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The complete Mobile Hydraulics Catalog from Bosch Rexroth at a glance:

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Part 2	Motors, Gears	Axial Piston Motors, External Gear Motors, Radial Piston Motors, Gears	RE 90010-02
Part 3	Mobile Controls	Control Blocks, Valve Modules, Pilot Control Devices, Power Brake Valves	RE 90010-03
Part 4	Mobile Electronics, Accumulators, Filters	Controllers, Application Software, Tools, Sensors, Displays, Video Cameras, Accumulators, Filters, Oil Measurement Technology	RE 90010-04
Part 5	Compact Hydraulics	Mechanical, Solenoid and Proportional Cartridge Valves, Integrated Circuits	RE 90010-05
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Dual-circuit power brake valve of compact design	LT 17	4x	66228	921
Hydraulic inch power brake valve	LT 31	1x	66227	933

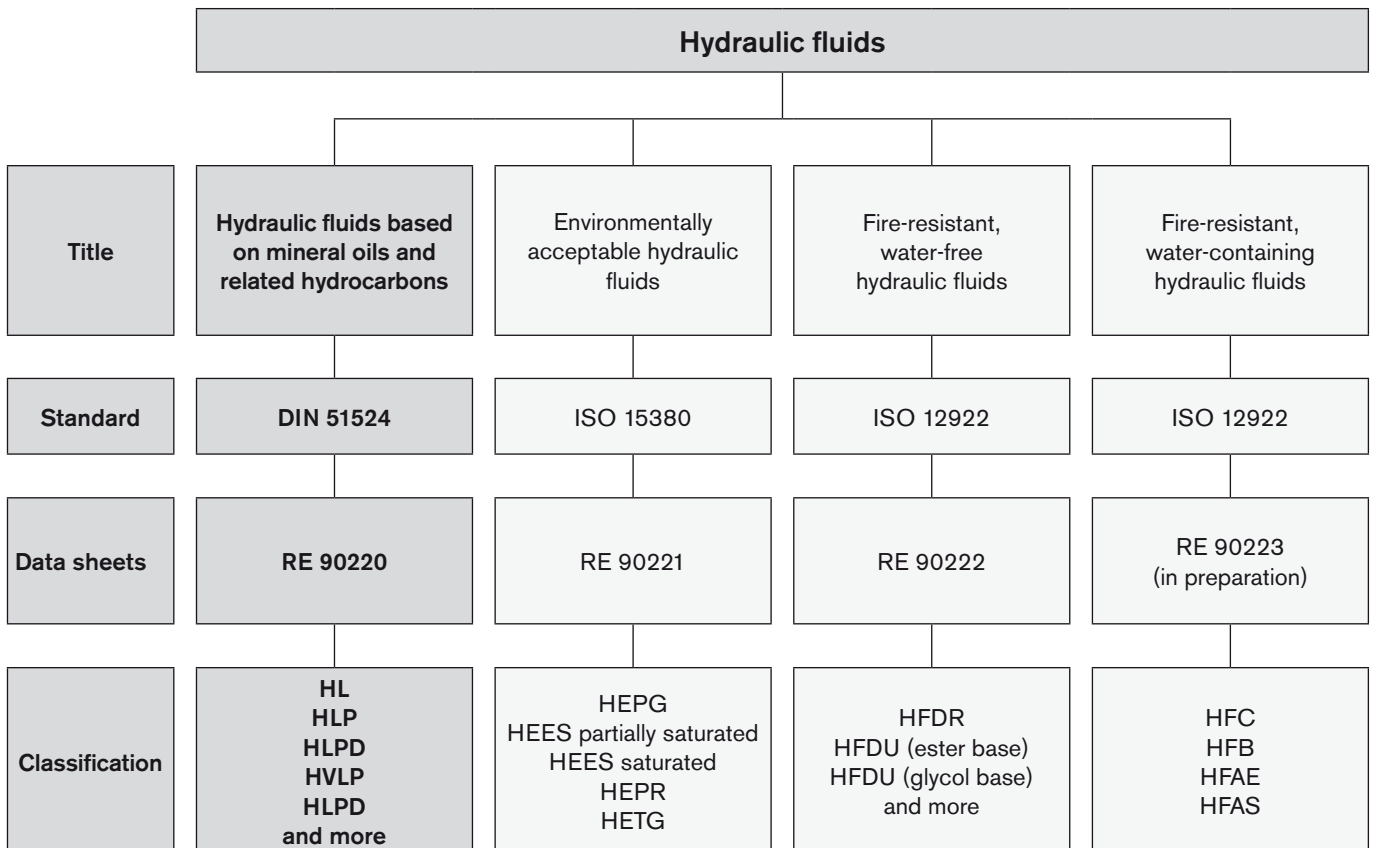
General

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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



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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.

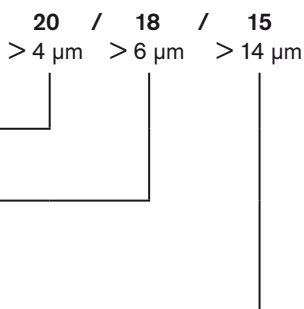
Hydraulic fluids frequently fail to meet these cleanliness requirements on delivery. Careful filtering is therefore required during operation and in particular, during filling in order to ensure the required cleanliness levels. Your lubricant manufacturer can tell you the cleanliness level of hydraulic 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
64,000	130,000	17
32,000	64,000	16
16,000	32,000	15
8,000	16,000	14
4,000	8,000	13
2,000	4,000	12
1,000	2,000	11
500	1,000	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.

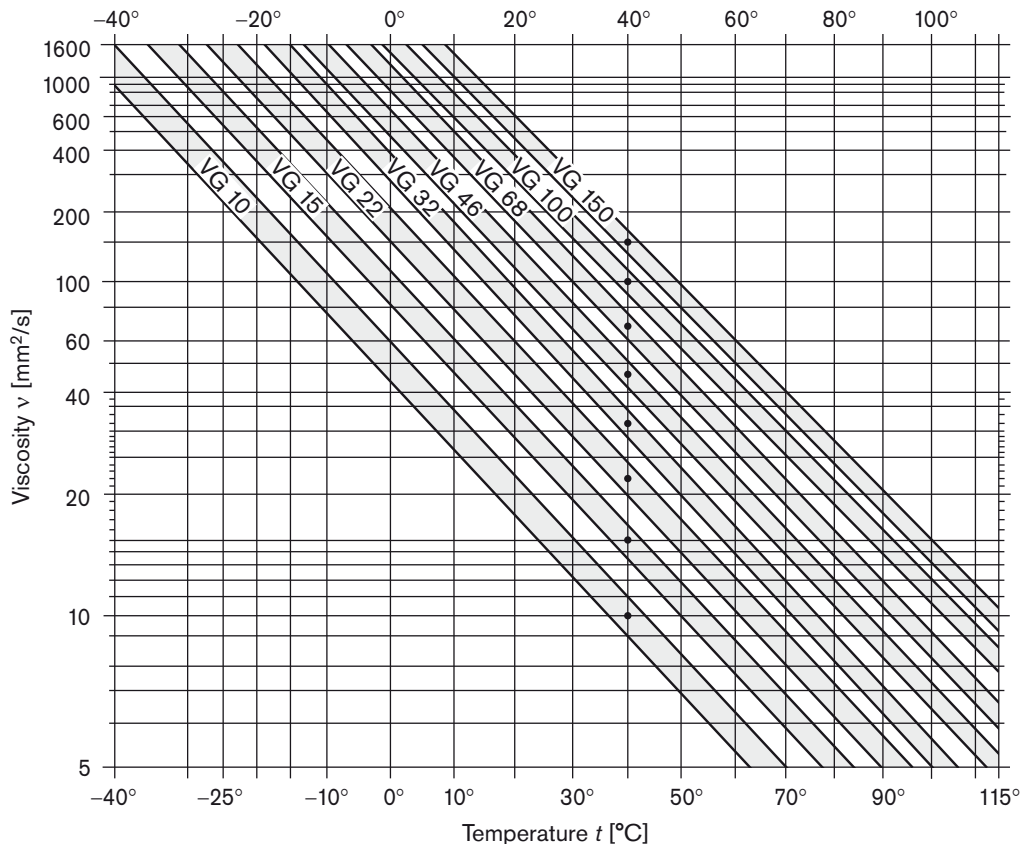
If the viscosity of a hydraulic fluid is below the permitted operating viscosity, increased leakage, wear, susceptibility to contamination and a shorter component life cycle will result.

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 $< 40^\circ\text{C}$ 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 be 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 $\geq 1 \mu\text{m}$ 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
<p>HVLP fluids according to DIN 51524-3 VI > 140</p>	<p>HLP hydraulic fluid with additional improved viscosity temperature behavior</p>	<p>HVLP fluids are used in systems operated over a wide temperature range.</p>	<p>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.</p> <p>The same notes and restrictions as defined for HLP fluids apply accordingly.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>HVLP fluids should be used only if required by the temperature ranges of the application.</p>
<p>HLPD fluids according to DIN 51524-2, HVLPD fluids in accordance with DIN 51524-3</p>	<p>HLP and HVLP hydraulic fluid with additional detergent and or dispersant additives</p>	<p>HLPD and HVLPD fluids are used in systems where deposits as well as solid or liquid contamination need to be kept temporarily suspended</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>

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) ingress 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 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 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 / HVLDP) 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 handling 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - May not be used.
3	Hydraulic fluids with classification HL, HLP, HLPD, HVLP, HVLPD to DIN 51502	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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. <p>Caution! Fluids used in pharmaceutical and foodstuff industries should not be confused with environmentally acceptable fluids!</p>

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	<ul style="list-style-type: none"> - 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)	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - Multi-purpose oils combine requirements for wet brakes, gearboxes, motor oil (STOU only) and hydraulics. - Fluids of the types: <ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 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. <p>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.</p>
14	Motor vehicle transmission oils	<ul style="list-style-type: none"> - 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!
15	Diesel, test diesel in acc. with DIN 4113	<ul style="list-style-type: none"> - Diesel / test diesel has poorer wear protection capabilities and a very low viscosity (< 3 mm²/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!

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	Hydraulic fluids for roller processes	<ul style="list-style-type: none">- 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.
17	Fluids for power steering, hydro-pneumatic suspension, active chassis etc.	<ul style="list-style-type: none">- 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 **American Petroleum Institute (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 mm²/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

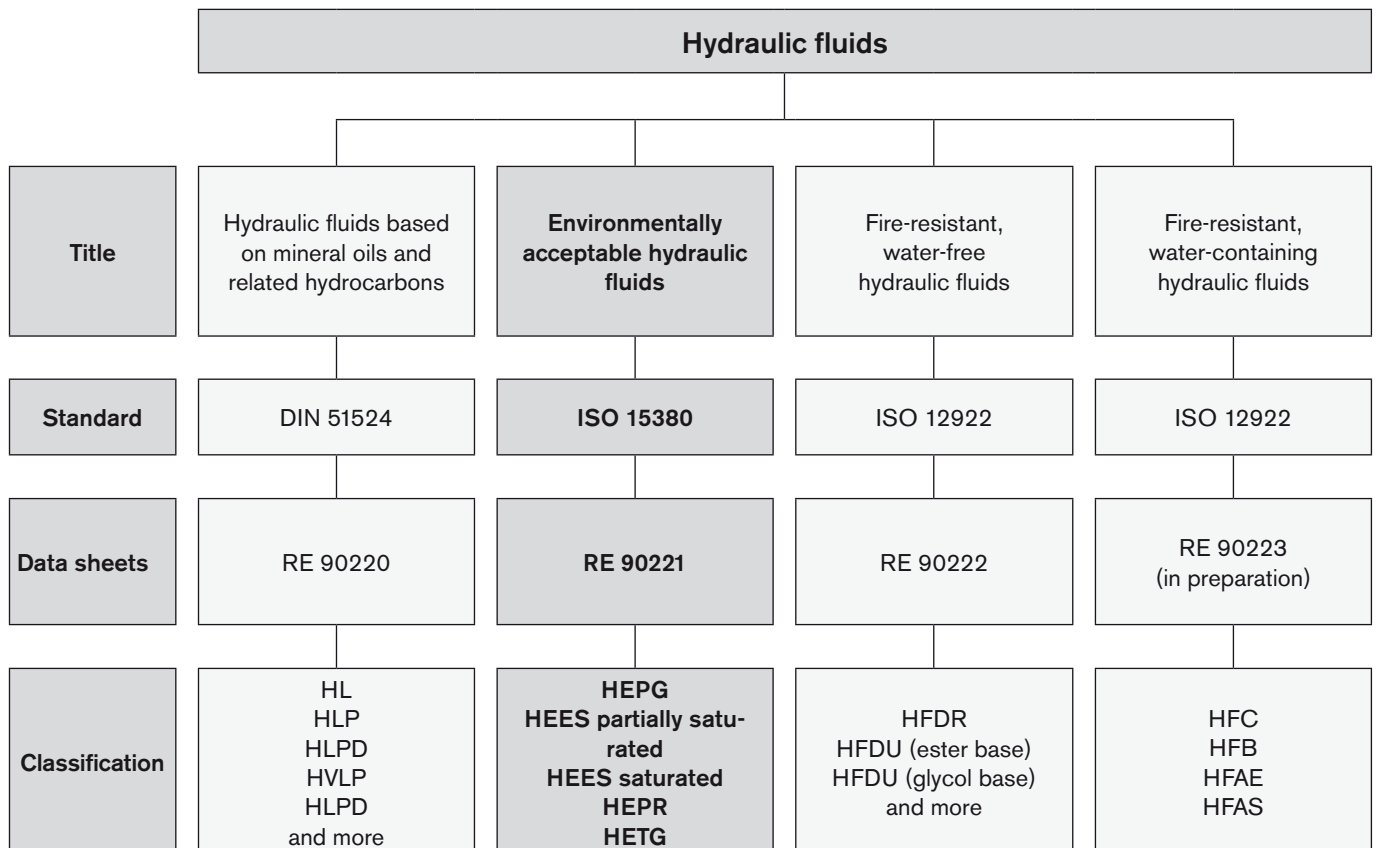
Viscosity index (VI)

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

Environmentally acceptable hydraulic fluids

RE 90221/05.12 1/14
Replaces: 05.10

Application notes and requirements for Rexroth hydraulic components



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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".

1.3 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	20 / 18 / 15 > 4 µm > 6 µm > 14 µm
250,000	500,000	19	
130,000	250,000	18	
64,000	130,000	17	
32,000	64,000	16	
16,000	32,000	15	
8,000	16,000	14	
4,000	8,000	13	
2,000	4,000	12	
1,000	2,000	11	
500	1,000	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.

3.1.2 Viscosity-temperature behavior

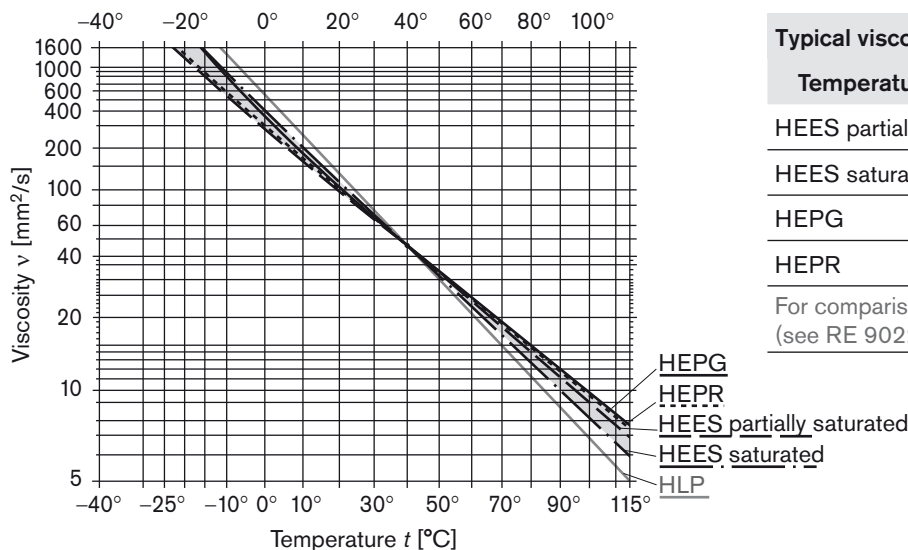
For hydraulic fluids, the viscosity temperature behavior (V-T behavior) is of particular importance. Viscosity is characterized in that it drops when the temperature increases and rises when the temperature drops. The interrelation between viscosity and temperature is described by the viscosity index (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 be 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 ($\geq 0.8 \mu\text{m}$), 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
<p>HEPG according to ISO 15380</p> <p>Density at 15 °C: typically > 0.97 kg/dm³</p> <p>VI: typical > 170</p>	Basic fluid, glycols	Systems on exposed water courses (locks, weirs, dredgers)	<p>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.</p> <ul style="list-style-type: none"> – 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.
<p>HEES partially saturated according to ISO 15380</p> <p>Density at 15 °C: typically 0.90–0.93 kg/dm³</p> <p>VI: typical > 160</p> <p>Iodine count < 90</p>	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.	<p>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.</p> <ul style="list-style-type: none"> – 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
<p>HEES saturated according to ISO 15380</p> <p>Density at 15 °C: typically 0.90–0.93 kg/dm³</p> <p>VI: typical 140–160</p> <p>Iodine count <15</p>	<p>Basic fluid: Ester based on renewable raw materials, synthetic esters, mixtures of various esters, mixtures with polyalphaolefines (< 30%)</p>	<p>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.</p>	<p>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.</p> <ul style="list-style-type: none"> – 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 additized – 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
<p>HEPR according to ISO 15380</p> <p>Density at 15 °C: typically 0.87 kg/dm³</p> <p>VI : typical 140–160</p>	<p>Basic fluid: synthetically manufactured hydrocarbons (polyalphaolefins PAO) partly mixed with esters (< 30 %)</p>	<p>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.</p>	<p>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.</p> <ul style="list-style-type: none"> – 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) <p>Note: Note shear stability (see chapter 4.11 "Fluid servicing, fluid analysis and filtration" and chapter 6 "Glossary")</p>
<p>HETG according to ISO 15380</p> <p>Density at 15 °C: typically 0.90-0.93 kg/dm³</p> <p>VI: typical > 200</p> <p>Iodine count > 90</p>	<p>Basic fluid: vegetable oils and triglycerides</p>	<p>Not recommended for Rexroth components!</p>	<p>Practical requirements are frequently not fulfilled by hydraulic fluids in this classification. Use only permissible after consultation.</p> <ul style="list-style-type: none"> – 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) ingress 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.

5 Disposal and environmental protection

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.

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 handling 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.

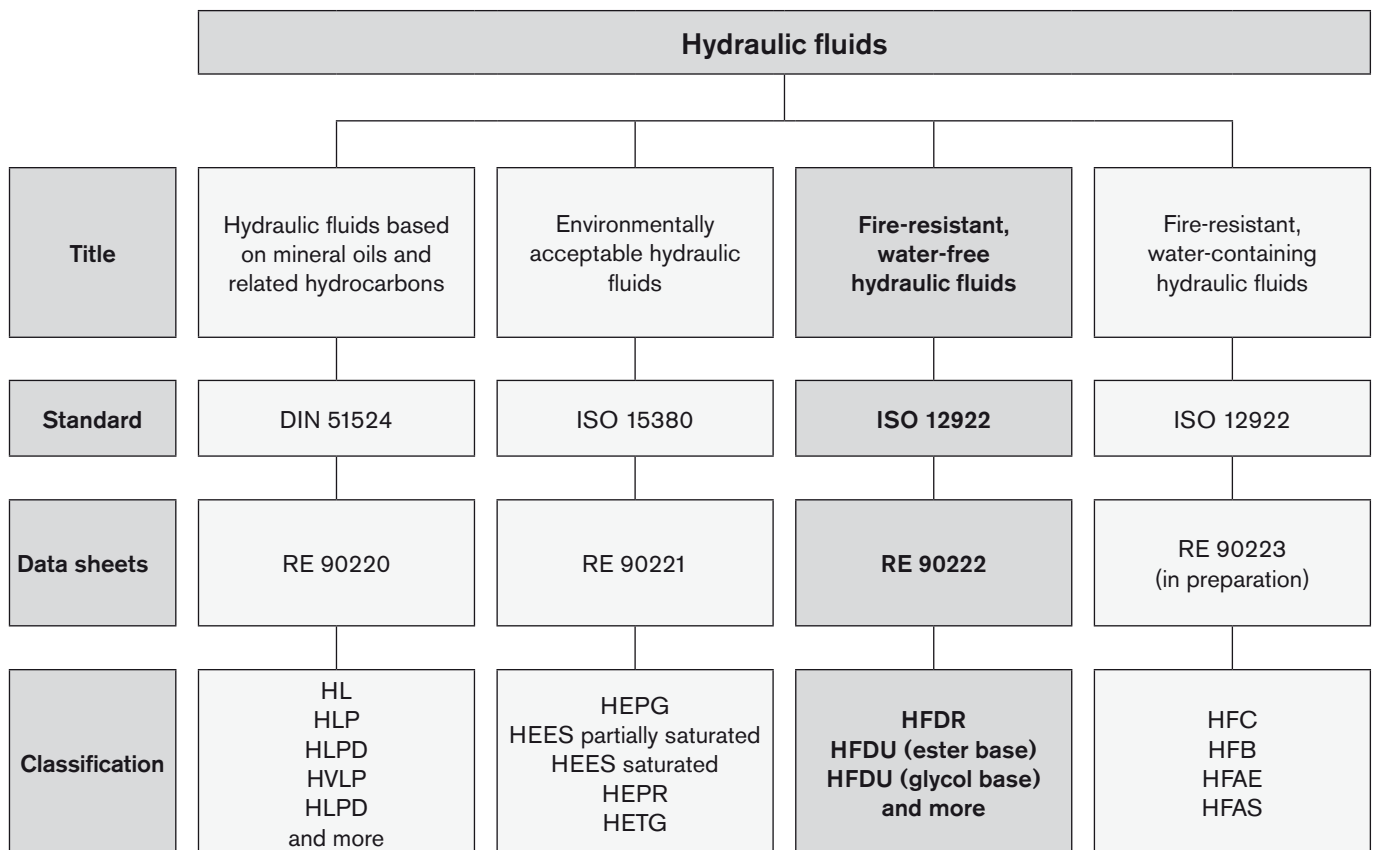
Viscosity index (VI)

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

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

RE 90222/05.12 1/16

Application notes and requirements for Rexroth hydraulic components



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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 as 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.

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	<p>20 / 18 / 15 > 4 µm > 6 µm > 14 µm</p>
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

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.

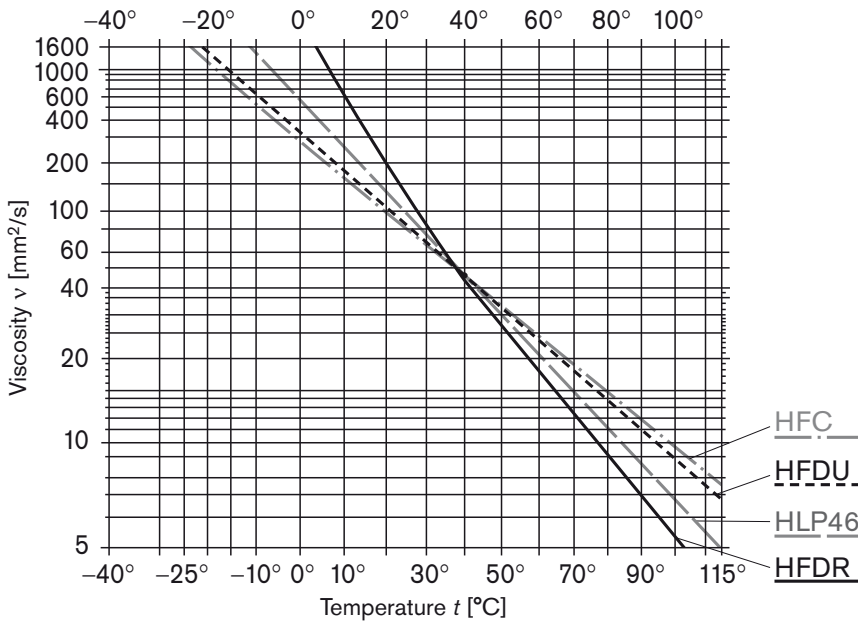
We recommend that the optimum operating viscosity range of each component be kept within the permissible temperature range. This usually requires either cooling or heating, or both. The permissible viscosity range and the necessary cleanliness level can be found in the product data sheet for the component 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 [mm ² /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 they 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 an approximate halving of the fluid service life for every 10 °C temperature increase and should therefore be 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 (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
<p>HFDU (glycol-based) according to ISO 12922</p> <p>Density at 15 °C: typically > 0.97 kg/dm³</p> <p>VI: typical > 170</p> <p>The classification "HFDU" is no longer listed in the current standard sheet VDMA 24317.</p>	<p>Base fluid: Glycols</p>	<p>Mobile systems with high thermal loading</p>	<p>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.</p> <ul style="list-style-type: none"> - 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).
<p>HFDU (ester-based) according to ISO 12922</p> <p>Density at 15 °C: typically 0.90-0.93 kg/dm³</p> <p>VI: typical > 160</p> <p>Iodine count < 90</p> <p>The classification "HFDU" is no longer listed in the current standard sheet VDMA 24317.</p>	<p>Base fluid: Ester based on regenerative raw materials, synthetic ester and mixtures of different esters</p> <p>Because of the fire resistance, HFDU hydraulic fluids based on ester are usually partially saturated esters</p>	<p>Suitable for most fields of application and components.</p>	<p>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.</p> <ul style="list-style-type: none"> - 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
<p>HFDR according to ISO 12922</p> <p>Density at 15 °C: typically 1.1 kg/dm³</p> <p>VI : typical 140–160</p>	Base fluid: phosphoric acid ester	Turbine control systems	<p>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.</p> <ul style="list-style-type: none"> – 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!	<p>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</p> <p>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</p> <p>Consult your lubricant manufacturer or your Bosch Rexroth sales partner if the classification of a hydraulic fluid is not clear.</p>
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) ingress 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 handling 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 mm²/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

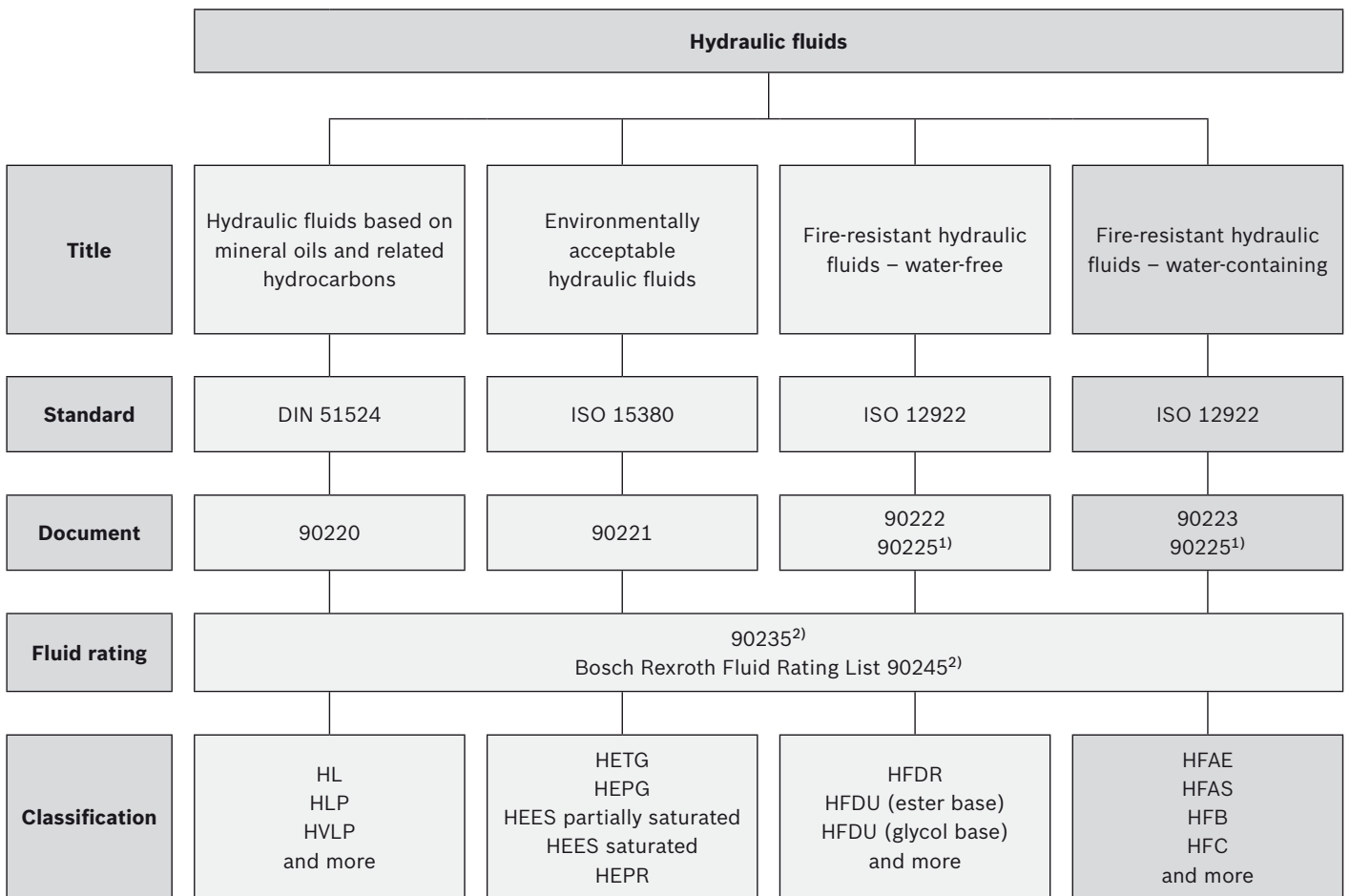
Viscosity index (VI)

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

Fire-resistant hydraulic fluids – water-containing (HFAE, HFAS, HFB, HFC)



Application notes and requirements for Rexroth hydraulic components



1) Valid for Bosch Rexroth axial piston units

2) Valid for Bosch Rexroth Business Unit “Mobile Applications” – pumps and motors

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1 Basic information

1.1 General instructions

Hydraulic fluid is the common element in any hydraulic system and must be selected very carefully. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency, and life cycle of the 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 document includes recommendations and regulations concerning the selection, operation, and disposal of water-containing, fire-resistant 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 also the responsibility of the operator 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 document does not release the operator from verifying the conformity and suitability of the respective hydraulic fluid for his system. The operator of a hydraulic system must ensure that the hydraulic fluid remains fit for purpose throughout its entire period of use.

The currently valid standard for fire-resistant hydraulic fluids is ISO 12922. In addition, even more detailed documents, guidelines, specifications, and laws (the observance of which the operator shall also be responsible) may be valid. This includes, for instance:

- a. 90235 - Assessment of hydraulic fluids used in Rexroth hydraulic components (pumps and motors)
- b. 7th Luxembourg Report: Luxembourg, April 1994 - Doc. No. 4746/10/91 EN "Requirements and tests applicable to fire-resistant hydraulic fluids used for power transmission and control (hydrostatic and hydrokinetic)"
- c. VDMA 24314 (1981-11): "Change of pressure liquids – Directives"
- d. VDMA 24317 (2005-11): "Fire-resistant hydraulic fluids - Minimum technical requirements"

- e. FM Approval Standard 6930 (2009-04): "Flammability Classification of Industrial Fluids" (only available in English)
- f. DIN Technical Report CEN/TR 14489 (2006-01): "Selection guidelines for protecting safety, health, and the environment"
- g. BGR 137 - Handling hydraulic fluids (1997-04): German trade association rules health and safety at work.
- h. DIN 24320: "Fire-resistant fluids - Hydraulic fluids of categories HFAE and HFAS - Characteristics and requirements"
- i. List of hydraulic fluids in the set of regulations for the mining sector (coal mining): http://www.bezregarnsberg.nrw.de/themen/s/schwerentflammbare_hydraulikfluessigkeiten/index.php
- j. RAG N 762010 (2012-10): "Fire-resistant hydraulic fluids HFC-E, requirements"
- k. RAG N 762011 (2012-09): "Requirements on synthetic, fire-resistant hydraulic fluids (HFA-S and synthetic emulsions)"
- l. Ordinance for all mining sectors - ABergV (1995-10): General Federal Mining Ordinance
- m. Occupational Health and Safety Ordinance for Mines (GesBergV) (1991-07): Mining ordinance for the health protection of mineworkers

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. Selection is the sole responsibility of the system operator with respect to requirements (application, construction and design of the system, hottest ignition source in the system, required fire protection).

The most important task in determining the fire resistance of hydraulic fluids is to find a test method that reproduces the situation occurring in a specific application. Different test methods are used to assess the fire resistance according to ISO 12922:

- ▶ Spray ignition characteristics according to ISO 15029-1 (Spray flame persistence – Hollow-cone nozzle method)
- ▶ Spray ignition characteristics according to ISO 15029-2 (Stabilized flame heat release method) Flammability index (RI)
- ▶ Wick flame persistence of fluids according to ISO 14935 (average flame persistence)
- ▶ Flammability on hot surfaces according to ISO 20823 (ignition temperature, spread of flame)

The required minimum values for the ignition temperature differ according to ISO 12922:

HFB: 650 °C, HFC: 600 °C, HFDU: 400 °C, HFDR: 700 °C

In general, fire-resistant hydraulic fluids are distinguished between fire-resistant, **water-free**, and fire-resistant, **water-containing** hydraulic fluids. The fire-resistant, water-free hydraulic fluids are described in Document 90222.

Fire resistant, water-containing hydraulic fluids are normally understood as hydraulic fluids with a proportion greater than 35% by mass of water (according to ISO 12922).

Information

- ▶ Only fire-resistant, water-containing hydraulic fluids can currently receive approval from the mining authorities for use in coal mining below ground.
- ▶ In contrast to water-free fluids, all fire-resistant, water-containing hydraulic fluids do not have a flash point or combustion point.
- ▶ The test conditions for determining the flammability on hot surfaces vary significantly within ISO 12922 between fire-resistant, water-free and fire-resistant, water-containing hydraulic fluids (e.g. different testing temperatures).
- ▶ Just as much care should be taken when working with fire-resistant hydraulic fluids as with other hydraulic fluids, e.g. mineral oils. Leakage in the hydraulic system must be prevented. The best and most cost-effective protection against fire and explosion is to prevent leakage with meticulous servicing, and maintenance and care of the hydraulic system.
- ▶ If possible, the system should be designed such that fires and explosions cannot arise.

1.3 Scope

This document must be applied when using fire-resistant, water-containing hydraulic fluids in Bosch Rexroth hydraulic components. Please note that the specifications in this document may be further defined by the data sheets for the individual components.

The use of the individual fire-resistant, water-containing hydraulic fluids according to the intended purpose can be found in the safety data sheets or other product description documents of the lubricant manufacturers.

Rexroth hydraulic components may only be operated with fire-resistant, water-containing hydraulic fluids according to ISO 12922 if this is 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 fire-resistant, water-containing 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.

See also sub-paragraphs 1.1 b., f., g., j., k., and l.

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 fire-resistant, water-containing hydraulic fluids, the cleanliness level is given as a three-digit numerical code in accordance with ISO 4406. The determination of this is made pursuant to the microscope method according to ISO 4407. The automatic method cannot be applied for fire-resistant, water-containing hydraulic fluids, since oil droplets could be counted as particles, for instance. This numerical code denotes the number of particles present in a hydraulic fluid for a defined quantity. Only particles $> 5 \mu\text{m}$ and $> 15 \mu\text{m}$ are counted here. The specification of the cleanliness level according to ISO 4406 thus only relates to those two particle sizes; for example: "ISO 4406: - / 18 / 15". The type of measuring method applied must always be specified as well when the cleanliness level is being determined. ISO 4406 is generally preferred in hydraulics. 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 according to ISO 4406 or better is to be maintained during operation. Special servo valves require better cleanliness levels of at least 18/16/13. An ordinal number lower by one signifies one half of the number of particles, and thus a higher level of 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 for the overall system. Please also note the information given in Table 1: "Cleanliness levels according to ISO 4406" and in the respective data sheets for the various hydraulic components.

As an option, SAE AS 4059 can be used instead of ISO 4406 if particles above the size of $14 \mu\text{m}$ are going to be identified. The specification of cleanliness levels using cumulative particle counts is indicated by way of a letter/numerical code, although usually the particle size with the highest code is specified.

Hydraulic fluids frequently fail to meet the cleanliness requirements on delivery (basic contamination in containers). Careful filtering is therefore required during operation and, in particular, during filling in order to ensure the required cleanliness levels in the system. Your lubricant manufacturer can tell you the cleanliness levels of hydraulic fluids as delivered. To maintain the required cleanliness level over the operating period, it is recommended that a tank breather filter be used.

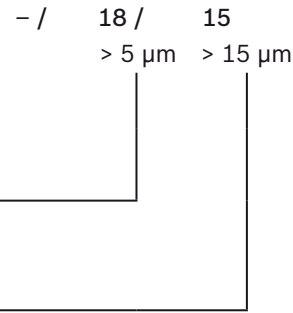
Information

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 solid matter contamination and cleanliness levels can be found in the Bosch Rexroth oil cleanliness booklet R999000239.

Filter inspections and tests can be ordered at Bosch Rexroth as a service using the number R928037504 - Filter inspection - (inspection of used filter cartridges).

Table 1: Cleanliness levels according to ISO 4406 (determination according to ISO 4407)

Particles per 100 ml		Ordinal 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

Fire-resistant, water-containing hydraulic fluids for Bosch Rexroth hydraulic components are assessed on the basis of their fulfillment of the minimum requirements according to ISO 12922.

Based on this, hydraulic fluids can be used that were assessed by Bosch Rexroth according to 90235 (fluid rating).

3.1 Selection criteria for the hydraulic fluid

The specified limit values for all components employed in the hydraulic system, for example required viscosities and cleanliness levels, need to be complied with while observing the specified operating conditions with the hydraulic fluid used. Please refer to the data sheet for the respective Rexroth hydraulic component for the permissible viscosity range, the required cleanliness levels, and the approved operating data.

Hydraulic fluid suitability depends, among other things, 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.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. However, internal leakage losses will be fewer. 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 could 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 in the components 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.

The viscosity is influenced by the water content. If water loss occurs during operation owing to temperatures > +40 °C, then the viscosity will increase firstly (mainly in

open systems). If the viscosity drops when the water content is reduced or if it remains the same, then the polymers in the water-glycol mixture are either damaged or sheared.

Fig. 1: Example ν - T -diagram HFA, HFAS concentrated, HFC compared to HFDR, HFDU (ester based) and HLP (reference values, double-logarithmic presentation)

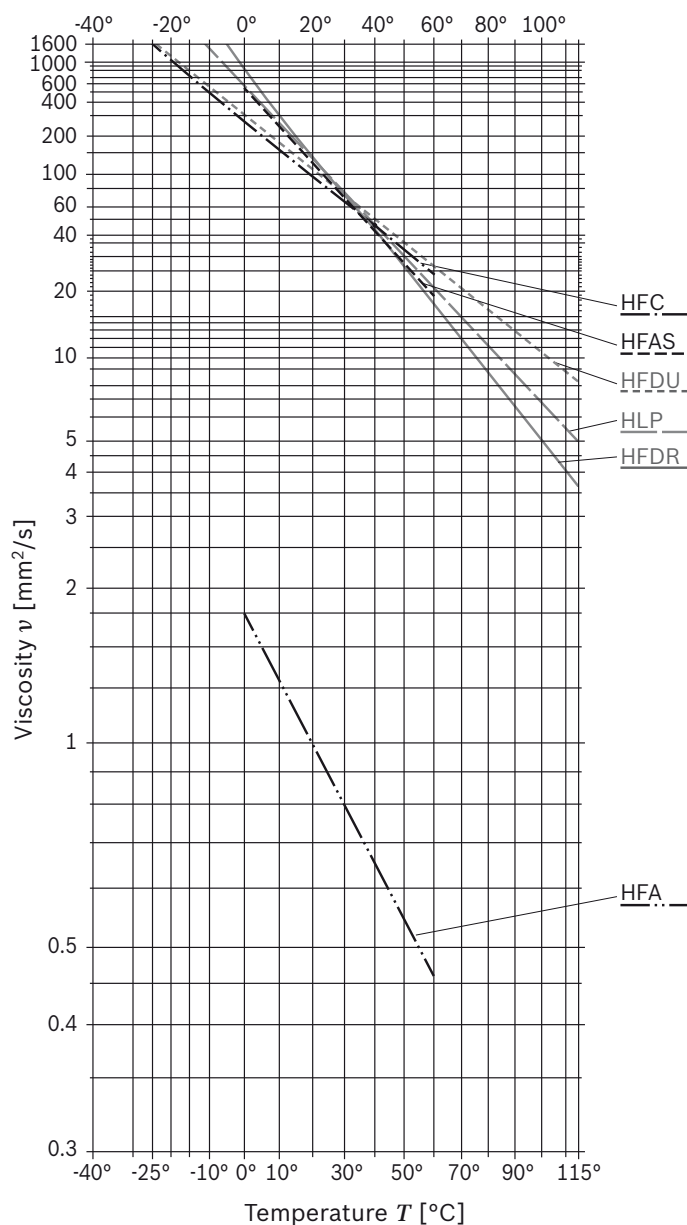


Table 2: Examples of typical viscosity data [mm²/s] in different hydraulic fluids

Temperature	-20 °C	0 °C	40 °C	60 °C	100 °C
HFA	- ¹⁾	1.75	0.65	0.47	- ²⁾
HFAS concentrated	- ¹⁾	550	42	18.7	- ²⁾
HFC	1183	295	46	24.3	- ²⁾
compare HFDR (see 90222)	(14250) ³⁾	956	43	17.1	(5) ³⁾
compare HFDU (ester based) (see 90222)	1195	310	50	26.5	10.4
compare HLP (see 90220)	(4034) ³⁾	547	46	20.8	(6.9) ³⁾

- 1) Not applicable (see Pour point)
- 2) Not applicable (water loss in depressurized reservoir)
- 3) Observe permissible viscosity range for the respective hydraulic component.

3.1.2 Viscosity temperature behavior

In hydraulic fluids, it is primarily the viscosity temperature behavior (ν - T -behavior) that is of particular importance.

In hydraulic fluids, the 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).

HFC hydraulic fluids have a better viscosity temperature behavior than HLP mineral oil.

In HFA hydraulic fluids, the dependency of the viscosity on the temperature is negligible.

The differing viscosity temperature behavior needs to be taken into consideration when selecting hydraulic fluid for the required temperature range.

Owing to a high vapor pressure in comparison to a similar HLP mineral oil, the maximum operating temperature when working with fire-resistant, water-containing hydraulic fluids must be limited. Reservoir temperatures above +50 °C must be prevented in open systems, because they can lead to serious water loss and accelerate the aging process in the hydraulic fluid. Furthermore, in HFC hydraulic fluids, water losses that are too high can lead to both an increase in viscosity and to a reduction in the fire-resistant properties.

Information

- ▶ The minimum operating temperature for HFA hydraulic fluids is +5 °C.
- ▶ HFC hydraulic fluids respond very well at low temperatures and have a lower pour point when compared to HLP mineral oils.

3.1.3 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components.

This is described in ISO 12922 for HFC hydraulic fluids using the following test methods:

- ▶ Mechanical testing in the vane pump (ISO 20763), method B (reduced temperature and working pressure when compared to HLP mineral oil)
- ▶ Testing in the four-ball apparatus (ISO 20623)
- ▶ Testing in the FZG test machine for mechanical stress in the gears (ISO 14635-1), reduced test temperature when compared with HLP mineral oil: in accordance with the 7th Luxembourg Report or ISO 12922 for HFB and HFC at 60 °C.

These test methods cannot be applied for HFA hydraulic fluids.

The test methods and test conditions for fire-resistant, water-containing hydraulic fluids are not comparable to those used for HLP/HVLP mineral oils. This is why the operating data for Rexroth hydraulic components that were optimized for HLP/HVLP mineral oils are (in part) limited. To some extent, Rexroth hydraulic components specifically developed for fire-resistant, water-containing hydraulic fluids are available without the limitation of operating data (e.g. in 92053, the A4VSO axial piston variable pump for HFC hydraulic fluids).

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 components 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.

The material incompatibilities mentioned here do not automatically result in function problems. However the elements of the materials are found in the hydraulic fluid after use. Material incompatibilities may, where applicable, lead to an accelerated aging process in the hydraulic fluid and to increased wear and corrosion of the components.

Table 3: Known incompatibilities of materials

Classification	Incompatible with
Water-containing HF... general	<p>Seals/plastics/coatings FKM elastomers are normally not resistant, NBR elastomers are recommended. Seals, plastics, coatings (of control cabinets, too), 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!</p> <p>Coatings on the inside of the reservoir Single component lacquer (e.g. zinc dust paint) is unstable; the use of stainless steel reservoirs (rustproof steel) is recommended.</p> <p>Zinc Zinc and zinc coatings exhibit in the static immersion test only a minimal amount of change in weight. If zinc (e.g. Zn die-cast housings for filters etc.) is attacked even to a minimal extent, then voluminous reaction products are formed (e.g. zinc soaps) that may block the filters, solenoids etc.</p> <p>Aluminum Aluminum alloys are not stable in all cases (risk of corrosion with cast aluminum). Above all, it is the simpler properties that get attacked, especially if they come into contact with steel parts. The electrochemical reaction with steel (potential difference approx. 1.23 V) may cause a severe case of aluminum removal. Anodized aluminum is suitable for static loading. Aluminum wrought alloys offer improved stability.</p> <p>Cadmium/magnesium Cadmium and magnesium alloys are not compatible.</p> <p>Lead Pure lead is noticeably attacked already in the static compatibility test.</p>
HFB	<p>Seals Polyurethane (AU) not stable</p>
HFC	<p>Seals Polyurethane (AU) not stable</p> <p>Tin and zinc Tin and zinc should be avoided in systems using HFC hydraulic fluids. Residual amounts of HLP mineral oils containing zinc and oils used for corrosion protection must be avoided.</p>

3.1.5 Aging resistance

Fire-resistant, water-containing hydraulic fluids are less subject to thermal load than HLP mineral oils, which is why they are substantially less subject to aging.

In HFAE hydraulic fluids, microbial contamination can cause undesirable aging in the hydraulic fluid. Fungal slime, cakes of fungus, and yeasts can clog filters and lines.

3.1.6 Environmental compatibility

Fire-resistant, water-containing hydraulic fluids are hydraulic fluids that can also be environmentally acceptable at the same time. The main criterion for fire-resistant, water-containing hydraulic fluids is the leak-free, technically problem-free application with the necessary fire resistance. Environmental compatibility is merely a supplementary criterion. You can recognize the environmental compatibility in the technical data sheet for the hydraulic fluid using the reference to:

- ▶ DIN Technical Report CEN/TR 14489
- ▶ BGR 137
- ▶ 7th Luxembourg Report, Part IV “assessment of health hazards” and Part VI “assessment of environmental compatibility”
- ▶ Occupational Health and Safety Ordinance for Mines (GesBergV)

Please refer to the safety data sheet of the respective hydraulic fluids for more information on environmental compatibility.

Information on other environmentally acceptable hydraulic fluids can be found (without reference to fire resistance) in Document 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 damage.

Furthermore, the system behavior can differ due to the higher proportion of undissolved air when compared with HLP mineral oil. According to ISO 12922, a specific value for the air separation ability is not required for the HFAE and HFAS classifications.

The air separation ability for the HFC classification depends

on the viscosity, the temperature, basic fluid, and aging. It cannot be improved by additives.

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.

According to ISO 12922 for instance, an ASA value of ≤ 25 minutes is required for HFC in viscosity class ISO VG 46, lower values are preferable.

3.2 Classification and fields of application

Table 4: Classification and fields of application

Classification	Features	Typical field of application	Information
HFAE according to ISO 12922	Oil-in-water emulsions	Mine support, hydrostatic drives, hydraulic strut extension below ground	Approved for all components that allow "HFAE according to ISO 12922" in the product data sheet for hydraulic fluids. Observe limitations in the operating data for the respective components.
Density at 15 °C typically 1.00 kg/dm ³	Viscosity at 40 °C: max. 5 mm ² /s		- Water-polluting (WGK 1 to 3) - Reservoir temperature +5 °C to +50 °C - Resistance to aging, see chapter 3.1.5 - Owing to the higher density by comparison to HLP, lower intake pressures are to be expected in pumps and, where applicable, the flow must be reduced and the intake conditions optimized (higher cavitation tendency)
Normal water content ≥ 95% (m/m)	Appearance: milky to translucent emulsion		
HFAS according to ISO 12922	Chemical solutions in water	Mine support, foundry technology, press hydraulics (example: hydroforming)	Approved for all components that allow "HFAS according to ISO 12922" in the product data sheet for hydraulic fluids. Observe limitations in the operating data for the respective components.
Density at 15 °C typically 1.00 kg/dm ³	Viscosity at 40 °C: max. 5 mm ² /s or thickened variants up to ISO VG 68		- Mineral-oil free - Water-polluting (WGK 1 to 2) - Reservoir temperature +5 °C to +50 °C - Owing to the higher density by comparison to HLP, lower intake pressures are to be expected in pumps and, where applicable, the flow must be reduced and the intake conditions optimized (higher cavitation tendency)
Normal water content ≥ 95% (m/m)	Appearance: transparent		
HFB according to ISO 12922	Water-in-oil emulsions	Mostly in coal mining below ground, primarily in the U.K. (hydrostatic control systems and drives)	Practical requirements are frequently not fulfilled by hydraulic fluids in this classification. As a result of a high mineral oil content up to 60%, they do not meet the limit values for spray ignition characteristics (fire resistance) prescribed in Germany. Observe limitations in the operating data for the respective components.
Density at 15 °C typically 0.92 to 1.05 kg/dm ³	Viscosity classes: ISO VG 46 up to 100		- Water-polluting (WGK 1 to 3) - Reservoir temperature +5 °C to +50 °C - Owing to the higher density by comparison to HLP mineral oil, lower intake pressures are to be expected in pumps and, where applicable, the flow must be reduced and the intake conditions optimized (higher cavitation tendency)
Normal water content ≥ 40% (m/m)			
HFC according to ISO 12922	Watery polymer solutions	All application areas where water-free hydraulic fluids are not permitted due to the risk of fire. For example: The steel industry, coking plants, foundries, hardening plants, forming presses, injection molding and pressure die casting machines, mining technology (exception: salt mining)	Approved for all components that allow "HFC according to ISO 12922" in the product data sheet for hydraulic fluids. Observe limitations in the operating data for the respective components.
Density at 15 °C typically 1.07 to 1.09 kg/dm ³	Viscosity classes: ISO VG 22 up to 68 Usually ISO VG 46		- Categorized as non-/minimally water-polluting (NWG/WGK 1) - Reservoir temperatures -20 °C to +50 °C - Very good viscosity temperature behavior - Owing to the higher density by comparison to HLP mineral oil, lower intake pressures are to be expected in pumps and, where applicable, the flow must be reduced and the intake conditions optimized (higher cavitation tendency).
VI: typically > 150			- A reservoir with an inspection port above the fill level is recommended in order to remove floating residual oil.
Normal water content ≥ 35% (m/m)			
HFC-E not standardized according to ISO 12922	Watery polymer solutions	Mostly in coal mining below ground, primarily in Germany	- Like HFC, but improved protection against wear and extended temperature range up to 70 °C
Density at 15 °C typically 1.07 to 1.14 kg/dm ³	Viscosity classes: ISO VG 46 up to 68 Normally ISO VG 68		
VI: typically > 135			
Normal water content 18 to 20% (m/m)			

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 delivery containers. The operator of a hydraulic system must ensure that the hydraulic fluid remains fit for purpose 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. A container is to be stored such that the risk of any foreign liquid or solid matter (e.g. water, foreign fluids, or dust) ingress into the inside of the container can be ruled out. After taking hydraulic fluids from the containers, these are to be properly resealed immediately. HFAE and HFAS hydraulic fluids are delivered in a concentrated form. Please observe the hardness (°dH) in order to produce the finished product, lower hardness values should be aimed at (°dH, calcium oxide CaO in ppm).

Recommendation:

- ▶ Store containers in a dry, roofed place
- ▶ Store HFA containers frost-protected
- ▶ Clean reservoir systems and machine reservoirs regularly

Please refer to the respective safety data sheet for the minimum storage duration and storage conditions.

4.3 Filling of new systems

Usually, the cleanliness levels of the hydraulic fluids as delivered do not meet the requirements of our hydraulic components at the company. When filling, hydraulic fluids must be filtered using an appropriate filter system to minimize solid particle contamination 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 section).

4.4 Hydraulic fluid changeover

Problems may be encountered in particular when changing over from fire-resistant, water-free hydraulic fluids or mineral oils to fire-resistant, water-containing 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 and miscibility of the new hydraulic fluid with the remains of the previous hydraulic fluid from the system.

Bosch Rexroth recommends obtaining verification of compatibility and miscibility from the manufacturer or supplier of the new hydraulic fluid. The remainder quantities of the old fluid need to be minimized. Mixing hydraulic fluids should be avoided; see following section.

Information on changing over hydraulic fluids with different classifications can be found in VDMA 24314 and ISO 7745, among others. Beyond that, please observe chapter 3.1.4 “Material compatibility”.

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, silt-ing, 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.

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 HLP mineral oil.

Bosch 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 are not approved.

Bosch 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.

The foaming behavior of fire-resistant, water-containing hydraulic fluids is normally worse than in HLP mineral oil.

4.8 Corrosion protection

Water generally has corrosive properties.

Corrosion protection is only possible to a limited extent due to the water content in fire-resistant, water-containing hydraulic fluids, despite the available corrosion protection additives.

Materials made of steel, copper, zinc, aluminum, bronze alloys and brass alloys, as well as combinations of these materials have a higher corrosion tendency.

4.9 Dissolved and undissolved 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. The consequence of this is material erosion on components. 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 section 3.1.7 "Air separation ability (ASA)".

4.10 Fluid servicing, fluid analysis, and filtration

To preserve the usage properties and ensure a long service life for hydraulic fluid and components, both the monitoring of the fluid condition and a filtration adapted to the application requirements are indispensable.

The application of hydraulic system filters with a filtration rate > 200 for $10\mu\text{m}$ particles ($\beta_{10(c)} > 200$ according to ISO 16889) is not recommended for fire-resistant, water-containing hydraulic fluids, since finer filters can break down the chemical composition of the fluid. If finer filters are required despite that, then the fluid manufacturer needs to be consulted before they are used.

$\beta_{10(c)} > 75$ according to ISO 16889 is recommended.

The effort is higher in the case of unfavorable usage conditions, increased stress on 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. A reference inspection is recommended both for the unused hydraulic fluid (casks) and after commissioning.

Minimum information in analyses (recommended)

Property or test conditions	Test method	HFAE	HFAS	HFB	HFC
Appearance		●	●	●	●
Water content	HFAE, HFB: ISO 3733 HFAS: ISO 6296; HFC: DIN 51777-1	●	●	●	●
Density at 15 °C	ISO 3675, DIN 51757 incl. supplementary sheet 1	–	–	●	●
pH value at 20 °C	ISO 20843	●	●	–	●
Viscosity at 20 °C, 40 °C, and 50 °C	ISO 3104, DIN 51562-1, ASTM D7042	●	●	●	●
Volume fraction of emulsified concentrate	DIN 51368 in conjunction with DIN 51423-2	●	–	●	–
Foreign oil proportion		●	●	●	●
Cleanliness level	ISO 4406	●	●	●	●
Content of foreign solid matter	ISO 4405	●	●	●	●
Microbial stability with details on bacteria, fungi, yeasts, and germ count		●	●	●	–
Elements	DIN 51399-1	●	●	●	●

Optional information

Property or test conditions	Test method	HFAE	HFAS	HFB	HFC
Reserve alkalinity compared with pH values 3.3 and 5.5		●	●	●	●
Testing in the four-ball apparatus	ISO 20623	–	–	–	●
Air separation ability at 50 °C	ISO 9120	–	–	–	●

Information

- ▶ If possible, compare the measurement results with the values of new oil or available trend analyses.
- ▶ The test report should include an evaluation / assessment pertaining to the further use of the hydraulic fluid.

When using fire-resistant, water-containing hydraulic fluids, the same servicing and maintenance requirements as applied for HLP/HVLP mineral oil are necessary. However, the scope of the analysis/analysis methods have to be adapted to the fluid properties.

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

Fire-resistant, water-containing hydraulic fluids contain alkaline additives. They are used both for the neutralization of contamination and for corrosion protection in the hydraulic system. If the reserve alkalinity drops significantly below the value for the unused hydraulic fluid, there is a chance that fully developed, acidic reaction products can no longer be fully neutralized. The risk of electrochemical corrosion in the system increases, which is why the proportion of corrosion protection inhibitors have to be checked during operation (reserve alkalinity compared with pH values 3.3 and 5.5).

If the water contained has noticeably vaporized, then distilled water or VE water needs to be replenished in order to set the initial viscosity; tap water must never be used. The addition of larger quantities of water should be done slowly and, if possible, in several positions during ongoing operation, so as to prevent the pump from occasionally sucking in pure water, and thus being damaged by that. It is recommended that the corresponding amount of water prior to the addition be mixed with approximately the same amount of HFC fluid, for example.

Ultimately, the evaluation by the test lab or lubricant manufacturers is authoritative. Their recommendation should be urgently observed.

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

The respective lubricant manufacturers provide specifications on environmentally friendly handling and storage. Please ensure that spilled 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 handling of used oils stipulate that used oils are not to be mixed with other products. Non-compliance will increase disposal costs.

Both the national legal or regulatory provisions and the information given in the respective safety data sheets (e.g. waste codes) must be observed for the disposal of the relevant hydraulic fluid.

6 Standardization

The information pertaining to the standards listed in this document relates to the respective standard edition currently valid.

7 Glossary

Additivation

Additives are chemical substances added to base fluids in small quantities to achieve or improve specific properties.

Alkaline additives

Hydraulic fluids can produce acids as a result of various aging processes. The hydraulic fluid contains alkaline additives in order to cushion/remove the acidification. These additives bind the acid residue and then become particles that are (can be) filtered out. A statement in regard of alkaline additives still effective is provided, on the one hand, by pH value, but better still is the statement pertaining to the content of free acids. In the alkaline f value range, acidic corrosion is not possible, even if acids are present.

Aging

The aging response in a hydraulic fluid describes the chronological sequence of the oxidative, thermal, and (sometimes) hydrolytic change in selected chemical and physical data under test conditions or in practice. (See chapter 3.1.5 "Aging resistance").

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.

ICP (optical emission spectrometry)

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 for determining the proportion of water in water-containing hydraulic fluids: potentiometric method according to DIN 51777-1

Cavitation

Cavitation is the creation of vapor filled cavities (vapor bubbles) in fluids due to insufficient vapor pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures, and pressures may occur temporarily, which may damage the component surfaces.

Reserve alkalinity

Determining the reserve alkalinity is used for the investigation of the corrosion protection still available. If the determined reserve alkalinity significantly drops below the initial value of the new oil, then acidic contamination can no longer be neutralized, this means that there is a potential threat to the system becoming damaged due to corrosion.

pH value

This is the measurement for the acidic or alkaline character of an aqueous solution or emulsion.

Pour point

This is 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 (energy dispersive or wavelength dispersive X-ray fluorescence analysis)

Is a procedure to determine almost all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast results.

VE water

Demineralized water, also known as deionized, fully desalinated water

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 categorized in ISO viscosity classes by kinematic viscosity. 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.

Control Blocks

Designation	Type	Size	Series	Data sheet	Page
Open-center control block	SM	12	1X	64122	73
Open-center control block	MO	40	1X	64370	101
Open-center control block	MO	52	1X	64373	113
Open-center control block	M8	32	1X	64294	125
Positive control block	M9	25	1X	64303	141
Flow sharing control block (LUDV)	SX	10	1X	64132	155
Flow sharing control block (LUDV)	SX	14	2X	64125	171
Flow sharing control block (LUDV)	M6	22	3X	64322	193
Flow sharing control block (LUDV)	M7	20	3X	64293	211
Flow sharing control block (LUDV)	M7	22	3X	64295	227
Flow sharing control block (LUDV)	M7	25	3X	64297	247
Flow sharing control block (LUDV)	RS	14	1X	64136	267
Load-sensing control block	SP	08	2X	64139	289
Load-sensing control block	M4	12	2X	64276	315
Load-sensing control block	M4	15	2X	64283	369
Load-sensing control block	M4	22	1X	64279	417
Load-sensing control block	SB	12		64386	435
Load-sensing control block	SB	23-M	1X	66130	475
Load-sensing control block	SB	23-EHS1	1X	66134	499
Load-sensing control block	SB	33-EHS1	2X	66136	531

Open center control block in sandwich plate design SM12



3SM12

- ▶ Series 1X
- ▶ Maximum pressure

	Medium pr.	High pr.
– pump side	250 bar	350 bar
– actuator side	300 bar	400 bar
- ▶ Flow at each directional valve 70 l/min

Features

- ▶ Control principle: 6/3-way system
- ▶ Circuit types: parallel, tandem or series circuits
- ▶ Low internal leakage
- ▶ Compact control block with low pressure losses
- ▶ Good fine control due to the extensive use of fine control grooves
- ▶ System protection via primary and secondary pressure relief valves

Design

- ▶ Compact sandwich plate design, can be combined so that the control block can meet the requirements of differing machines:
 - Inlet element
 - Up to 10 directional valves
 - End element
- ▶ Type of actuation
 - Hydraulic
 - Mechanical

Fields of application

- ▶ Mini excavators, excavators, auxiliary functions on agricultural tractors, loaders, drilling rigs, lifting machines, material handling

Contents

Functional description	2
Control block, basic version: Modular design	3
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Characteristic curves	5
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Directional valves	14
End elements	16
Dimensions	17
SM12 control block for tractor auxiliary functions	20
Ordering code	20
Inlet elements	22
Directional valves	23
Intermediate plate	25
End elements	25
Dimensions	26

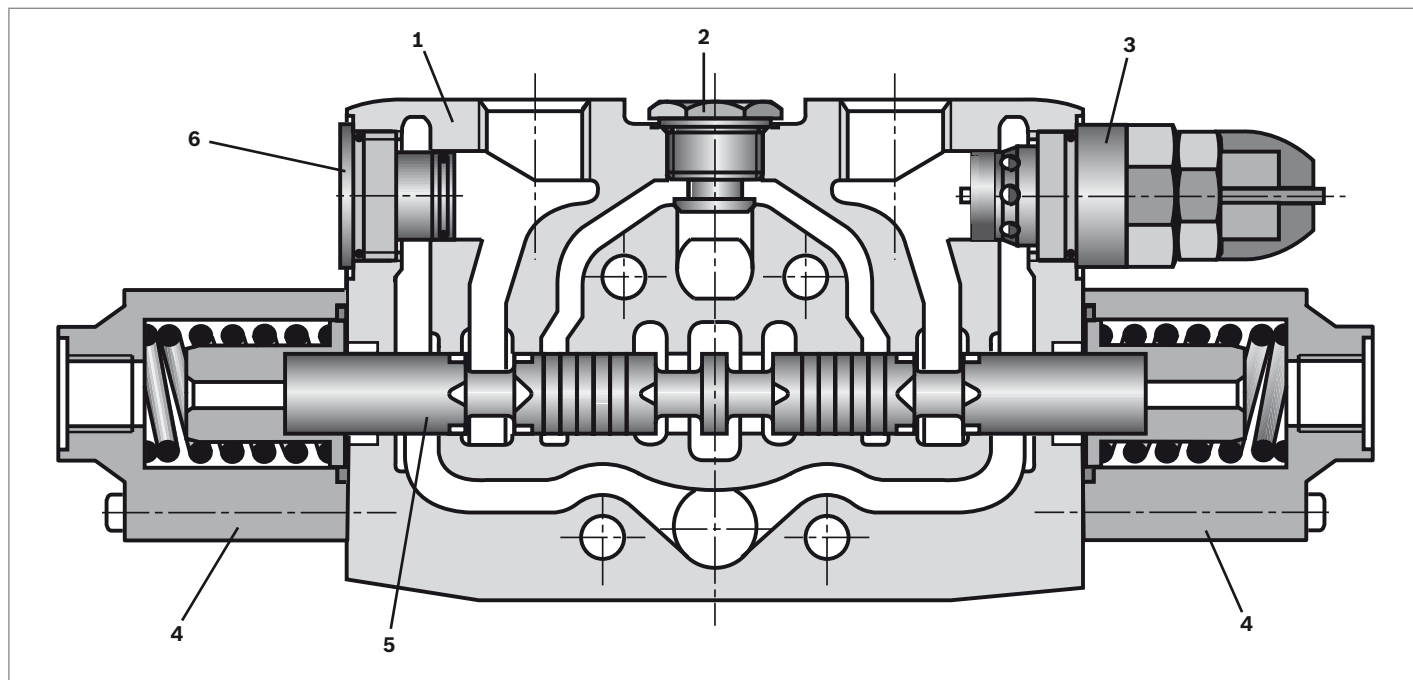
Functional description

The SM12 control block basically comprises of an inlet element, directional valve elements and an outlet element. The control blocks are designed to the 6-way principle and comprises of a housing (1), control spool (5), load holding check valve (2), spool actuation and return system (4), cavities (3) for the secondary pressure valves or relief/anti-cavitation valves, as well as anti-cavitation valves or plugs (6).

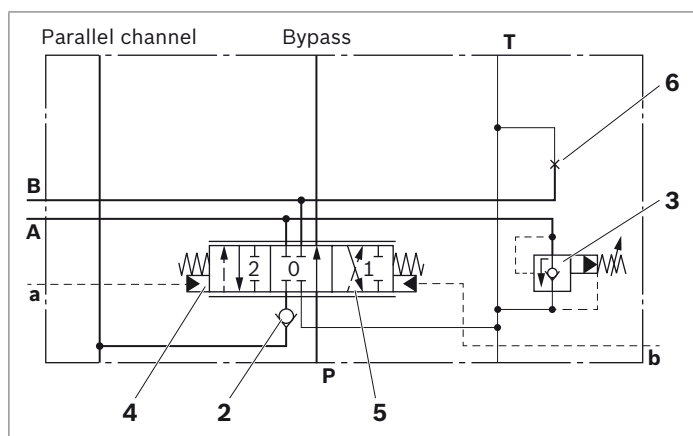
With all of the spool axes in their neutral position the flow passes via the bypass channel at zero pressure to tank. If one of the control spools is actuated then the connection from the pump to the actuator is opened via the

fine control grooves, whilst the bypass is throttled by fine control grooves. If the pump pressure exceeds the actuator pressure, the pressure fluid starts to flow over the check valve to the actuator. With further movement of the control spool (5) the volume of fluid is increasingly diverted from the bypass channel to the actuator (fine control). The spool stroke is divided into three phases: overlap (leak-free in the neutral position), fine control range (flow and pressure), residual stroke (fully open). Due to the large fine control range of the spool stroke it is possible to sensitively control the actuators.

