rev	**22.5**	**28**	**32**	**38**	**45**
max. continuous pressure p_1	bar	180				
max. starting pressure p_2		210				
min. rotational speed	min⁻¹	500				
max. rotational speed p_1		3,000		2,800	2,600	
Motor outlet pressure p_A Leakage-oil line pressure p_L	bar					

[1]) On request *) Short-term when starting 10 bar





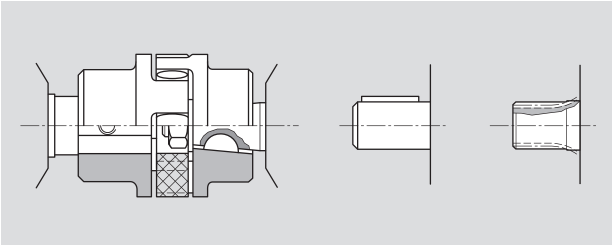
p_1 max. continuous pressure
p_2 starting pressure (depending on the application, this must be taken into consideration when setting the pressure of the hydraulic system's pressure-relief valve).

Power take-off

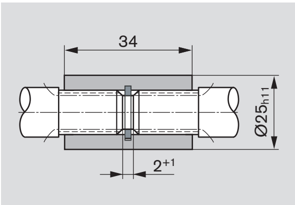
1. Flexible couplings
The coupling must not transfer any radial or axial forces to the motor.

The maximum radial run out of shaft spigot is 0.2 mm.

Refer to the fitting instructions provided by the coupling manufacturer for details of the maximum permitted shaft misalignment.



2. Sleeve couplings
Used on shafts with DIN or SAE splining.
Note: There must be no radial or axial forces exerted on the motor or sleeve coupling. The sleeve must be free to move axially. The distance between the motor shaft and drive shaft must be 2^{+1}. Oil-bath or oil-mist lubrication is necessary.



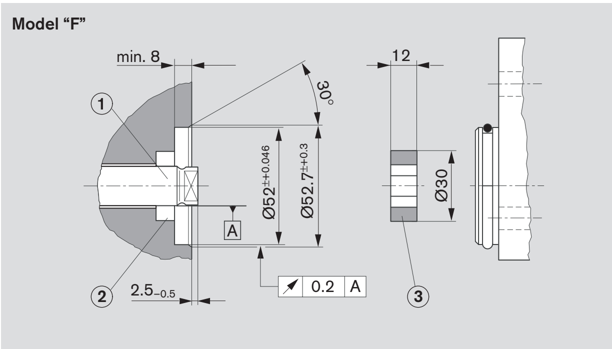
Spline shaft	$M_{max.}$ [Nm]	V [cm³/rev]	$p_{max.}$ [bar]
DIN	190	8...22.5	$p_{max.}$
SAE	130		

3. Drive shaft with tang
For the close-coupling of the motors to gearboxes, etc. the motors shaft has a special drive shaft with tang which combines with a center coupling ③. There is no shaft seal.

The recommended arrangements and dimensions for the drive end and sealing are as follows.

① Drive shaft
Case-hardened steel DIN 17 210, e.g. 20 MnCrS 5
case-hardened 0.6 deep; HRc 60 ±3.
Surface for sealing ring ground without rifling $R_{max.} \leq 4\mu m$

② Radial shaft seal
Rubber-covered seal (see DIN 3760, Type AS or double-lipped ring).
Cut 15° chamfer or fit shaft seal with protective sleeve.

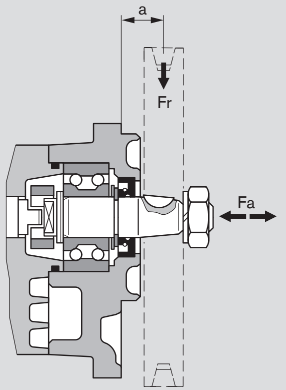


$M_{max.}$ [Nm]	V [cm³/rev]	$p_{max.}$ [bar]
65	8...14	280
	16	230
	19	190
	22.5	160

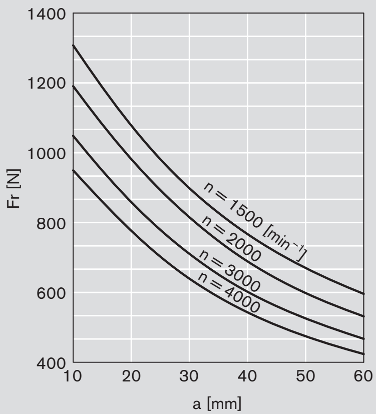
4. Outboard bearing Model "F"

Outboard bearings eliminate possible problems when the motors are driven by V-belts or gearwheels. The diagrams below show the maximum overhung and thrust loads that can be tolerated, referring to a bearing life of L_H = 1,000 hours.

$M_{max.}$ [Nm]	V [cm³/rev]	$p_{max.}$ [bar]
65	16	230
	19	190
	22.5	160

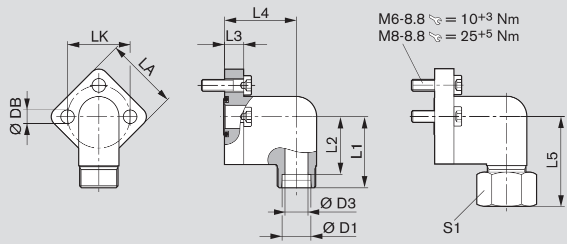


Fr is reduced by 0.7 Fa when axial loading Fa is applied.



Connectors

Gear motor flange, 3-bolt, 90° angle, for square flange 30 see page 8



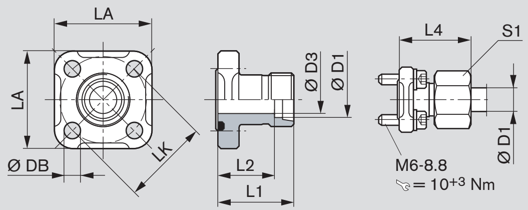
LK	D1	D3	L1	L2	L3	L4	L5	LA	S1	DB	Screws 3 pieces	O-ring NBR *)	Weight [kg]	Ordering-No.	p [bar]
30	12L	10	37	30.0	10	37.5	46	38	22	6.4	M6x22	16x2.5	0.13	**1 515 702 146**	250
30	15L	12	37	30.0	10	37.5	47	38	27	6.4	M6x22	16x2.5	0.14	**1 515 702 147**	250
30	18L	15	37	30.0	10	37.5	47	38	32	6.4	M6x22	16x2.5	0.17	**1 515 702 148**	160
40	22L	19	43	35.5	14	41.0	53	48	36	8.4	M8x30	24x2.5	0.29	**1 515 702 149**	160
40	28L	24	43	35.5	14	41.0	53	48	41	8.4	M8x30	24x2.5	0.40	**1 515 702 150**	160

Complete screw connection with O-ring, metric screw set, nut/mother and sleeve fitting *) NBR = Perbunan®

3

Connectors (continuation)

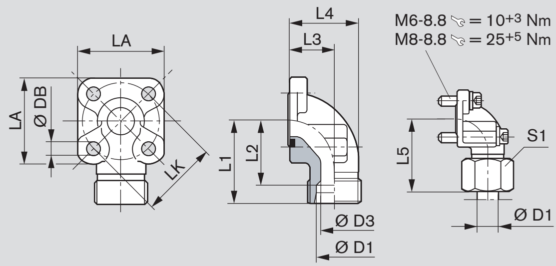
Gear motor flange, straight, for square flange 20 see page 8



LK	D1	D3	L1	L2	L4	LA	S1	DB	Screws 4 pieces	O-ring NBR *)	Weight [kg]	Ordering-No.	*p* [bar]
35	10L	8	30	23.0	39.0	40	19	6.4	M6x22	20x2.5	0.09	**1 515 702 064**	315
35	12L	10	30	23.0	39.0	40	22	6.4	M6x22	20x2.5	0.10	**1 515 702 065**	315
35	15L	12	30	23.0	38.0	40	27	6.4	M6x22	20x2.5	0.10	**1 515 702 066**	250
40	15L	12	35	28.0	43.0	42	27	6.4	M6x22	24x2.5	0.12	**1 515 702 067**	100
40	18L	15	35	27.5	44.0	42	32	6.4	M6x22	24x2.5	0.13	**1 515 702 068**	100
40	22L	19	35	27.5	44.5	42	36	6.4	M6x22	24x2.5	0.12	**1 515 702 069**	100
40	28L	24	42	27.5	34.5	42	41	6.4	M6x22	24x2.5	0.15	**1 515 702 008**	100

Complete screw connection with O-ring, metric screw set, nut/mother and sleeve fitting *) NBR = Perbunan®

Gear motor flange, 90° angle, for square flange 20 see page 8

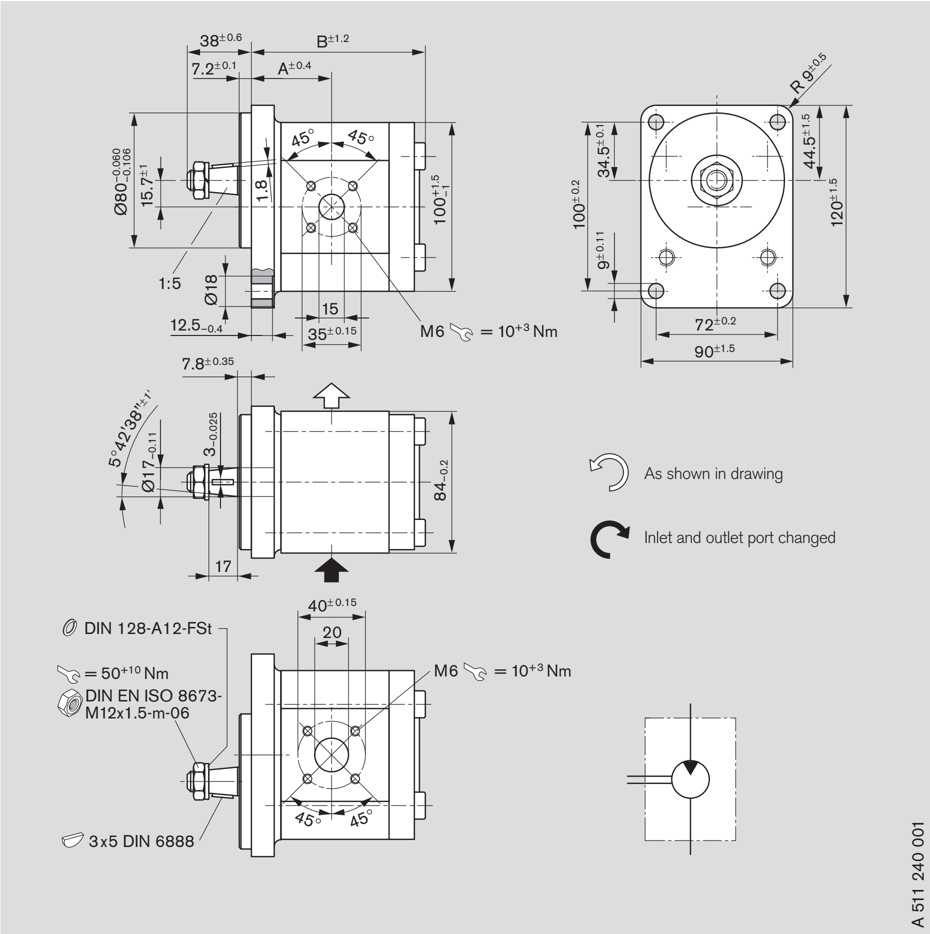


LK	D1	D3	L1	L2	L3	L4	L5	LA	S1	DB	Screws 2 pcs.	2 pcs.	O-ring NBR *)	Weight [kg]	Ordering-No.	*p* [bar]
35	10L	8	38	31.0	16.5	26.5	47.0	40	19	6.4	M6 x 22	M6 x 35	20 x 2.5	0.16	**1 515 702 070**	315
35	12L	10	38	31.0	16.5	26.5	47.0	40	22	6.4	M6 x 22	M6 x 35	20 x 2.5	0.16	**1 515 702 071**	315
35	15L	12	38	31.0	16.5	26.5	46.0	40	27	6.4	M6 x 22	M6 x 35	20 x 2.5	0.15	**1 515 702 072**	250
35	16S	12	38	29.5	20.0	31.0	48.0	40	30	6.4	M6 x 22	M6 x 40	20 x 2.5	0.18	**1 515 702 002**	315
35	18L	15	38	29.5	20.0	31.0	47.0	40	32	6.4	M6 x 22	M6 x 40	20 x 2.5	0.18	**1 545 702 006**	250
35	20S	16	45	34.5	25.0	38.0	56.0	40	36	6.4	M6 x 22	M6 x 45	20 x 2.5	0.24	**1 515 702 017**	315
40	15L	12	38	31.0	22.5	36.5	46.0	42	27	6.4	M6 x 22	M6 x 22	24 x 2.5	0.15	**1 515 702 076**	100
40	18L	15	38	30.5	22.5	36.5	47.0	42	32	6.4	M6 x 22	M6 x 22	24 x 2.5	0.17	**1 515 702 074**	100
40	20S	16	40	29.5	22.5	35.5	50.0	42	36	6.4	M6 x 22	M6 x 45	24 x 2.5	0.20	**1 515 702 011**	250
40	22L	19	38	30.5	22.5	36.5	47.5	42	36	6.4	M6 x 22	M6 x 22	24 x 2.5	0.17	**1 515 702 075**	100
40	28L	22	40	32.5	28.0	43.0	49.0	42	41	6.4	M6 x 20	M6 x 50	24 x 2.5	0.24	**1 515 702 010**	100
40	35L	31	41	30.5	34.0	55.0	52.0	42	50	6.4	M6 x 22	M6 x 60	24 x 2.5	0.33	**1 515 702 018**	100
55	20S	17	45	34.5	24.0	40.0	56.0	58	36	8.4	M8 x 25	M8 x 50	33 x 2.5	0.44	**1 515 702 004**	250
55	30S	26	49	35.5	32.0	50.0	62.0	58	50	8.4	M8 x 25	M8 x 50	33 x 2.5	0.50	**1 515 702 006**	250
55	35L	31	49	38.5	32.0	51.5	62.0	58	50	8.4	M8 x 25	M8 x 60	33 x 2.5	0.47	**1 515 702 005**	100
55	42L	38	49	38.0	40.0	64.5	61.0	58	60	8.4	M8 x 25	M8 x 70	33 x 2.5	0.60	**1 515 702 019**	100

Complete screw connection with O-ring. metric screw set. nut/mother and sleeve fitting *) NBR = Perbunan®

Dimensions in mm

F-Motor

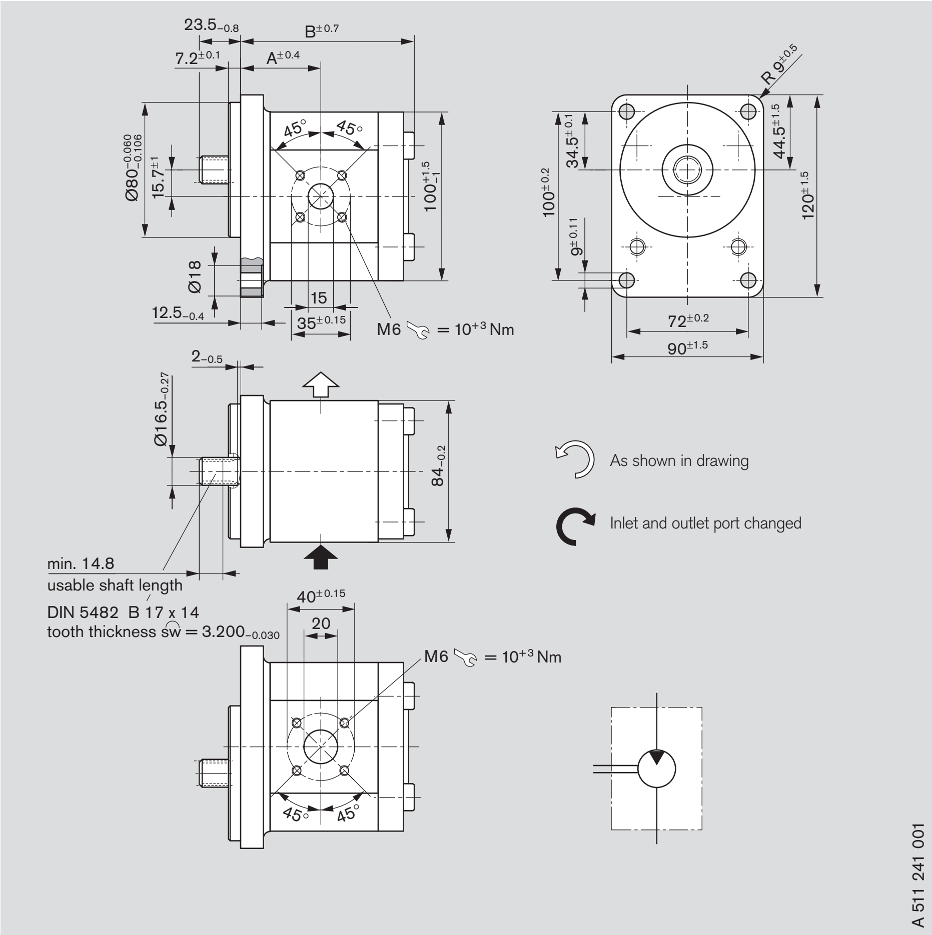


Ordering code
AZMF – 1x – □ □ □ □ C B 20 M B
AZMF – 10 – □ □ □ □ C B 20 K B*
AZMF – 10 – □ □ □ □ C B 20 M B – S0012 **

Displacement [cm³/rev]	Ordering-No. L	R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B
8	**0 511 425 300**	**0 511 425 001**	210	500	4,000	2.9	43.2	91.1
11	**0 511 525 300**	**0 511 525 001**	210	500	3,500	3.0	47.0	96.3
14	**0 511 525 304**	**–**	210	500	3,000	3.2	47.5	101.3
16	**–**	**0 511 625 005**	210	500	3,000	3.4	47.5	104.7
19	**0 511 625 308**	**0 511 625 003**	180	500	3,000	3.6	47.5	109.7
19	**–**	**0 511 625 009 ***	180	500	3,000	3.6	47.5	109.7
22.5	**0 511 725 304 ****	**0 511 725 005 ****	210	500	3,000	3.9	61.1	125.3

Dimensions in mm

F-Motor



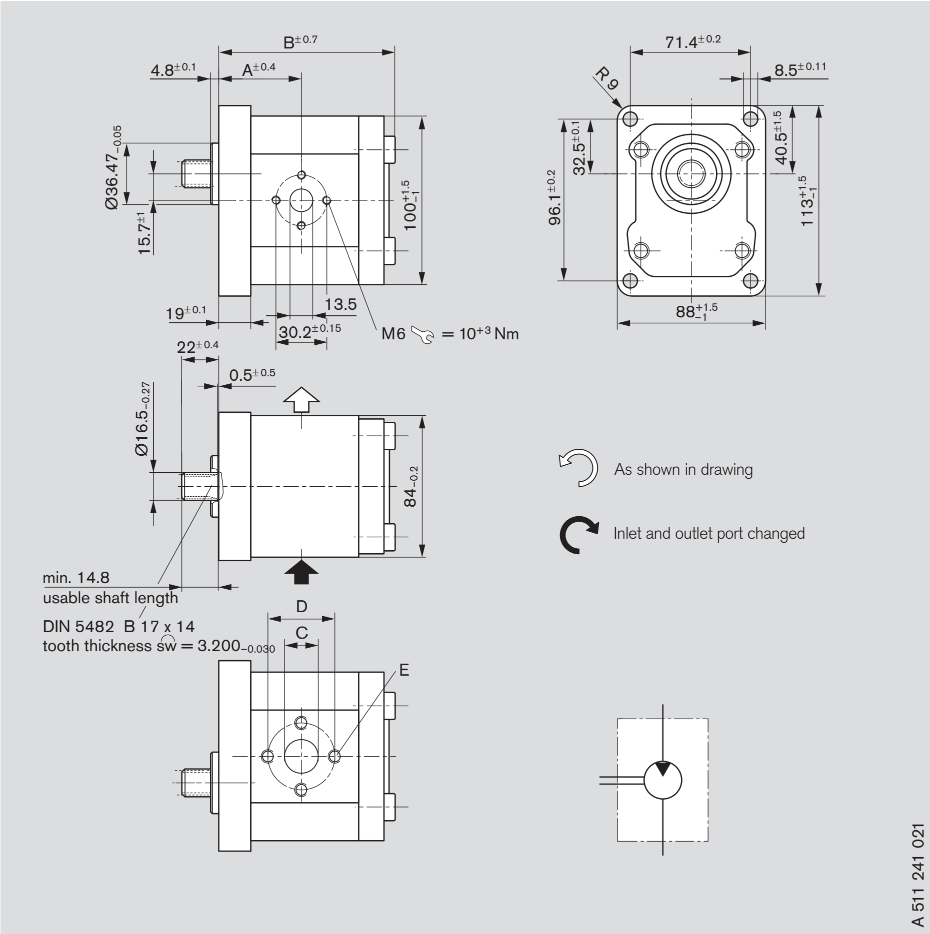
Ordering code

AZMF – 10 – □ □ □ □ F B 20 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
8	**0 511 425 301**	**0 511 425 002**	210	500	4,000	2.9	43.2	91.0
11	**0 511 525 301**	**0 511 525 002**	210	500	3,500	3.0	47.0	96.0
14	**0 511 525 303**	**–**	210	500	3,000	3.2	47.5	101.0
16	**0 511 625 301**	**0 511 625 001**	210	500	3,000	3.4	47.5	104.4
19	**0 511 625 300**	**0 511 625 002**	180	500	3,000	3.6	47.5	109.4
22.5	**0 511 725 303**	**0 511 725 004**	180	500	3,000	3.8	61.1	126.8

Dimensions in mm

F-Motor

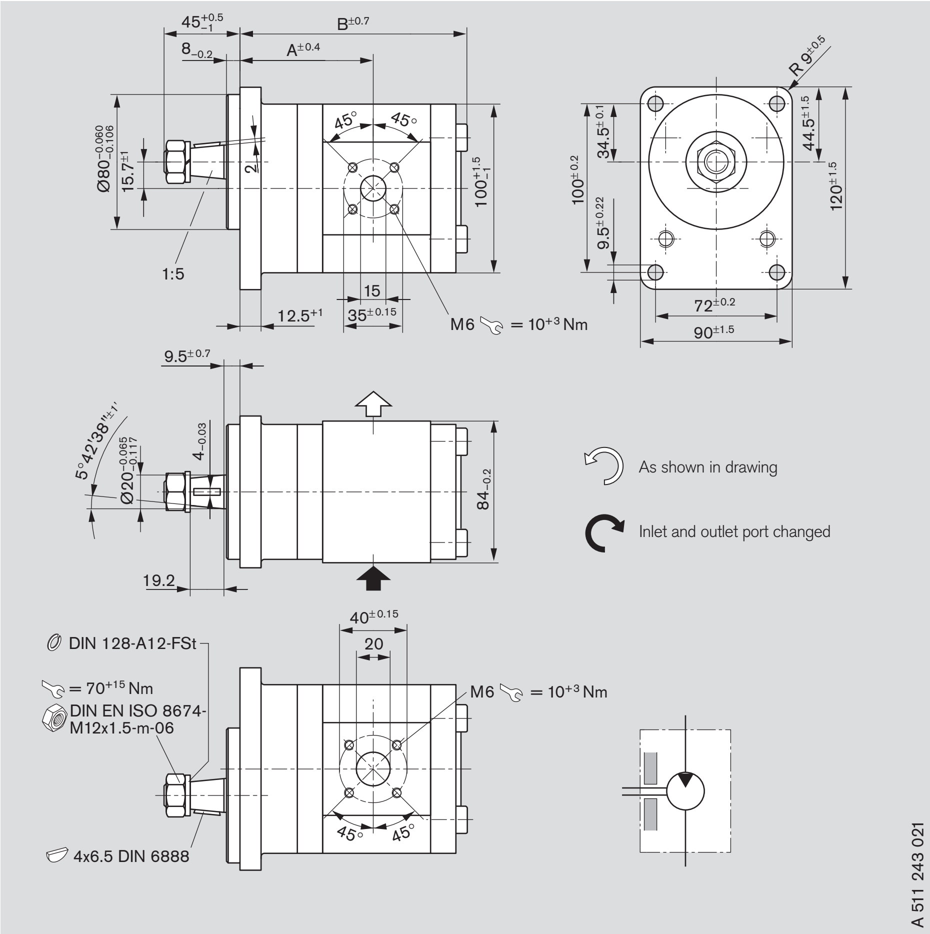


Ordering code
AZMF – 10 – □ □ □ □ F O 30 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	C	D	E
8	–	**0 511 425 003**	210	500	4,000	2.9	44.9	90.7	13.5	30.2	M6 = 10+3
19	**0 511 625 303**	–	180	500	3,000	3.7	49.0	109.1	20.0	39.7	M8 = 25+5
22.5	–	**0 511 725 305**	180	500	3,000	3.9	56.6	114.5	20.0	39.7	M8 = 25+5

Dimensions in mm

F-Motor

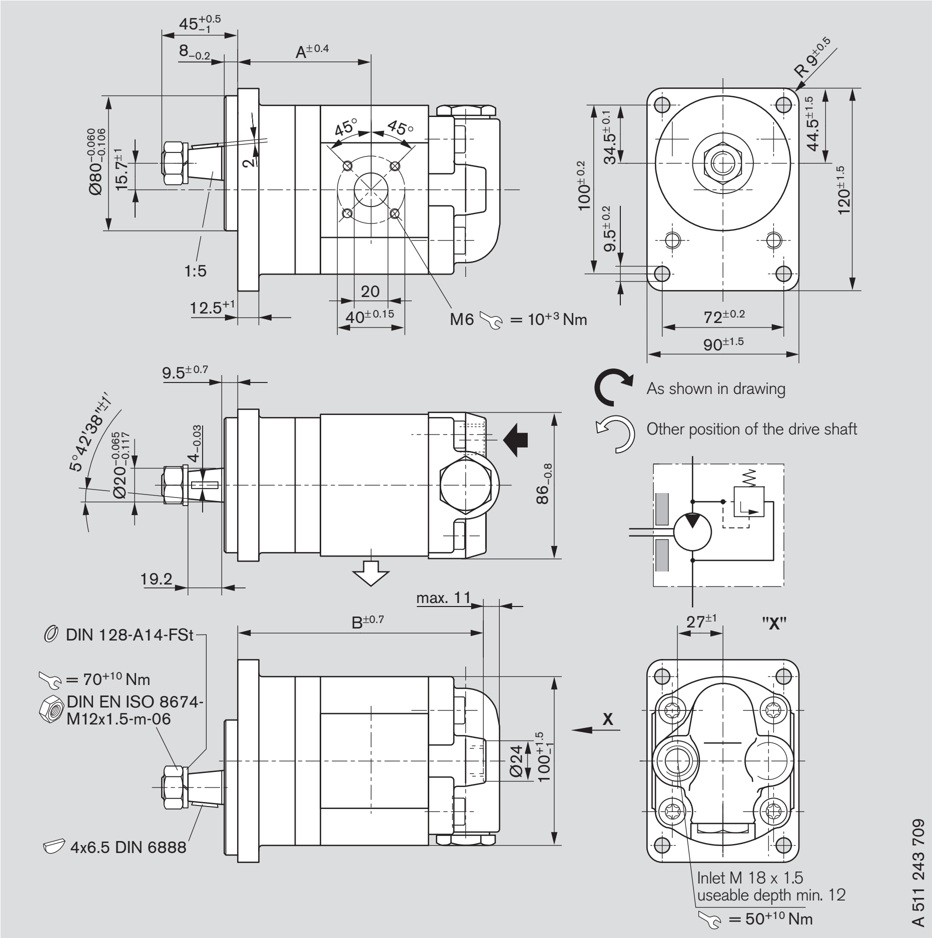


Ordering code
AZMF – 10 – □ □ □ □ S A 20 M B
AZMF – 10 – □ □ □ □ S A 20 M B – S0012

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
8	**0 511 445 300**	**0 511 445 001**	250	500	4,000	3.5	74.7	120.6
11	**0 511 545 300**	**0 511 545 001**	250	500	3,500	3.6	78.5	125.6
14	**0 511 545 301**	–	250	500	3,000	3.7	79.0	130.6
16	**0 511 645 300**	**0 511 645 001**	250	500	3,000	3.8	79.0	134.0
16	–	**0 511 645 003**	230	500	3,000	3.8	93.0	134.0
19	**0 511 645 302**	–	190	500	3,000	4.2	79.0	139.0
22.5	**0 511 745 300***	**0 511 745 001***	160	500	2,500	4.8	92.6	156.4

Dimensions in mm

F-Motor



3

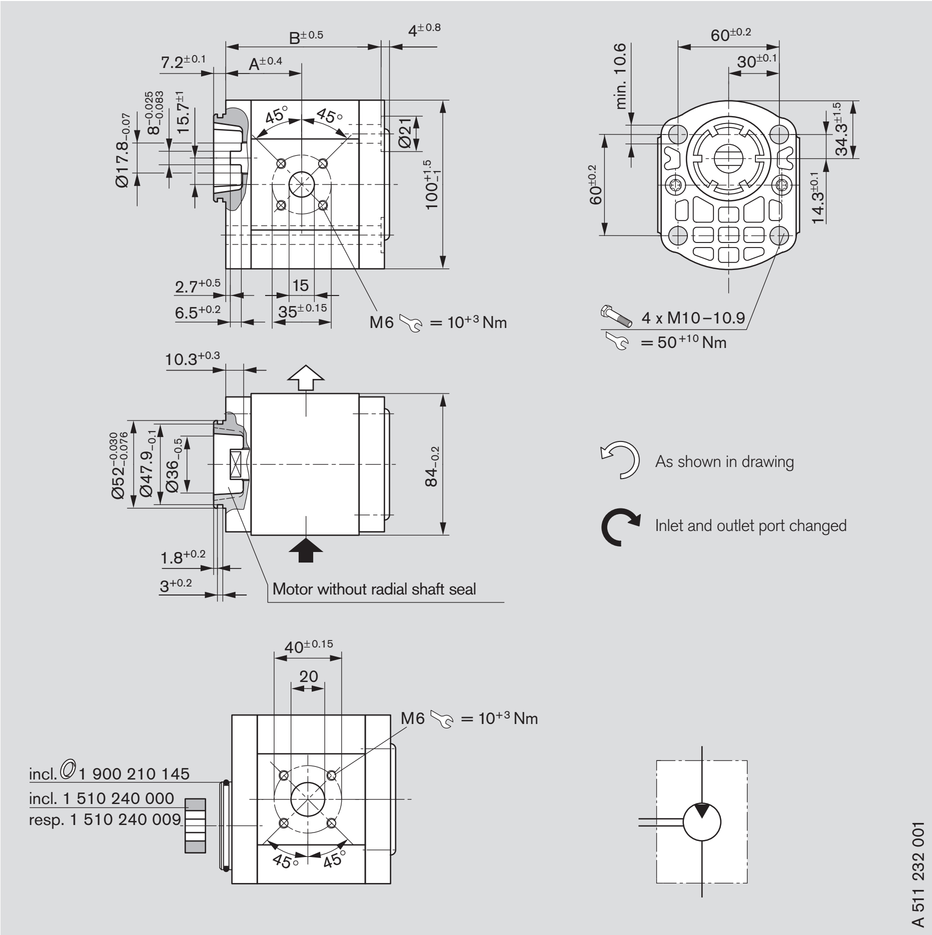
Ordering code

AZMF – 10 – ☐ ☐ ☐ ☐ S A 20 M D XXXXX – S0076

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
8	**0 511 445 301**	**0 511 445 003**	200	500	4,000	3.6	74.7	133.1
11	**0 511 545 302**	0 511 545 003	150	500	3,500	3.8	79.1	138.1