▼ Section SM12



▼ Symbol SM12, hydraulic



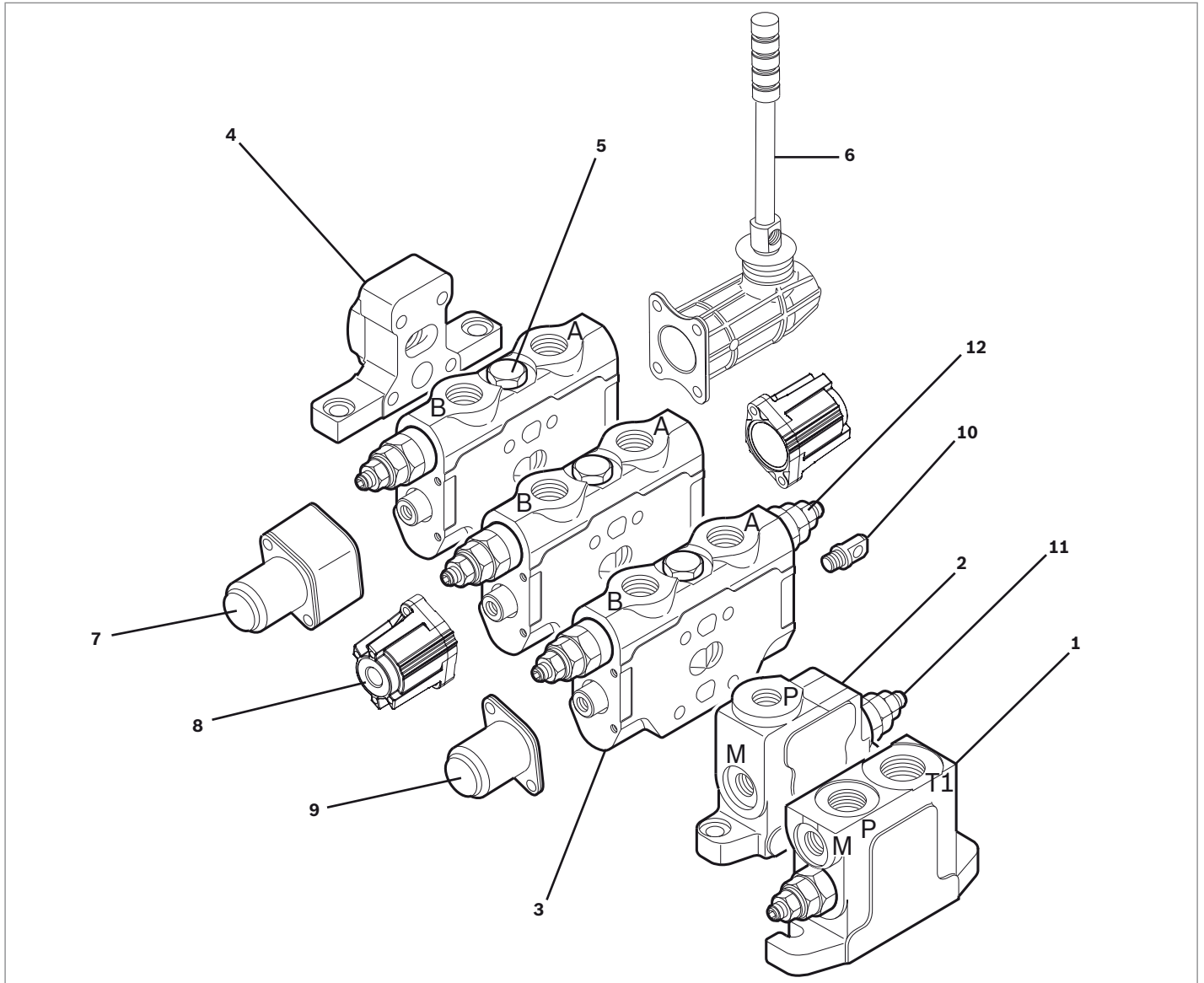
- 1 Housing
- 2 Check valve
- 3 Secondary valve
- 4 Operating element
- 5 Spool
- 6 Plug screw

Ports

P	Pump
A, B	Actuator
T	Tank

Control block, basic version: Modular design

▼ Modular design SM12



- | | |
|---|--|
| <p>1 Inlet element, separate, with connection T1, version E (only for the medium pressure version)</p> <p>2 Inlet element, separate, without connection T1, version A (only for the high pressure version)</p> <p>3 Directional valve element</p> <p>4 End element, version R or C</p> <p>5 Check valve</p> <p>6 Manual operator, encapsulated lever, version R5</p> | <p>7 Spring return mechanism, detents in switched positions 3, version E2</p> <p>8 Control cover for hydraulic actuation H200</p> <p>9 Spring return cover, version A2</p> <p>10 Mechanical operator with tongue, version Z1</p> <p>11 Primary pressure relief valve</p> <p>12 Secondary valve</p> |
|---|--|

Technical data

General			
Weight	Inlet element, separate, with connections P and T1	kg	1.8
	Directional valve	kg	2.1
	End element	kg	0.9
Installation position			Any
Type of connection			Pipe threads according to ISO 228/1 (Standard)
Ambient temperature range		°C	-40 to +60
Hydraulic			
			Medium pressure version
			High pressure version
Nominal pressure		bar	250
Max. operating pressure at port	P, M, P3	bar	250
	A, B	bar	300
	T, T1	bar	20 bar. If EHR12 : 10 bar, if kick-out : 6 bar
Max. control pressure at port	a, b	bar	35
	a, b (actuation H200)		We recommend the use of control curve – With a 3 positions spool : 4TH6 curve no. 106 – With a 4 positions spool : 4TH6 curve no. 12
Leakage oil flow (at 100 bar, 36 mm ² /s)		cm ³ /min	15 ¹⁾
Hydraulic fluid			Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet 90221, at request
Hydraulic fluid temperature range		°C	-20 to +80
Viscosity range		mm ² /s	10 to 380
Maximum admissible degree of contamination of the hydraulic fluid cleanliness class according to ISO 4406 (c)			Class 20/18/15, for this we recommend using a filter with a minimum retention rate of β ₁₀ ≥ 75
Mechanical			
Spool return force (without detent)		N	90 to 125 (with standard spring)
Max. permissible actuation force on the spool	axial	N	1000 during 20% of total cycles then 500
	radial	N	16

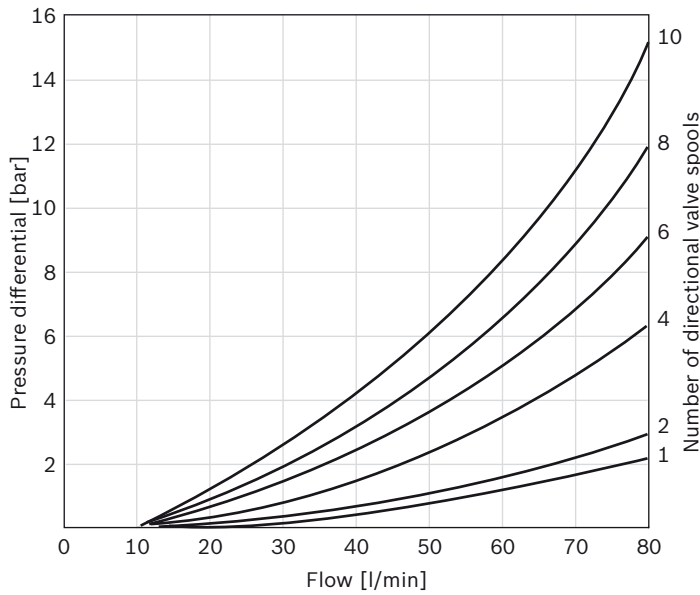
NOTE

For applications outside these parameters, please consult us!

¹⁾ Lower oil leakage available on demand.

Characteristic curves

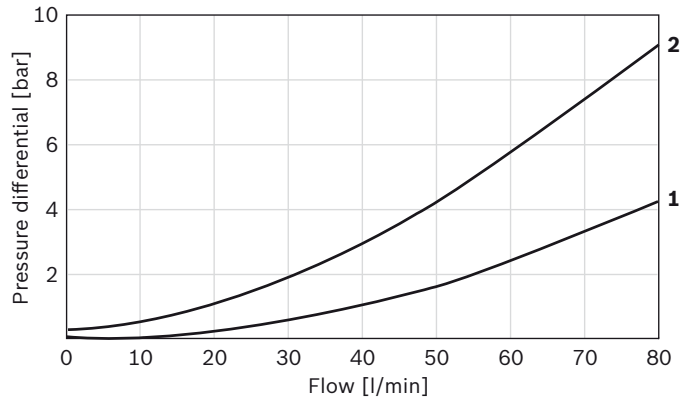
▼ Pressure differential in the neutral position, P → T:
for all spool variations



NOTE

Characteristic curves measured at $\nu = 41 \text{ mm}^2/\text{s}$,
 $\theta = 50 \text{ }^\circ\text{C}$.

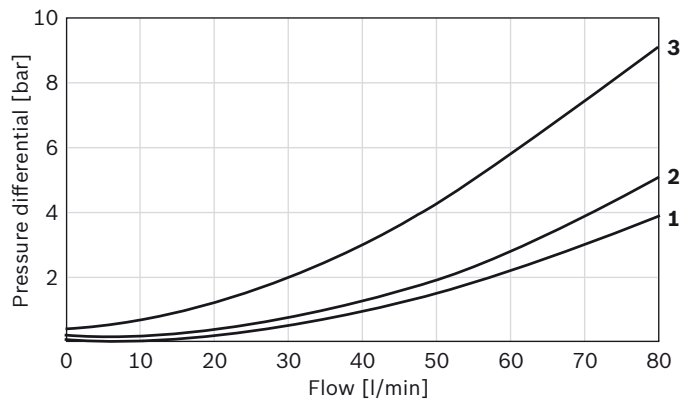
▼ Pressure differential for a double acting spool (001-011)
with switching P → A / B → T
with switching P → B / A → T



- 1 B → T / A → T
- 2 P → A / P → B

(measured at a control block with 1 directional valve spool)

▼ Pressure differential for a single acting spool (014)
with switching P → B
with lowering position P → T / B → T

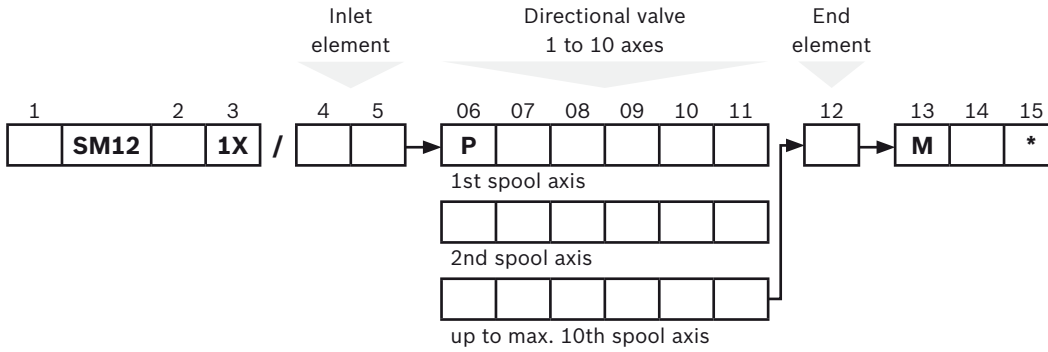


- 1 B → T
- 2 P → T
- 3 P → B

(measured at a control block with 1 directional valve spool)

Ordering code

SM12 control block basic version



01	No. of spool axes 1 to 10	
----	---------------------------	--

Design

02	High pressure version (not possible with end element C)	H
	Medium pressure version	L

Series

03	10 to 19 (unchanged installation and connection dimensions)	1X
----	---	-----------

Inlet element¹⁾

04	With port P and T1 (medium pressure version)	E
	With port P , without port T1 (high pressure version)	A
05	Without primary pressure relief valve (with plugged cavity)	000
	With primary pressure relief valve (pressure details in bar, 3-digit)	V...0

Directional valve type

06	Parallel directional valve	P
	Tandem directional valve	T
	Series directional valve (always used with spool variant 010 , see next page)	S

¹⁾ The pressure gauge connection **M** is plugged with a metal plug.

Control spool variants

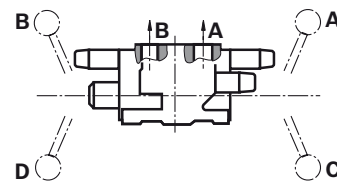
07	Actuation on connection side A	Actuation on connection side B		
			3 positions double acting spool closed ports	001
			3 positions double acting spool open ports (engine, ...)	011
			3 positions single acting spool	014
			4 positions double acting spool	004
			Serial 3 positions spool	010

Type of actuation

08	Spool return via a spring	A2 ..
	Spool return via a spring with detent in spool position 2	B2 ..
	Spool return via a spring with detent in spool position 1	C2 ..
	Spool return via a spring with detent in spool positions 1, 2	D2 ..
	Spool return via a spring with detent in spool position 3 (4th position)	E2 ..
	Manual operator (not possible with secondary valves with lever in position A or B)	.. M1
	Manual operator, encapsulated lever (with rubber boot)	.. R5
	Spool end with tongue (Ø 6)	.. Z1
	Hydraulic operator, spool return via a spring	H200
	Hydraulic operator, spool return via a spring for the 4th position spool version 004	H400

Actuation orientation

09	Without mechanical or manual operator	-
	Manual operator on connection side A – lever up or mechanical operator with tongue on connection side A ^{2) 3)}	A
	Manual operator on connection side B – lever up or mechanical operator with tongue on connection side B ³⁾	B
	Manual operator on connection side A – lever down	C
	Manual operator on connection side B – lever down	D



2) **A** = preferred operator location

3) Manual operator M1 is not compatible with orientations A and B

Secondary valves

10	Pressure relief/anti-cavitation valve, pilot operated (pressure details in bar, 3-digit)	H...0
11	Anti-cavitation valve	E
	Plug	Q

End element

12	End element with tank port T	R
	End element with pressure port P3 for downstream actuators (port T1 is in the inlet element) (not possible with high pressure version H)	C

Seal material

13	NBR seals	M
----	-----------	----------

Line connections

14	Pipe threads according to ISO 228/1	01
	UNF threads according to ISO 11926	41

15	Further details in clear text	*
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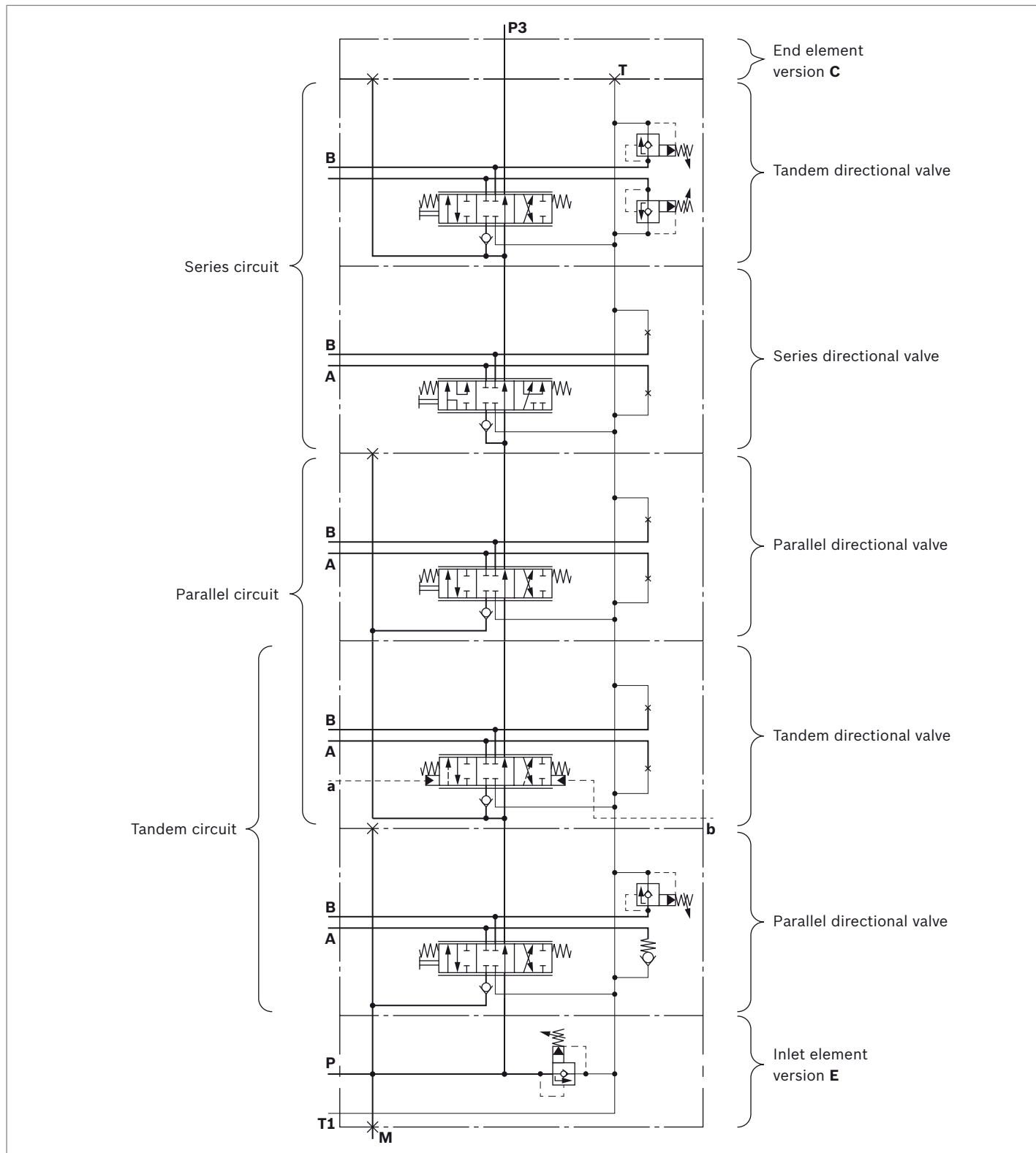
Ordering example:

2 SM12 L 1X / E 220 P 001 A2Z1 A Q Q

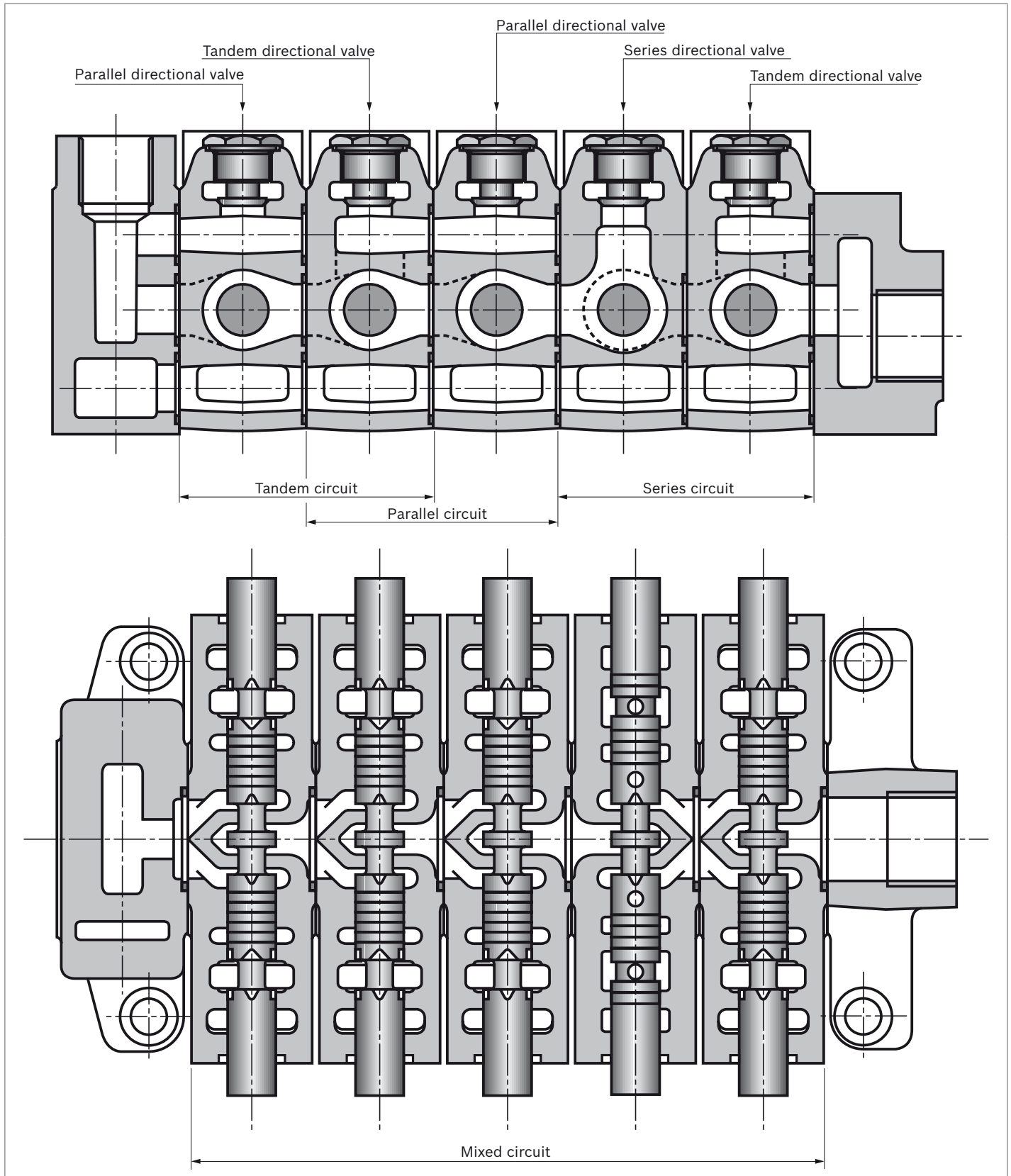
P 004 E2Z1 A H250 H250 R M01

Types of circuit

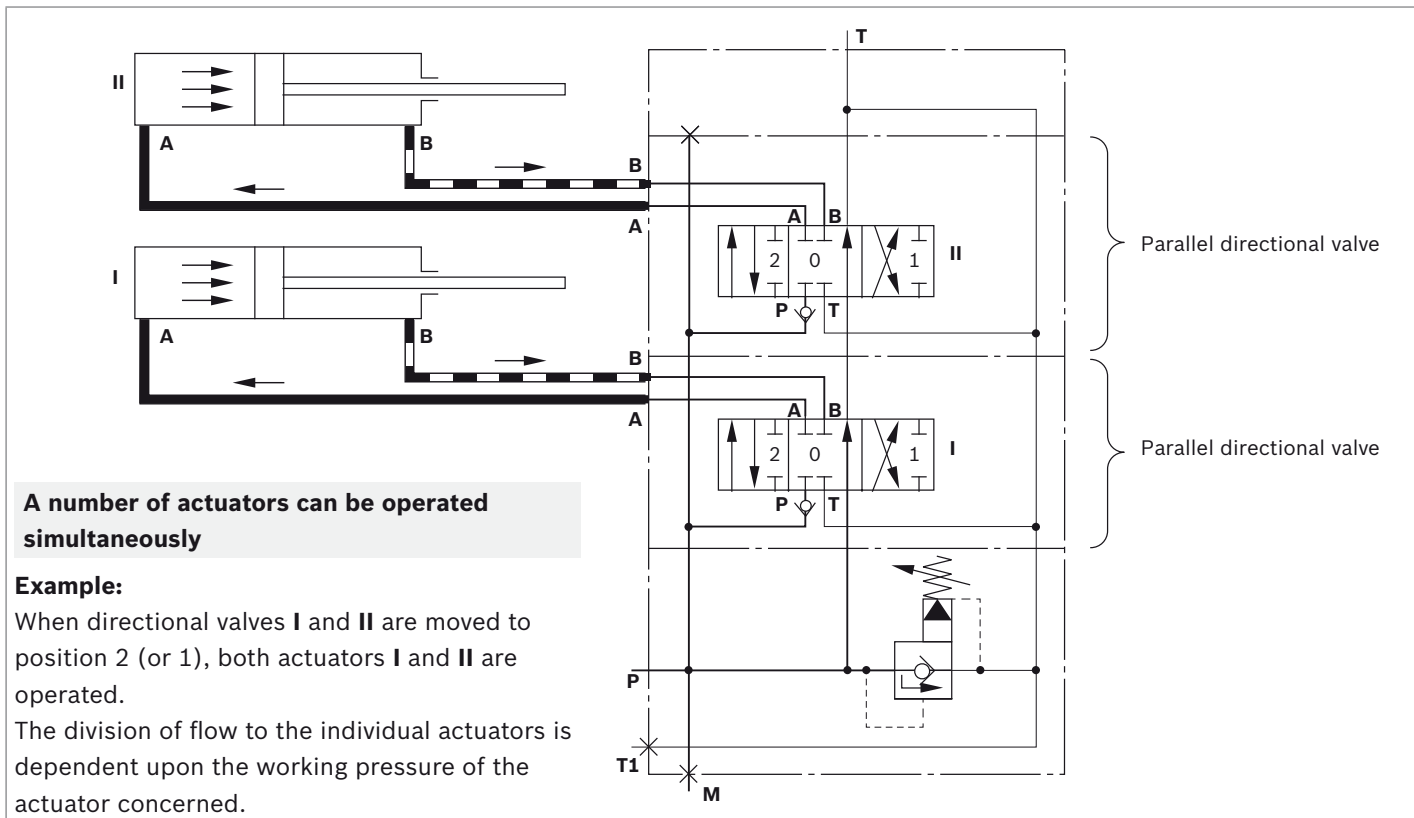
▼ Circuit example: complete control block



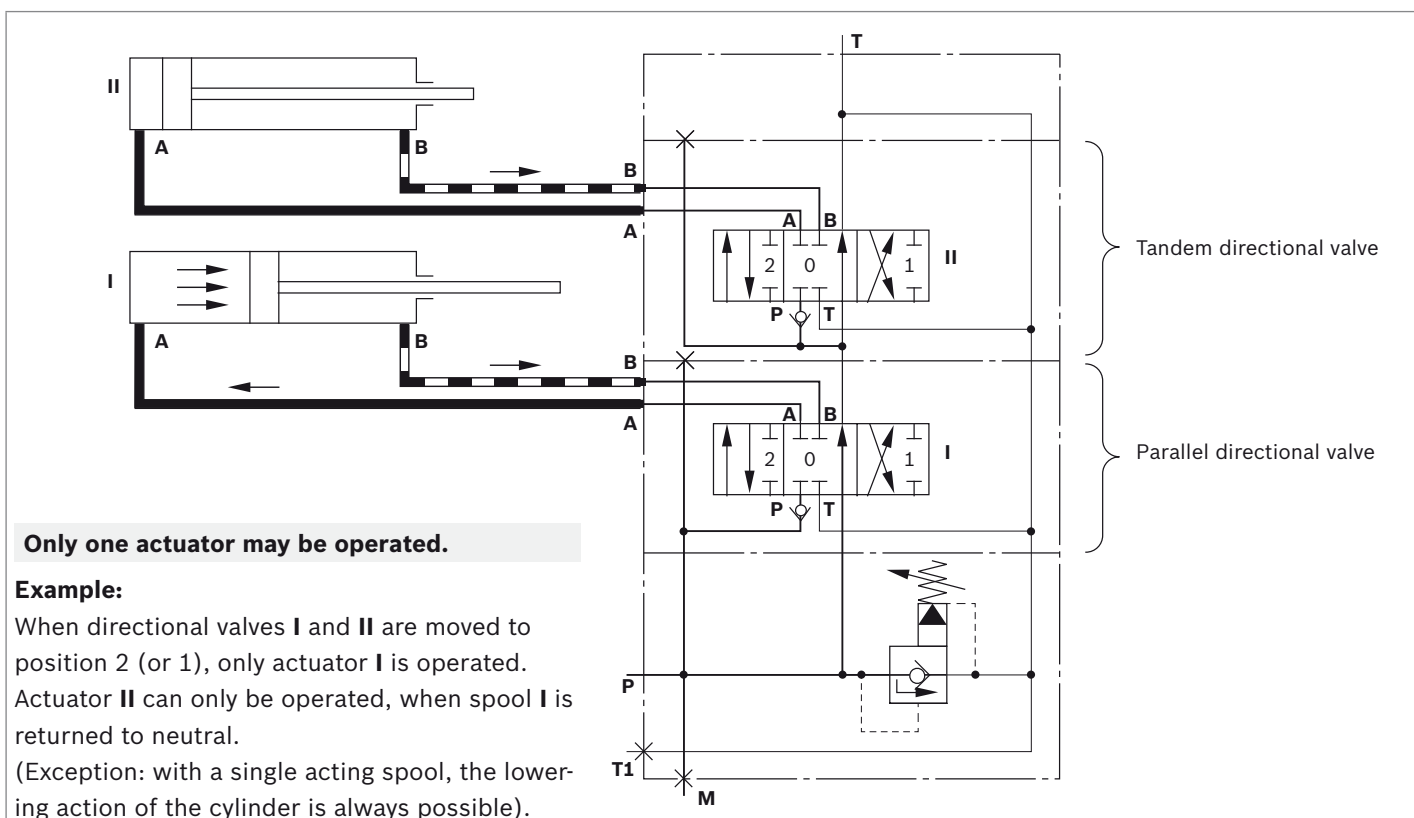
▼ Section circuit types



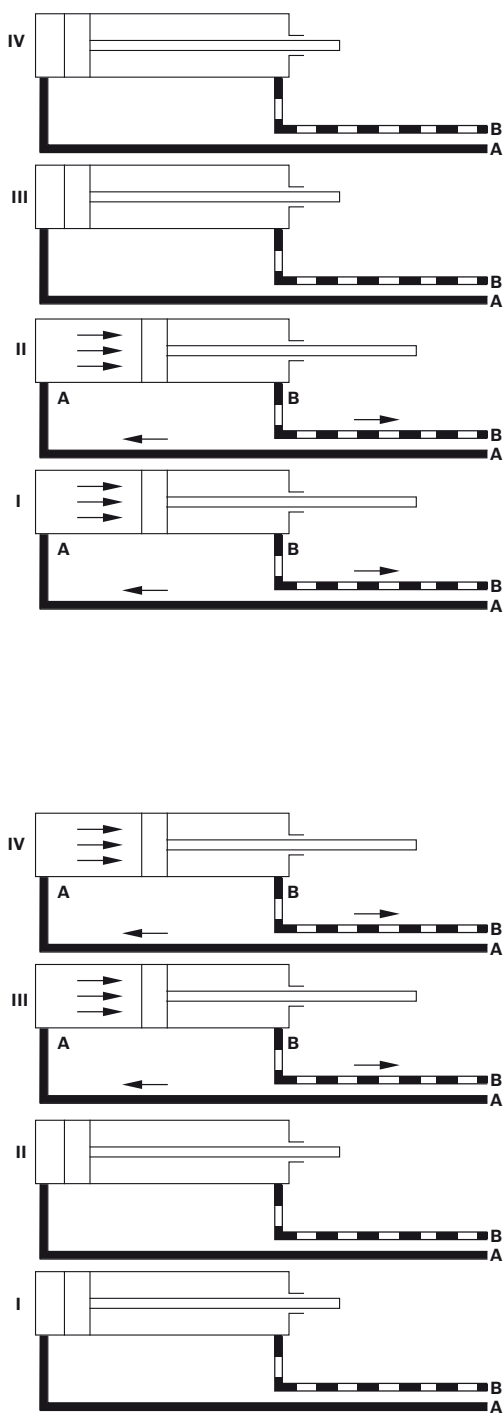
▼ Parallel circuit



▼ Tandem circuit

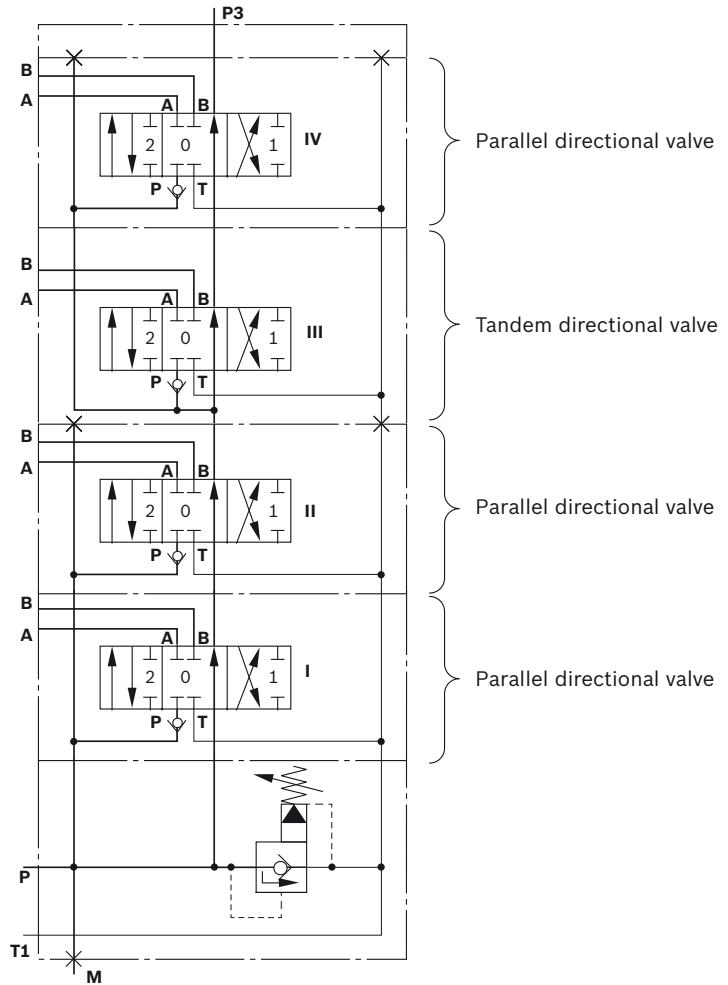


▼ Mixed circuit



Example 1:

When directional valves **I** and **II** are simultaneously operated, the oil supply to the other elements is interrupted.



Example 2:

In order to operate actuator **III** and/or **IV**, directional valve spools **I** and **II** must be returned to neutral.

Inlet elements

With ports **P** and **T1** (medium pressure version)

Ordering code:

E	V...0
---	-------

- ▶ With primary pressure relief valve¹⁾
- ▶ Pressure details in bar after **V** required (3-digit)

Ordering code:

E	000
---	-----

- ▶ Without primary pressure relief valve

With port **P**, without port **T1**

(high pressure version)

Ordering code:

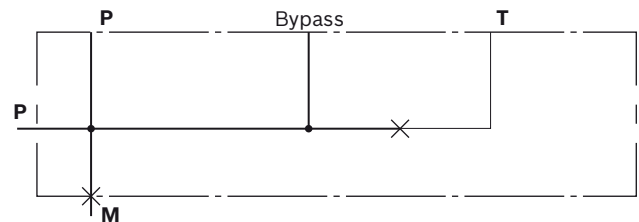
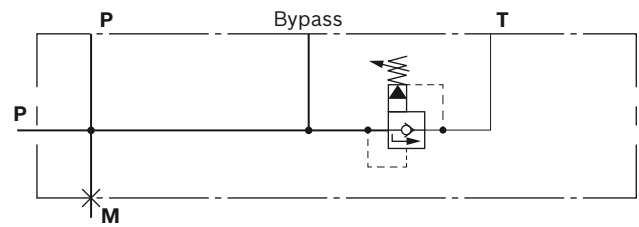
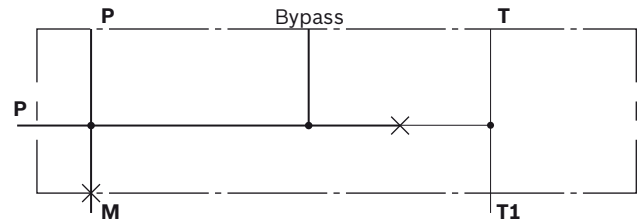
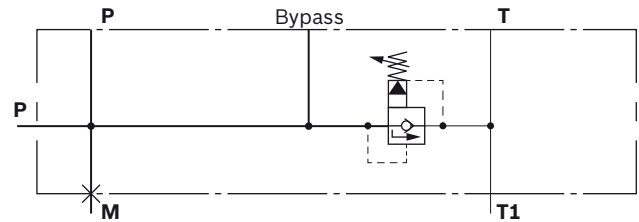
A	V...0
---	-------

- ▶ With primary pressure relief valve¹⁾
- ▶ Pressure details in bar after **V** required (3-digit)

Ordering code:

A	000
---	-----

- ▶ Without primary pressure relief valve



NOTE

The pressure gauge connection **M** is plugged with a metal plug.

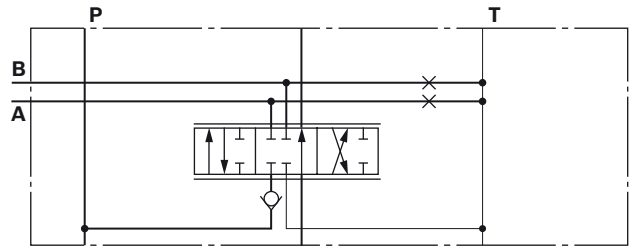
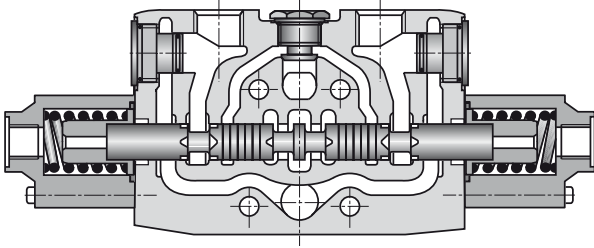
¹⁾ The primary pressure relief valve shown above is a pilot operated relief/anti-cavitation valve. The setting of the stated pressure value is carried out with a flow of 15 l/min. The pressure settings of the primary pressure relief valves must not exceed the permissible pressure of the block itself.

Directional valves

Parallel directional valve with check valve

Ordering code:

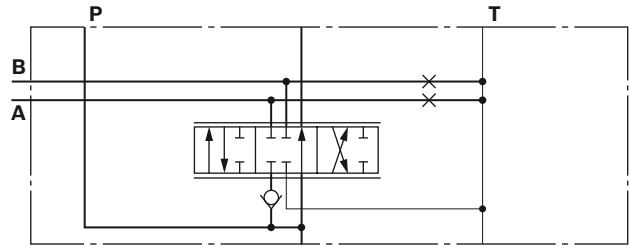
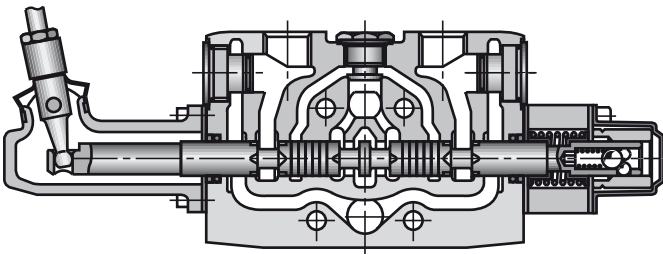
P	001		Q	Q
---	-----	--	---	---



Tandem directional valve with check valve

Ordering code:

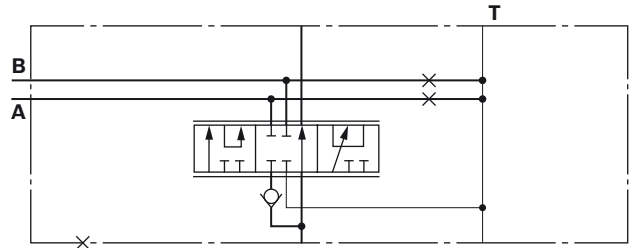
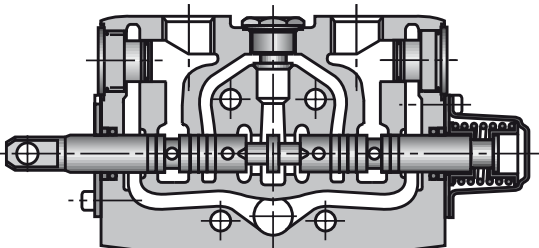
T	001		Q	Q
---	-----	--	---	---



Series directional valve

Ordering code:

S	010		Q	Q
---	-----	--	---	---

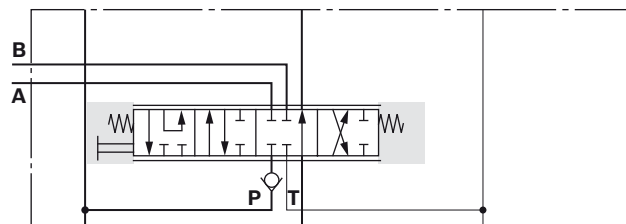


Types of actuation

Mechanical actuation

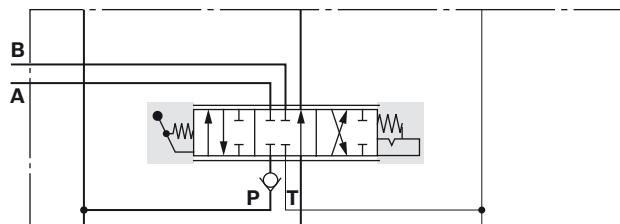
Ordering code:

... A2Z1 A ...



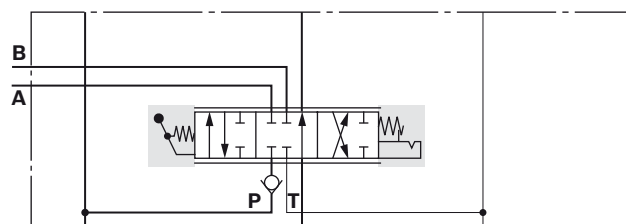
Ordering code:

... B2M1 A ...



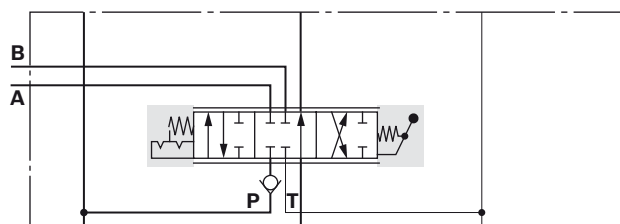
Ordering code:

... C2M1 A ...



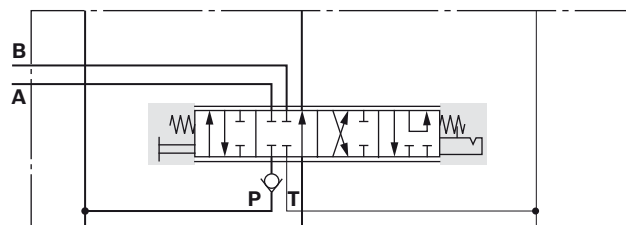
Ordering code:

... D2R5 B ...



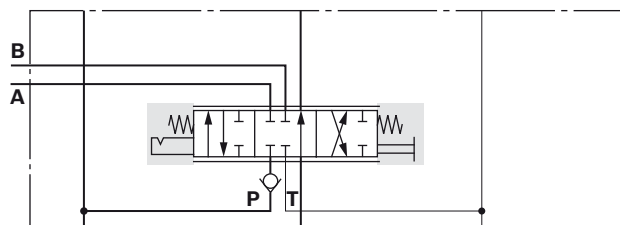
Ordering code:

P 004 E2Z1 A ...



Ordering code:

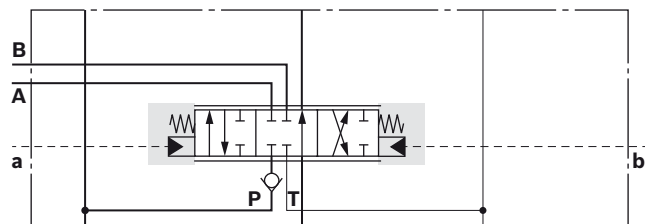
P 004 E2Z1 B ...



Hydraulic actuation

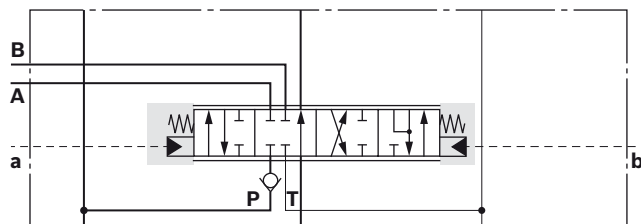
Ordering code:

... H200 ...



Ordering code:

... H400 ...

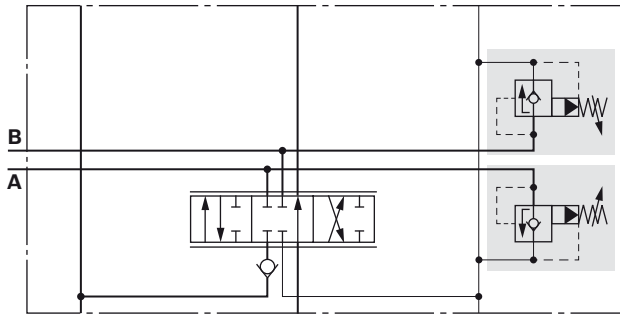


Secondary valves

Ordering code:

...	H...	H...
-----	------	------

- For valve **H...** the setting of the stated pressure values has been carried out at a flow of 5 l/min.



NOTE

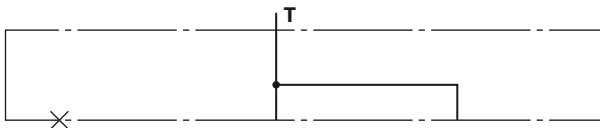
The pressure setting of these valves must not exceed the maximum permissible pressure of the control block.

End elements

With tank port T (medium and high pressure version)

Ordering code:

R



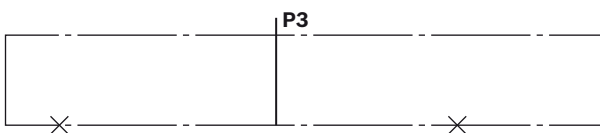
With pressure port P3 for downstream actuators

(only for medium pressure version)

Ordering code:

C

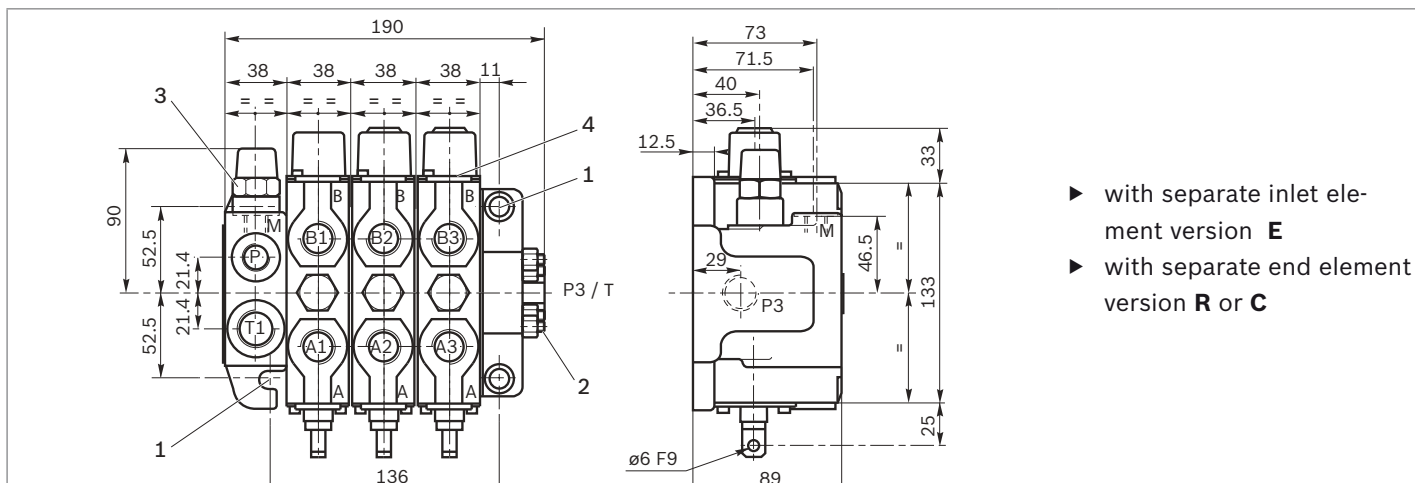
- Port **T1** is to be provided in the inlet element



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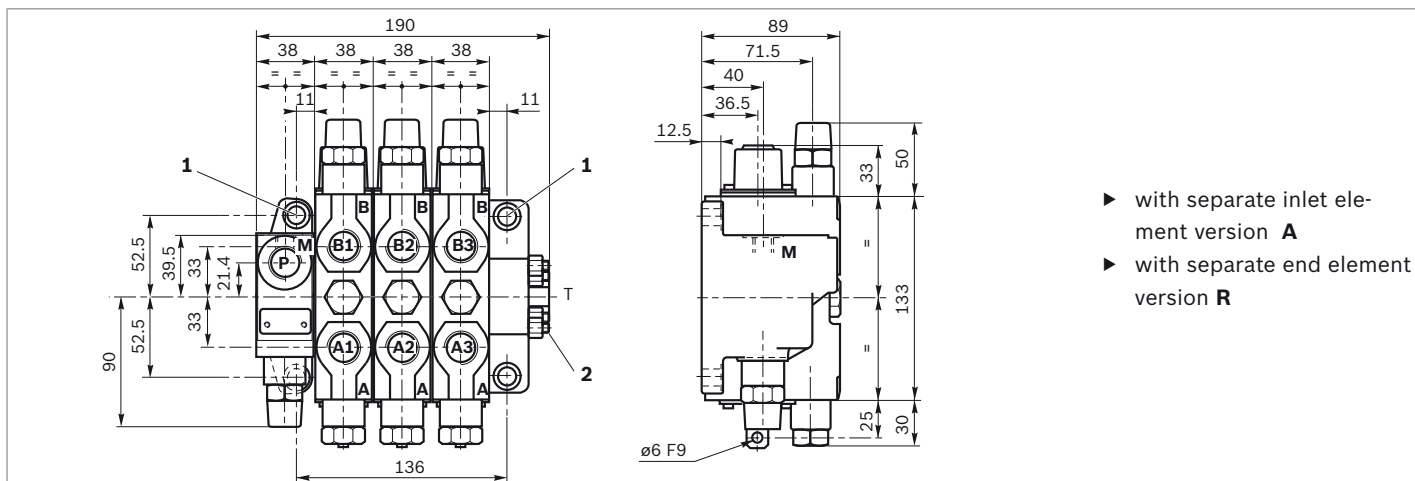
Dimensions

▼ SM12 control block, medium pressure version (ordering code L)



- ▶ with separate inlet element version **E**
- ▶ with separate end element version **R** or **C**

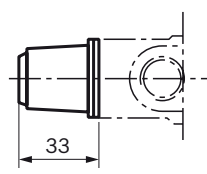
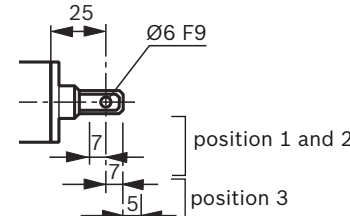
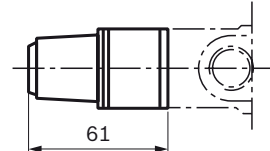
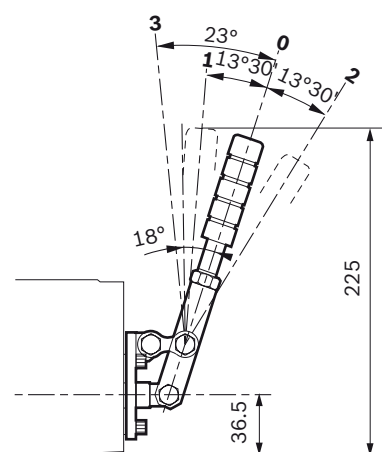
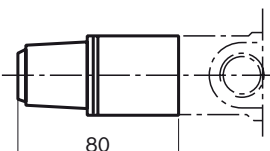
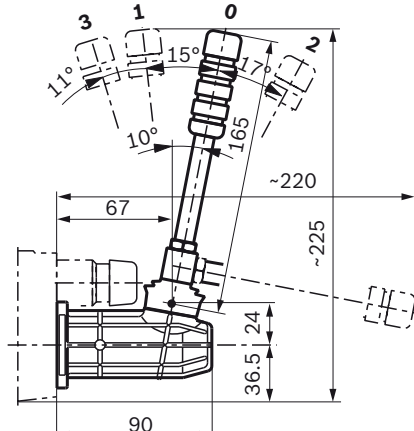
▼ SM12 control block, high pressure version (ordering code H)



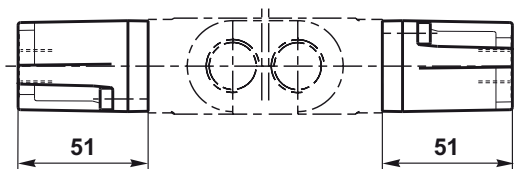
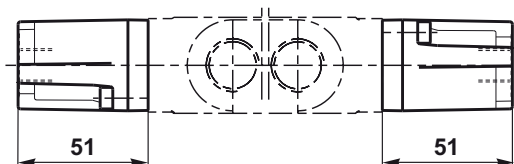
- ▶ with separate inlet element version **A**
- ▶ with separate end element version **R**

- | | | |
|--|---|---|
| <p>1 Control block fixing holes $\varnothing 11h13$</p> <p>2 4 tie rods (nut tightening torque = $18^{+1.8}$ Nm)</p> | <p>3 Primary pressure relief valve (tightening torque = 70^{+7} Nm)</p> <p>4 Plug screw Q (tightening torque = 70^{+7} Nm)</p> | <p>5 Secondary valve version A-B-H (tightening torque = 70^{+7} Nm)</p> <p>6 Anti-cavitation valve version E (tightening torque = 70^{+7} Nm)</p> |
|--|---|---|

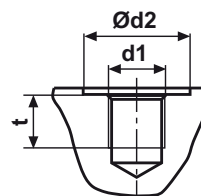
▼ Types of actuation

Spring return	Manual operation
<p>Ordering code A2</p> 	<p>Ordering code Z1</p> 
<p>Ordering code B2 / C2 / D2</p> 	<p>Ordering code M1 (not possible with secondary valves, with the lever pointing upwards)</p> 
<p>Ordering code E2</p> 	<p>Ordering code R5</p> 

▼ Types of actuation

Hydraulic actuation with spool return via a spring**Ordering code****H200****Hydraulic actuation with spool return via a spring for the 4th position spool****Ordering code****H400****Line connections**

Ports	01			41		
	d1	Ød2	t	d1	Ød2	t
A, B, P, P3	G 1/2	34	13	7/8-14 UNF-2B	35	13
T	G 3/4	42	20	1-1/16-12 UNF-2B	42	20
M, a, b	G 1/4	25	12.5	9/16-18 UNF-2B	26	13

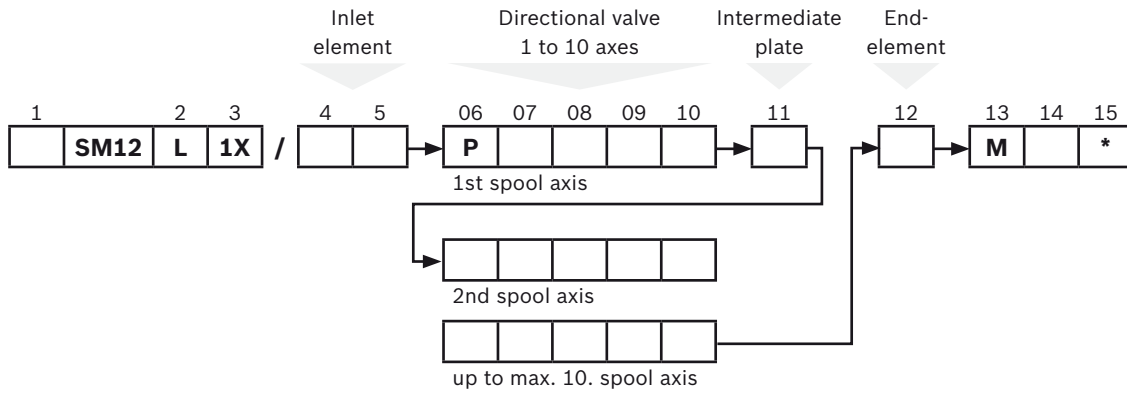
**Installation guidelines**

Ports	Tightening torque for the pipe connections [Nm]
P, P3, A, B	50
a, b	20
T, T1	70
M	20

- ▶ Recommended fixing: in 3 locations
- ▶ Mounting surface: Flatness = 0.5 mm
- ▶ Do not point the power washer at sensitive components, e.g. rubber components (bellow), electrical connections and operating elements.

SM12 control block for tractor auxiliary functions

Ordering code



01	No. of spool axes 1 to 10	
----	---------------------------	--

Design		
02	Medium pressure version	L

Series		
03	10 to 19 (unchanged installation and connection dimensions)	1X

Inlet element¹⁾		
04	With ports P and T1 with primary pressure relief valve (pressure details in bar, 3-digit)	EV...0
	With ports P and T1 without primary pressure relief valve (with plugged cavity)	E000
05	With adjustable priority flow divider (always without primary pressure relief valve)	C

Directional valve type		
06	Parallel directional valve	P
	Parallel directional valve with leak-free valve on connection side B (It is not possible to fit a secondary valve to side B)	D

Control spool											
07	<table border="0"> <tr> <th>Actuation on side A, conventional version</th> <th>Actuation on side B, „Kick-out“ version</th> <th>with check valve</th> </tr> <tr> <td></td> <td></td> <td>001</td> </tr> <tr> <td></td> <td></td> <td>004</td> </tr> </table>	Actuation on side A, conventional version	Actuation on side B, „Kick-out“ version	with check valve			001			004	
Actuation on side A, conventional version	Actuation on side B, „Kick-out“ version	with check valve									
		001									
		004									

¹⁾ The pressure gauge connection **M** is plugged with a metal plug.

Type of actuation

08	Spool return via a spring	A2 ..
	Spool return via a spring with detent in spool position 2	B2 ..
	Spool return via a spring with detent in spool position 1	C2 ..
	Spool return via a spring with detent in spool positions 1, 2	D2 ..
	Spool return via a spring with detent in spool position 3 (4th position)	E2 ..
	Spool return via a spring, with detent in switched positions 1, 2 internal hydraulic detent release with $p = 145 +15 -0$ bar (Kick-out)	KD2
	Spool return via a spring, with detent in switched positions 1, 2 internal hydraulic detent release with $p = 145 +15 -0$ bar (Kick-out) for 4 positions spool type 004	KE2
	Spool end with tongue ($\varnothing 8$)	.. Z3
	Spool end with fork	.. G1

Secondary valves

09	Pressure relief/anti-cavitation valve, pilot operated (pressure details in bar, 3-digit)	H...
10	Anti-cavitation valve	E
	Plug	Q
	Switch for change-over to single acting / double acting version	R
	Without secondary valve cavity Attention! Only in port B for a directional valve with leak-free valve	Z

Intermediate plate

11	Intermediate inlet element with tube ²⁾	U1
	With spacer	S

End element

12	End element with pressure port P3 for downstream actuators (port T1 is in the inlet element)	C
	End element with electro-hydraulic hitch control valves EHR12	EHR

Seal material

13	NBR seals	M
----	-----------	---

Line connections

14	Metric threads according to ISO 6149	06
15	Further details in clear text	*

Ordering example:

4 SM12 L 1X / EV000 P 001 KD2 Z1 B Q R
S
D 001 KD2 Z1 B H200 Z
S
P 004 KE2 Z1 B H200 Q
S
P 001 A2 Z1 B Q Q C M06

²⁾ Only possible between the 1st and 2nd directional valve

Inlet elements

With port P and T1

Ordering code:

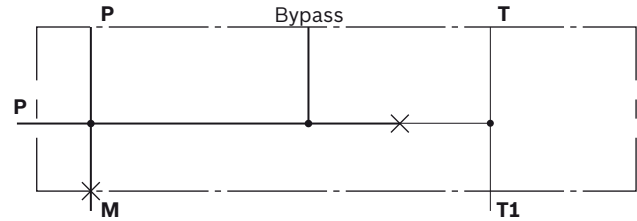
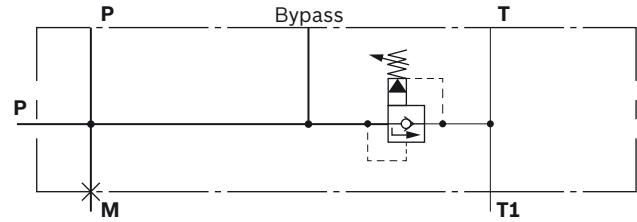
EV...0

- ▶ With primary pressure relief valve¹⁾
- ▶ Pressure details in bar after **V** required (3-digit)

Ordering code:

E000

- ▶ Without primary pressure relief valve

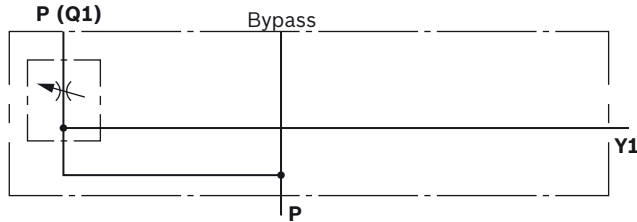


Inlet element with adjustable priority flow divider

Ordering code:

C

- ▶ Without primary pressure relief valve
- ▶ **Q1** = adjustable priority flow, 2 to 50 l/min
- ▶ **Y1** = residual flow (**Y1** can have pressure applied that can be up to the set value of the circuit pressure relief valve)
- ▶ Can be used as a single inlet element or combination with EV...



NOTE

The pressure gauge connection **M** is plugged with a metal plug.

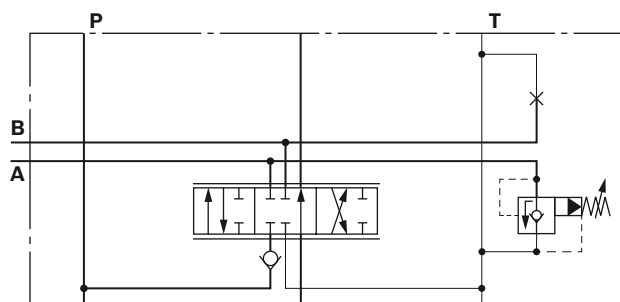
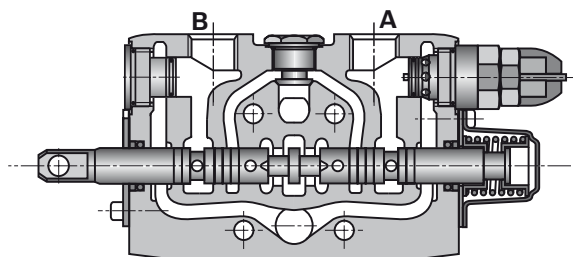
¹⁾ The primary pressure relief valve shown above is a pilot operated relief/anti-cavitation valve. The setting of the stated pressure value is carried out with a flow of 15 l/min. The pressure settings of the primary pressure relief valves must not exceed the permissible pressure of the block itself.

Directional valves

Parallel directional valve with check valve

Ordering code:

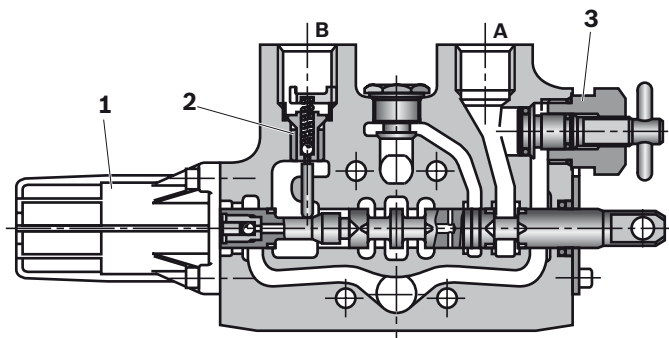
P	001		H	Q
---	-----	--	---	---



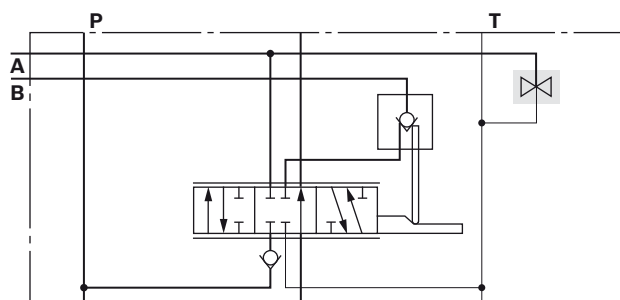
Parallel directional valve with leak-free valve on connection side B

Ordering code:

D	001		R	Z
---	-----	--	---	---



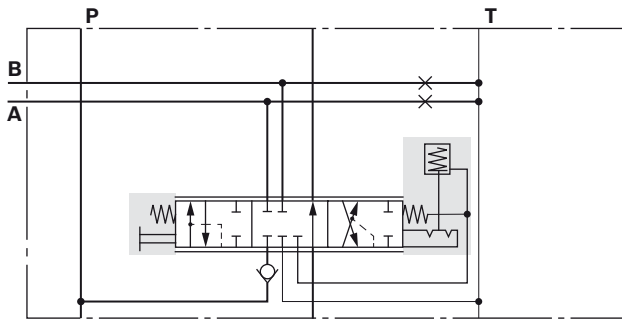
- 1 Cover for hydraulic detent release (Kick-out)
- 2 Leak-free valve
- 3 Change-over to single-acting / double acting version



Types of actuation

Ordering code:

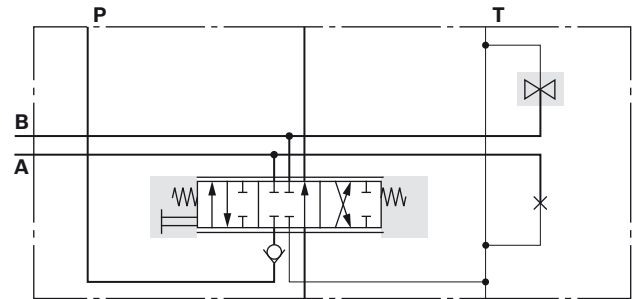
P	001	KD2Z1	A	Q	Q
---	-----	-------	---	---	---



Switch for change over to single acting / double acting cylinder with a double acting spool

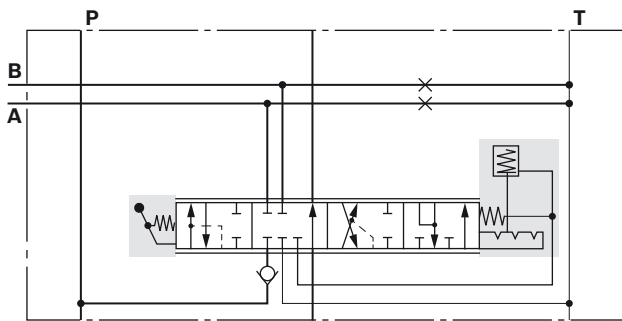
Ordering code:

P	001	A2Z1	A	Q	R
---	-----	------	---	---	---

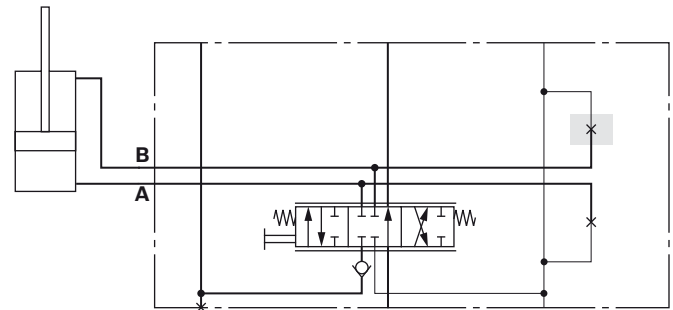


Ordering code:

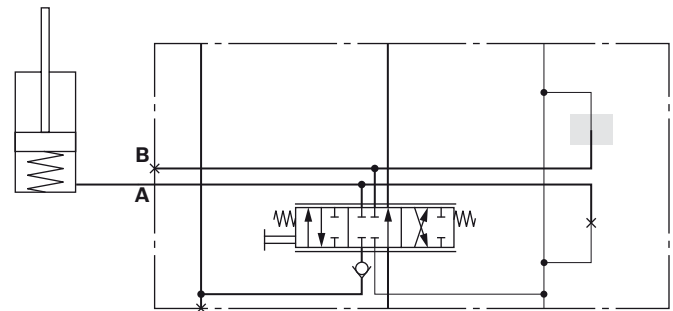
P	004	KE2R5	A	Q	Q
---	-----	-------	---	---	---



▼ Configuration with double acting cylinder, switch closed

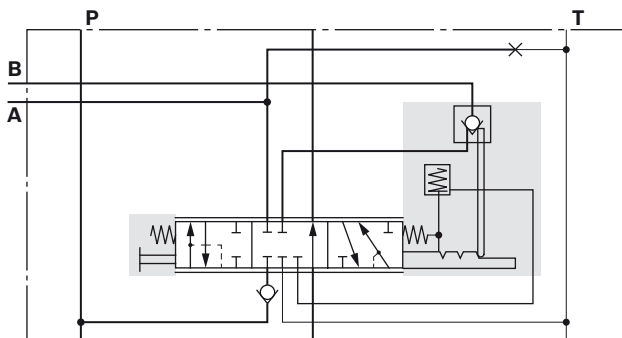


▼ Configuration with single acting cylinder, switch open



Ordering code:

D	001	KD2Z1	A	R	Z
---	-----	-------	---	---	---



NOTE

For the mounting possibilities of a secondary valve : see details on page 16.

Intermediate plate

Intermediate inlet element with tube

Ordering code:

U1

Spacer

Ordering code:

S

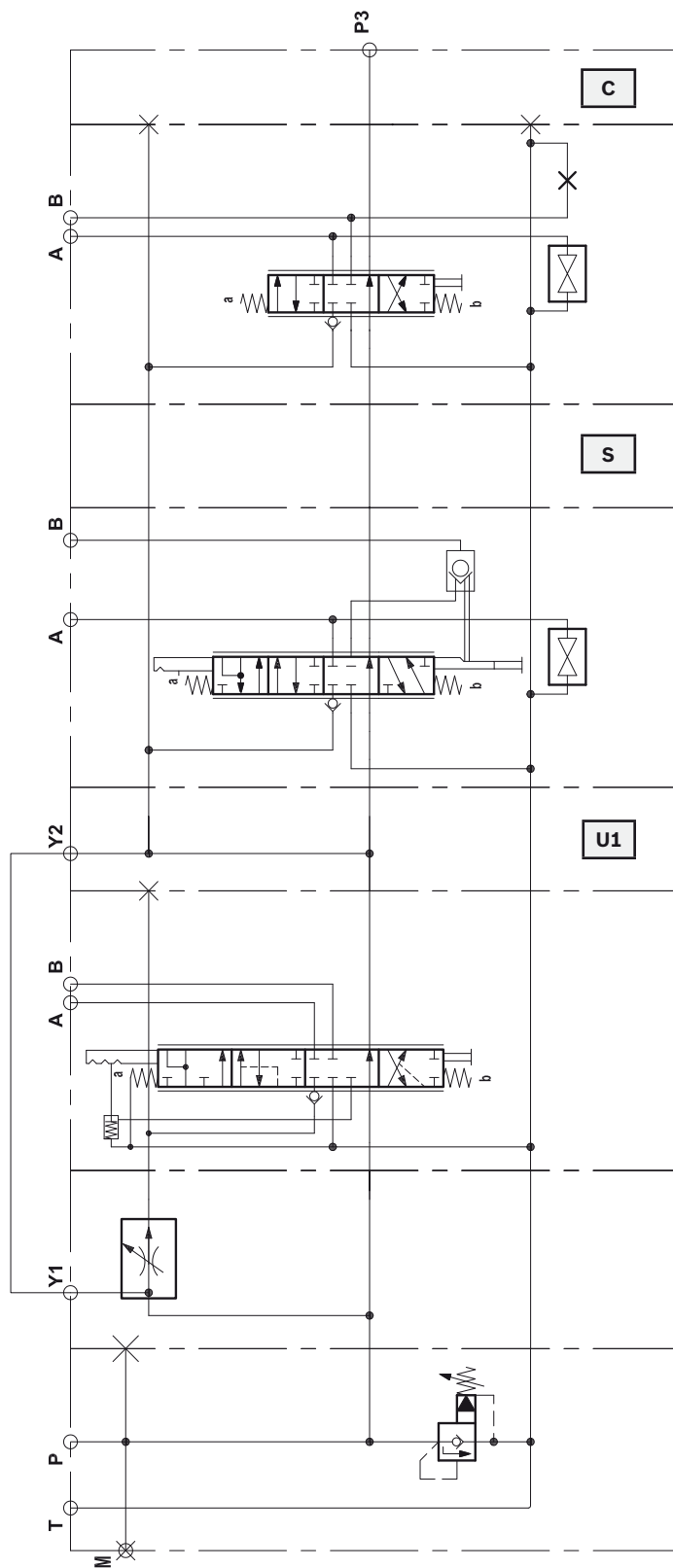
End elements

With pressure port P3 for downstream actuators

Ordering code:

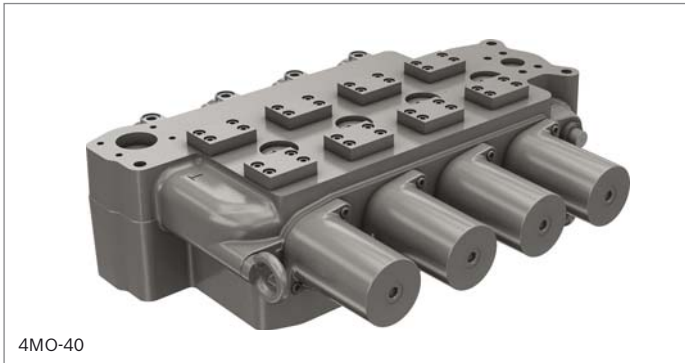
C

► Port **T1** is to be provided in the inlet element



Open center control block in monoblock design

MO-40



- ▶ Size 40
- ▶ Series 1X
- ▶ Maximum working pressure
 - on pump side 350 bar
 - on consumer side 420 bar
- ▶ Maximum flow 680 l/min

Features

- ▶ Valve control in accordance with the 6/3-way principle
- ▶ Large fine control range for flow control with progressive flow characteristic
- ▶ High pressure carry-over feature for downstream consumers when using **C** port (separation of by-pass line from tank line)
- ▶ Low internal leakage due to fitted main spool
- ▶ Main spool with automatic air bleed possible

Design

- ▶ Monoblock with 1, 3 or 4 consumer axes
- ▶ Type of actuation
 - Hydraulic
 - Electrohydraulic
- ▶ Pressure limitation
 - Primary pressure relief valve in the **P** supply line
 - Secondary pressure relief valves/anti-cavitation valves in stacking element design.