Dimensions in mm

F-Motor

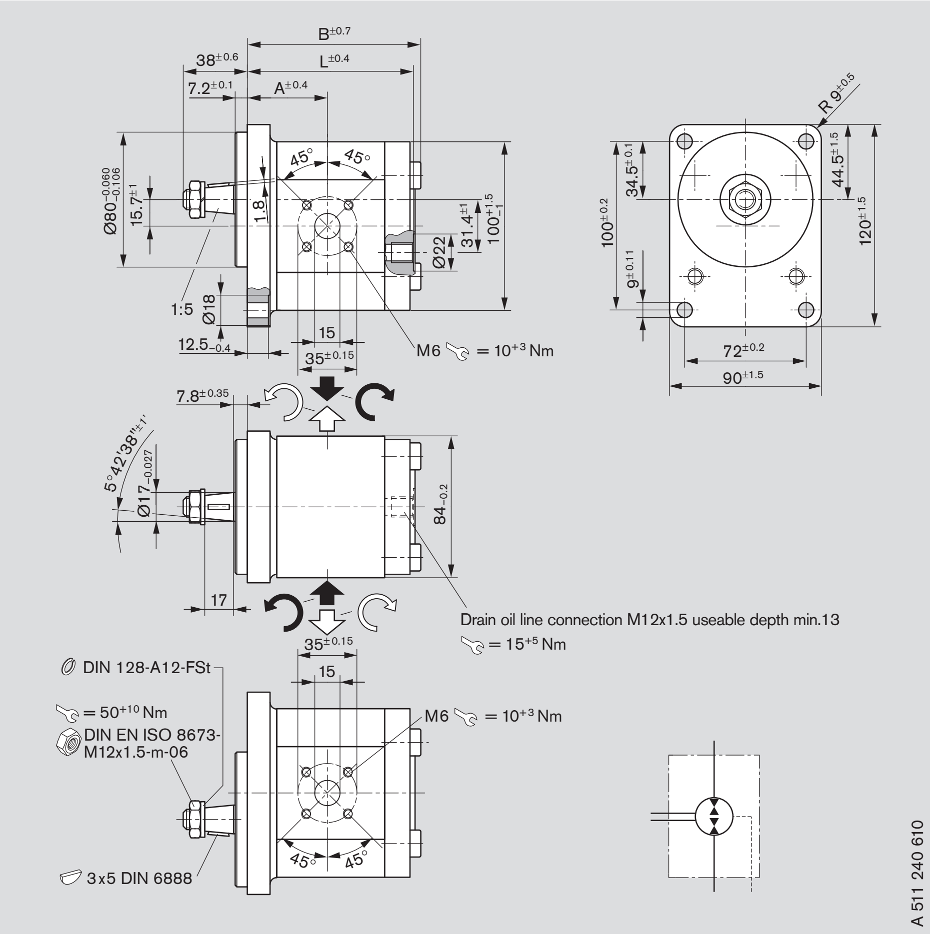


Ordering code
AZMF – 10 – □ □ □ □ N T 20 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
8	**0 511 415 300**	**0 511 415 001**	250	500	4,000	2.5	40.7	80.3
11	**0 511 515 300**	**0 511 515 001**	250	500	3,500	2.6	44.5	85.3
16	**0 511 615 301**	**0 511 615 002**	230	500	3,000	3.0	45.0	93.7
19	**0 511 615 300**	**0 511 615 001**	190	500	3,000	3.2	45.0	98.7
22.5	**0 511 715 300**	**0 511 715 001**	160	500	3,000	3.4	52.6	104.1

Dimensions in mm

F-Motor



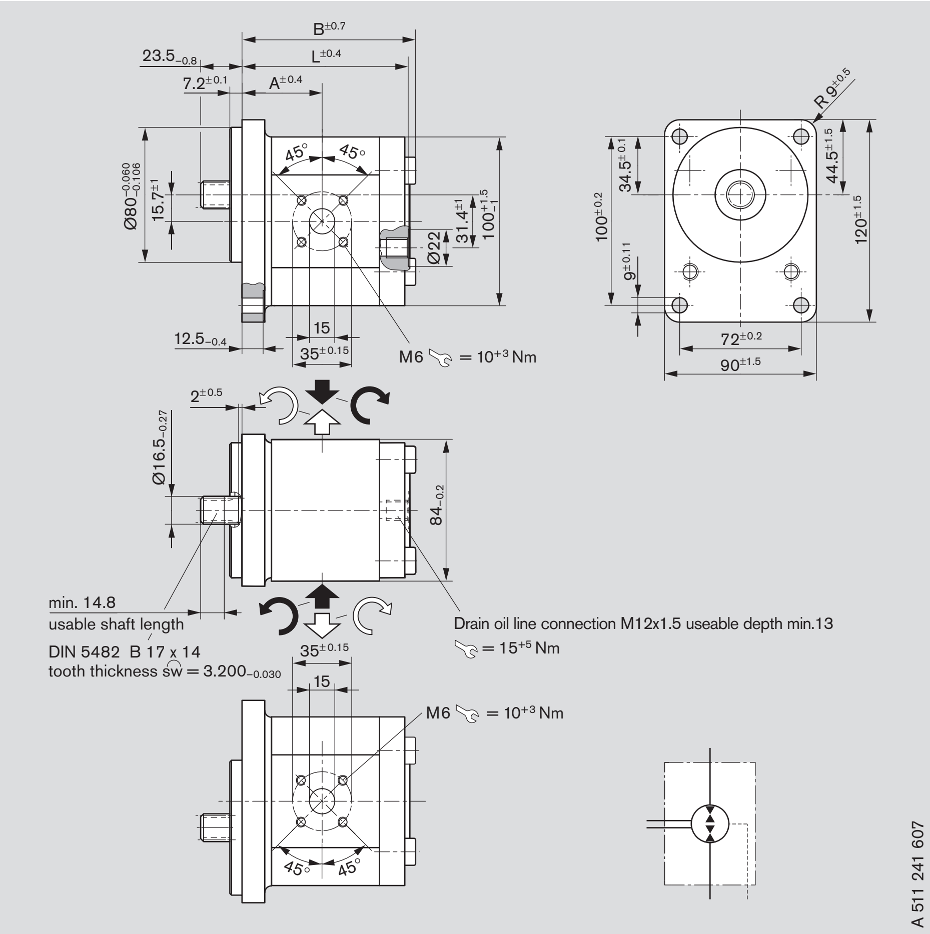
3

Ordering code
AZMF – 10 – ☐ ☐ ☐ U C B 20 M L
AZMF – 10 – ☐ ☐ ☐ U C B 20 K L*

Displace-ment [cm³/rev]	Ordering-No. Universal	Max. operating-pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 425 601**	210	500	4,000	3.4	43.2	90.7	85.8
11	**0 511 525 604**	210	500	3,500	4.2	47.0	95.9	90.8
16	**0 511 625 602**	210	500	3,000	3.9	47.5	104.3	99.2
22.5	**0 511 725 601** *	180	500	3,000	3.9	55.1	114.6	109.6

Dimensions in mm

F-Motor

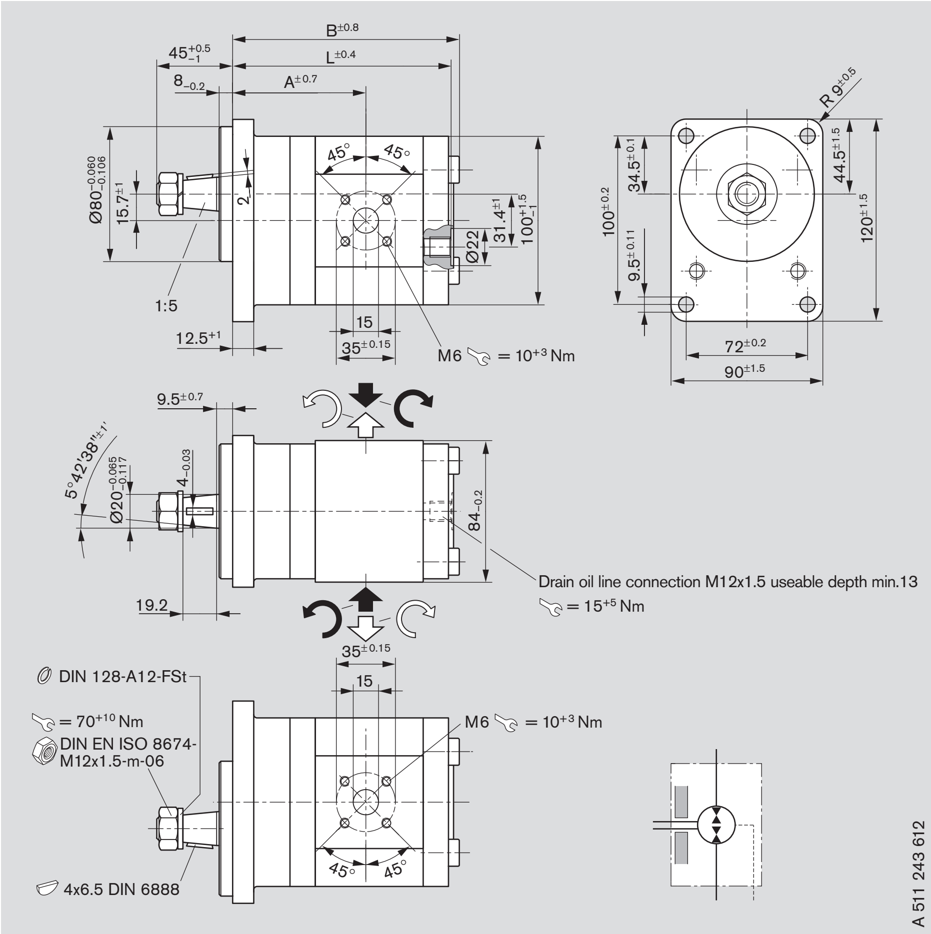


Ordering code
AZMF – 10 – □ □ □ U F B 20 M L

Displace-ment [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotating speed [min⁻¹]	Max. rotating speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 425 603**	210	500	4,000	2.9	43.2	91.0	85.8
11	**0 511 525 601**	210	500	3,500	3.0	47.0	96.0	90.8
16	**0 511 625 603**	210	500	3,000	3.4	47.5	104.4	99.2
19	**0 511 625 605**	180	500	3,000	3.6	47.5	109.4	104.2
22.5	**0 511 725 602**	180	500	3,000	3.8	55.1	114.8	109.6

Dimensions in mm

F-Motor

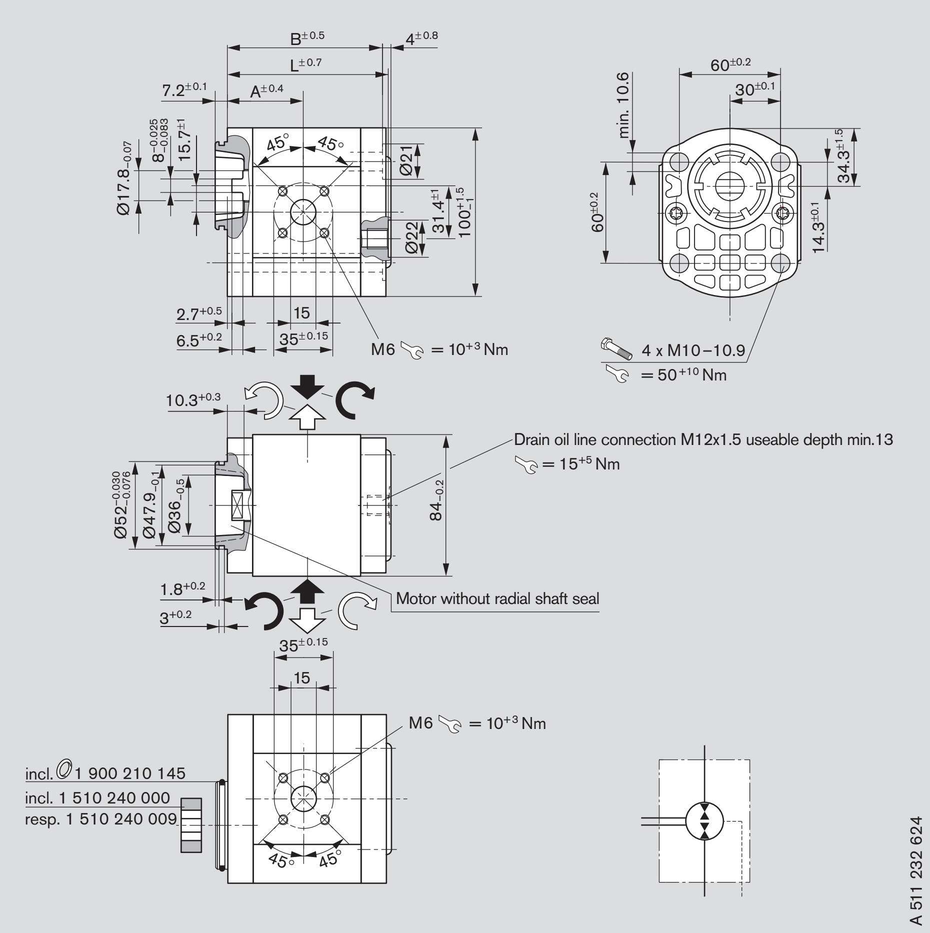


Ordering code
AZMF – 10 – □ □ □ U S A 20 M L

Displacement [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 445 601**	250	500	4,000	3.5	74.8	120.8	116.9
11	**0 511 545 601**	250	500	3,500	3.6	78.6	125.8	121.9
16	**0 511 645 601**	230	500	3,000	4.0	79.1	134.2	130.3
19	**0 511 645 603**	190	500	3,000	4.2	79.1	139.2	135.3

Dimensions in mm

F-Motor

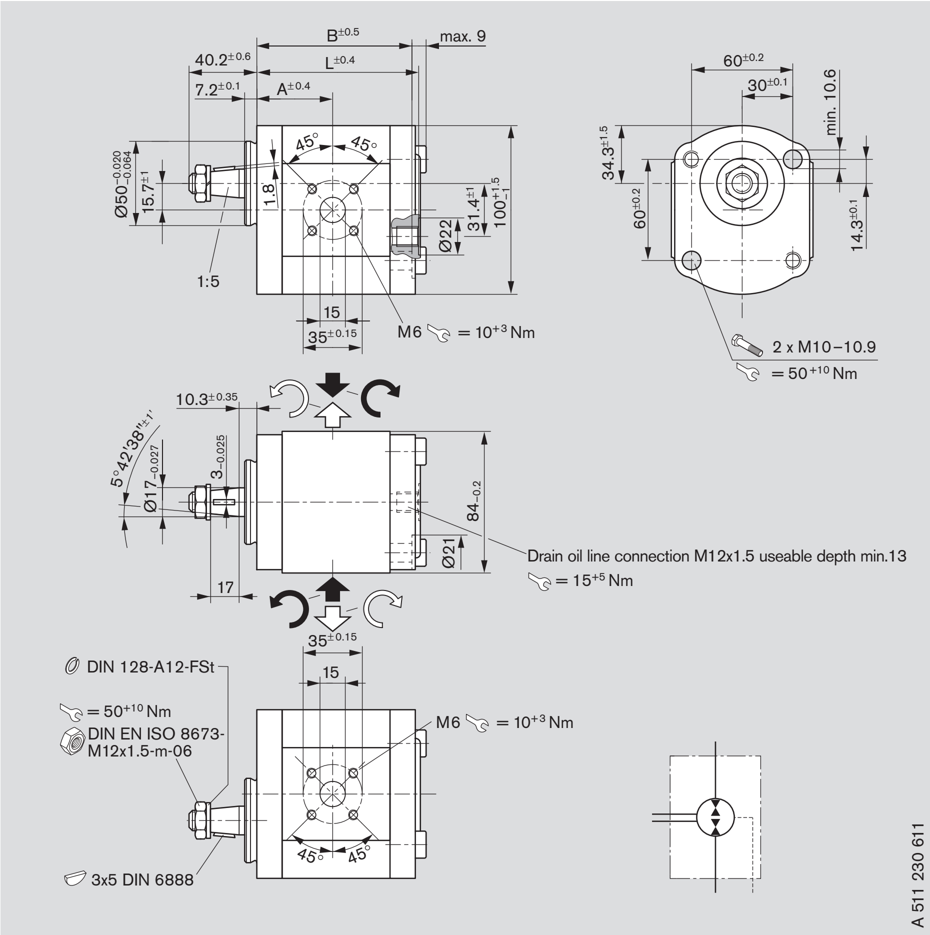


Ordering code
AZMF – 10 – □ □ □ U N T 20 M L – S0164

Displacement [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 415 605**	250	500	4,000	2.5	40.7	80.3	82.8
11	**0 511 515 602**	250	500	3,500	2.6	44.5	85.3	87.8
16	**0 511 615 607**	230	500	3,000	3.0	45.0	93.7	96.2
19	**0 511 615 608**	190	500	3,000	3.2	45.0	98.7	101.2
22.5	**0 511 715 601**	160	500	3,000	3.4	52.6	104.1	106.6

Dimensions in mm

F-Motor



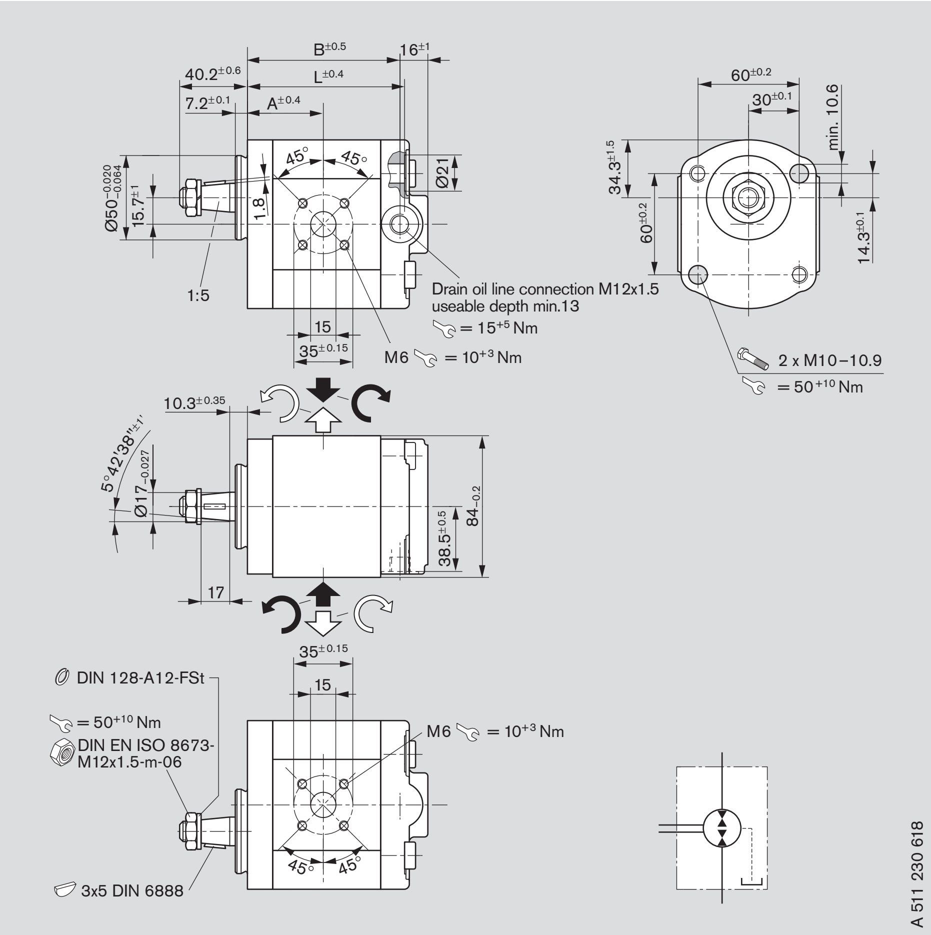
3

Ordering code
AZMF – 1X – □ □ □ U C P 20 M L

Displace-ment [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 415 606**	210	500	4,000	2.8	40.7	80.3	83.3
11	**0 511 515 601**	210	500	3,500	2.8	44.5	85.3	88.3
14	**0 511 515 605**	210	500	3,000	3.1	45.0	90.3	93.3
16	**0 511 615 609**	210	500	3,000	3.1	45.0	93.7	96.7

Dimensions in mm

F-Motor

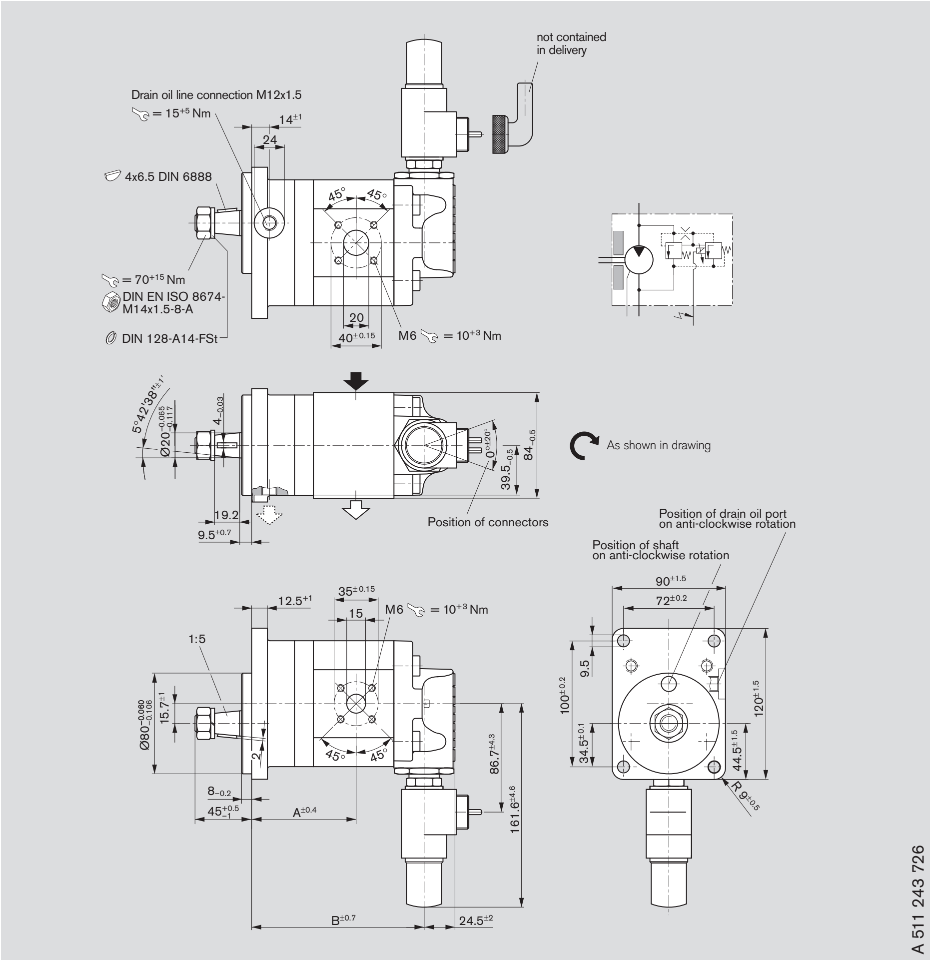


Ordering code
AZMF – 11 – □ □ □ U C N 20 M B – S0077

Displace-ment [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
8	**0 511 415 607**	210	500	4,000	2.9	40.7	80.3	80.3

Dimensions in mm

F-Motor



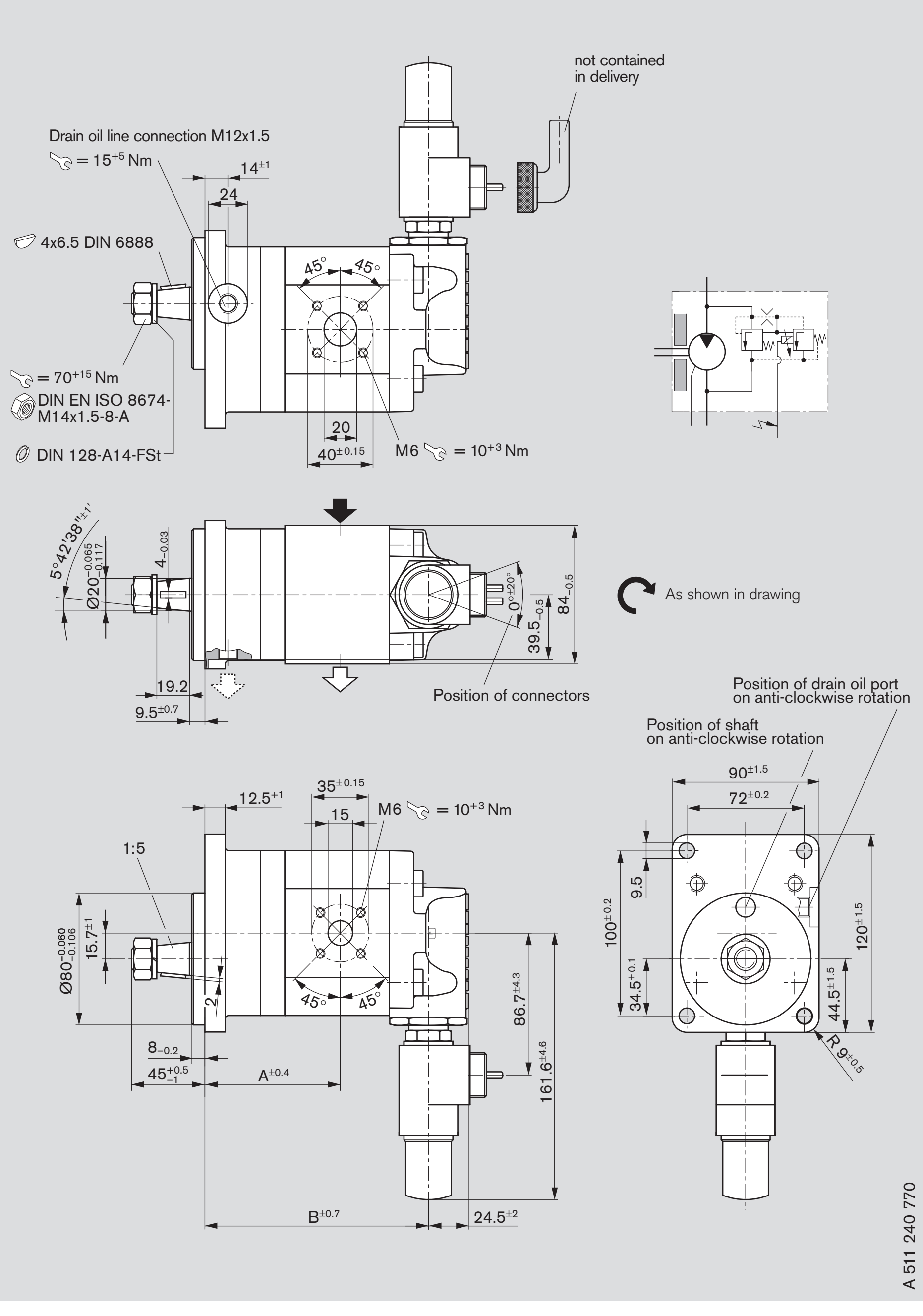
3

Ordering code
AZMF – 11 – □ □ □ □ S A 20 P GXXXX
AZMF – 12 – □ □ □ □ S A 20 P GXXXX*

Displacement [cm³/rev]	Ordering-No. L	 R	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	PVR [bar]	Coil nominal current [*I*]	kg	Dimension [mm] A	 B
16	–	**0 511 645 007**	500	3,000	130	1.5	5.0	79.0	137.7
16	–	**0 511 645 005** *	500	3,000	170	1.5	5.0	79.0	137.7
16	**0 511 645 306**	–	500	3,000	170	1.5	5.1	79.0	137.7
16	**0 511 645 307**	–	500	3,000	210	1.5	5.1	79.0	137.7
16	–	**0 511 645 011** *	500	3,000	210	1.5	5.1	79.0	137.7

Dimensions in mm

F-Motor



Dimensions in mm

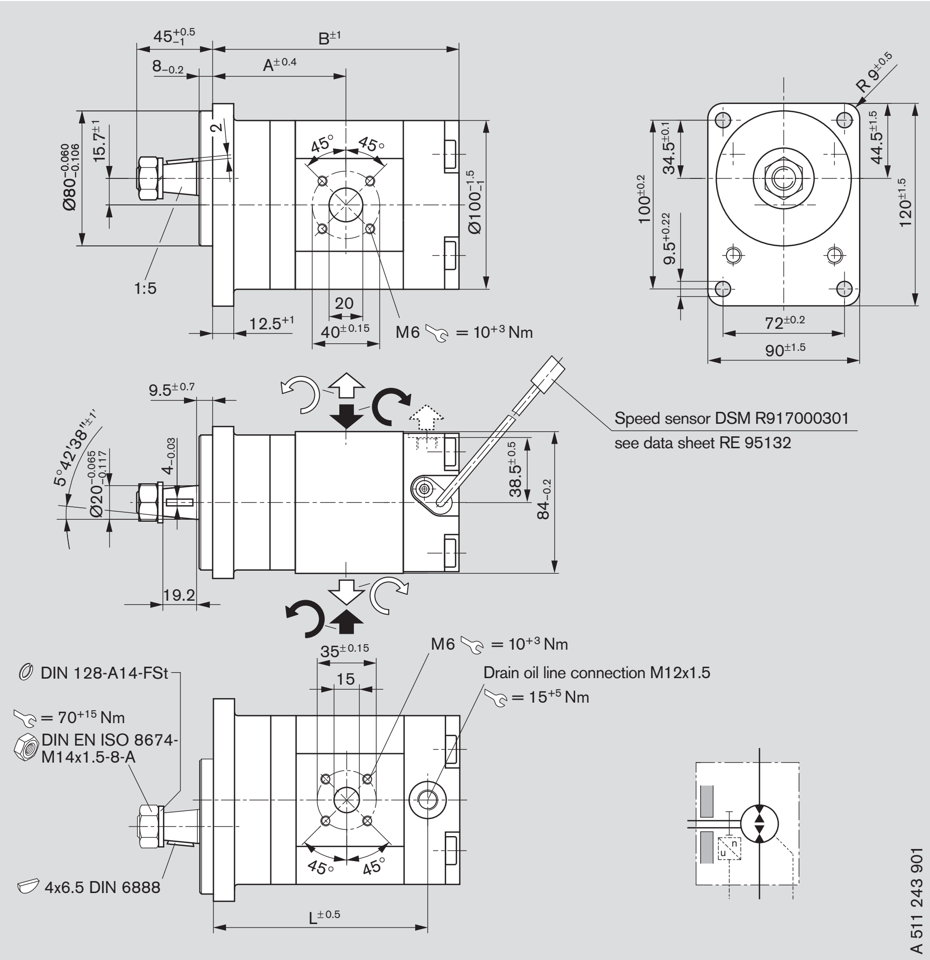
F-Motor

Ordering code
AZMF – 11 – ☐ ☐ ☐ ☐ C B 20 P GXXXX

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	PRV [bar]	Coil nominal current [*I*]	kg	Dimension [mm] A	Dimension [mm] B
8	**0 511 425 302**	–	500	4,000	210	0.75	4.7	48.7	98.3
8	–	**0 511 425 015**	500	4,000	90	1.5	4.6	48.7	98.3
8	–	**0 511 425 013**	500	4,000	130	1.5	4.7	48.7	98.3
8	–	**0 511 425 012**	500	4,000	170	1.5	4.7	48.7	98.3
8	–	**0 511 425 014**	500	4,000	150	1.5	4.7	48.7	98.3
11	–	**0 511 525 013**	500	3,500	170	1.5	4.7	47.5	103.5
11	–	**0 511 525 011**	500	3,500	180	0.75	4.8	47.5	103.5
11	**0 511 525 309**	–	500	3,500	90	1.5	4.8	47.5	103.5
11	**0 511 525 308**	–	500	3,500	180	0.75	4.8	47.5	103.5
14	–	**0 511 525 014**	500	3,000	210	1.5	4.9	43.2	108.5
16	–	**0 511 625 019**	500	3,000	210	1.5	5.0	47.5	111.7
16	**0 511 625 309**	–	500	3,000	210	1.5	5.0	47.5	111.7
16	–	**0 511 625 020**	500	3,000	210	0.75	5.0	47.5	111.7
19	–	**0 511 625 018**	500	3,000	210	1.5	5.1	47.5	116.7
19	–	**0 511 625 022**	500	3,000	210	0.75	4.0	47.5	116.7
19	–	**0 511 625 021**	500	3,000	180	0.75	5.1	47.5	116.7
22.5	**0 511 725 311**	–	500	3,000	210	1.5	5.3	55.1	122.1
22.5	–	**0 511 725 021**	500	3,000	210	1.5	5.3	55.1	122.1
22.5	–	**0 510 725 023**	500	3,000	210	0.75	5.3	55.1	122.1
22.5	–	**0 511 725 027**	500	3,000	170	1.5	5.2	55.1	122.1