Fields of application

- ▶ Mining excavators
- ▶ Drilling rigs
- ▶ Cranes

Contents

Functional description	2
Technical data	5
Ordering code	6
Characteristic curves	8
Dimensions	9
Related documents	12

Functional description

High pressure mobile control blocks, type MO-40 are directional control valves in monoblock design. They provide fine control of the speed and flow direction. The valves are optionally operated hydraulically or electrohydraulically. The control blocks of type MO-40 consist mainly of the housing (1), the main spool (2), load holding valve (3), the operating element (4), the return springs (5), mounted feed valves (6) (optional) and mounted secondary pressure relief valves (7) (optional).

The 6/3-way valves combine the function of a 4/3-way valve and a 2/2-way valve. In non-actuated state, the main spool (2) is kept in the initial position by the return springs (5). In this position, the connection from the pump to the consumer is closed, the 2/2-way part is open and allows fluid to flow without pressure from P to T (free circulation). If the main spool (2) is moved out of its initial position, the connection from the pump to the consumer is opened via metering notches. The pump pressure increases. When the pressure at the consumer port is reached, the load holding valve (3) opens and the hydraulic fluid begins to flow to the consumer. As the main spool (2) continues its movement, the opening to the tank takes place via metering notches for the hydraulic fluid coming from the consumer and the flow is gradually fed from the 2/2-way line to the consumer channel (fine control).

On the 3-spool control block, the load holding valves (3) are always integrated in the main spool. With the 1-spool and 4-spool version, the load holding valves (3) are located in the housing (1).

Spool stroke

The spool stroke is divided into approx. 30 % control land overlap and 50 % fine control range, while the remaining stroke serves to create the full opening. The overlap and a low spool tolerance serve to reduce internal leakage. Due to the large fine control range, the consumers can be sensitively controlled.

Control characteristics, operating forces

Uniform quality of the control characteristics and low operating forces are achieved through optimum design of the metering edges in the housing, favorable shape of the metering notches and fitting of the main spool with constant clearance.

Pressure setting of the primary and secondary valves

The specified pressure values are set as follows:

- ▶ direct operated pressure valves at a flow of 2 to 3 l/min
- ▶ pilot operated pressure valves at a flow of 10 l/min.

Circuit types

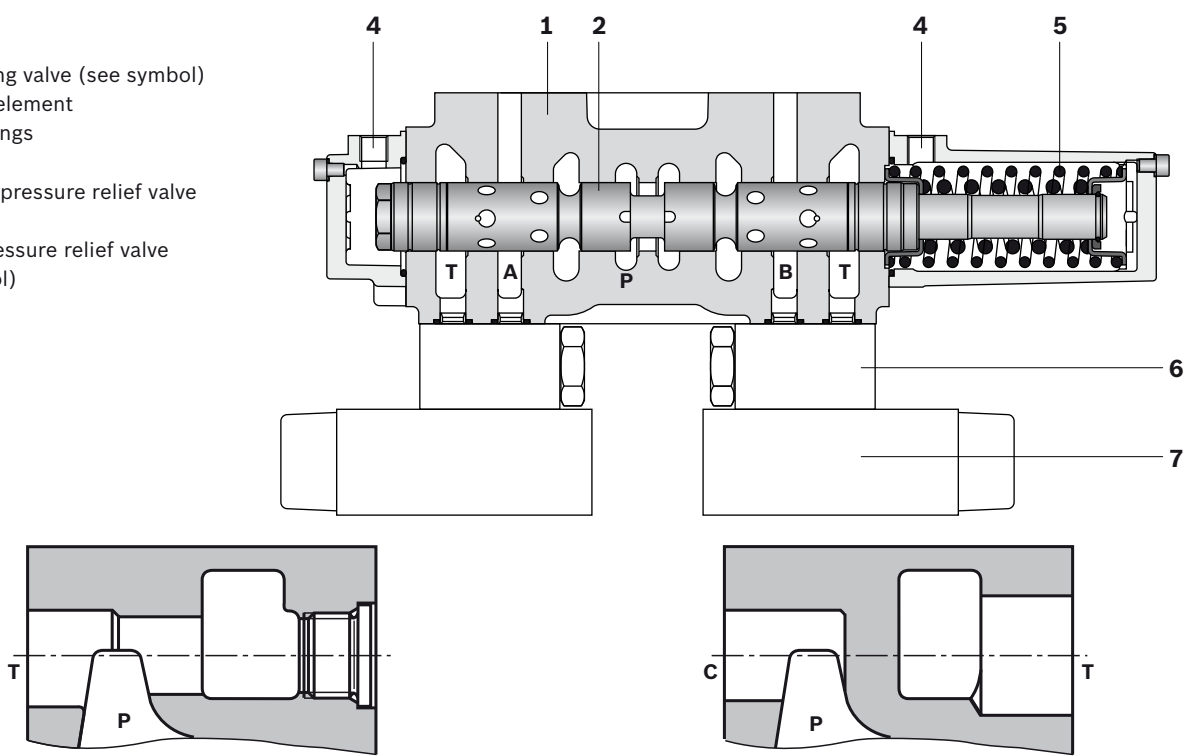
Number of spool axes	Size	Possible circuit type	Ordering code
1	MO-40	1	T
3		1 - - 2 - - 3	T
4		1 //2//3//4	P
4		1 - - 2//3 - - 4	L
4		1//2//3 - - 4	M

// = parallel circuit

- - = tandem circuit

▼ Cross section (example)

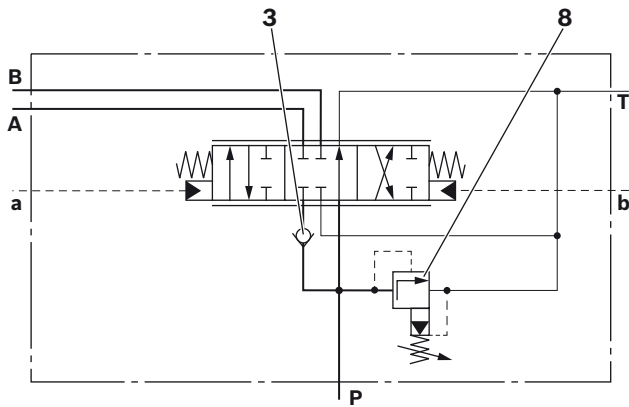
- 1 Housing
- 2 Main spool
- 3 Load holding valve (see symbol)
- 4 Operating element
- 5 Return springs
- 6 Feed valve
- 7 Secondary pressure relief valve (optional)
- 8 Primary pressure relief valve (see symbol)



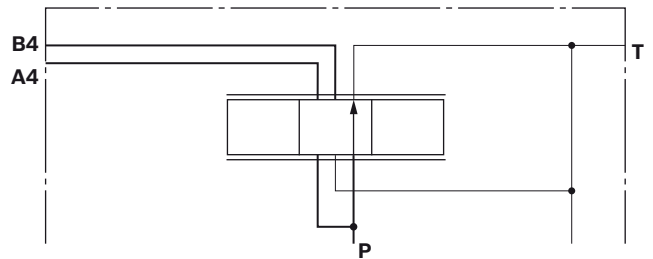
Version R (standard)
Port T consumer side
(only when **no** port C is required).

Version C
By-pass channel is separated from the tank line.

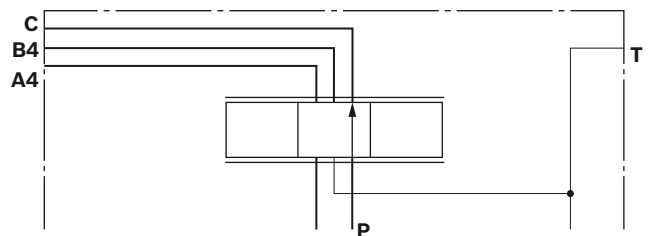
▼ Symbol example for a 1-spool block, hydraulic actuation



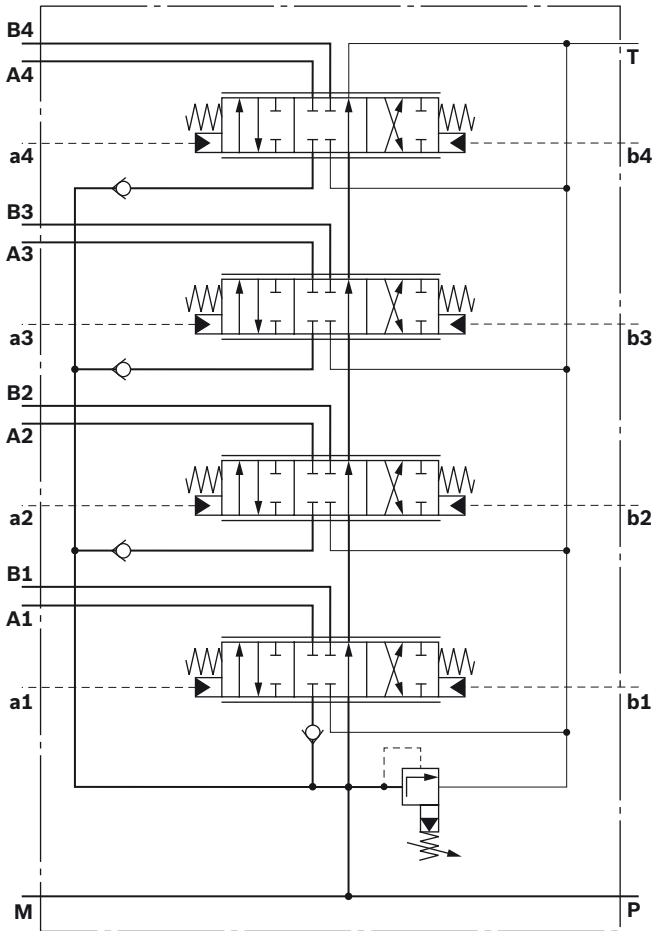
▼ With version R, the circulation and return go into a tank



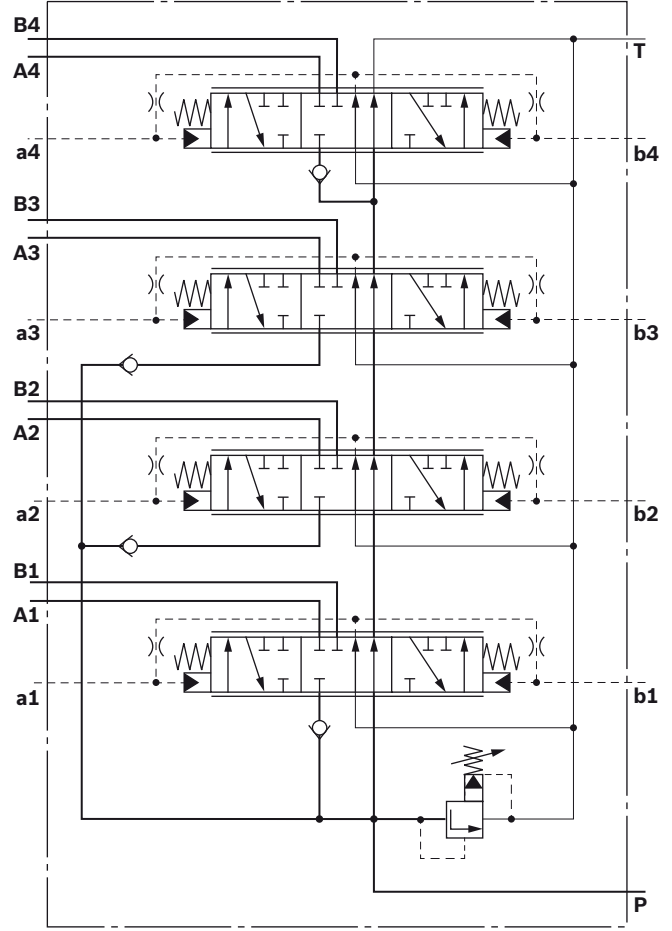
▼ With version C, the tank line is separated from the by-pass channel



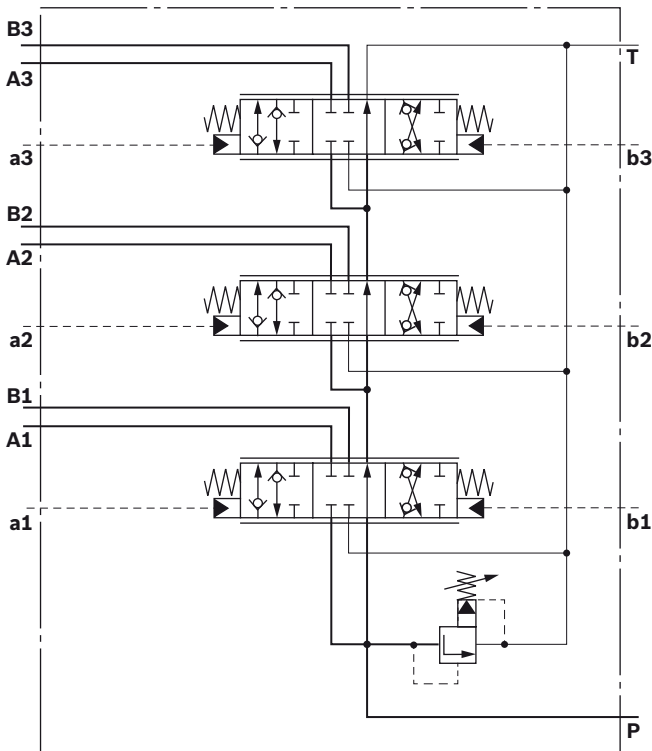
▼ Symbol 4MO-40 in parallel circuit (1//2//3//4)



▼ Symbol 4MO-40 in mixed circuit (1//2//3//4)

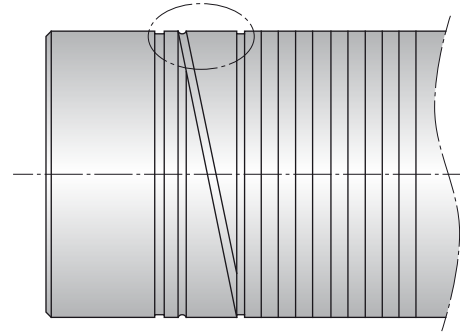


▼ Symbol 3MO-40 in tandem circuit (1 -- 2 -- 3)



On versions with a tandem circuit, the pump channel is blocked to the next pool axis if the free circulation is closed when an upstream main pool is actuated.

▼ Main spool with flushing grooves (on request)



Technical data

General				
Weight with secondary valves	Electrohydraulically operated	kg	approx. 487 (4-spool control block)	
Installation position	Any			
Line connections	SAE flange port according to ISO 6162			
Ambient temperature range		°C	-20 to +80	
Priming	One-coat paint RAL 5010			
Hydraulic				
Maximum working pressure at port	P, C, X	p	bar	350
	A, B	p	bar	420
	T	p	bar	30
	L	p	bar	0
Maximum pilot pressure at port	Pst	p	bar	30 (higher pressures on request)
	a, b	p	bar	30 (higher pressures on request)
Maximum flow		l/min	680	
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request			
Hydraulic fluid temperature range		°C	-20 to +80	
Viscosity range		ν	mm ² /s	10 to 380
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)	Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$			
Recommended hydraulic pilot controls	2TH6	see data sheet 64552	} Control curve no. 06	
	4TH5/6	see data sheet 64555		
	TH7	see data sheet 64558		

Note

- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data was determined with a viscosity range of $\nu = 41 \text{ mm}^2/\text{s}$ and a temperature of $\theta = 50 \text{ °C}$.

Ordering code

Short type				Spool axis						Additional information							
01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
	MO	-	40	-	1X	/											*
										1st spool axis							
										2nd spool axis							
										3rd spool axis							
										4th spool axis							

Short type

01	Number of spool axes 1, 3 or 4	
02	Series control block MO	MO
03	Size 40	40
04	Series 10 to 19 (unchanged installation and connection dimensions)	1X

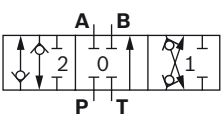
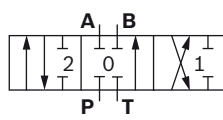
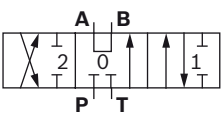
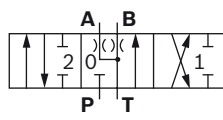
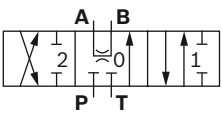
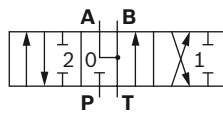
Primary pressure limitation ¹⁾

05	Without	Q 000-000
	Pressure relief valve, pilot operated (MHDBV, see data sheet 64642)	V ...-000
	Pressure/anti-cavitation valve with pressure sequencing stage (MHDBH, see data sheet 64642)	B ...-...
	Pressure/anti-cavitation valve with pressure cut-off stage (MHDBM, see data sheet 64642)	L ...-...

Circuit type

06	Number of spool axes	Possible circuit type	
	1	1 Tandem circuit	T
	3	1 -- 2 -- 3 Tandem circuit	T
	4	1 //2//3//4 Parallel circuit	P
	4	1 -- 2//3 -- 4 Mixed circuit	L
	4	1//2//3 -- 4 Parallel circuit, final axis in tandem circuit	M
// = parallel circuit -- = tandem circuit			

Spool type

07		001		005
		002		006
		003		009

¹⁾ Pressure information for pressure limitation and pressure sequencing/cut-off stage in bar, 3-digit

Type of actuation

08	Hydraulic	H
	Electrohydraulic proportional	W2
	Electrohydraulic switchable	W4

Secondary valves for A- and B-side¹⁾

09	Without	Z
10	Pressure relief valve, pilot operated size 22	C...
	Pressure relief valve, pilot operated size 22 + anti-cavitation valve size 22	F...
	Pressure relief valve, direct operated size 22	R...
	Pressure relief valve, direct operated size 22 + anti-cavitation valve size 22	T...
	Feed valve size 22	S
	Cover plate for secondary valve mounting face size 22	U

Tank port

11	With tank port T	R
	With tank port T and pressure carry over port C for downstream consumers (not possible for tank port on consumer side, ordering code V)	C

Line connections

12	SAE flange port according to ISO 6162	11
----	---------------------------------------	-----------

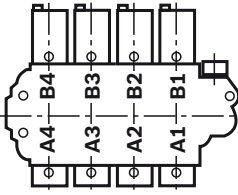
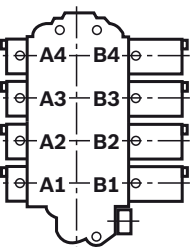
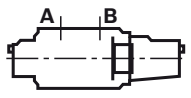
Pump port position

13	Pump port P on secondary valve side	S
	Pump port P on consumer port side	V

Tank port position

14	Tank port T on secondary valve side	S
	Tank port T on consumer port side (not possible with version C)	V

Installation position (standard)

15	Designation of installation position from horizontal. This determines the position of the air bleed.		1
			2
			3

Sealing material

16	FKM (fluoroelastomer)	V
	NBR (nitrile-rubber)	M

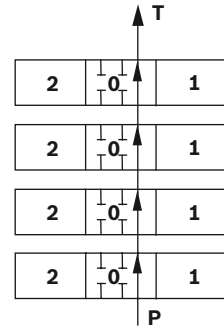
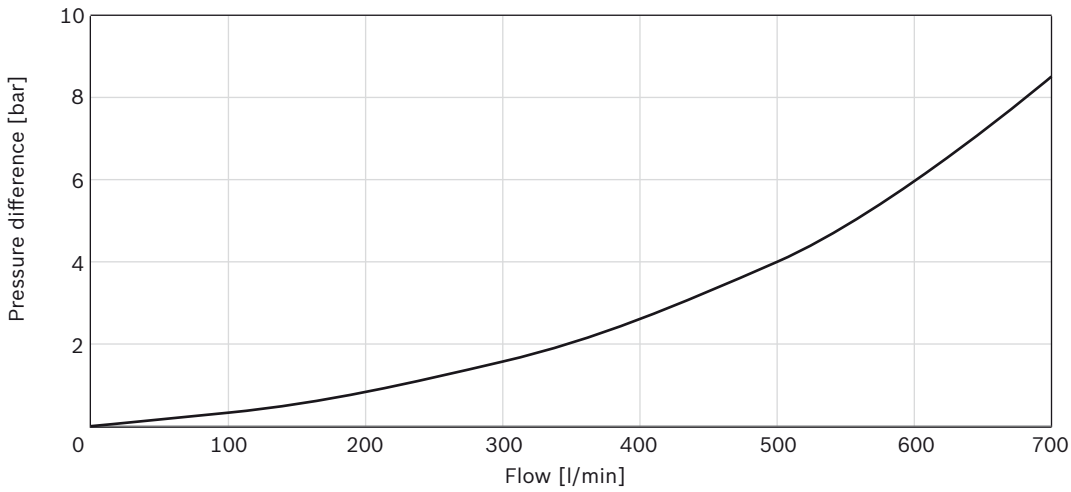
Optional

17	Flushing grooves in the main spool	S
18	Further specifications in plain text	*

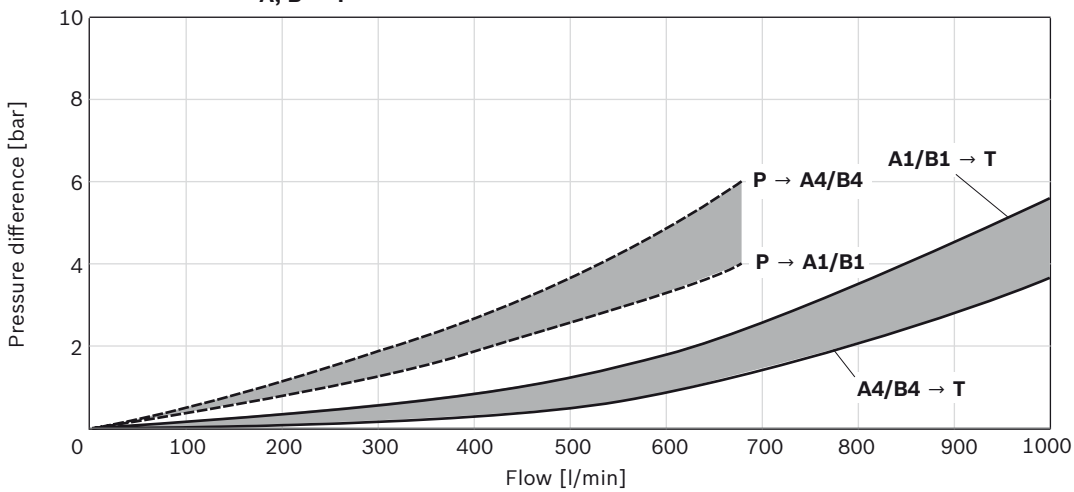
²⁾ If two valves R or T are mounted per consumer port, the code letters + pressure setting are listed twice in the ordering code. Pressure information in bar, 3-digit

Characteristic curves

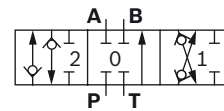
- ▼ $\Delta p - q_v$ - Flow characteristic curve
P → T in mid position, free by-pass)



- ▼ $\Delta p - q_v$ - Flow characteristic curves
 - - - - - P → A, B
 ———— A, B → T



- ▼ Symbol 001



Note

Characteristic curves measured at $\nu = 41 \text{ mm}^2/\text{s}$ and $\theta = 50 \text{ }^\circ\text{C}$.

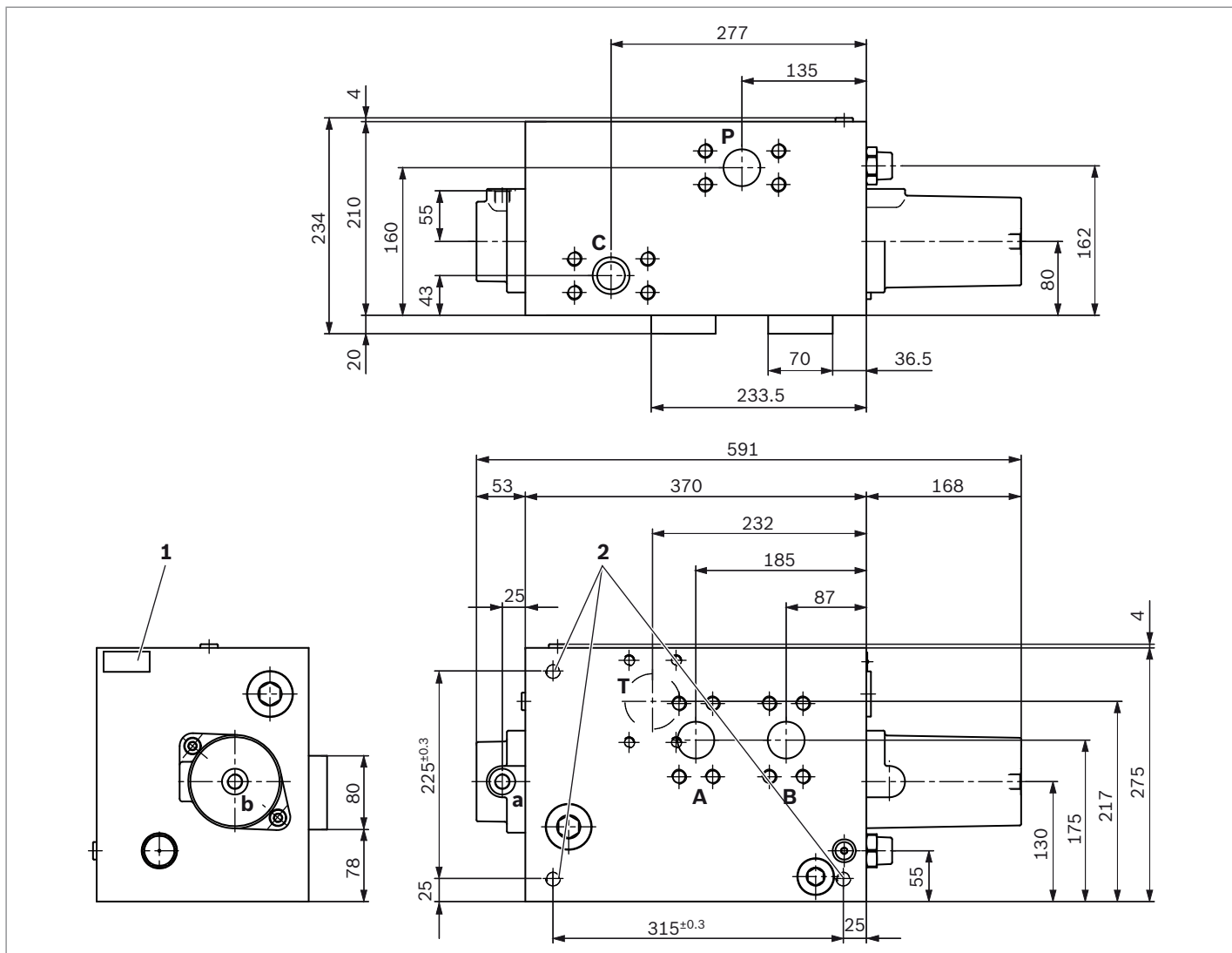
Dimensions

Line connections

SAE flange ports according to ISO 6162

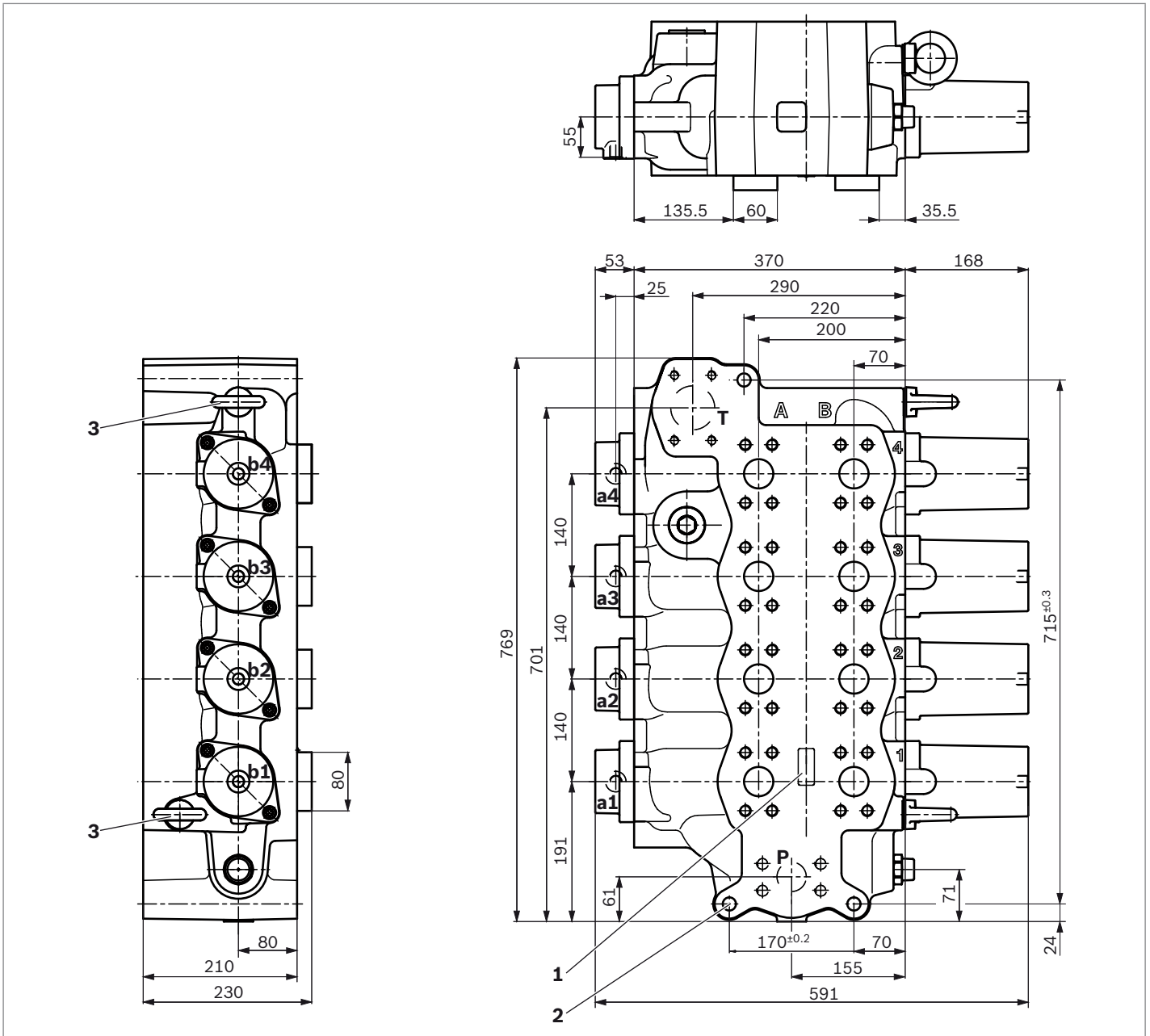
Ports		
P	Pump	DN 38 (SAE 1 1/2 in 6000 PSI)
T	Tank	DN 64 (SAE 2 1/2 in 3000 PSI)
A, B	Consumer	DN 38 (SAE 1 1/2 in 6000 PSI)
a, b	Pilot oil	G 3/8
C	Pump pressure transfer	DN 38 (SAE 1 1/2 in 6000 PSI)

▼ 1MO-40



- 1 Name plate
- 2 Three fastening threads M16, 25 deep

▼ 4MO-40



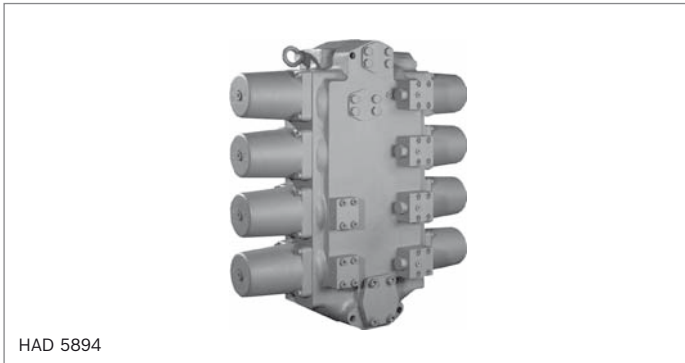
- 1 Name plate
- 2 Three fastening holes Ø 18
- 3 Attachment point

Related documents

The MO-40 control blocks are system components. Observe the instructions for the other system components. Only commission the product if the following documentation is available to you and you have understood and observed it.

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Instruction manual
System documentation from the machine manufacturer		Instruction manual

Open center control block in monoblock design MO-52



- ▶ Size 52
- ▶ Series 1X
- ▶ Maximum working pressure
 - on pump side 350 bar
 - on consumer side 420 bar
- ▶ Maximum flow 1600 l/min

Features

- ▶ Valve control in accordance with the 6/3-way principle
- ▶ Large fine control range for flow control with progressive flow characteristic
- ▶ High pressure carry-over feature for downstream consumers when using C port (separation of by-pass line from tank line)
- ▶ Low internal leakage due to fitted main spool
- ▶ Main spool with automatic air bleed possible

Design

- ▶ Monoblock with 1, 3 or 4 consumer axes
- ▶ Type of actuation
 - Hydraulic
 - Electrohydraulic
- ▶ Pressure limitation
 - Primary pressure relief valve in the P supply line
 - Secondary pressure relief valves/feed valves in stacking element design.

Fields of application

- ▶ Mining excavators

Contents

Functional description	2
Technical Data	5
Ordering Code	6
Dimensions	8
Related documents	11

Functional description

High pressure mobile control blocks, type MO-52 are directional control valves in monoblock design. They provide fine control of the speed and volume flow direction. The valves are optionally operated hydraulically or electrohydraulically. The control blocks of type MO-52 consist mainly of the housing (1), the main spool (2), load holding valve (3), the operating element (4), the return springs (5), mounted feed valves (6) (optional) and mounted secondary pressure relief valves (7) (optional).

The 6/3-way valves combine the function of a 4/3-way valve and a 2/2-way valve. In non-actuated state, the main spool (2) is kept in the initial position by the return springs (5). In this position, the connection from the pump to the consumer is closed, the 2/2-way part is open and allows fluid to flow without pressure from **P** to **T** (free circulation).

If the main spool (2) is moved out of its initial position, the connection from the pump to the consumer is opened via metering notches. The pump pressure increases. When the pressure at the consumer port is reached, the load holding valve (3) opens and the hydraulic fluid begins to flow to the consumer. As the main spool (2) continues its movement, the opening to the tank takes place via metering notches for the hydraulic fluid coming from the consumer and the flow is gradually fed from the 2/2-way line to the consumer channel (fine control).

On the 1 and 4-spool control block, the load holding valves (3) are always integrated in the main spool. With the 3-spool version, the load holding valves (3) are located in the housing (1).

Brake spool

Use in hydrostatic travel drive of tracked vehicles as fully automatic control break in both directions of travel. Friction-locked, cavitation-free downhill driving is achieved by controlling the outlet cross section depending on the supply pressure (only possible for 3-spool control blocks).

Spool stroke

The spool stroke is divided into approx. 30% control land overlap and 50% fine control range, while the remaining stroke serves to create the full opening.

The overlap and a low spool tolerance serve to reduce internal leakage. Due to the large fine control range, the consumers can be sensitively controlled.

Control characteristics, operating forces

Uniform quality of the control characteristics and low operating forces are achieved through optimum design of the metering edges in the housing, favorable shape of the metering notches and fitting of the main spool with constant clearance.

Pressure setting of the primary and secondary valves

The specified pressure values are set as follows:

- ▶ direct operated pressure valves at a flow of 2 to 3 l/min
- ▶ pilot operated pressure valves at a flow of 10 l/min.

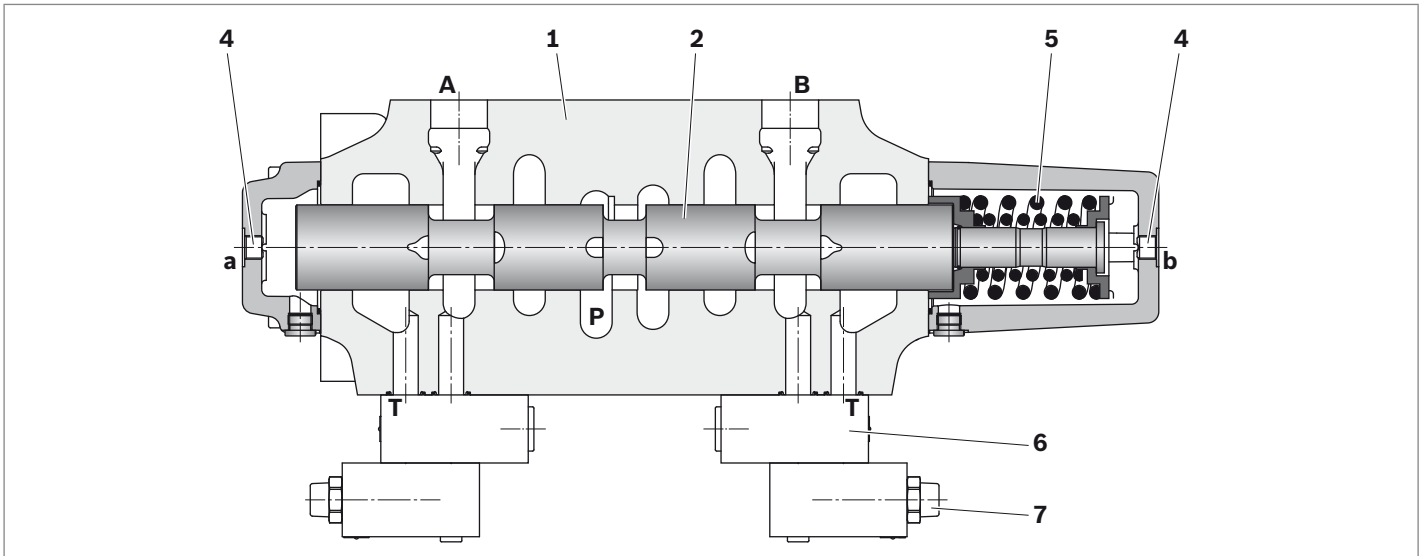
Circuit types

Number of spool axes	Size	Possible circuit type	Ordering code
1	MO-52	1	T
3		1 -- 2 -- 3	T
3		1 -- 2//3	L
4		1 -- 2 -- 3 -- 4	T

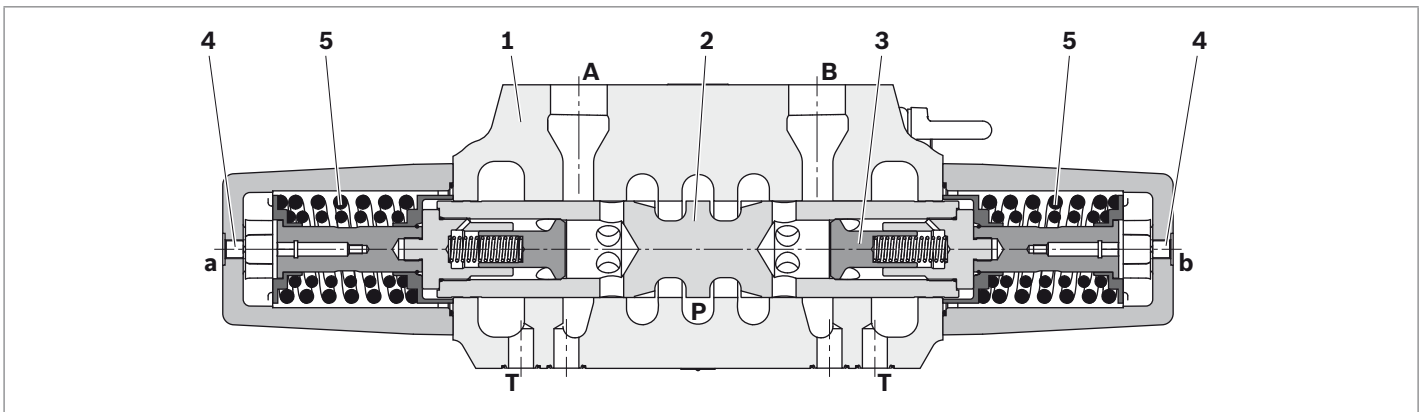
// = parallel circuit

-- = tandem circuit

▼ Sectional view (example 3MO-52)

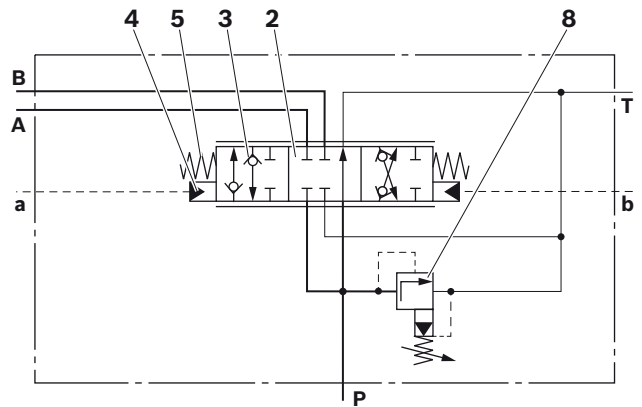


▼ Sectional view (example 4MO-52)



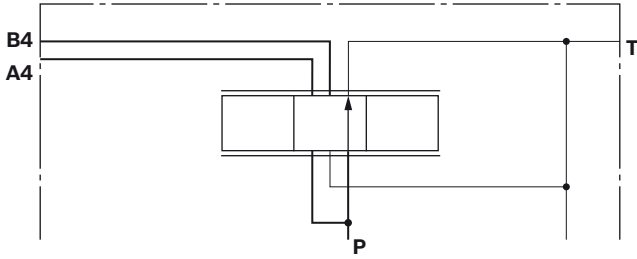
- 1 Housing
- 2 Main spool
- 3 Load holding valve
- 4 Actuation element
- 5 Return springs
- 6 Feed valve
- 7 Secondary pressure relief valve (optional)
- 8 Primary pressure relief valve (see symbol)

▼ Symbol (example 1MO-52, hydraulically operated)

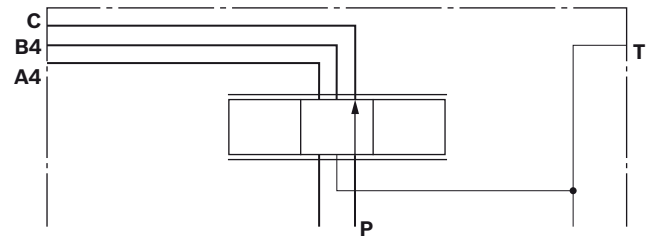


Ports	
P	Pump
T	Tank
A, B	Consumer
a, b	Pilot oil
C	Pump pressure transfer

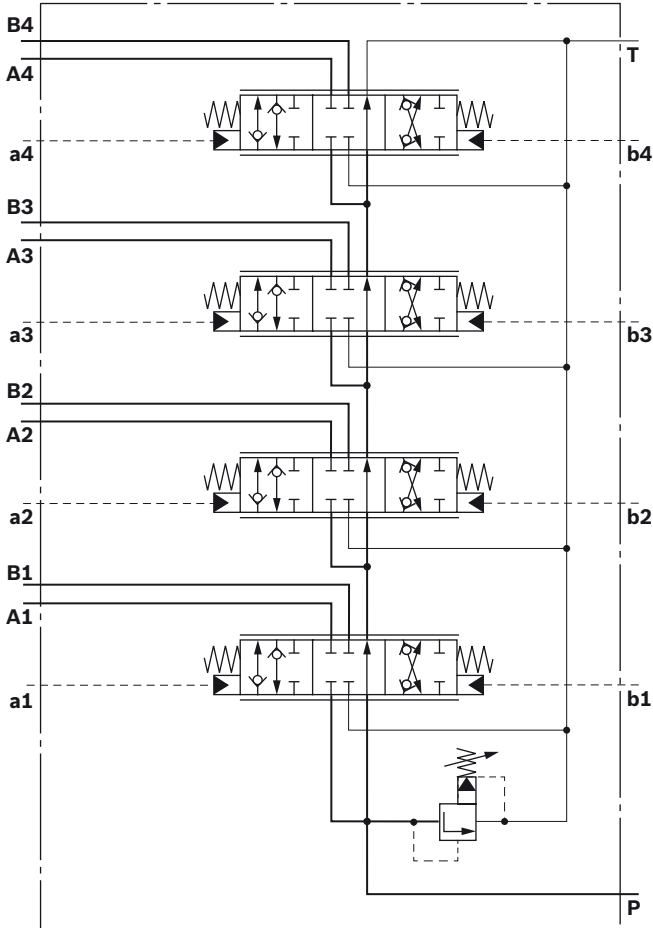
▼ With version R, the circulation and return go into a tank



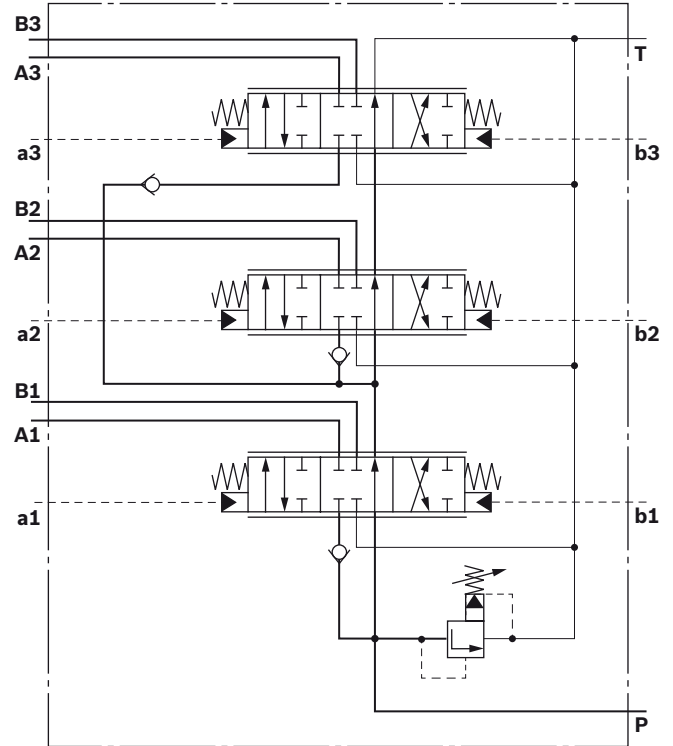
▼ With version C, the tank line is separated from the by-pass channel



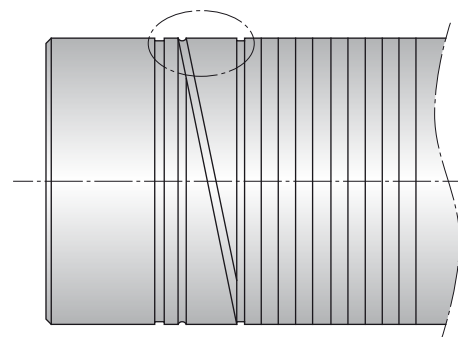
▼ Symbol 4MO-52 in tandem circuit (1 -- 2 -- 3 -- 4)



▼ Symbol 3MO-52 in mixed circuit (1 -- 2//3)



▼ Main spool with flushing grooves (on request)



On versions with a tandem circuit, the pump channel is blocked to the next spool axis if the free circulation is closed when an upstream main spool is actuated.

Technical Data

General					
Maximum weight (approx.) without secondary valves	Number of consumer axes		1	3	4
	Hydraulically operated	kg	260	839	720
Installation position	No restrictions, for preference see ordering code				
Line connections	SAE flange connection according to ISO 6162				
Ambient temperature range	θ	°C	-20 to +80		
Priming	One-coat paint RAL 5010				
Hydraulic					
Maximum working pressure at port	P, C, X	p	bar	350	
	A, B	p	bar	420	
	T	p	bar	30	
	L	p	bar	0	
Maximum pilot pressure at port	Pst	p	bar	30 (higher pressures on request)	
	a, b	p	bar	30 (higher pressures on request)	
Maximum flow		q_v	l/min	1600	
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to ISO 15380 and hydraulic fluids as specified in data sheet 90221, on request				
Hydraulic fluid temperature range		θ	°C	-20 to +80	
Viscosity range		ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)	Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$				
Recommended hydraulic pilot controls	2TH6		see data sheet 64552	} Control curve no. 06	
	4TH5/6		see data sheet 64555		
	TH7		see data sheet 64558		

Note

- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data was determined with a viscosity range of $\nu = 41 \text{ mm}^2/\text{s}$ and a temperature of $\theta = 50 \text{ °C}$.

Ordering Code

Short type				Spool axis						Additional information							
01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18
	MO	-	52	-	1X	/											*
										1 st Spool axis							
										2 nd Spool axis							
										3 rd Spool axis							
										4 th Spool axis							

Short type

01	Number of spool axes 1, 3 or 4	
02	Series control block MO	MO
03	Size 52	52
04	Series 10 to 19 (unchanged installation and connection dimensions)	1X

Primary pressure limitation ¹⁾

05	Without	Q 000-000
	Pressure relief valve, pilot operated (MHDBV, see data sheet 64642)	V ...-000
	Pressure relief/feed valve with pressure sequencing stage (MHDBH, see data sheet 64642)	B ...-...
	Pressure relief/feed valve with pressure cut-off stage (MHDBM, see data sheet 64642)	L ...-...

Circuit type

06	Number of spool axes	Possible circuit type	
	1	1 Tandem circuit	T
	3	1 -- 2 -- 3 Tandem circuit	T
	3	1 -- 2//3 Mixed circuit	L
	4	1 -- 2 -- 3 -- 4 Tandem circuit	T
// = parallel circuit -- = tandem circuit			

Spool type²⁾

07		001		005
		006		009

Type of actuation

08	Hydraulic	H
	Electrohydraulically proportional	W2
	Electrohydraulically switchable	W4

1) Pressure information for pressure limitation and pressure sequencing/ cut-off stage in bar, 3-digit

2) Further spool types on request

Secondary valves for A- and B-side

09	Without	Z
10	Pressure relief / replenishment valve, pilot operated (specified pressure in bar, 3-digit)	H...
	Feed valve	S

Tank port

11	With tank port T	R
	With tank port T and pressure carry over port C for downstream consumers (not possible for tank port on consumer side, ordering code V)	C
	With tank port T and pressure carry over port C for downstream consumers (port C connected by threaded plug)	K

Line connections

12	Flange port according to ISO 6162	11
----	-----------------------------------	----

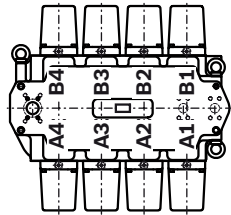
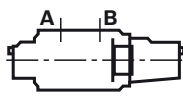
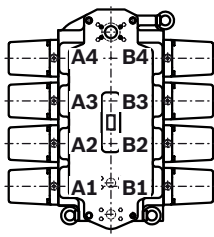
Pump port position¹⁾

13	Pump port P on secondary valve side	S
	Pump port P on consumer port side	V

Tank port position¹⁾

14	Tank port T on secondary valve side	S
	Tank port T on consumer port side (not possible with version C)	V

Installation position (standard)

15	Designation of mounting position from horizontal. This parameter fixes the position of the air bleed.		1
			3
			2

Sealing material

16	NBR (nitrile rubber)	M
----	----------------------	---

Optional

17	Flushing grooves in the main spool	S
18	Further specifications in plain text	*

¹⁾ Only one version is available if required. Design takes place during the quote.

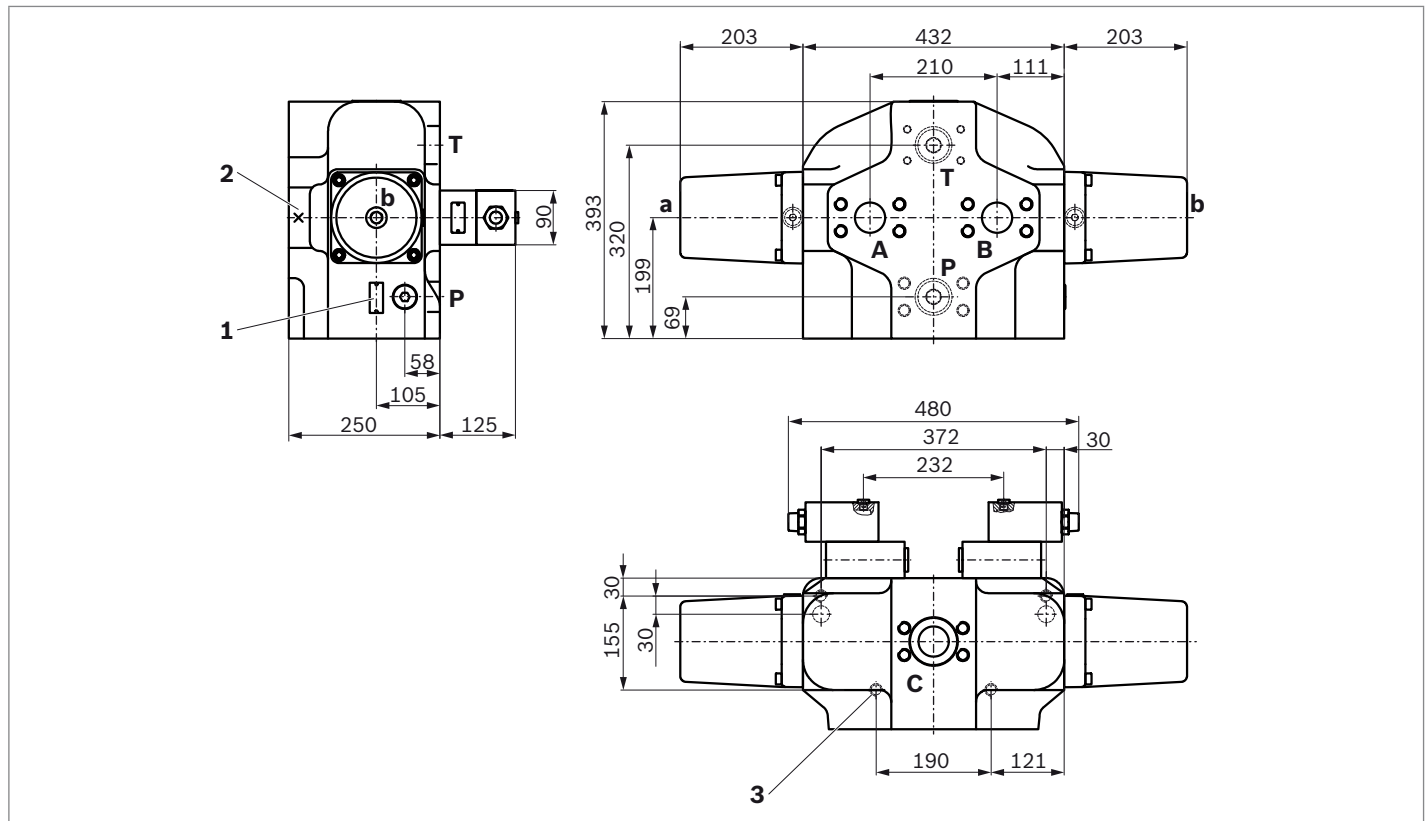
Dimensions

Line connections

Flange ports according to ISO 6162

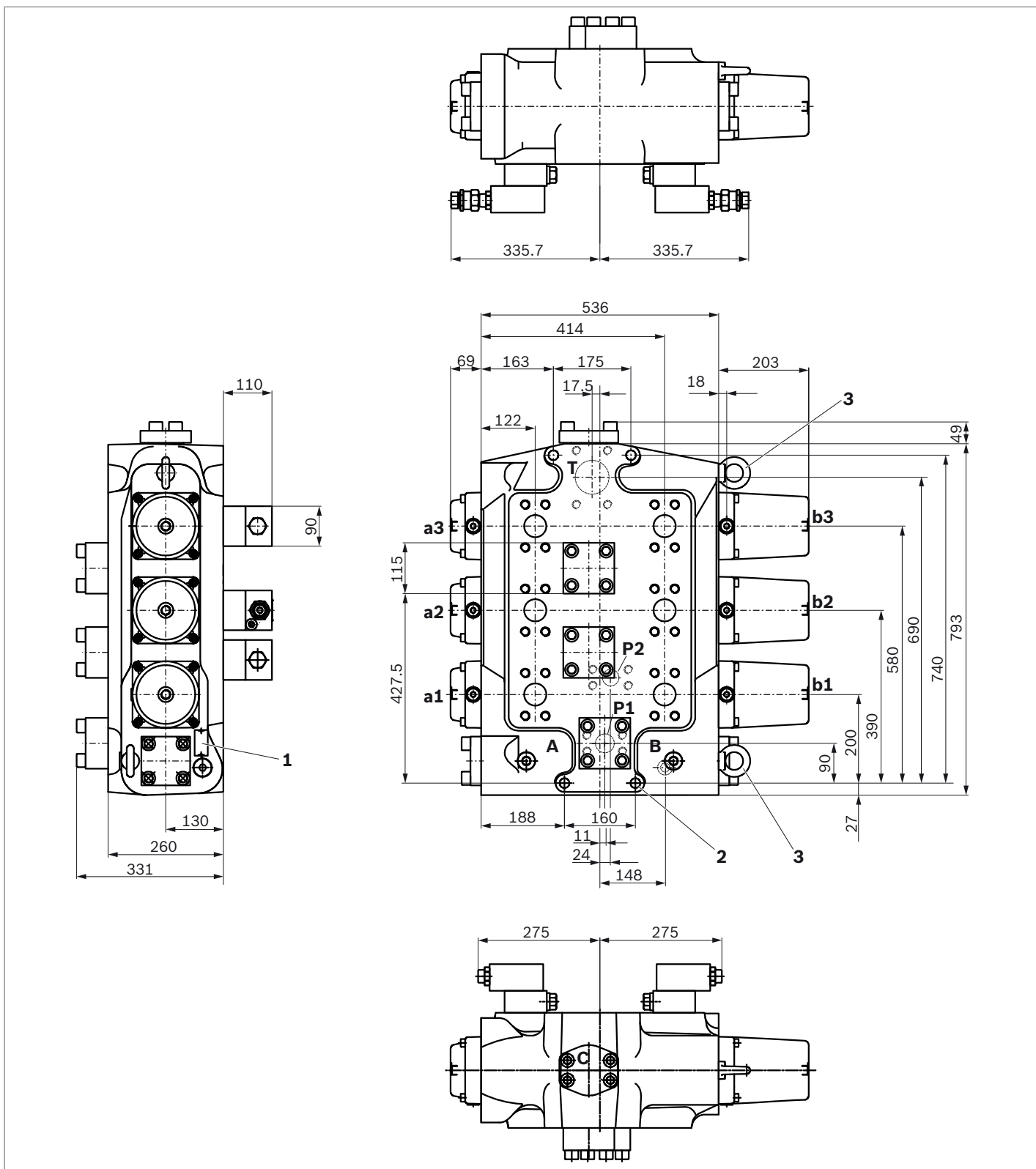
Ports		1MO-52		3MO-52		4MO-52	
P1, P2	Pump	SAE 2 in	6000 PSI	SAE 1 1/2 in	6000 PSI	SAE 1 1/2 in	6000 PSI
T	Tank	SAE 2 1/2 in	3000 PSI	SAE 3 1/2 in	3000 PSI	SAE 3 in	3000 PSI
T'	Tank	-	-	-	-	SAE 2 in	3000 PSI
A, B	Consumer	SAE 2 in	6000 PSI	SAE 2 in	6000 PSI	SAE 2 in	6000 PSI
a, b	Pilot oil	G 1/2	-	G 1/2	-	G 1/2	-
C	Pump pressure transfer	SAE 2 in	6000 PSI	SAE 2 in	6000 PSI	SAE 2 in	6000 PSI

▼ 1MO-52 with hydraulic actuation



- 1 Name plate
- 2 Spool bore dimensions
- 3 Four fastening threads M20, 31 deep

▼ 3MO-52 with hydraulic actuation



- 1 Name plate
- 2 Four fastening holes, Ø22
- 3 Attachment point

Hydraulic Actuator 3MO-52

Related documents

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Instruction manual
System documentation from the machine manufacturer		Instruction manual

Compact Valve Block

Type M8

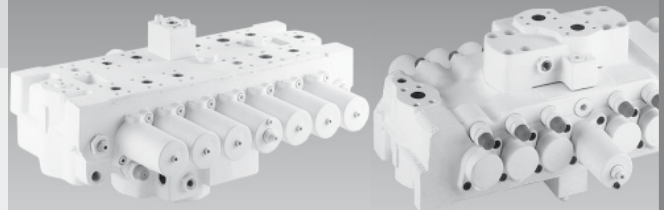
Nominal size 16...32

Series 1X

Maximum control pressure:

- pump side 350 bar
- actuator side 420 bar

Maximum flow 2 x 450 L/min



H/A 1707

H/A 1705

Compact valve block M8
(view from above)

Compact valve block M8
(view from below)

Overview of contents

Contents	Page
Features	1
Technical features	2
Function, circuit diagram for excavator valve block	3
Installation and service notes	4
Technical data	4
Operating Curves	4 to 6
Spool selection, Port sizes	7
Unit dimensions	8 to 15
Primary and secondary valves	16

Features

Compact valve blocks, series M8 are primarily used for the control of standard functions in track driven and wheeled excavators, such as arms, buckets, transmission, dipper and slew (swing) within a 2 circuit hydraulic system.

They may even be usefully used in drilling devices and cranes. Compact valve block M8 replaces the previous 4 axis valve blocks in 2 circuit controls.

The advantage of this type over a separated design lies in the reduced time and effort required for assembly and piping.

Technical features

- Valve control to the 6/3 way principle
- Proportional control characteristic
- Further fine control range for sensitive flow control
- Hydraulic control by means of pilot operated device type TH, electrical control available on request
- Spool axes:

for size 16	min. 8 to max.10
for size 18	min. 7 to max. 9
for size 22	7
for size 25	6
for size 32	min. 6 to max. 8
- Various circuit variations (parallel/tandem/series)
- Simultaneous control of various actuators possible
- Internal flow summation of max. 3 actuators (Other actuators possible externally)
- Spools for track transmission controls with integrated deceleration functions
- Priority circuit for slew operation
- Flange mountable flow divider with compensator valve for transmission spool axes, ports for tank, cooler and anti-cavitation
- Various primary and secondary cartridge valves

Spool stroke, control characteristics

The spool stroke is divided into approx. 30 % control land overlap, approx. 50 % fine control range and approx. 20 % residual stroke for creating fully opened cross-section.

Optimum fine control is achieved by means of the fine control grooves in the pilot devices.

Deceleration spool

These are used in hydrostatic transmissions in tracked vehicles and are used to avoid the over-running of the drive in both directions of travel. Controlled, cavitation-free downhill travel is achieved by control of the return oil opening dependent on the feed pressure.

Warning: For the deceleration spool to function correctly system optimisation must be carried out on the vehicle.

Before going into series production, the valve must be tested in situ and final installation certified as being correct!

Ordering Code

Project department together with the customer will specify the ordering code for the valve blocks of series M8.

Function, circuit diagram for excavator valve block

The block mainly comprises the housing, the control spool with return springs (1), built-in primary cartridge valves (3) and secondary cartridge valves (4), as well as load holding valves (2). Connected to pump P1 (5) are usually arm (12, spool axis 1) and bucket (13, spool axis 2), as well as transmission L (14, spool axis 3). Arm and bucket may be supplied with fluid either in parallel or in series, i.e. both functions may be carried out simultaneously. If these functions are not used, the pump flow is available for control of the transmission.

Pump P2 (6) usually supplies the slew (17, spool axis 7), dipper (16, spool axis 6) and transmission R (15, spool axis 5). The slew has priority over the dipper and transmission (tandem circuit). The dipper function has priority over the transmission. Flow from pump P2 not required for these functions may [by operating the C valve (10)] be used for the external summation with another actuator.

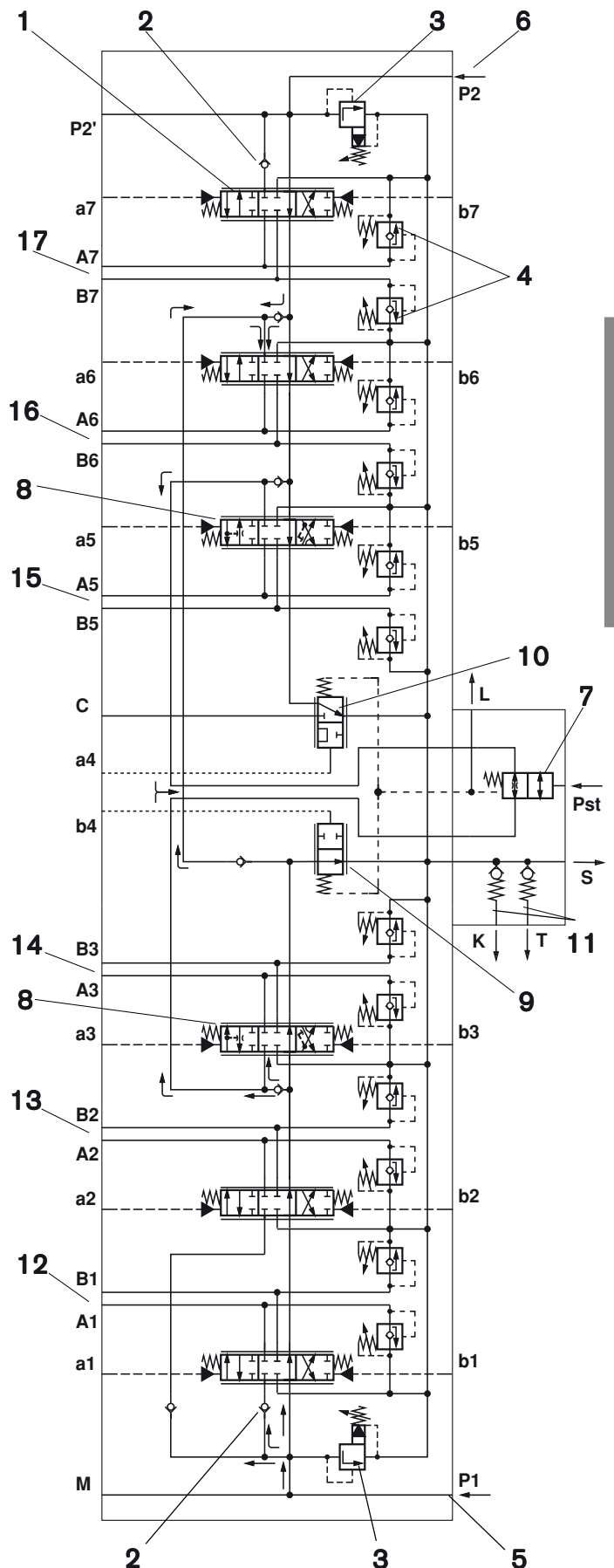
If neither arm, bucket nor transmission L (spool axes 1-3) are operated, flow from pump P1 may be made available by internally activating the summation valve (9) of spool axis 6 (control of dipper) (dipper summation).

By means of the transmission compensation valve (7) the remaining of oil from pumps P1 and P2 may be combined for the supply of both spool axes for the transmissions. Hence various operations may be carried out during travel, without the vehicle deviating from its path of travel. If only the transmission spools are operated, the transmission compensation valve is then at rest and only a residual compensation is carried out.

Preload valves (11) arranged in the return cause the return oil to be divided between the cooler and tank. The return oil which has built up may only be removed via port "S" and then fed to the slew motor for the purpose of anti-cavitation.

In addition to the model of the compact valve block described here, further variations exist, which our project department MH-V is willing to provide information on. Similary help is provided for the design of hydraulic controls using M8 valve blocks.

- | | | | |
|----|---|-------------|-----------------------------|
| 1 | Control spool | P1; P2 | pump ports |
| 2 | Load holding valve | Pst, a., b. | control ports |
| 3 | Primary valve | S | anti-cavitation port |
| 4 | Secondary valve | K | cooler port |
| 5 | Port for pump 1 | T | tank port |
| 6 | Port for pump 2 | L | leakage oil port |
| 7 | Transmission compensation valve with residual oil at rest | M | pressure gauge port |
| 8 | Spool with integrated deceleration function | C | Port for external summation |
| 9 | Summation valve (internal, dipper summation) | | |
| 10 | C valve external summation | | |
| 11 | Preload valves | | |
| 12 | Port: arm | | |
| 13 | Port: spoon | | |
| 14 | Port: left transmission | | |
| 15 | Port: right transmission | | |
| 16 | Port: dipper | | |
| 17 | Port: slew (swing) | | |



Installation and service notes

Installation

The installation position of the compact valve block is optional. Mechanical distortion is not permissible.

Service notes

- Primary and secondary valves may be exchanged without disassembling block. They must not be adjusted by the customer.
- If a control spool needs to be removed, only the long cover of the spool axis needs to be removed first.

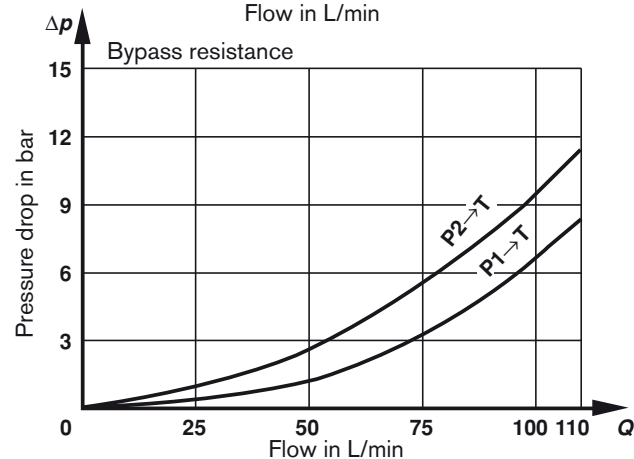
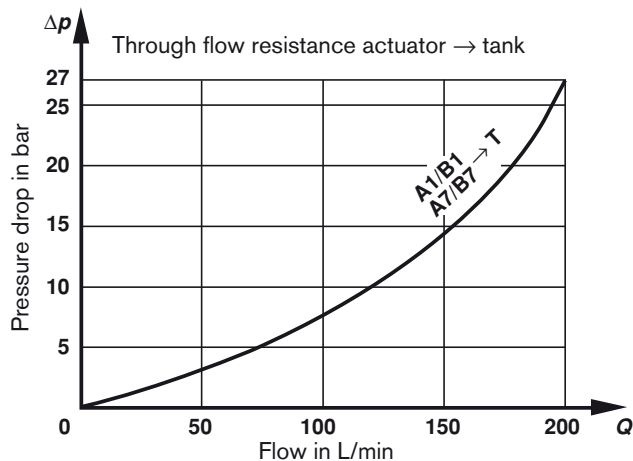
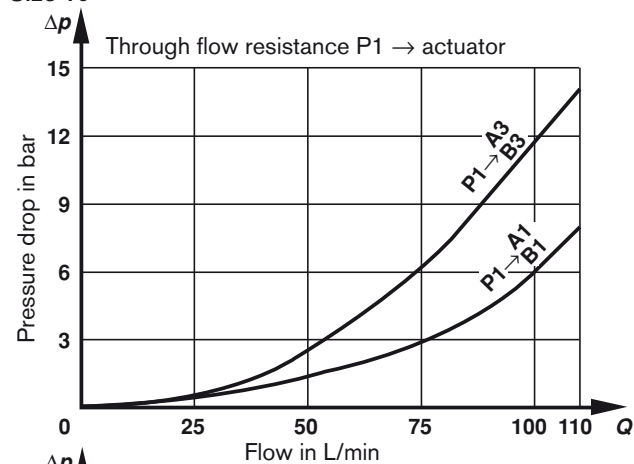
Technical data (For operation outside these parameters, please consult us!)

Fluid	Mineral oil (HL, HLP) to DIN 51 524 Phosphate ester (HFD-R)					
Fluid temperature range	°C	- 20 to + 80				
Viscosity range	mm ² /s	10 to 380				
Degree of contamination of fluid (maximum permissible)	ISO 4406 (C) Class 20/18/15					
Flow, max.	Size	16	18	22	25	32
	L/min	2 x 110	2 x 150 ¹⁾ 2 x 200 ²⁾	2 x 230	2 x 300	2 x 450
Operating pressure (maximum)	- pump side	bar 350				
	- actuator side	bar 420				
	- tank side	bar 30				
	- leakage oil	bar Low pressure				
Control pressure, max.	bar	30				
Fine control range	bar	8 ... 19 for control curve 06 8 ... 25 for control curve 70 (for suitable pilot units see RE 64 552, RE 64 555 and RE 64 558) Other control curves on enquiry				
Weight	See Unit dimensions on pages 8 - 15 (approx. weights) Exact weight will depend on the equipment used.					

¹⁾ with brake piston 007 ²⁾ without brake piston

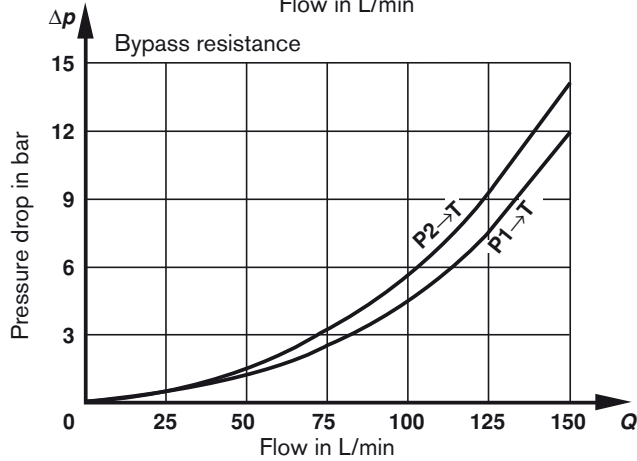
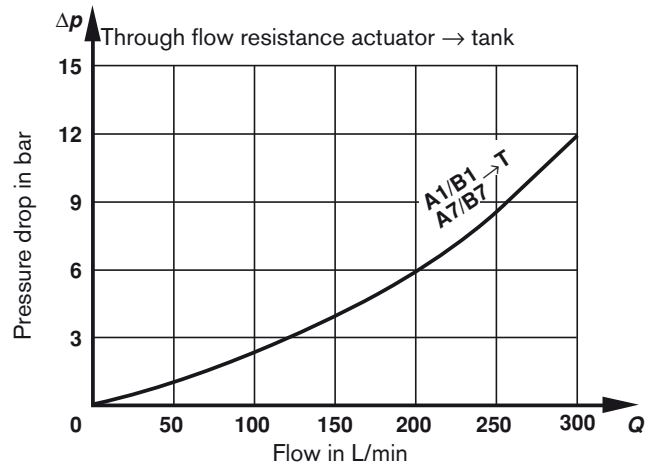
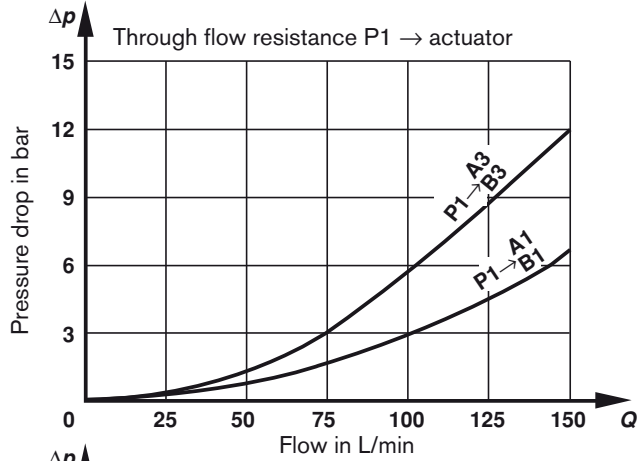
Operating Curves (measured at $v = 41 \text{ mm}^2/\text{s}$ and $\vartheta = 50 \text{ }^\circ\text{C}$)

Size 16

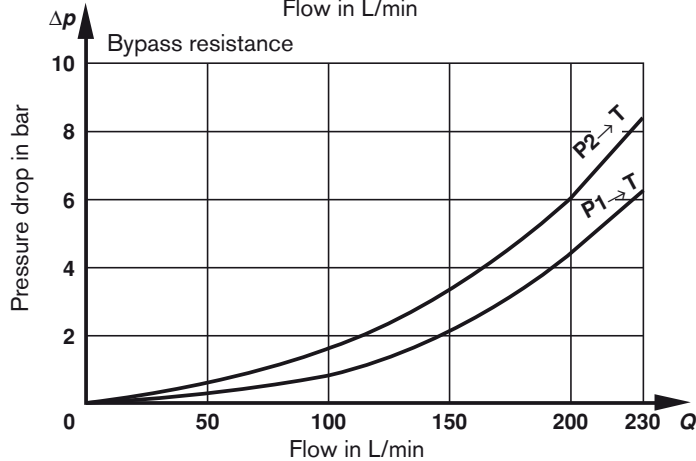
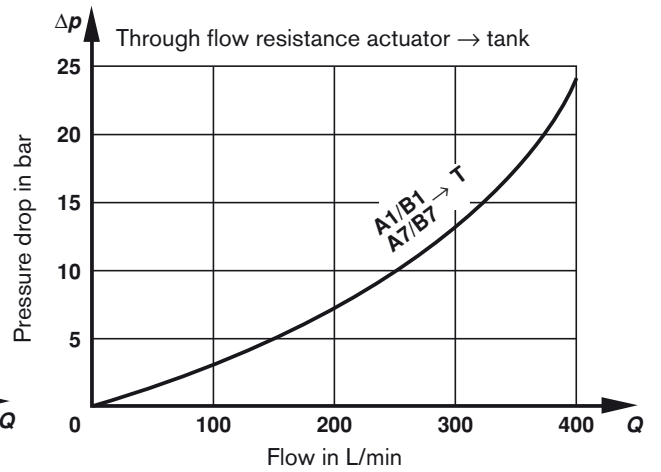
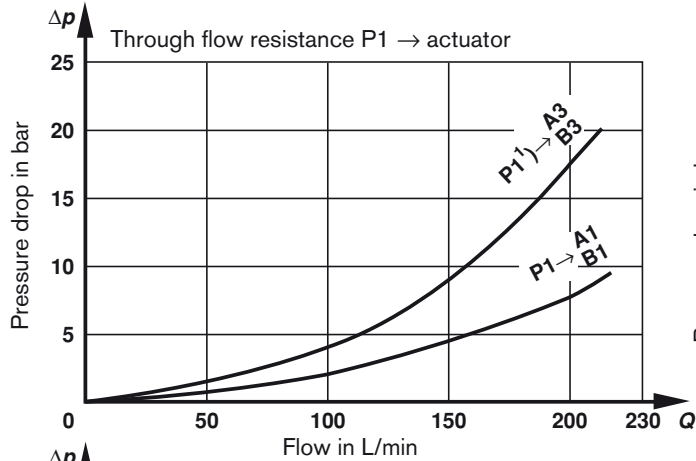


Operating Curves (measured at $v = 41 \text{ mm}^2/\text{s}$ and $\vartheta = 50 \text{ }^\circ\text{C}$)

Size 18



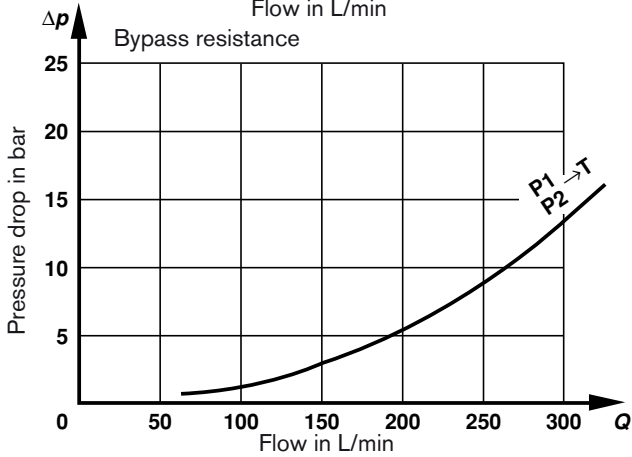
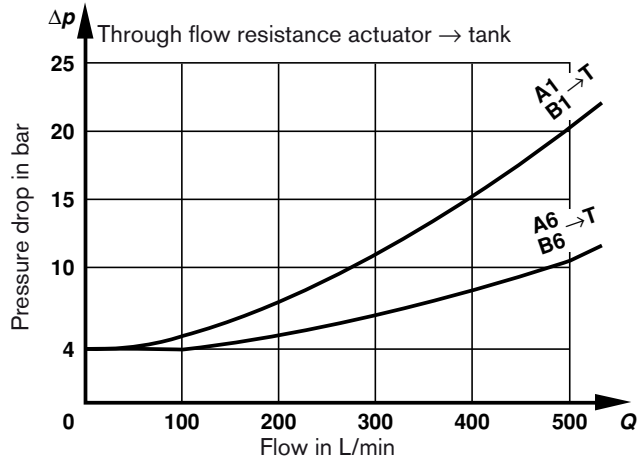
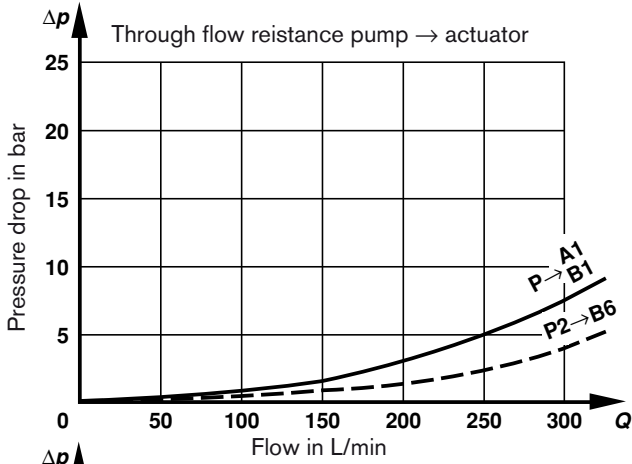
Size 22



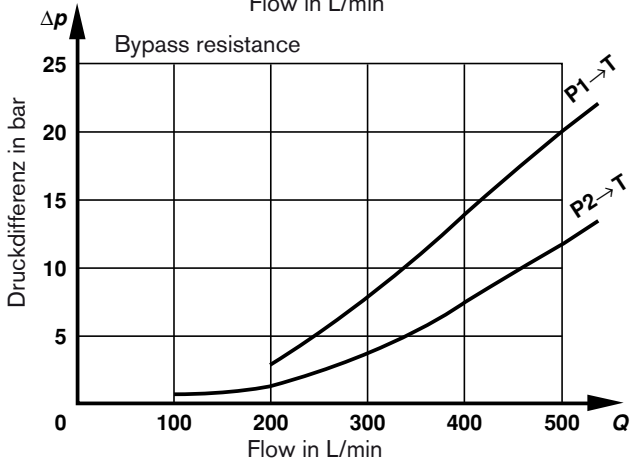
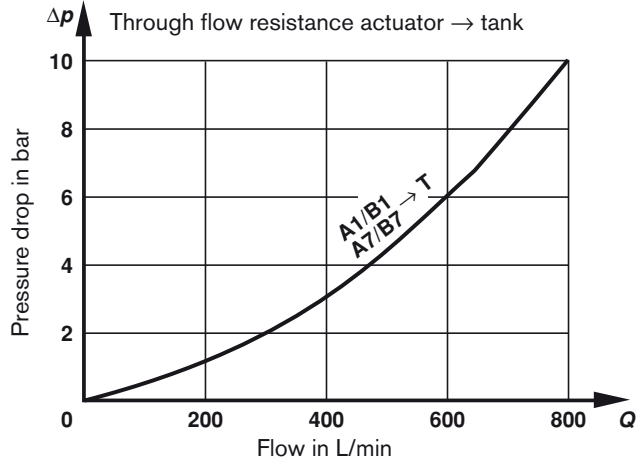
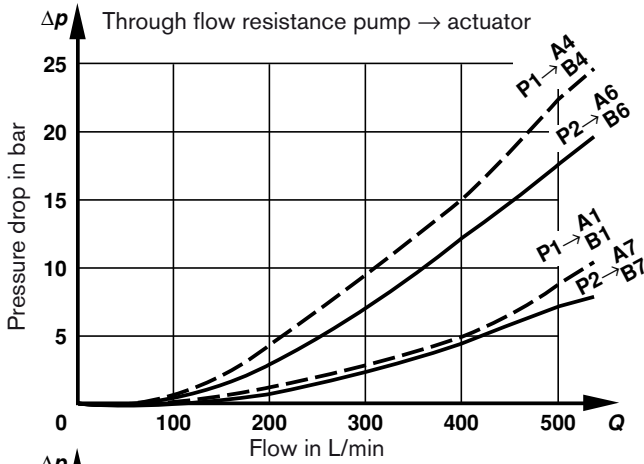
1) for brake piston 007

Operating Curves (measured at $v = 41 \text{ mm}^2/\text{s}$ and $\vartheta = 50 \text{ }^\circ\text{C}$)

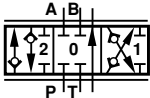
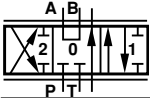
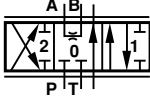
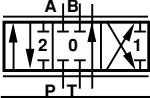
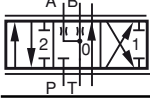
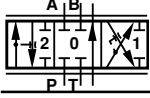
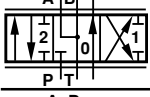
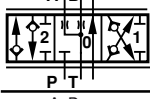


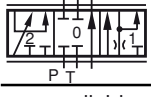
Size 25



Size 32



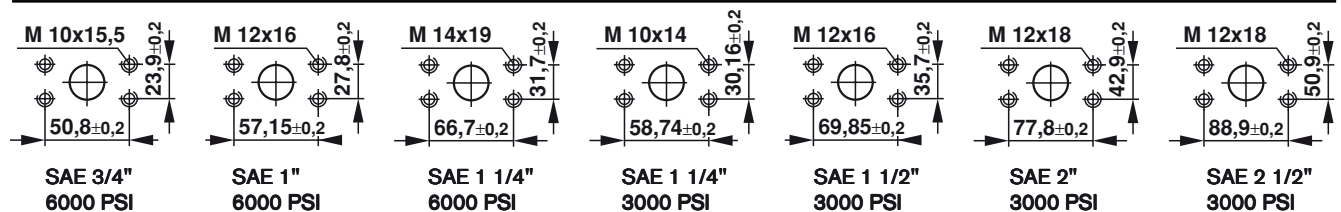
Spool selection

Symbols		Size16	Size18	Size 22	Size 25	Size 32
 = 001			●	●	●	●
 = 002		●	●	●	●	●
 = 003		●	●	●	●	●
 = 005		●	●	●	●	●
 = 006		●	●	●	●	
 = 007		●	●	●	●	●
 = 009		●	●	●	●	●
 = 026		●	●	●	●	●
 = 115				●		
 = 139			●			
 = 149		●	●			

● = available

Port sizes

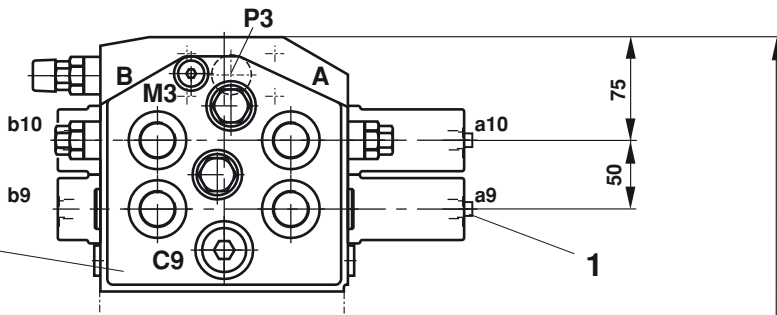
Port	Size 16	Size 18	Size 22	Size 25	Size 32
A, B, C, P2'	M27 x 2	SAE 3/4" 6000 PSI	SAE 3/4" 6000 PSI	SAE 1" 6000 PSI	SAE 1 1/4" 6000 PSI
A6, B6	M33 x 2	SAE 1" 6000 PSI	SAE 1" 6000 PSI	SAE 1 1/4" 6000 PSI	SAE 1 1/4" 6000 PSI
P1, P2	SAE 3/4" 6000 PSI	SAE 1" 6000 PSI	SAE 1" 6000 PSI	SAE 1" 6000 PSI	SAE 1 1/4" 6000 PSI
K	SAE 1" 3000 PSI	SAE 1 1/4" 3000 PSI	SAE 1 1/4" 3000 PSI	SAE 1 1/2" 3000 PSI	SAE 2" 3000 PSI
T	SAE 1" 3000 PSI	SAE 1 1/2" 3000 PSI	SAE 1 1/2" 3000 PSI	SAE 2" 3000 PSI	SAE 2 1/2" 3000 PSI
a, b, L	1/4" BSP	1/4" BSP	1/4" BSP	1/4" BSP	1/4" BSP
Pst	1/4" BSP	1/4" BSP	1/4" BSP	1/4" BSP	-
M1	1/4" BSP	1/4" BSP	M22 x 1,5	M22 x 1,5	M22 x 1,5
S	M26 x 1,5	M33 x 2	M33 x 2	-	-



Unit dimensions: M8-16, variation 1, 2 and 3 (Dimensions in mm)

Variation 3

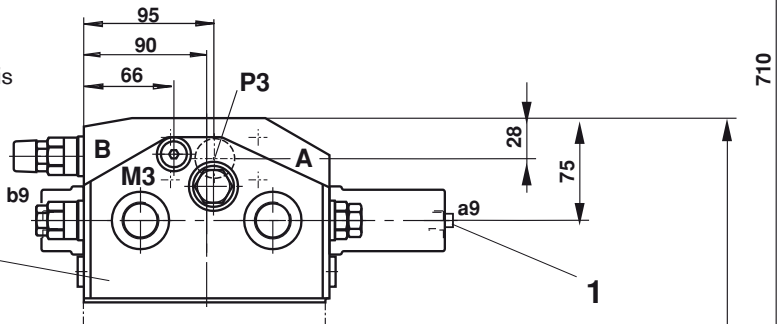
(basic block with 2-axis extension)



4.2

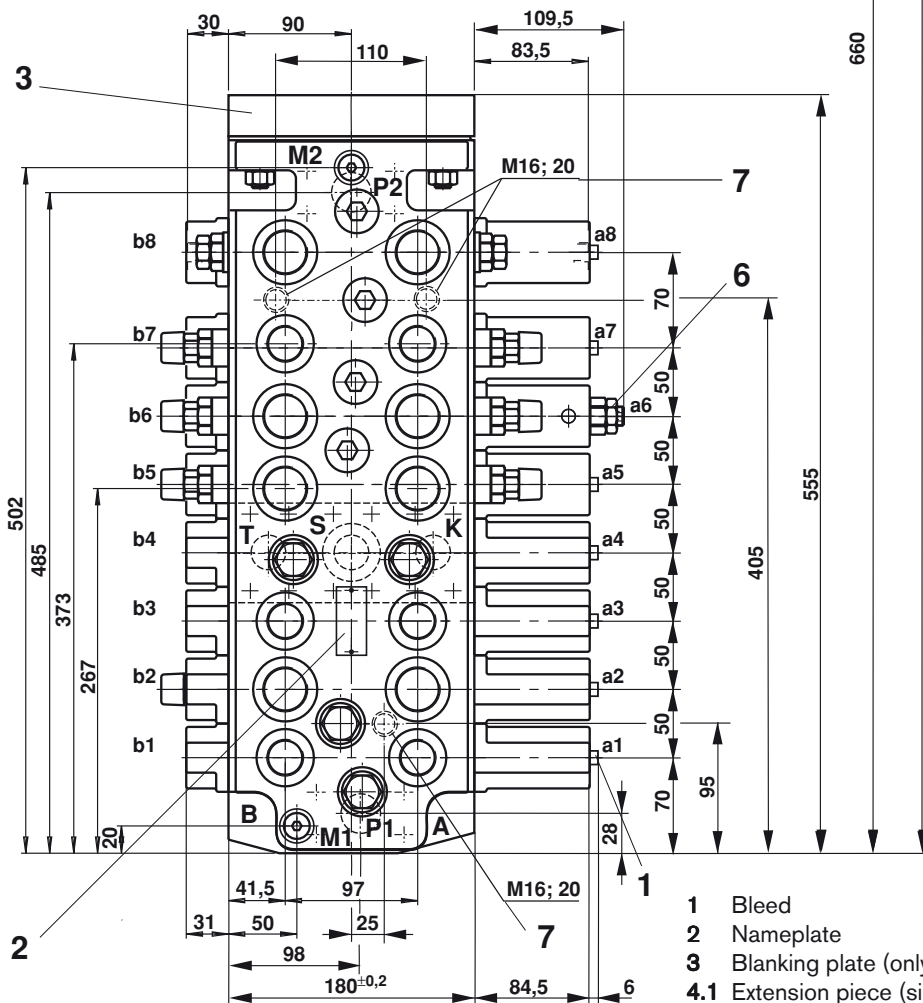
Variation 2

(basic block with single axis extension)



4.1

Variation 1 (extendable)



2

3

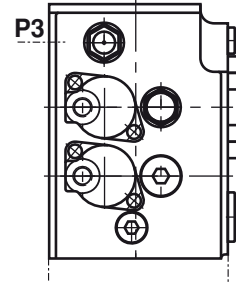
6

7

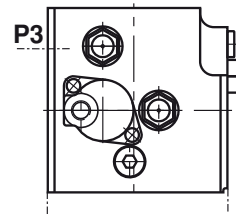
- 1 Bleed
- 2 Nameplate
- 3 Blanking plate (only variation 1)
- 4.1 Extension piece (single axis)
- 4.2 Extension piece (2-axis)
- 5 Transport aid
- 6 Piston stroke limitation
- 7 Mounting bores

For dimensions see page 7

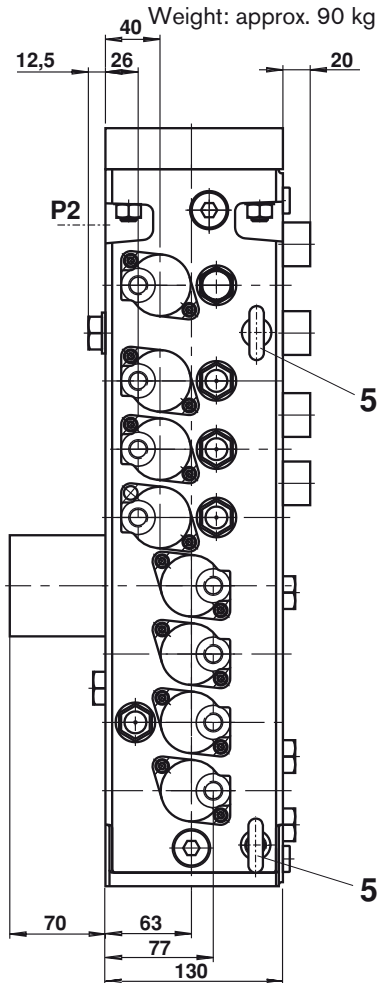
Weight: approx. 113 kg



Weight: approx. 95 kg



Weight: approx. 90 kg

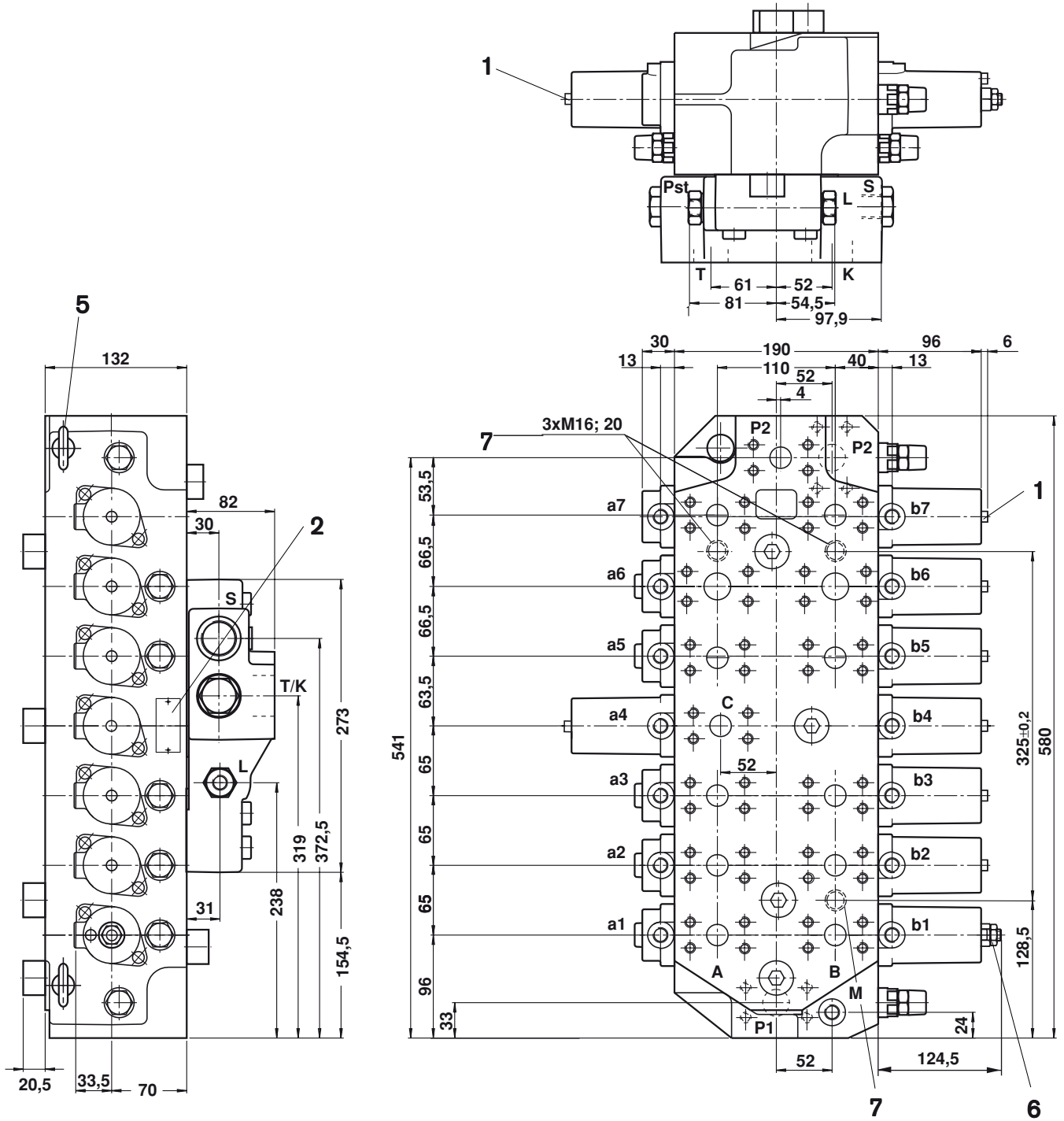


Unit dimensions: M8-18, variation 1 (Dimensions in mm)

For dimensions see page 7

7-axis valve block (not extendable)

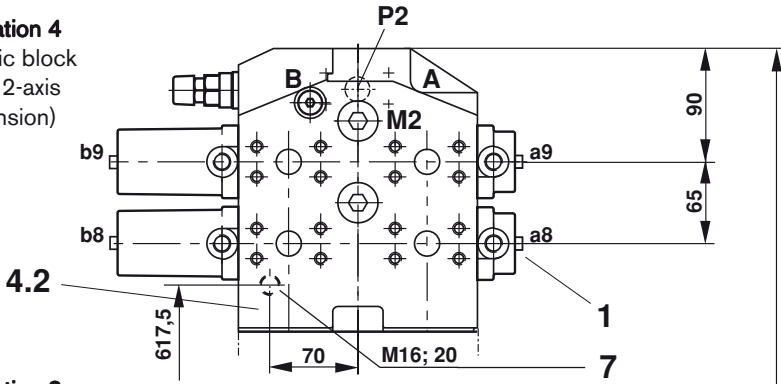
Weight: approx. 112 kg



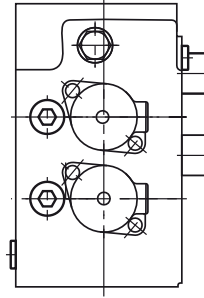
- 1 Bleed
- 2 Nameplate
- 3 Blanking plate (only Variation 2)
- 4.1 Extension piece (single axis)
- 4.2 Extension piece (2-axis)
- 5 Transport aid
- 6 Piston stroke limitation
- 7 Mounting bores

Unit dimensions: M8-18, variation 2; 3 and 4 (Dimensions in mm)

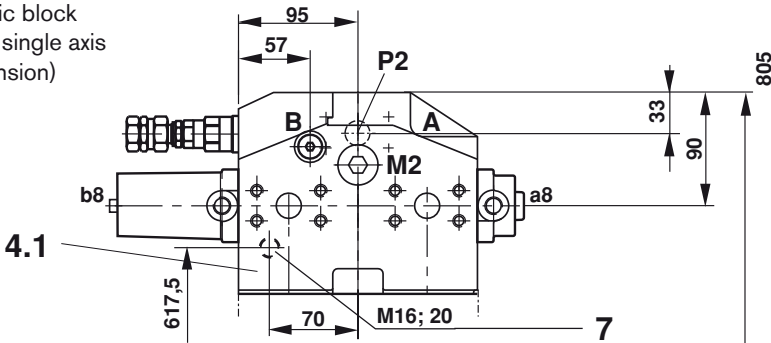
Variation 4
(basic block
with 2-axis
extension)



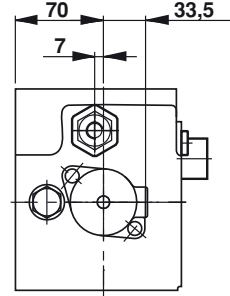
For dimensions see page 7
Weight: approx. 140 kg



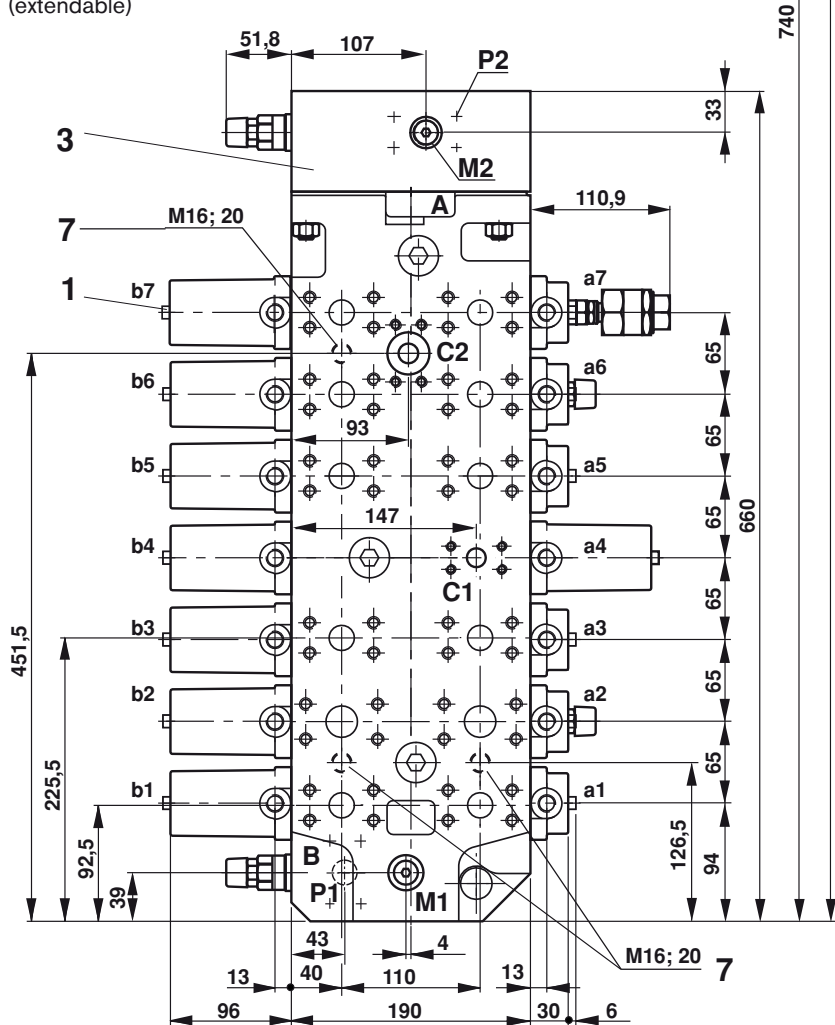
Variation 3
(basic block
with single axis
extension)



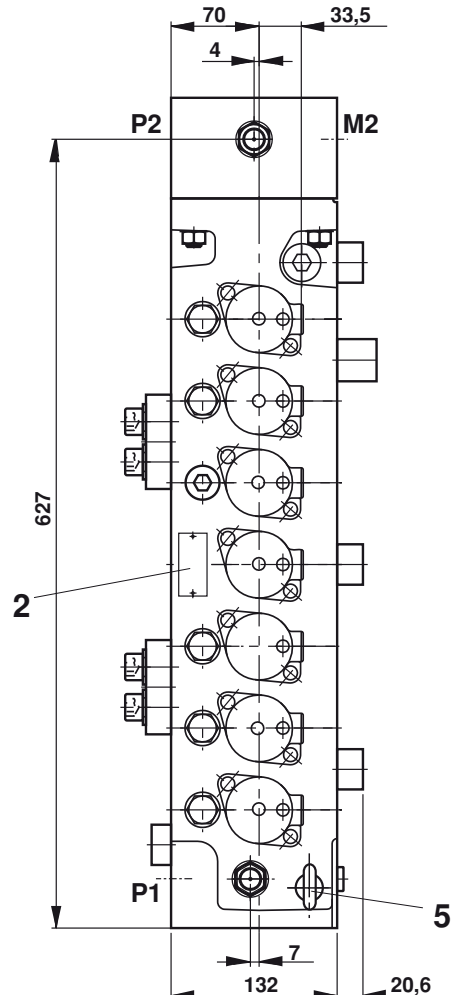
Weight: approx. 127 kg



Variation 2
(extendable)



Weight: approx. 115 kg



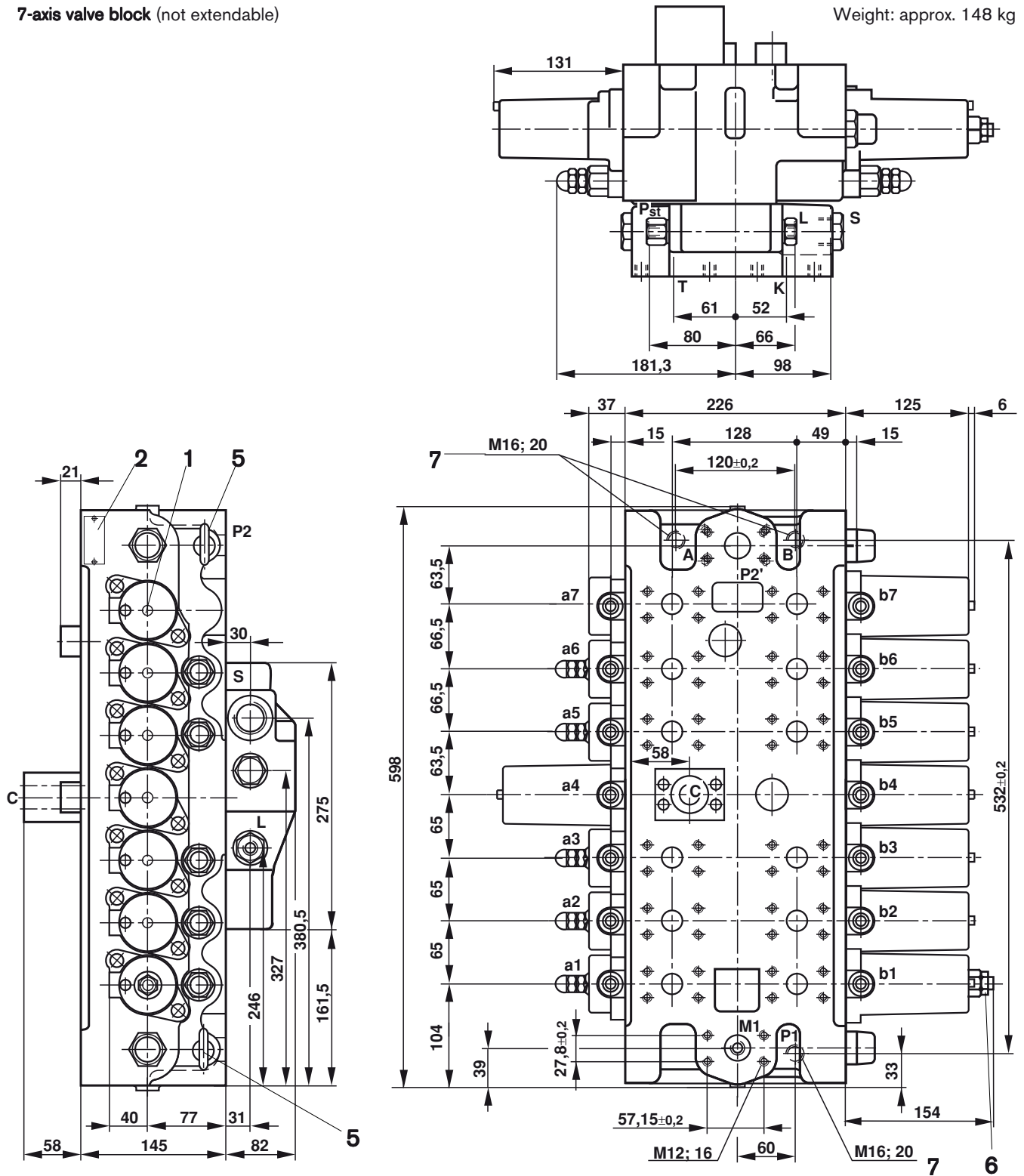
For explanations of items see page 9

Unit dimensions: M8-22, variation 1 (Dimensions in mm)

7-axis valve block (not extendable)

For dimensions see page 7

Weight: approx. 148 kg



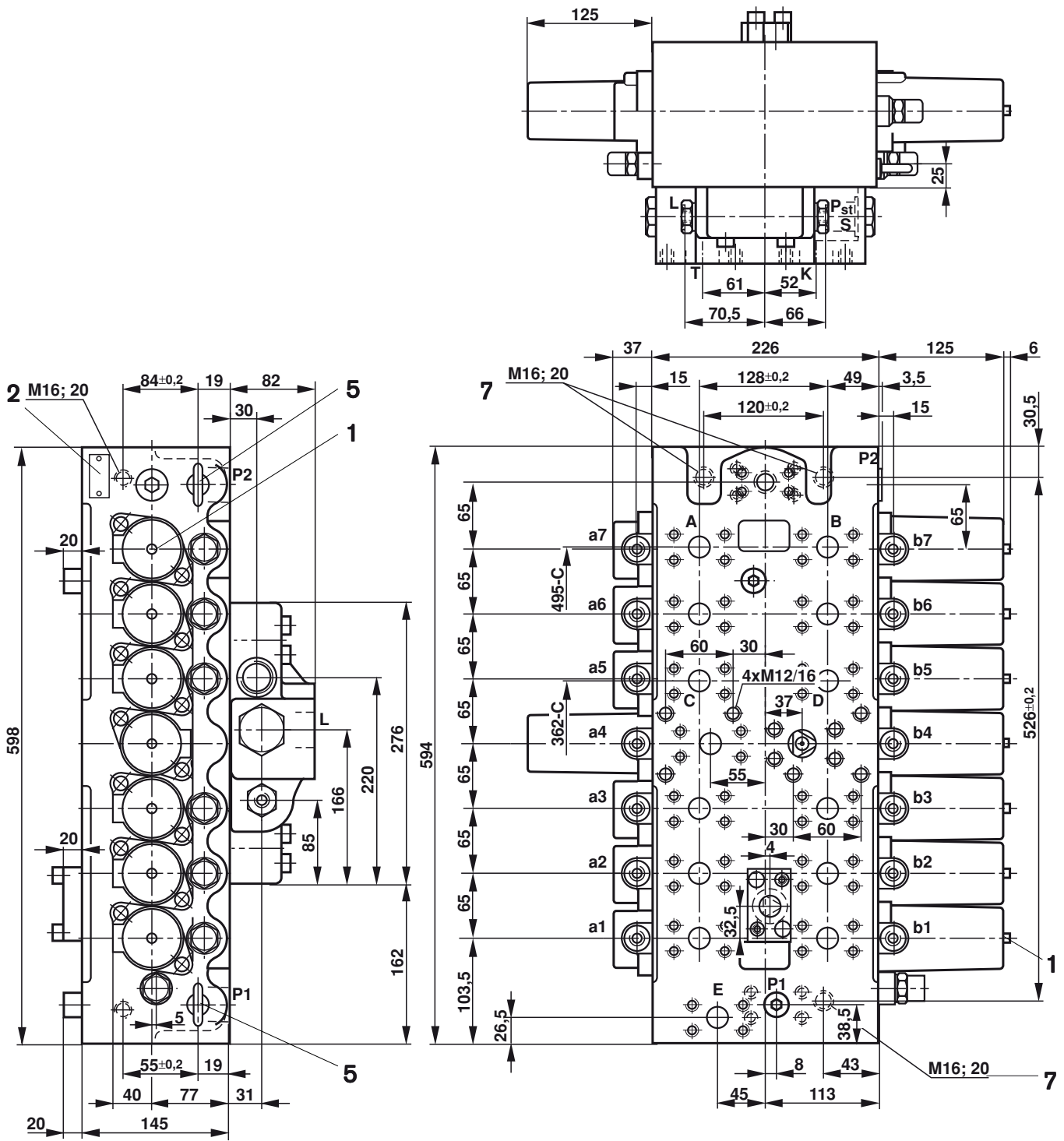
- 1 Bleed
- 2 Nameplate
- 5 Transport aid
- 6 Piston stroke limitation
- 7 Mounting bores

Unit dimensions: M8-22, variation 2 (Dimensions in mm)

7-axis valve block (not extendable)

For dimensions see page 7

Weight: approx. 150 kg



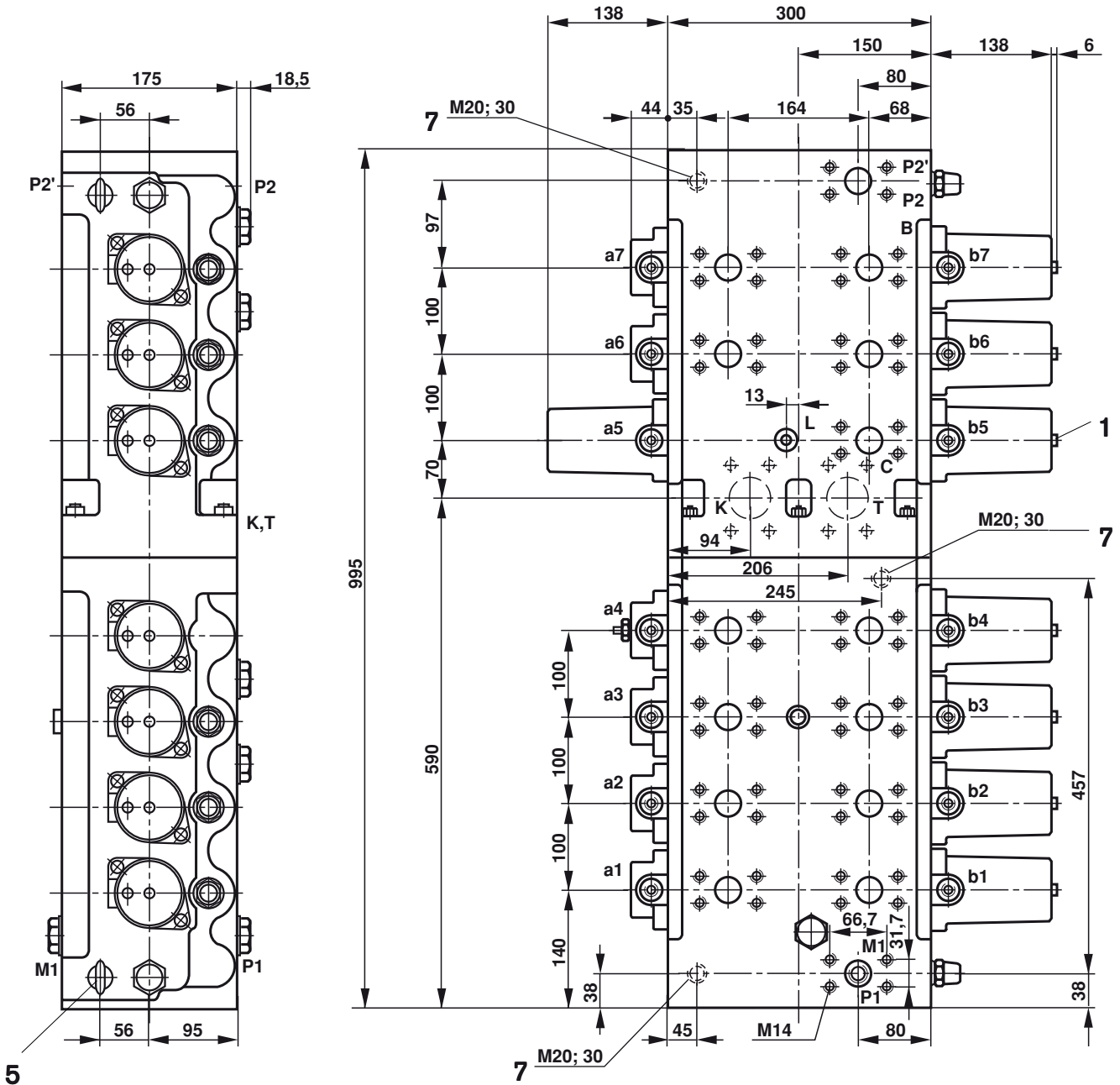
- 1 Bleed
- 2 Nameplate
- 5 Transport aid
- 7 Mounting bores

Unit dimensions: M8-32, variation 1 (Dimensions in mm)

For dimensions see page 7

Weight approx. 325 kg

7-axis valve block (not extendable) *)



- 1 Bleed
- 2 Nameplate
- 5 Transport aid
- 7 Mounting bores

*) Dimensions for 6-axis valve block on request

Primär- und Sekundärventile

Primary valves available:

- Pressure relief valve, pilot operated, without anti-cavitation
- Pressure control/anti-cavitation valve, pilot operated
- Pressure control/anti-cavitation valve pilot operated with pressure isolation stage
- Pressure relief valve pilot operated with pressure isolation stage

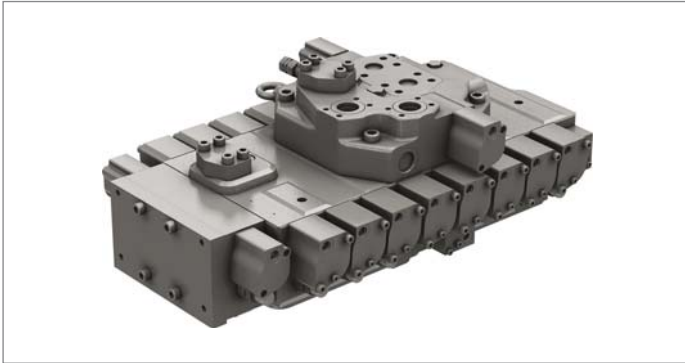
Secondary valves available:

- Pressure relief valve, pilot operated without anti-cavitation
- Pressure control/anti-cavitation valve, pilot operated
- Anti-cavitation valve
- Pressure relief valve with pressure isolation stage (off)
- Pressure relief valve with pressure isolation stage (on)

Project department will be pleased to provide information on the availability and application possibilities for these valves for the various sizes of compact block series M8.

Positive control block in mono block design

M9-25



- ▶ Size 25
- ▶ Series 1X
- ▶ Maximum operating pressure
 - 350 bar on the pump side
 - 380 bar on the actuator side
- ▶ Maximum flow
 - 2 x 300 l/min on the pump side

Features

- ▶ Control principle: 2 circuit positive control (no fixed pump circuit possible)
- ▶ 6/3-way valve control
- ▶ Internal summing functions for arm and boom
- ▶ Improved distribution of quantities with parallel motions for driving/equipment
- ▶ Arm regeneration with braking valve function at the tank
- ▶ Boom spool with integrated regeneration function
- ▶ Optimum boom supply with parallel motions of the bucket or rotating mechanism
- ▶ Semi priority of the rotating mechanism axis with regard to the arm axis
- ▶ Integrated anti drift valves for the arm rod and the boom base
- ▶ Primary and secondary pressure limitation via pilot operated screw-in cartridge valves with combined feed function to avoid cavitation

Design

- ▶ Mono block with 7 actuator axes and 2 summing semi-axes
- ▶ Can be extended with directional valves (maximum of 2)
- ▶ Flanged inlet element with primary valve, tank and cooler preload valve, movement compensation valve
- ▶ Cost-effective piping with low Δp
- ▶ Type of actuation
 - Hydraulic

Contents

Functional description	2
Technical data	3
Ordering code	4
Symbols	7
Primary and secondary pressure limitation	9
Dimensions	9
Project planning information	13
Related documents	13

Functional description

Fields of application

The series M9 compact control blocks primarily control the standard functions of tracked excavators or mobile excavators in a 2 circuit hydraulic system, such as boom, bucket, travel drive, arm and rotating mechanism.

In this context, it is very important that the driver can control the many possible parallel movements of a hydraulic excavator easily, comfortably and without a high amount of concentration and with optimum use of energy.

Control block M9-25

The control block mainly consists of the housing (1), the main spools (2) with return springs (3), integrated primary and secondary cartridge valves (4) and load holding valves (5).

Actuator control

The right travel drive (spool axis 3), rotating mechanism (spool axis 2) and arm (spool axis 1) are connected to pump **P1**.

Compared to a true parallel connection, the influence of the arm motions on the motions of the rotating mechanism is reduced. Therefore, semipriority of the rotating mechanism is achieved by switching the rotating mechanism and arm sections. Quantity fluctuations of the rotating

mechanism due to the parallel movements that drivers consider uncomfortable are minimized.

The left travel drive (spool axis 4), boom (spool axis 5), bucket (spool axis 6) and option section (spool axis 7) are connected to pump **P2**.

The selected switching guarantees sufficient supply of the boom function in parallel movement with the bucket movement with a lower load. This prevents the boom from stopping.

The option section (spool axis 7) integrated into the block is connected in parallel to the boom. Other option sections can be flange-mounted at the sides. The pump is connected via the parallel channel.

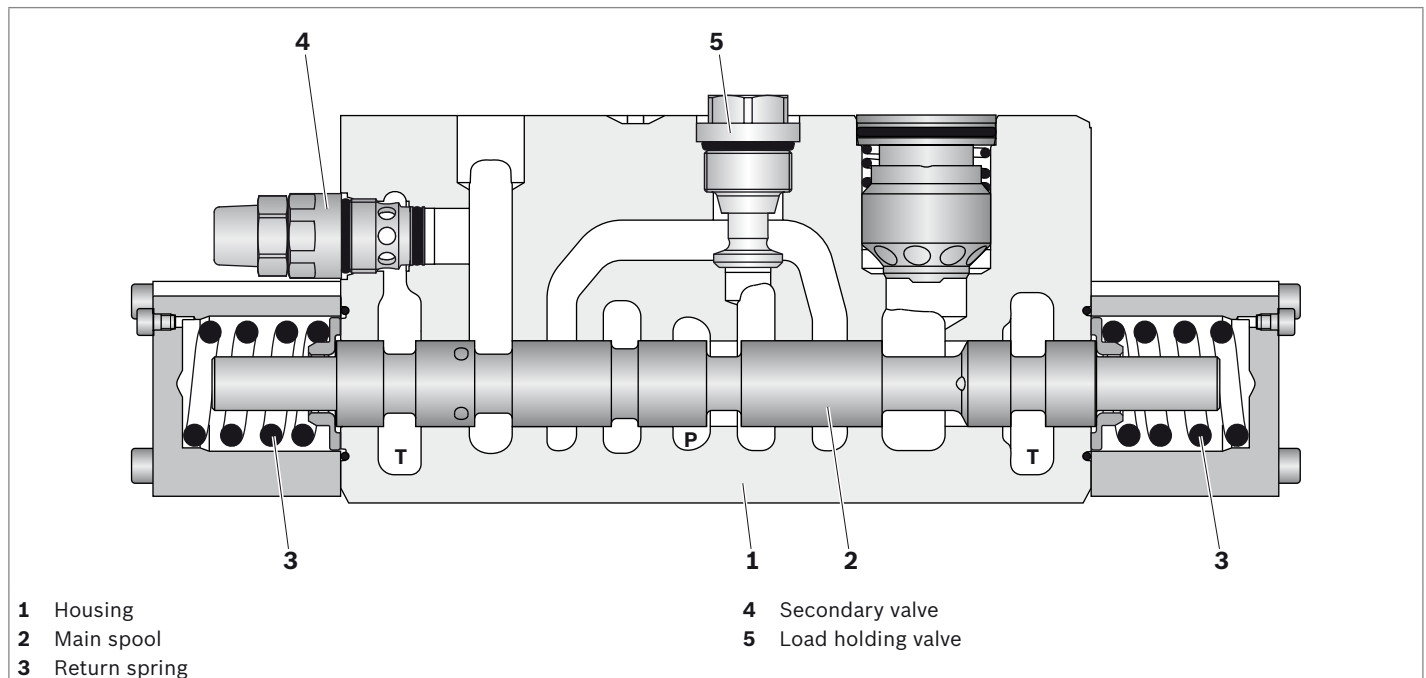
Summing

Both circuits contain one summing valve each. They allow for internal supply of the functions lift boom and arm on/off with two pumps.

Inlet element

The inlet element is used to determine quantity distribution with parallel motions for driving/equipment. In the parallel movement, the inlet element switches pump **P1** to both travel drive sections and pump **P2** is switched to the equipment via the parallel channels of the two circuits.

▼ Section M9-25



Technical data

general				
Weight	7-fold mono block	kg	195	
	Directional valve M9-25	kg	20	
	End plate	kg	6.5	
Installation position				Any
Type of connection of the actuators				See page 9
Ambient temperature range	θ	°C	-20 to +80	
Priming				Single coat paint RAL 5001
hydraulic				
Maximum operating pressure at the port	P	p	bar	350
	A, B	p	bar	380
	T	p	bar	30
	L	p	bar	Must be led to the tank in a depressurized form
Maximum pilot pressure at the port	a, b	p	bar	35
Pilot pressure range (recommended)	Hydraulic	p	bar	0 to 35
Maximum flow at the port	P	q_{Vmax}	l/min	2 x 300
	A, B	q_{Vmax}	l/min	
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet RE 90221, at request
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$

Notice

For applications outside these parameters, please consult us!

Ordering code

Information on the name plate

The ordering code serves to specify the technical features and requirements.

The Rexroth distribution organization derives a short type as well as a material number from the ordering code.

01	02	03	04	05	06	07	08						
M9	-	-	1X	/		M9-25	/	H	/	V	11	*

Series

01	Control block M9	M9
----	------------------	----

02	4-digit control block number
----	------------------------------	------

Series

03	10 to 19 (unchanged installation and connection dimensions)	1X
----	---	----

04	Total number of spool axes	7 to 9
----	----------------------------	--------

Type of actuation

05	Hydraulic	H
----	-----------	---

Seal material

06	FKM seals	V
----	-----------	---

Actuator ports

07	Flange connection according to DIN EN 6162	11
----	--	----

08	Further details in the plain text	*
----	-----------------------------------	---

Features of the spool axes

	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
M9-25-1X /	1			—	H			H				—			—	
	1. Spool axis (arm)															
	2			—	H			H				—			—	
	2. Spool axis (rotating mechanism)															
	3	J		—	H			H				—			—	
	3. Spool axis (driving right)															
	4	J		—	H			H				—			—	
	4. Spool axis (driving left)															
	5			—	H			H				—			—	
	5. Spool axis (boom)															
	6			—	H			H				—			—	
	6. Spool axis (bucket)															
	7			—	H			H				—			—	
	7. Spool axis (option)															
M9/22-1X /	8			—	H			H				—			—	
	8. Spool axis (option)															
M9/22-1X /	9			—	H			H				—			—	
	9. Spool axis (option)															

7-fold mono block

Directional valves to be flange-mounted (optional)

01	Spool axis number	1 to 9
----	-------------------	---------------

Spool type ²⁾

02	Main spools A/B/T blocked in neutral position	E
	Main spools A/B → T open in neutral position	J
	Main spools A/B → T throttled at the tank in neutral position	Q
	Main spools P/B → A in spool position b	R

Flow

03	Supply quantity A (in l/min, 3 digits)	...
04	Supply quantity B (in l/min, 3 digits)	...

Type of actuation

		A side			B side		
		05	06	07	08	09	10
05,08	Hydraulic ³⁾	H			H		
06	Shuttle	Without shuttle		00		00	
09		With 0.8 mm shuttle		08		08	
		With 1.0 mm shuttle		10		10	
		With 1.2 mm shuttle		12		12	
07,10	Pilot oil port	G 1/4 without adapter			Z		Z

2) For the symbols, see "Main spool" on page 7
 With hydraulic cylinders, the gear ratio must be specified in the plain text as E and Q spools have supply and outlet characteristic curves.

3) With measuring port.

... ..

Secondary valves

		A side			B side		
		11	12	13	14	15	16
11	Without	Z	000	000	Z	000	000
14	Feed valve	E	000	000	E	000	000
	Pressure relief/feed valve	H	...	000	H	...	000
	Pressure relief/feed valve with pressure sequencing function	B	...	...	N	...	...
12, 15	Specified pressure of the pressure relief/feed valve (in bar, 3 digits)	...			...
13, 16	Specified pressure of the pressure sequencing function (in bar, 3 digits)	...			...

Notice

All functions can only be combined to a limited extent.
Every enquiry requires individual verification.

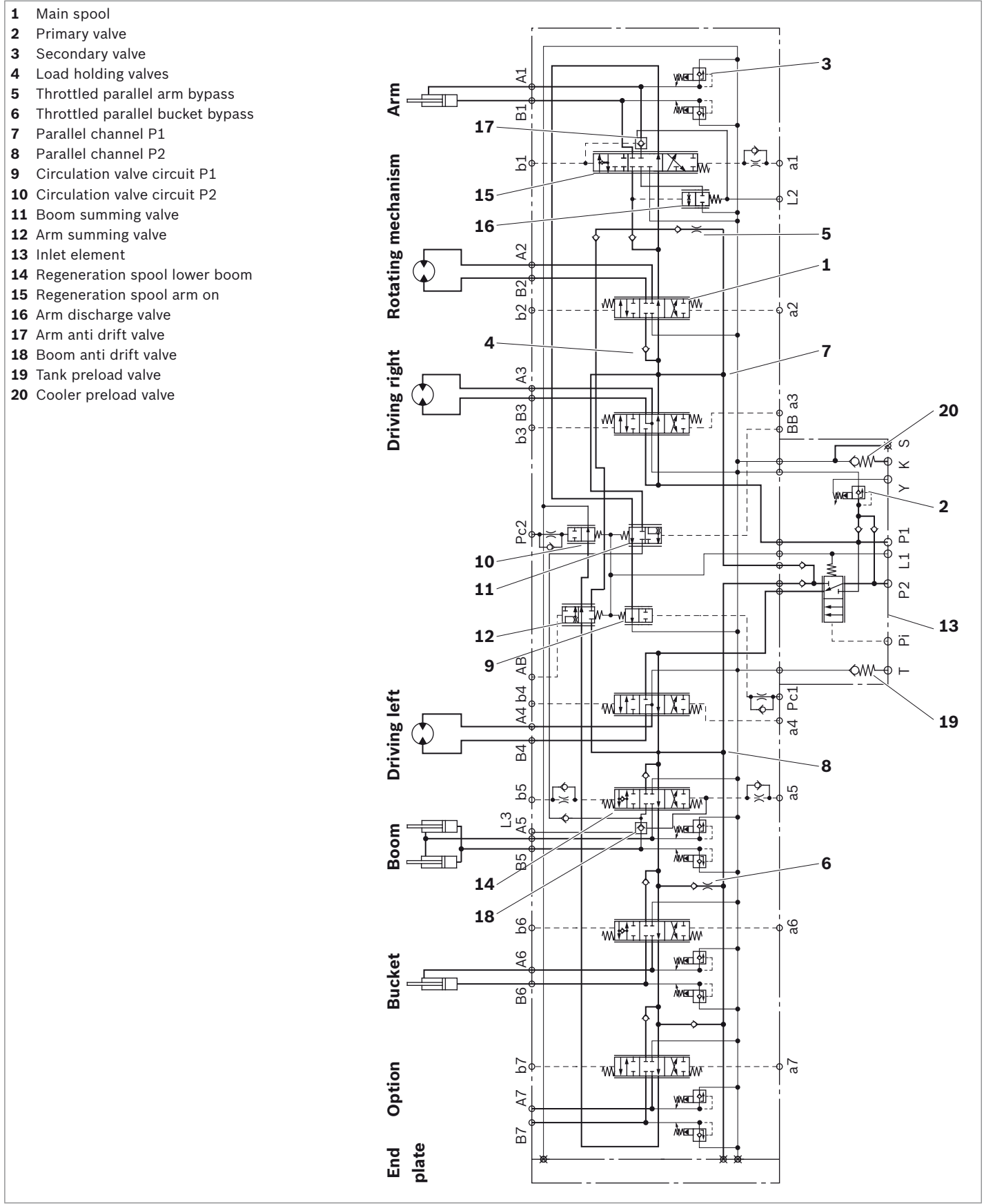
Symbols

Main spool

Ordering code	Main use	Symbol
E	▶ Shut-off valve	
J	▶ Hydraulic motor as actuator (A/B → T) ▶ Actuator ports are unloaded to the tank in neutral position	
Q	▶ Application with defined remaining opening (A/B → T) ▶ Actuator port is unloaded to the tank in neutral position	
R	▶ E spool with regeneration function for the boom (cylinder base side to cylinder ring chamber)	
R	▶ E spool with regeneration function for the arm	

Control block

Example: 7-fold mono block



Hydraulic schematic diagram of a 7-fold mono block control system.

Primary and secondary pressure limitation

The following primary valves can be selected:

- ▶ Pressure relief valve, pilot operated
- ▶ Pressure relief valve, pilot operated with pressure sequencing range and pressure cut-off range

The following secondary valves can be selected:

- ▶ Pressure/feed valve, pilot operated
- ▶ Feed valve
- ▶ Pressure relief valve, pilot operated with pressure sequencing range

Dimensions

Line connections

Port	Dimension	Similar standard
P1, P2 A1, B5	DN 28 (SAE 1 1/4" 6000 PSI)	DIN ISO 6162-2
A2 – A7, B1 – B4, B6, B7	DN 25 (SAE 1" 6000 PSI)	DIN ISO 6162-2
T K	DN 28 (SAE 1 1/4" 3000 PSI)	DIN ISO 6162-1
S	M33 x 2	DIN EN ISO 9974-1
Y, Y', L	DN 10 (G 1/4)	DIN EN ISO 1179-1
a1 – a7, b1 – b7	DN 10 G 1/4 (version Z)	DIN EN ISO 1179-1

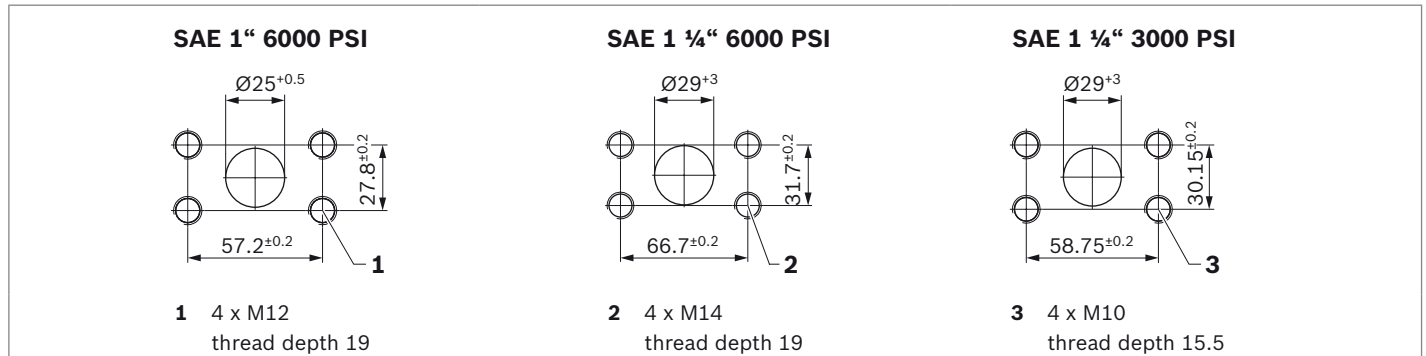
Connections	
P	Pump
T	Tank
K	Cooler
A, B	Actuator
S	Feed connection of the rotating mechanism
Y, L	Leakage oil connection (depressurized to the tank)
a, b	Pilot oil port

Install SAE flanges according to the manufacturer's specifications:

1. Tighten the mounting bolts manually.
2. Diagonally tighten the mounting bolts.
3. Tighten the mounting bolts gradually with the specified torque (manufacturer's specifications).

Notice

Non-compliance may cause malfunctions due to stress on the anti drift valves!

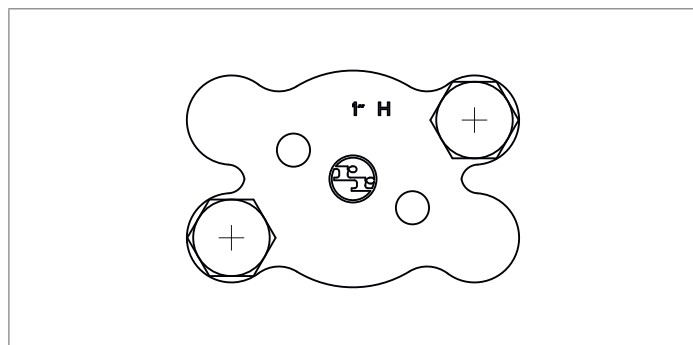


Flange cover

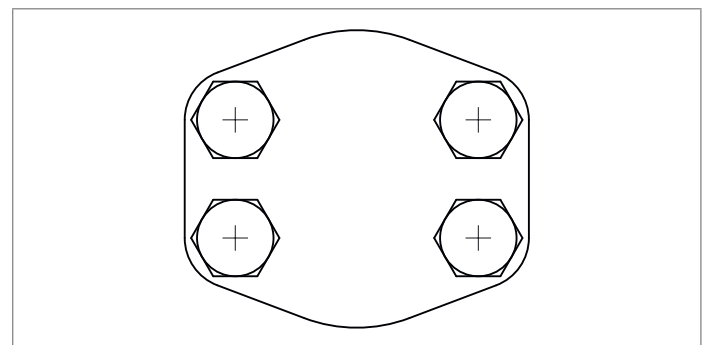
M9-25 control blocks are delivered by default with the following flange cover.

Optionally, M9-25 control blocks can be equipped with the following flange cover. This option must be specified in the configuration in clear text.