Dimensions in mm

F-Motor

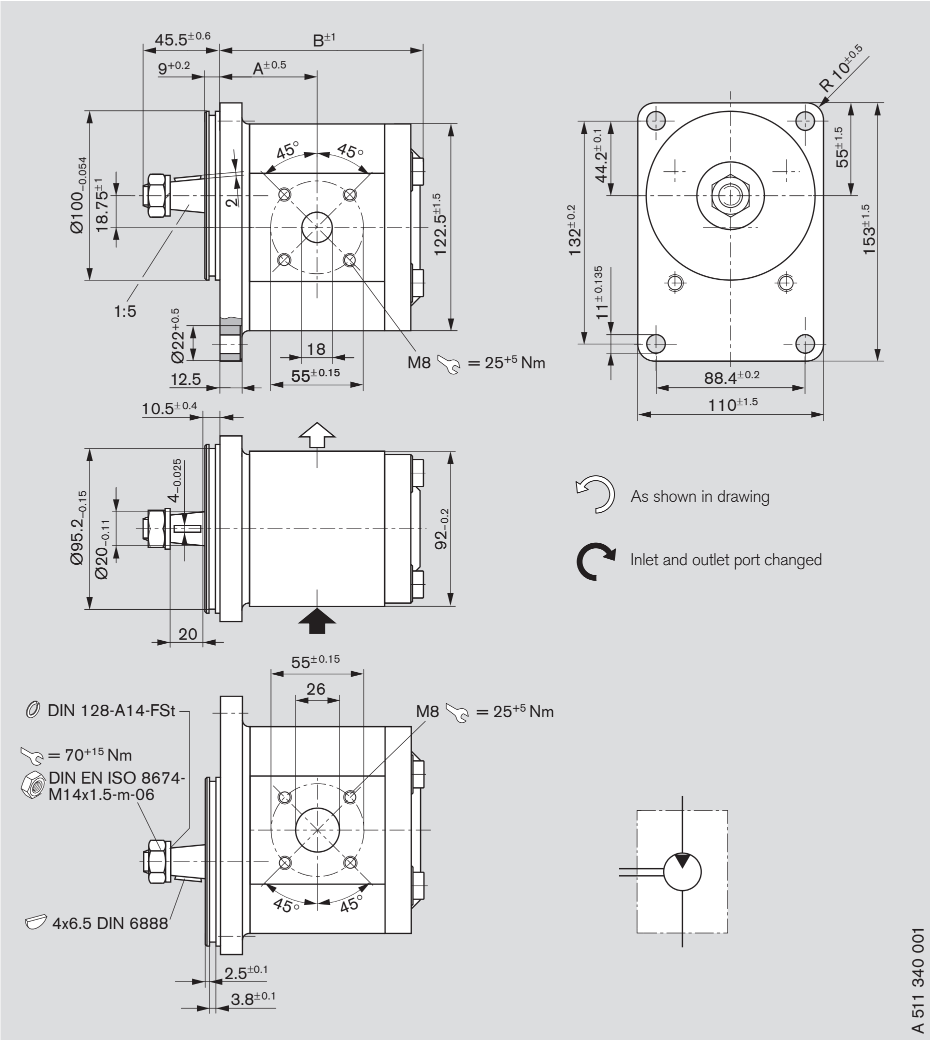


Ordering code
AZMF – 12 – □ □ □ U S A 20 P L – S0079

Displace-ment [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B	L
16	**0 511 645 607**	230	500	3,000	3.6	79	146.7	127.7

Dimensions in mm

N-Motor



3

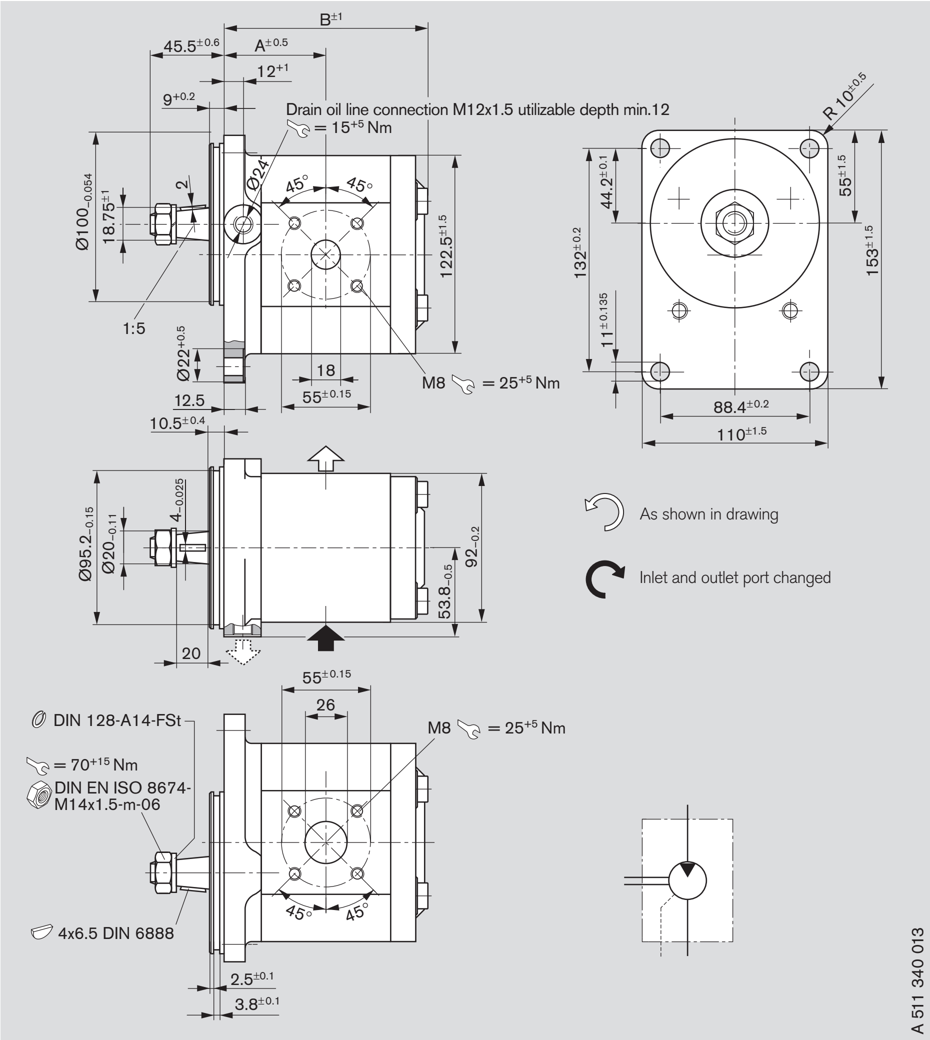
Ordering code

AZMN – 11 – □ □ □ □ C B 20 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
25	**0 511 725 307**	–	210	500	3,000	6.3	55.0	116.1
28	**0 511 725 309**	**0 511 725 019**	200	500	3,000	6.3	56.6	119.1

Dimensions in mm

N-Motor

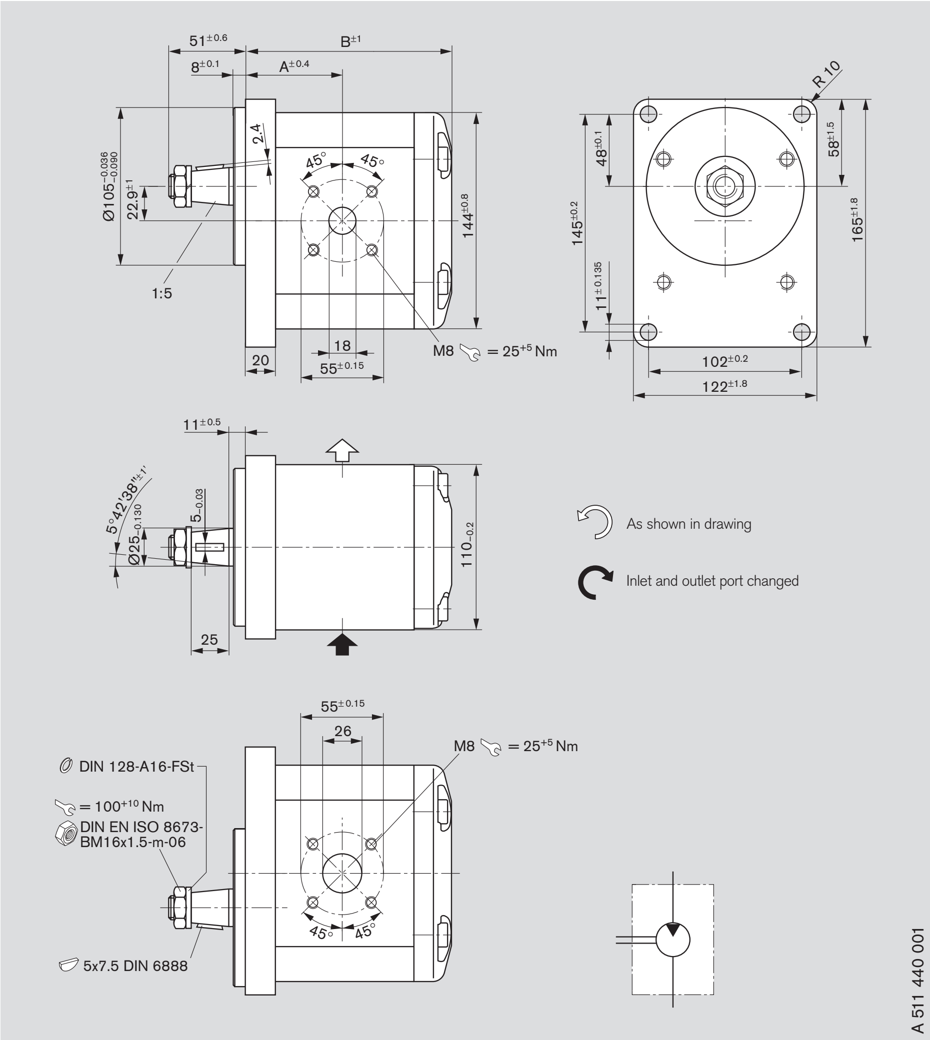


Ordering code
AZMN – 11 – □ □ □ □ C B 20 P B – S0097

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
25	–	**0 511 725 024**	210		3,000	10.3	60.5	120.8
28	**0 511 725 312**	–	210		2,800	6.1	62.0	123.8

Dimensions in mm

G-Motor



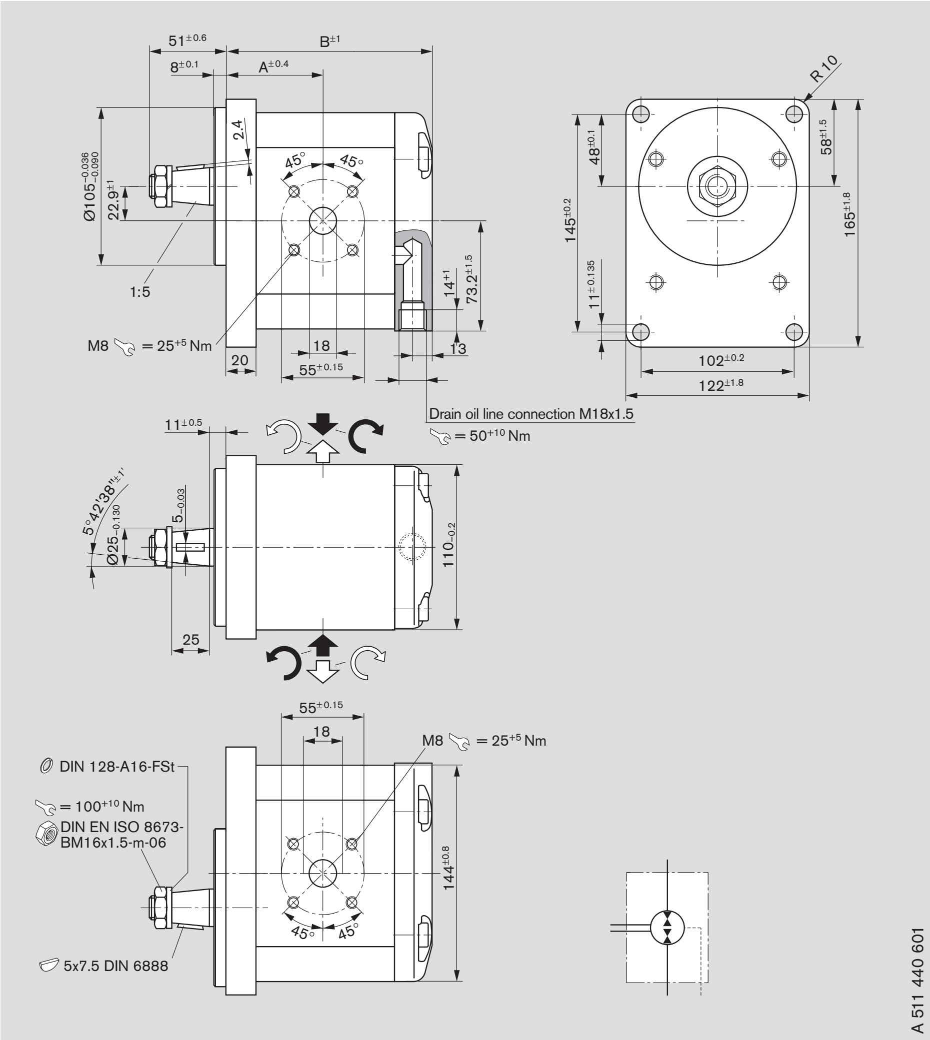
3

Ordering code
AZMG – 11 – ☐ ☐ ☐ ☐ C B 20 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
22.5	**0 511 725 300**	**0 511 725 001**	180	500	3,000	9.1	61.0	128.7
32	**0 511 725 301**	**0 511 725 002**	180	500	2,800	9.6	64.5	137.2
45	**0 511 725 302**	**0 511 725 003**	180	500	2,600	10.1	69.5	149.2

Dimensions in mm

G-Motor



Ordering code

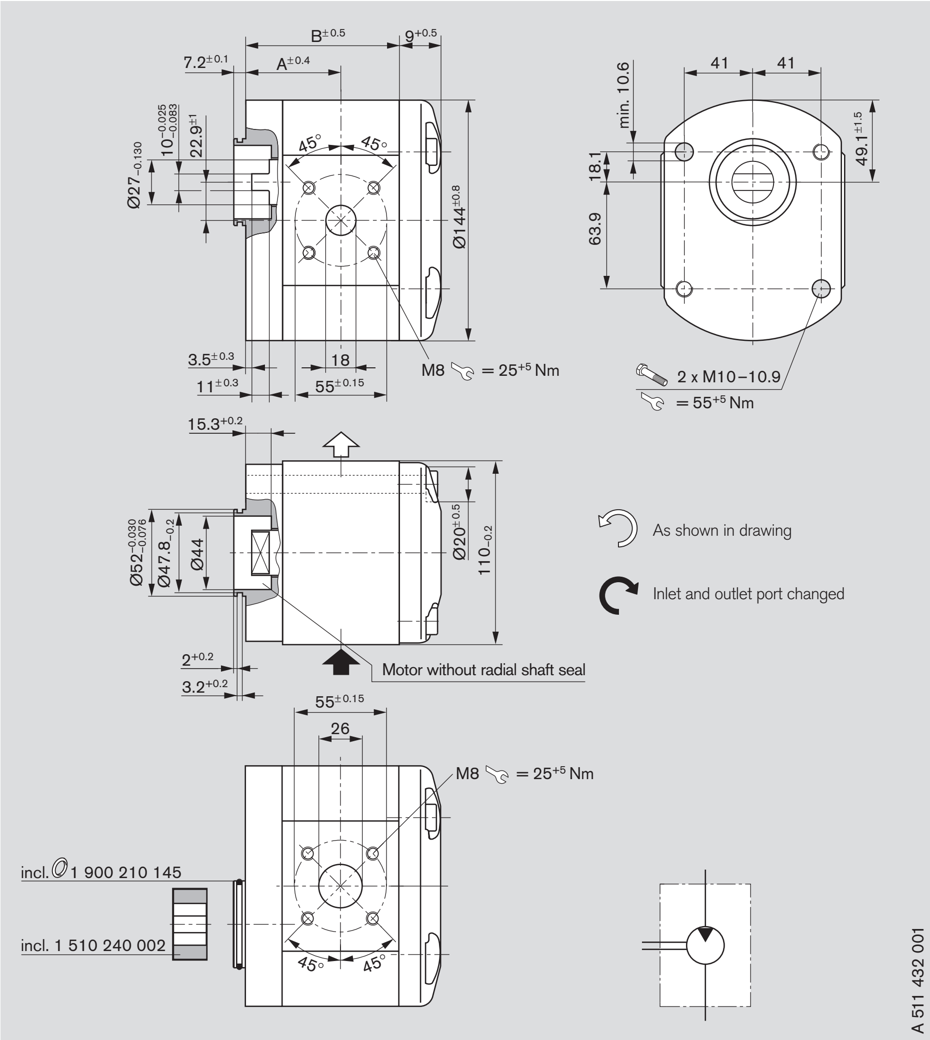
AZMG – 11 – ☐ ☐ ☐ U C B 20 K X* – S0077

AZMG – 11 – ☐ ☐ ☐ U C B 20 M X – S0077

Displacement [cm³/rev]	Ordering-No. Universal	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	B
22.5	**0 511 725 600**	210	500	3,000	9.0	61.0	128.7
28	**0 511 726 603**	210	500	3,000	9.2	63.0	133.7
32	**0 511 726 604***	210	500	2,800	9.4	64.5	137.2

Dimensions in mm

G-Motor



Ordering code
AZMG – 11 – □ □ □ □ N M 20 M B

Displacement [cm³/rev]	Ordering-No. L	Ordering-No. R	Max. operating pressure [bar]	Min. rotation speed [min⁻¹]	Max. rotation speed [min⁻¹]	kg	Dimension [mm] A	Dimension [mm] B
45		**0 511 715 002**	210	500	2,600	8.4	70.5	151.2

3

Notes

Filter recommendation
The major share of premature failures in external gear motors is caused by contaminated pressure fluid.
As a warranty cannot be issued for dirt-specific wear, we recommended filtration compliant with cleanliness level 20/18/15 ISO 4406, which reduces the degree of contamination to a permissible dimension in terms of the size and concentration of dirt particles:

Operating pressure [bar]	>160	<160
Contamination class NAS 1638	9	10
Contamination class ISO 4406	18/15	19/16
To be reached with $\beta_X = 75$	20	25

We recommend that a full-flow filter always be used.
Basic contamination of the pressure fluid used may not exceed class 20/18/15 according to ISO 4406. Experience has shown that new fluid quite often lies above this value. In such instances a filling device with special filter should be used.

General
- The motors supplied by us have been checked for function and performance. No modifications of any kind may be made to the pumps; any such changes will render the warranty null and void!
- Motor may only be operated in compliance with permitted data (see pages 14 – 18).

Project planning notes
Comprehensive notes and suggestions are available in Hydraulics Trainer, Volume 3 RE 00 281, “Project planning notes and design of hydraulic systems”. Where external gear motors are used we recommend that the following note be adhered to.

Technical data
All stated technical data is dependent on production tolerances and is valid for specific marginal conditions.
Note that, as a consequence, scattering is possible, and at certain marginal conditions (e.g. viscosity) **the technical data may change.**

Characteristics
When designing the external gear motor, note the maximum possible service data based on the characteristics displayed on pages 10 to 14.

Additional information on the proper handling of hydraulic products from Bosch Rexroth is available in our document:
“General product information for hydraulic products”
RE 07 008.

Leakage oil line
A leakage oil line must be connected directly to the tank in reversible motors or motors stressed by run-back. Observe sufficient dimensions.

Contained in delivery
The components with characteristics as described under device measurements and ordering code, pages 19 – 39, are contained in delivery.

You can find further information in our publication:
“General Operating Instructions for External Gear Units”
RE 07 012-B1.

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Radial piston motors

Designation	Type	Size	Component series	p_{max} in bar	Data sheet	Page
Radial piston motors (Hägglunds)	CBM	2000 ... 6000		350	15300	381
Fixed displacement	MKM, MRM	11 ... 250	1X	315	15190	417

Rexroth
Bosch Group

Radial piston hydraulic motor

Type Hägglunds CBM

RE 15300
Edition: 2012-08

- Size: 2000 ... 6000
- Capacity: 75 838 ... 380 133 cm^3/rev *[4 628 - 23 197 in^3/rev]*
- Specific torque: 1 200 ... 6 000 Nm/bar *[61 024 ... 305 119 ft-lbs/1000 psi]*
- Nominal speed: 8 ... 53 rpm
- Maximum operating pressure: 350 bar *[5 076 psi]*

Features

- The most powerful direct drive in the world.
- 50 % more torque - now torque up to 1970 kNm
- High torque to weight ratio
- Modular design

Contents

Quick selection diagram for Hägglunds CBM motors

The diagram below represents the torque and speed, corresponding to a modified rating life L10mh= 40 000 h. Oil viscosity in motor case 40 cSt. Contamination level not exceeding ISO 4406:1999 18/16/13 (NAS 1638, class 7). The diagram is based on a charge pressure of 15 bar (218 psi).

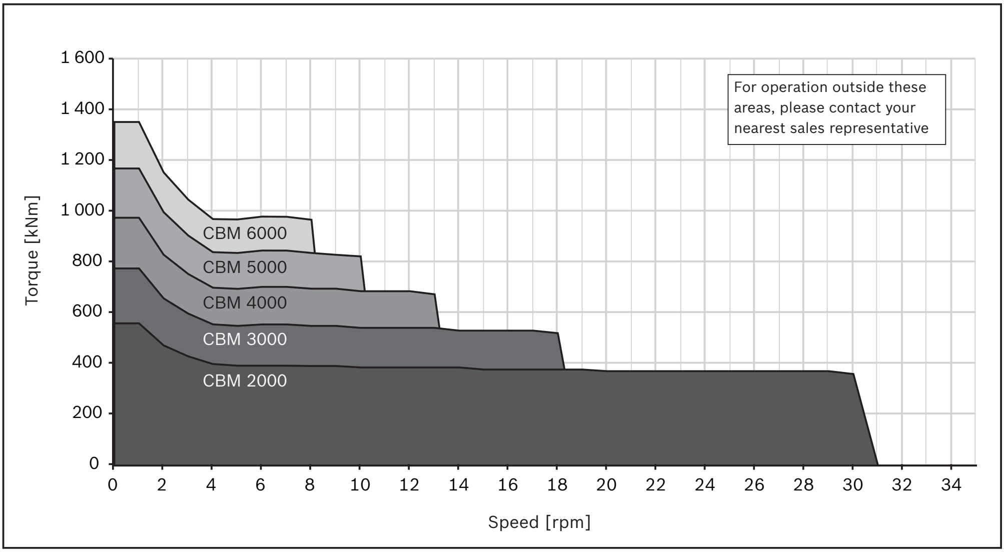


Fig 1a: Quick selection diagram

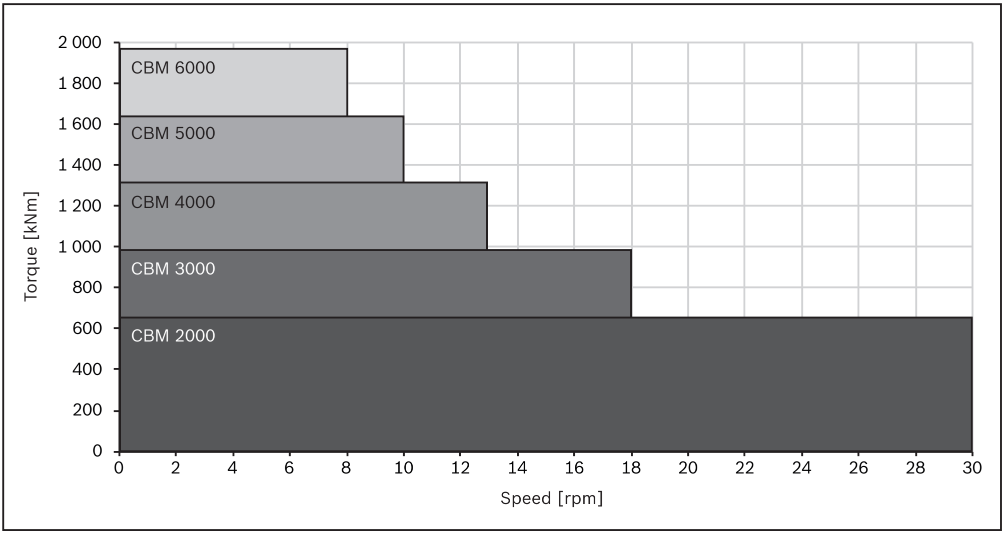


Fig 1b: Max torque diagram

Functional description

Bosch Rexroth‘s hydraulic industrial motor Hägglunds CBM is of the radial-piston type with a rotating cylinder block/ hollow shaft and a stationary housing. The cylinder block is mounted in fixed roller bearings in the housing. An even number of pistons are radially located in bores inside the cylinder block, and the valve plate directs the incoming and outgoing oil to and from the working pistons. Each piston is working against a cam roller.

When the hydraulic pressure is acting on the pistons, the cam rollers are pushed against the slope on the cam ring that is rigidly connected to the housing, thereby producing a torque. The cam rollers transfer the reaction force to the pistons which are guided in the cylinder block. Rotation therefore occurs, and the torque available is proportional to the pressure in the system.

Oil main lines are connected to ports A and C in the connection block and drain lines to ports D1, D2, D3 or D4 in the motor housing.

The motor is connected to the shaft of the driven machine through the hollow shaft of the cylinder block. The torque is transmitted by splines.

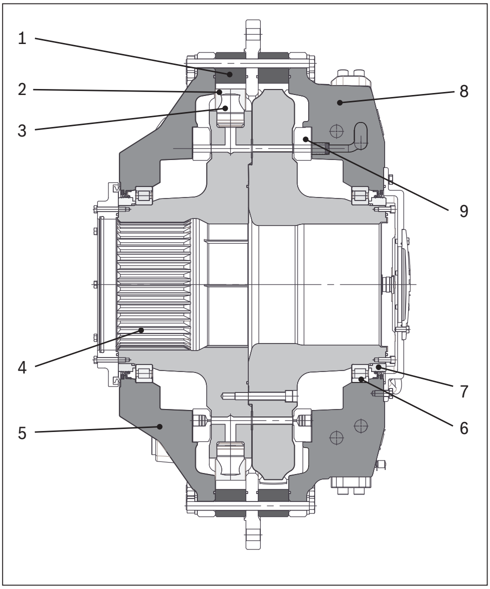


Fig. 2: Hägglunds CBM motor

1.	Cam ring	6.	Cylindrical roller bearing
2.	Cam roller	7.	Wearing part
3.	Piston	8.	Connection housing
4.	Cylinder block, spline	9.	Distributor
5.	Housing cover		

Valid patents

US 4522110, US 005979295A, SE 456517, EP 0102915, JP 83162704, GB 1385693, EP 0524437.

Quality

To assure our quality we maintain a Quality Assurance System, certified to standard ISO 9001.

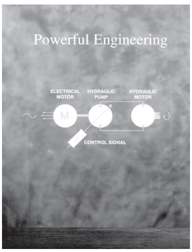
4

Calculation fundementals

Output power	$P=\frac{T\cdot n}{9549}$	(kW) on driven shaft	$P=\frac{T\cdot n}{5252}$	(hp) on driven shaft
Output torque (η_m=98%)	$T=T_s\cdot(p-\Delta p_l-p_c)\cdot\eta_m$	(Nm)	$T=\frac{T_s\cdot(p-\Delta p_l-p_c)\cdot\eta_m}{1000}$	(lbf·ft)
Pressure required (η_m=98%)	$p=\frac{T}{T_s\cdot\eta_m}+\Delta p_l+p_c$	(bar)	$p=\frac{T\cdot 1000}{T_s\cdot\eta_m}+\Delta p_l+p_c$	(psi)
Flow rate required	$q=\frac{n\cdot V_i}{1000}+q_l$	(l/min)	$q=\frac{n\cdot V_i}{231}+q_l$	(gpm)
Output speed	$n=\frac{q-q_l}{V_i}\cdot 1000$	(rpm)	$n=\frac{q-q_l}{V_i}\cdot 231$	(rpm)
Inlet power	$P_{in}=\frac{q\cdot(p-p_c)}{600}$	(kW)	$P_{in}=\frac{q\cdot(p-p_c)}{1714}$	(hp)

Quantity	**Symbol**		**Metric**	**US**
Power	P	=	kW	hp
Output torque	T	=	Nm	ft-lbs
Specific torque	Ts	=	Nm/bar	ft-lbs/1000
psi				
Rotational speed	n	=	rpm	rpm
Required pressure	p	=	bar	psi
Pressure loss	Δp	=	bar	psi
Charge pressure	pc	=	bar	psi
Flow rate required	q	=	l/min	gpm
Total volumetric loss	ql	=	l/min	gpm
Displacement	Vi	=	cm3/rev	in3/rev
Mechanical efficiency	ηm	=	0.98*	

*Not valid for starting efficiency



For more information, see Powerful Engineering (EN347-4)

Definitions

Rated speed[1)]
Rated speed is the highest allowed speed for a charge pressure of 12 bar (174 psi) above case pressure. When a closed loop system is used, a minimum of 15% of oil is to be exchanged in the main loop.