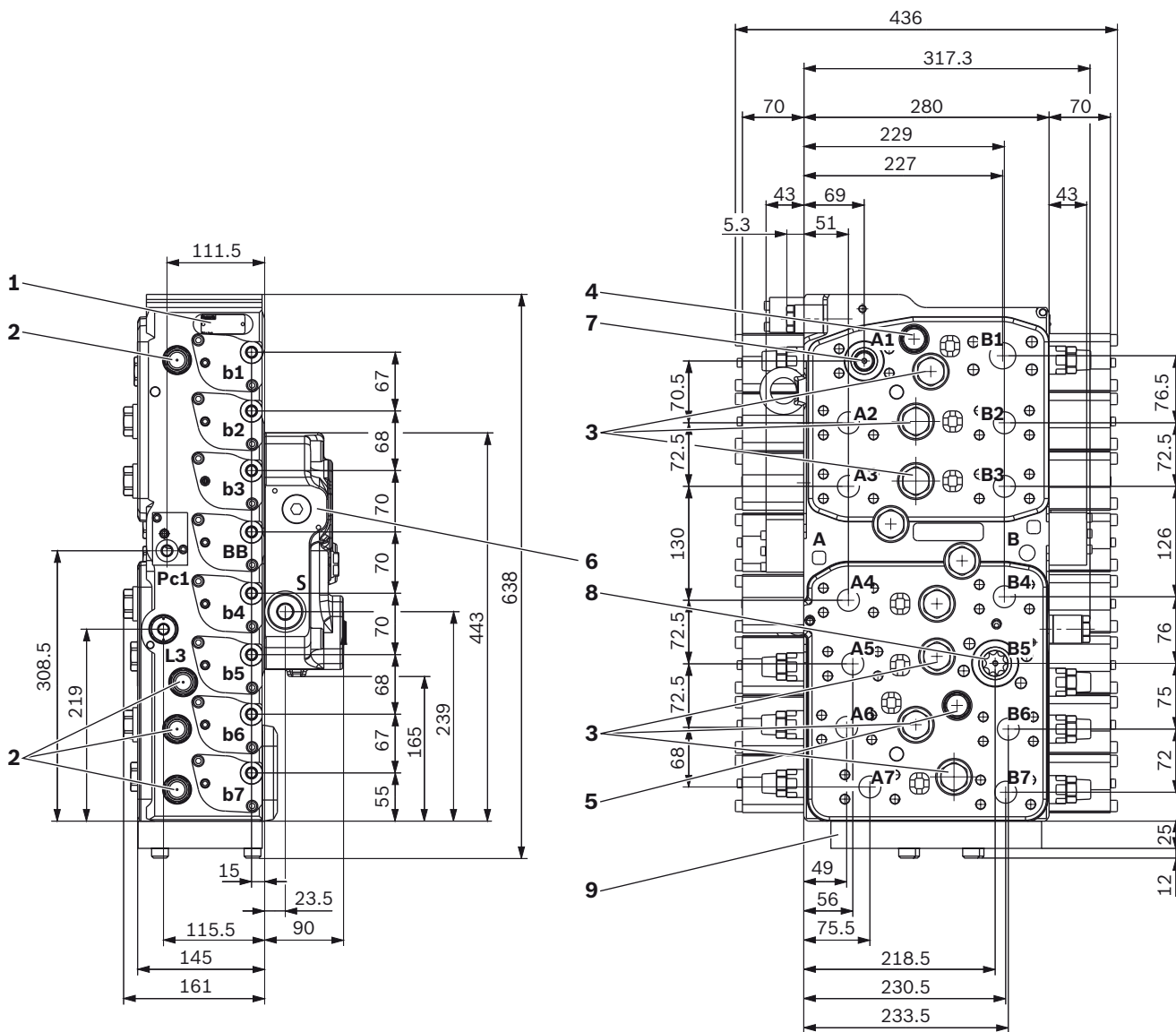
▼ **Standard flange cover**



▼ **Optional flange cover**



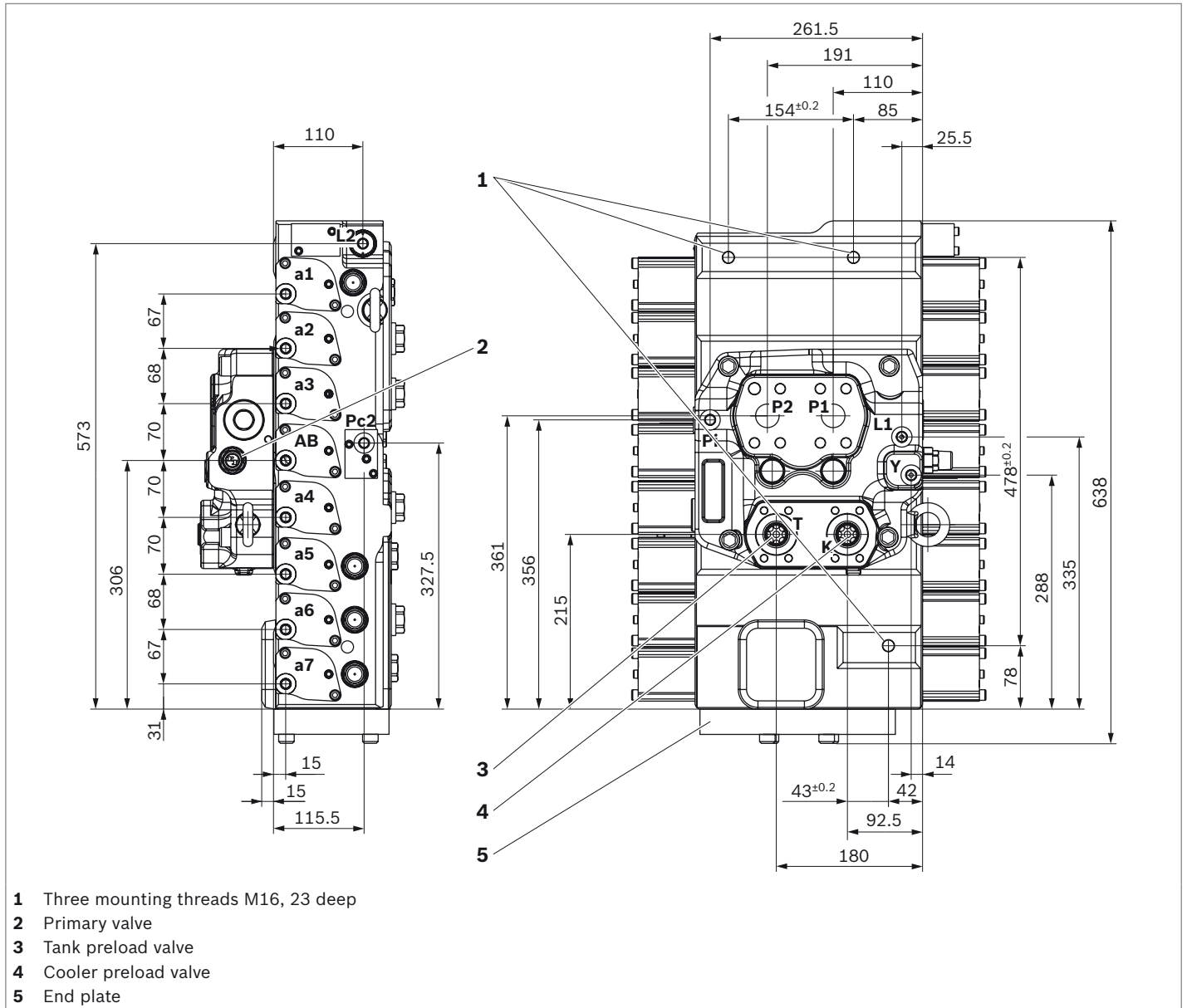
▼ Example 7M9-25



- 1 Name plate
- 2 Secondary valve
- 3 Load holding valve
- 4 Throttled parallel arm bypass
- 5 Throttled parallel bucket bypass
- 6 Inlet element
- 7 Arm anti drift valve
- 8 Boom anti drift valve
- 9 End plate

Hydraulic Valve Assembly - Example 7M9-25

▼ Example 7M9-25 (back)



Project planning information

The control block M9-25 is the core component of the hydraulic control of a mobile working machine. It is therefore recommended to only specify it in connection with an overall hydraulic circuit diagram.

For the design of a hydraulic control block of type M9-25, the following boundary conditions are relevant for project planning and should be enclosed to the enquiry:

- ▶ Machine type
- ▶ Maximum and minimum pump flow at rated speed
- ▶ Type of the pump controller
- ▶ Description of the actuator on the sections (e.g. boom, winch)
- ▶ Cylinder ratios/motor displacement
- ▶ Information whether a system element is installed downstream the valve (e.g. hose burst check valve, lowering brake valve)
- ▶ Information on the loads (pressures) to be throttled per axis if there is no braking valve or the like.

Related documents

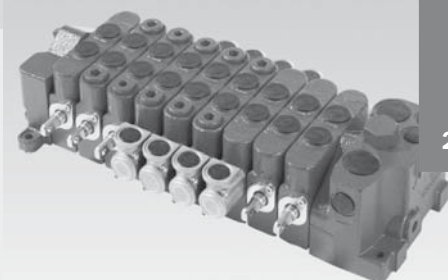
The control blocks M9-25 are system components. Also observe the instructions for the other system components. The product may not be commissioned until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

LUDV control block of sandwich plate design

Type SX 10

Nominal size 10
 Series 1X
 Maximum pressure, pump side 250 bar
 Maximum pressure, actuator side 300 bar
 Inlet flow 80 l/mn
 Flow at each directional valve element 50 l/mn



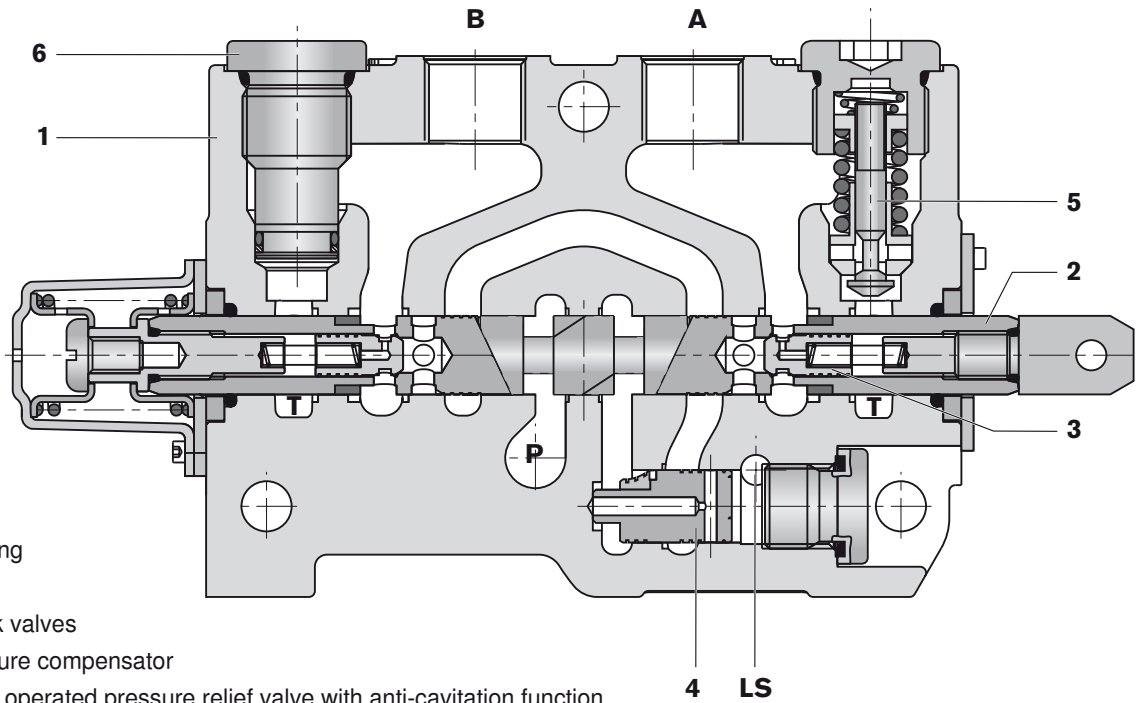
Contents

Special features	1
Functional description, Section	2
Hydraulic Symbol	2
Technical data	3 to 4
Ordering details	5 to 7
Inlet element - Final element	8
Directional valve element	9 to 10
Unit dimensions (in mm)	11 to 13
Assembly possibilities	14
Pipe connections	14

Special features

- Distributes the flow between the directional valve elements according to the requirements, independently of the pressure and available flow.
- Compact sandwich plate design, can be combined so that the control block can meet the requirements of differing machines.
- No shuttle valves.
- Limitation of system maximum pressure via LS pressure relief valve.
- System protection via LS and secondary pressure relief valves.

Functional description, Section



- 1 Housing
- 2 Spool
- 3 Check valves
- 4 Pressure compensator
- 5 Direct operated pressure relief valve with anti-cavitation function
- 6 Plug

The SX 10 directional control block basically consists of one inlet element, a number of directional valve elements and one final element.

The inlet element contains one fixing point and the pipe connection ports P, T, LS, M.

This element also contains all the components required for the system function, namely: a flow control valve for the controlled unloading of the LS line, a LS relief valve for the limitation of the maximum pressure in the system and a pressure compensator.

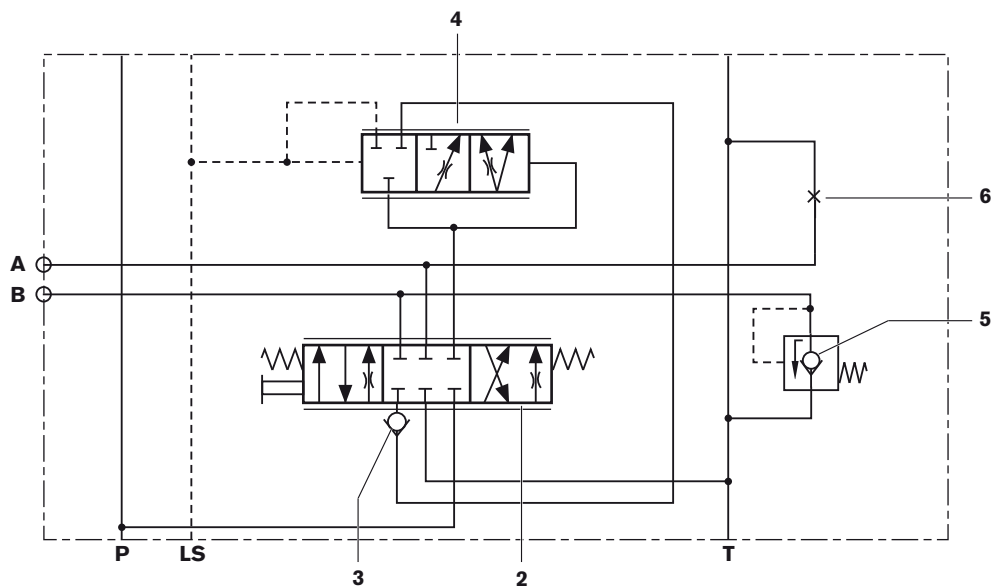
Each SX directional valve element is composed of a housing (1), a spool (2), two load holding check valves (3) placed inside the spool, a pressure compensator (4), cavities for direct operated pressure relief valves with anti-cavitation function (5), and anti-cavitation check valves or plugs (6).

The final element has two fixing points.

Hydraulic Symbol

Orifices

- P Pump
- A, B Actuator
- T Tank
- LS Load Sensing



Technical data (For applications outside these parameters, please consult us!)

General

Design	flangeable (up to 10 directional valve elements)
Description	flow distribution between the directional valve elements proportional to the requirements, independently of the pressure and available flow
Type	SX 10
Installation	optional
Nominal size	10

Hydraulic

Max. permissible flow	port P	l/min	80
	port A, B	l/min	50
Standard leakage oil flow on load holding (at 100 bar, 36 mm ² /s)		cm ³ /min	15 maxi
Max. operating pressure per connection	P, M, LS	bar	250
	A, B	bar	300
	T	bar	20
	for applications at higher pressure: please consult us.		
Secondary valves setting pressure tolerances (at 5 l/min)	bar	setting	tolerance
		101 - 170	-5 / +10
		171 - 230	-7 / +13
		231 - 300	-10 / +15
Max. control pressure per connection	a, b	bar	35
	we recommend the use of control curve 6 to 25 bar, and inlet pressure (30 bar mini)		
Pressure fluid	mineral oils (HL, HLP) to DIN 51524 ¹⁾ . HEES fluids to VDMA 24568 as well as fluids to Rexroth catalogue sheet RE 90221: please consult us.		
¹⁾ suitable for NBR seals			
Pressure fluid temperature range	°C	-20 to +100 inside the block	
Viscosity range	mm ² /s	10 to 380	
Maximum permissible degree of contamination authorised for hydraulic fluid, purity degree according to ISO 4406 (c)	Class 20/18/15, therefore we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$		

Technical data (For applications outside these parameters, please consult us!)

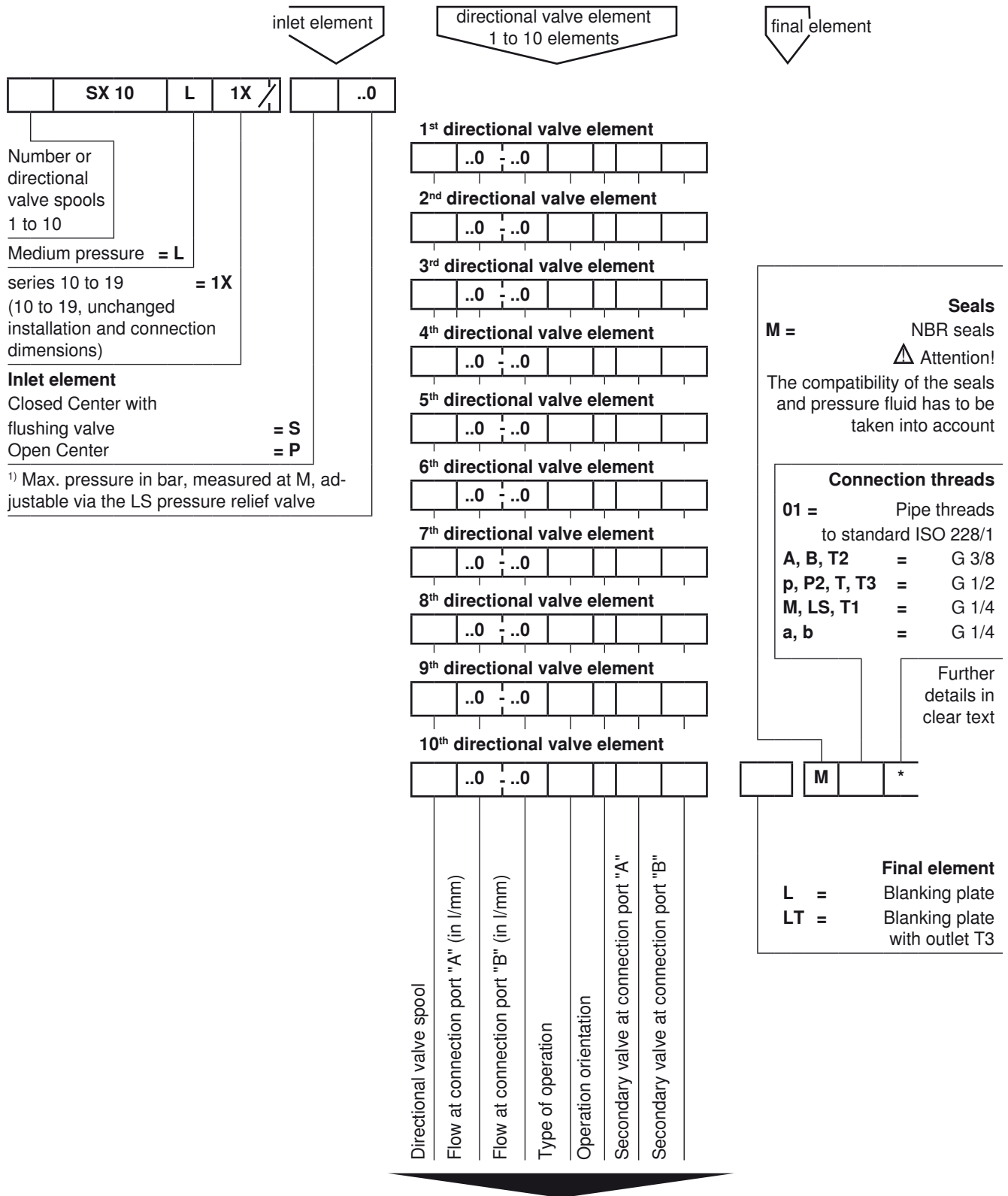
Mechanical

Weight		
Inlet element	kg	5
Directional valve element	kg	2.1
Blanking plate	kg	2
Spool return force	N	55 to 95 (with standard spring)
Max. permissible actuation force on the spool (for 1 million cycles)		
- axial	N	1000 during 20% of total cycles then 500
- radial	N	16
Storage temperature	°C	-40 to +60

Installation guidelines

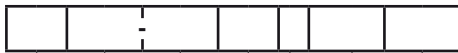
		Pipe connections				
		P, P2	T, T3	M, LS, T1	A, B, T2	a, b
Tightening torque for the pipe connections	Nm	50	50	20	30	20
Recommended fixing		at 3 locations				
Flatness of the mounting surface	mm	0.5				
Setting of system pressure The hydraulic circuit may not generate any un- controlled leak flow in the LS line		via the LS pressure relief valve				
Do not direct the jet of a pressure washing unit directly at the unit						

Ordering details: SX 10 directional control block



Ordering details: see page 6

¹⁾ set with a Δp of 15 bar between M and LS



port "A"

port "B"

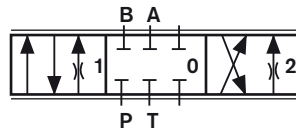
Secondary valves
H..0* = direct actuated pressure relief valve with anti-cavitation function
***** = pressure value in bar
E = anti-cavitation check valve
Q = plug

Operation orientation
No code = without mechanical operator (H200)
A = mechanical operator on connection side A
B = mechanical operator on connection side B

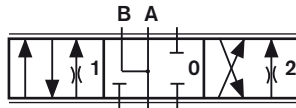
Type of operation
A2 = 3 positions spool return via a spring
E2 = 4 positions spool return via a spring
Z1 = mechanical operator with tongue (Ø 6)
H 200 = hydraulic operator, spool return via a spring
H 230 = hydraulic operator, spool return via a spring, stroke limitation on connection sides A and B

Flow at connection ports
050 = flow at connection port B in l/min
 Other flow values (rated in 10 l/min ranges): please consult us
050 = flow at connection port A in l/min
 Other flow values (rated in 10 l/min ranges): please consult us

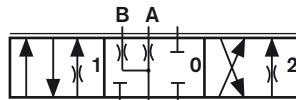
Directional valve spools



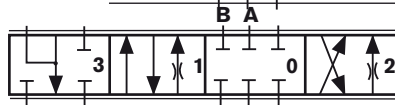
= EA



= JA



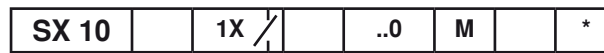
= QA



= WA

Ordering details: separate element

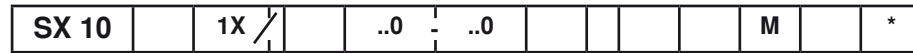
Inlet element



see ordering details page 5

see ordering details of inlet element page 5

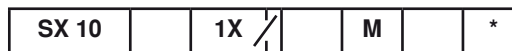
Directional valve element



see ordering details pages 5 and 6

see ordering details of directional valve element pages 5 and 6

Final element



see ordering details page 5

see ordering details of final element page 5

Ordering example - complete block SX10

Desired execution:

3 directional valve elements

Inlet element:

Open Center,
Max. pressure = 200 bar

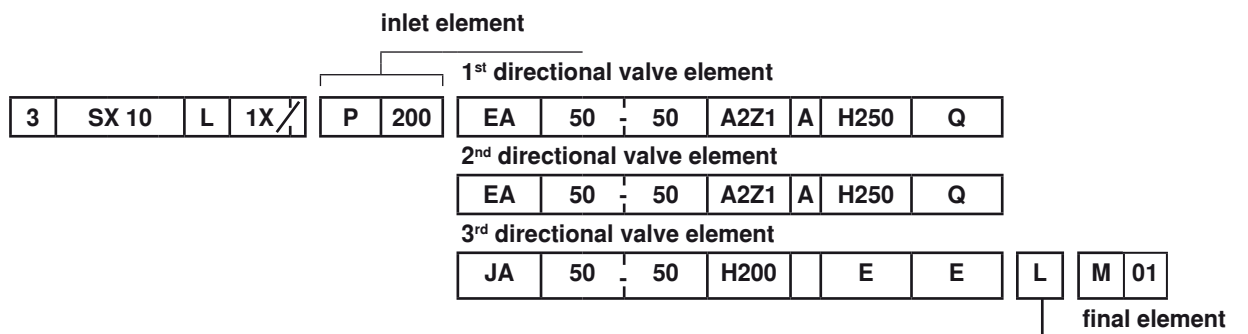
3 directional valve elements:

- 1st and 2nd elements:
 - Spool symbol = EA
 - Flow in A = 50 l/min, Flow in B = 50 l/min
 - Mechanical operator with tongue on connection side A, spool return via a spring
 - Secondary valve in A = direct operated pressure relief valve with anti-cavitation function set at 250 bar
 - Secondary valve in B = plug
- 3rd element:
 - Spool symbol = JA
 - Flow in A = 50 l/min, Flow in B = 50 l/min
 - Hydraulic operator, spool return via a spring
 - Secondary valves in A and B = anti-cavitation check valve

Final element:

Blanking plat

Ordering details:

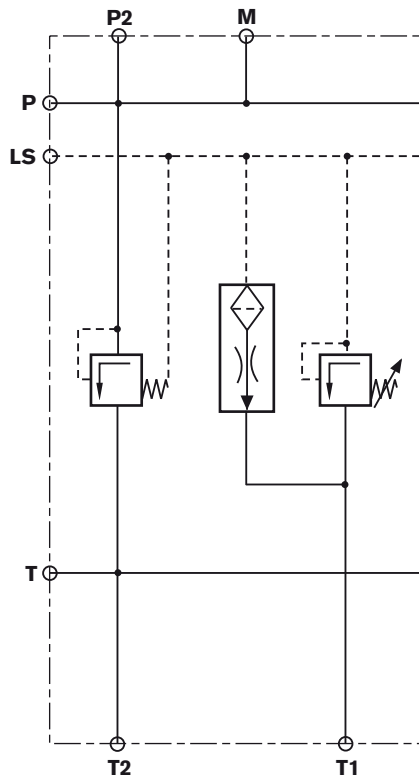


Inlet element

Closed center with flushing valve

Ordering detail

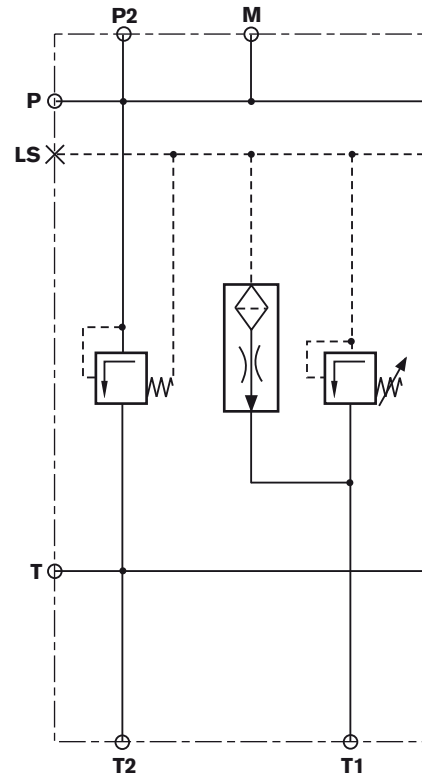
S



Open center

Ordering detail

P



Final element

Blanking plate

Ordering detail

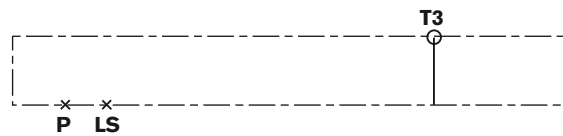
L



Blanking plate with outlet T3

Ordering detail

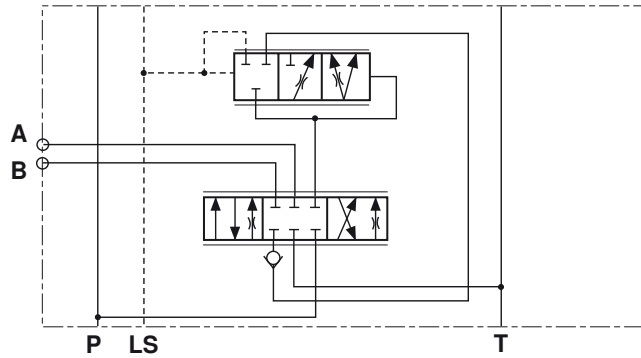
LT



Directional valve element

Representation of the SX directional valve element

Simplified symbol used to illustrate SX directional control circuits

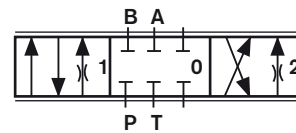


Spool variations

Ordering detail

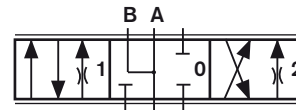
EA...-...:

Symbol EA



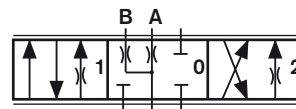
JA...-...:

Symbol JA



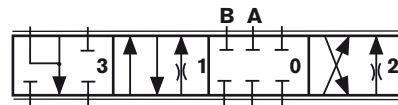
QA...-...:

Symbol QA



WA...-...:

Symbol WA

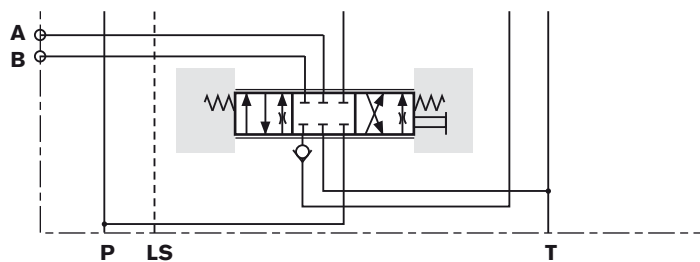


Type of operator

Mechanical operator with tongue on connection side A, spool return via a spring 3 positions

Ordering detail

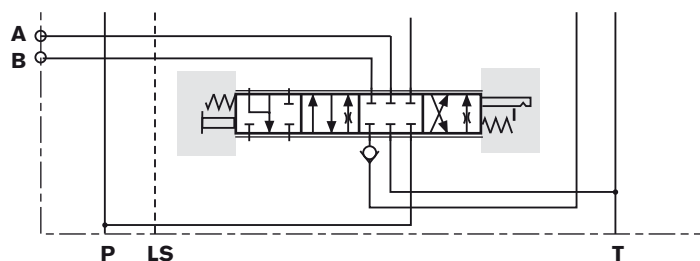
A2Z1A



Mechanical operator with tongue on connection side B, spool return via a spring 4 positions

Codification

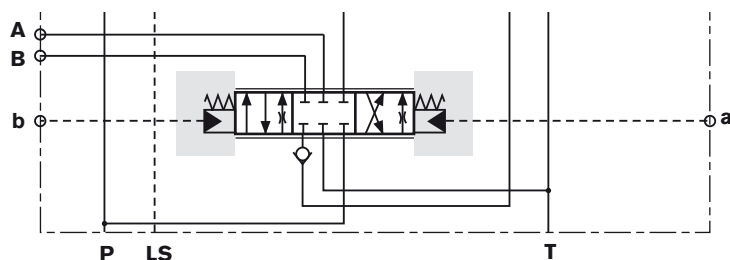
E2Z1B



Directional valve element

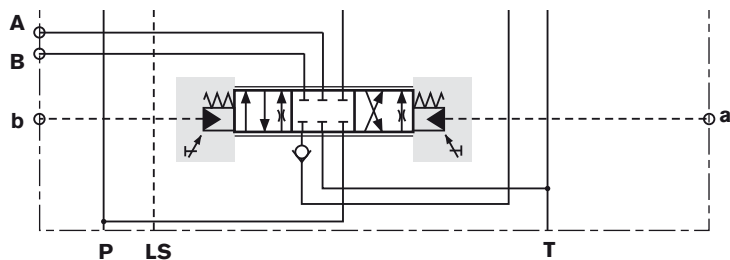
Hydraulic operator, spool return via a spring

Ordering detail
H200



Hydraulic operator with adjustable stop pins, spool return via a spring

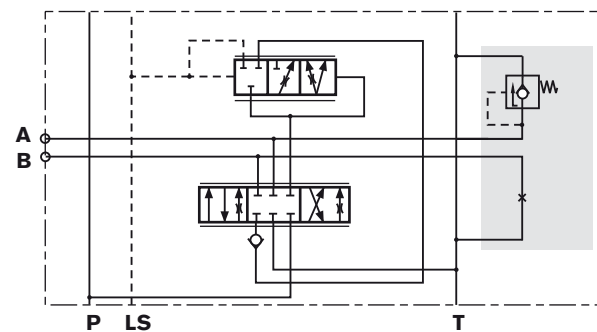
Ordering detail
H230



Secondary valves

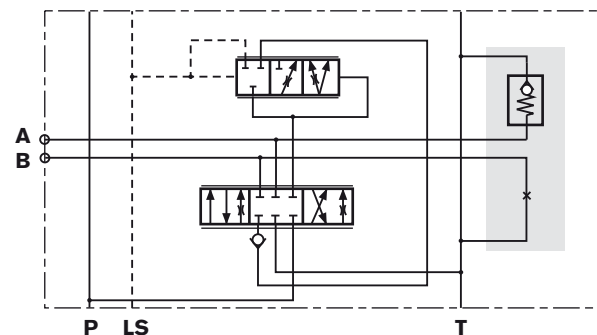
Direct operated pressure relief valve with anti-cavitation function (on connection side A); plug (on connection side B)

Ordering detail
H...Q

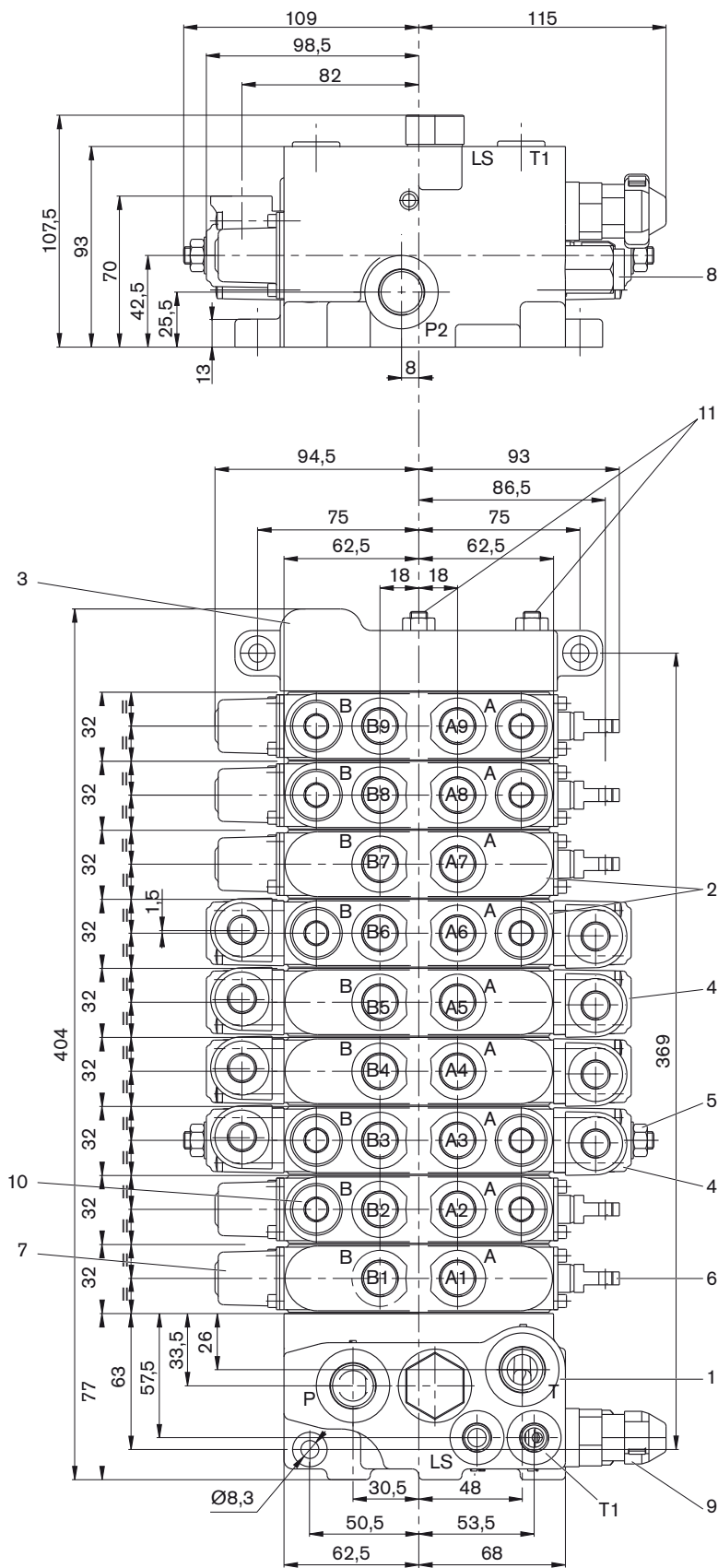


Anti-cavitation check valve (on connection side A); plug (on connection side B)

Ordering detail
EQ



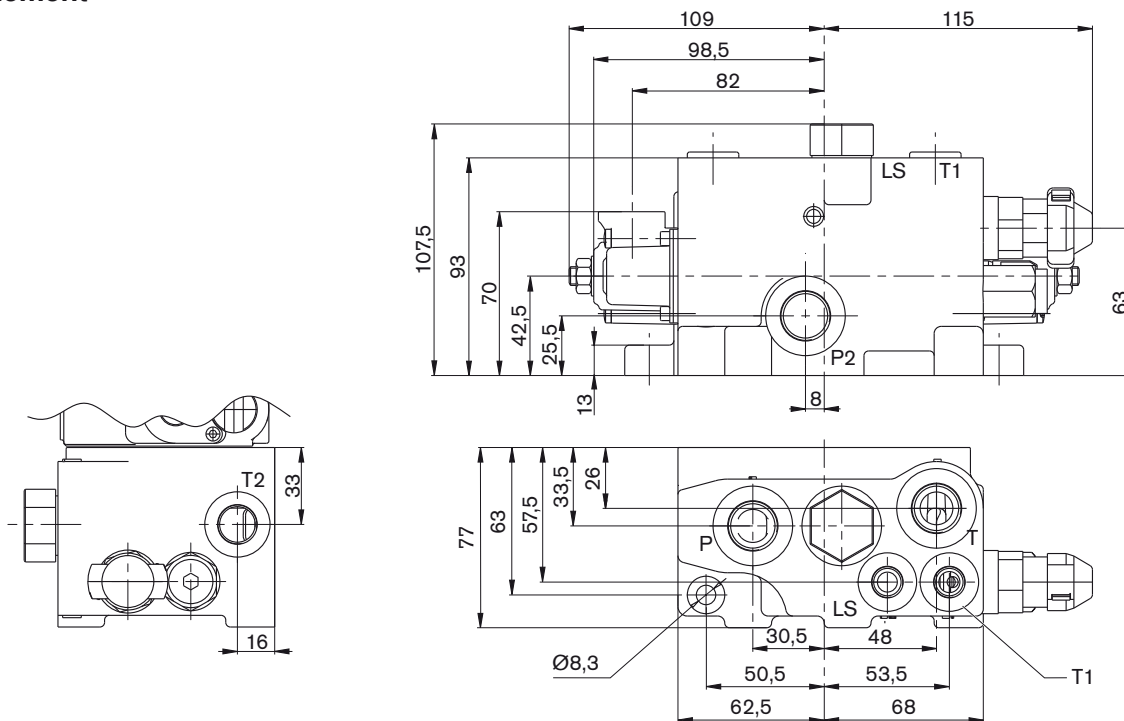
Unit dimensions (in mm)



- 1 Inlet element
- 2 Directional valve element
- 3 Blanking plate
- 4 Cover for hydraulic operator
- 5 Stroke limitation and hydraulic connection
- 6 Mechanical operator with tongue
- 7 Cover for spring return arrangement
- 8 LS flow control valve
(tightening torque = $20 \pm 10\%$ Nm)
- 9 LS pressure relief valve
(tightening torque = $45 \pm 10\%$ Nm)
- 10 Secondary pressure relief valve
(tightening torque = 30 to 35 Nm)
- 11 3 tie rods (nuts tightening torque = $20 \pm 10\%$ Nm)

Unit dimensions (in mm)

Inlet element



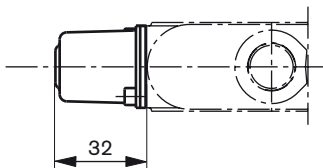
Mechanical or manual operators, spool return via a spring

Spool return via a spring

3 positions

Ordering detail

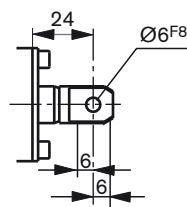
A2



Manual operators

Ordering detail

Z1

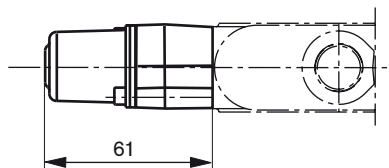


Tongue thickness
6 mm

4 positions

Ordering detail

E2

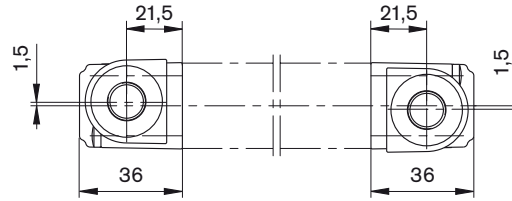


Unit dimensions (in mm)

Hydraulic operator, spool return via a spring

Ordering detail

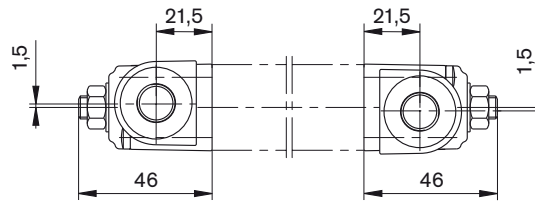
H200



Hydraulic operator with adjustable stop pin, spool return via a spring

Ordering detail

H230

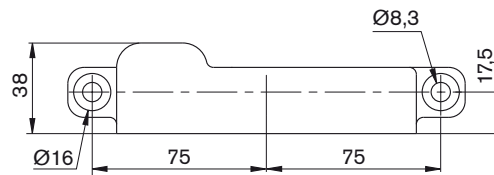


Final element

Blanking plate

Ordering detail

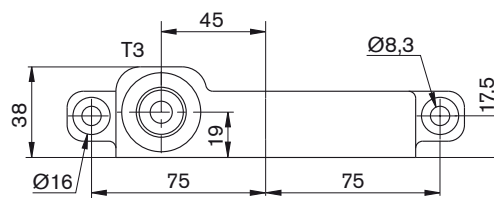
L



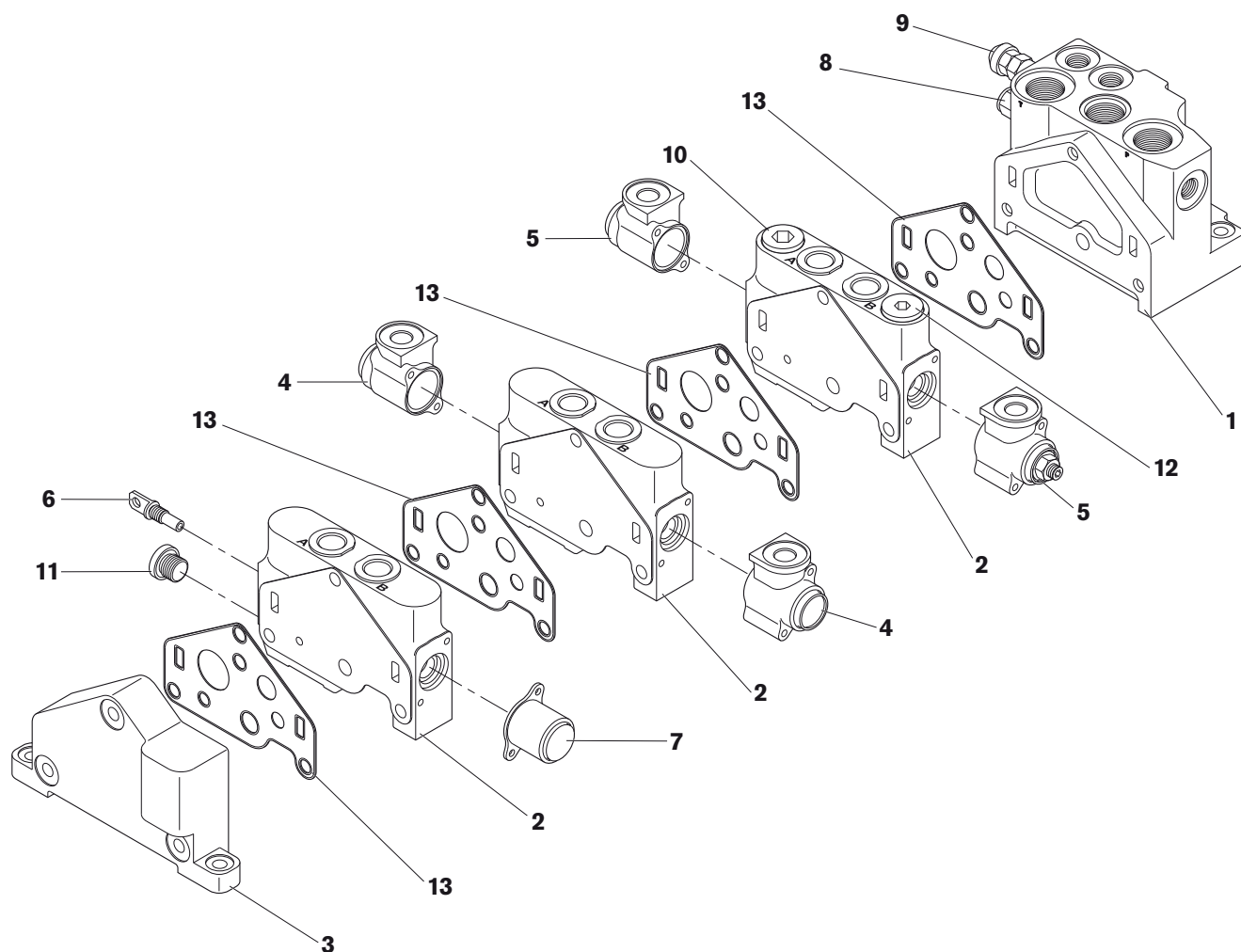
Blanking plate with outlet T3

Ordering detail

LT

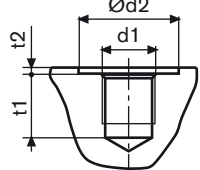


Assembly possibilities



- | | | | |
|---|---|----|--|
| 1 | Inlet element | 8 | LS flow control valve |
| 2 | Directional valve element | 9 | LS pressure relief valve |
| 3 | Blanking plate L | 10 | Secondary pressure relief valve |
| 4 | Cover for hydraulic operator H200 | 11 | Plug for individual pressure compensator |
| 5 | Cover for hydraulic operator H230 | 12 | Plug |
| 6 | Mechanical operator with tongue type Z1 | 13 | Seals plate |
| 7 | Spring return arrangement type A2 | | |

Pipe connections

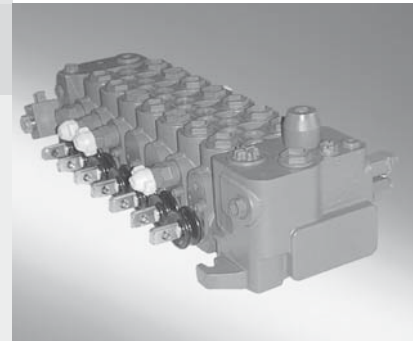


01				
ports	d1	Ød2	t1	t2
A, B, T2	G 3/8	-	14	1
P, P2, T, T3	G 1/2	34	14	1
M, LS, T1, a, b	G 1/4	25	12	1

LUDV control block of sandwich plate design

Type SX 14, SX 14 S

Nominal size 14
Series 2X
Maximum pressure, pump side 250 bar
Maximum pressure, actuator side 300 bar
Inlet flow 175 l/min



2

Table of contents

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Special features	1
About this datasheet	2
Sections	3
Functional description, Symbol	4
Technical data	5, 6
Characteristic curves	7
Ordering details	8 to 11
Inlet elements	12
Directional valve elements	13 to 15
Final elements, Circuit example	16
Unit dimensions	17 to 20
Assembly possibilities	21
Pipe connections	22

Special features

- Distributes the flow between the directional valve elements according to the requirements, independently of the pressure and available flow.
- Compact sandwich plate design, can be combined so that the control block can meet the requirements of several type of machines.
- No shuttle valves.
- Limitation of system maximum pressure via LS pressure relief valve.
- System protection via LS and secondary pressure relief valves.

About this datasheet

This manual describes functioning, technical data and ordering details of control blocks SX 14 and SX 14 S. This manual is illustrated with hydraulic symbols, sections and unit dimensions drawings.

Related documents

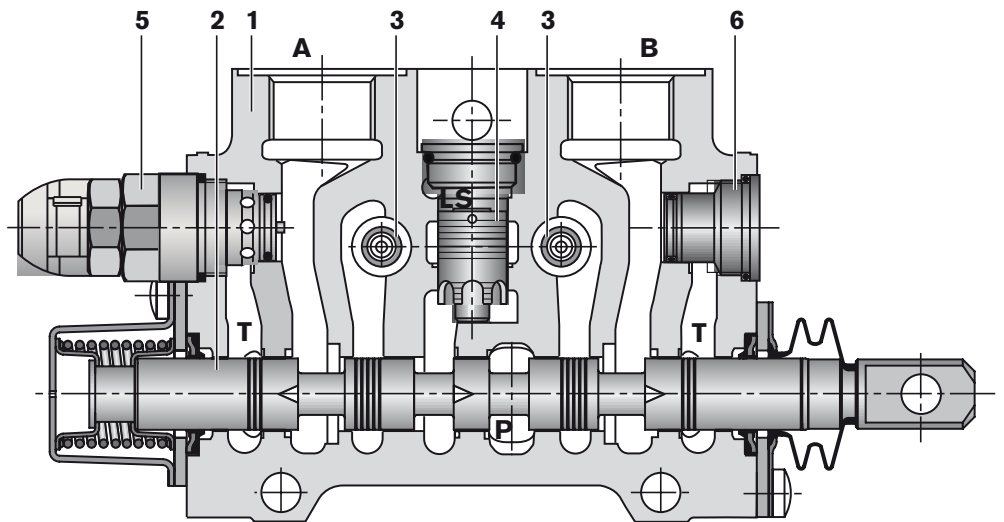
SX 14 and SX 14 S are system components.

- Also follow the instructions for the other system components.
- Also follow the instructions in the following manuals:
 - System documentation from the system manufacturer
 - Service instruction manual RE64025
 - Spare parts manual RDEF64125-E
 - Assembly Instructions RE64125-S

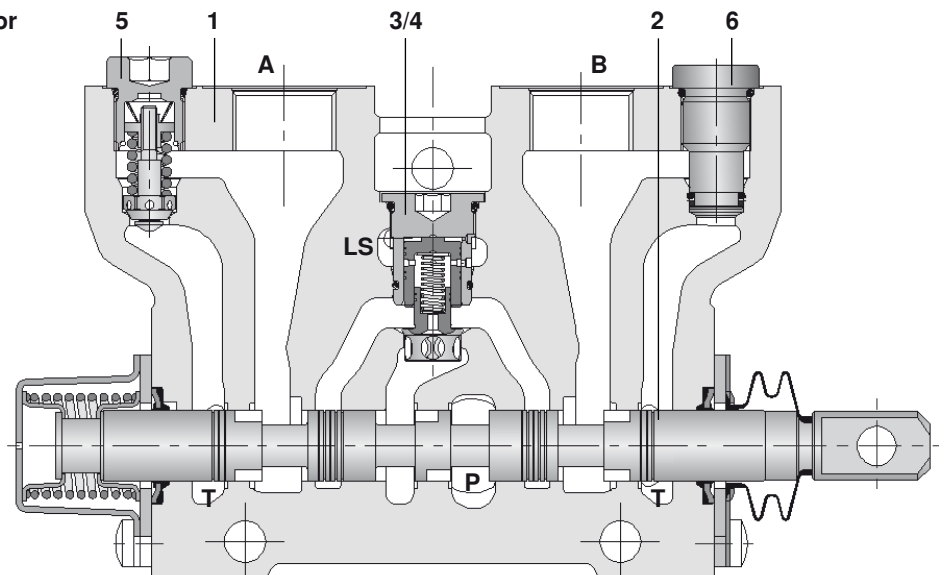
Sections

Standard SX 14 (SX 14)

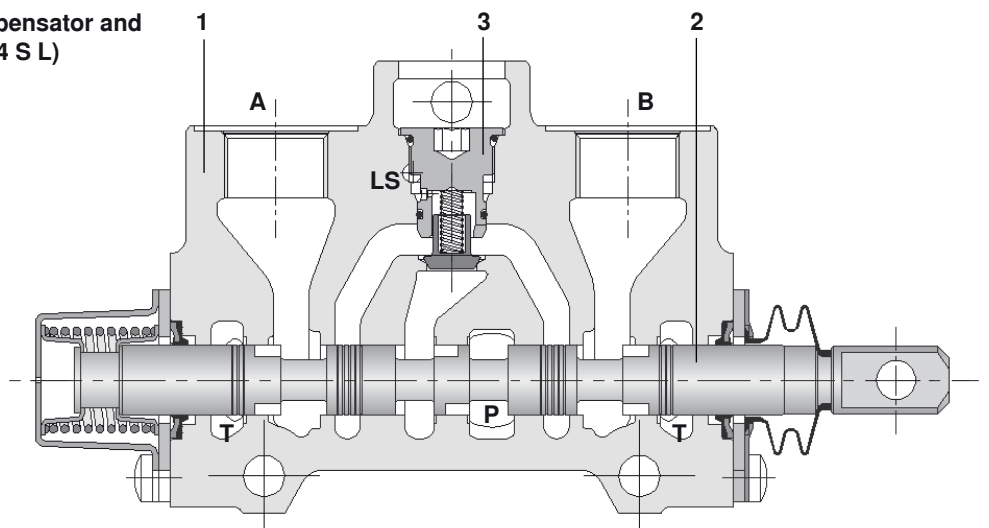
- 1 Housing
- 2 Spool
- 3 Check valves
- 4 Pressure compensator
- 5 Secondary valve
- 6 Plug



SX 14 S with pressure compensator and secondary valves (SX 14 S C)



SX 14 S without pressure compensator and without secondary valve (SX 14 S L)



Functional description

The SX 14 directional control block basically consists of one inlet element, a number of directional valve elements and one final element.

The inlet element contains 2 fixing points and the pipe connection ports P, T, LS, M.

This element also contains all the components required for the system function, namely: a flow control valve for the controlled unloading of the LS line and a LS relief valve for the limitation of the maximum pressure in the system.

Each standard SX 14 (SX 14) directional valve element is composed of a housing (1), a spool (2), two load holding

check valves (3), a pressure compensator (4), cavities (5) for secondary relief/anti-cavitation check valves, and anti-cavitation check valves or plugs (6).

Each SX 14 S directional valve element is composed of a housing (1), a spool (2), one load holding check valve / compensator (3/4) or only a load hold check valve (3), and if needed of cavity for secondary valves (5) or for plugs (6).

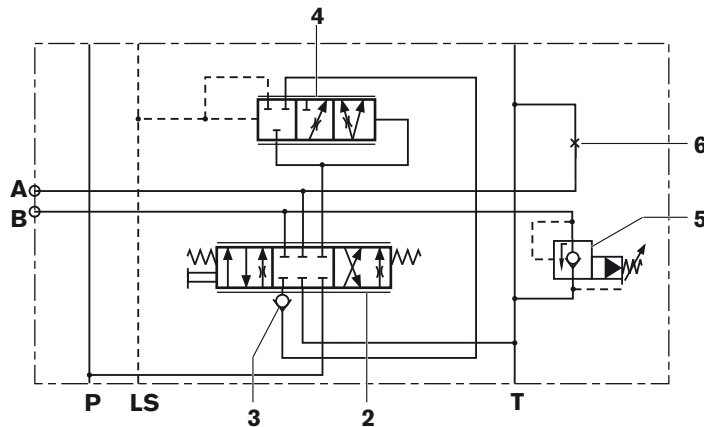
The final element has one fixing point.

Symbol, hydraulic

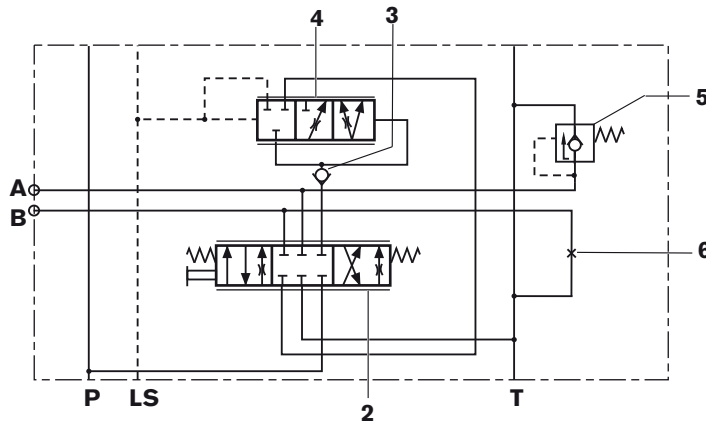
Standard SX 14 (SX 14)

Ports

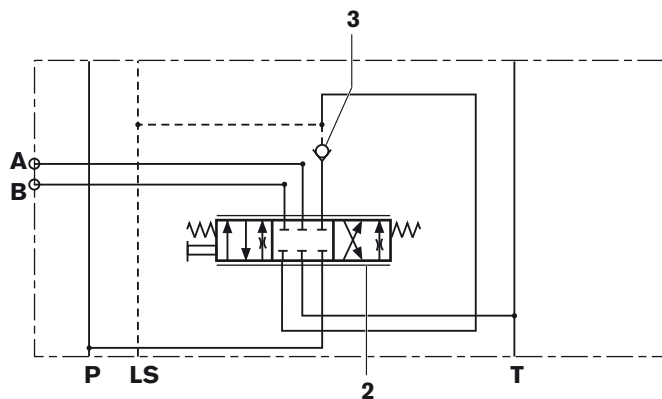
- P Pump
- A, B Actuator
- T Tank
- LS Load Sensing



SX 14 S with pressure compensator and secondary valves (SX 14 S C)



SX 14 S without pressure compensator and without secondary valve (SX 14 S L)



Technical data (for applications outside these parameters, please consult us!)

General

Design	Flangeable (up to 9 directional valve elements)
Description	Flow distribution between the directional valve elements according to the requirements, independently of the pressure and available flow
Type	SX 14
Assembly position	Any
Connections	Threads
Nominal size	14
Standard primer	Blue (RAL 5010)

Hydraulic

Max. permissible flow on port P	l/min	175												
Standard leakage oil flow on load holding (at 100 bar, 36 mm ² /s)	cm ³ /mn	20												
Max. operating pressure per connection														
– P, M, LS, D, DLS	bar	250												
– A, B	bar	300												
– T	bar	20												
Secondary valves setting pressure tolerances (at 5 l/min)														
– H..0 direct actuated (SX14 S)	bar	<table border="1"> <thead> <tr> <th>setting</th> <th>tolerance</th> </tr> </thead> <tbody> <tr> <td>71 → 120</td> <td>-4 / +8</td> </tr> <tr> <td>121 → 200</td> <td>-6 / +12</td> </tr> <tr> <td>201 → 270</td> <td>-8 / +12</td> </tr> <tr> <td>271 → 320</td> <td>-10 / +14</td> </tr> <tr> <td>321 → 420</td> <td>-12 / +18</td> </tr> </tbody> </table>	setting	tolerance	71 → 120	-4 / +8	121 → 200	-6 / +12	201 → 270	-8 / +12	271 → 320	-10 / +14	321 → 420	-12 / +18
setting	tolerance													
71 → 120	-4 / +8													
121 → 200	-6 / +12													
201 → 270	-8 / +12													
271 → 320	-10 / +14													
321 → 420	-12 / +18													
– H..0 pilot operated (standard SX 14)	bar	0 / +5												
Max. control pressure per connection ¹⁾														
– a, b	bar	35												
		We recommend the use of control curve 6 to 25 bar, and inlet pressure (4TH6 curve no. 70)												
Pressure fluid		Mineral oils (HL, HLP) according to DIN 51524 ²⁾ . Other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified under RE 90221, at request.												
Pressure fluid temperature range	°C	-20 to +100 (for higher temperatures, please consult us)												
Viscosity range	mm ² /s	10 to 380												
Max. admissible degree of contamination of the hydraulic fluid, cleanliness class according to NAS 1638		Class 9, we therefore recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$												

¹⁾ pilot pressure regulated by a pressure reducing valve and protected by a relief valve

²⁾ suitable for NBR seals

Technical data (for applications outside these parameters, please consult us!)

Mechanical

Weight	- Inlet element	kg	10
	- Directional valve element SX 14	kg	4.5
	- Directional valve element SX 14 S with secondary valves	kg	5
	- Directional valve element SX 14 S without secondary valve	kg	4
	- Blanking plate	kg	2
Spool return force	N	Minimum value 54, depending of operation (for more details please consult us)	
Max. permissible actuation force on the spool (for 1 million cycles)	- axial	N	1000 during 20 % of total cycles then 500
	- radial	N	20
	Storage temperature range, ambient	°C	-40 to +60

Electrical

Electrical detent when spool is pushed (operation S2) (datas for 25 °C)			
- supply voltage	V	12 (min. 10; max. 16)	
- supply current	mA	780 (min. 670; max. 785)	
- power input	W	9.35 ±5 %	
- resistance	Ω	15.4 ±5 Ω	
- lifetime		1 million cycles at 90 °C, work factor 50 %	
- protection classification		IP65	
- maximum temperature reached by the electro-magnet	°C	110 at a room temperature of 90 °C	
Solenoid On / Off (operation V212)			
- supply voltage	V	12	
- supply current	A	4	
- power input	W	48	
- resistance	Ω	3	

Application guidelines

		Pipe connections			
		A, B, P, T3	T	a, b, DLS, LS, M, T1	D
Tightening torque for the pipe connections	Nm	70	100	20	50
Recommended fixing		at 3 locations maximum			
Flatness of the mounting surface	mm	0.5			
Setting of system pressure		via the LS relief valve			

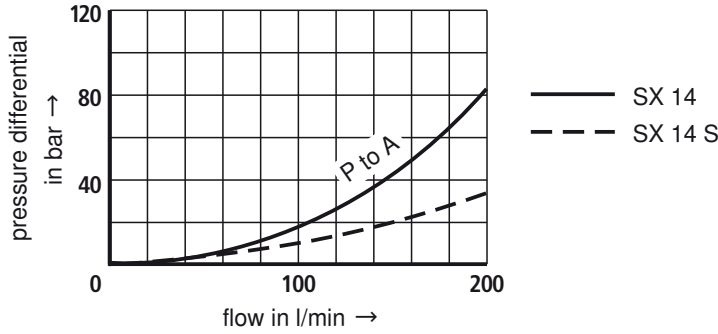
- Do not direct the jet of a pressure washing unit directly at the unit.

- No free-wheeling diode required for electrical operations.

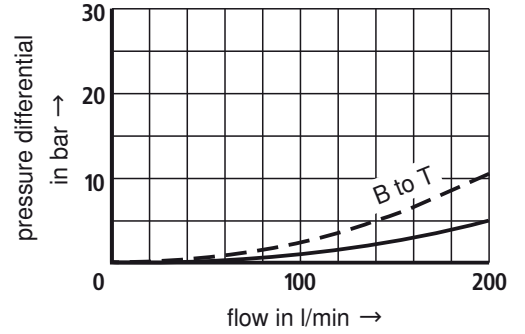
- Mechanical operation spool : a greasy appearance on the tongue side is normal (due to natural effect of seal lubrication). It could be necessary to proceed to a regular cleaning of this area.