Max speed
Maximum speed is the maximum allowed speed. Special considerations are necessary regarding charge pressure, cooling and choice of hydraulic system for speeds rated above.

1) Operating above rated conditions requires approval from Bosch Rexroth.

Accepted conditions for standard type of motor:

1. Oil viscosity 15 - **40** - 10000 cSt. See page 21.
2. Temperature -35 °C to +70 °C (-31 °F to +158 °F).
3. Running case pressure 0-3 bar (0-43,5 psi) Max case pressure 8 bar (116 psi)
4. Charge pressure (see diagram).
5. Volumetric losses (see diagram).

Motor data

Table 1a: Metric motor data Hägglunds CBM motor

Motor type	Displacement	Specific torque	Rated speed* 1)	Max speed	Max pressure**	Max torque2)	Max power intermittent3)
	cm³/rev	Nm/bar	rpm	rpm	bar	kNm	kW
CBM 2000-1200	75 838	1 200	53	53	350	394	2 186
CBM 2000-1400	88 279	1 400	44	44	350	460	2 118
CBM 2000-1600	100 782	1 600	38	38	350	525	2 090
CBM 2000-1800	113 726	1 800	33	33	350	591	2 042
CBM 2000	126 732	2 000	30	30	350	657	2 063
CBM 3000-2200	138 670	2 200	27	27	350	722	2 042
CBM 3000-2400	151 173	2 400	24	24	350	788	1 980
CBM 3000-2600	164 117	2 600	22	22	350	854	1 966
CBM 3000-2800	177 123	2 800	20	20	350	919	1 925
CBM 3000	190 066	3 000	18	18	350	985	1 856
CBM 4000-3200	201 565	3 200	16	16	350	1 051	1 793
CBM 4000-3400	214 508	3 400	15	15	350	1 116	1 774
CBM 4000-3600	227 514	3 600	14	14	350	1 182	1 755
CBM 4000-3800	240 458	3 800	13	13	350	1 248	1 738
CBM 4000	253 464	4 000	13	13	350	1 313	1 722
CBM 5000-4600	290 849	4 600	11	11	350	1 510	1 678
CBM 5000	316 798	5 000	10	10	350	1 642	1 653
CBM 6000-5600	354 246	5 600	8	8	350	1 838	1 619
CBM 6000	380 133	6 000	8	8	350	1 970	1 599

Table 1b: US motor data Hägglunds CBM motor

Motor type	Displacement	Specific torque	Rated speed* 1)	Max speed	Max pressure**	Max torque2)	Max power intermittent3)
	in³/rev	lbf*ft/1000 psi	rpm	rpm	psi	lbf*ft	hp
CBM 2000-1200	4 628	61 024	53	53	5 076	290 543	2 932
CBM 2000-1400	5 387	71 194	44	44	5 076	338 967	2 840
CBM 2000-1600	6 150	81 365	38	38	5 076	387 391	2 803
CBM 2000-1800	6 940	91 536	33	33	5 076	435 815	2 738
CBM 2000	7 734	101 706	30	30	5 076	484 239	2 766
CBM 3000-2200	8 462	111 877	27	27	5 076	532 663	2 738
CBM 3000-2400	9 225	122 047	24	24	5 076	581 087	2 655
CBM 3000-2600	10 015	132 218	22	22	5 076	629 511	2 637
CBM 3000-2800	10 809	142 389	20	20	5 076	677 935	2 582
CBM 3000	11 599	152 559	18	18	5 076	726 359	2 489
CBM 4000-3200	12 300	162 730	16	16	5 076	774 783	2 405
CBM 4000-3400	13 090	172 901	15	15	5 076	823 206	2 378
CBM 4000-3600	13 884	183 071	14	14	5 076	871 630	2 354
CBM 4000-3800	14 674	193 242	13	13	5 076	920 054	2 331
CBM 4000	15 467	203 412	13	13	5 076	968 478	2 309
CBM 5000-4600	17 749	233 924	11	11	5 076	1 113 750	2 251
CBM 5000	19 332	254 266	10	10	5 076	1 210 598	2 217
CBM 6000-5600	21 617	284 777	8	8	5 076	1 355 870	2 171
CBM 6000	23 197	305 119	8	8	5 076	1 452 717	2 144

*) Related to a required pressure of 12 bar for motors in braking mode.

**) The motors are designed according to DNV-rules. Test pressure 420 bar. Peak/transient pressure 420 bar maximum, allowed to occur 10000 times.

1) Special considerations regarding charge pressure, cooling and choice of hydraulic system for speed above rated, 8 ports must be used for higher speed.

2) Calculated as: Metric= Ts·(350-15)·0,98.

3) Valid for minimum permissible oil viscosity 15 cSt in the motor case.

Ordering codes

In order to identify Hägglunds equipment exactly, the following ordering code is used. These ordering codes should be stated in full in all correspondence e.g. when ordering spare parts.

Example Hägglunds CBM motor:

C	B	M		2000			S	A	0	N	0	A		00		00
01	02	03		04		05	06	07	08	09	10	11		12		13

01	Motor series	**C**
02	Generation	**B**
03	Magnum	**M**
04	**Motor size**	
	CBM 2000	**2000**
	CBM 3000	**3000**
	CBM 4000	**4000**
	CBM 5000	**5000**
	CBM 6000	**6000**
05	Specific torque (Nm/bar)	
06	**Mounting alternatives, shaft**	
	Splines	**S**
07	**Tandem kit**	
	Motor not prepared for TA kit	**A**
	Motor prepared for TA kit	**B**
08	**Displacement shift valve**	
	Motor not prepared for displacement shift	**0**
09	**Type of seal**	
	Nitrile	**N**
	Viton	**V**
10	**Through hole kit**	
	No	**0**
	Yes	**H**
11	**Piston set**	
	Coated pistons and uncoated cam rollers	**A**
12	Modification*	**00-99**
13	**Design***	
	Standard	**00**
	Special index	**01-99**

* To be filled in by DC-IA/EHD

Painting	
Orange	**Standard**
Other	**Option**

Order code example Torque arm for Hägglunds CBM:

TC	A		200	-	0	-	0	-	00
01	02		03		04		05		06

01	Torque arm	**TC**
02	Generation	**A**
03	**Torque arm size**	
	TCA 200 for CBM 2000	**200**
	TCA 400 for CBM 3000 and CBM 4000	**400**
	TCA 600 for CBM 5000 and CBM 6000	**600**
04	**Attachment**	
	Pivoted	**2**
	Other	**9**
05	Modification*	**00-99**
06	**Design***	
	Standard	**00**
	Special index	**01-99**

* To be filled in by DC-IA/EHD

Order code example for tandem kit for Hägglunds CBM:

T	B	M		40		H		00		00
01	02	03		04		05		06		07

01	Tandem kit	**T**
02	Generation	**B**
03	Magnum	**M**
04	Size	**40**
05	**Through hole**	
	No	**0**
	Yes	**H**
06	Modification*	**00-99**
07	**Design***	
	Standard	**00**
	Special index	**01-99**

* To be filled in by DC-IA/EHD

4

Dimensions, motor with splines for torque arm mounting

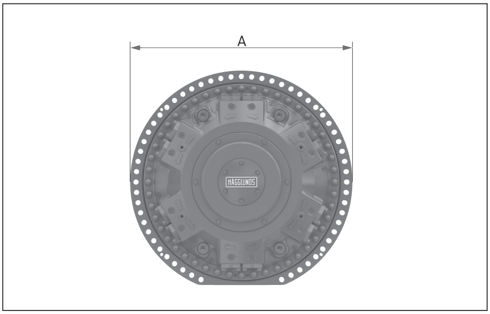


Fig. 3

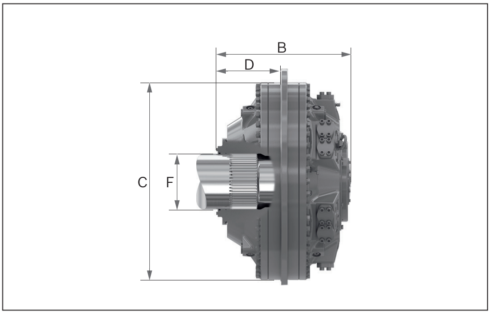


Fig. 4: CBM 2000

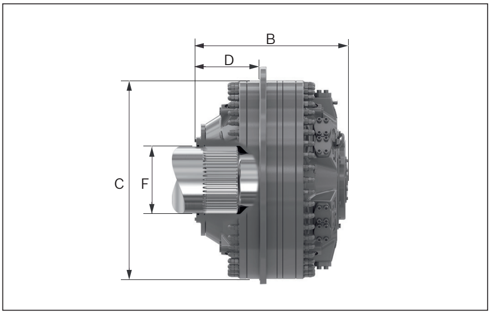


Fig. 5: CBM 3000

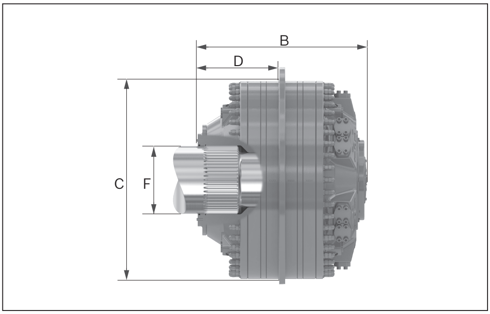


Fig. 6: CBM 4000

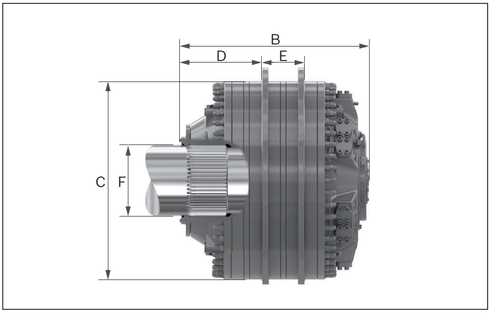


Fig. 7: CBM 5000

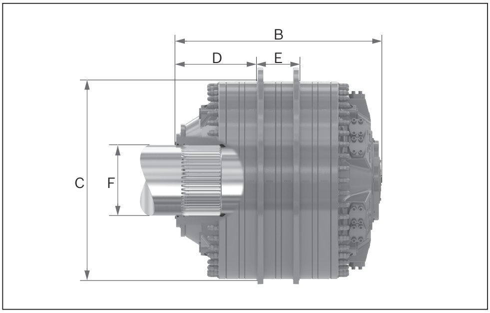


Fig. 8: CBM 6000

Table 2: Dimensions, motor with splines for torque arm mounting

Motor type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	Weight (kg)	Main conn.	Drain conn.
CBM 2000	1 460	872	1 300	419	-	N360x8x30x44x9H	4 100	SAE 2”	BSP 1 1/4” and 2”
CBM 3000	1 460	990	1 300	419	-	N440x8x30x54x9H	5 000	SAE 2”	BSP 1 1/4” and 2”
CBM 4000	1 460	1 108	1 300	537	-	N440x8x30x54x9H	5 800	SAE 2”	BSP 1 1/4” and 2”
CBM 5000	1 460	1 224	1 300	535	270	N460x8x30x56x9H	6 700	SAE 2”	BSP 1 1/4” and 2”
CBM 6000	1 460	1 342	1 300	535	270	N460x8x30x56x9H	7 500	SAE 2”	BSP 1 1/4” and 2”

With splines for flange or torque arm mounting.
The splines shall be lubricated, either oiled with hydraulic oil at assembly, or filled with transmission oil from the connected gearbox. To avoid wear in the splines, the installation must be within the specified tolerances in fig. 9. For control of spline, see table 4. When splines are used for torque arm mounting, the splines shall be lubricated with oil at assembly, see fig. 10. For control of spline, see table 4.

Table 3: Recommeded material in the shaft

Unidirectional drives	Bidirectional drives
Steel with yield strength Rel_{min} = 450 N/mm²	Steel with yield strength Rel_{min} = 700 N/mm²

Table 4

Spline	CBM 2000		CBM 3000/4000		CBM 5000/6000	
Tooth data	W360		W440		W460	
Tooth profile and bottom form	DIN 5480		DIN 5480		DIN 5480	
Tolerance	8f		8f		8f	
Guide	Flank		Flank		Flank	
Pressure angle	30°		30°		30°	
Module	8		8		8	
Number of teeth	44		54		56	
Pitch diameter	Ø352		Ø432		Ø448	
Bottom diameter	Ø340,8	0 / -1,801	Ø420,8	0 / -1,825	Ø440,8	0 / -1,825
Tip diameter	Ø358,4	h11	Ø438,4	h11	Ø458,4	h11
Measure over measuring pins	377,099	-0,107 / -0,188	457,155	-0,121 / -0,212	476,907	-0,118 / -0,208
Diameter of measuring pins	Ø16		Ø16		Ø16	
Addendum modification x*m	-0,4		-0,4		-1,6	

Flange mounting

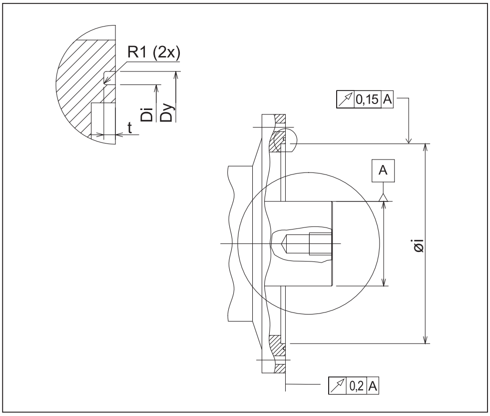


Fig. 9

For production of shaft see dwg 078 2432, 078 2451 and 078 2673.

Table 5

	øi		Dy	Di	t
CBM 2000-4000	1 300	+0.125 / 0	ø 1 329	ø 1 315	4.4±0.1

* O-ring to be used in submerged applications, or for external lubrication of the splines.

Torque arm mounting

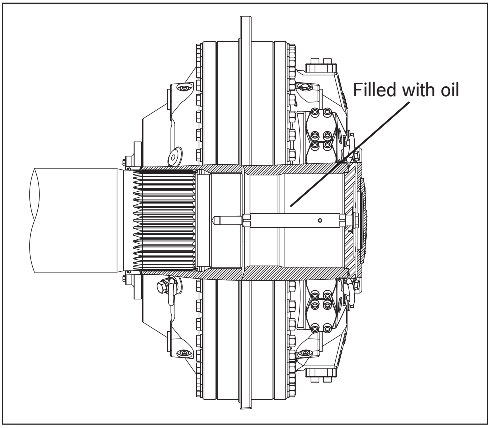


Fig. 10

For production of shaft see dwg 078 2432, 078 2451 and 078 2673.

4

Dimensions, motor with hollow shaft, coupling adapter

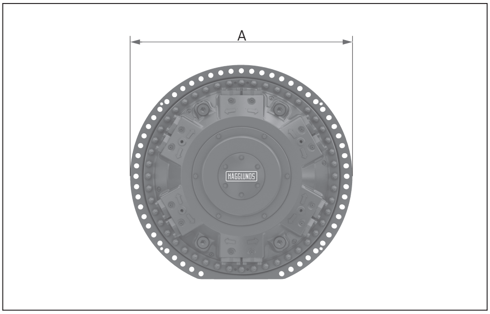


Fig. 11

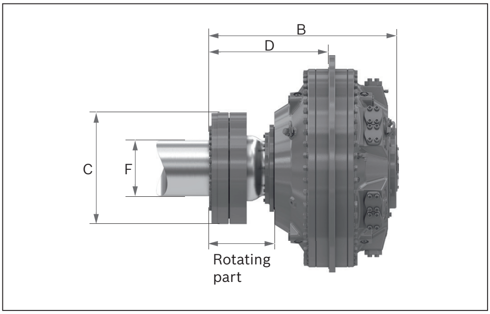


Fig. 12: CBM 2000

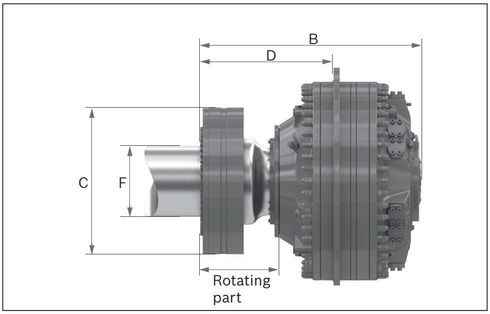


Fig. 13: CBM 3000

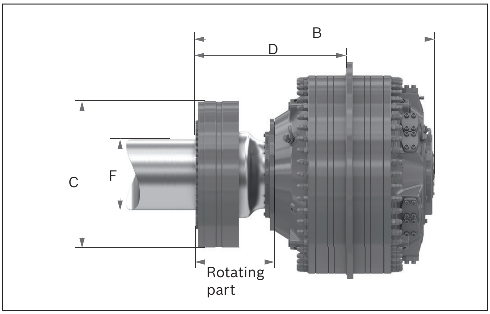


Fig. 14: CBM 4000

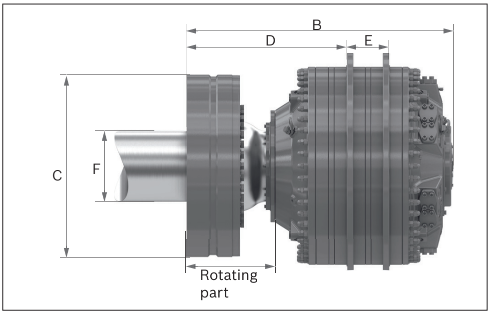


Fig. 15: CBM 5000

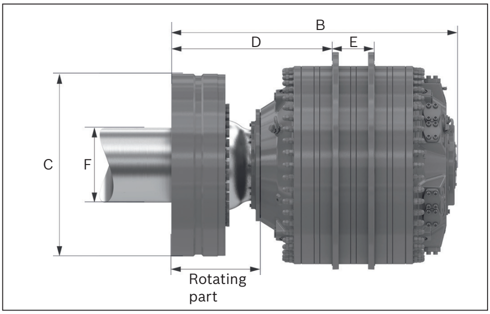


Fig. 16: CBM 6000

Table 6: Dimensions motor with hollow shaft, shaft coupling

Motor	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	Weight (kg)	Main conn.	Drain conn.
CB 2000	1 460	1 227	720	773	-	360	4 850	2"	1 1/4" och 2"
CB 3000	1 460	1 434	950	863	-	460	6 600	2"	1 1/4" och 2"
CB 4000	1 460	1 552	950	981	-	460	7 450	2"	1 1/4" och 2"
CB 5000	1 460	1 719	1 180	1 030	270,2	480	9 700	2"	1 1/4" och 2"
CB 6000	1 460	1 838	1 180	1 030	270,2	480	10 500	2"	1 1/4" och 2"

Design of driven shaft end on heavily loaded shaft

Where the driven shaft is heavily loaded and is subject to high stresses, for example for changes in the direction of rotation and/or load, it is recommended that the driven shaft should have a stress relieving groove; see figure below and tables 8 and 9.

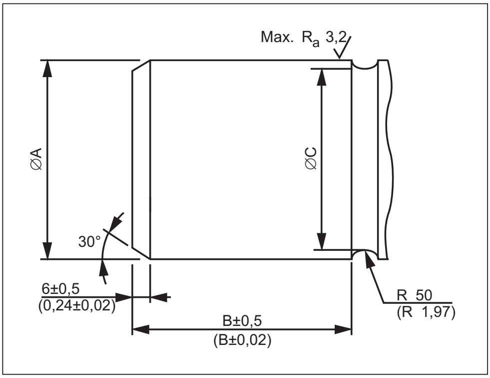


Fig. 17

Normally loaded shaft

In drives with only one direction of rotation and/or load where the stresses in the shaft are moderate, the shaft can be plain, see fig. 18 and tables 8 and 9.

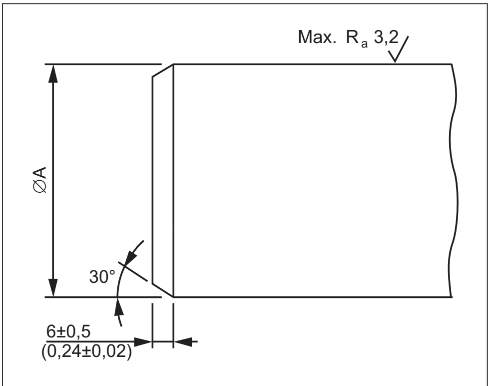


Fig. 18

Table 7

Dim		CBM 2000		CBM 3000 CBM 4000		CBM 5000 CBM 6000	
A	mm	ø360	-0,018 / -0,075	ø460	-0,020 / -0,083	ø480	-0,020 / -0,083
	in	ø14,1732	-0,00068 / -0,00292	ø18,1102	-0,00075 / -0,00323	ø18,8976	-0,00075 / -0,00323
B	mm	257		300		320	
	in	10,12		11,81		12,60	
C	mm	354		454		474	
	in	13,94		17,87		18,66	

Note! The dimensions are valid for +20 °C (68 °F)

Table 8: Recommeded material in the shaft

Unidirectional drives	Bidirectional drives
Steel with yield strength Rel_{min} = 300 N/mm²	Steel with yield strength Rel_{min} = 450 N/mm²

4

Accessories

Torque arm, type TCA 200 - 600

Easy to apply - Hägglunds torque arms.
A shaft mounted gearless drive is achieved by utilizing the standard Hägglunds torque arm. Spline shaft for external load, or shaft for shaft coupling can be used. As a result, alignment problems, expensive flexible couplings and bed plates are eliminated.

Table 9

Dimensions Torque arms	Max, torque, Nm (lbf.ft)	
	For alternating or pulsating torque	At static torque
TCA 200 for CBM 2000	700 000 (516 300)	840 000 (619 600)
TCA 400 for CBM 3000/CBM 4000	1 400 000 (1 032 600)	1 680 000 (1 239 100)
TCA 600 for CBM 5000/CBM 6000	2 100 000 (1 548 900)	2 520 000 (1 858 700)

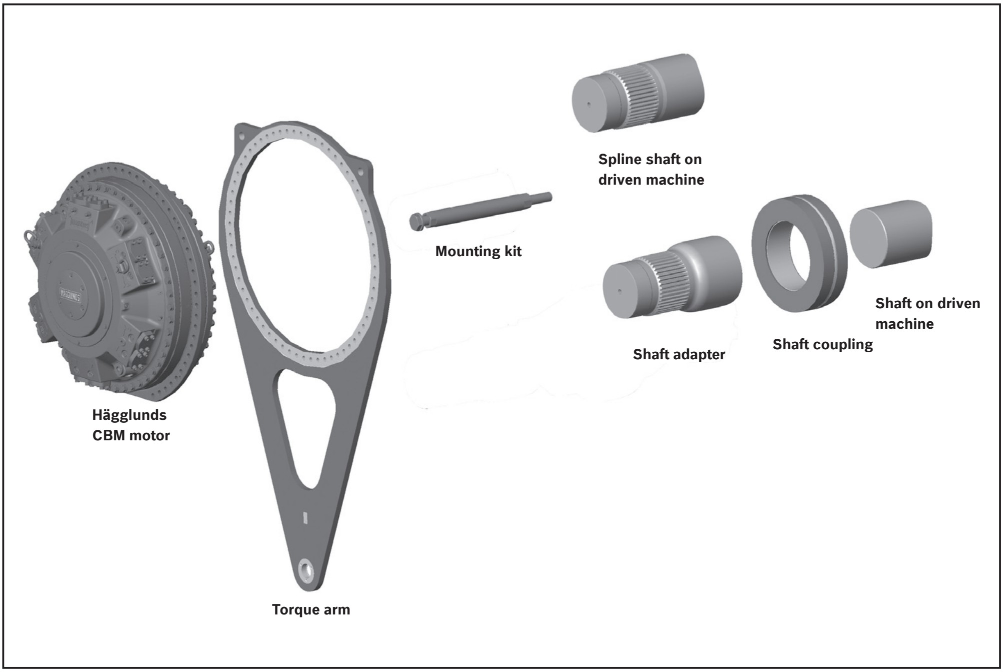


Fig. 19: Torque arm

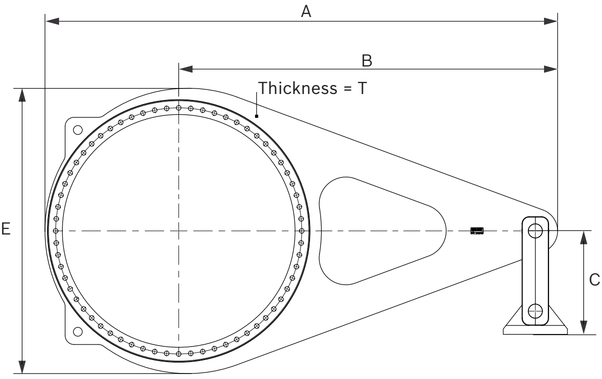


Fig. 20: Dimensions torque arm

Table 10: Dimensions torque arm

Torque arm	A mm (in)	B mm (in)	C mm (in)	D	E mm (in)	T mm (in)	Weight kg (lb)
TCA 200 for CBM 2000	2 875 (113,19)	2 000 (78,74)	580 (22,83)	M30	1 600 (62,99)	40 (1,57)	445 (981)
TCA 400 for CBM 3000/ CBM 4000	3 900 (153,54)	3 000 (118,11)	690 (27,17)	M30	1 600 (62,99)	50 (1,97)	875 (1 929)
TCA 600 for CBM 5000/ CBM 6000	3 900 (153,54)	3 000 (118,11)	840 (33,07)	M30	1 600 (62,99)	50 (1,97)	2 000 (4 409)

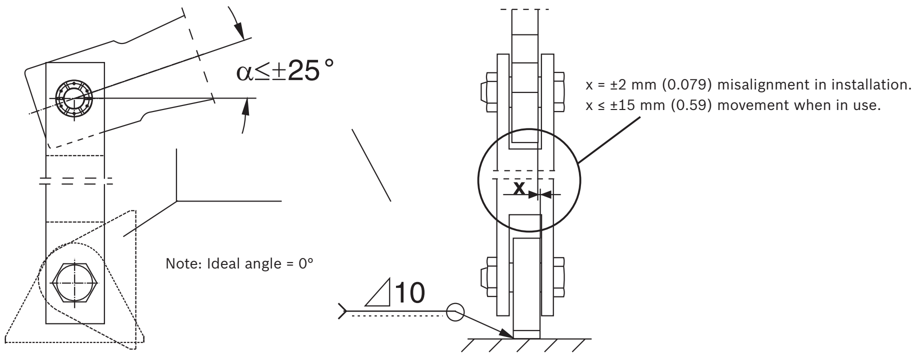


Fig 21: Mounting of pivoted attachment

4

Double ended torque arm, DTCBM 2000-1200 - DTCBM 6000

Double ended torque arm, including double acting hydraulic cylinder and pivoted attachment.
Following are included in delivery:

- Screws and washers (motor-torque arm)
- Hose kit + clamps
- Hose flange connections

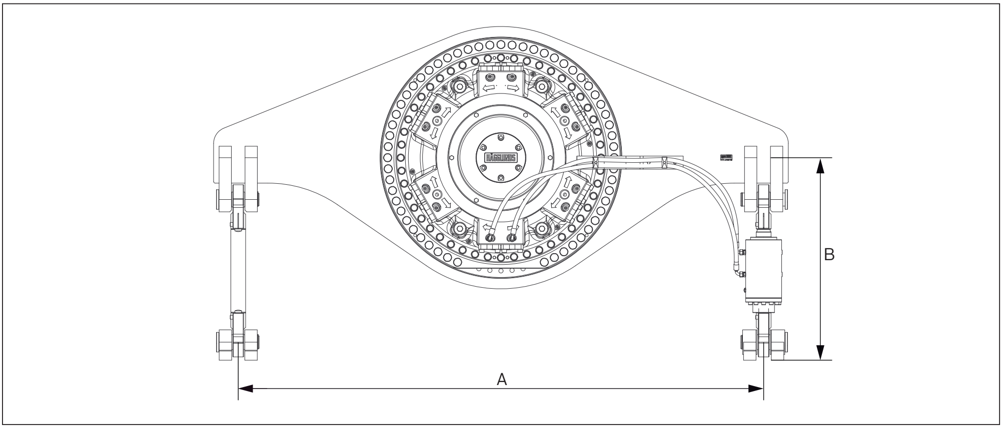


Fig. 22: Dimensions double torque arm

Table 11: Dimensions double torque arm

Torque Arm	Motor type	Ordering code	A mm (In)	B mm (In)	Weight Kg (lb)
078 2510-801 R939056847	CBM 6000-6000	DTCBM 6000	3 600 (141,73)		2 170 (4 784)
078 2510-802 R939056848	CBM 6000-5600 CBM 5000-5000	DTCBM 6000-5600	3 200 (125,98)		1 960 (4 321)
078 2510-803 R939056849	CBM 5000-4600	DTCBM 5000-4600	2 800 (110,23)		1 760 (3 880)
078 2509-801 R939056144	CBM 4000-4000 CBM 4000-3800	DTCBM 4000	4 200 (165,35)		1 130 (2 491)
078 2509-802 R939056145	CBM 4000-3600 CBM 4000-3400 CBM 4000-3200	DTCBM 4000-3600	3 600 (141,73)		950 (2 094)
078 2509-803 R939056850	CBM 3000-3000 CBM 3000-2800	DTCBM 3000		1 235 (48,62)	
078 2509-804 R939056851	CBM 3000-2600 CBM 3000-2400	DTCBM 3000-2600			
078 2509-805 R939056146	CBM 3000-2200 CBM 2000-2000	DTCBM 3000-2200	3 200 (125,98)		850 (1 874)
078 2509-806 R939056852	CBM 2000-1800	DTCBM 2000-1800			
078 2509-807 R939056853	CBM 2000-1600 CBM 2000-1400	DTCBM 2000-1600	2 800 (110,24)		740 (1 631)
078 2509-808 R939056854	CBM 2000-1200	DTCBM 2000-1200			

Mounting set SMCB1 for speed encoder

Speed encoder kit for Compact CBM 2000-6000 motors where the speed encoder is enclosed and well protected.
The mounting set can be used for both spline and shaft coupling motors.
The encoder is used for detection of speed by pulse-frequency or/either direction of rotation by pulse-train.