Characteristic curves (measured at $v = 36 \text{ mm}^2/\text{s}$ and $\theta = 50 \text{ }^\circ\text{C}$)

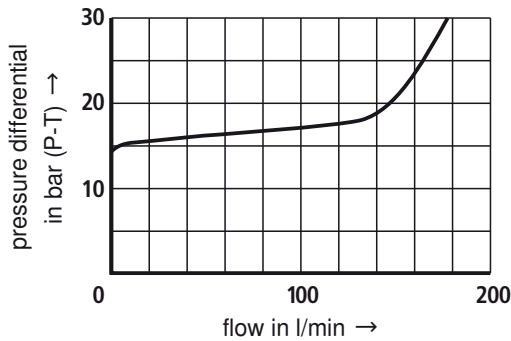
Pressure differential with P switched to A/B with spool 200 l/min



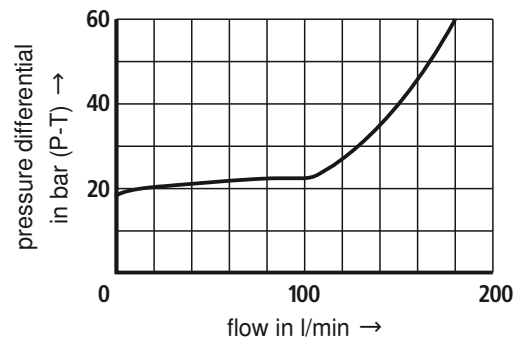
Pressure differential with A/B switched to T with spool 200 l/min



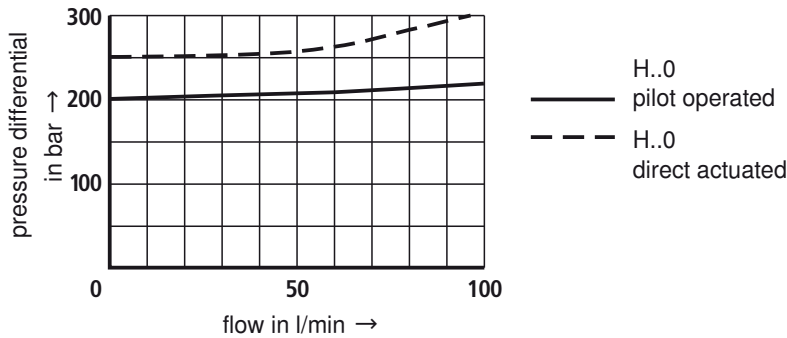
Pressure differential in the neutral position of inlet element type P (Open Center execution)



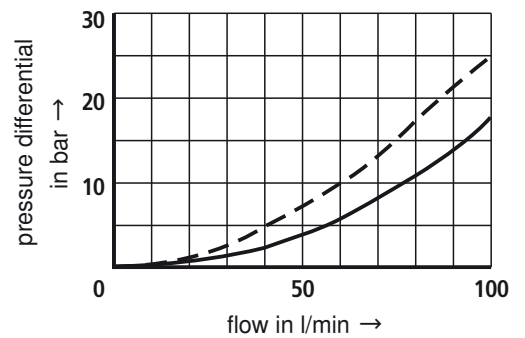
Pressure differential in the neutral position of the inlet element with flushing valve



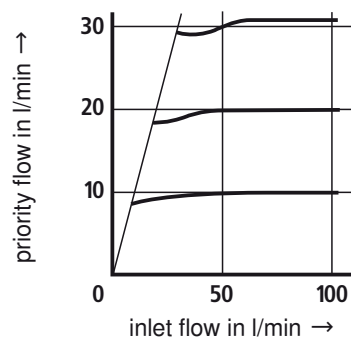
Secondaries valves characteristic A/B switched to T



Anti-cavitation check valves Characteristic T switched to A/B



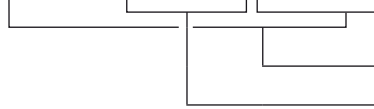
Priority flow in relationship to the inlet flow



Ordering details: separate elements

Inlet element

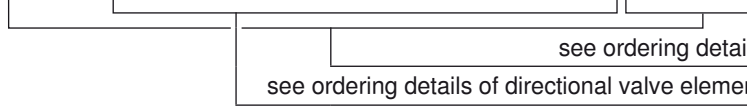
SX 14		2X/	..0	M		*
-------	--	-----	-----	---	--	---



see ordering details page 9
see ordering details of inlet element page 9

Directional valve element

SX 14		2X/	..0	..0					M		*
-------	--	-----	-----	-----	--	--	--	--	---	--	---



see ordering details pages 9 and 10
see ordering details of directional valve element pages 9 and 10

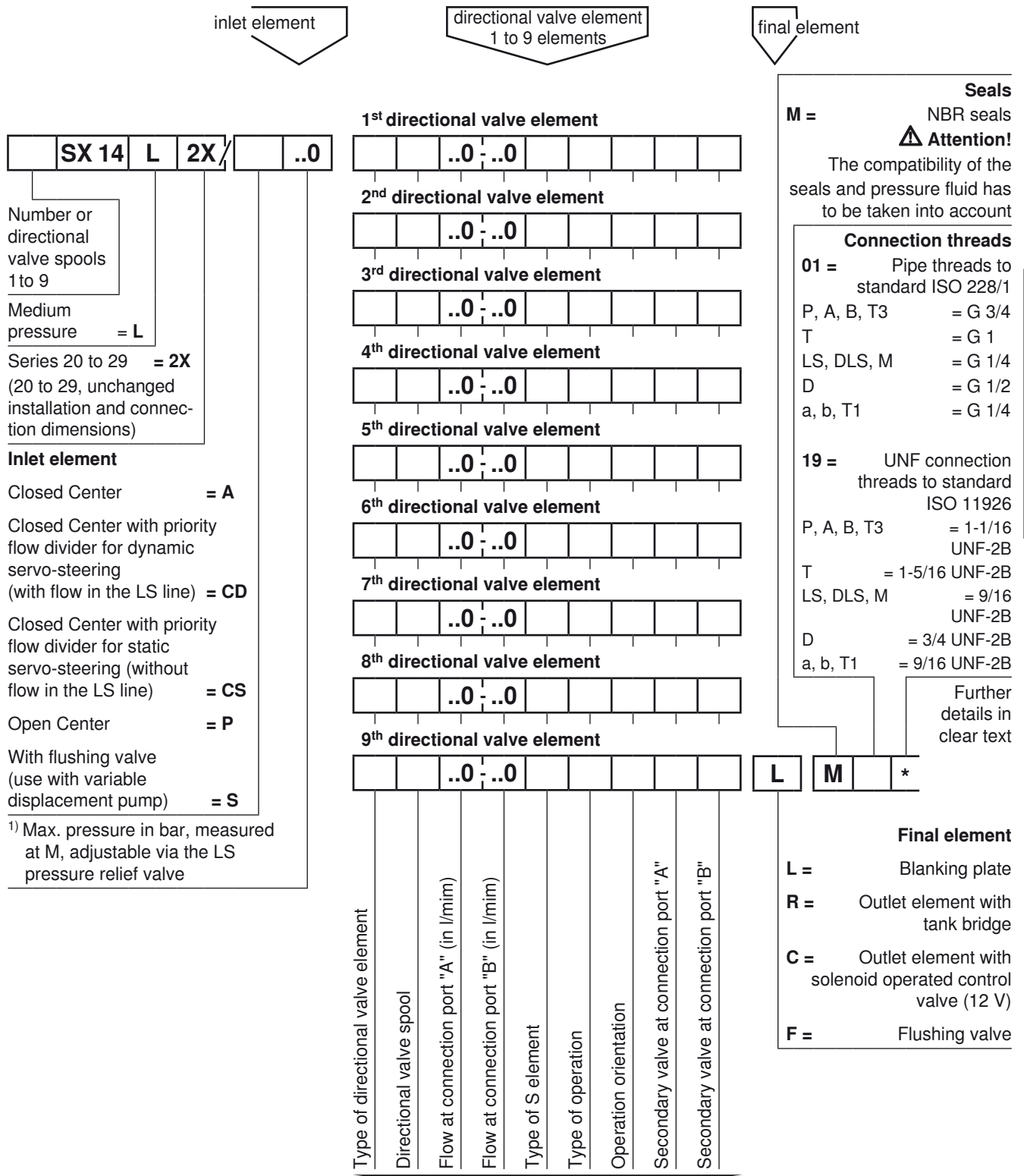
Final element

SX 14		2X/		M		*
-------	--	-----	--	---	--	---



see ordering details page 9
see ordering details of final element page 9

Ordering details: SX 14 directional control block



ordering details : see page 10

¹⁾ set with a Δp of 15 bar between M and LS (not for inlet element in Open Center execution)

Ordering example: complete block SX 14

Desired execution: 4 directional valve elements

Inlet element: Open Center,
Max. pressure = 220 bar

4 directional valve elements:

- 1st element:
 - Standard element
 - Spool symbol = EA
 - Flow in A = 120 l/min, flow in B = 80 l/min
 - Mechanical operator with tongue on connection side A, spool return via a spring
 - Secondary valve in A = relief / anti-cavitation check valve set at 300 bar
 - Secondary valve in B = plug

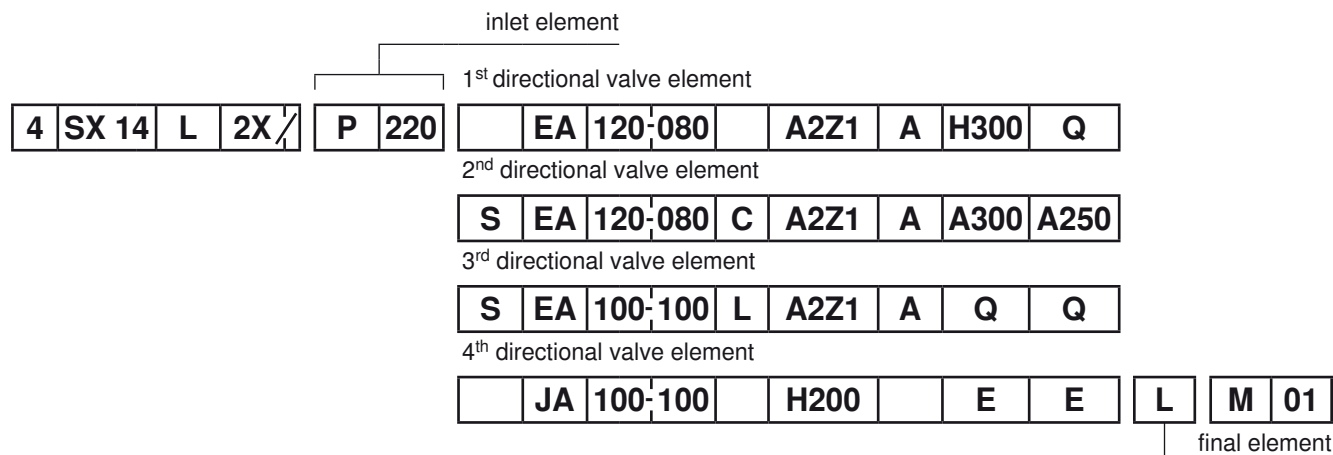
- 2nd element:
 - S element
 - Spool symbol = EA
 - Flow in A = 120 l/min, flow in B = 80 l/min
 - Check valve + pressure compensator
 - Mechanical operator with tongue on connection side A, spool return via a spring
 - Secondary valve in A = direct actuated relief / anti-cavitation check valve set at 300 bar
 - Secondary valve in B = direct actuated relief / anti-cavitation check valve set at 250 bar

- 3rd element :
 - S element
 - Spool symbol = EA
 - Flow in A = 100 l/min, flow in B = 100 l/min
 - Check valve
 - Mechanical operator with tongue on connection side A, spool return via a spring
 - Plugs in A and B

- 4th element :
 - Standard element
 - Spool symbol = JA
 - Flow in A = 100 l/min, Flow in B = 100 l/min
 - Hydraulic operator, spool return via a spring
 - Secondary valves in A and B = anti-cavitation check valve

Final element : Blanking plate

Type code:

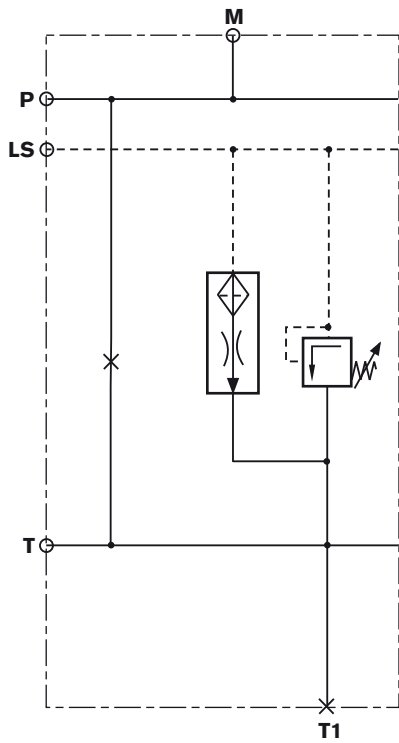


Inlet elements

Closed Center

Ordering detail

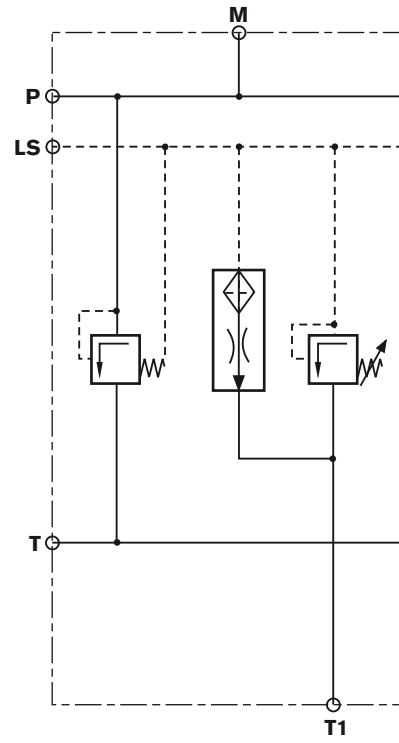
A



Open Center

Ordering detail

P

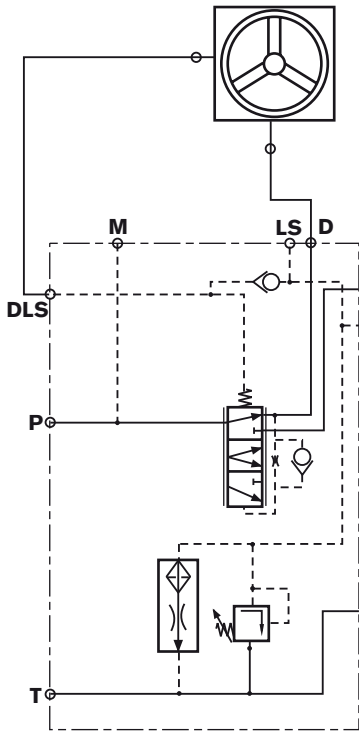


Closed Center with priority flow divider

for static servo-steering

Ordering detail

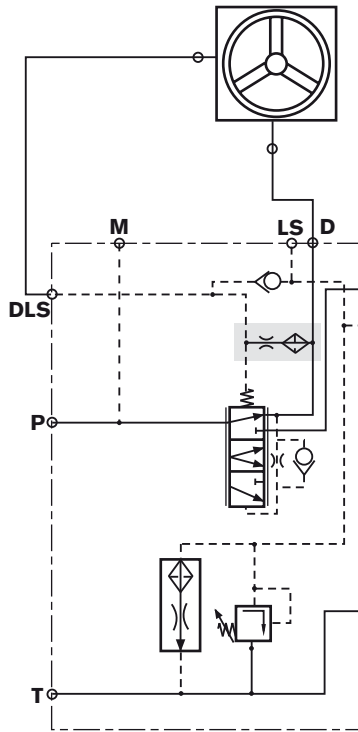
CS



for dynamic servo-steering

Ordering detail

CD

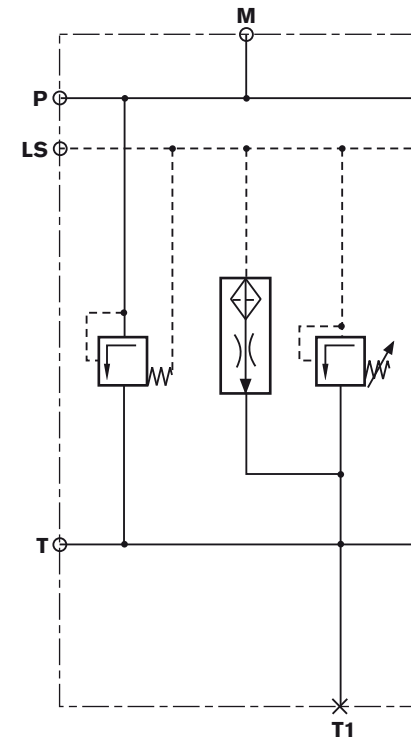


Flushing valve

(use with variable displacement pump and q_{min})

Ordering detail

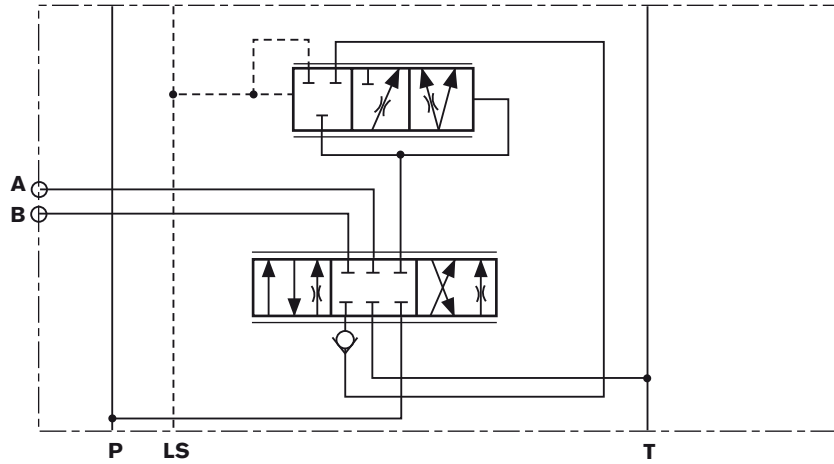
S



Directional valve elements

Representation of the SX directional valve element

Simplified symbol used to illustrate SX directional control circuits



Spool variations Ordering detail

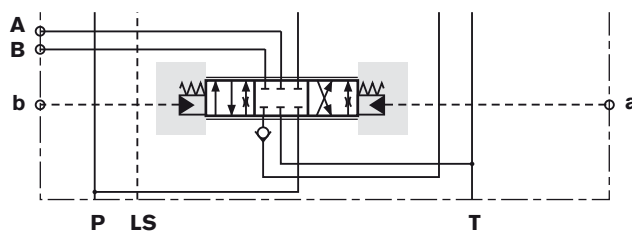
EA...-... :	symbol EA	
JA...-... :	symbol JA	
QA...-... :	symbol QA	
WA...-... :	symbol WA	

Directional valve elements

Type of operation

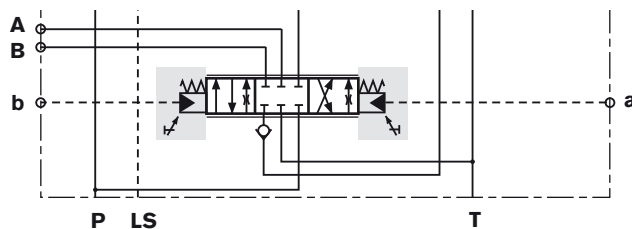
Hydraulic operator, spool return via a spring

Ordering detail
H200



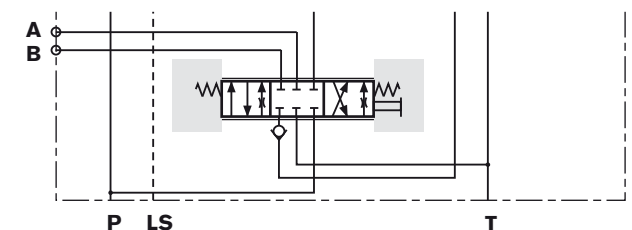
Hydraulic operator with stroke limitation, spool return via a spring

Ordering detail
H230



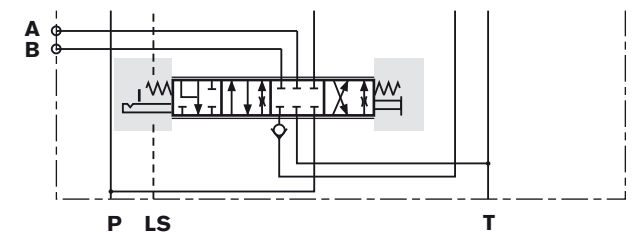
Mechanical operator with tongue on connection side A, spool return via a spring

Ordering detail
A2Z1A



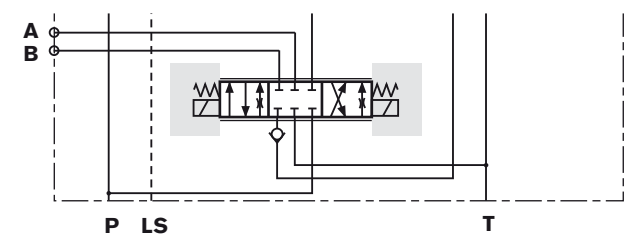
Mechanical operator with tongue on connection side A, spool return via a spring and mechanical detent when spool is pulled

Ordering detail
E2Z1A



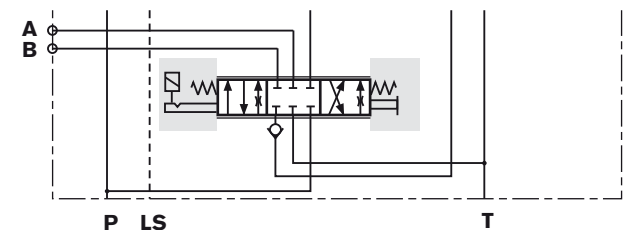
Direct electrical operation

Ordering detail
V212



Mechanical operator with tongue on connection side A, spool return via a spring and electrical detent when spool is pushed

Ordering detail
S2Z1A



Directional valve elements

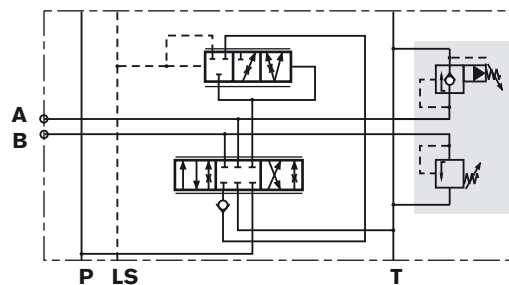
Secondary valves

Relief / anti-cavitation check valve, pilot operated (connection side A); direct actuated pressure relief valve (connection side B) on standard SX 14

(the setting of the given pressure values is carried out at a flow of 5 l/min)

Ordering detail

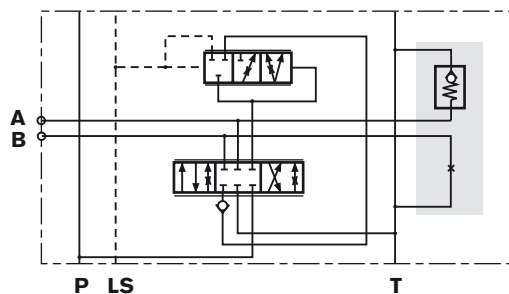
H...A...



Anti-cavitation check valve (connection side A); plug (connection side B) on standard SX 14

Ordering detail

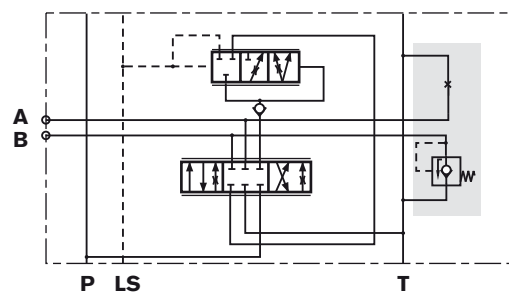
EQ



Plug (connection side A); direct actuated pressure relief valve (connection side B) on SX 14 S

Ordering detail

QH...



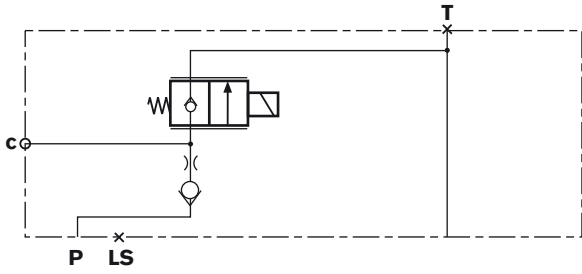
2

Final elements

Outlet element with solenoid operated control valve

Ordering detail

C

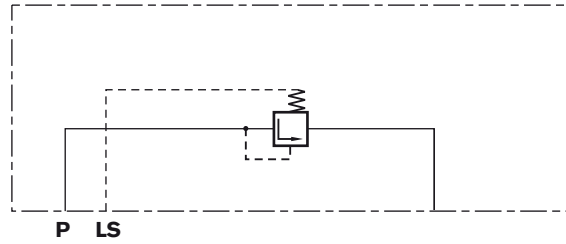


Outlet element with Flushing valve

(for use with inlet element CS or CD)

Ordering detail

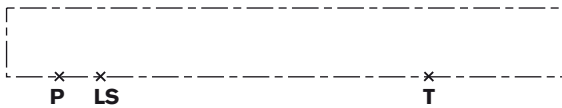
F



Blanking plate

Ordering detail

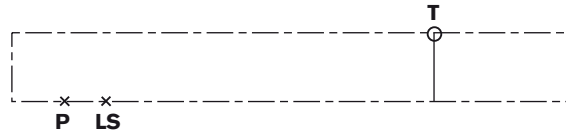
L



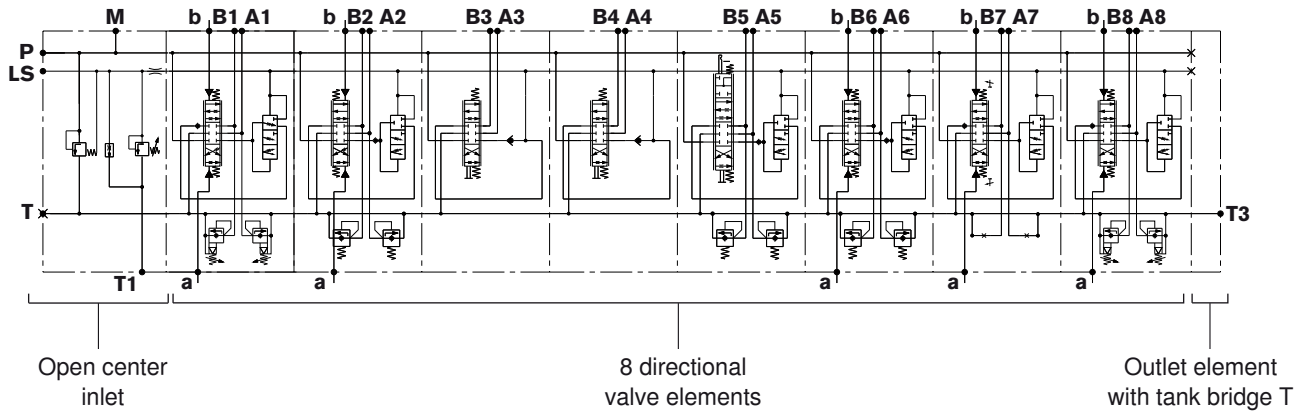
Outlet element with tank bridge T

Ordering detail

R



Circuit example: complete directional control block



Unit dimensions (in mm)

Inlet element in open center execution

Ordering detail

P

or

Inlet element in closed center execution

Ordering detail

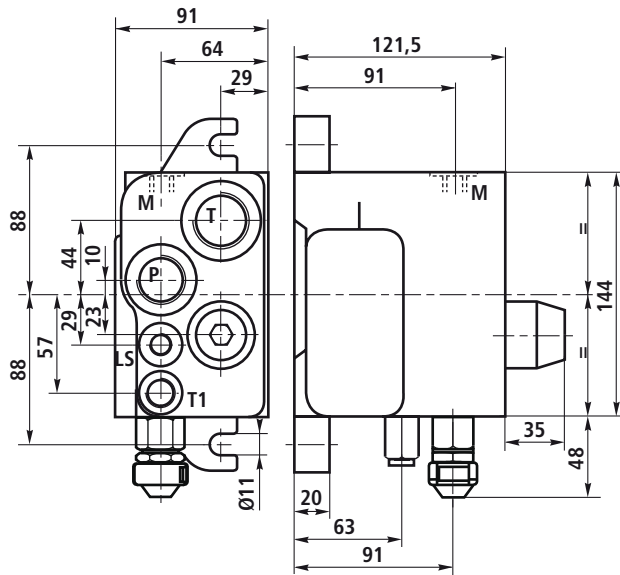
A

or

Inlet element with flushing valve

Ordering detail

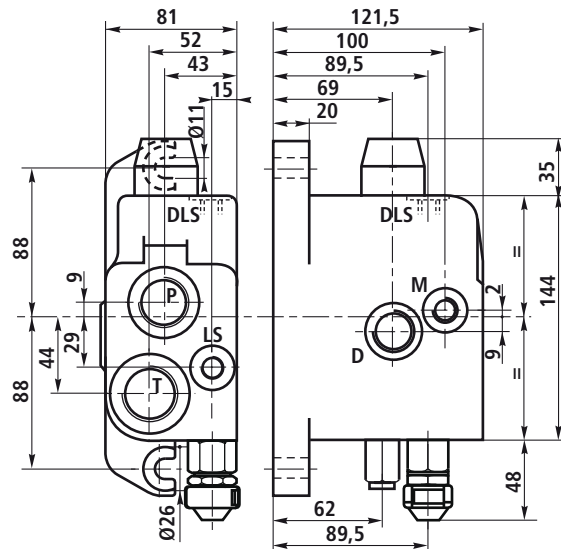
S



Inlet element in closed center execution with priority flow divider

Ordering detail

CD or CS

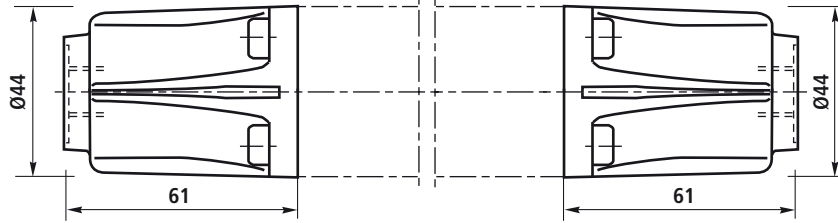


Unit dimensions (in mm)

Hydraulic operator, spool return via a spring

Ordering detail

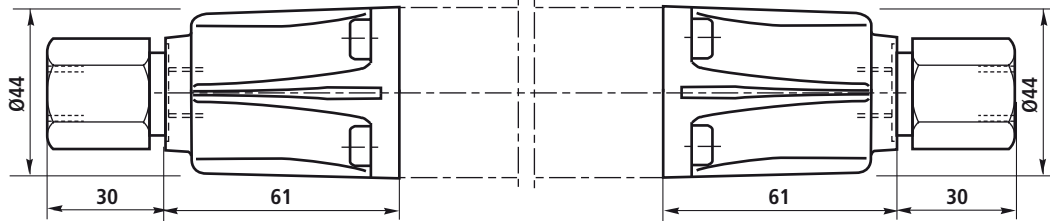
H200



Hydraulic operator with stroke limitation, spool return via a spring

Ordering detail

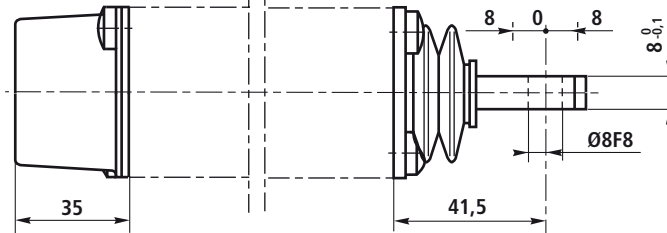
H230



Mechanical operator with tongue, spool return via a spring

Ordering detail

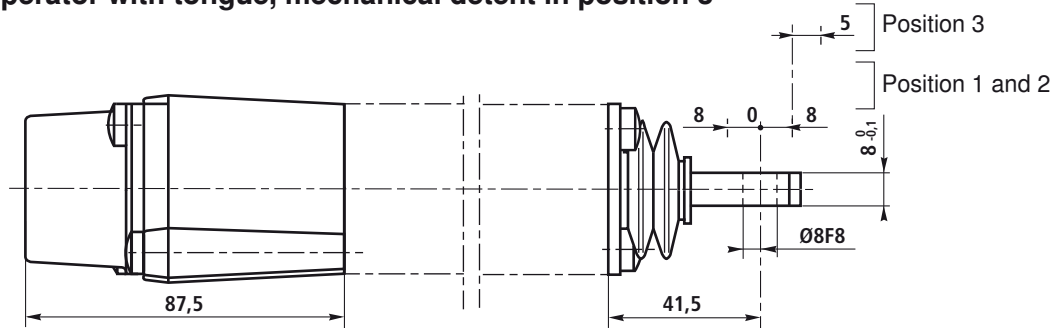
A221



Mechanical operator with tongue, mechanical detent in position 3

Ordering detail

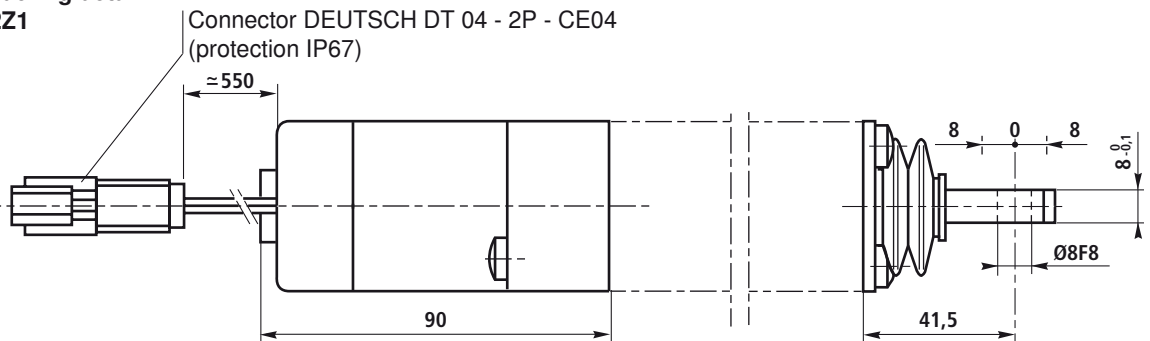
E221



Mechanical operator with tongue, electrical detent when spool is pushed

Ordering detail

S221

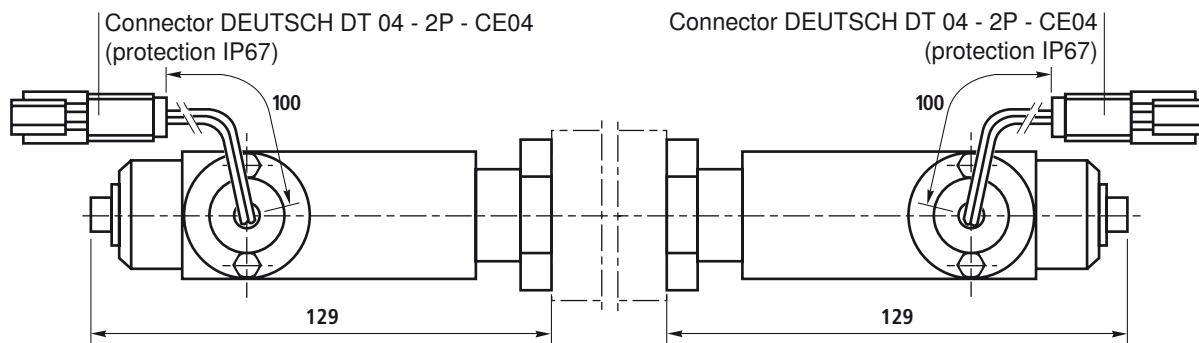


Unit dimensions (in mm)

Direct electrical operation

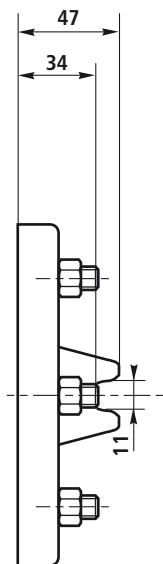
Ordering detail

V212



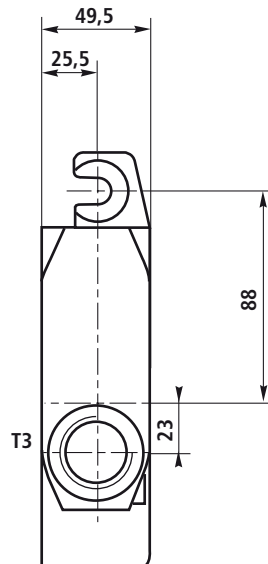
Blanking plate

Ordering detail
L



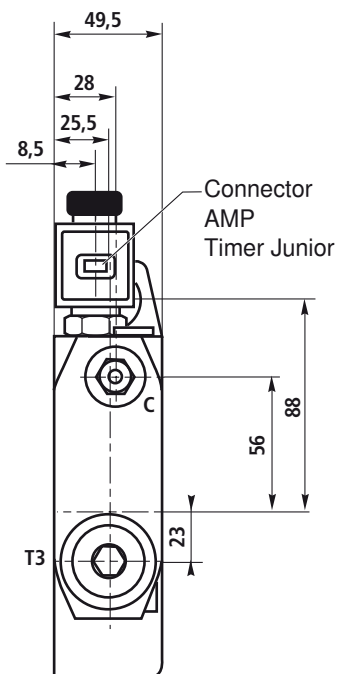
Outlet element with tank bridge

Ordering detail
R



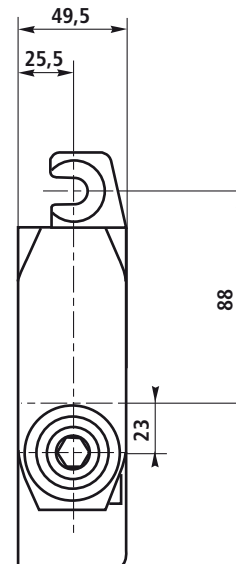
Outlet element with solenoid operated control valve

Ordering detail
C

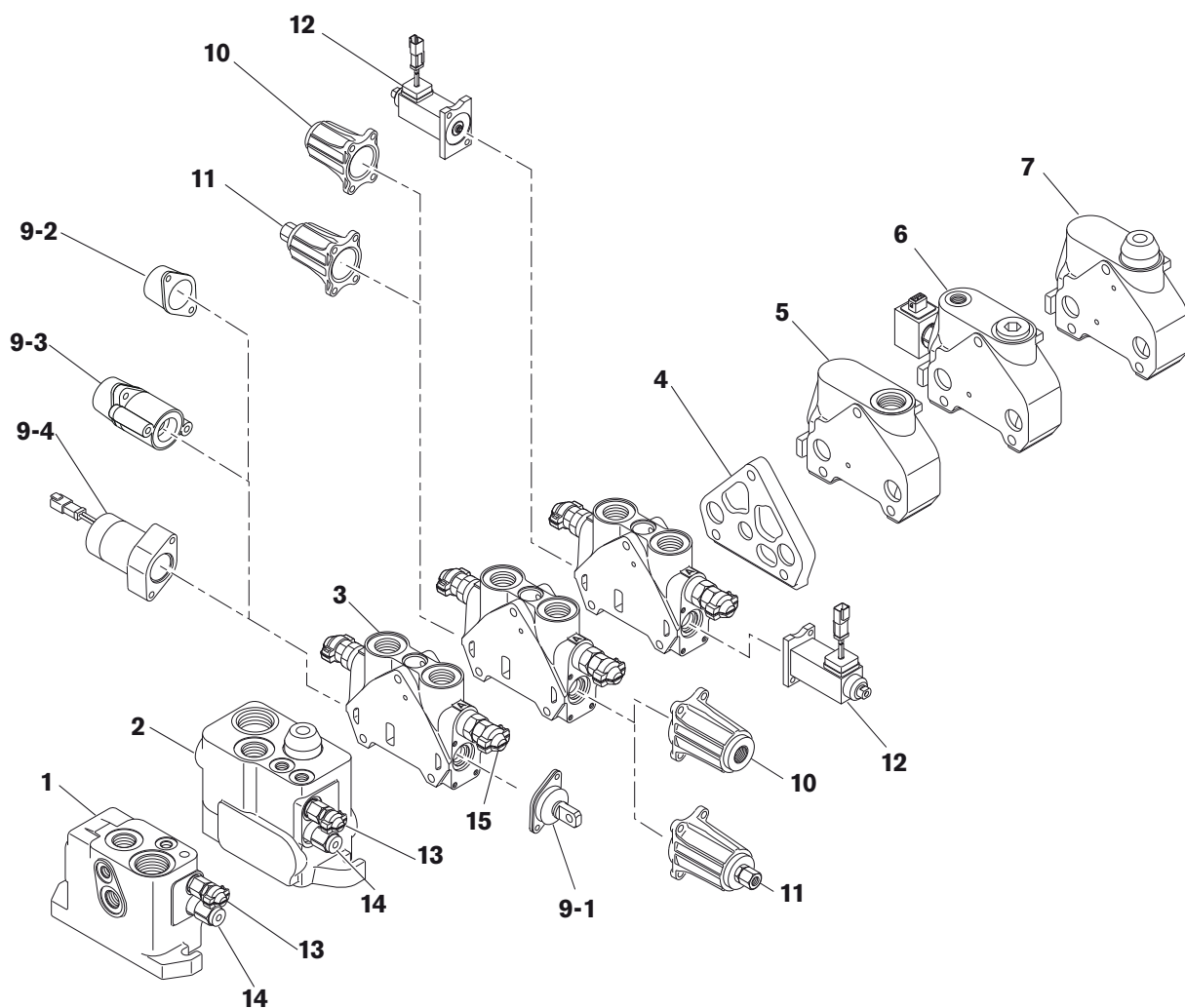


Flushing valve

Ordering detail
F

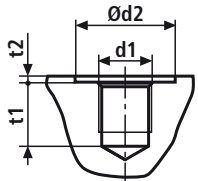


Assembly possibilities

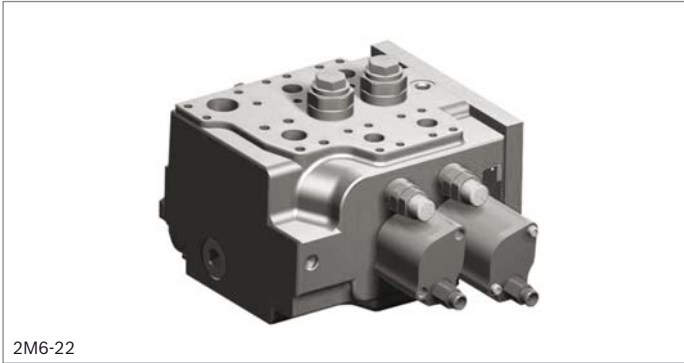


- | | |
|--|--|
| <p>1 Inlet element with priority flow divider CD or CS</p> <p>2 Inlet element - Closed Center A - Open Center P or with flushing valve S</p> <p>3 Directional valve element SX14 or SX14S</p> <p>4 Blanking plate L</p> <p>5 Outlet element with tank bridge R</p> <p>6 Outlet element with solenoid operated control valve C</p> <p>7 Flushing valve F</p> <p>9-1 Mechanical operator with tongue Z1</p> <p>9-2 Spring return arrangement, type A2</p> | <p>9-3 Spring return arrangement, mechanical detent in spool position 3, type E2</p> <p>9-4 Spring return arrangement, electrical detent when spool is pushed, type S2</p> <p>10 Hydraulic operator with spool return via a spring H200</p> <p>11 Hydraulic operator with stroke limitation H230</p> <p>12 Direct electrical operation V212</p> <p>13 LS relief valve</p> <p>14 Flow control valve</p> <p>15 Secondary valve</p> |
|--|--|

Pipe connections

		01				19			
	connection	d1	Ød2	t1	t2	d1	Ød2	t1	t2
	A, B, P, T3	G 3/4	42	25	2,5	1-1/16 UNF-2B	42	24	2,4
	T	G 1	47	27	2,5	1-5/16 UNF-2B	50	24	3,2
	M, LS, DLS, a, b, T1	G 1/4	25	16	1,5	9/16 UNF-2B	26	16	1,6
	D	G 1/2	34	20	2,5	3/4 UNF-2B	32	18	2,4

Flow sharing control block in mono block / sandwich plate design M6-22



2M6-22

- ▶ Size 22
- ▶ Series 3X
- ▶ Maximum operating pressure
 - on pump side 350 bar
 - on consumer side 420 bar
- ▶ Maximum flow
 - on pump side 350 l/min
 - on consumer side 300 l/min

Features

- ▶ Load pressure independent flow sharing (LUDV)
- ▶ Closed center for variable displacement pump
- ▶ Regeneration function in mono block
- ▶ Floating position function
- ▶ Integrated pilot oil generation
- ▶ Primary and secondary pressure limitation
- ▶ LS pressure limitation for the entire control block

Design

- ▶ Mono block with two consumer axes
- ▶ Expandable with directional valves (max. 4)
- ▶ End plate
- ▶ Type of actuation
 - Hydraulic
 - Electrohydraulic

Fields of application

- ▶ Wheeled loaders
- ▶ Bulldozers
- ▶ Crawler-mounted loaders

Contents

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Technical Data	4
Characteristic curves	5
Ordering code	6
Symbols	11
Dimensions	14
Project planning aid (e.g. for wheeled loader)	17
Related documents	18

Functional description

Control block M6-22

Proportional directional valve based on the LUDV principle (load pressure independent flow distribution).

Load pressure compensation, LUDV

The control block M6-22 operates on the LUDV principle. On this load sensing version, the pressure compensator **(3)** is mounted between the main spool **(2)** and the consumer ports **(A, B)**.

The maximum load pressure of all consumers involved is reported to all pressure compensators and simultaneously to the pump.

In contrast to standard LS designs, with LUDV individual consumers do not come to an unwanted standstill if the pump flow is not sufficient to supply all functions with the required nominal volume. In this case, the speed of all working movements is reduced in the same ratio.

Consumer control

The main spool **(2)** is used to determine the flow direction and the flow level that reaches the consumer ports **(A or B)**.

The spring chambers **(6)** are supplied with pilot pressure either via the pilot ports **a** and **b** (hydraulic control) or internally using integral pressure reducing valves (electrohydraulic control). The level of the pilot pressure in the spring chamber **(6)** determines the stroke of the main spool **(2)**.

The pressure compensator **(3)** controls the pressure differential at the main spool **(2)**.

Load holding

A load holding valve is integrated in the pressure compensator **(3)** in each functional axis.

Flow limitation

The maximum flow can be individually set to a precise value using the stroke limiter **(7)**.

Pressure limitation, consumer ports

Pressure relief valves with large nominal widths with combined feed function **(5)** protect the consumers against overloads and cavitation.

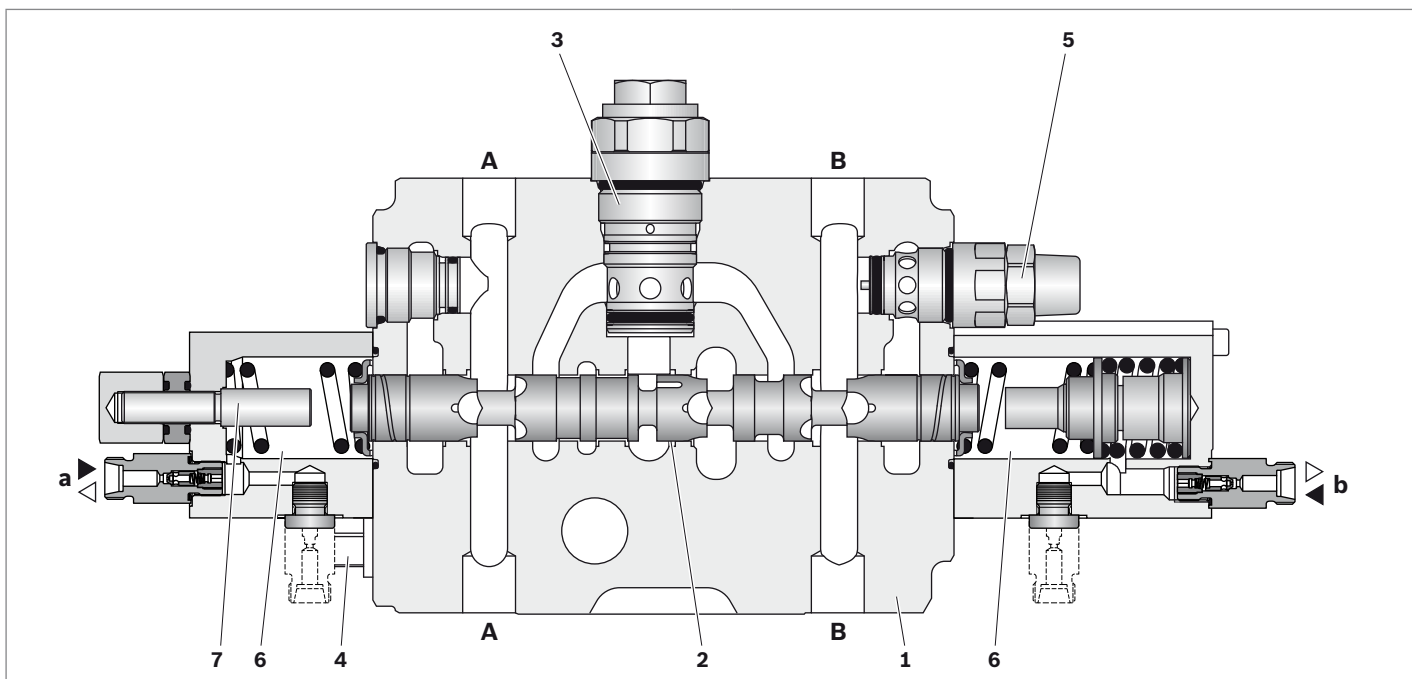
Floating position

The floating position is achieved either in axis 1 or 2 using a 4-position spool.

Regeneration

To prevent cavitation caused by negative loads in axis 1 or 2 (e.g. tipping forward or lowering), the oil in the tank duct is preloaded by a valve and fed into the consumer **A** using a feed valve **(4)** after the pressure compensator.

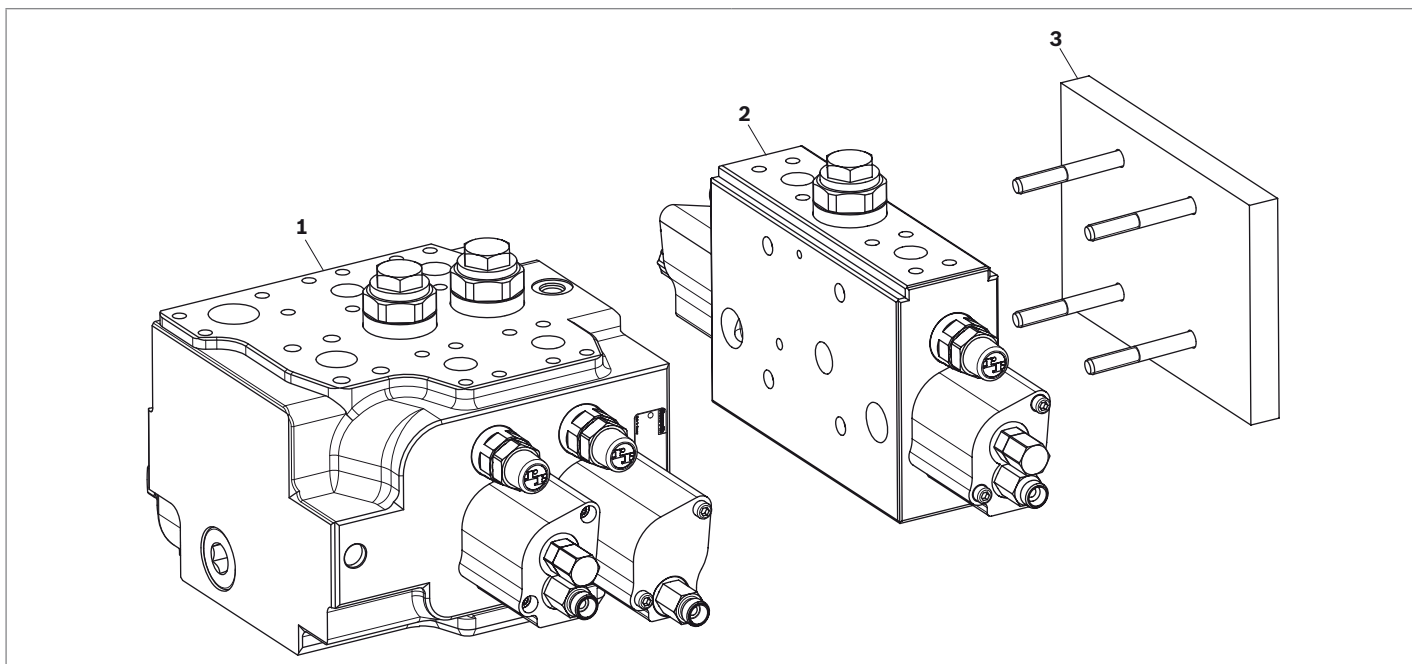
▼ Section M6-22



- | | |
|--|--------------------------------|
| 1 Housing | 5 Pressure relief / feed valve |
| 2 Main spool | 6 Spring chamber |
| 3 Pressure compensator with load holding | 7 Stroke limiter |
| 4 Feed valve for regeneration | |

2

▼ Design



- | |
|--|
| 1 Two-way mono block with inlet function |
| 2 Flange-mountable directional valve |
| 3 End plate |

Technical Data

General				
Weight	Two-way mono block		kg	65
	Directional valve		kg	15
	End plate		kg	approx. 4
Installation Position	Hydraulically operated			Any
	Electrohydraulically operated			Horizontal, pump and tank port upwards
Consumer connection type				Flange port according to DIN EN ISO 6162
Ambient temperature range		θ	°C	-20 to +80
Priming (standard)				One-coat paint RAL 5010
Hydraulic				
Maximum working pressure at port	P	p	bar	350
	A, B, LS	p	bar	420
	T	p	bar	30
	Y (L)	p	bar	Must be routed to tank without pressure
Maximum pilot pressure at port	X (Pst)	p	bar	40
	a, b	p	bar	40
Pilot pressure range	hydraulic	p	bar	0 to 35
	Electrohydraulic	p	bar	0 to 35
Maximum flow at port	P	q_{Vmax}	l/min	350
	A, B	q_{Vmax}	l/min	300 (load compensated at $\Delta p = 16$ bar)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	10 to 380
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Recommended hydraulic pilot controls			Type	4 THF6, 4 TH6, 2 TH6 Control curve 14, see page 5

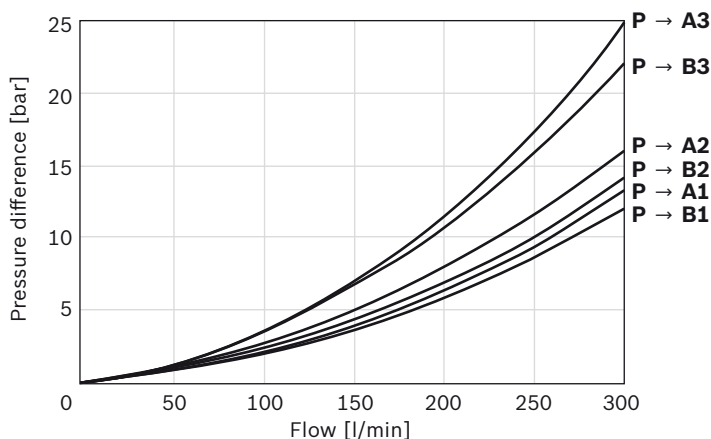
Electric			
Voltage type	DC voltage		
On/off valves FTWE 4 K (see data sheet 58008)			
Available voltages	V	12	24
Solenoid coil resistance at 20 °C	Ω	10	40
Power consumption at 20 °C	W	14.4	14.4
Duty cycle	%	100	100
Proportional valve FTDRE 4 K (see data sheet 58038)			
Available voltages	V	12	24
Solenoid coil resistance at 20 °C	Ω	2.4	12
Duty cycle	%	100	100
Max. solenoid current	mA	1800	800
Recommended chopper frequency ¹⁾	Hz	200	200
Connector version	C	Junior Timer, 2-pin (AMP)	
	K	DT04-2P (Deutsch)	
Type of protection according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Connector version C	IP 65 (with installed and locked plug-in connector) ²⁾	
	Connector version K	IP 67 and IP 69K (with Rexroth plug-in connector, material no. R901022127) ²⁾	
Electronic controls	Analog amplifier RA, see data sheet 95230 BODAS control unit RC, see data sheet 95200		

Note

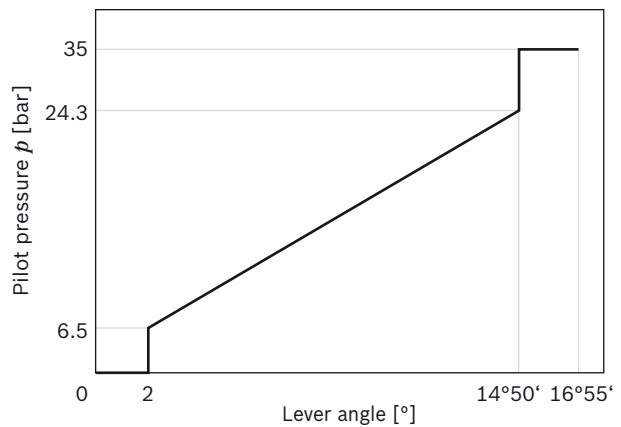
- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{s}$ (HLP46: 50 °C).

Characteristic curves

▼ **Flow resistance Pump → Consumer**
(double ports in axis 1 and 2)



▼ **TH control curve 14**



1) The chopper frequency is to be optimized after the application. Hereby, the use temperature range is to be observed.
2) Plug-in connectors are not included and must be ordered separately, see data sheet 08006.

Ordering code

Specifications on the name plate

The ordering code is used to record the technical features and requirements. The Rexroth distribution organization uses the ordering code to derive a short type and a material number.

Note

- ▶ Customer-specific name plate on request.
- ▶ All functions can only be combined to a limited extent. Every inquiry requires an individual verification.

01	02	03	04	05	06	07
M6	-	....	-	3X	/	M6-22
						*

Short type

01	Flow sharing control block (LUDV) M6 series	M6
02	4-digit control block number	....
03	Series 30 to 39 (unchanged installation and connection dimensions)	3X

Spool axes

04	Number of spool axes	2 to 6
----	----------------------	--------

Size

05	Size of the series	M6-22
----	--------------------	-------

Type of actuation

06	Hydraulic	H
	Electrohydraulic	W
07	Customer-specific specifications	*

Overall control block features

01		02	03	04	05	06		07	08	09
	M6-22	/	J				/	V	11	*

Spool axes

01	Number of spool axes	2 to 6
----	----------------------	--------

Inlet

02	Closed center	J
----	---------------	---

Primary pressure limitation

03	Without (with threaded plug, retrofitted primary pressure limitation)	Q
	With primary pressure relief valve, specified pressure in bar, 3-digit	...

LS pressure limitation

04	Without (with threaded plug, retrofitted LS pressure limitation)	SQ
	With LS pressure relief valve, specified pressure in bar, 3-digit	S...

Type of actuation

05	Hydraulic	H
	Electrohydraulic	W

LS shuttle

06	No LS shuttle	Z
	With LS shuttle (\varnothing 1.2 to \varnothing 0.6 mm)	L

Sealing material

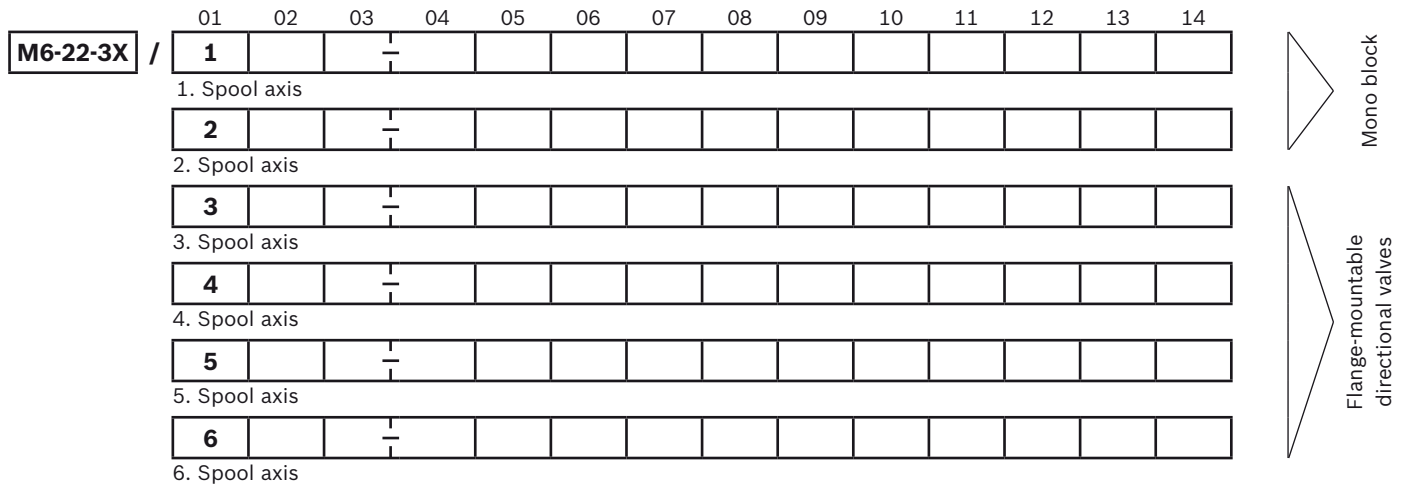
07	FKM seals (fluoroelastomer)	V
----	-----------------------------	---

Consumer ports

08	Flange ports according to ISO 6162	11
----	------------------------------------	----

09	Further specifications in plain text	*
----	--------------------------------------	---

Spool axis features



01	Spool axis number	1 to 6
----	-------------------	---------------

Spool type¹⁾

02	Main spool A/B/T blocked in neutral position	E
	Main spool A/B→T open in neutral position	J
	Main spool A/B→T throttled to tank in neutral position	Q
	Main spool rapid traverse ²⁾	N
	4-position spool ³⁾	W
	5-position spool ²⁾	K

Flow

		A side	B side
03, 04	Flow in consumer port A and B (parameter in l/min, 3-digit)	...	...

Type of actuation

		05	06	07
05	Hydraulic	H		
06	Pilot oil port ⁴⁾	G1/4 according to DIN EN ISO 1179-1 (without adapter)	Z	
		M16 × 1.5 / GE10L according to DIN EN ISO 8434 (poppet seal)	G	
		11/16-16UN2A / O-LOK according to SAE J1453 (O-ring-seal)	O	
07	Preferable oil port position	Axial		A
		Radial		R
05	Electrohydraulic	W		
06	Proportional	24 V	81	
		12 V	83	
	Switchable	24 V	61	
		12 V	63	
07	Connector version	Junior-Timer, 2-pin (AMP)		C
		DT04-2P (Deutsch)		K

1) For symbols, see 11.

On hydraulic cylinders, specifying the gear ratio is required, as inlet and outlet characteristic curves are created for E and Q spools. Further spool types on request.

2) Only possible in spool axis 2

3) Only possible in spool axis 1 and 2

4) See "Line connections" on page 14

Shuttle

08	No shuttle	00	
	With shuttle \varnothing 0.6 mm	06	
	With shuttle \varnothing 0.8 mm	08	
	With shuttle \varnothing 1.0 mm	10	
	With shuttle \varnothing 1.2 mm	12	

Secondary valves

		A side	B side
09	Without	Z	Z
10	Anti-cavitation valve	E	E
	Pressure relief / feed valve, specified pressure in bar, 3-digit	H...	H...

Regeneration/check valve

11	Without	Z
	With regeneration valve ⁵⁾	A

Consumer ports

		A side	B side
12	Connections on the pressure compensator side	BZ	BZ
13	Connections on the opposite side of the pressure compensator	ZD	ZD
	Double ports ⁵⁾	BD	BD

Pressure compensator bypass

14	Without	Z
	With pressure compensator bypass \varnothing 5 mm ⁶⁾	5
	With pressure compensator bypass \varnothing 8 mm ⁶⁾	8

5) Only possible in spool axis 1 and 2

6) Required when using power-controlled pump

End plate

		01	02	03	04	05	06	07
M6-22-3X	/	E						*

Plate type

01	End plate	E
----	-----------	----------

Line connections

02	Without ports	Z
	Metric thread according to ISO 6149-1	G

Pilot oil supply

03	Without	ZZ
	Internal pilot oil generation for internal and external use	YY
	Internal pilot oil generation for external use	YZ

Pilot oil switch-off

04	Without	Z
	With switch-off valve	A

Unloading function

05	Without	Z
	With unloading valve	U
	With unloading valve with improvement in pump dynamics (with residual amount)	R

Flushing port

06	Without	Z
	With flushing ports	S

07	Further specifications in plain text	*
----	--------------------------------------	----------

Symbols

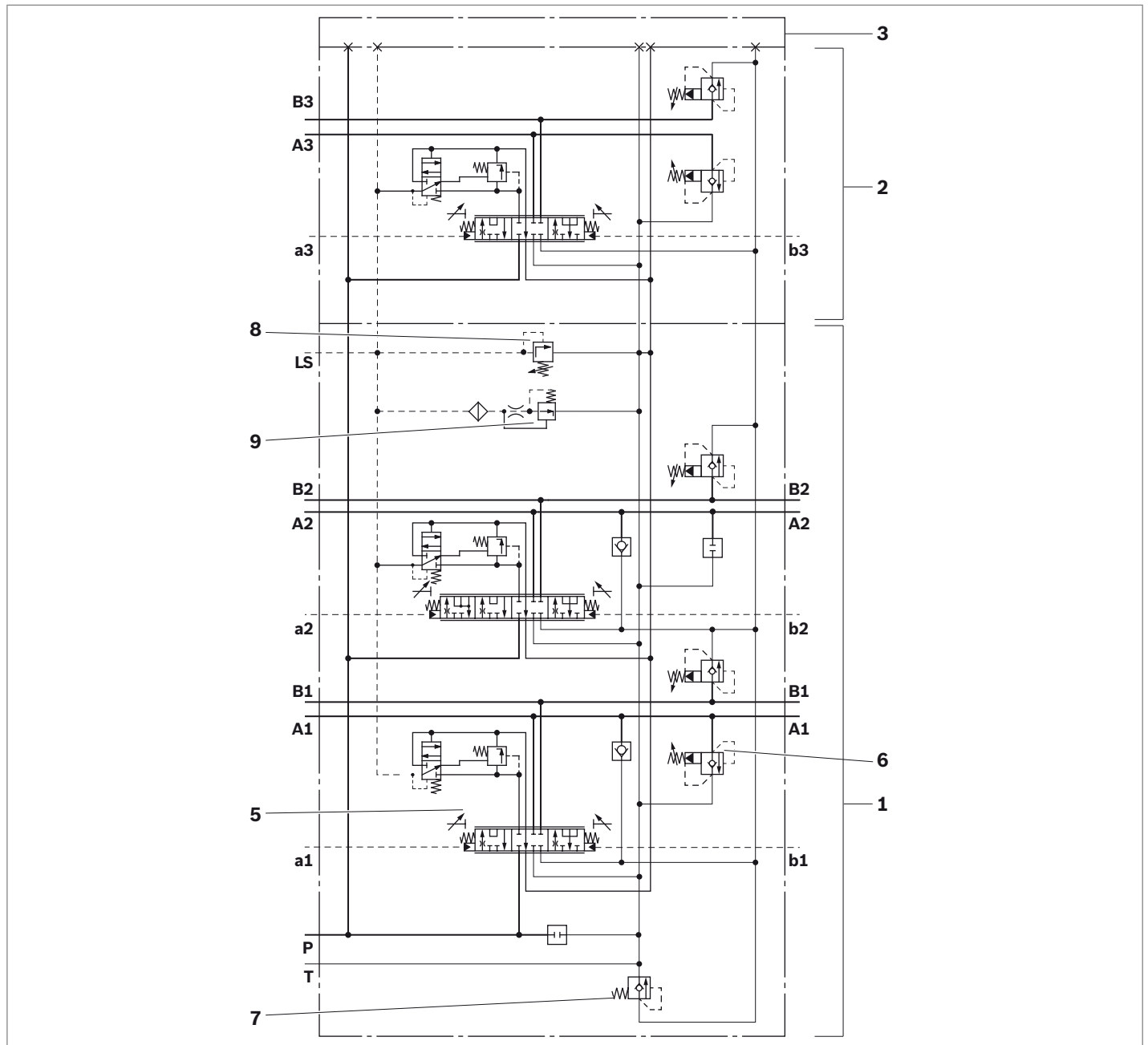
Main spool

Ordering code	Main use	Symbol
E	<ul style="list-style-type: none"> - Hydraulic cylinder as consumer - Spool with blocked ports A/B in neutral position 	
J	<ul style="list-style-type: none"> - Hydraulic motors as consumers - Consumer ports A/B → T open in neutral position 	
Q	<ul style="list-style-type: none"> - Hydraulic cylinder and motors as consumers combined with pipe burst safety valve, check Q meter and lowering brake valve - Spool with defined residual opening (A/B → T) in neutral position - Consumer port unloaded in neutral position 	
W	<ul style="list-style-type: none"> - 4-position spool - Floating position (A/B→T), connection via pressure jump on control unit (4th position) - Hydraulic cylinder as consumer - Spool with blocked ports A/B in neutral position 	
N	<ul style="list-style-type: none"> - Rapid traverse for P kinematics - Differential circuit - Spool with blocked ports A/B in neutral position 	
K	<ul style="list-style-type: none"> - 5-position spool - Lowering → Differential circuit → Floating (floating via pressure jump) Bulldozer power regeneration (4th position) - Floating position (A/B→T), connection via pressure jump on control unit (5. position) 	



Control block

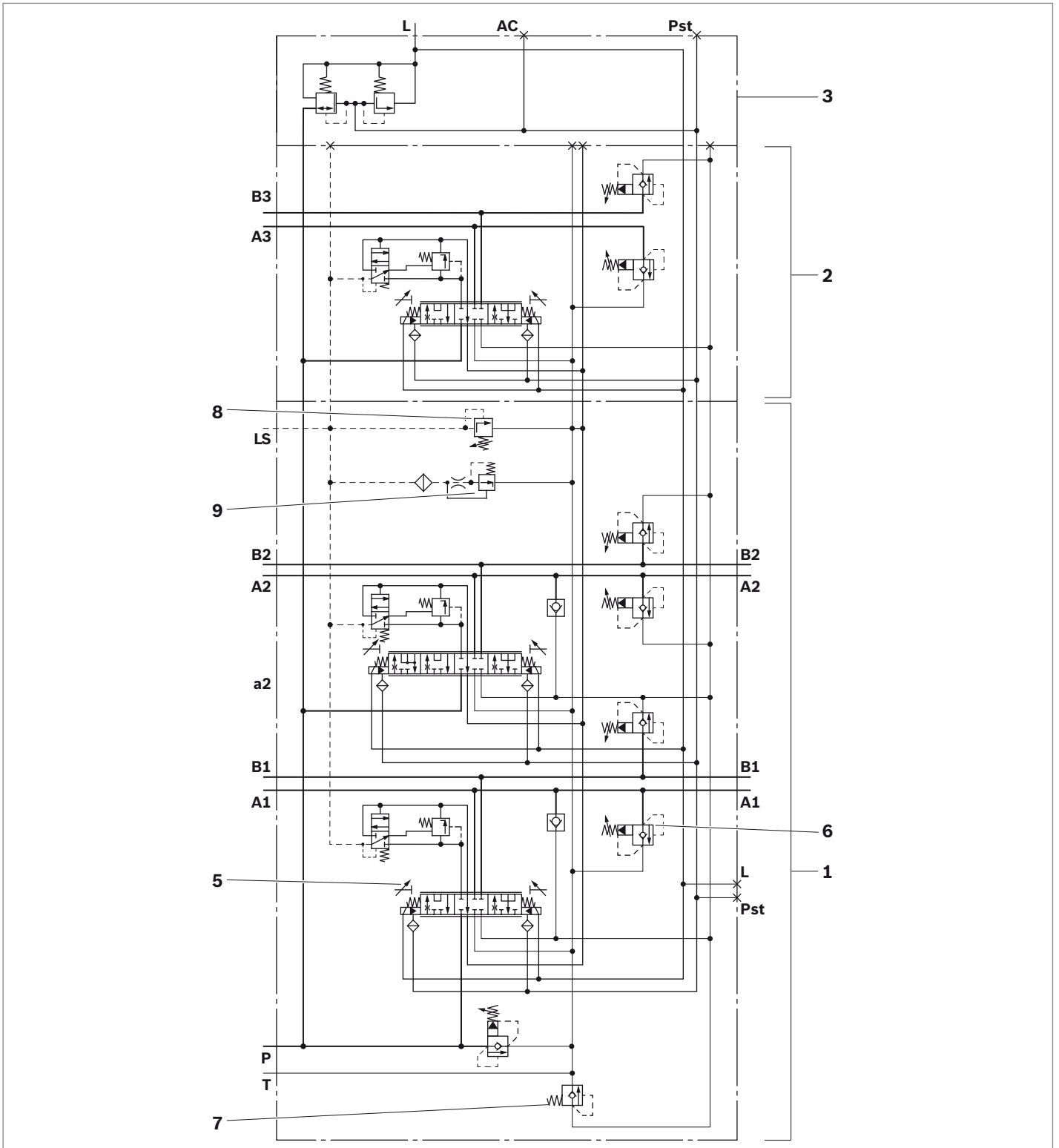
▼ Hydraulic actuation, example 2-way mono block with 1 directional valve



- 1 Two-way mono block
- 2 Directional valve
- 3 End plate (no function)
- 5 Stroke limiter
- 6 Secondary pressure relief valve

- 7 Tank pre-loading valve
- 8 LS pressure relief valve
- 9 LS flow controller

▼ Electrohydraulic actuation, example 2-way mono block with 1 directional valve

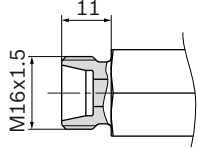
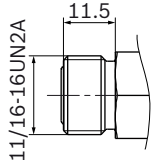


- 1 Two-way mono block
- 2 Directional valve
- 3 End plate (with function)
- 5 Stroke limiter
- 6 Secondary pressure relief valve

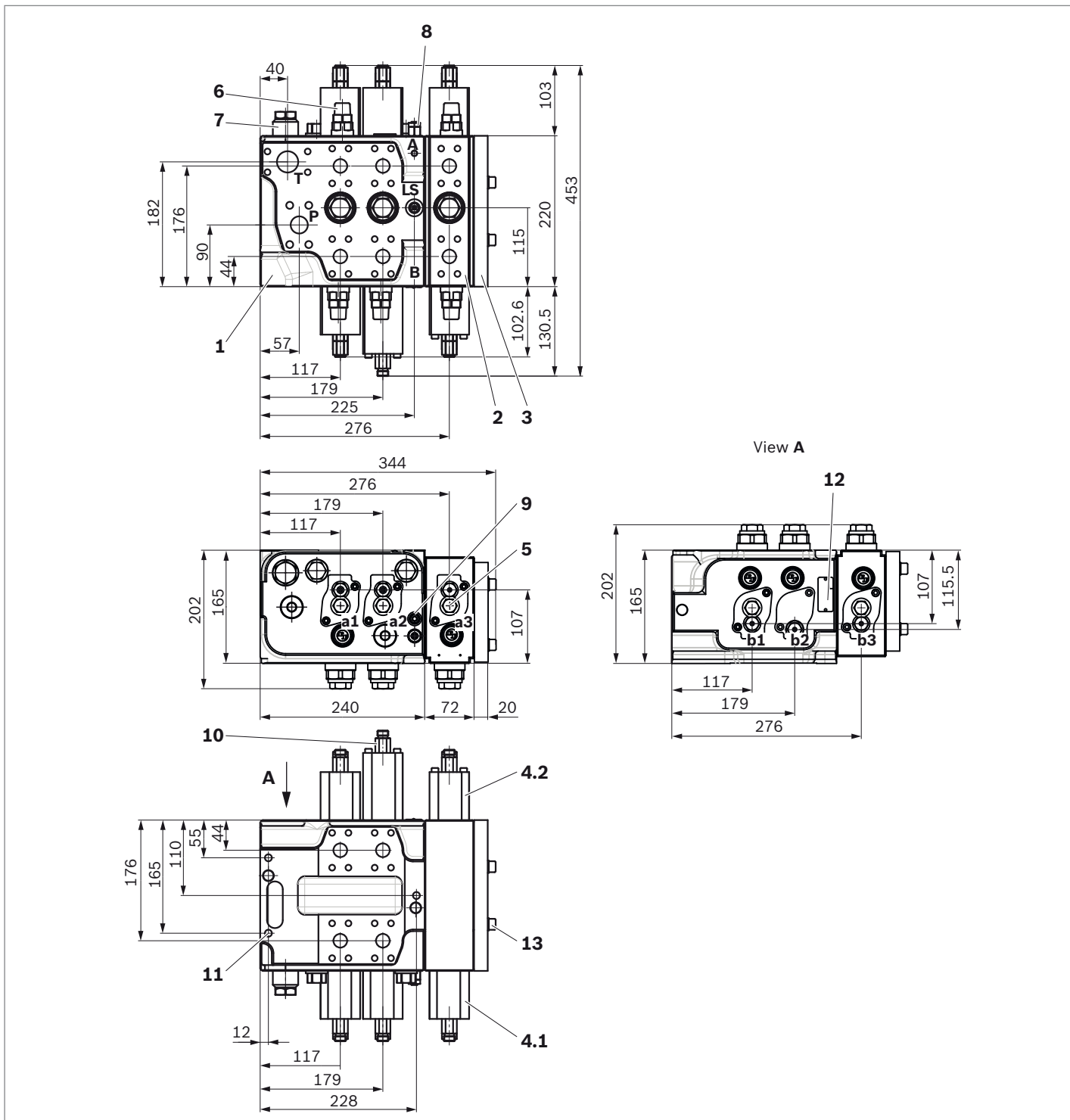
- 7 Tank pre-loading valve
- 8 LS pressure relief valve
- 9 LS flow controller

Dimensions

Line connections

Ports		Dimension	Relevant standard
P	Pump port	DN 25 (SAE 1 in 6000 PSI)	DIN ISO 6162-2
T	Tank port	DN 28 (SAE 1 1/4 in 3000 PSI)	DIN ISO 6162-1
A, B	Consumer ports	DN19 (SAE 3/4 in 6000 PSI)	DIN ISO 6162-2
LS	Load sensing	M14 × 1.5	DIN EN ISO 6149-1
Pst	Pilot oil supply	M14 × 1.5	DIN EN ISO 6149-1
L	Tank port, depressurized	M14 × 1.5	DIN EN ISO 6149-1
AC	Accumulator port (pilot oil)	M14 × 1.5	DIN EN ISO 6149-1
a, b	Pilot oil ports		
	– Standard, without adapter (Z design)	G 1/4	DIN EN ISO 1179-1
	– Poppet seal, with adapter for pipe connection (G design)	M16 × 1.5 / GE10L	DIN EN ISO 8434
			
	– O-ring seal, with adapter for pipe connection (O design)	11/16-16UN2A / O-LOK	SAE J 1453-3
			

▼ Hydraulic actuation, example 2-way mono block with 1 directional valve



- 1 Two-way mono block
- 2 Directional valve
- 3 End plate (no function)
- 4.1 Control cover A side
- 4.2 Control cover B side
- 5 Stroke limiter
- 6 Secondary pressure relief valve
- 7 Tank pre-loading valve
- 8 LS pressure relief valve
- 9 LS flow controller
- 10 Double nipple with shuttle valve
- 11 Three fastening threads M12, 19 deep
- 12 Name plate
- 13 Tie rod

Hydraulic actuator with 2-way mono block and 1 directional valve

Project planning aid (e.g. for wheeled loader)

General information		Diesel engine data	
Project number:		Designation:	
Customer:		Power:	kW
Machine type:		Load speed:	rpm
Machine designation:		Max. speed:	rpm
Stroke cylinder:	Bottom Ø:	mm	
	Rod Ø:	mm	
	Active stroke:	mm	
	Number:	units	
Tip cylinder:	Bottom Ø:	mm	
	Rod Ø:	mm	
	Active stroke:	mm	
	Number:	units	
Pump		Designation:	
		Displacement:	cm ³ /rev
		Nominal speed:	rpm
		Pump control Δp :	bar
		Controller type:	
		Maximum pump pressure:	bar

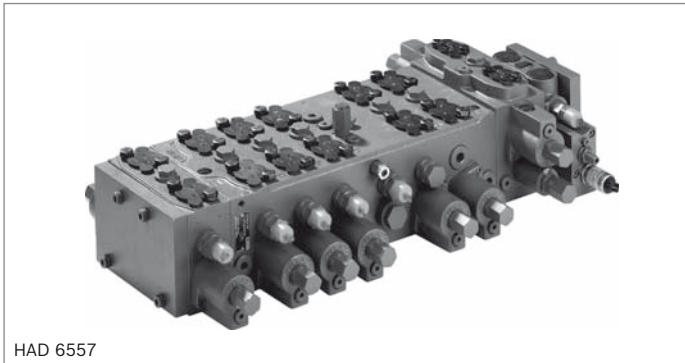
Supplementary information			
Cycle times			
Kinematics: <input type="checkbox"/> Z kinematics <input type="checkbox"/> P kinematics (parallel)	Lifting:	sec at	mm stroke
	Lowering:	sec at	mm stroke
	Depressurized lowering:	sec at	mm stroke
	Tipping backwards:	sec at	mm stroke
	Tipping forwards:	sec at	mm stroke
	Option A:	l/min	
	Option B:	l/min	

Related documents

The M6-22 control blocks are system components. Observe the instructions for the other system components. Only commission the product if the following documentation is available to you and you have understood and observed it.