Fig. 23

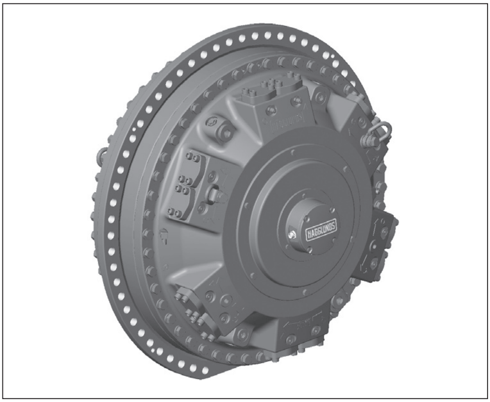


Fig. 24 CBM 2000 with SMCB1

Cross-over valve, COCB 1000

The valve can be used on CBM motors with adapter 041 0523-801. The valve is bolted on the adapter which is bolted on the motor, and the valve protects the motor and system from too high pressure, if the motor is suddenly stopped.
The relief valves have a standard pressure settings of 350 bar (5076 psi), but are fully adjustable between 50 bar (725 psi) to 350 bar (5076 psi). Pressure setting is made without charge pressure.
Screws and O-rings are included in delivery.
The valve for charge pressure have a standard pressure setting of 15 bar (218 psi), but are fully adjustable down to 3 bar (43,5 psi).
Anti-cavitation check valves are built into the block, and makes it possible to arrange for external supply of charge pressure.

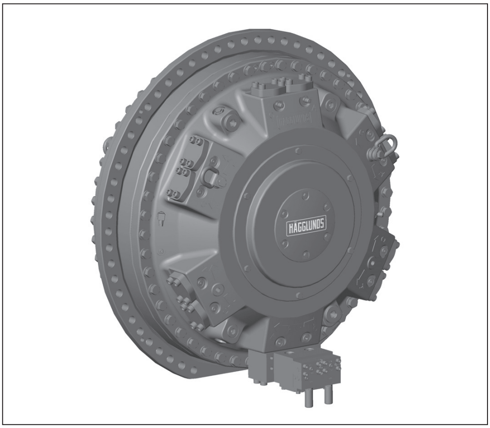


Fig. 25

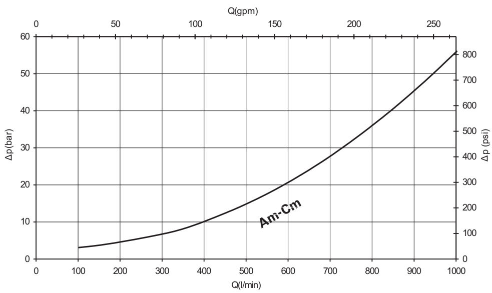


Fig. 25: Pressure loss COCB

4

Coupling adapter, CBM 2000-6000

The adapter includes shrink disk and shaft adapter. Mounting kit must be ordered separately.
The coupling adapter is designed for shaft, that can not be made with splines.

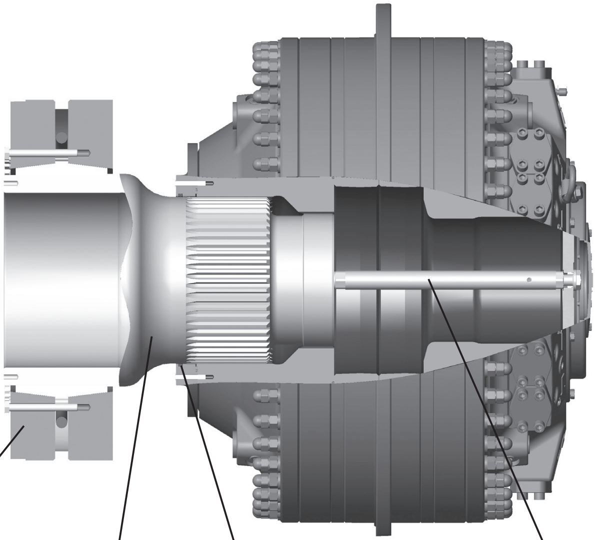


Fig. 26

Table 12: Ordering code, coupling adapter

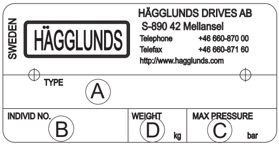
Motor type	Unidirectional drive	Bidirectional drive
CBM 2000	078 2411-801 R939055538	078 2412-801 R939055544
CBM 3000/4000	078 2411-802 R939056668	078 2412-802 R939056674
CBM 5000/6000		078 2412-803 R939056676

Table 13: Ordering code

Motor type	Ordering code
CBM 2000	R939055413 078 2315-801
CBM 3000	R939055509 078 2315-802
CBM 4000	R939055497 078 2315-803
CBM 5000	R939055505 078 2315-804
CBM 6000	R939055506 078 2315-805

Hägglunds tandem motors

A Tandem motor consists of 3 major units, Front motor + Tandem kit TBM xx + Rear motor. On the stamping sign on the Tandem kit, the max pressure and the total weight for the complete unit are declared. Note that the complete Ordering code for a Tandem motor, contains of 3 individual Ordering codes (3 parts).



A: TBM-type, same as Ordering code
B: Week of assembly (yy-ww)
C: Max working pressure for the assembly
D: Total weight of the assembly

Fig 27: Stamping for TBM-unit

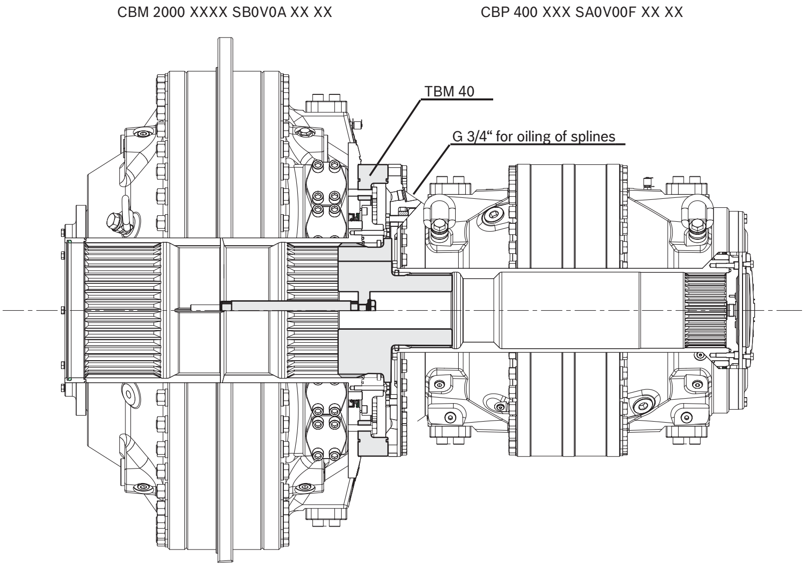


Fig. 27: Example, CBM 2000 XXXX SB0V0A XX XX + TBM 40 X 00 00 + CBP 400 XXX SA0V00F XX XX

Table 14

Tandem motor	Max. pressure		Total weight		A Lenght		B Diameter		Max. torque to driven shaft	
	bar	psi	kg	lb	mm	in	mm	in	Nm	lbf•ft
CBM 2000 + TBM 40 +CBP 400			6 505	14 344	1 845	72,6			840 000	619 554
CBM 3000 + TBM 40 +CBP 400			7 437	16 399	1 963	77,3			1 190 000	877 702
CBM 4000 + TBM 40 +CBP 400	350	5 076	8 320	18 346	2 081	81,9	1 460	57,5	1 540 000	1 135 850
CBM 5000 + TBM 40 +CBP 400			9 140	20 154	2 199	86,6			1 890 000	1 393 997
CBM 6000 + TBM 40 +CBP 400			10 005	22 061	2 317	91,2			2 240 000	1 652 145

Diagrams for Hägglunds CBM

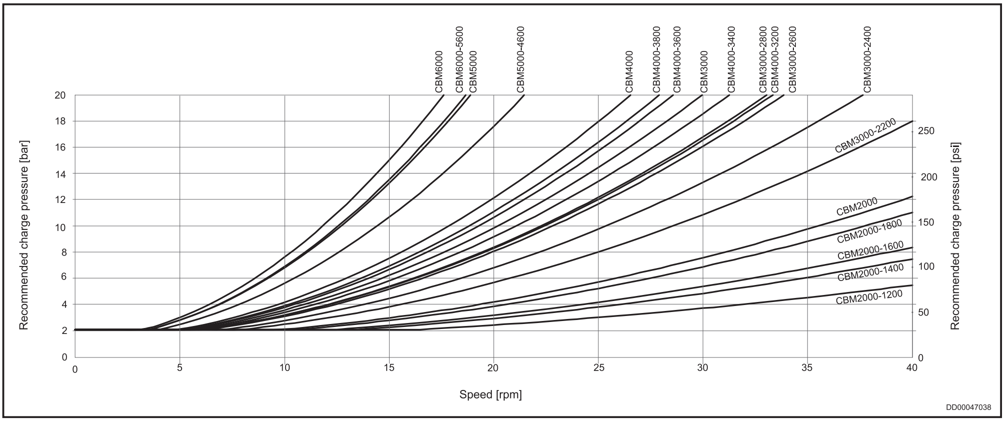


Fig 28: Recommended charge pressure - Compact CBM motors 4-port connection. Valid for oil viscosity 40 cSt.

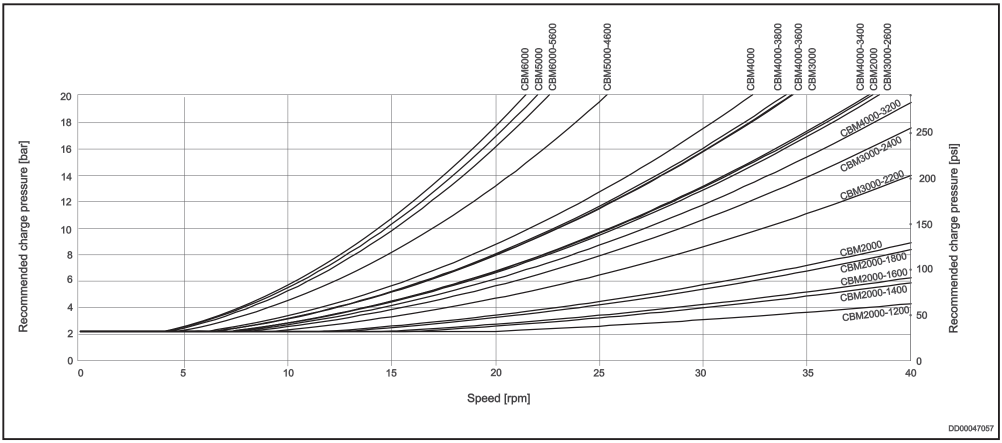


Fig 29: Recommended charge pressure -Compact CBM motors 8-port connection. Valid for oil viscosity 40 cSt.

Case 1: The motor works in braking mode. Required charge pressure at the inlet port is according to diagram above.
Case 2: The motor works in driving mode only. Required back pressure at the outlet port corresponds to 30% of value given in diagram above, but may not be lower than 2 bar (29 psi).

Overall efficiency, oil viscosity 40 cSt, Pc = 15 bar (217 psi)

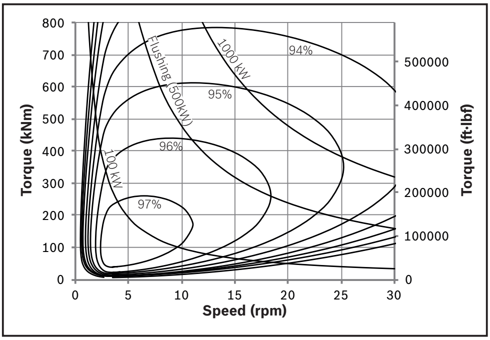


Fig 30: CBM 2000 8-port

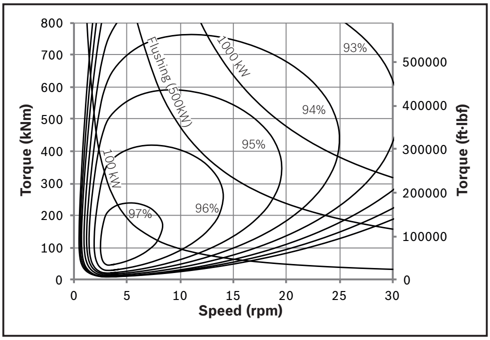


Fig 31: CBM 2000 4-port

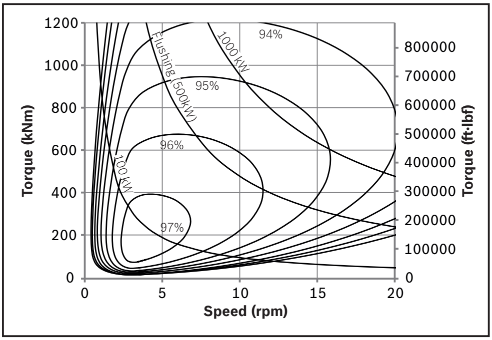


Fig 32: CBM 3000 8-port

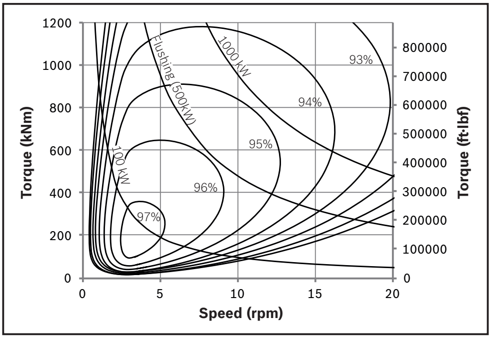


Fig 33: CBM 3000 4-port

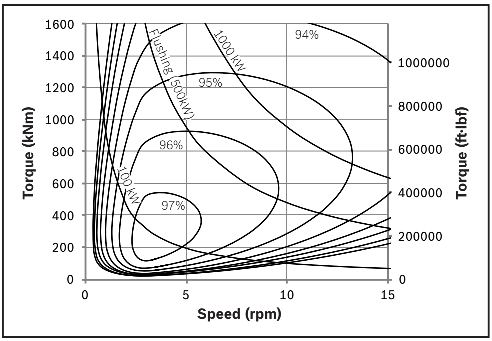


Fig 34: CBM 4000 8-port

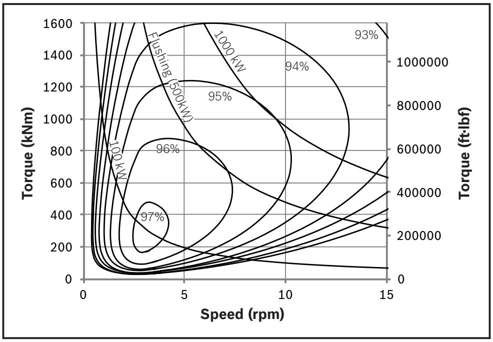


Fig 35: CBM 4000 4-port

4

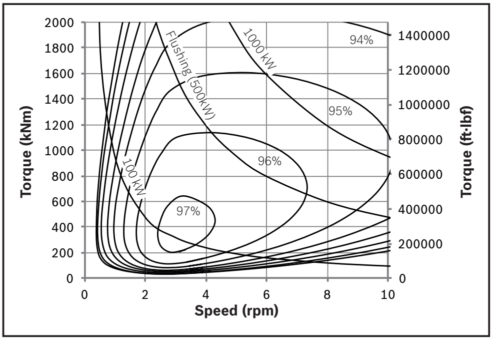


Fig 36: CBM 5000 8-port

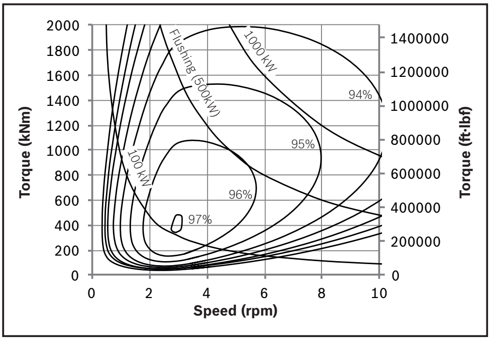


Fig 37: CBM 5000 4-port

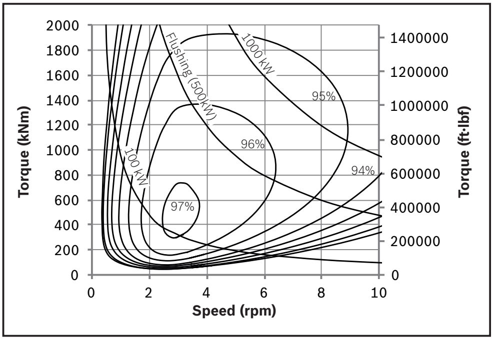


Fig 38: CBM 6000 8-port

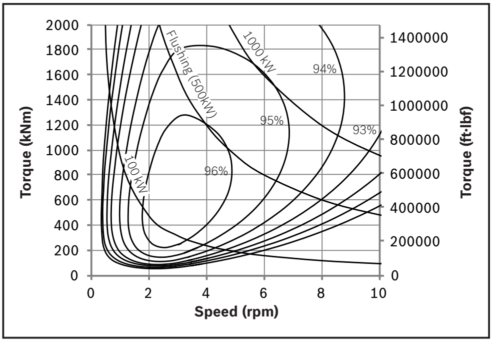


Fig 39: CBM 6000 4-port

Flushing of motor case

The Hägglunds CBM motors have very high total efficiency, and they are now frequently used in applications with high power. To avoid high temperature in the motor case, the losses generated in the motors must be cooled away, because high temperature gives lower viscosity and this gives reduction in rating life and max allowed power for the motor.
For continuous duty the motor case must be flushed when the power exceed the following max power:

Max power without flushing

- CBM 2000 - 6000 500 kW (670 hp)

Volumetric losses - Compact CBM motors

Valid for an oil viscosity of 40 cSt.

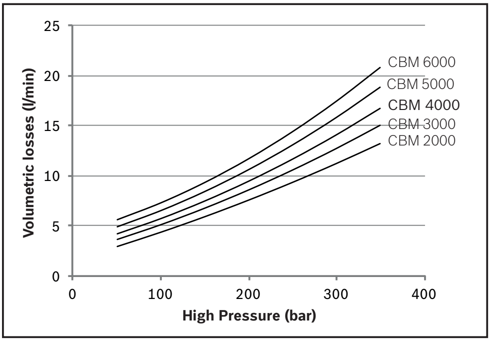


Fig 40: volumetric loss

Variation in volumetric loss at different oil viscosities for Compact motors

When calculating volumetric losses using other viscosities than 40 cSt, multiply the value given in the volumetric loss diagram by the factor K.

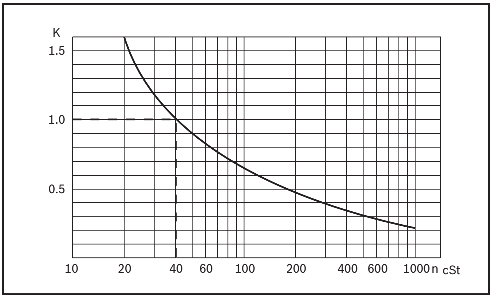


Fig 41

Diagrams for Hägglunds CBM

Pressure loss, oil viscosity 40 cSt

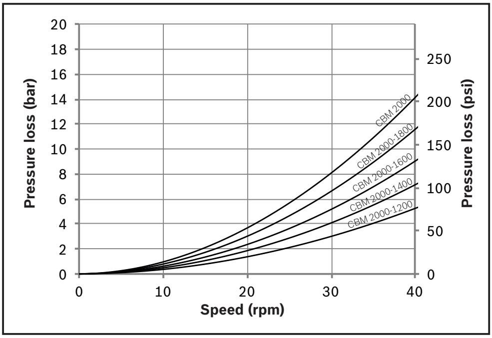


Fig 42: CBM 2000 pressure loss 4 ports

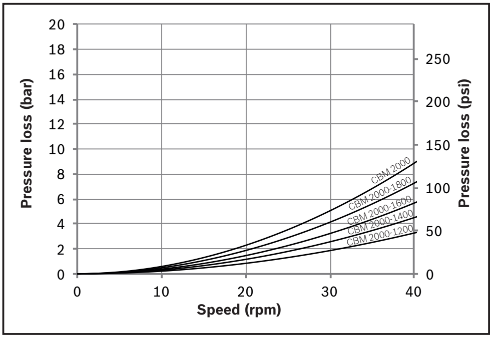


Fig 43: CBM 2000 pressure loss 8 ports

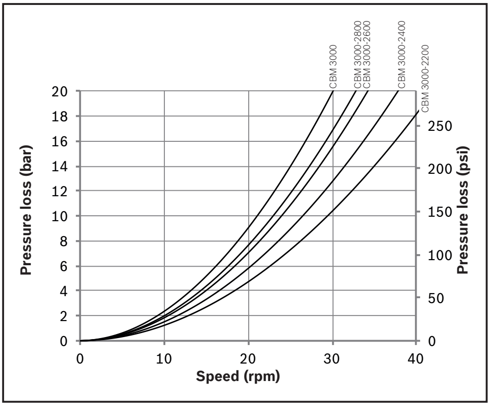


Fig 44: CBM 3000 pressure loss 4 ports

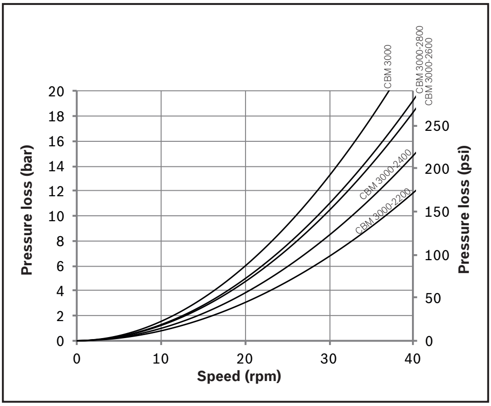


Fig 45: CBM 3000 pressure loss 8 ports

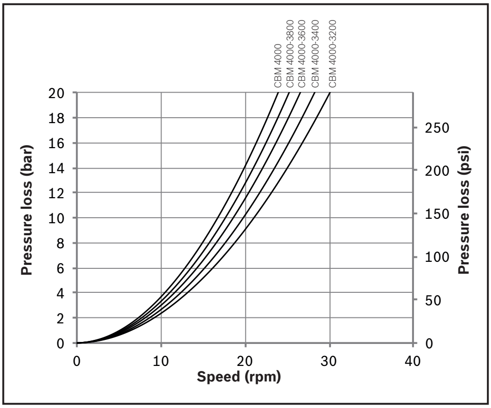


Fig 46: CBM 4000 pressure loss 4 ports

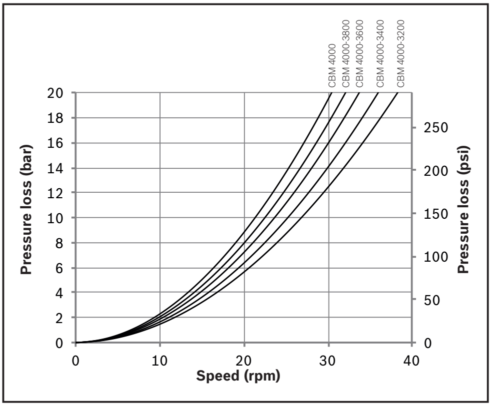


Fig 47: CBM 4000 pressure loss 8 ports

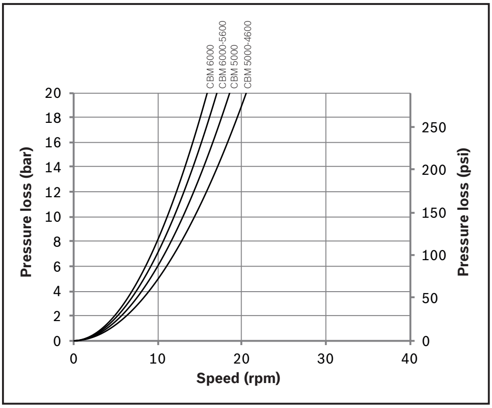


Fig 48: CBM 5000, 6000 pressure loss 4 ports

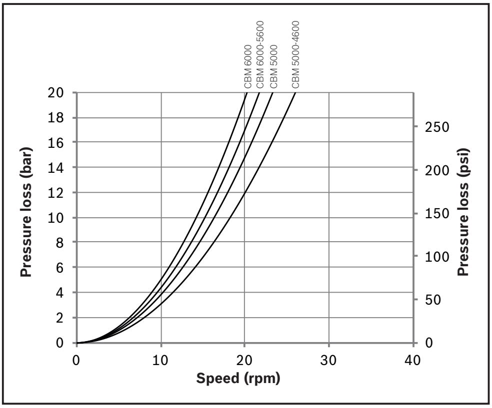


Fig 49: CBM 5000, 6000 pressure loss 8 ports

4

Choice of hydraulic fluid

The Hägglunds hydraulic motors are primarily designed to operate on conventional petroleum based hydraulic oils. The hydraulic oil can be chosen in consultation with the oil supplier of your local sales office, bearing the following requirements in mind:

General

The oil shall have FZG (90) fail stage minimum 11 described in IP 334 (DIN 51354). The oil must also contain inhibitors to prevent oxidation, corrosion and foaming. The viscosity of mineral oil is highly dependent of the temperature. The final choice of oil must depend on the operating temperature that can be expected or that has been established in the system and not in the hydraulic tank. High temperatures in the system greatly reduce the service life of oil and rubber seals, as well as resulting in low viscosity, which in turn provides poor lubrication. Content of water shall be less than 0,1%. In industrial applications with high demands for service life, the content of water shall be less than 0,05%.
Viscosity index = 100 is recommended. Viscosity index = 150 can be used for operation with large temperature difference, however many hydraulic fluids are subject to temporary and permanent reductions of the viscosity. Hägglunds recommendation is always to use the base oil viscosity when calculating the rated life and max allowed power. For heavy-duty applications we recommend synthetic oils.

Recomended viscosity in motor case at operating temperature: 40-150 cSt.

Table 15: Temperature limits

Normal operating temperature should be less than +50 °C (122 °F)		
	Temp °C	**Temp °F**
Nitrile seals (std motor)	-35 °C to +70 °C	-31 °F to +158 °F
Viton seals	-20 °C to +100 °C	-4 °F to +212 °F

Table 16: Viscosity limits

Minimum viscosity limits at operating temprature in motor case	
Standard motors with coated piston, uncoated cam rollers and charge pressure below 50 bar (725 psi).	15 cSt *

*) Low viscosity gives reduced service life for the motors. Maximum permitted viscosity is 10.000 cSt.

Fire resistant fluid

The following fluids are tested for Hägglunds motors (ISO/DP 6071).

Table 17

Fluid	Approved	Seals	Internal paint
HFA: Oil (3-5%) in water emulsion	No	-	-
HFB: Inverted emulsion 40-45% water in oil	Yes	Nitrile (std motor)	Not painted*
HFC: Water-glycol	Yes	Nitrile * (std motor)	Not painted*
HFD synthetic fluids			
HFD:S - Chlorinated hydrocarbons	Yes	Viton	Not painted*
HFD:T - Mixture of the above	Yes	Viton	Not painted*
HFD:U - Other compositions	Yes	Viton	Not painted*

* Must be specified in the order.

Down rating of pressure data and basic rating life

Down rating of pressure, for motors used in systems with fire resistant fluids, the maximum pressure for motor given on data sheet must be multiplied with following factors:

HFA-fluid	not fit for use
HFB-fluid	0.7 x maximum pressure for motor
HFC-fluid	0.7 x maximum pressure for motor
HFD-fluid	0.9 x maximum pressure for motor

Down rating of basic rating life, for motors used in systems with fire resistant fluids, the “expected basic rated life” must be multiplied with following factors:

HFA-fluid	not fit for use
HFB-fluid	0.26 x expected life with mineral oil
HFC-fluid	0.24 x expected life with mineral oil
HFD-fluid	0.80 x expected life with mineral oil

Filtration

The oil in a hydraulic system must always be filtered and also new oil from your supplier has to be filtered when adding it to the system. The grade of filtration in a hydraulic system is a question of service life v.s. money spent on filtration.
In order to obtain stated service life it is important to follow our recommendations concerning contamination level.
When choosing the filter it is important to consider the amount of dirt particles that the filter can absorb and still operate satisfactory. For that reason we recommend a filter with an indicator that gives a signal when it is time to change the filter cartridge.

Filtering recommendations
Before start-up, check that the system is thoroughly cleaned.

- 1. For industrial applications the contamination level should not exceed ISO 4406:1999 18/16/13 (NAS 1638, class 7).
- 2. When filling the tank and motor case, we recommend the use of a filter with the grade of filtration $\beta 10 \geq 75$.
-

Explanation of "Grade of Filtration"
Grade of filtration **$\beta 10 \geq 75$** indicates the following:
$\beta 10$ means the size of particle ≥10µm that will be removed by filtration.
=75 means the grade of filtration of above mentioned size of particle. The grade of filtration is defined as number of particles in the oil before filtration in relation to number of particles in the oil after filtration.

Ex. Grade of filtration is **$\beta 10 \geq 75$**.
Before the filtration the oil contains N number of particles ≥10µm and after passing the filter once the oil contains

$$\frac{N}{75}$$

number of particles ≥10µm.
This means that

$$N - \frac{N}{75} = \frac{74 \cdot N}{75}$$

number of particles have been filtered (=98.6%).

Environmentally acceptable fluids

Table 18

Fluid	Approved	Seals	Internal paint
Vegetable */** Fluid HTG	Yes	Nitrile (std motor)	-
Synthetic ** Esters HE	Yes	Nitrile (std motor)	-

* Vegetable fluids give good lubrication and small change of viscosity with different temperature. Vegetable fluids must be controlled every 3 months and temperature shall be less than +45 °C (113 °F) to give good service life for the fluid.

** Environmentally acceptable fluid give the same service life for the drive, as mineral oil.

4

Versatile mounting - examples of installations

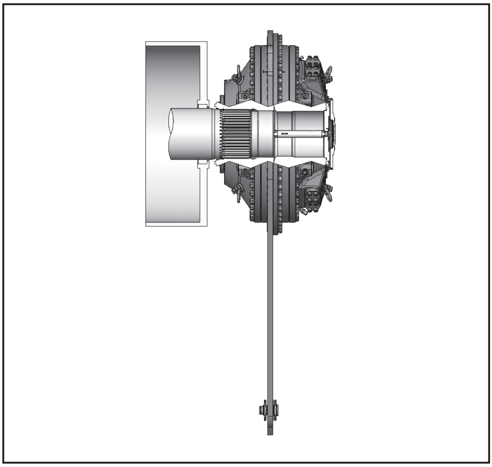


Fig 50: Torque arm mounted motor with splines.

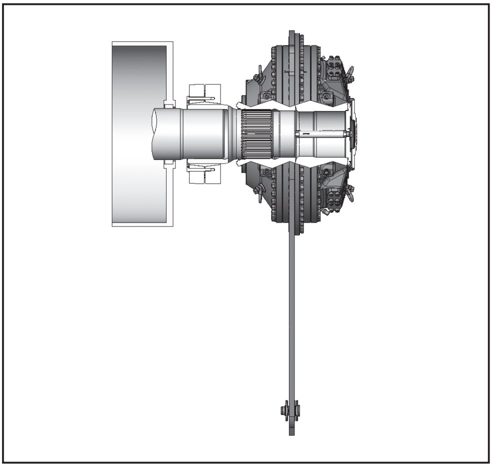


Fig 51: Torque arm mounted motor with coupling adapter.

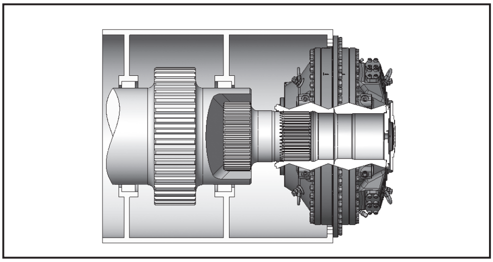


Fig 52: Flange mounted motor with splines and high radial load Fr on driven shaft.