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Instruction manual
System documentation from the machine manufacturer		Instruction manual

LUDV control block in mono block/sandwich plate design M7-20



- ▶ Size 20
- ▶ Series 3X
- ▶ Maximum operating pressure
 - On the pump side 380 bar
 - On the actuator side 420 bar
- ▶ Maximum flow
 - On the pump side 350 l/min
 - On the actuator side 250 l/min

Features

- ▶ Load pressure-independent flow distribution LUDV
- ▶ Closed center for variable displacement pump
- ▶ Integrated load holding valves
- ▶ Integrated tank/cooler preloading possible
- ▶ Unloading function for
 - Improved response behavior
 - Reduction of switch-off peaks
- ▶ Cracking pressure of the unloading valve depending on Δp (standard: 23 bar)

Design

- ▶ Mono block with 5 actuator axes
- ▶ Can be extended by directional valves of different sizes (max. 8)
- ▶ Pure sandwich plate design possible
- ▶ Type of actuation
 - Hydraulic

Fields of application

- ▶ Excavators
- ▶ Stripping shovels/caterpillar cranes
- ▶ Handling equipment
- ▶ Cranes
- ▶ Drilling machinery

Contents

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Project planning information	16
Related documents	16

Functional description

Control block M7-20

Proportional directional valve according to the LUDV principle (load pressure independent flow distribution).

Load pressure compensation, LUDV

The control block M7-20 works according to the LUDV principle. The pressure compensator (4) of this load-sensing version is mounted between the main spool (6) and the actuator ports (A, B).

The highest load pressure of all actuators involved is notified to all pressure compensators and simultaneously to the pump.

As opposed to standard LS versions, there is no unwanted standstill of individual actuators with LUDV if the pump flow is not sufficient for supplying all functions with the desired rated volume. The speed of all working movements will then be reduced in the same ratio.

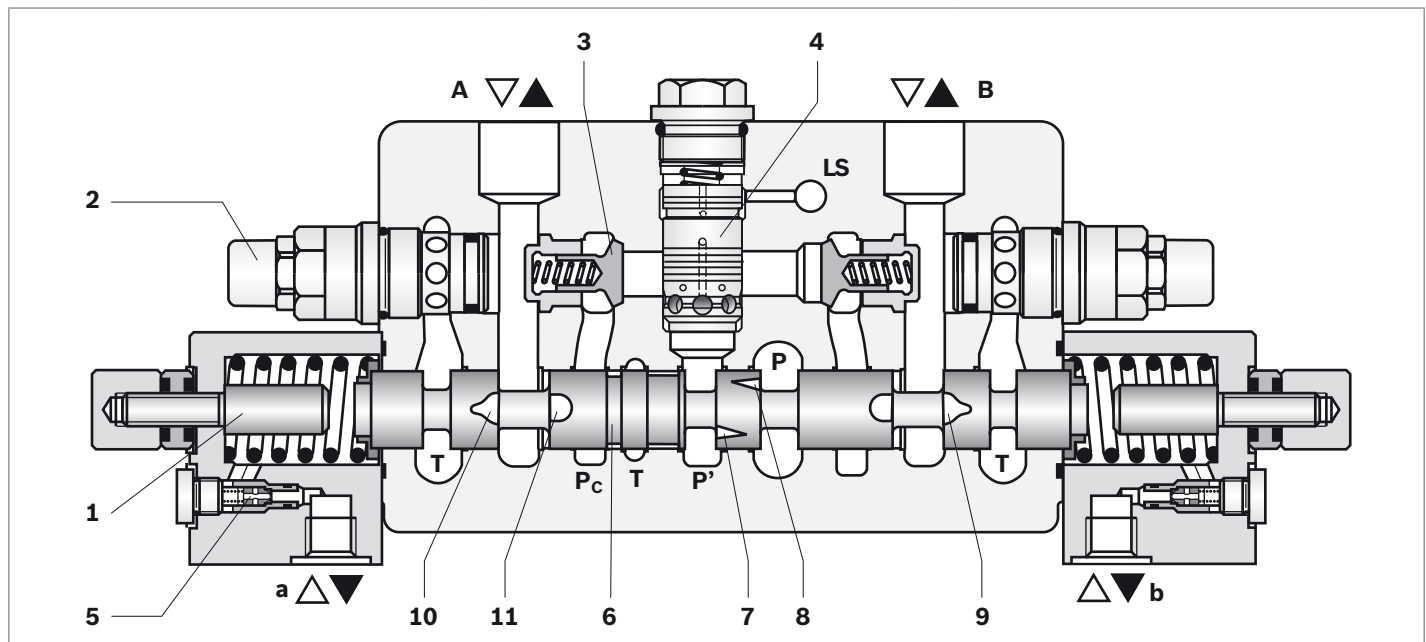
Actuator control

In the neutral position of the main spool (no control pressure at the ports a or b, the connection from the pump to the P' channel is blocked by the main spool. The load holding valves and the pressure compensator are closed. The actuator ports are blocked by the main spool overlap in the housing.

The LUDV pressure compensator consists of a main spool and a compression spring defining a stable initial position. The main spool (6) is proportionally moved to the right against the spring force by the applied control pressure of the pilot control unit in the control cover a. The supply metering orifice (7) of the main spool opens the connection from the pump port P to the channel P'. The pressure in this chamber opens the pressure compensator (4) and is applied to the load holding valves (3).

The actuator pressure p_c of port A keeps the left load holding valve (3) closed via the passages in the main spool (11). When the value of P' exceeds that of p_c , the check valve is opened. The connection from the pump to the actuator is established and initiates the movement. The oil displaced in the actuator flows from B via the outlet orifice (9) back to the tank. The secondary pressure relief valves (2) remain closed as long as the pressure in the actuator port remains below their pressure setting. The main poppet of the combined pressure relief/feed valve (2) in the supply (side A) opens in the event of cavitation in the actuator port and enables feed-in from the tank channel. In this connection, an optional tank pre-loading increases the feed-in volume.

▼ Section M7-20



- | | | |
|--|--------------------------------------|---|
| 1 Stroke limitation | 5 Pilot pressure shuttle | 9 Outlet orifice B → T |
| 2 Secondary pressure relief valve/feed valve | 6 Main spool | 10 Outlet orifice A → T |
| 3 Load holding valve | 7 Supply metering orifice P → P' → A | 11 Directional grooves P → A
(P → B accordingly) |
| 4 LUDV pressure compensator | 8 Supply metering orifice P → P' → B | |

Technical data

general				
Weight	5-fold mono block	kg	Approx. 90	
	Directional valve M7-20	kg	Approx. 12	
	Inlet plate	kg	15	
	End plate	kg	Approx. 3	
Installation position				Any
Type of actuator connection				Flange connection according to DIN EN ISO 6262
Ambient temperature range	θ	°C	-20 to +80	
Priming				Single-layer coating RAL 5010
hydraulic				
Maximum operating pressure at port	P	p	bar	380
	A, B	p	bar	420
	LS	p	bar	360
	T	p	bar	30
	L	p	bar	Must be led to the tank in a depressurized form
Maximum pilot pressure at port	a, b	p	bar	40
Pilot pressure range	Hydraulic	p	bar	0 to 23 (27)
Maximum flow at port	P	q_{Vmax}	l/min	350
	A, B	q_{Vmax}	l/min	250 (at Δp block input P – LS = 19 bar)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet 90221, upon request
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this, it is recommended to use a filter with a minimum retention rate of $\beta_{10} \geq 75$
Recommended hydraulic pilot control units			Type	4 TH6...; characteristic curve 70, see data sheet 64555 2 TH6 R...; characteristic curve 70, see data sheet 64552

Notice

- For applications outside these parameters, please consult us!
- The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{s}$ (HLP46: 50 °C).

Characteristic curve

▼ Typical spool characteristic curve



Ordering code

Explanations

The ordering code documents the default functional features of the valve series which is set-up as a modular system. This series consists of a 5-fold mono block with LUDV function at which up to two LUDV directional valves with a respective end plate can be installed on one front side. On the opposite front side, LS directional valves and additional type SX14 directional valves with end plates can be flanged. The number of spool axes in the mono block and the number of individual LUDV and LS directional valve plates together define the total number of spool axes in the control block.

It is also possible to set up the block in pure sandwich plate design consisting of type M7-20/LS and type SX14 directional valves.

The first part of the ordering code (set-up of the overall control block) specifies the block configuration without definition of the individual spool axes.

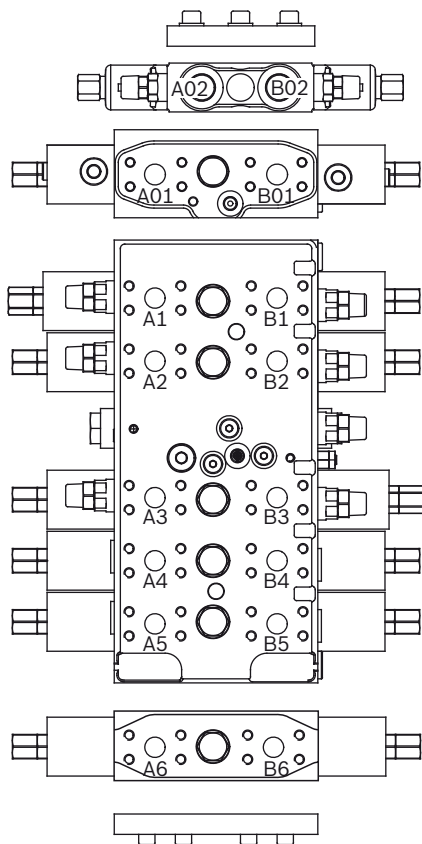
The second part of the ordering code (features of the overall control block) defines the available detail features and settings of the block.

Finally, the corresponding features for every spool axis of the block must be selected.

In order to ensure fast and clear processing of your order, please specify all features. In case of questions, please contact the relevant application specialist in sales-related product management.

Combination possibilities

▼ **Mono block/sandwich plate design**



End plate 2

Directional valves, group 3

SX14 LUDV (can only be flanged to M7 20/LS)

Directional valves, group 2

M7-20/LS

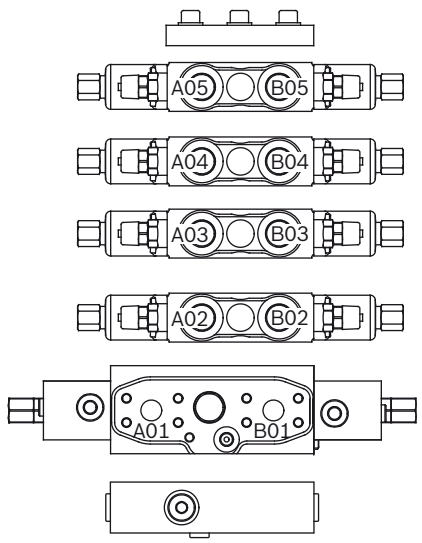
5-fold mono block

Directional valves, group 1

M7-20 LUDV

End plate 1

▼ **Sandwich plate design**



End plate 2

Directional valves, group 3

SX14 LUDV (can only be flanged to M7-20 LS)

Directional valves, group 2

M7-20/LS

Inlet plate

with P and T connections

Information on the name plate

The ordering code serves to specify the technical features and requirements.

The Rexroth distribution organization derives a short designation as well as a material number from the ordering code.

01	02	03	04	05	06	07	08	09									
M7	-	-	3X	/		M7	-	20	/		-	H	/	V	11	*

Series

01	LUDV control block M7	M7
----	-----------------------	----

02	4-digit control block number
----	------------------------------	------

Series

03	30 to 39 (unchanged installation and connection dimensions)	3X
----	---	----

04	Total number of spool axes	1 to 13
----	----------------------------	---------

Design

05	5-fold mono block	5
	Sandwich plate design	S

Type of actuation

06	Hydraulic	H
----	-----------	---

Seal material

07	FKM seals	V
----	-----------	---

Actuator ports

08	Flange connection according to DIN EN ISO 6162	11
----	--	----

09	Further details in the plain text	*
----	-----------------------------------	---

Overall control block set-up

01		02	03	04	05	06	07	08	09	10
	M7-20	/		K			K		S	

01	Total number of spool axes	1 to 13
----	----------------------------	----------------

Design

02	5-fold mono block	5
	Sandwich plate design	S

Directional valves group 1 ¹⁾

03	M7-20 LUDV	K
04	Number of directional valves	0 to 2

End plate 1

05	LUDV without function	L
	LUDV with P port	C
	Without end plate in sandwich plate design	Z

Directional valves group 2

06	M7-20/LS	K
07	Number of directional valves ²⁾	0 to 3

Directional valves group 3

08	SX14	S
09	Number of directional valves ²⁾	0 to 4

End plate 2

10	Without function	Z
	With P port	C

1) For a pure sandwich plate design, "K 0" is to be specified

2) The groups may add up to a maximum of 6

Overall control block features

	01	02		03	04	05		06	07	08	09	10
M7-20	/		-				-					

Primary pressure limitation

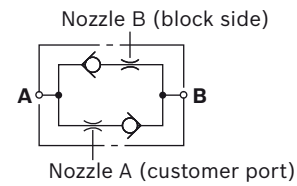
		01	02	03
01	Without	Q	000	000
	Pressure relief valve, pilot operated (MHDBV, see data sheet 64642)	V	...	000
	Pressure/feed valve with pressure sequencing stage (MHDBB, see data sheet 64642)	B	...	...
02	Specified pressure of the pressure relief valve (in bar, 3-digit)		...	
03	Specified pressure of the pressure sequencing stage (in bar, 3-digit)			...

LS pressure limitation

		04	05	06
04	Without	Q	000	000
	Pressure relief valve, direct operated (MHDBD 04, see data sheet 64642)	S	...	000
	Pressure relief valve, direct operated with pressure sequencing stage (MHDBZ)	A	...	...
05	Specified pressure of the pressure relief valve (in bar, 3-digit)		...	
06	Specified pressure of the pressure sequencing stage (in bar, 3-digit)			...

LS shuttle (nozzle diameter)

07	Without LS shuttle			L0
	A 0.6 – B 1.2			L1
	A 1.0 – B 0.4			L2
	A 1.2 – B 0.4			L3
	A 1.2 – B 0.6			L4
	A 2.0 – B 0.4			L5



Unloading function (q_{Vmin} circuit)

08	Without unloading function	Z
	With unloading function	U

Tank preloading ³⁾

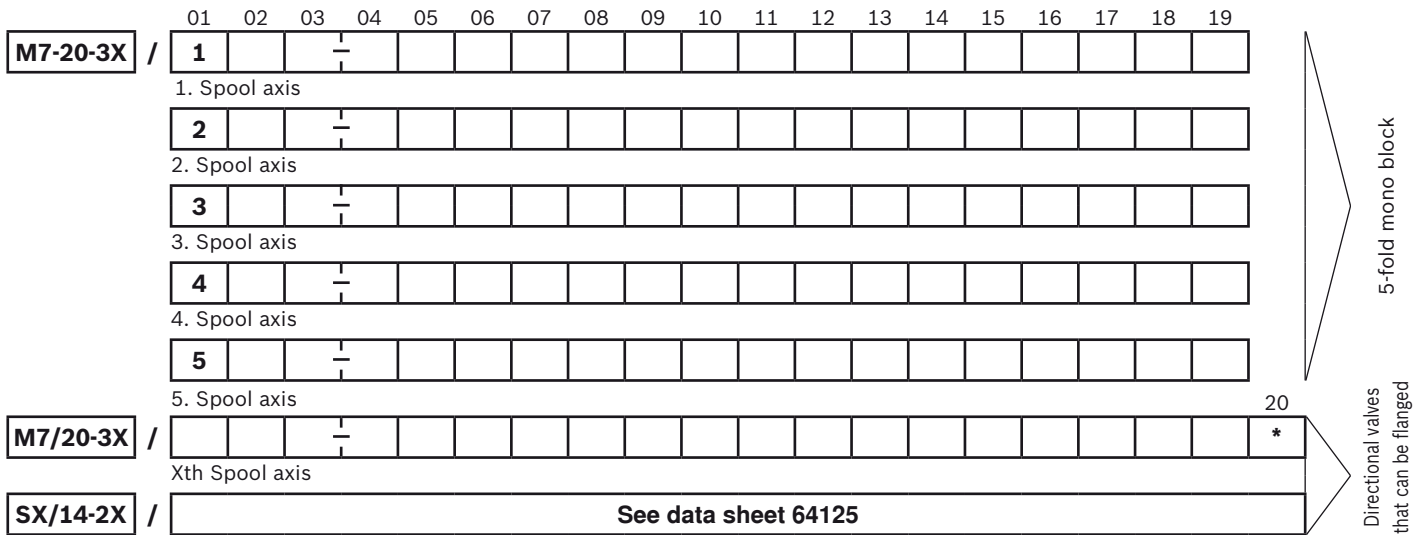
09	Without tank preloading	TZ
	0.5 bar	T1
	2.0 bar	T2
	3.5 bar	T3
	5.5 bar	T5
	7.0 bar	T7

Cooler preloading ³⁾

10	Without cooler preloading	KZ
	0.5 bar	K1
	2.0 bar	K2
	3.5 bar	K3
	5.5 bar	K5
	7.0 bar	K7

³⁾ When designing the preload values, the cooling power necessary for the machine is to be considered.

Spool axis design



01	Number of the spool axis	1 to X
----	--------------------------	---------------

Spool type ⁴⁾

02	Main spool A/B/T blocked in neutral position	E
	Main spool A/B → T blocked in neutral position	J
	Main spool A/B → T throttled to the tank in neutral position	Q
	Main spool P/B → A in spool position b	R
	Extra spool ⁵⁾	S

Flow

03	Actuator port A (in l/min, 3-digit)	...
04	Actuator port B (in l/min, 3-digit)	...

Load holding

05	With (both sides)	L
	Without	Z

Pressure compensator ⁶⁾

06	Direct operated	D
	Pilot operated	V

4) For symbols, see "Main spool" on page 11.
 The gear ratio of hydraulic cylinders must be specified in plain text as E and Q spools have supply and outlet characteristic curves.
 Further spool types on demand.

5) Functional description in plain text

6) For symbols, see "Pressure compensator" on page 11

Type of actuation			A side			B side		
			07	08	09	10	11	12
07, 10	Hydraulic ⁷⁾		H			H		
08	Shuttle	Without shuttle		00			00	
11		With shuttle 0.3 mm		03			03	
		With shuttle 0.5 mm		05			05	
		With shuttle 0.6 mm		06			06	
		With shuttle 0.8 mm		08			08	
09	Pilot oil port position	Axial			A			A
12		Radial			R			R

Pilot oil port ⁸⁾

13	Poppet seal						G
	O-ring seal						O
	G 1/4 without adapter (only with H00)						Z

Secondary valves			A side			B side		
			14	15	16	17	18	19
14	Without		Z	000	000	Z	000	000
17	Feed valve (MHSV 22, see data sheet 64642)		E	000	000	E	000	000
	Pressure/feed valve (MHDBN 22, see data sheet 64602)		H	...	000	H	...	000
	Pressure/feed valve with pressure sequencing stage (MHDBB 22, see data sheet 64642)		B	...	...	N	...	...
15, 18	Specified pressure of the pressure/feed valve (in bar, 3-digit)			...			...
16, 19	Specified pressure of the pressure sequencing function (in bar, 3-digit)				...			...

20	Specification of the type M7-20/LS directional valve plate in plain text							*
----	--	--	--	--	--	--	--	----------

7) With measuring port

8) See "Line connections" on page 14

Symbols

Main spool

Ordering code	Main use	Symbol
E	<ul style="list-style-type: none"> ▶ Hydraulic cylinder as actuator ▶ Spool with blocked ports A/B in neutral position 	
J	<ul style="list-style-type: none"> ▶ Hydraulic motors as actuator ▶ Actuator ports A/B → T open in neutral position 	
Q	<ul style="list-style-type: none"> ▶ Hydraulic cylinders and motors as actuator in connection with hose burst check valve, check-Q-meter and lowering brake valve ▶ Spool valve with defined remaining opening (A/B → T) in neutral position 	
R	<ul style="list-style-type: none"> ▶ E spool with regeneration function ▶ Main spool P/B → A 	

Notice

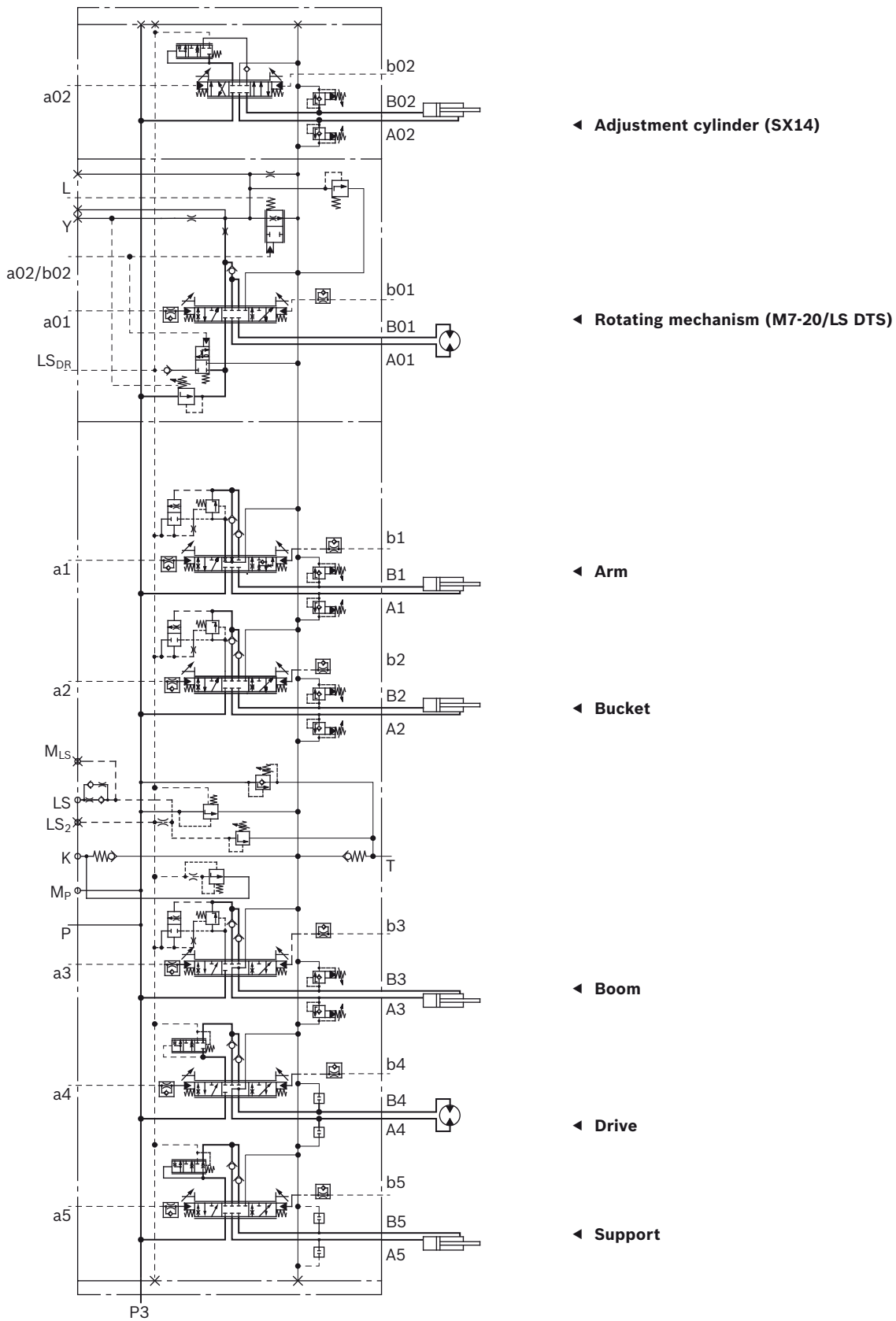
Further main spools on demand.

Pressure compensator

Ordering code	Main use	Symbol
D	Direct operated (standard)	
V	Pilot operated ▶ Use in case of superimposed motion if the actuator with the highest load changes frequently	

Control block

Example: 5-fold mono block with one M7 20/LS and one SX14 directional valve

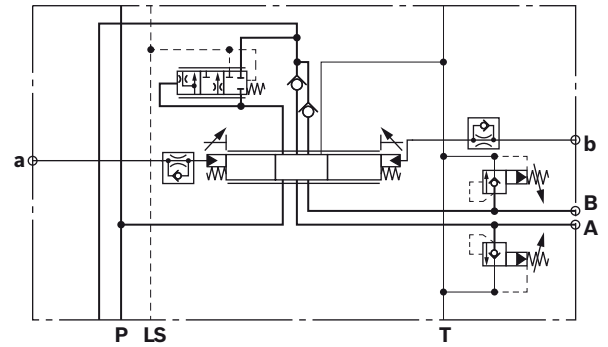


Directional valves

1-fold M7-20 LUDV

Short description

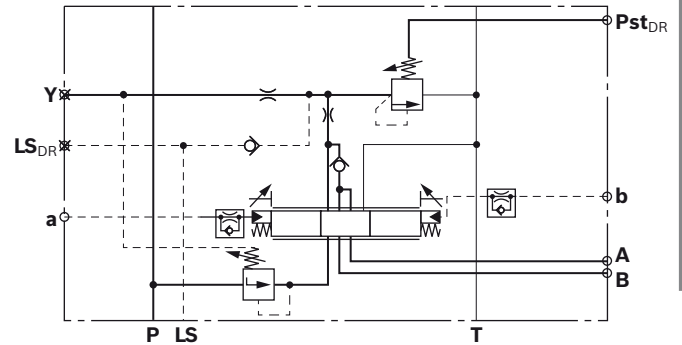
- ▶ LUDV directional valve plate
- ▶ Hydraulically controlled
- ▶ Switching speed of the main spool can be influenced
- ▶ Stroke stops available for exact flow setting
- ▶ Pressure/feed valves (optional)
- ▶ Load holding valves
- ▶ Maximum flow 250 l/min



1-fold M7-20/LS (standard)

Short description

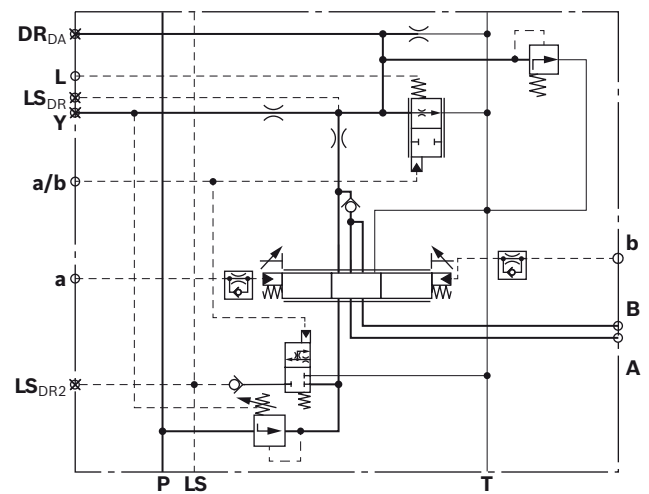
- ▶ LS directional valve plate (e.g. for grabber)
- ▶ LS section pressure limitation
- ▶ Hydraulically controlled
- ▶ Switching speed of the main spool can be influenced
- ▶ Stroke stops available for exact flow setting
- ▶ Load holding valve
- ▶ No secondary limitation possible
- ▶ Maximum flow 200 l/min



1-fold M7-20/LS DTS

Short description

- ▶ LS directional valve plate for rotating mechanism
- ▶ DTS pressure distributor circuit for oscillation-free actuation of the rotating mechanism
- ▶ Hydraulically controlled
- ▶ Maximum flow 180 l/m; in case of larger flows, a combination with the standard LS directional valve plate is possible



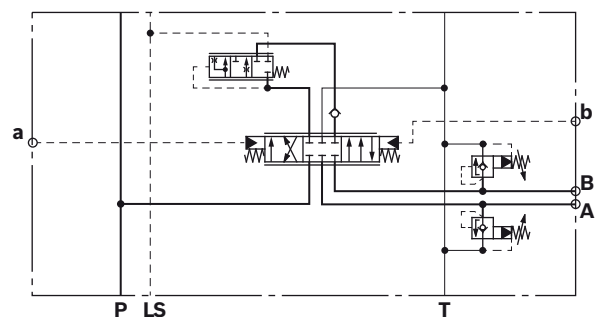
Notice

If more than one LS directional valve plate is used, the LS connection must be established externally.

1-fold SX14

Short description

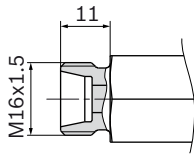
- ▶ LUDV directional valve plate
- ▶ Hydraulically controlled (optional electro-hydraulically)
- ▶ Stroke stops available for exact flow setting
- ▶ Pressure/feed valves
- ▶ Load holding valves
- ▶ Maximum flow 160 l/min



Dimensions

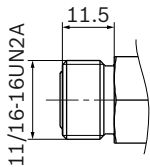
Line connections

Port	Dimension	Similar standard
P1	DN 25 (SAE 1" 6000 PSI)	DIN ISO 6162-2
P2, P3	DN 19 (SAE 3/4" 6000 PSI)	DIN ISO 6162-2
T	DN 25 (SAE 1" 3000 PSI)	DIN ISO 6162-1
K	DN 25 (SAE 1" 3000 PSI)	DIN ISO 6162-1
A1 - B5	DN 19 (SAE 3/4" 6000 PSI)	DIN ISO 6162-2
A0.. - B0..	DN 19 (SAE 3/4" 6000 PSI)	DIN ISO 6162-2
	SX14: DN 19 (G 3/4)	DIN EN ISO 1179-1
LS, LS_{DR}		
L	DN 10 (G 1/4)	DIN EN ISO 1179-1
Y		
M_{LS}, M_P	G 1/4 (version Z)	DIN EN ISO 1179



Poppet seal (version **G**):
L10 according to DIN EN ISO 8434

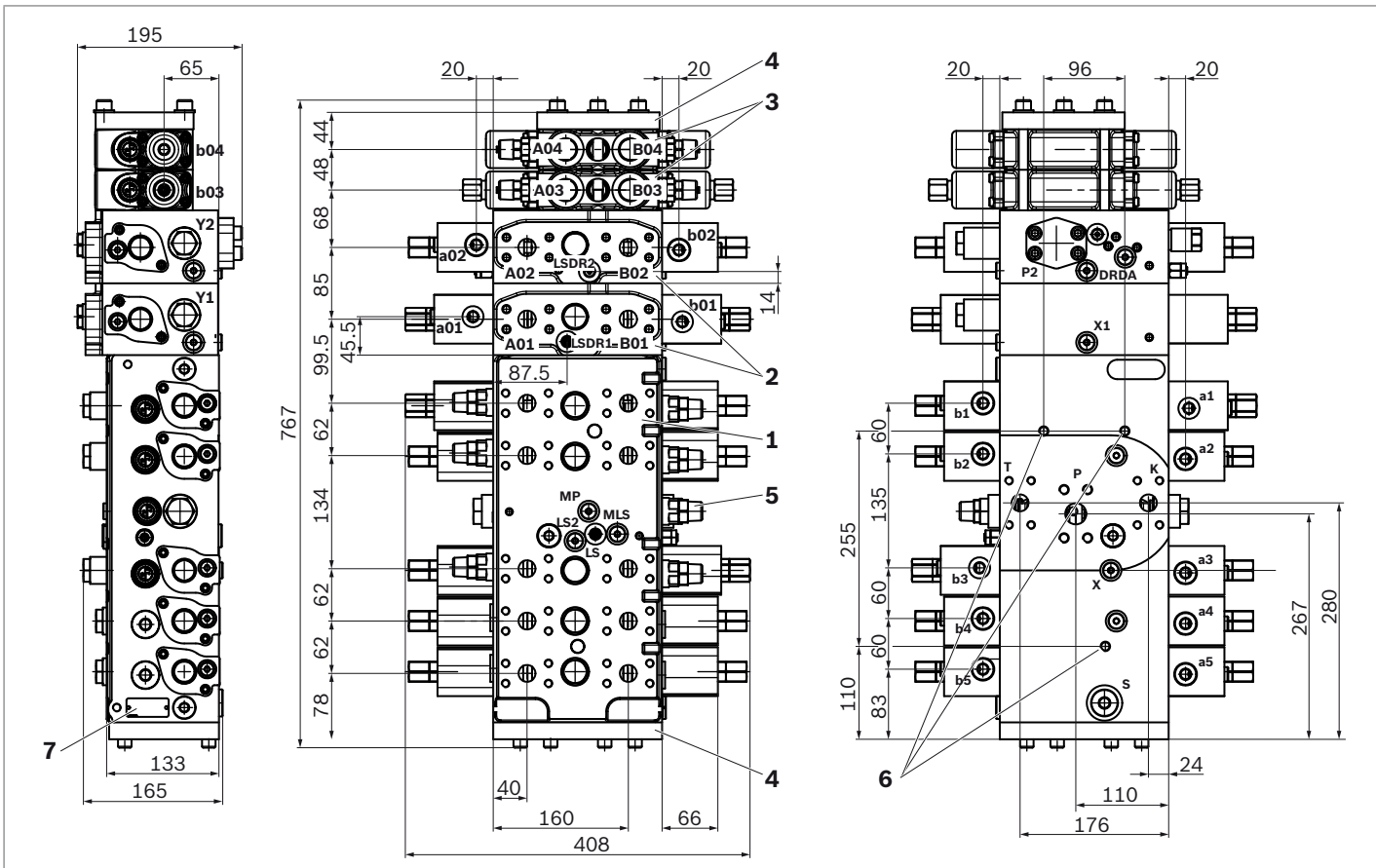
a, b



O-ring seal (version **O**):
SAE J 1453-3

Ports	
P	Pump
T	Tank
K	Cooler
A, B	Actuator
LS	Load sensing
L	Leakage oil connection (depressurized to the tank)
Y	Load pressure LS valve plate
M	Measuring port
a, b	Pilot oil port

▼ Example 9M7-20



- 1 5-fold mono block
- 2 M7-20/LS directional valves
- 3 SX14 directional valves
- 4 End plate
- 5 Primary pressure relief valve
- 6 Three M12 mounting threads
- 7 Name plate

Project planning information

The LUDV control block M7-20 is the core component of the hydraulic control system of a mobile working machine. It is therefore recommended to only specify it in connection with an overall hydraulic circuit diagram.

For the design of a hydraulic LUDV control block of type M7-20, the following boundary conditions are relevant for project planning and should be enclosed to the enquiry:

- ▶ Machine type
- ▶ Pump flow at rated speed
- ▶ Type of pump control
- ▶ Description of the actuator on the sections (e.g. boom, winch)
- ▶ Cylinder ratios/displacement of the motor
- ▶ Information on whether a system element is installed downstream of the valve (e.g. hose burst check valve, lowering brake valve)
- ▶ Information on the loads (pressures) to be throttled per axis if there is no braking valve or similar.

Related documents

The control blocks M7-20 are system components. Also observe the instructions for the other system components. Do not commission the product until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

Flow sharing control block in mono block / sandwich plate design

M7-22



HAD 6169

- ▶ Size 22
- ▶ Series 3X
- ▶ Maximum working pressure
 - on the pump side 380 bar
 - on the consumer side 420 bar
- ▶ Maximum flow
 - 1 x 420 l/min or 2 x 350 l/min on the pump side
 - on the consumer side 400 l/min

Features

- ▶ Load pressure independent flow sharing (LUDV)
- ▶ Closed center for variable pump
- ▶ Integrated load holding valves
- ▶ Integrated reservoir pre-loading possible
 - 3-fold block (**K** internal, **T** mounted)
 - 5-fold block (**K** and **T** internal)
- ▶ Unloading function for
 - Improved responsiveness
 - Reduction of switch-off peaks
 - Flushing and cooling
 - Lower risk of cavitation

Design

- ▶ Mono block with 3 or 5 consumer axes
- ▶ Expandable with directional valves of various sizes (max. 9)
- ▶ Type of actuation
 - Hydraulic
 - Electrohydraulic

Fields of application

- ▶ Cranes
- ▶ Excavators
- ▶ Stripping shovels/crawler cranes
- ▶ Material handling machines
- ▶ Drilling equipment

Contents

Functional description	2
Technical data	3
Characteristic curve	4
Ordering details	5
Symbols	11
Dimensions	15
Project planning notes	18
Accessories	18
Related documents	19

Functional description

Control block M7-22

Proportional directional valve based on the LUDV principle (load pressure independent flow distribution).

Load pressure compensation, LUDV

The control block M7-22 operates on the LUDV principle. On this load sensing version, the pressure compensator (3) is mounted between the control spool (6) and the consumer ports (A, B).

The maximum load pressure of all consumers involved is reported to all pressure compensators and simultaneously to the pump.

In contrast to standard LS designs, with LUDV individual consumers do not come to an unwanted standstill if the pump flow is not sufficient to supply all functions with the required nominal volume. In this case, the speed of all working movements is reduced in the same ratio.

Consumer control

In the neutral position of the control spool (no pilot pressure at the ports a or b), the connection of the pump to the P' channel is shut off by the control spool. The load holding valves (2) and the pressure compensator (3) are closed. The consumer ports are shut off by the overlap of

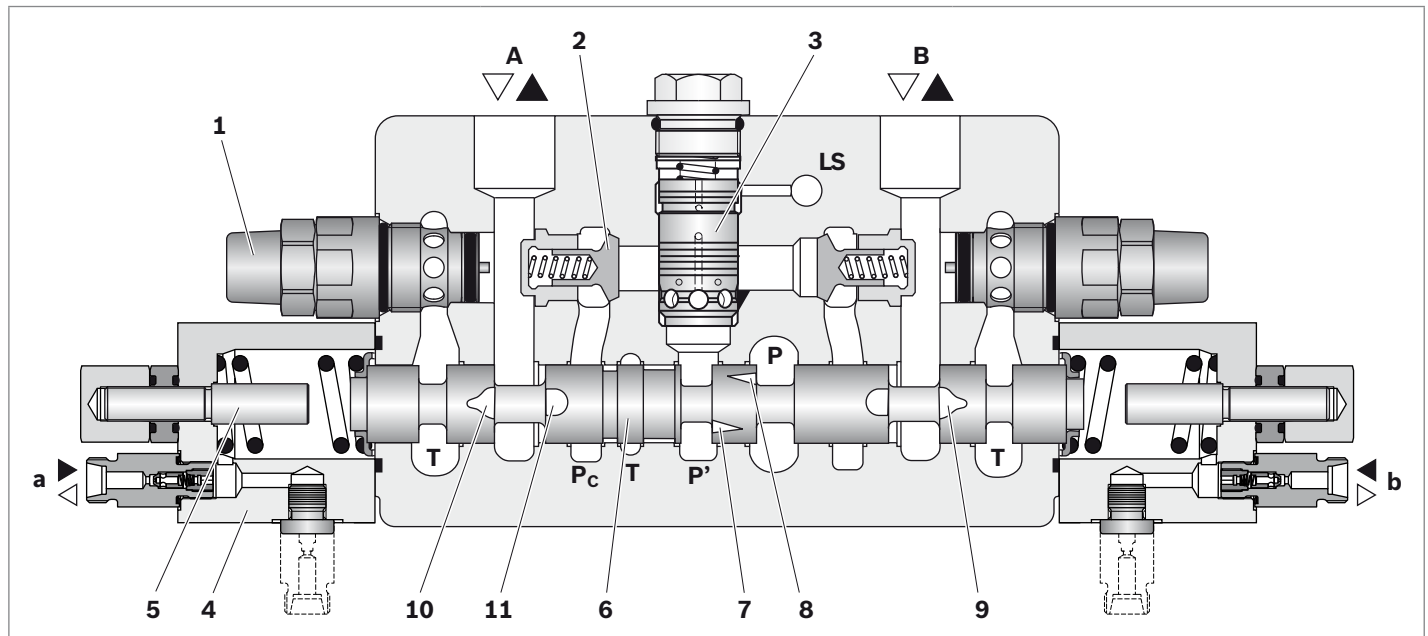
the control spool (6) in the housing.

The LUDV pressure compensator consists of a control spool and a compression spring, which defines a stable initial position.

The control spool (6) is moved proportionally to the right by the applied pilot pressure of the pilot control device in the control cover a against the spring force. The inlet metering orifice (7) of the control spool opens the connection from the pump port P to the channel P'. The pressure in this chamber opens the pressure compensator (3) and is applied up to the load holding valves (2).

The consumer pressure p_c of port A keeps (11) the left load holding valve (2) via the passages in the control spool. The increase of P' via p_c opens the check valve. The connection is created between pump and the consumer and initiates the movement. The oil displaced in the consumer flows from B via the outlet orifice (9) back to the reservoir. The secondary pressure relief valves (1) remain closed as long as the pressure in the consumer port remains below their pressure setting. The main poppet of the combined pressure relief/feed valve (1) in the inlet (side A) opens on cavitation in the consumer port and enables feeding from the reservoir line. An optional reservoir pre-loading increases the feed flow.

▼ Section M7-22



- | | | |
|--|--------------------------------------|---|
| 1 Secondary pressure relief valve / feed valve | 5 Stroke limiter | 9 Outlet orifice B → T |
| 2 Load holding valve | 6 Control spool | 10 Outlet orifice A → T |
| 3 LUDV pressure compensator | 7 Inlet, metering orifice P → P' → A | 11 Directional grooves P → A (according to P → B) |
| 4 Cover (hydraulic) | 8 Inlet, metering orifice P → P' → B | |

Technical data

General				
Weight	3-fold mono block	kg	approx. 64	
	5-fold mono block	kg	approx. 90	
	M7-20 directional valve	kg	approx. 12	
	M7-22 directional valve	kg	approx. 19.5	
	End plate	kg	approx. 3.7	
Installation position				Any
Consumer connection type				Flange port according to DIN EN ISO 6162
Ambient temperature range	θ	°C	-20 to +80	
Priming (standard)				One-coat paint RAL 5010
Hydraulic				
Maximum working pressure at port	P	p	bar	380
	A, B	p	bar	420
	LS	p	bar	360
	T	p	bar	30
	L, Y	p	bar	Must be routed to reservoir without pressure
Maximum pilot pressure at port	Pst, X	p	bar	35
	a, b	p	bar	35
Pilot pressure range	Hydraulic	p	bar	0 to 23 (27)
	Electrohydraulic	p	bar	0 to 27
Maximum flow at port (at Δp block inlet P → LS = 19 bar)	P	q_{Vmax}	l/min	420
	A, B	q_{Vmax}	l/min	350 with E control spool
		q_{Vmax}	l/min	400 with J control spool
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to ISO 15380 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid Cleanliness level as per ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Recommended hydraulic pilot controls			Type	4 TH6...; characteristic curve 70, see data sheet 64555 2 TH6 R...; characteristic curve 70, see data sheet 64552

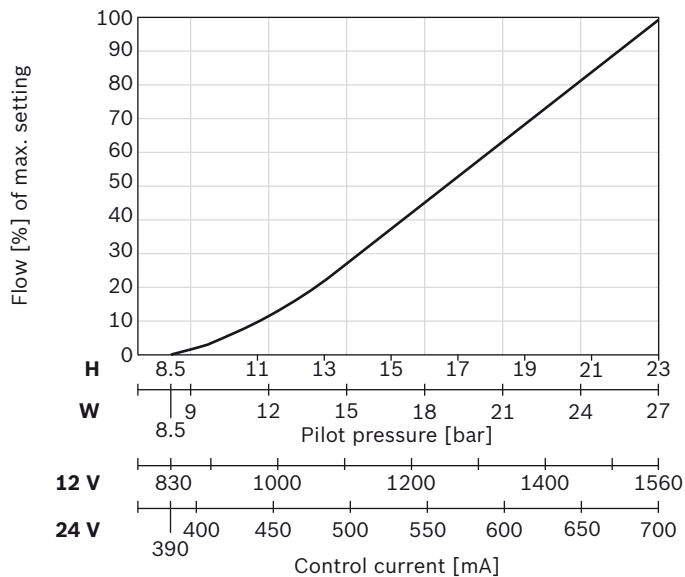
Electric			
Voltage type		DC voltage	
On/off valves FTWE 4 K (see data sheet 58008)			
Supply voltage	V	12	24
Power consumption at 20 °C	W	14.4	14.4
Solenoid coil resistance at 20 °C	Ω	10	40
Duty cycle	%	100	100
Proportional value FTDRE 4 K (see data sheet 58038)			
Supply voltage	V	12	24
Solenoid coil resistance at 20 °C	Ω	2.4	12
Duty cycle	%	100	100
Max. control current	mA	1800	800
Recommended chopper frequency	Hz	200	200
Connector version	C	Junior Timer, (AMP)	
	K	DT04-2P (Deutsch)	
Type of protection according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Connector version C	IP65 (with installed and locked plug-in connector) ¹⁾	
		IP67 and IP69K (with Rexroth plug-in connector, material no. R901022127) ¹⁾	
	Connector version K	IP 67 and IP 69K (with installed and locked plug-in connector) ¹⁾	
Control electronics, e.g. BODAS		Control unit RA, see data sheet 95230 Control unit RC, see data sheet 95200	

Notice

- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{sec}$ (HLP46: 50 °C).

Characteristic curve

▼ **Typical spool characteristic curve**



1) Plug-in connectors are not included in the scope of delivery and must be ordered separately, see accessories on page 18.

Ordering details

Specifications on the name plate

The ordering details are used to record the technical features and requirements.

The Rexroth sales organization uses the ordering details to derive a short type and a material number.

01	02	03	04	05
M7	-	....	-	3X / M7-22
01	Series: LUDV control block M7			M7
02	4-digit control block number			....
03	Series 30 to 39 (unchanged installation and connection dimensions)			3X
04	Total number of spool axes			3 to 9
05	Type of actuation	Hydraulic	H	
		Electrohydraulic ¹⁾	W	

Abbreviations

The ordering code documents the standard functional features of the valve series mounted according to the modular principle. This consists of a 3-fold or 5-fold mono block with LUDV function, to which a group of up to four LUDV directional valves, with or without intermediate plates and with the corresponding end plate, can be mounted on a front side. LS directional valves, as well as additional valves of type SX14, can be flanged with end plate to the opposite front side. The number of spool axes in the mono block and the number of individual directional valve sections gives the total number of spool axes in the control block.

The block configuration without definition of the individual spool axes is defined in the first part of the ordering code (overall control block layout).

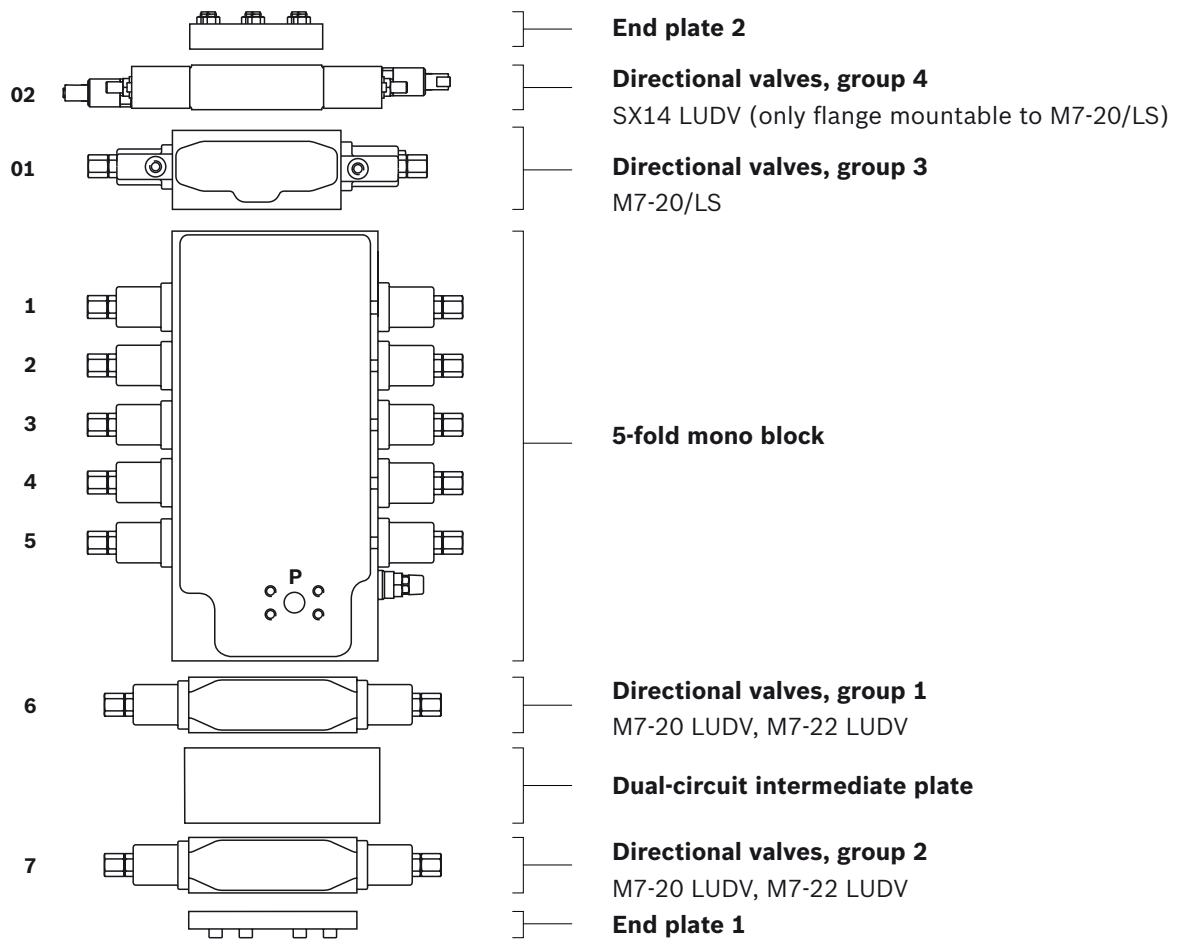
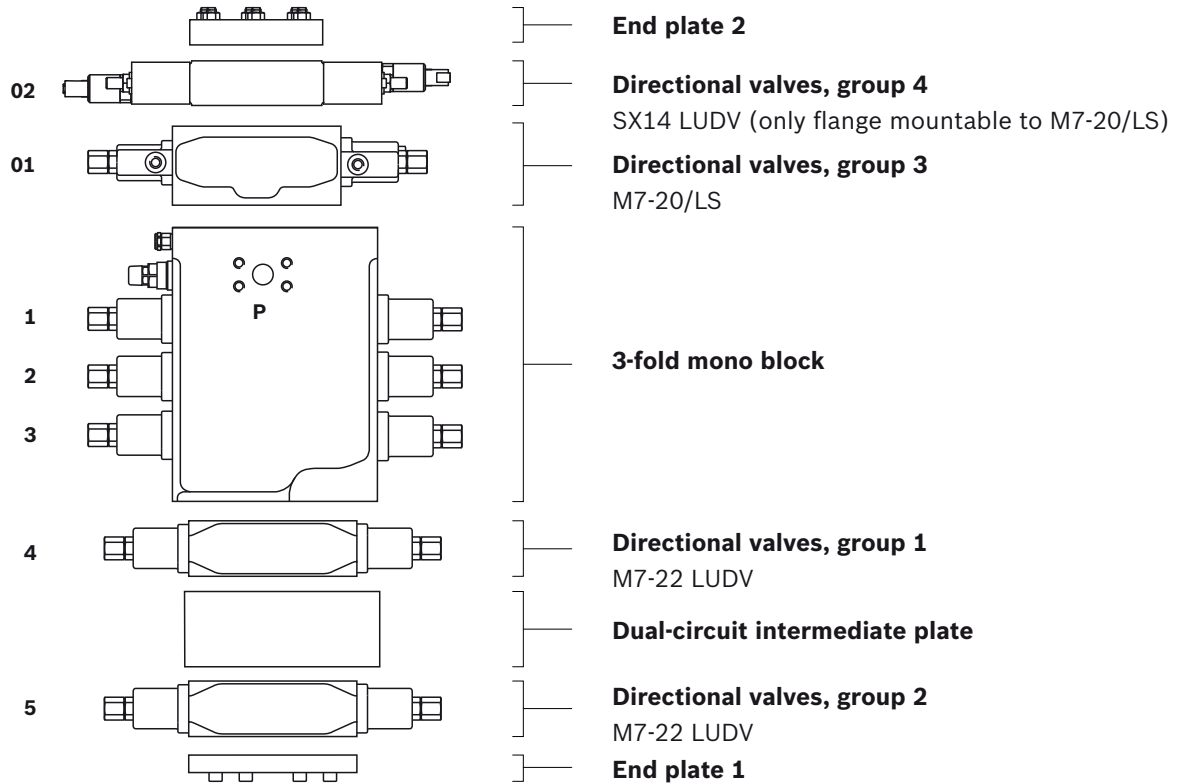
The available detail features and setting values of the block are defined in the second part of the ordering code (overall control block features).

Finally, the features corresponding to each spool axis of the block must then be selected.

The complete specification of all features is the precondition for the quick and unambiguous processing of an order. For any questions, please contact the relevant application specialist in sales-related product management.

¹⁾ The standard version is pilot valves with manual actuation

Combination options



Layout of overall control block

01		02	03	04	05	06	07	08	09	10	11	12
	M7-22	/				-		K		S		

01	Total number of spool axes	3 to 9
----	----------------------------	--------

System type

02	Single-circuit system	E
	Dual-circuit system	T

Construction

03	3-fold mono block	3
	5-fold mono block	5

Directional valves, group 1 and 2

04	M7-20 LUDV ¹⁾	K
	M7-22 LUDV	G
05	Number of directional valves, groups 1 ²⁾	0 to 4
06	Number of directional valves, groups 2 ²⁾	0 to 4

End plate 1

07	LUDV, no function	L
	LUDV with P port	C

Directional valves, group 3

08	M7-20/LS	K
09	Number of directional valves	0 to 4

Directional valves, groups 4³⁾

10	SX14	S
11	Number of directional valves	0 to 4

End plate 2

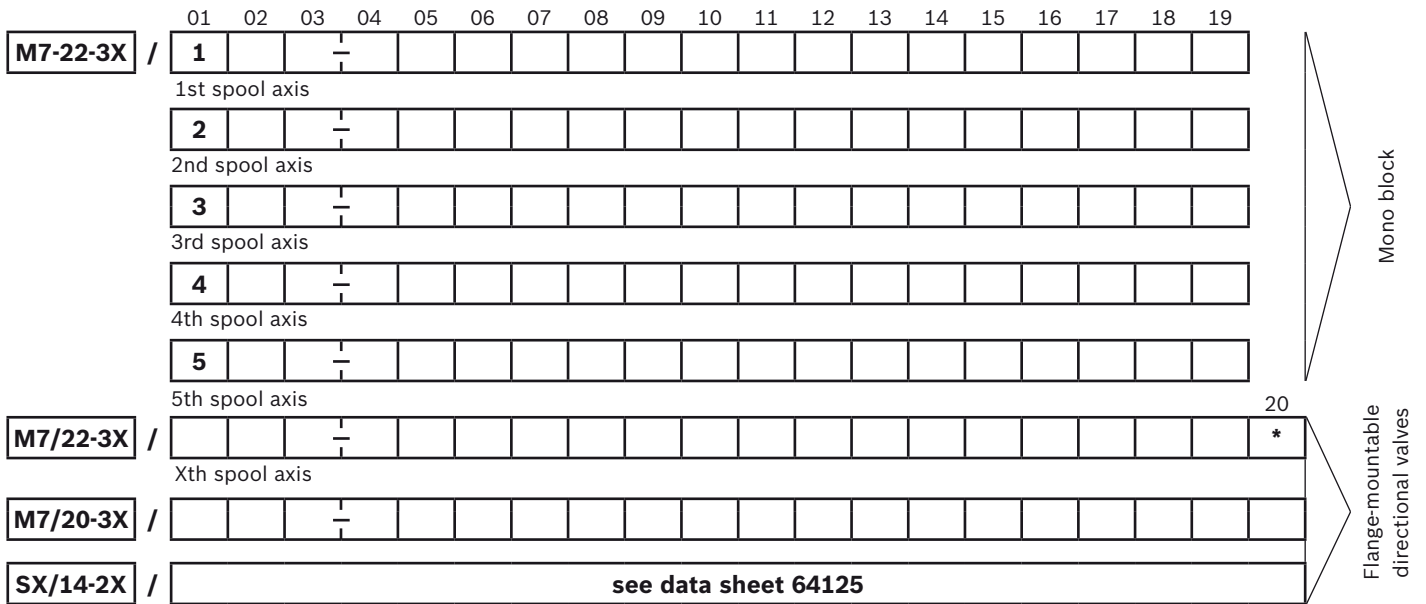
12	Without function	Z
	With P port	C

1) Not possible in combination with 3-fold mono block

2) The sum of both groups must be a maximum of 4

3) Only flange mountable to directional valves M7-20/LS

Spool axis features



01	Spool axis number	1 to X
----	-------------------	---------------

Spool type⁵⁾

02	Main spool A/B/T blocked in neutral position	E
	Main spool A/B→T open in neutral position	J
	Main spool A/B→T throttled to reservoir in neutral position	Q
	Control spool P/B→A in switch position b	R
	Special spool ⁶⁾	S

Flow

03	Consumer port A (in l/min, 3-digit)	...
04	Consumer port B (in l/min, 3-digit)	...

Load holding

05	Without	Z
	With load holding (on both sides)	L

Pressure compensator⁷⁾

06	Directly operated	D
	Pilot operated	V

5) For symbols, see "Control spool" on page 11.
On hydraulic cylinders, specifying the gear ratio in plain text is required, since E and Q spools have inlet and outlet characteristic curves. Further spool types on request.

6) Functional description in plain text

7) For symbols, see "Pressure compensator" on page 11

Type of actuation		A side			B side		
		07	08	09	10	11	12
07, 10	Hydraulic⁸⁾	H			H		
08, 11	Shuttle	No shuttle	00			00	
		With shuttle 0.3 mm	03			03	
		With shuttle 0.5 mm	05			05	
		With shuttle 0.6 mm	06			06	
		With shuttle 0.8 mm	08			08	
09, 12	Pilot oil port position	Axial		A			A
		Radial		R			R
07, 10	Electrohydraulic⁹⁾	W			W		
08, 11	Proportional	24 V	81			81	
		12 V	83			83	
	Switchable	24 V	61			61	
		12 V	63			63	
09, 12	Connector version	Junior-Timer, 2-pin (AMP)		C			C
		DT04-2P (Deutsch)		K			K

Pilot oil port for hydraulic actuation¹⁰⁾

13	Poppet seal					G
	O-ring seal					O
	G 1/4 without adapter (with H00 only)					Z

Secondary valves		A side			B side		
		14	15	16	17	18	19
14, 17	Without	Z	000	000	Z	000	000
	Feed valve (MHSV 22, see data sheet 64642)	E	000	000	E	000	000
	Pressure/feed valve (MHDBN 22, see data sheet 64602)	H	...	000	H	...	000
	Pressure relief/feed valve with pressure sequencing stage (MHDBB 22, see data sheet 64642)	B	...	...	B	...	...
15, 18	Specified pressure for pressure valve/feed valve (in bar, 3-digit)		...			...
16, 19	Specified pressure for pressure sequencing function (in bar, 3-digit)			...			...
20	Type M7-20/LS section specification in plain text						*

8) With measuring port

9) A specification in plain text is required for electrohydraulic actuation via remote control plate (e.g. HICFP).

10) See "Line connections" on page 15

Symbols

Control spool

Ordering code	Main use	Symbol
E	<ul style="list-style-type: none"> ▶ Hydraulic cylinder as consumer ▶ Spool with blocked ports A/B in neutral position 	
J	<ul style="list-style-type: none"> ▶ Hydraulic motors as consumers ▶ Consumer ports A/B → T open in neutral position 	
Q	<ul style="list-style-type: none"> ▶ Hydraulic cylinder and motors as consumers combined with pipe burst safety valve, check Q meter and lowering brake valve ▶ Spool with defined residual opening (A/B → T) in neutral position 	
R	<ul style="list-style-type: none"> ▶ E spool with regeneration function ▶ Control spool P/B→A 	

Notice

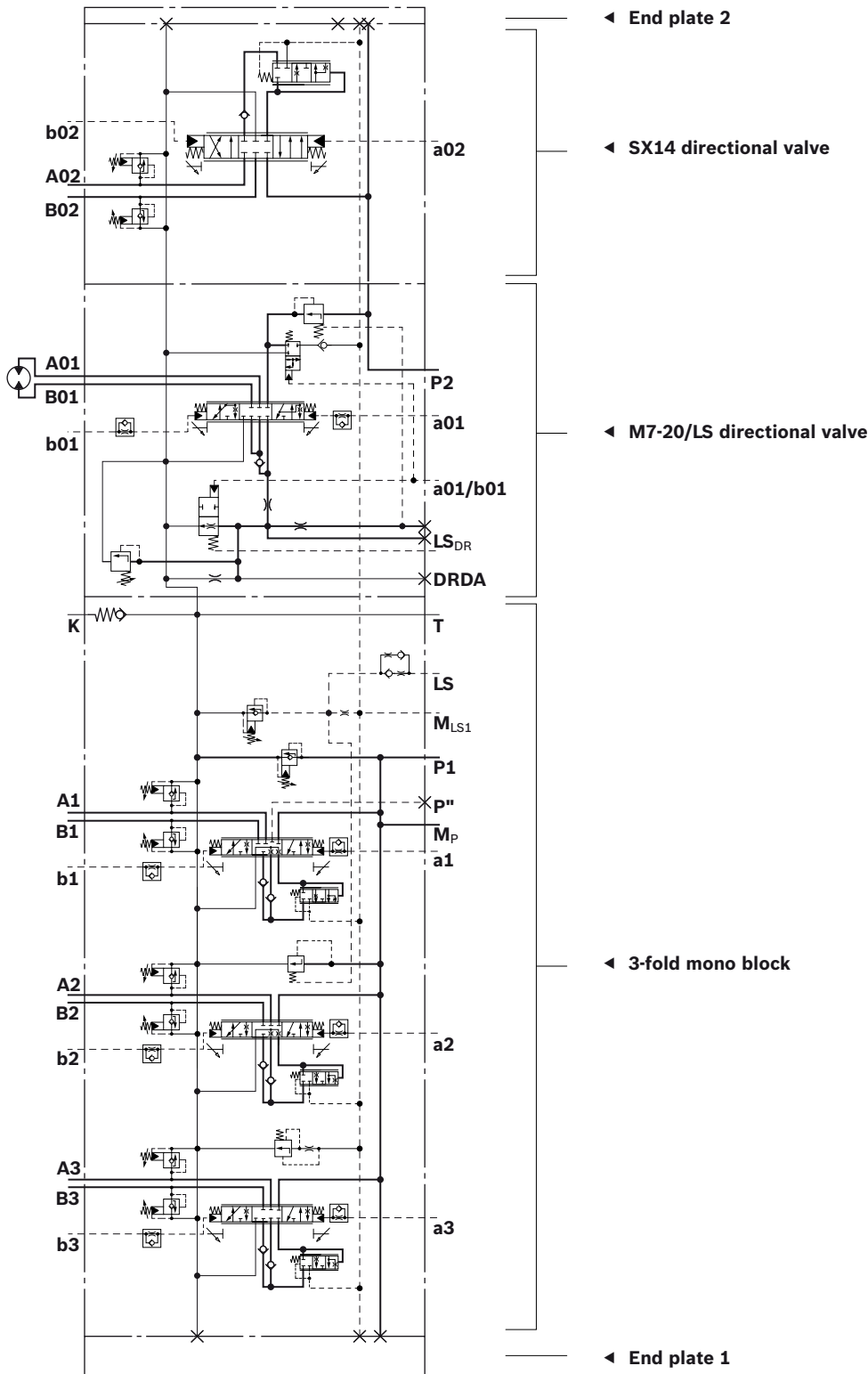
Additional control spools available on request.