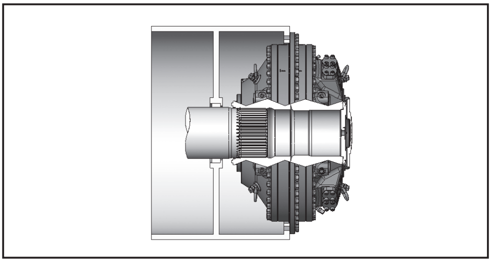


Fig 53: Flange mounted motor with splines and low radial load from driven shaft.

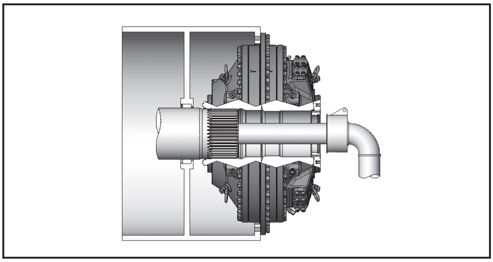


Fig 54: Flange mounted motor with splines and through hole for cooling of the driven machine.

Declaration of Conformity

Example of the Declaration of Conformity given by Hägglunds Drives AB

Rexroth
Bosch Group

Declaration of Incorporation (Translation of the Declaration of Incorporation)
As defined by the EC Machinery Directive 2006/42/EC, Appendix II B

Doc. No.:
Date:

The manufacturer
Hägglunds Drives AB, Bosch Rexroth

hereby declares that the partly completed machinery

Name:	Hägglunds CBM
Function:	Hydraulic motor
Model:	Compact
Type:	CBM
Serial number:	
Trade name:	Hägglunds CBM

satisfies the following essential requirements of Machinery Directive 2006/42/EC in accordance with the chapter numbers in Appendix I:

General principle no. 1.												

The requirements are fulfilled provided that the data in the product documentation (fitting instructions, operating instructions, project management and configuration documents) are implemented by the product user. The requirements of Appendix I to Machinery Directive 2006/42/EC not mentioned here are not applied and have no relevance for the product.

It is also declared that the special technical documents for this partly completed machinery have been compiled in accordance with Appendix VII, Part B. These are transferred on request to the market surveillance body in paper-based/electronic format.

Conformity with the provisions of further EU Directives, Standards or Specifications:

SS-EN 982
SS-EN 12100-1
SS-EN 12100-2

The partly completed machinery may only be put into operation when it has been established that the machine into which the partly completed machinery is to be incorporated conforms to the provisions of EC Machinery Directive 2006/42/EC, where relevant according to this directive.

The individual below is authorized to compile the relevant technical files:

Name:
Address: Hägglunds Drives AB, Bosch Rexroth, 895 80 Mellansel

Place/date/signature as indicated in the original declaration

Mellansel 01.06.12

We reserve the right to make changes to the content of the Declaration of Incorporation. Current issue on request.

Doc.-No. page 1 / 4

The Declaration of Conformity above, is available on request for deliveries from Hägglunds Drives AB. Translations into other languages are also available.

Bosch Rexroth Mellansel AB
895 80 Mellansel, Sweden
Tel: +46 (0) 660 870 00
Fax: +46 (0) 660 871 60
documentation.mll@boschrexroth.se
www.boschrexroth.com

RE 15 190/07.03

Replaces: 02.92

Radial piston hydraulic motors with a fixed displacement Types MKM, MRM

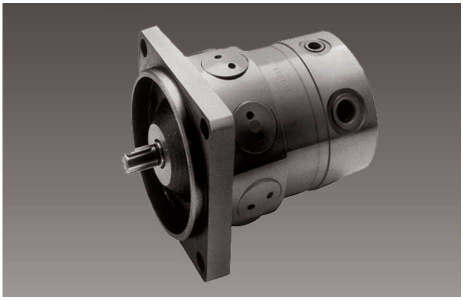
Nominal sizes 11 to 250

Series 1X

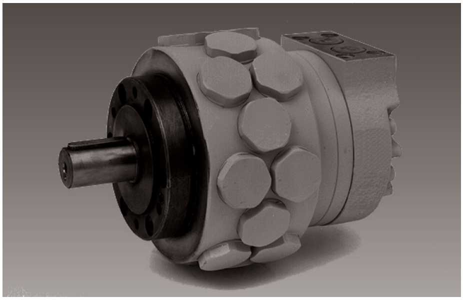
Maximum operating pressure 315 bar

Maximum displacement 251 L/min

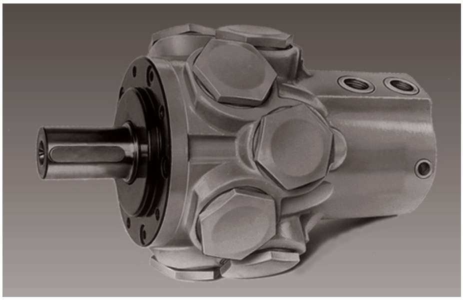
Maximum torque 1165 Nm



Type MKM 11 AZ 1X/M2 A0



Type MKM 90 AZ 1X/M1 A1



Type MRM 160 AZ 1X/M1 A0

Overview of contents

Features

– Wide speed range
– Linear acting backlash compensation control
– Smooth rotation even at very low speeds
– Extremely small moment of inertia permitting high reversal frequency
– Very suitable for control applications
– Suitable for fire resistant fluids
– Very low operating noise level
– Versions with:
  • Shaft for tachometer
  • Through shaft
  • Built-on valves
  • With brakes

Ordering details

				1X /						*

Motor type

Standard motor (NS 11, 22, 32, 45, 63, 90, 110)	**= MKM**
Motor with backlash compensation control (NS 11, 80, 125, 160, 250)	**= MRM**

Displacement – NS

	MKM	MRM	
11 cm^3 = NS 11	•	•	**= 11**
22 cm^3 = NS 22	•	–	**= 22**
33 cm^3 = NS 32	•	–	**= 32**
44 cm^3 = NS 45	•	–	**= 45**
66 cm^3 = NS 63	•	–	**= 63**
81 cm^3 = NS 80	–	•	**= 80**
89 cm^3 = NS 90	•	–	**= 90**
110 cm^3 = NS 110	•	–	**= 110**
126 cm^3 = NS 125	–	•	**= 125**
161 cm^3 = NS 160	–	•	**= 160**
251 cm^3 = NS 250	–	•	**= 250**

• = Available

1st shaft end

Cylindrical, key DIN 6885	**= A**
Splined shaft DIN 5480 (**only** motor type **MRM** without NS 11)	**= K**
Internally splined shaft DIN 5480 (**only** motor type **MRM** without NS 11)	**= H**

2nd shaft end

Without 2nd shaft end	**= Z**
Cylindrical Ø 10 mm for tacho connection	**= M**
Splined Ø 28 mm DIN 5480 (**only** motor type **MKM** without NS 11)	**= M10-**

Series 10 to 19 (10 to 19, unchanged installation and connection dimensions)	**= 1X**

NBR seals, suitable for HLP mineral oil to DIN 51 524 part 2	**= M**
FKM seals, suitable for phosphate ester (HFD) for HFB and HFC – pressure reduced to 70 %	**= V**

Further details in clear text e. g. gear unit tacho/valves

Holding brake

No code =	**Without** brakes
LBD9A2 **LBD11A2** **LBD124A2** **LBD249A2**	(see technical data on page 5)

Built-on valves, subplate mounting (only in conjunction with line connections **A1**)

No code =	None
N01 =	Pressure-anti-cavitation valve (pressure stage in clear text)
N61 =	Pressure-anti-cavitation valve Valve connection NS 6 to DIN 24 340
N101 =	Pressure-anti-cavitation valve Valve connection NS 10 to DIN 24 340

Additional details

No code =	Standard
S99 =	Flushing connection (**not** for NS 11)
T =	Increased clearance for very high speeds and very high temperatures

Pipe connections

A0=	Threaded connection, radial
A1=	Flange connection, radial (for NS 80, 125, 160, 250-SAE 3/4")
B5=	Threaded connections, axial (**only** NS 22, 32, 45, 63, 90, 110)

Flange version

1 =	Face mounting - standard version (**not** for type **MKM** NS 11)
2 =	Flange mounting
3 =	Face mounting (**only** for NS 22, 32, 45, 63, 90, 110)

Ordering example: MKM 45 AZ1X/M2A0

Technical data (for applications outside these parameters, please consult us!)

General

Design	Radial piston motor, fixed displacement
Type	MKM; MRM
Mounting style	Flange mounting; front face mounting
Connection type	Threaded; flange (depending on version)
Installation	Optional
Shaft loading, bearing life	See page 6

			11[1)]	11[2)]	22	32	45	63	80	90	110	125	160	250
Nominal size	*NS*													
Moment of inertia	*J*	kg cm^2	2.63	2.63	2.8	2.8	3.3	3.3	17	3.9	4.1	17	23	23
Weight	*m*	kg	12	12	17.4	17.4	18.8	18.8	40	21.4	21.4	40	58	58

Hydraulic

				11	11	22	32	45	63	80	90	110	125	160	250
Displacement		*V*	cm^3	11	11	22	33	44	66	81	89	110	126	161	251
Torque	Specific theoretic	*T*	Nm/bar	0.17	0.17	0.35	0.52	0.7	1.05	1.29	1.41	1.75	2	2.56	4
	Specific average	*T*	Nm/bar	0.15	0.15	0.32	0.48	0.63	0.95	1.16	1.27	1.59	1.8	2.38	3.7
	Continuous	*T*	Nm	21	24	50	76.8	100	152	290	178	223	360	595	740
	Max.	*T*	Nm	31.5	37.5	78	120	157	237	365	266	334	567	750	1165
Pressure differential	Continuous pressure	Δp	bar	140	160	160	160	160	160	250	140	140	200	250	200
	Operating pressure, max	Δp	bar	210	250	250	250	250	250	315	210	210	315	315	315
	Peak pressure [3)]	Δp	bar	250	315	315	315	315	315	400	250	250	350	400	350
Max. summated pressure in ports A + B		*p*	bar	250	315	315	315	315	315	400	250	250	350	400	350
Leakage fluid pressure		*p*	bar	1.5 bar (special seals for higher pressures on request.)											
Speed range	From	*n*	min^{-1}	10	5	10	10	5	5	5	5	5	5	5	5
	Up to	*n*	min^{-1}	3000	3600	2250	1500	1800	1200	800	900	750	600	800	600
				For speeds ≤ 10 min^{-1} please take the operating instructions into account, depending on the application minimum speeds of 0.1 min^{-1} are possible in closed loop applications.											
Power	Continuous	*P*	kW	3.5	4.7	6	6	9.5	9.5	12	8.5	8.5	12	24	24
	Intermittent	*P*	kW	4.3	5.8	7.5	7.5	11	11	15	10	10	15	30	30

$P_{continuous}$ Continuous working power (with a max. return pressure of 10 bar): If continuously exceeded, then rotary group flushing should be provided.
$P_{intermittent}$ Power that intermittently (max. 10 % ED within an operating period of one hour) can be demanded.

Pressure fluid			HLP mineral oil to DIN 51 524 part 2
			HFB and HFC fluids – pressures reduced to 70 %,
			Phosphate ester (HFD), FKM seals required
Pressure fluid temperature range	ϑ	°C	– 30 to + 90
Viscosity range	ν	mm^2/s	20 to 150 recommended operating range 30 to 50, up to 1000 on start-up
Cleanliness class to ISO code			Maximum permissible degree of contamination of the pressure fluid is to ISO 4406 class 20/18/15

The cleanlines class stated for the components must be adhered too in hydraulic systems. Effective filtration prevents faults from occurring and at the same time increases the component service life.
For the selection of filters see catalogue sheets RE 50 070, RE 50 076 and RE 50 081.

4

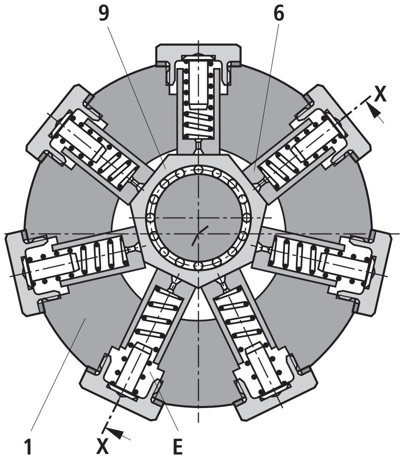
Technical data for the holding brake

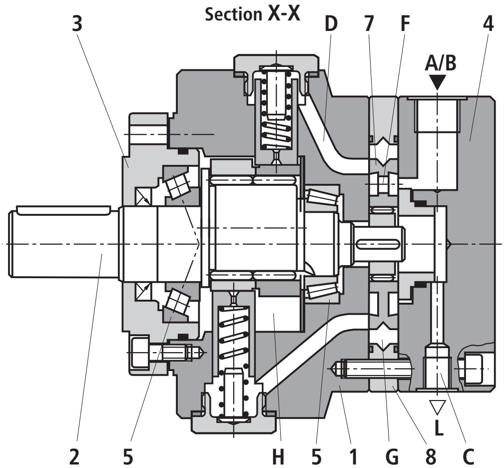
Design			Spring pressure multiple disc brake, static holding brake; dynamic operation only in the case of an emergency			
Brake type			LBD9A2	LBD11A2	LBD124A2	LBD249A2
Static braking moment (wet running)	$T_ü$	Nm	17	190	400	740
Dynamic braking moment (wet running)	T_s	Nm	11	140	300	500
Air pressure	*p*	bar	20 – 250	30 – 320	30 – 320	30 – 320
Weight	*m*	kg	8	9.5	28	32
Motor type cross reference			MKM 11 A2 MRM 11 A2	MKM 22 A1 MKM 32 A1 MKM 45 A1 MKM 63 A1 MKM 90 A1 MKM 110 A1	MRM 80 K2 MRM 125 K2	MRM 160 K2 MRM 250 K2

1) MKM; 2) MRM

3) Definition to DIN 24 312 peak pressure = pressure curve which temporarily exceeds the maximum operating pressure and at which the motor continues to remain operable.

Function, section





Types MKM and MRM hydraulic motors are fixed displacement external radial piston motors.

Design

The main components are housing (1), crankshaft (2), cover (3), cover plate (4), tapered roller bearings (5), pistons (6), control (7).

Rotary group details

The radial pistons (6) act on the crankshaft (2) via needle bearings (9) or via heptagonal rings with needle bearings.

Crankshaft bearings:

Pre-stressed, generously sized tapered roller bearings (5) in the X-arrangement.

Power transmission pistons (6) – crankshaft (2):

Via needle bearings (9) (or heptagon ring with needle bearings)

Low friction losses, very long life, not sensitive to contamination, also suitable for maximum pressures and motor speeds, high starting torque, no stick/slip at low motor speeds, minimal leakage and high efficiency.

Operating medium, feed and return

The operating medium is supplied to and carried away from the motor by way of ports A or B. The cylinder chambers (E) are filled or emptied by way of the control and the channels (D) in the housing (1).

Torque generation; operating stroke

The operating medium in the cylinder chambers (E), which are at present connected to the supply, are pressurised. The pistons (6) are pushed from the outside (external loading!) onto the eccentric of the crankshaft (operating stroke) and the crankshaft rotates.

Operating medium return

The pistons (6), which are again pushed outwards by the rotation of the crankshaft (2) eccentric, expel the fluid from the cylinder chambers (E), which are at present connected to the return flow line.

Control

Design:

A flat distributor which moves in a linear manner.

Purpose:

Distribution of incoming flow to the cylinder chambers, collection of return flow.

Operating principle:

The control plate (7) incorprates an inner annular area (F) and forms with the annulus (8) an external annular chamber (G). By offsetting the control plate (7) radially between the motor housing (1) and locking cover (4) with the help of the eccentric which is connected firmly relative to the crankshaft (2) the inner and the outer annular areas are alternately brought into contact with the cylinders. The annular areas themselves open out into ports A or B on the outside.

Leakages

Leakages occurring at piston (6) and control (7) are collected in the motor casing (H) and discharged via drain port (C).

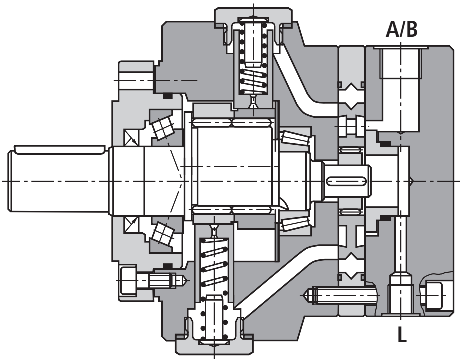
Flushing

With high powers and/or temperatures we recommend the use of rotary group flushing.

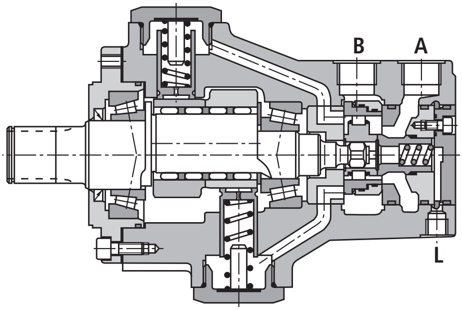
Dependent on the type, 1 to 4 litres of flushing oil is fed into the drain connection L (4) and is then passed together with the motor leakage via the flushing port S99 to tank.

Motor types - overview

MKM



MRM



Features

Rotary group (MKM)

– 7, 14 or 21 radially arranged pistons
– Power transmission piston - crankshaft: by means of pistons via heptagonal ring with needle cage

Control

– Needle cage between the control plate and eccentric
– A flat distributor plate that moves in a linear manner with gap seals to counter internal leakage and gap compensating sealing against external leakage.
– Hydrostatic spring supported pressing of the pressure piece onto the control plate
– Reduction in external leakage with minimal friction losses

Rotary group (MRM)

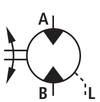
– 5 or 10 radially arranged pistons
– Power transmission piston - crankshaft: by means of hydrostatically unloaded pistons and pentagonal ring with needle cage

Control

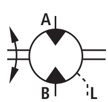
– Roller bearings between the control rings and eccentric
– A flat distributor plate that moves in a linear manner with backlash compensation
– Hydrostatic spring supported pressing of the control rings onto the flat surfaces
– Hydrostatic backlash compensation of the flat eccentric surfaces, spring supported via the pressure piece
– Reliable backlash compensation even at high reversing frequencies
– Only very slight leakage with minimal friction losses
– The miniaturised shuttle valve ensures: that within the ring chamber. between the control lands. the higher pressure that the motor is being subjected too is applied

Symbols

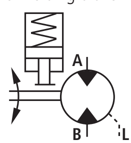
With one shaft end



With 2 shaft ends



With holding brake



Bearing life, shaft strength

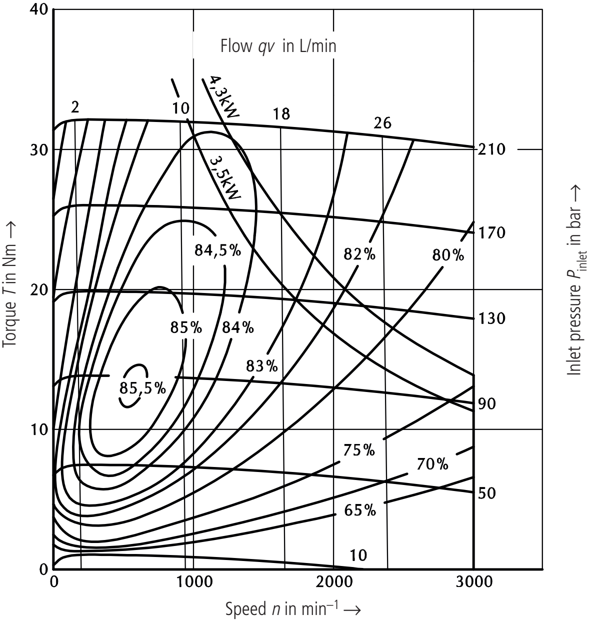
$L_{n\text{-}hyd10}$ is the modified nominal bearing life using mineral oil with a viscosity of n = 36 mm^2/s in operating hours where 10 % of the bearings may fail. 90 % achieve a higher bearing life. The average mean bearing life $L_{n\text{-}hyd50}$ with mineral oil is approximately five times $L_{n\text{-}hyd10}$. In practice a minimum of $L_{n\text{-}hyd50}$ can be expected for hydraulic drives with mineral oil. As the operating speed is incorporated into the calculation approximately as a proportionate figure, the table value is converted accordingly.

Type	Speed n (min^{-1})	$L_{n\text{-}hyd10}$ in operating hours at a defined Δp and speed n with no external forces on the drive shaft.						
		100 bar	140 bar	160 bar	180 bar	210 bar	250 bar	315 bar
MKM / MRM11	1000	>100000	88950	56995	38489	23024		
MKM 22/32	500	>100000	>100000	81400	54969	32883	18388	
MKM 45/63	350	43679	14228	9119	6157	3683	2059	
MKM 90/110	250	15719	5121	3281	2216	1325		
MRM 80	400	>100000	>100000	>100000	>100000	97424	54484	25217
MRM 125	400	>100000	85030	54484	36792	22009	12308	5697
MRM 160	400	>100000	38925	24941	16843	10075	5634	2608
MRM 250	300	31319	10203	6537	4415	2641	1477	684

Type	Speed n (min^{-1})	$L_{n\text{-}hyd10}$ in operating hours at a defined Δp and speed n MKM 11, 22, 32, 45, 63 max. permissible radial force at the centre of the output shaft = 4500 N MKM 90, 110 max. permissible radial force at the centre of the output shaft = 3000 N MRM 80, 125, 160, 250 max. permissible radial force at the centre of the output shaft = 10 000 N						
		100 bar	140 bar	160 bar	180 bar	210 bar	250 bar	315 bar
MKM / MRM11	1000	4963	4485	4235	3983	3614		
MKM 22/32	500	5838	5092	4717	4353	3839	3225	
MKM 45/63	350	9319	5898	4713	3788	2767	1704	
MKM 90/110	250	11423	4689	3098	2115	1281		
MRM 80	400	27172	22727	20610	18623	15923	12872	9118
MRM 125	400	20998	15203	12872	10897	8514	6190	3810
MRM 160	400	25074	14939	11648	9167	6523	4289	2344
MRM 250	300	14150	6882	4977	3681	2421	1387	656

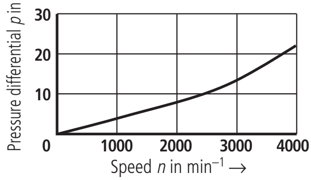
Characteristic curves (average value) measured at $\nu = 36\ mm^2/s$; $\vartheta_{oil} = 50\ °C$; $p_{outlet} = 0$ bar; $p_{leakage\ oil} = 0$ bar

MKM 11

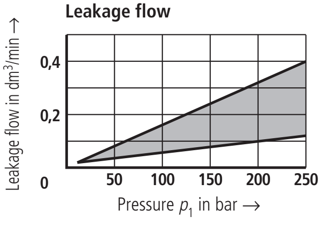


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

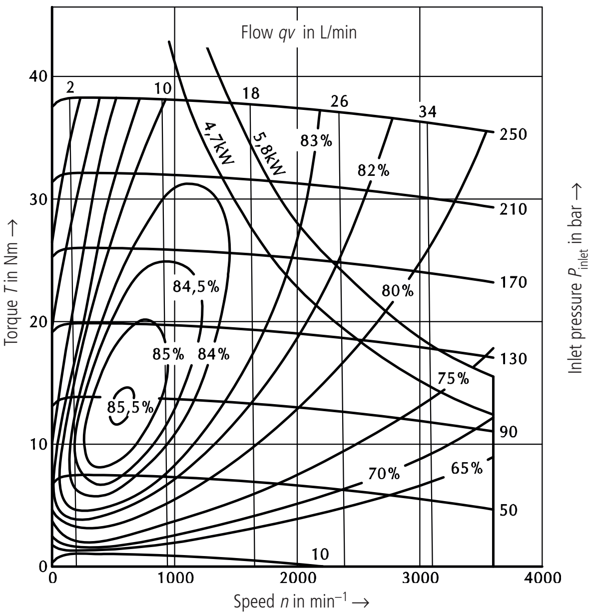
Off-load characteristi curve



Leakage flow

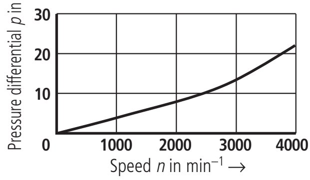


MRM 11

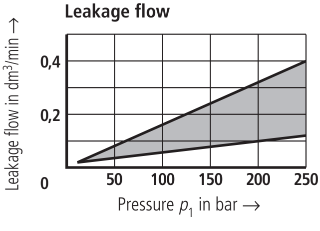


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve



Leakage flow



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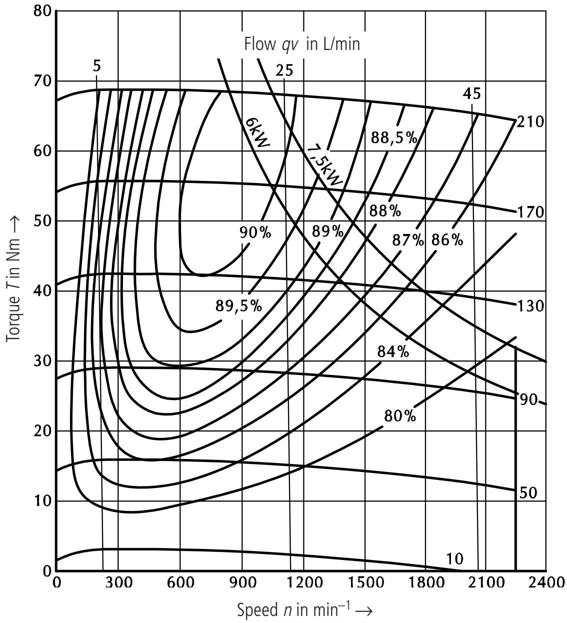
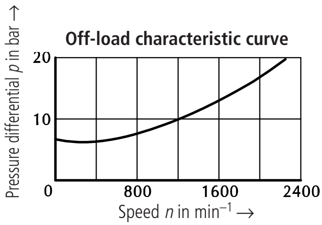
Characteristic curves (average value) measured at ν = 36 mm²/s; ϑ_{oil} = 50 °C; p_{outlet} = 0 bar; $p_{leakage\ oil}$ = 0 bar

MKM 22

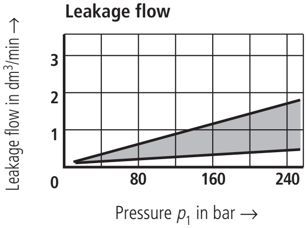


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

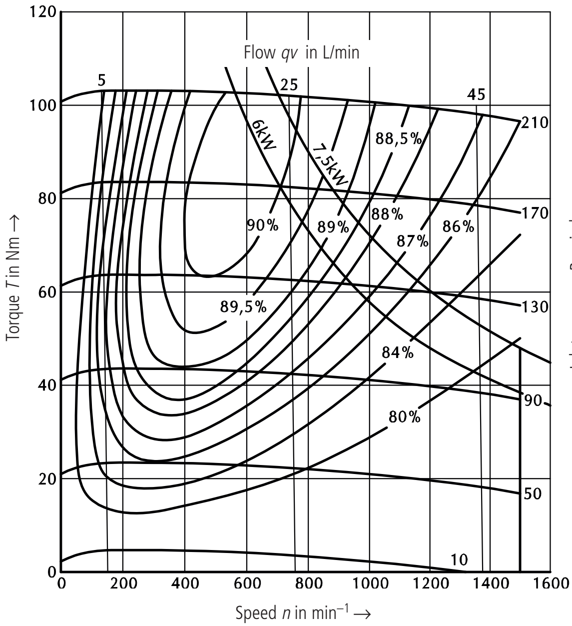
Off-load characteristic curve



Leakage flow

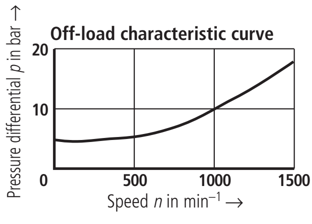


MKM 32

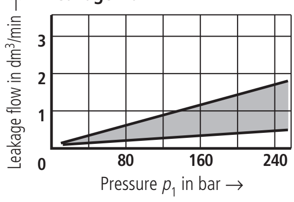


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve

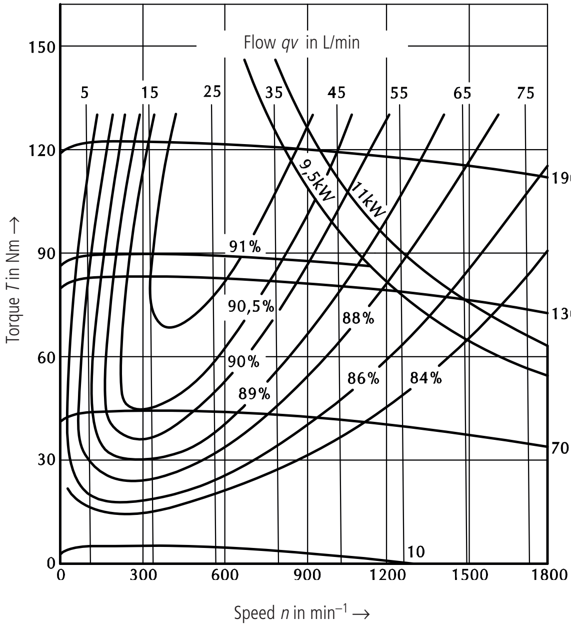


Leakage flow



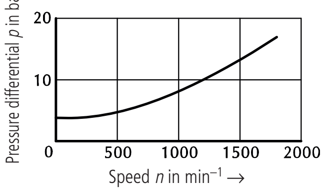
Characteristic curves (average value) measured at $\nu = 36\ mm^2/s$; $\vartheta_{oil} = 50\ °C$; $p_{outlet} = 0$ bar; $p_{leakage\ oil} = 0$ bar

MKM 45

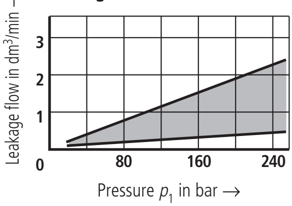


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

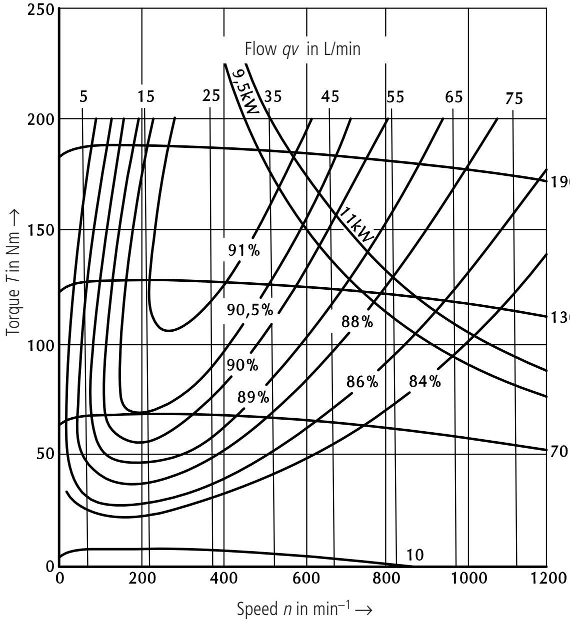
Off-load characteristic curve



Leakage flow

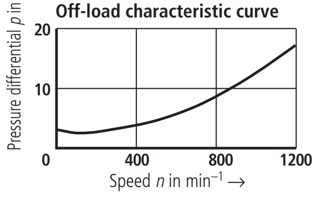


MKM 63

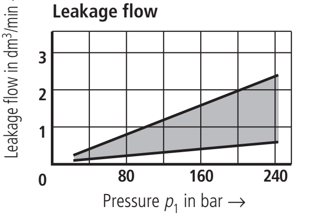


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve

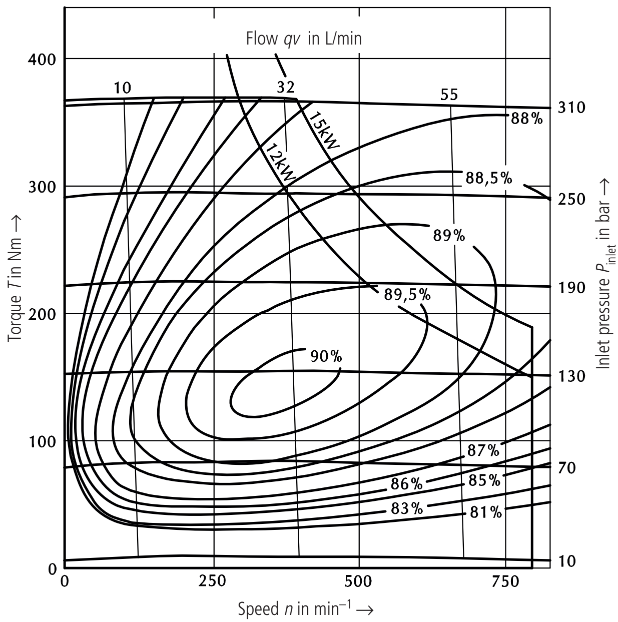


Leakage flow



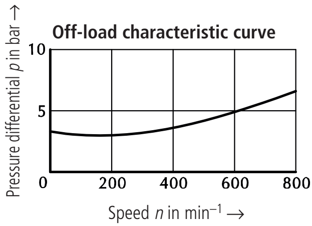
Characteristic curves (average value) measured at ν = 36 mm^2/s; ϑ_{oil}= 50 °C; p_{outlet} = 0 bar; $p_{leakage\ oil}$ = 0 bar

MRM 80

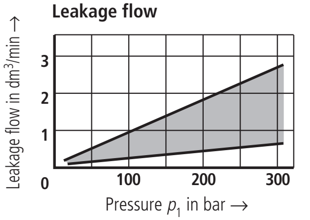


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

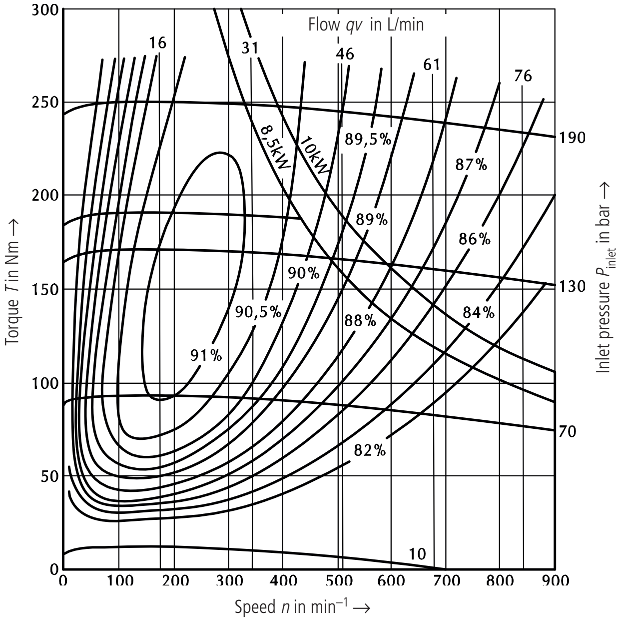
Off-load characteristic curve



Leakage flow

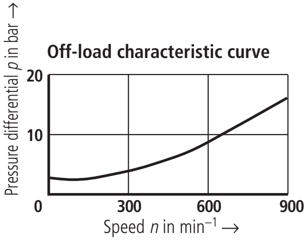


MKM 90

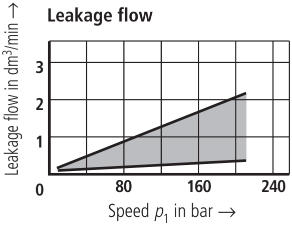


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve

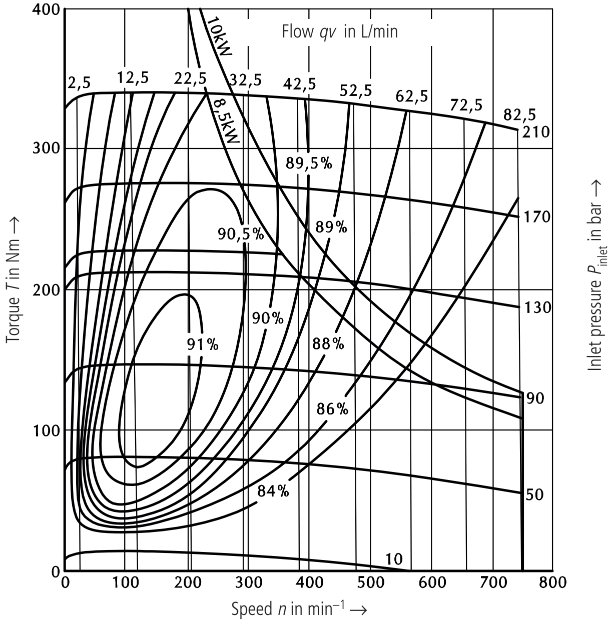


Leakage flow



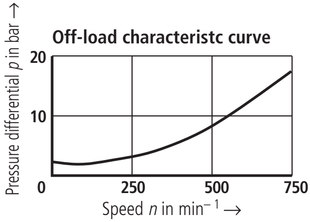
Characteristic curves (average value) measured at $\nu = 36\ mm^2/s$; $\vartheta_{oil} = 50\ °C$; $p_{outlet} = 0$ bar; $p_{leakage\ oil} = 0$ bar

MKM 110

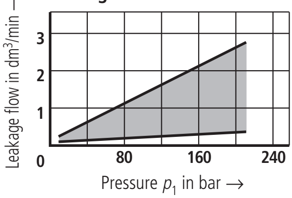


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

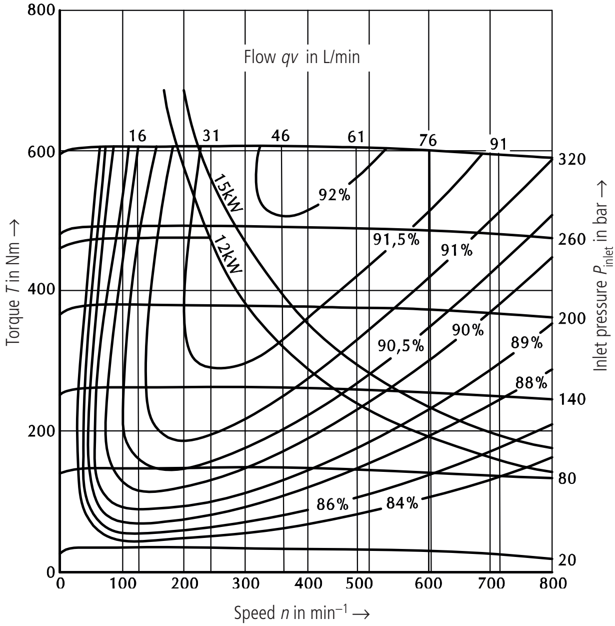
Off-load characteristc curve



Leakage flow

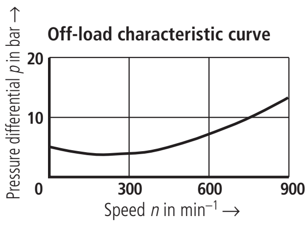


MRM 125

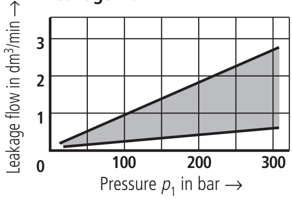


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve



Leakage flow



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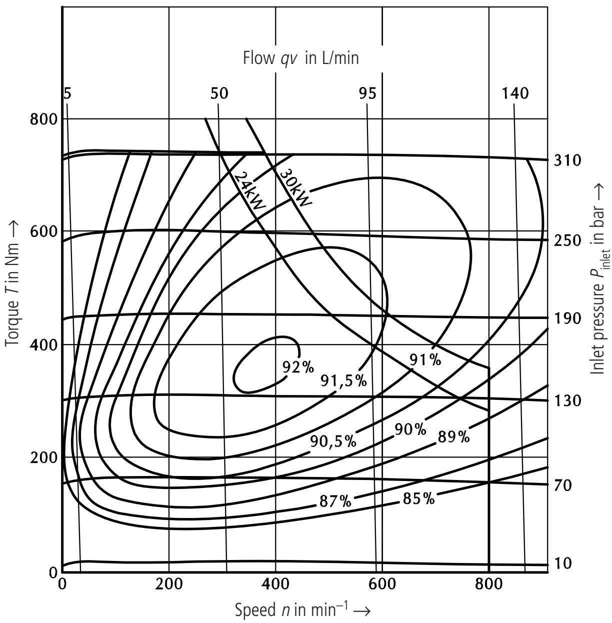
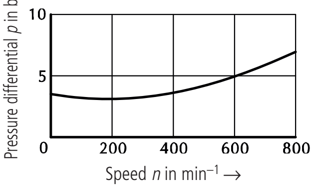
Characteristic curves (average value) measured at $\nu = 36\ mm^2/s$; $\vartheta_{oil} = 50\ °C$; $p_{outlet} = 0\ bar$; $p_{leakage\ oil} = 0\ bar$

MRM 160

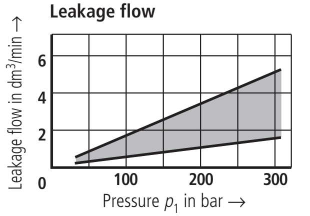


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

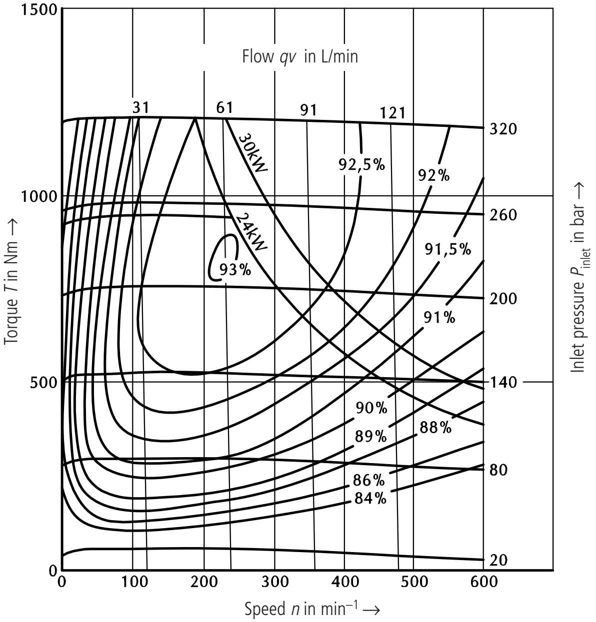
Off-load characteristic curve



Leakage flow

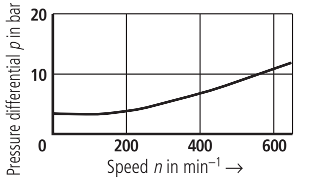


MRM 250

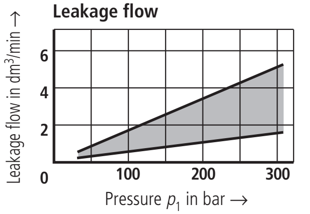


Minimum feed pressure during brake operation and closed circuit operation to the off-load characteristic curve.

Off-load characteristic curve



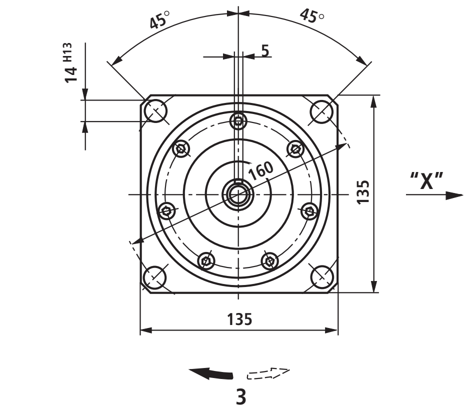
Leakage flow

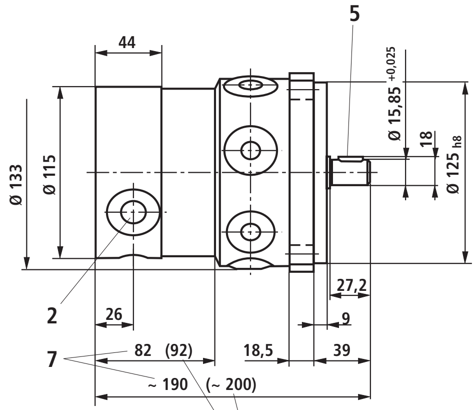


Unit dimensions: MKM 11 and MRM 11 (dimensions in mm)

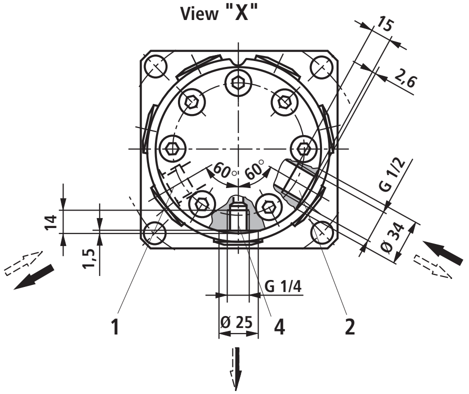
Flange version „2“ (ISO 3019/2)

Pipe connection „A0“



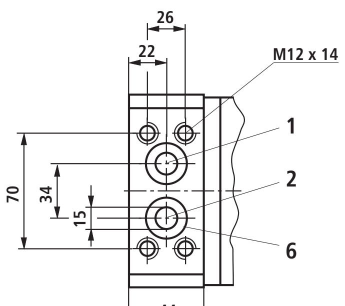


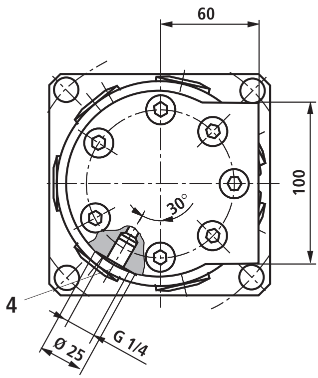
View "X"



1 Port A
2 Port B
3 Direction of rotation viewed on the shaft end
Right: With flow from port B to A
Left: With flow from port A to B
4 Leakage port
5 Key A 5 x 5 x 20 DIN 6885
6 Counterbore for O-ring 21.89 x 2.62
7 Type MKM 11
8 Type MRM 11

Pipe connection “A1”



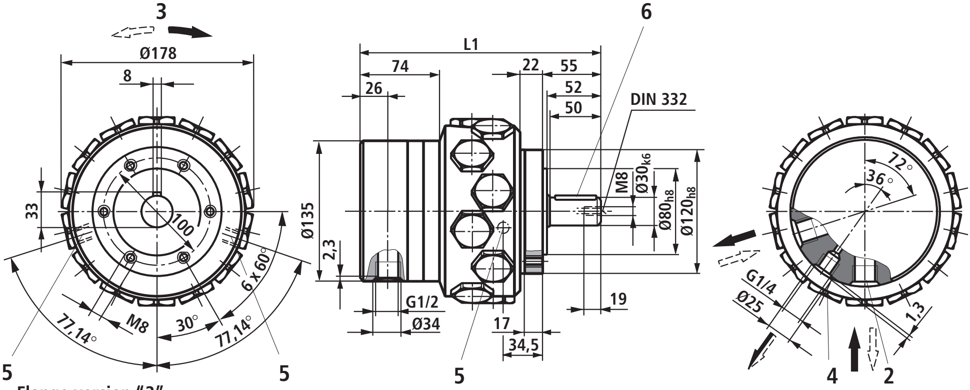


4

Unit dimensions: MKM 22, 32, 45, 63, 90 and 110 (dimensions in mm)

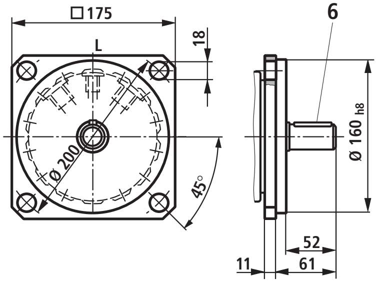
Flange version „1"

Pipe connection „A0"



Flange version "2"

DIN ISO 3019/2



Type	L1	Piston row(s)
MKM 22	208	1
MKM 32	208	1
MKM 45	226	2
MKM 63	226	2
MKM 90	248	3
MKM 110	248	3

1 Port A

2 Port B

3 Direction of rotation viewed on the shaft end

Right: With flow from port B to A

Left: With flow from port A to B

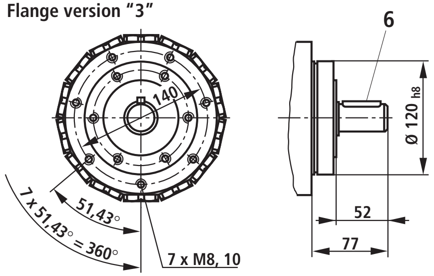
4 Leakage port G1/4

5 Flushing connection 2 x G1/4 (version **„S99"**)

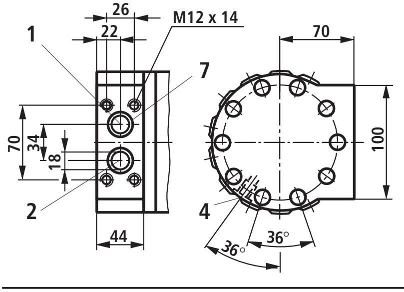
6 Key A 8 x 7 x 45 DIN 6885

7 Counterbore for O-ring 21.89 x 2.62

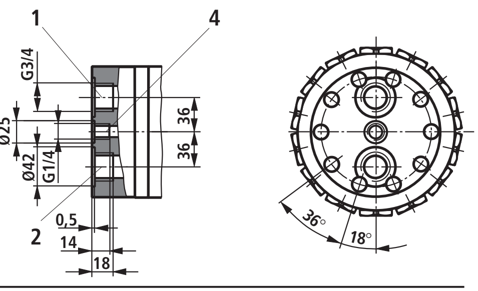
Flange version "3"



Pipe connection "A1"

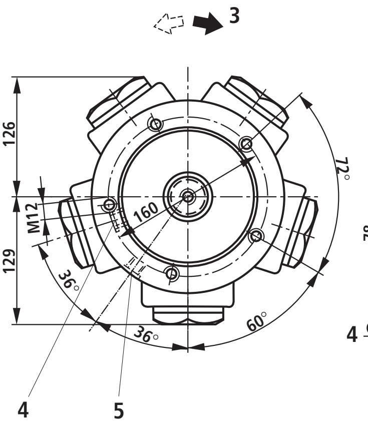


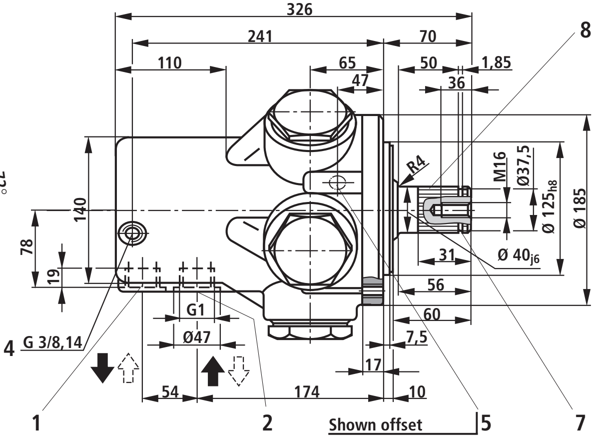
Pipe connection "B5"



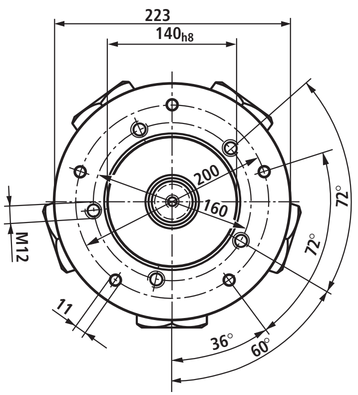
Unit dimensions: MRM 80 and 125 (dimensions in mm)

Flange version „1" with splined shaft „K"
Pipe connection „A0"



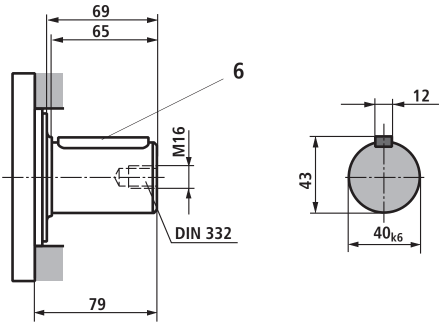


Flange version "2"
with through holes

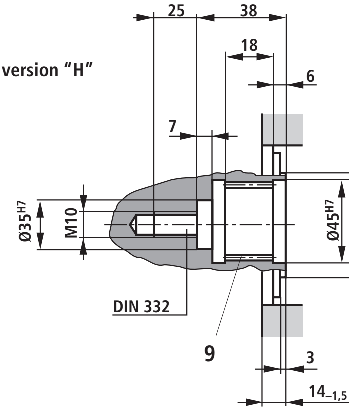


1 Port A G 1
2 Port B G 1
3 Direction of rotation viewed on the shaft end
Right: With flow from port B to A
Left: With flow from port A to B
4 Leakage port G 3/8
Counterbore Ø 28 mm, offset 72° in relation to ports A and B
5 Flushing connection G 3/8 (version **„S99"**)
6 Key A 12 x 8 x 56 DIN 6885
7 Shaft groove for retaining ring DIN 471
8 Splined shaft connection DIN 5480
W40 x 2 x 18 x 7h
9 Splined shaft connection DIN 5480
N45 x 2 x 21 x 9H

Shaft version "A"

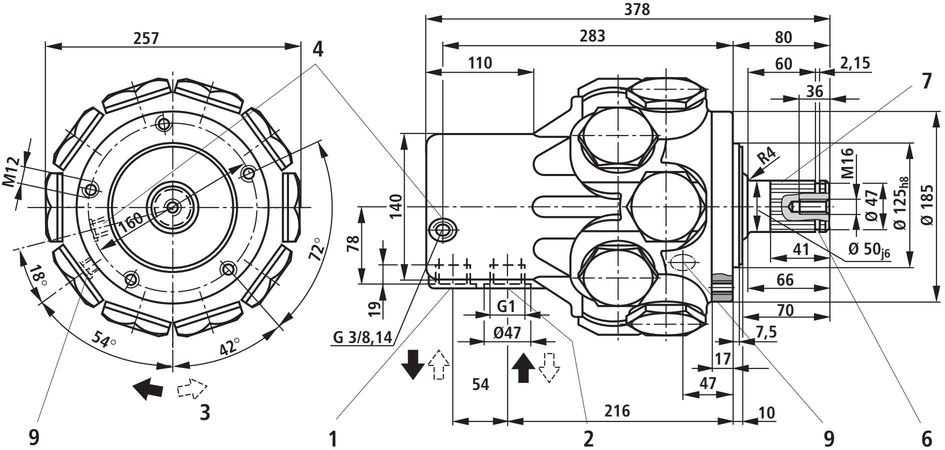


Shaft version "H"

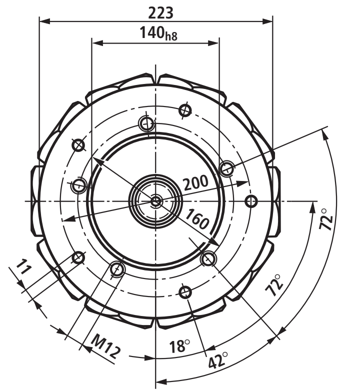


Unit dimensions: MRM 160 and 250 (dimensions in mm)

Flange version „1" with splined shaft „K"
Pipe connection „A0"



Flange version "2"
with through holes



1 Port A G 1

2 Port B G 1

3 Direction of rotation viewed on the shaft end
Right: With flow from port B to A
links: With flow from port A to B

4 Leakage port
Counterbore Ø 28 mm, offset 72 ° in relation to ports A and B

5 Key A 14 x 9 x 70 DIN 6885

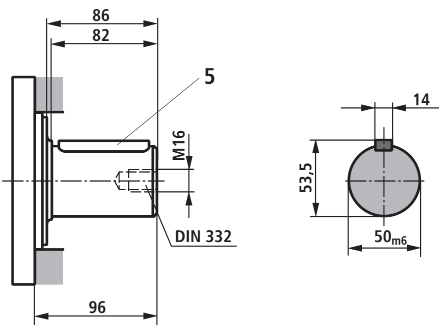
6 Shaft groove for retaining ring DIN 471

7 Splined shaft connection DIN 5480
W50 x 2 x 24 x 7h

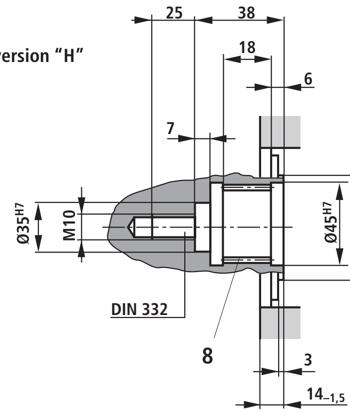
8 Splined shaft connection DIN 5480
N45 x 2 x 21 x 9H

9 Flushing connection G 3/8 (version **„S99"**)

Shaft version "A"



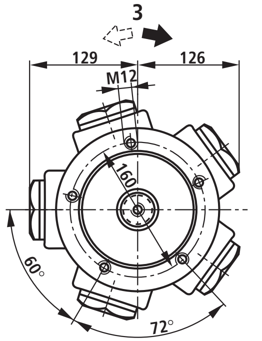
Shaft version "H"

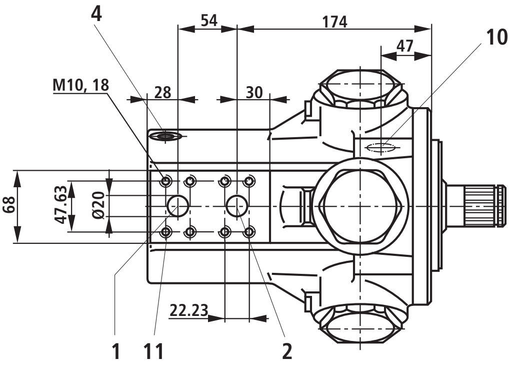


Unit dimensions MRM 80, 125, 160 a und 250 (dimensions in mm)

MRM 80, MRM 125
Flange version "1"
with splined shaft "K"
Pipe connection "A1"

For dimensions see page 15

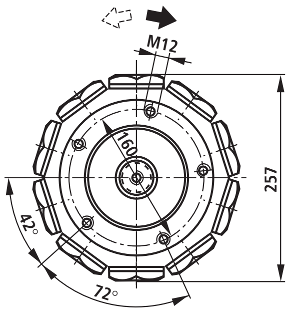


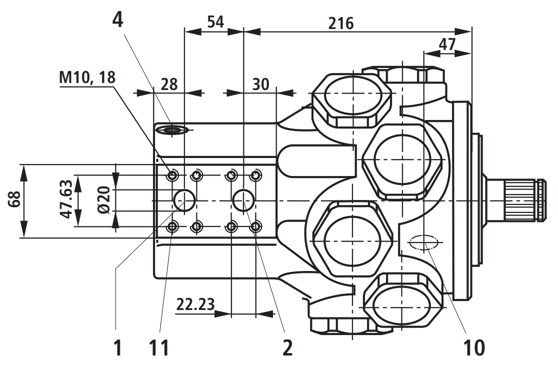


1 Port A SAE J 518 3/4" standard
2 Port B SAE J 518 3/4" standard
3 Direction of rotation viewed on the shaft end
Right: With flow from port B to A
Left: With flow from port A to B
4 Leakage port G 3/8
Counterbore Ø 28 mm, offset 72° in relation to ports A and B
10 Flushing connection G 3/8 (version **„S99"**)
11 Flange height from centre of shaft $80^{+0.5}$ mm

MRM 160, MRM 250
Flange version "1"
with splined shaft "K"
Pipe connection "A1"

For dimensions see page 16



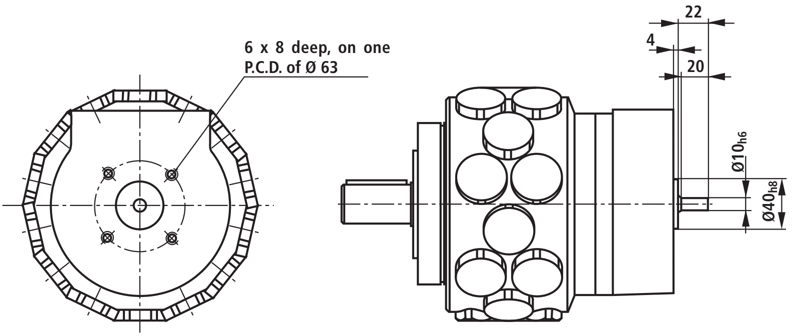


4

Motor with tachometer shaft (dimensions in mm)

Ordering detail **"M"**

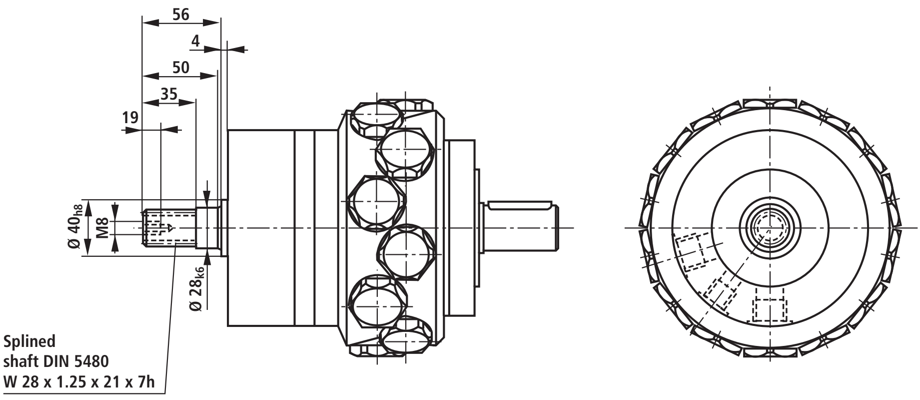
One size of tachometer shaft for all types, for measuring the motor speed, transmits a maximum torque of 5 Nm (for higher output torques please consult us).



Motor with through shaft (dimensions in mm)

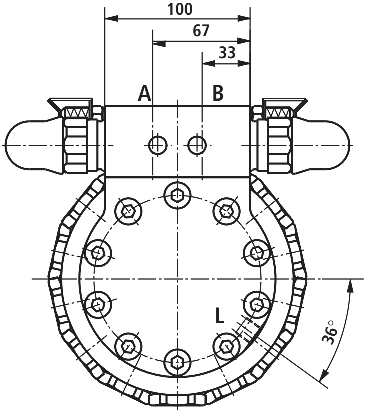
Ordering detail **"M10–"** (only for MKM 22 to 110)

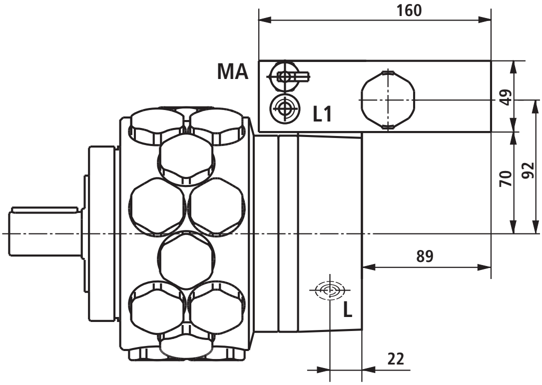
All of the radial piston motors of series MKM without the MKM 11 can be supplied with a through shaft, ordering detail M10-, for transmitting the full motor torque.



Valve design: pressure relief, anti-cavitation/feed, MKM...N01 (dimensions in mm)

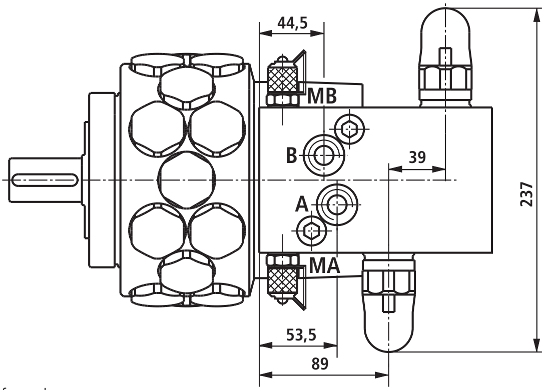
Series MKM radial piston motors with two direct operated pressure relief valves, gauge port G 1/4, anti-cavitation/feed via two 0.1 bar check valves and G 1/2 pipe connections.





	Port		Counter bore	
	Thread	Depth	Ø	Depth
A	G 1/2	16	28	$1.3^{+0.1}$
B	G 1/2	16	28	$1.3^{+0.1}$
L	G 1/4	14	25	$1.3_{-0.3}$
L1	G 1/4	14	20	1
L2	G 1/4	14	20	1
MA	G 1/4	12	20	1
MB	G 1/4	12	20	1

Pressure stage I	Up to 100 bar
Pressure stage II	Up to 200 bar
Pressure stage III	Up to 315 bar

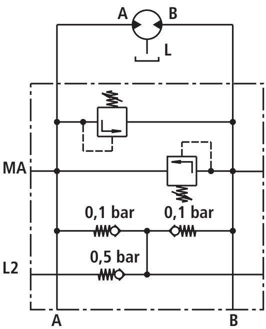


Note:

The valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

Symbol (Version „MKM...N01"), function

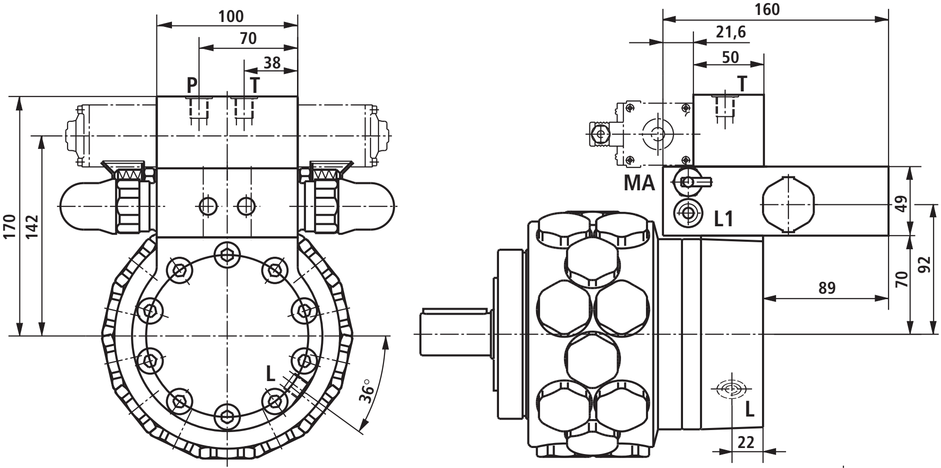


Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. For the anti-cavitation function, the motor connection L is connected to L1 on the block and L2 is connected to tank. The leakage back pressure of 0.5 bar causes the motor leakage oil to be fed into the circuit.

4

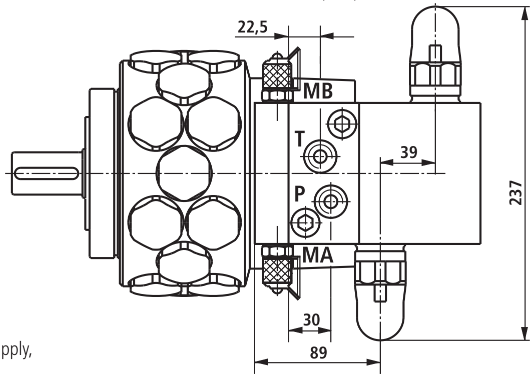
Valve design: pressure relief, anti-cavitation/feed, valve connection NS 6, MKM...N61 (in mm)

Series MKM radial piston motors with two direct operated pressure relief valves, gauge ports G 1/4, anti-cavitation/feed via two 0.1 bar check valves, G 1/2 pipe connections and valve connections NS 6 to DIN 24 340 form A6 (CETOP 3).



Port			Counter bore	
	Thread	Depth	Ø	Depth
A, B	G 1/2	16	28	$2.1^{+0.1}$
P, T	G 3/8	12	23	$0.5^{+0.1}$
L	G 1/4	14	25	$1.3_{-0.3}$
L1, L2	G 1/4	14	20	1
MA, MB	G 1/4	12	20	1

Pressure stage I	Up to 100 bar
Pressure stage II	Up to 200 bar
Pressure stage III	Up to 315 bar

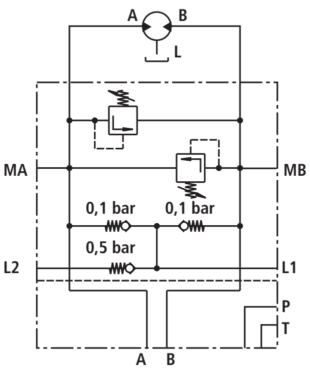


Note:

The valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

Symbol (version „MKM...N61"), function

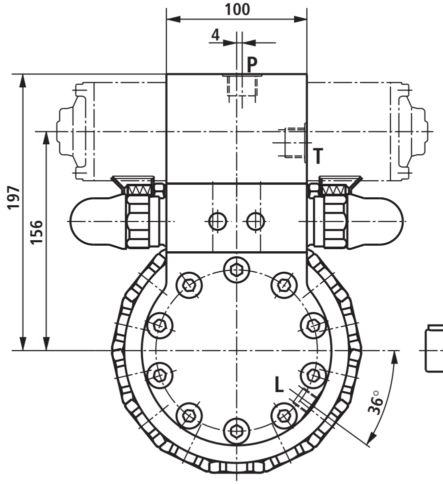


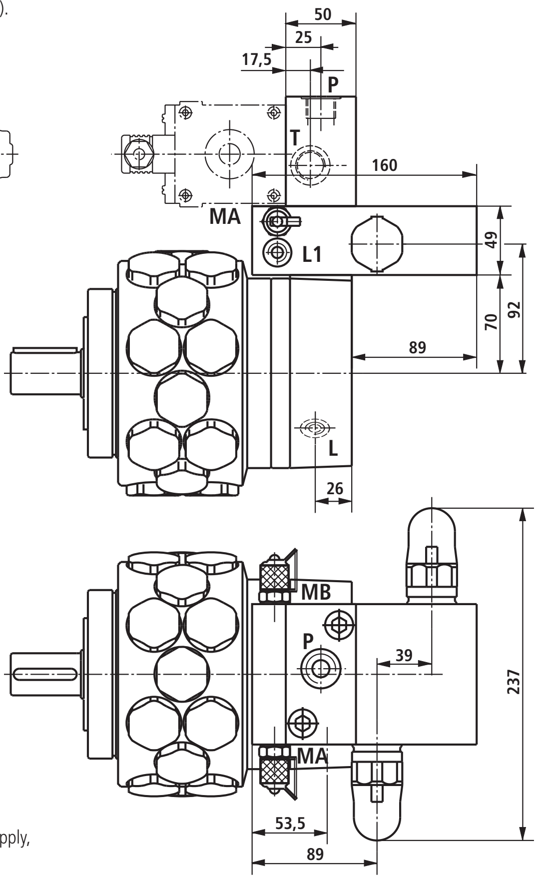
With this block design valves with a porting pattern to DIN 24 340 form A6 are bolted directly onto the motor.

Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves, the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. For the anti-cavitation function the motor connection L is connected to L1 on the block and L2 is connected to tank. The leakage back pressure of 0.5 bar causes the motor leakage oil to be fed into the circuit.

Valve design: pressure relief, anti-cavitation/feed, valve connection NS 10, MKM...N101 (in mm)

Series MKM radial piston motors with two direct operated pressure relief valves, gauge port G 1/4, anti-cavitation/feed via two 0.1 bar check valves and valve connection DIN 24 340 form A10 (CETOP 5).





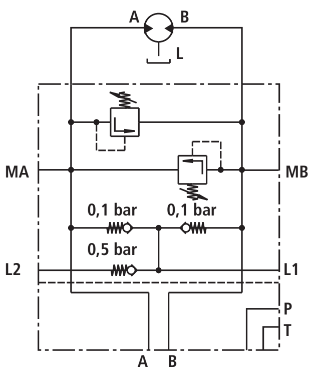
	Port Thread	Depth	Counter bore Ø	Depth
A, B	G 1/2	16	28	$2.1^{+0.1}$
P, T	G 1/2	14	28	0.5
L	G 1/4	14	25	$1.3_{-0.3}$
L1, L2	G 1/4	14	20	1
MA, MB	G 1/4	12	20	1
Pressure stage I			Up to 100 bar	
Pressure stage II			Up to 200 bar	
Pressure stage III			Up to 315 bar	

Note:

The valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

Symbol (version „MKM...N101"), function



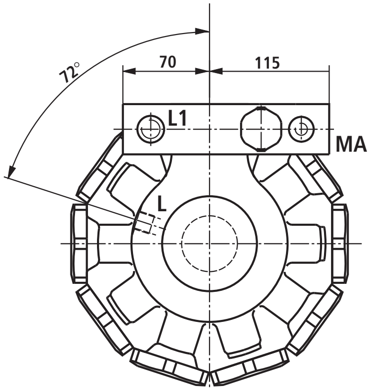
With this block design, directional, proportional or servo valves with a porting pattern to DIN 24 340 form A10 are bolted directly onto the motor.

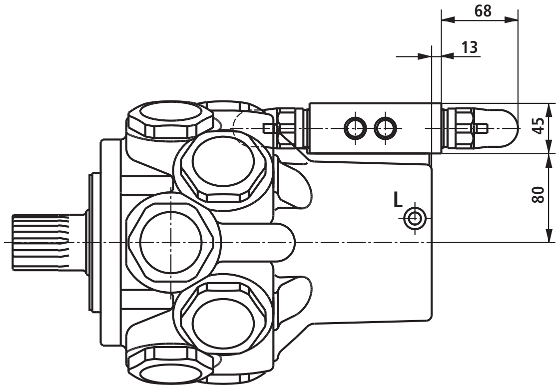
Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. For anti-cavitation function the motor connection L is connected to L1 on the block and L2 is connected to tank. The leakage back pressure of 0.5 bar causes the motor leakage oil to be fed into the circuit.

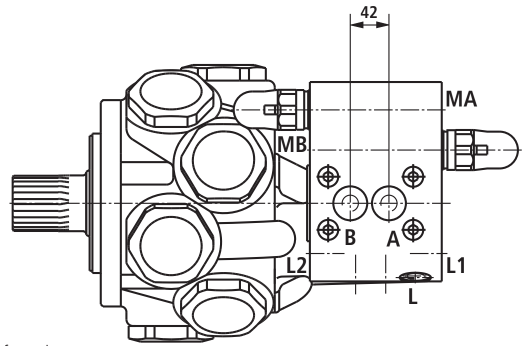
4

Valve design: pressure relief, anti-cavitation/feed, MRM...N01 (dimensions in mm)

Series MRM radial piston motors with two direct operated pressure relief valves, gauge ports G1/4, anti-cavitation/feed via two 0.1 bar check valves and G 3/4 pipe connections.







	Port Thread	Port Depth	Counter bore Ø	Counter bore Depth
A, B	G 3/4	17	33	$2.1^{+0.1}$
L	G 3/8	14	28	1.5
L1, L2	G 3/8	14	24	1
MA, MB	G 1/4	14	20	1

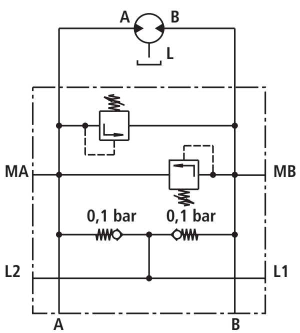
Pressure stage I	Up to 100 bar
Pressure stage II	Up to 200 bar
Pressure stage III	Up to 315 bar

Note:

The valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

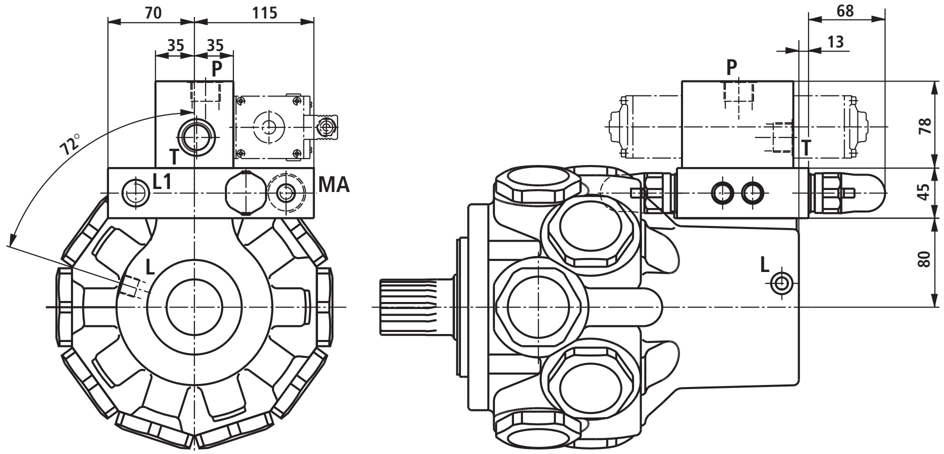
Symbol (version „MRM...N01"), function



Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. When there is sufficient back pressure L1 can be connected with the tank line.

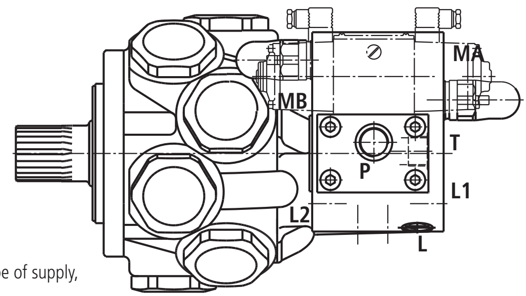
Valve design: pressure relief, anti-cavitation/feed, valve connection NS 6, MRM...N61 (in mm)

Series MRM radial piston motors with two direct operated pressure relief valves, gauge port G 1/4, anti-cavitation/feed via two 0.1 bar check valves and valve connection DIN 24 340 form A6 (CETOP 3).



	Port Thread	Depth	Counter bore Ø	Depth
P, T	G 1/2	17	28	1
L	G 3/8	14	28	1.5
L1, L2	G 3/8	14	24	1
MA, MB	G 1/4	14	20	1

Pressure stage I	Up to 100 bar
Pressure stage II	Up to 200 bar
Pressure stage III	Up to 315 bar

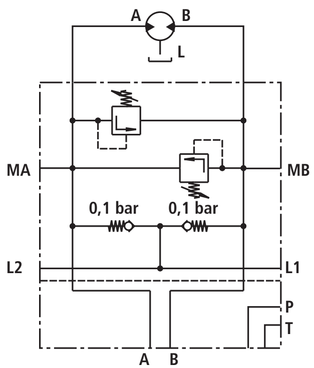


Note:

The valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

Symbol (version „MRM...N61"), function



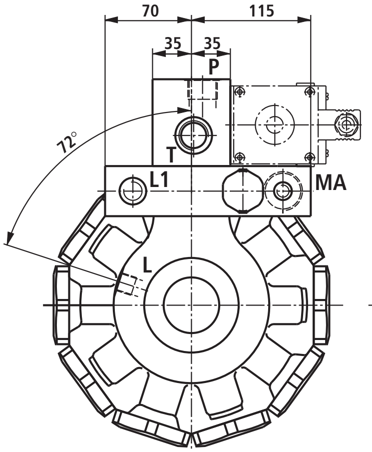
With this block design, valves with a porting pattern to DIN 24 340 form A6 are bolted directly onto the motor, due to the low entrapped volume of oil, this gives the drive good open loop or closed loop control characteristics.

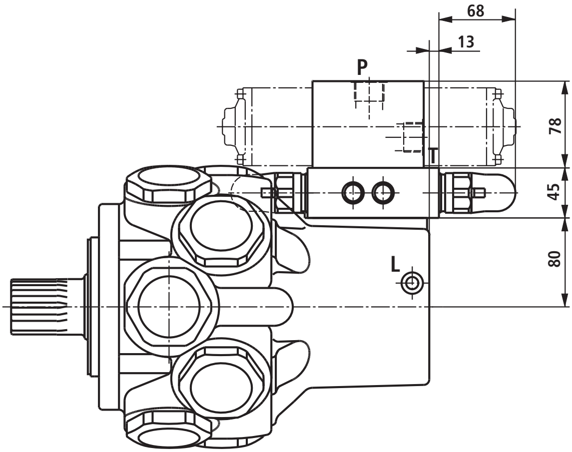
Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. When there is sufficient back pressure L1 can be connected with the tank line. L2 is plugged.

4

Valve design: pressure relief, anti-cavitation/feed, valve connection NS 10, MRM...N101 (in mm)

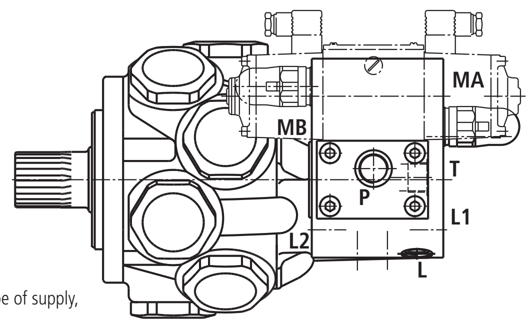
Series MRM radial piston motors with two direct operated pressure relief valves, gauge port G 1/4, anti-cavitation/feed via two 0.1 bar check valves and valve connection DIN 24 340 form A10 (CETOP 5).





	Port		Counter bore	
	Thread	Depth	Ø	Depth
P, T	G 3/4	18	33	0.5
L	G 3/8	14	28	1.5
L1, L2	G 3/8	14	24	1
MA, MB	G 1/4	14	20	1

Pressure stage I	Up to 100 bar
Pressure stage II	Up to 200 bar
Pressure stage III	Up to 315 bar

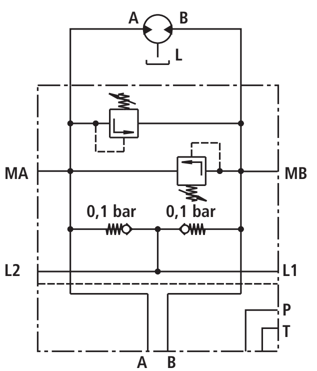


Note:

The Valve cartridges are **not** included within the scope of supply, they must be ordered separately!

Pressure stage to be stated in clear text!

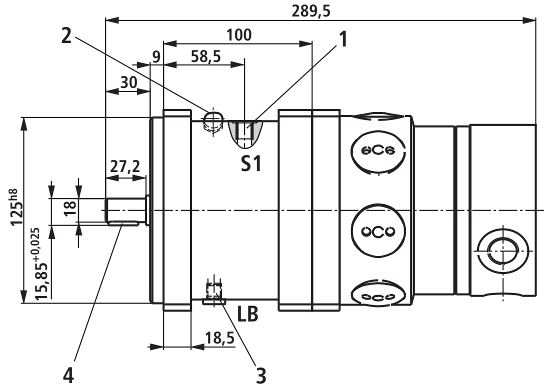
Symbol (version „MRM...N101"), function

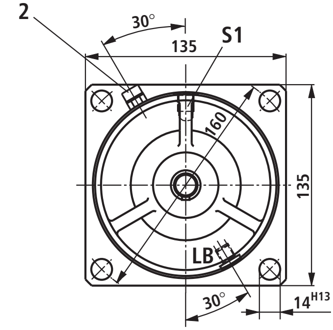


With this block design, valves with a porting pattern to DIN 24 340 form A10 are bolted directly onto the motor, due to the low entrapped volume of oil, this gives the drive good open loop or closed loop control characteristics.

Two individually adjustable DBDS 10 K1X/... valves protect the drive from overloads. Via port L1 and two 0.1 bar check valves the occurring leakage is fed back into the drive. A flow control valve can be screwed into port L1 so that the feed flow can be controlled. When there is sufficient back pressure L1 can be connected with the tank line. L2 is plugged.

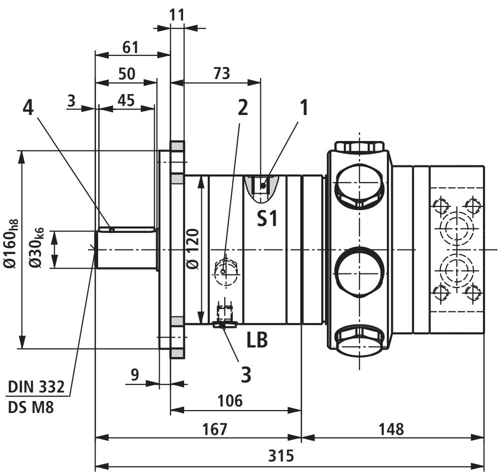
Holding brake type LBD9A2 for motor types MKM 11 and MRM 11 (dimensions in mm)

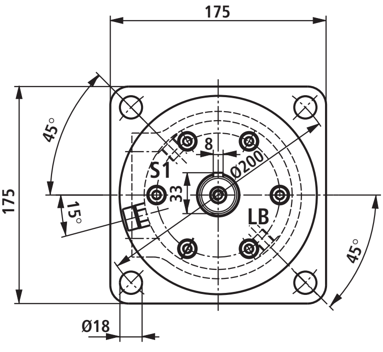




1 Control line G 1/4 to bleed the brake
2 Breather filter (brake) M12 x 1.5
3 Brake drain oil connection M12 x 1.5
4 Key A5x5x20 DIN 6885

Holding brake type LBD11A2 for motor types MKM 22 to 110 (dimensions in mm)

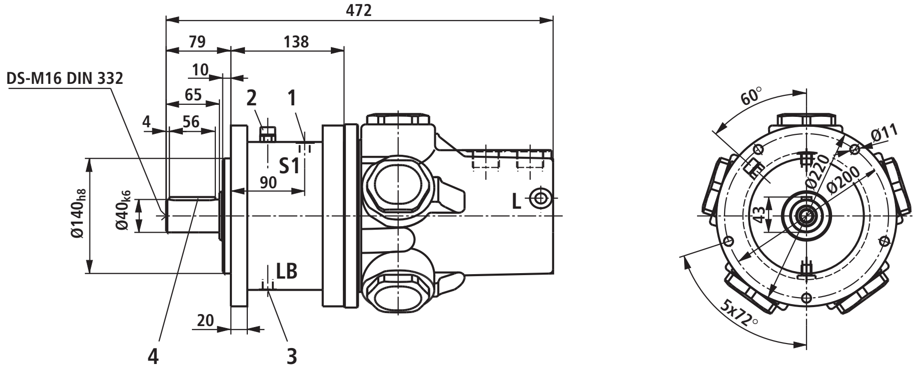




1 Control line G 1/4 to bleed the brake
2 Breather filter (brake) M12 x 1.5
3 Brake drain oil connection M12 x 1.5
4 Key A8 x 7 x 45 DIN 6885

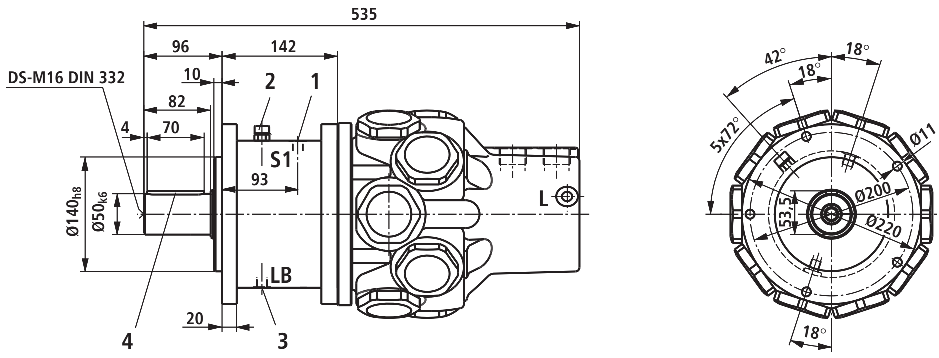
4

Holding brake type LBD124A2 for motor types MRM 80 / MRM 125 (dimensions in mm)



1 Control line G 1/4 to bleed the brake
2 Breather filter (brake) M12 x 1.5
3 Brake drain oil connection M12 x 1.5
4 Key A12 x 8 x 56 DIN 6885

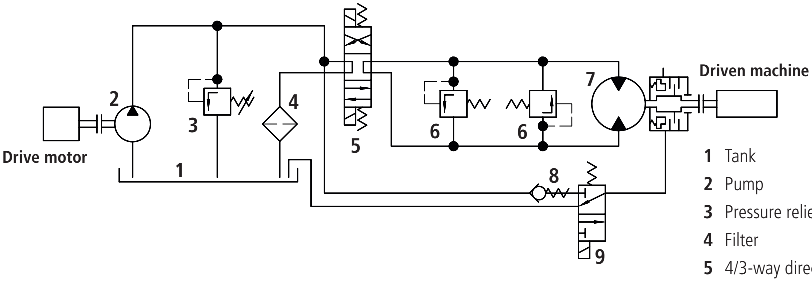
Holding brake type LBD249A2 for motor types MRM 160 / MRM 250 (dimensions in mm)



1 Control line G 1/4 to bleed the brake
2 Breather filter (brake) M12 x 1.5
3 Brake drain oil connection M12 x 1.5
4 Key A14 x 9 x 70 DIN 6885

Circuit example

Open circuit with brake control



1 Tank
2 Pump
3 Pressure relief valve
4 Filter
5 4/3-way directional valve
6 Pressure relief valve
7 Hydraulic brake motor
8 Check valve
9 3/2-way directional valve

Storage, assembly, commissioning

Storage

As delivered all of the connection holes in the motor housing are plugged with plastic plugs. The internal components are coated with hydraulic oil from the run on the test rig. The drive shaft and connection flange are protected by an anti-corrosion oil. The motor can be stored in this condition, in a dry room, for approx. 6 months.

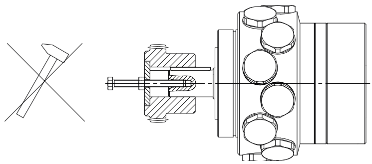
For longer storage periods the motor is to be fully filled with a water emulsifing hydraulic oil H-LPD. All ports are to be plugged or have blanking flanges, these are to be oil tight. After no later than 12 months the hydraulic oil must be replaced and the drive shaft rotated by hand approx. 10 times.

Mounting, assembly

– The installation orientation is optional.
– Never use a hammer to drive on the couplings, pinions, etc., use screws to pull them on. Use the threaded hole in the drive shaft.
– The mounting surface must be flat and rigid.
– Use fixing screws with a minimum tensile strength class of 10.9, with reversal operation used location bolts.
– Correctly line up the motor during assembly.
– Tighten the bolts to the prescribed tightening torque.

The brakes have a leakage oil connection and a breather filter M12x1.5. Both of the connections can be exchanged. Fit the filter to the highest point so that oil cannot run out.

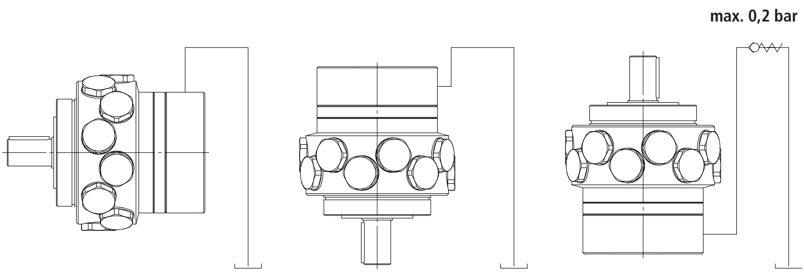
When installing the holding brake apply it with pilot pressure so that the shaft can be rotated.



Drain oil line

Lay the drain oil line so that the motor housing cannot drain, if necessary fit a check valve with maximum opening pressure of 0.2.

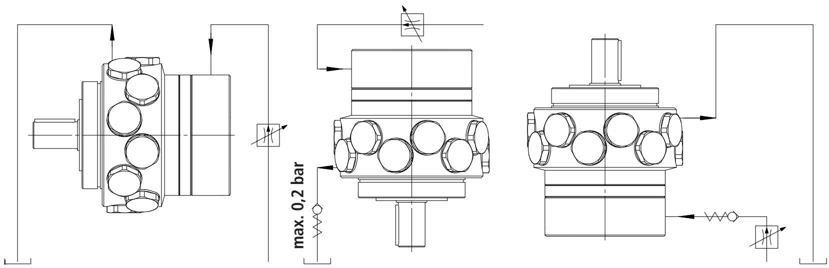
4



Storage, assembly, commissioning

Flushing connection

Flushing the motor with approx. 1 - 3 L/min (dependent on the type) is recommended for high temperatures and powers. Leakage and flushing fluid is passed back to the reservoir. The maximum permissible housing pressure in the leakage chamber is 1.5 bar.



Commissioning

Motor

Before the initial commissioning the motor has to be filled with filtered operating medium via the drain connection. Drive the motor at a low power until leakage oil escapes, then full power can be applied.

For motors with a separate flushing circuit first switch on the flushing circuit then the motor.

Check the housing pressure: maximum of 1.5 bar leakage pressure.

Brake

Fill the brake before commissioning via the breather filter, remove the filter to access the filling point (wet running).

LBD9A2	LBD11A2	LBD124A2	LBD249A2
0.01 litre	0.01 litre	0.02 litre	0.04 litre

Switch the holding brake more than once and check for correct function.

During operation the motor and holding brake must not become warmer than the operating medium.

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