Pressure compensator

Ordering code	Description	Symbol
D	Directly operated (standard)	
V	Pilot operated ▶ Used for superimposed movements when the highest loaded consumer changes often	

Control block

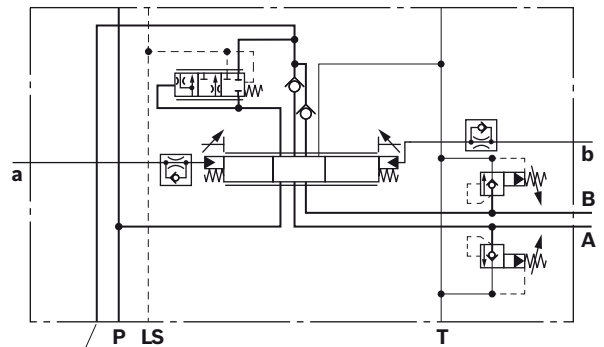
▼ Example: 3-fold mono block with 1 directional valve M7-20/LS and 1 directional valve SX14



Directional valves

1-fold M7-20 LUDV

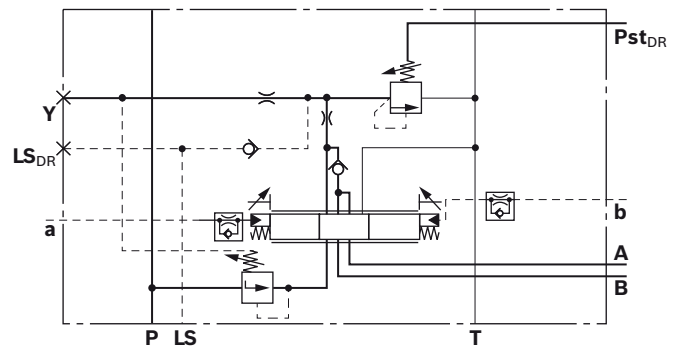
- ▶ LUDV section
- ▶ Hydraulically or electrohydraulically controlled
- ▶ Switching speed of the control spool is influenced
- ▶ Stroke limitation for exact quantity setting available
- ▶ Pressure valve/feed valve (optional)
- ▶ Load holding valve
- ▶ Maximum flow 250 l/min



Channel for driving compensation orifice only for the first 1M7-22 section on the mono block 3M7-22

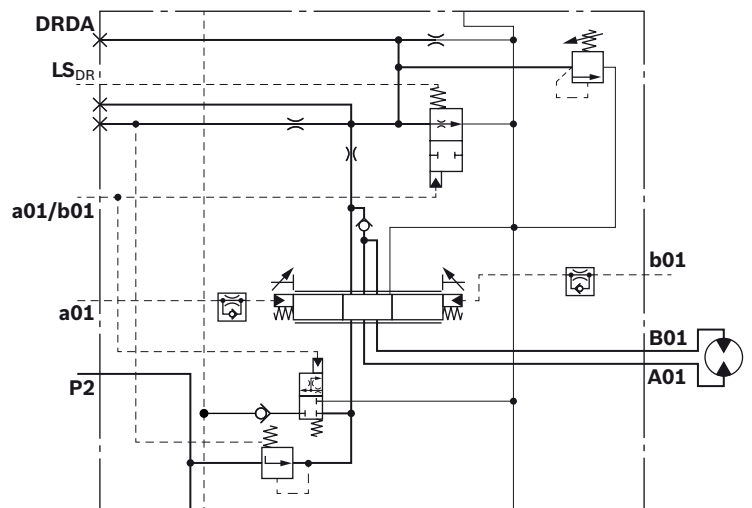
1-fold M7-20/LS (Standard)

- ▶ LS section (e.g. for grabber)
- ▶ LS section pressure limitation
- ▶ Hydraulically controlled
- ▶ Switching speed of the control spool is influenced
- ▶ Stroke limitation for exact quantity setting available
- ▶ Load holding valve
- ▶ No secondary pressure limitation possible
- ▶ Maximum flow 200 l/min



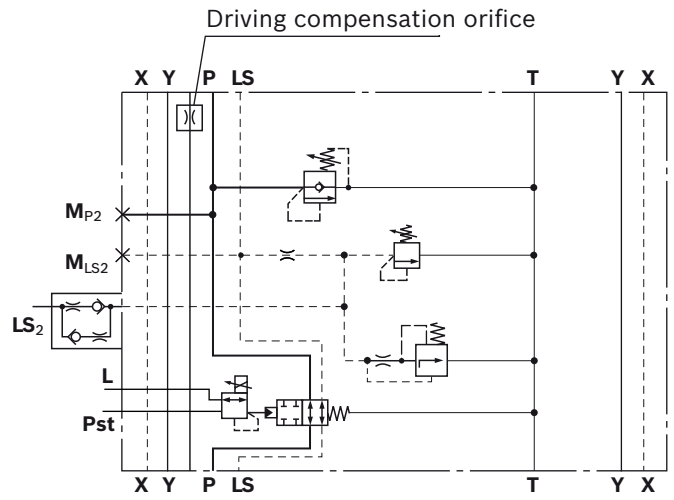
1-fold M7-20/LS (DTS)

- ▶ LS section for particularly sensitive acceleration of a slew drive
- ▶ Superposition of pressure control and flow control
- ▶ LS section pressure limitation
- ▶ Hydraulically or electrohydraulically controlled
- ▶ Switching speed of the control spool is influenced
- ▶ Stroke limitation for exact quantity setting available
- ▶ Load holding valve
- ▶ No secondary pressure limitation possible
- ▶ Maximum flow 200 l/min



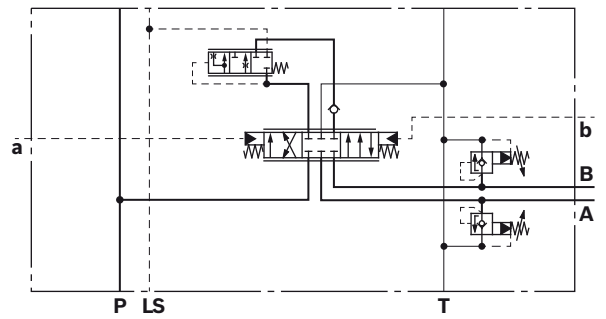
Dual-circuit intermediate plate M7-22

- ▶ Dual-circuit valve → separation/connection of P1 and P2 (LS1 and LS2)
- ▶ Primary pressure limitation, LS pressure limitation and LS unloading integrated for 2nd circuit
- ▶ Integrated driving compensation orifice, also deactivatable (standard for tracked vehicles)



1-fold SX14

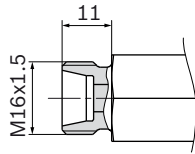
- ▶ LUDV section
- ▶ Hydraulically controlled (optionally electrohydraulically controlled)
- ▶ Stroke limitation for exact quantity setting available
- ▶ Pressure valve/feed valve
- ▶ Load holding valve
- ▶ Maximum flow 160 l/min



Dimensions

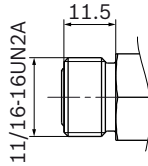
Line connections

Port	Dimension	Relevant standard
P1	DN 32 (SAE 1 1/4 in 6000 PSI)	DIN ISO 6162-2
P2	DN 19 (SAE 3/4 in 6000 PSI)	DIN ISO 6162-2
T, K	DN 32 (SAE 1 1/4 in 3000 PSI)	DIN ISO 6162-1
A, B	DN 25 (SAE 1 in 6000 PSI)	DIN ISO 6162-2
A0.., B0..	DN 19 (SAE 3/4 in 6000 PSI)	DIN ISO 6162-2
	SX14: DN 19 (G 3/4)	DIN EN ISO 1179-1
LS, DRDA		
L, Y	DN 10 (G 1/4)	DIN EN ISO 1179-1
Pst, X		
M	G 1/4 (Z design)	DIN EN ISO 1179



Poppet seal (**G** design):
L10 according to DIN EN ISO 8434

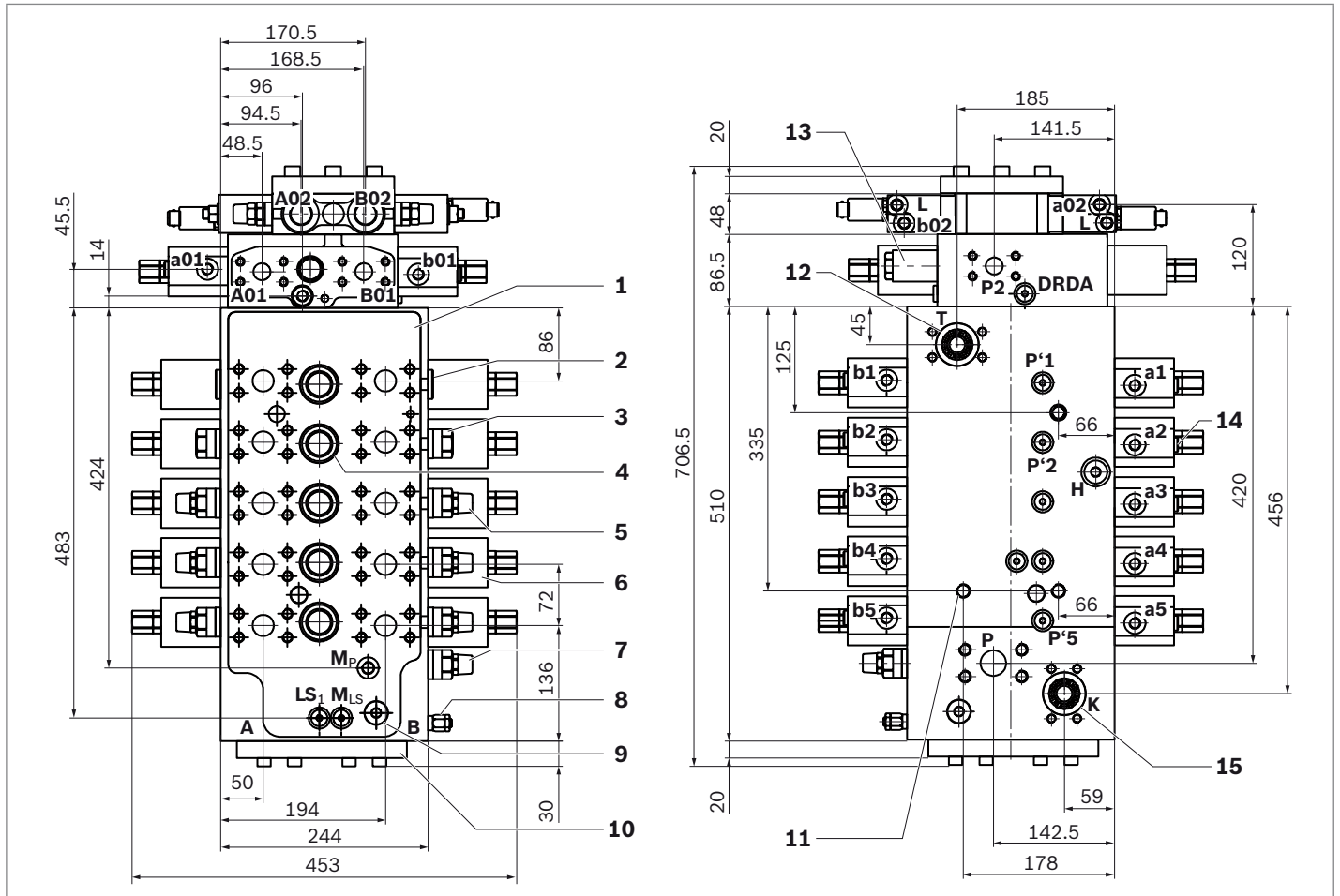
a, b



O-ring seal (**O** design):
SAE J 1453-3

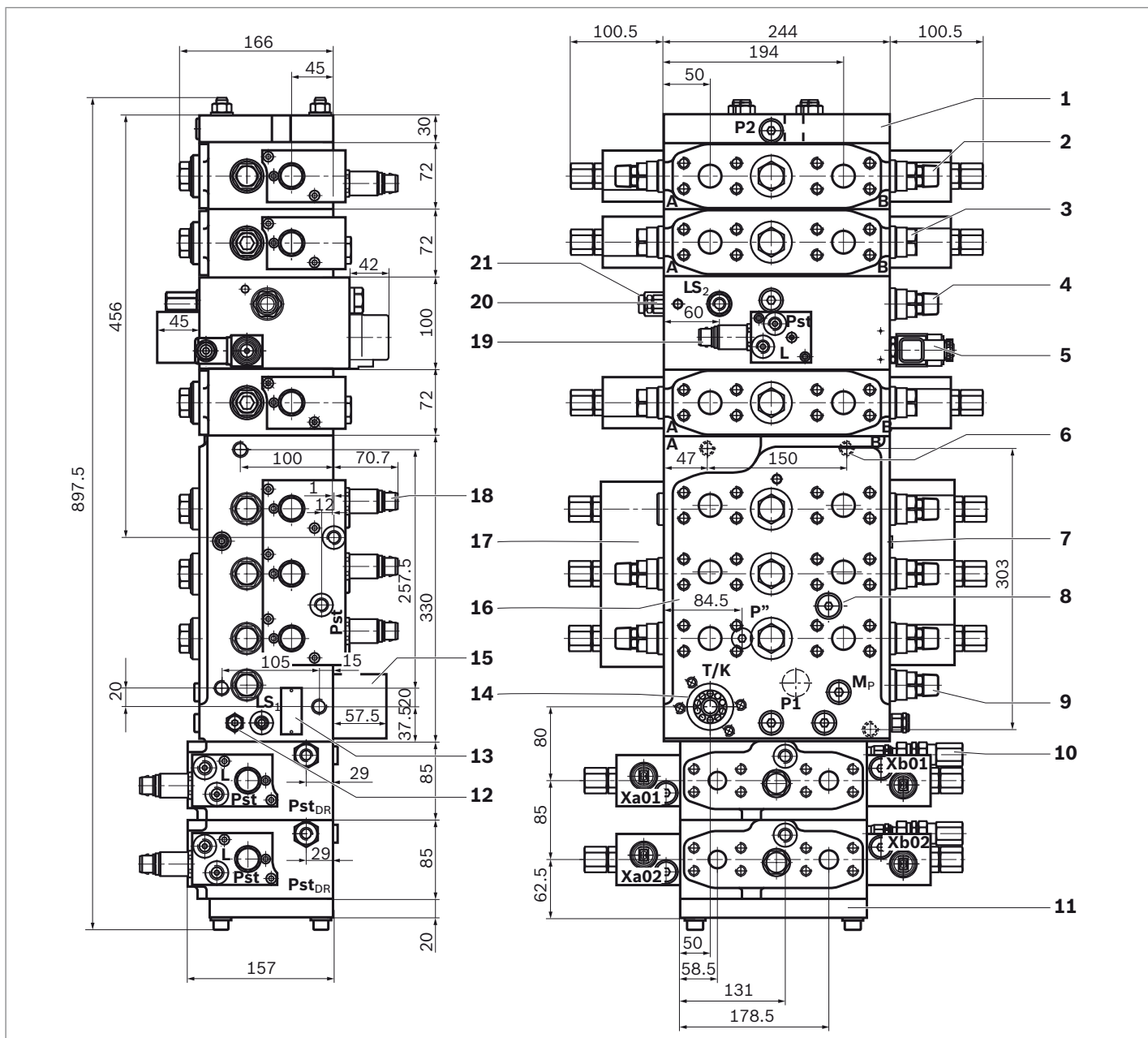
Ports	
P	Pump port
T	Reservoir port
K	Cooler port
A, B	Consumer port
LS	Load-sensing port
L	Leakage oil port (not under pressure to the reservoir)
Y	Load pressure, LS section
M	Measuring port
a, b	Pilot oil port

▼ Example: 7M7-22, hydraulic actuation



- 1 5-fold mono block
- 2 Threaded plug
- 3 Feed valve
- 4 LUDV pressure compensator
- 5 Secondary pressure relief valve
- 6 Control cover with stroke limiter
- 7 Primary pressure relief valve
- 8 LS pressure limitation
- 9 (q_{Vmin} circuit)
- 10 End plate M7-20
- 11 Three fastening threads M16, 24 deep
- 12 Reservoir pre-loading
- 13 LS pressure compensator
- 14 P_{st} shuttle
- 15 Cooler preloading

▼ Example: 8M7-22, electrohydraulic actuation



- | | |
|--|---|
| <ul style="list-style-type: none"> 1 End plate 2 2 Secondary pressure relief valve 3 Feed valve 4 Primary pressure relief valve 2nd circuit 5 Switchable compensating orifice 6 Three fastening threads M16, 22 deep 7 LS unloading 1st circuit 8 (q_{Vmin} circuit) 9 Primary pressure relief valve 1st circuit 10 Torque control valve 11 End plate 1 12 LS pressure limitation 1st circuit | <ul style="list-style-type: none"> 13 Name plate 14 Cooler preloading 15 Reservoir pre-loading (as subplate-mounted valve) 16 3-fold mono block 17 Electrohydraulic control cover with stroke limiter 18 Electrical switching valve or proportional valve 19 Single-circuit/dual-circuit switching 20 LS unloading 2nd circuit 21 LS pressure limitation 2nd circuit |
|--|---|

Project planning notes

The LUDV control block M7-22 is the core component of the hydraulic control of a mobile working machine. We therefore recommend it to be specified only in combination with a hydraulic overall circuit diagram.

For the design of a hydraulic LUDV control block of type M7-22, the following project planning boundary conditions are relevant and should accompany the inquiry:

- ▶ Machine type
- ▶ Pump flow at rated speed
- ▶ Type of pump controller
- ▶ Description of the consumer on the sections (e.g. boom, winch)
- ▶ Cylinder ratios/motor displacement
- ▶ Information as to whether a system element is connected downstream of the valve (e.g. pipe burst safety valve, lowering brake valve)
- ▶ Specification of loads (pressures) to be throttled per axis if no brake valve or similar is available.

Accessories

Plug-in connector for FTDRE... and FTWE...

Recommended plug-in connector for connector version C Junior Timer, 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended plug-in connector for Junior Timer, 2-pin (AMP)



Recommended plug-in connector for connector version K DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

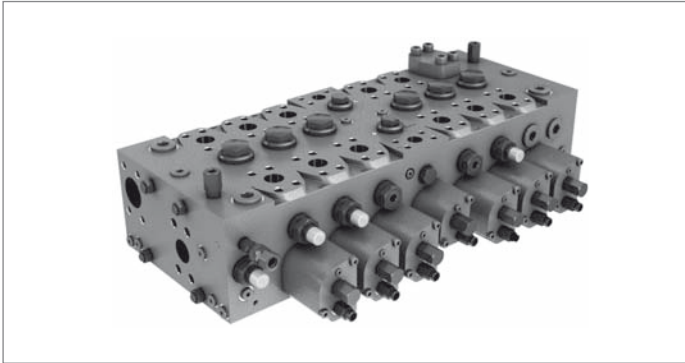
▼ Recommended plug-in connector for DT04 (DEUTSCH)



Related documents

Further information on installation, commissioning, and operation can be found in the instruction manual 64025-B: “Control blocks for mobile applications”.

Flow sharing control block in sandwich plate design M7-25



- ▶ Size 25
- ▶ Series 3X
- ▶ Maximum working pressure
 - on the pump side 380 bar
 - on the consumer side 420 bar
- ▶ Maximum flow
 - on the pump side 1 x 700 l/min or 2 x 600 l/min
 - on the consumer side 700 l/min

Features

- ▶ Load pressure independent flow sharing (LUDV)
- ▶ Closed center for variable pump
- ▶ Unloading function for
 - Improved responsiveness
 - Flushing and cooling

Design

- ▶ Sandwich plate design
 - max. 6 directional valves with single-circuit system
 - max. 2 x 4 directional valves with dual-circuit system
- ▶ Type of actuation
 - Hydraulic
 - Electrohydraulic

Fields of application

- ▶ Cranes
- ▶ Excavators
- ▶ Stripping shovels/crawler cranes
- ▶ Material handling machines
- ▶ Drilling equipment

Contents

Functional description	2
Technical data	3
Characteristic curves	5
Ordering code	6
Order examples	10
Symbols	12
Dimensions	15
Project planning notes	18
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Related documents	19

Functional description

Control block M7-25

Proportional directional valve based on the LUDV principle (load pressure independent flow distribution).

Load pressure compensation, LUDV

The control block M7-25 operates on the LUDV principle. On this load sensing version, the pressure compensator (3) is mounted between the control spool (6) and the consumer ports (A, B).

The maximum load pressure of all consumers involved is reported to all pressure compensators and simultaneously to the pump.

In contrast to standard LS designs, with LUDV individual consumers do not come to an unwanted standstill if the pump flow is not sufficient to supply all functions with the required nominal volume. In this case, the speed of all working movements is reduced in the same ratio.

Consumer control

In the neutral position of the control spool (no pilot pressure at the ports a or b), the connection of the pump to the P' channel is shut off by the control spool. The load holding valves (2) and the pressure compensator (3) are closed.

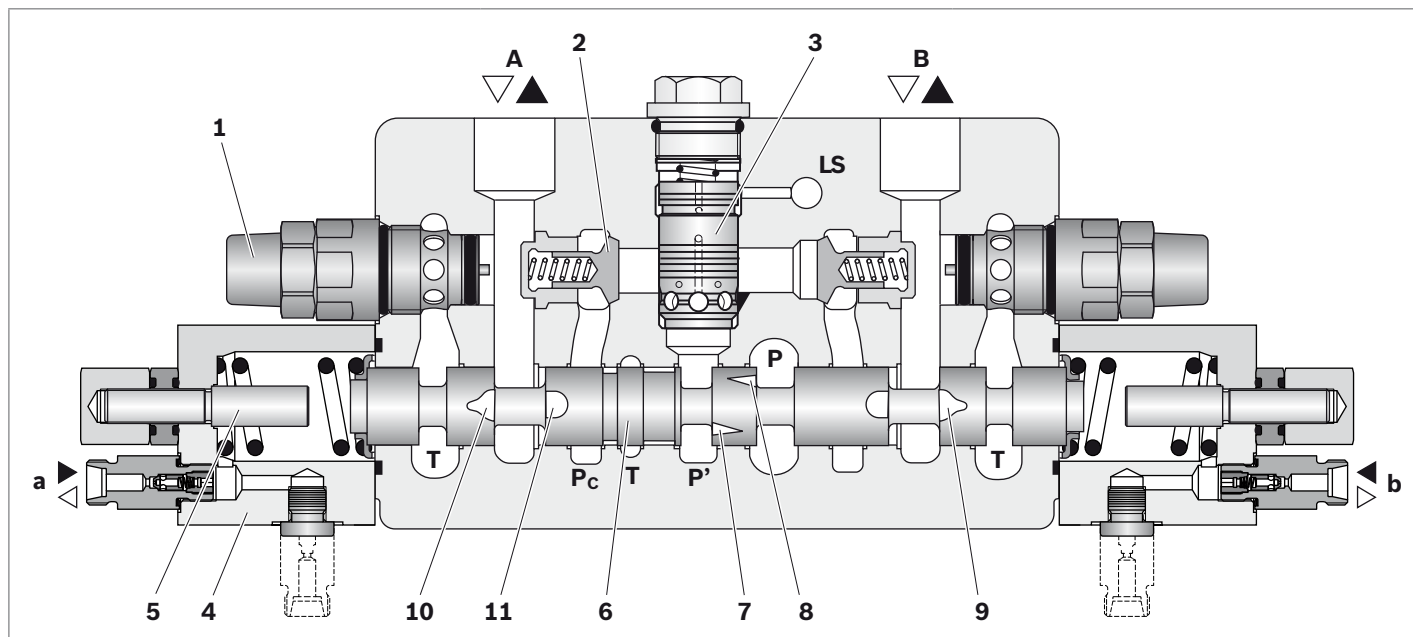
The consumer ports are shut off by the overlap of the control spool (6) in the housing.

The LUDV pressure compensator consists of a control spool and a compression spring, which defines a stable initial position.

The control spool (6) is moved proportionally to the right by the applied pilot pressure of the pilot control device in the control cover a against the spring force. The inlet metering orifice (7) of the control spool opens the connection from the pump port P to the channel P'. The pressure in this chamber opens the pressure compensator (3) and is applied up to the load holding valves (2).

The consumer pressure p_c of port A keeps the left load holding valve (2) closed via the passages in the control spool (11). The increase of P' via p_c opens the check valve. The connection is created between pump and the consumer and initiates the movement. The oil displaced in the consumer flows from B via the outlet orifice (9) back to the reservoir. The secondary pressure relief valves (1) remain closed as long as the pressure in the consumer port remains below their pressure setting. The main poppet of the combined pressure relief/feed valve (1) in the inlet (side A) opens on cavitation in the consumer port and enables feeding from the reservoir line. An optional reservoir pre-loading increases the feed flow.

▼ Sectional view M7-25



- | | | |
|--|--------------------------------------|---|
| 1 Secondary pressure relief valve / feed valve | 5 Stroke limiter | 9 Outlet orifice B → T |
| 2 Load holding valve | 6 Control spool | 10 Outlet orifice A → T |
| 3 LUDV pressure compensator | 7 Inlet, metering orifice P → P' → A | 11 Directional grooves P → A (according to P → B) |
| 4 Cover (hydraulic) | 8 Inlet, metering orifice P → P' → B | |

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Technical data

General				
Weight	Port plate		kg	approx. 25
	Dual-circuit intermediate plate		kg	approx. 35
	M7-25 directional valve		kg	approx. 30
	End plate		kg	approx. 14
Installation position				any, but not with the consumer ports to the bottom
Consumer connection type				Flange port according to DIN EN ISO 6162
Ambient temperature range	θ	°C	-20 to +80	
Priming (standard)				One-coat paint RAL 5010
Hydraulic				
Maximum working pressure at port	P	p	bar	380
	A, B	p	bar	420
	LS	p	bar	360
	T	p	bar	30
	Y (L)	p	bar	Must be routed to reservoir without pressure
Maximum pilot pressure at port	X (P _{st})	p	bar	40
	a, b	p	bar	40
Pilot pressure range	Hydraulic	p	bar	0 to 23 (27)
	Electrohydraulic	p	bar	0 to 27
Maximum flow at port	P	q_{Vmax}	l/min	2 × 600
	A, B	q_{Vmax}	l/min	700 with J control spool
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to ISO 15380 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid Cleanliness level as per ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Recommended hydraulic pilot controls			Type	4 TH6...; characteristic curve 70, see data sheet 64555 2 TH6 R...; characteristic curve 70, see data sheet 64552

Electric			
Voltage type	DC voltage		
On/off valves FTWE 4 K (see data sheet 58008)			
Supply voltage	V	12	24
Power consumption at 20 °C	W	14.4	14.4
Solenoid coil resistance at 20 °C	Ω	10	40
Duty cycle	%	100	100
Proportional valve FTDRE 4 K (see data sheet 58038)			
Supply voltage	V	12	24
Solenoid coil resistance at 20 °C	Ω	2.4	12
Duty cycle	%	100	100
Max. control current	mA	1800	800
Recommended chopper frequency	Hz	200	200
Connector version	C	Junior Timer, (AMP)	
	K	DT04-2P (Deutsch)	
Type of protection according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Connector version C	IP65 (with installed and locked plug-in connector) ¹⁾	
		IP67 and IP69K (with Rexroth plug-in connector, material no. R901022127) ¹⁾	
	Connector version K	IP67 and IP69K (with installed and locked plug-in connector) ¹⁾	
Control electronics, e.g. BODAS		Control unit RA, see data sheet 95230 Control unit RC, see data sheet 95200	

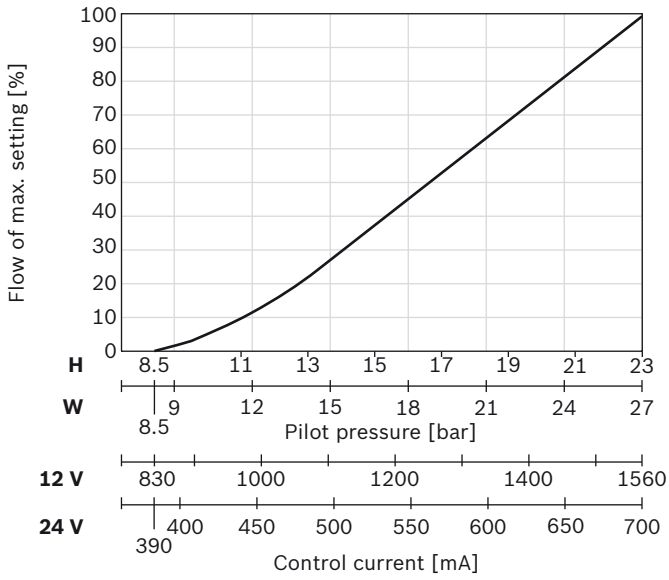
Notice

- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{s}$ (HLP46: 50 °C).

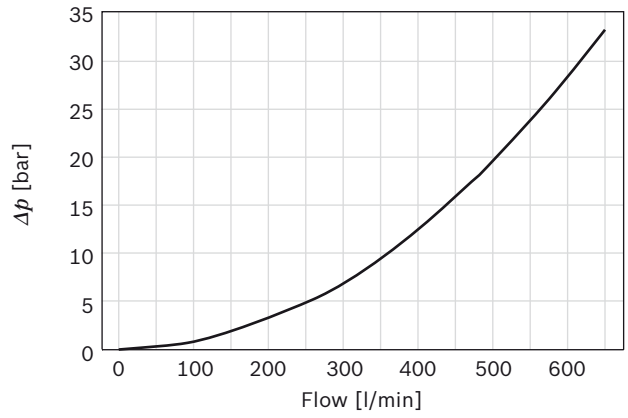
¹⁾ Plug-in connectors are not included in the scope of delivery and must be ordered separately, see accessories on page 18.

Characteristic curves

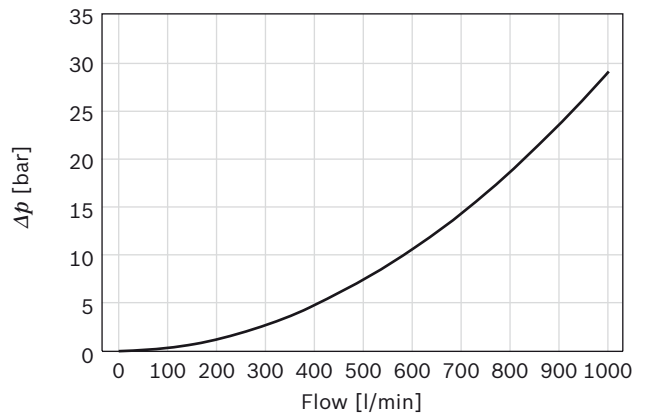
▼ Typical spool characteristic curve



▼ Pressure loss P → A/B (measured with E spool)



▼ Pressure loss A/B → T (measured with J spool)



Ordering code

Specifications on the name plate

The ordering code is used to record the technical features and requirements.

The Rexroth sales organization uses the ordering code to derive a short type and a material number.

01	02	03	04	05
M7	-	....	-	3X / M7-25
01	Series: LUDV control block M7			M7
02	4-digit control block number			....
03	Series 30 to 39 (unchanged installation and connection dimensions)			3X
04	Total number of spool axes			1 to 8
05	Type of actuation	Hydraulic	H	
		Electrohydraulic ¹⁾	W	

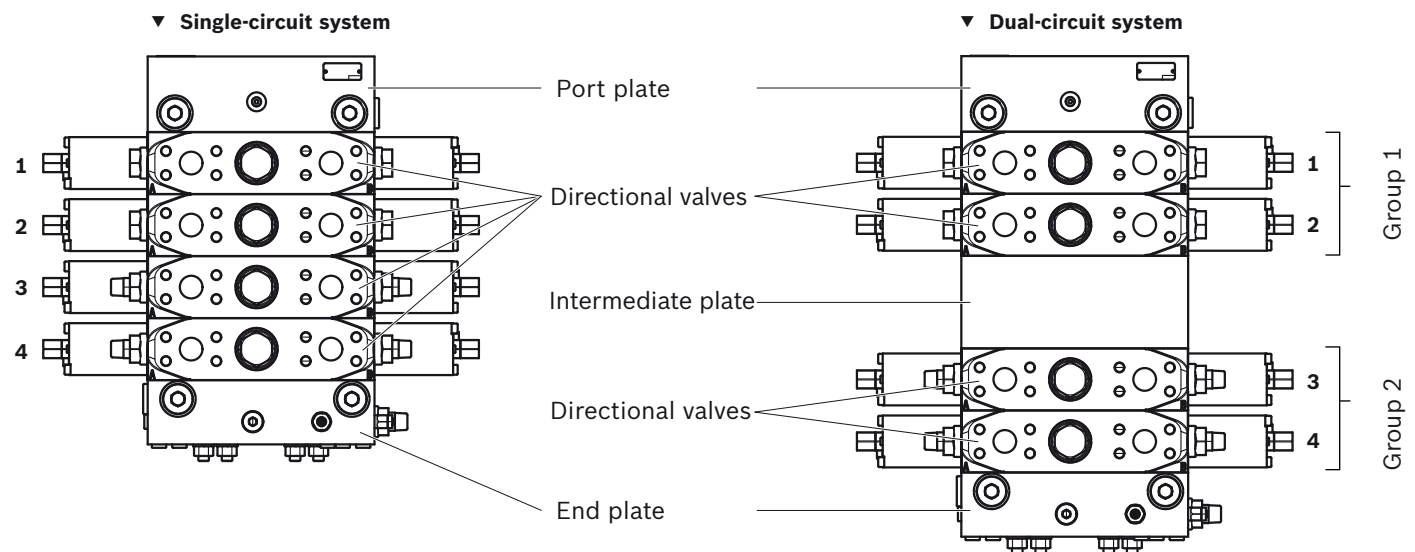
Explanatory notes

The ordering code documents the standard functional features of the valve series mounted according to the modular principle. This consists of a port plate, to which a group of up to four LUDV directional valves with intermediate plate or six directional valves with corresponding end plate, can be mounted on the front side.

The block configuration without definition of the individual spool axes is defined in the first part of the ordering code (overall control block layout).

In the second part of the ordering code, the features corresponding to each spool axis of the block must be selected. The complete specification of all features is the precondition for the quick and unambiguous processing of an order. For any questions, please contact the relevant application specialist in sales-related product management.

Combination options



¹⁾ The standard version is pilot valves with manual actuation

Overall control block layout and features

01	02	03	04	05	06	07	08	09	10	11
M7-25	/			-			-			

01	Total number of spool axes	1 to 8
----	----------------------------	---------------

Directional valves, group 1

02	Number of directional valves with single-circuit system	1 to 6
	Number of directional valves with dual-circuit system	1 to 4

System type

03	Single-circuit system	E
	Dual-circuit system	T

Directional valves, group 2

04	Number of directional valves with single-circuit system	0
	Number of directional valves with dual-circuit system	1 to 4

Primary pressure limitation

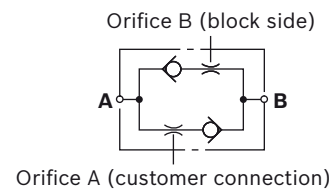
05	Without primary pressure limitation	Q00
	With pressure relief valve (specified pressure in bar, 3-digit)	...

LS pressure limitation

		06	07	08
06	Without LS pressure limitation	Q	000	000
	With pressure relief valve, direct operated (MHDBD 04, see data sheet 64642)	S	...	000
	With pressure relief valve, direct operated with pressure sequencing stage (MHDBZ)	A	...	...
07	Specified pressure of pressure relief valve (in bar, 3-digit).		...	
08	Specified pressure of pressure sequencing stage (in bar, 3-digit).			...

LS shuttle (orifice diameter)

09	No LS shuttle	L0
	A 0.6 – B 1.2	L1
	A 1.0 – B 0.4	L2
	A 1.2 – B 0.4	L3
	A 1.2 – B 0.6 (standard)	L4
	A 2.0 – B 0.4	L5



Unloading function (q_{vmin} circuit)

10	Without unloading function	Z
	With unloading function	U

End plate

11	Without function	Z
	With P and T port	C

Spool axis features

M7-25-3X /	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	
	1			—		D														
	1st spool axis																			
	2			—		D														
2nd spool axis																				
3			—		D															
3rd spool axis, etc.																				

01	Spool axis number	1 to X
----	-------------------	---------------

Spool type¹⁾

02	Main spool A/B/T blocked in neutral position	E
	Main spool A/B→T open in neutral position	J
	Main spool A/B→T throttled to reservoir in neutral position	Q
	Control spool P/B→A in switching position b	R
	Control spool A ↔ B neutral	M

Flow

03	Consumer port A (in l/min, 3-digit)	...
04	Consumer port B (in l/min, 3-digit)	...

Load holding

05	Without load holding	Z
	With load holding (on both sides)	L

Pressure compensator²⁾

06	Direct operated	D
----	-----------------	----------

Type of actuation

			A side			B side		
			07	08	09	10	11	12
07, 10	Hydraulic³⁾		H			H		
08, 11	Shuttle	No shuttle		00			00	
		With shuttle 0.3 mm		03			03	
		With shuttle 0.5 mm		05			05	
		With shuttle 0.6 mm		06			06	
		With shuttle 0.8 mm		08			08	
09, 12	Pilot oil port position	Axial			A			A
07, 10	Electrohydraulic⁴⁾		W			W		
08, 11	Proportional	24 V		81			81	
		12 V		83			83	
	Switchable	24 V		61			61	
		12 V		63			63	
09, 12	Connector version	Junior-Timer, 2-pin (AMP)			C			C
		DT04-2P (Deutsch)			K			K

1) For symbols, see “Control spool” on page 12.
 On hydraulic cylinders, specifying the gear ratio in plain text is required, since E and Q spools have inlet and outlet characteristic curves. Further spool types on request.

2) For symbol, see “Pressure compensator” on page 12

3) With measuring port

4) A specification in plain text is required for electrohydraulic actuation via remote control plate (e.g. HICFP).

Pilot oil port for hydraulic actuation⁵⁾

13	Poppet seal	G
	O-ring seal	O
	G 1/4 without adapter (with H00 only)	Z

		A side			B side		
		14	15	16	17	18	19
Secondary valves							
14,	Without secondary valves	Z	000	000	Z	000	000
17	Feed valve (MHSV 22, see data sheet 64642)	E	000	000	E	000	000
	Pressure/feed valve (MHDBN 22, see data sheet 64602)	H	...	000	H	...	000
	Pressure relief/feed valve with pressure sequencing stage (MHDBB 22, see data sheet 64642)	B	...	...	B	...	...
15, 18	Specified pressure for pressure valve/feed valve (in bar, 3-digit)		...			...
16, 19	Specified pressure for pressure sequencing function (in bar, 3-digit)			...			...

⁵⁾ See "Line connections" on page 15

Dual-circuit control block with intermediate plate

Features	<ul style="list-style-type: none"> – 4-fold control block (2 directional valves, intermediate plate, 2 directional valves) – Dual-circuit system – Primary pressure limitation, set to 350 bar – LS pressure limitation, set to 320 bar – With LS shuttle – With unloading function
-----------------	---

1st spool axis	<ul style="list-style-type: none"> – Spool symbol K, flow in A and B 500 l/min – Without load holding – With directly operated pressure compensator – Type of actuation: electrohydraulically proportional 24 V with Deutsch connector – Secondary valves: Pressure relief / feed valves, set to 350 bar on consumer port A and B
-----------------------	--

2nd spool axis	<ul style="list-style-type: none"> – Spool symbol J, flow in A and B 300 l/min – Without load holding – With directly operated pressure compensator – Type of actuation: electrohydraulically proportional 24 V with Deutsch connector – Secondary valves: Feed valves on consumer ports A and B
-----------------------	---

Intermediate plate

3rd spool axis	<ul style="list-style-type: none"> – Spool symbol Q, flow in A 700 l/min and in B 400 l/min – Without load holding – With directly operated pressure compensator – Type of actuation: electrohydraulically proportional 24 V with Deutsch connector – Secondary valves: Pressure relief / feed valves, set to 420 bar on consumer port A and B
-----------------------	---

4th spool axis	<ul style="list-style-type: none"> – Spool symbol Q, flow in A and B 250 l/min – Without load holding – With directly operated pressure compensator – Type of actuation: electrohydraulically proportional 24 V with Deutsch connector – Secondary valves: without valve on consumer port A; pressure relief / feed valve on consumer port B, set to 200 bar
-----------------------	---

Ordering codes:

Overall control block layout and features

01	02	03	04	05	06	07	08	09	10	11			
4	M7	25	/	2	T	2	350	S	320	000	L4	U	Z

1st spool axis

01	02	03	04	05	06	07	08	09	10	11	12	14	15	16	17	18	19
1	Q	500	500	Z	D	W	81	K	W	81	K	H	350	000	H	350	000

2nd spool axis

01	02	03	04	05	06	07	08	09	10	11	12	14	15	16	17	18	19
2	J	300	300	Z	D	W	81	K	W	81	K	E	000	000	E	000	000

3rd spool axis

01	02	03	04	05	06	07	08	09	10	11	12	14	15	16	17	18	19
3	Q	700	400	Z	D	W	81	K	W	81	K	H	420	000	H	420	000

4th spool axis

01	02	03	04	05	06	07	08	09	10	11	12	14	15	16	17	18	19
4	Q	700	400	Z	D	W	81	K	W	81	K	Z	000	000	H	200	000

For symbol, see page 14.

Symbols

Control spool

Ordering code	Main use	Symbol
E	<ul style="list-style-type: none"> ▶ Hydraulic cylinder as consumer ▶ Spool with blocked ports A/B in neutral position 	
J	<ul style="list-style-type: none"> ▶ Hydraulic motors as consumers ▶ Consumer ports A/B → T open in neutral position 	
Q	<ul style="list-style-type: none"> ▶ Hydraulic cylinder and motors as consumers combined with pipe burst safety valve, check Q meter and lowering brake valve ▶ Spool with defined residual opening (A/B → T) in neutral position 	
R	<ul style="list-style-type: none"> ▶ E spool with regeneration function ▶ Control spool P/B → A 	
M	<ul style="list-style-type: none"> ▶ Control spool A ↔ B connected neutral ▶ Only possible without load holding valves 	

Notice

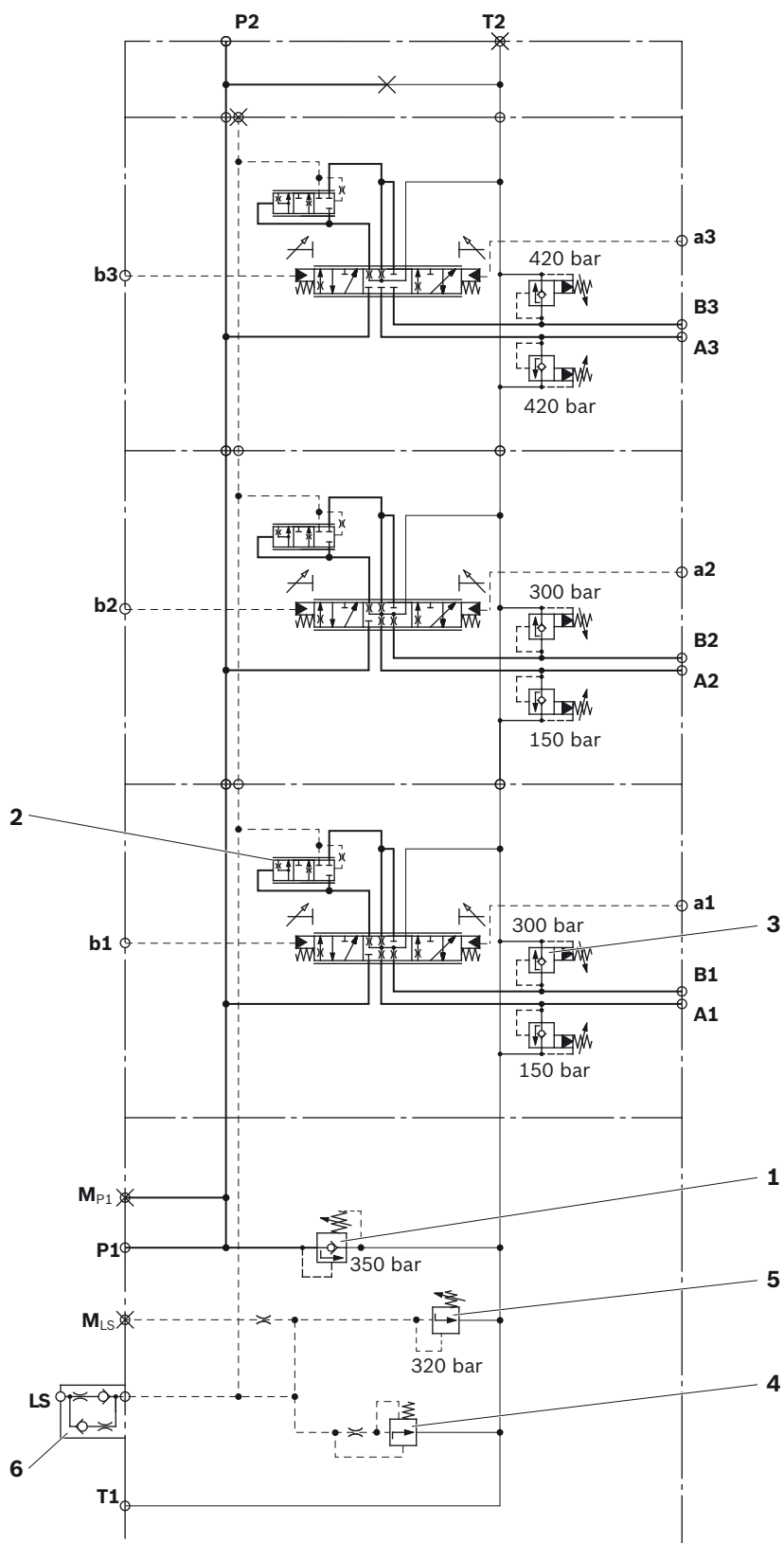
Additional control spools available on request.

Pressure compensator

Ordering code	Description	Symbol
D	Directly operated (standard)	

Single-circuit control block

▼ Example 3M7-25 (according to order example on page 10)

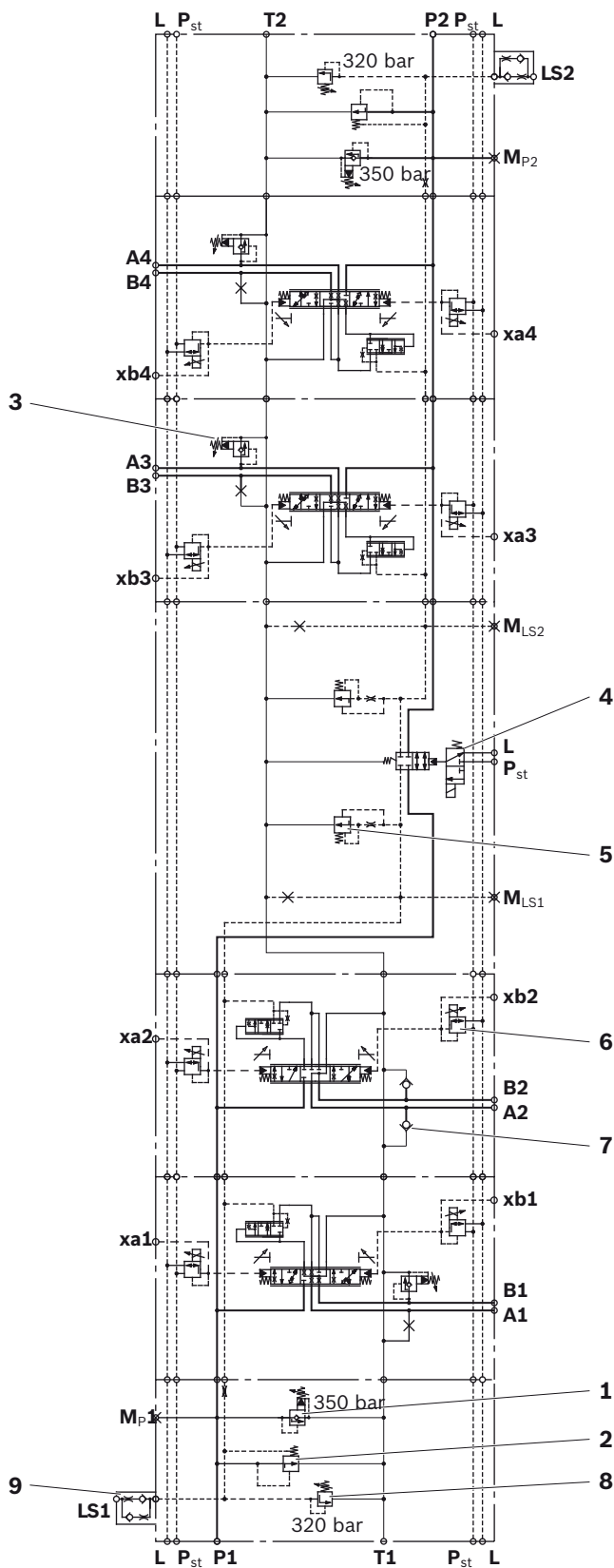


- 1 Primary pressure relief valve
- 2 LUDV pressure compensator
- 3 Anti-cavitation valve
- 4 LS flow controller
- 5 LS pressure relief valve
- 6 LS shuttle



Dual-circuit control block with intermediate plate

▼ **Example 4M7-25** (according to order example on page 11)



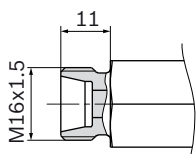
- 1 Primary pressure relief valve
- 2 Unloading valve
- 3 Pressure relief / feed valve
- 4 Electric pilot control for summation (switchable)
- 5 LS flow controller
- 6 Electric pilot control
- 7 Feed valve
- 8 LS pressure relief valve
- 9 LS shuttle

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Dimensions

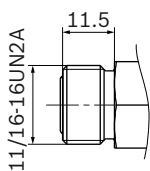
Line connections

Port	Dimension	Relevant standard
P1	DN 32 (SAE 1 1/4 in 6000 PSI)	DIN ISO 6162-2
P2	DN 38 (SAE 1 1/2 in 6000 PSI)	
T1	DN 38 (SAE 1 1/2 in 3000 PSI)	DIN ISO 6162-1
T2	DN 51 (SAE 2 in 3000 PSI)	
A, B	DN 32 (SAE 1 1/4 in 6000 PSI)	DIN ISO 6162-2
LS, M	DN 10 (G 1/4)	DIN EN ISO 1179-1
	G 1/4 (Z version)	DIN EN ISO 1179



a, b

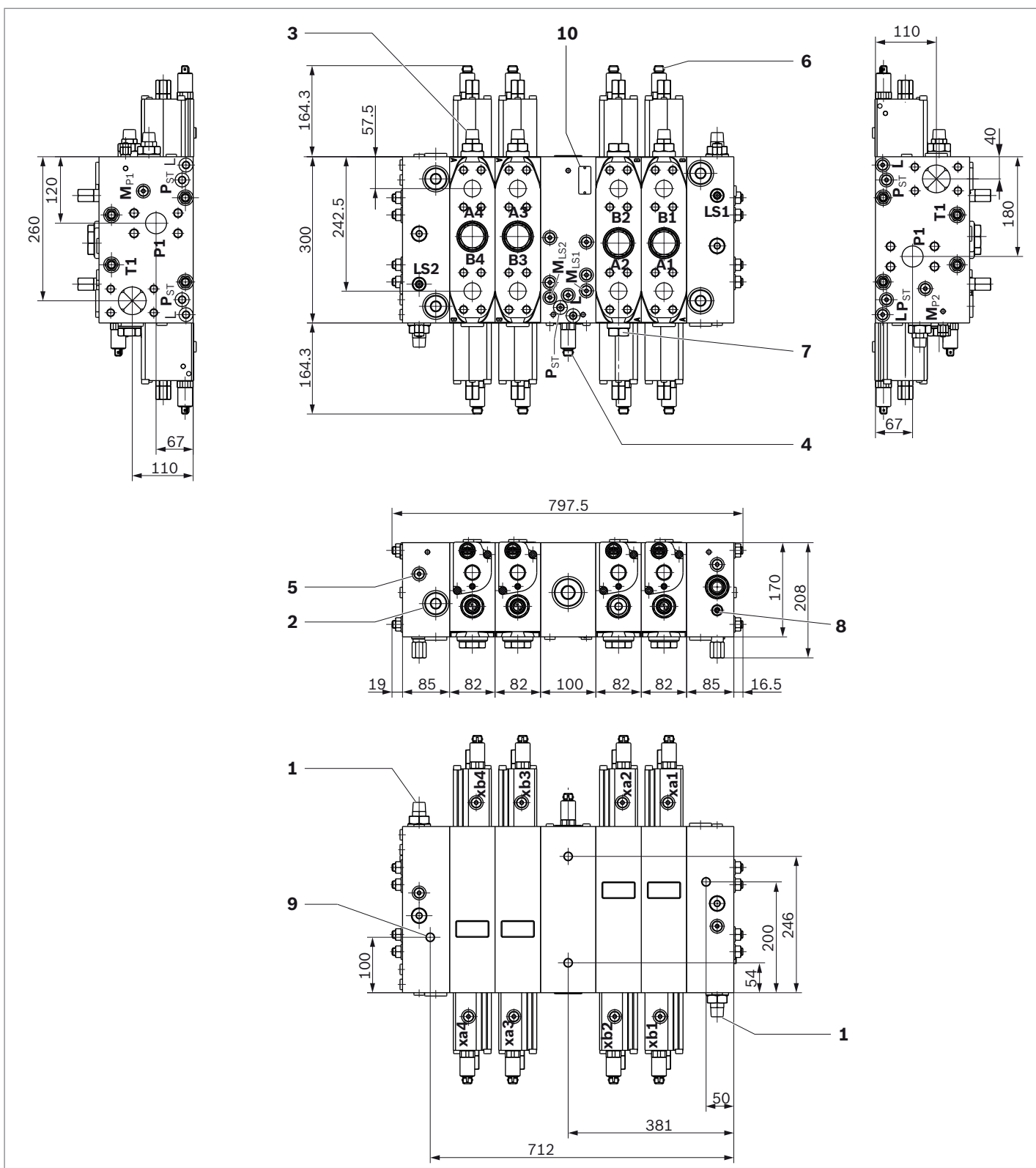
Poppet seal (**G** version):
L10 according to DIN EN ISO 8434



O-ring seal (**O** version):
SAE J 1453-3

Ports	
P	Pump port
T	Tank port
A, B	Consumer port
LS	Load-sensing port
M	Measuring port
a, b	Pilot oil port

▼ Dual-circuit control block with intermediate plate, example 4M7-25 (according to order example on page 11)



- | | | | |
|---|--------------------------------------|----|-------------------------------------|
| 1 | Primary pressure relief valve | 6 | Electric pilot control |
| 2 | Unloading valve | 7 | Feed valve |
| 3 | Pressure relief / feed valve | 8 | LS pressure relief valve |
| 4 | Electric pilot control for summation | 9 | Four fastening threads M16, 20 deep |
| 5 | LS flow controller | 10 | Name plate |

Hydraulische Regelventile B 30 Re 10 (A)

Project planning notes

The LUDV control block M7-25 is the core component of the hydraulic control of a mobile working machine. We therefore recommend it to be specified only in combination with a hydraulic overall circuit diagram.

For the design of a hydraulic flow sharing control block of type M7-25, the following project planning boundary conditions are relevant and should accompany the inquiry:

- ▶ Machine type
- ▶ Pump flow at rated speed
- ▶ Type of pump controller
- ▶ Description of the consumer on the sections (e.g. boom, winch)
- ▶ Cylinder ratios/motor displacement
- ▶ Information as to whether a system element is connected downstream of the valve (e.g. pipe burst safety valve, lowering brake valve)
- ▶ Specification of loads (pressures) to be throttled per axis if no brake valve or similar is available.

Accessories

Plug-in connector for FTDRE... and FTWE...

Recommended plug-in connector for connector version C Junior Timer, 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended plug-in connector for Junior Timer, 2-pin (AMP)



Recommended plug-in connector for connector version K DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

▼ Recommended plug-in connector for DT04 (DEUTSCH)



Related documents

Further information on installation, commissioning, and operation can be found in the instruction manual 64025-B: “Control blocks for mobile applications”.

Flow-sharing (LUDV) control block in sandwich plate design RS14



- ▶ Nominal size 14
- ▶ Series 1X
- ▶ Maximum pressure
 - on pump side 250 bar
 - on consumer side 300 bar
- ▶ Inlet flow 175 l/min

Features

- ▶ Distributes the flow between the directional valve elements according to the requirements, independently of the pressure and available flow
- ▶ Compact sandwich plate design, can be combined so that the control block can meet the requirements of several type of machines
- ▶ No shuttle valves required
- ▶ Limitation of system maximum pressure via LS pressure relief valve
- ▶ System protection via LS combine to flushing valve
- ▶ Equipments protection by secondary pressure valve

Contents

About this data sheet	2
Related documents	2
Functional description	3
Technical data	4
Characteristic curves	6
Ordering code	7
Hydraulic symbols	11
Dimensions	16
Assembly possibilities	21
Pipe connections	22

About this data sheet

This manual describes functioning, technical datas and ordering codes of control block RS14. This data sheet is illustrated with hydraulic symbols, sections and unit dimensions drawings.

Related documents

RS14 is a system component.

- ▶ Observe the instructions for the other system components.
- ▶ Also observe the instructions in the following manuals:
 - System documentation from the system manufacturer
 - Operating instructions RE 64025-B
 - Spare parts manual RDEF 64136-E
 - Repair manual RE 64136-S

Functional description

The RS14 directional control block basically consists of one inlet element, a number of directional valve elements and one end element.

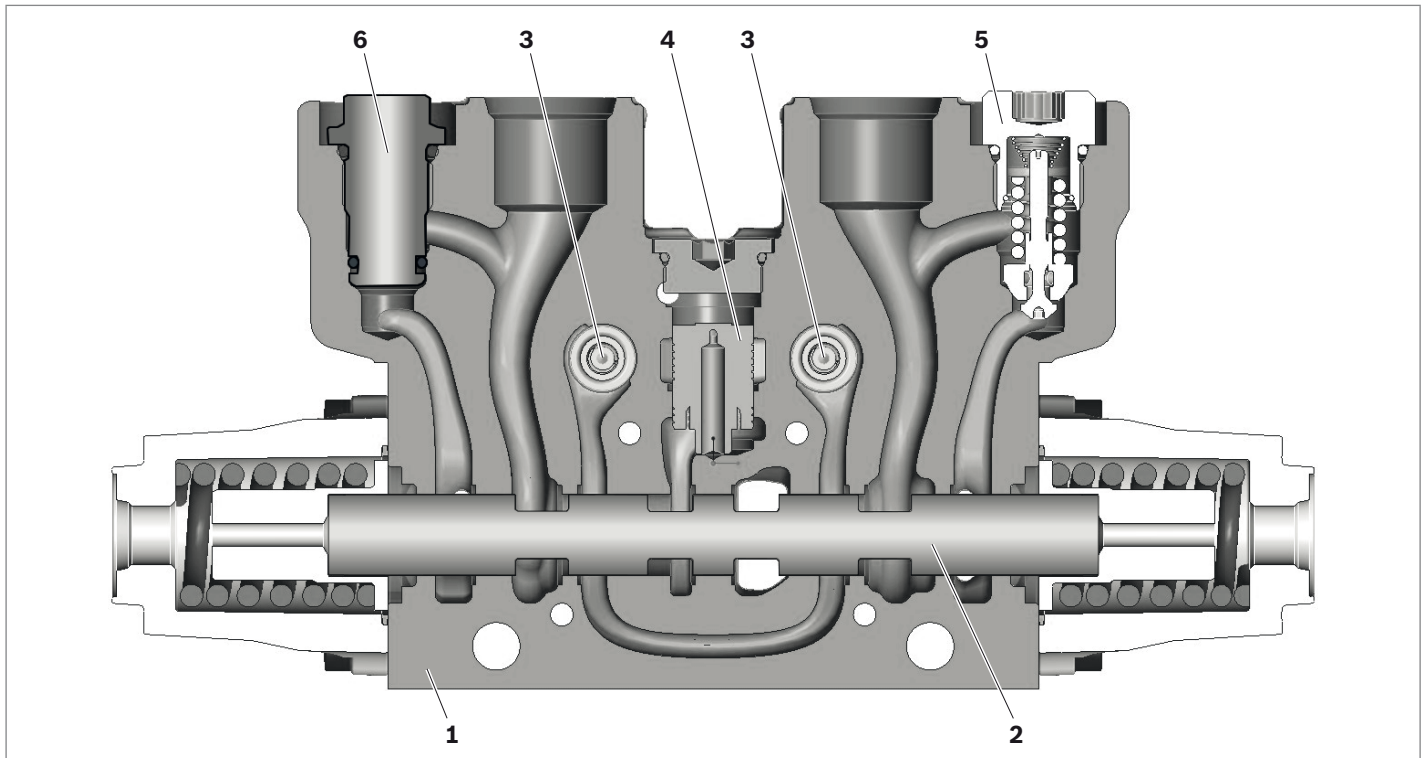
The inlet element contains 2 fixing points and the pipe connection ports **P, T, LS, M**.

This element also contains all the components required for the system function, namely: a flow control valve for the controlled unloading of the LS line and a LS relief valve for the limitation of the maximum pressure in the system.

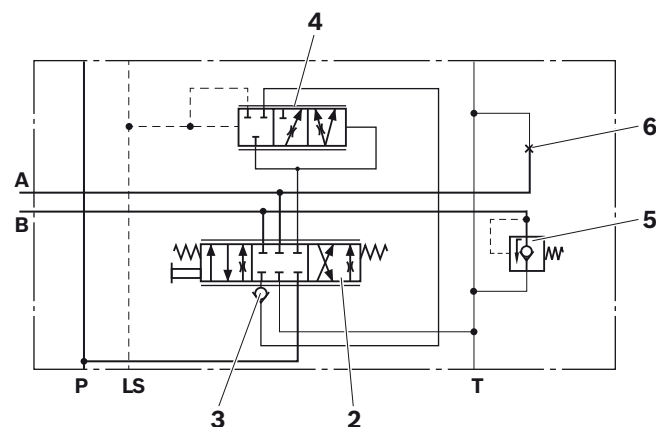
Each standard RS directional valve element comprises of a housing (1), a control spool (2), two load holding check valves (3), a pressure compensator (4), cavities (5) for secondary relief/anti-cavitation check valves, and anti-cavitation check valves or plugs (6).

The end element has one fixing point.

▼ Cross section RS14



▼ Symbol RS14, hydraulic actuation



- 1 Housing
- 2 Control spool
- 3 Check valves
- 4 Pressure compensator
- 5 Secondary valve
- 6 Plug

Ports	
P	Pump
A, B	Consumer
T	Tank
LS	Load sensing

Technical data

General						
Design	Flangeable (up to 9 directional valve elements)					
Description	Flow distribution between the directional valve elements according to the requirements, independently of the pressure and available flow					
Type	RS14					
Nominal size	14					
Weight	inlet element	kg	10			
	directional valve element	kg	4.7			
	blanking plate	kg	2			
	electro-hydraulic end element	kg	7.2			
Installation position	Any					
Connections	Threads					
Ambient storage temperature range	θ	°C	-40 to +60			
Priming (Standard)	One-coat paint RAL 5010					
Hydraulic						
Maximum permissible flow at port	P	q_v	l/min	175		
Standard leakage oil flow on load holding (at 100 bar, 36 mm ² /s)				cm ³ /min 20		
Maximum operating pressure at port				Medium pressure	High pressure	
	P, M, LS, D, DLS	p	bar	250	350	
	A, B	p	bar	300	400	
	T	p	bar	20	20	
Secondary valves setting pressure tolerances (at 5 l/min)	H..0 direct actuated				Setting	Tolerance
					71 → 120	-4 / +8
					121 → 120	-6 / +12
					201 → 270	-8 / +12
					271 → 320	-10 / +14
					321 → 420	-12 / +18
Max. control pressure at port	a, b	bar		35	We recommend the use of control curve 6 to 25 bar, and inlet pressure (4TH6 curve no. 70)	
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524 (suitable for NBR seals), other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request					
Hydraulic fluid temperature range	θ	°C	-20 to +80			
Viscosity range	ν	mm ² /s	2.8 to 380			
Maximum admissible degree of contamination of the hydraulic fluid	Class 9, we therefore recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$					
Mechanical						
Spool return force			N	Minimum value 54, depending of actuation (for more details please consult us)		
Maximum permissible actuation force on the spool (for 1 million cycles)	axial	N		1000 during 20 % of total cycles then 500		
	radial	N		20		

Electric		
Electrical detent when spool is pushed (actuation S2) (data for 25 °C)		
supply voltage	V	12 (min. 10; max. 16)
supply current	mA	780 (min. 670; max. 785)
power input	W	9.35 ± 5 %
resistance	Ω	15.4 ± 5 Ω
lifetime		1 million cycles at 90 °C, work factor 50 %
protection classification		IP65
maximum temperature reached by the electro-magnet	°C	110 at a room temperature of 90 °C
Electro-hydraulic actuation (actuation W200)		see datasheet 64658

Application guidelines

		Pipe connections				
		P, T	P2	M, LS	A, B	a, b
Tightening torque for the pipe connections	Nm	90	60	30	60	30
Recommended fixing		at 3 locations maximum				
Flatness of the mounting surface	mm	0.5				
Setting of system pressure		via the LS relief valve				

Do not use high-pressure washers for cleaning.
 No free-wheeling diode required for electrical actuations.
 Mechanical actuation spool: a greasy appearance on the tongue side is normal (due to natural effect of seal lubrication). It could be necessary to proceed to a regular cleaning of this area.

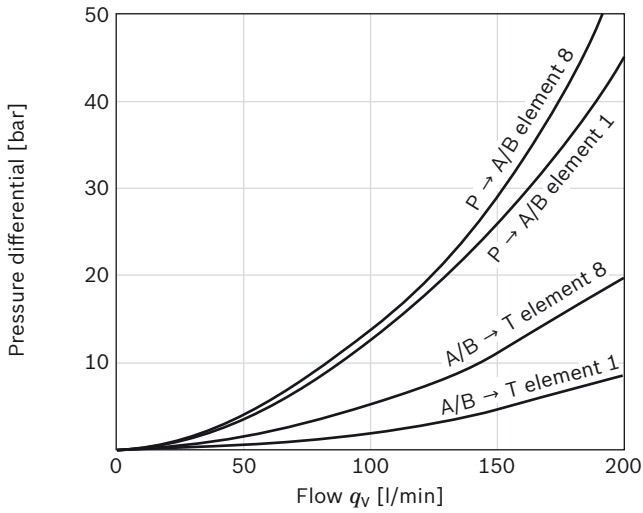
Note

Please contact us if the unit is to be used outside the specified range of values.

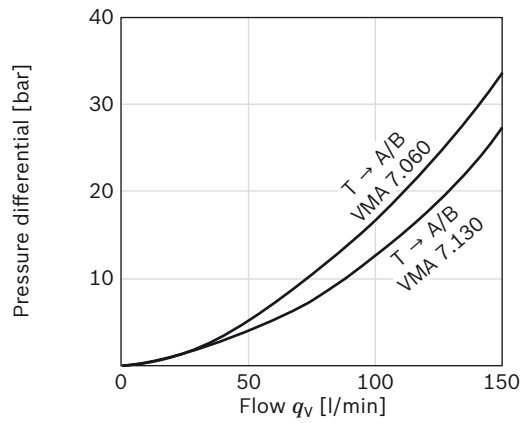


Characteristic curves

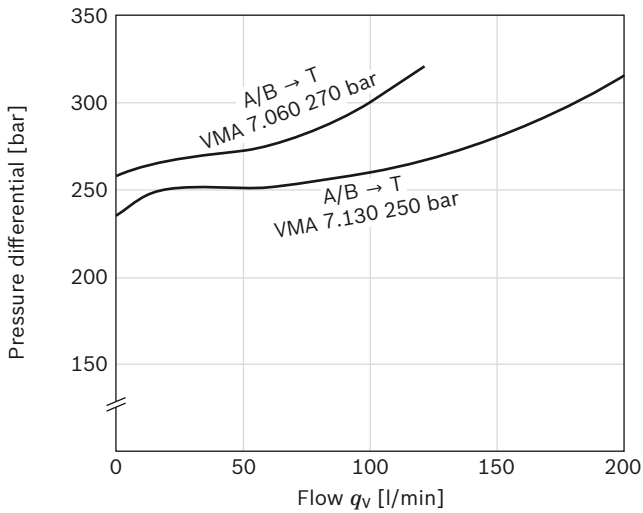
▼ Block pressure drop with fully opened spool



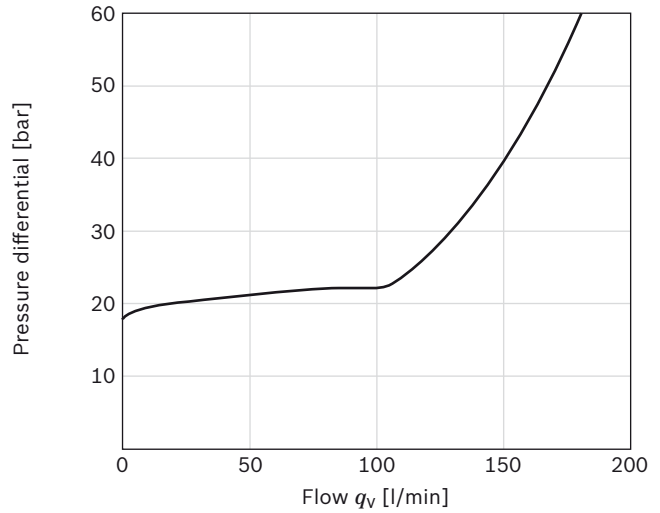
▼ Secondary pressure relief valves T to A/B



▼ Secondary pressure relief valves A/B to T



▼ Flushing valve in neutral

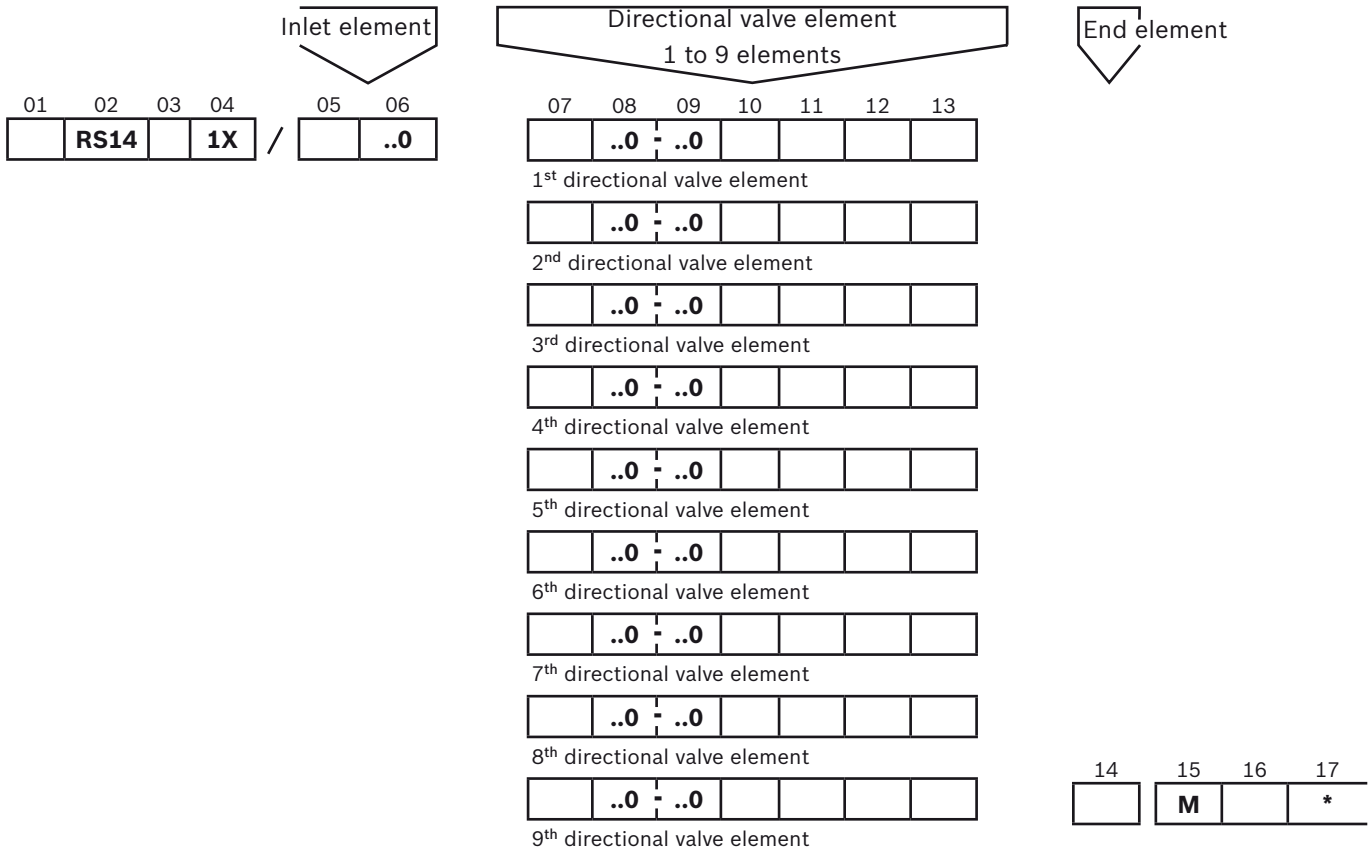


Note

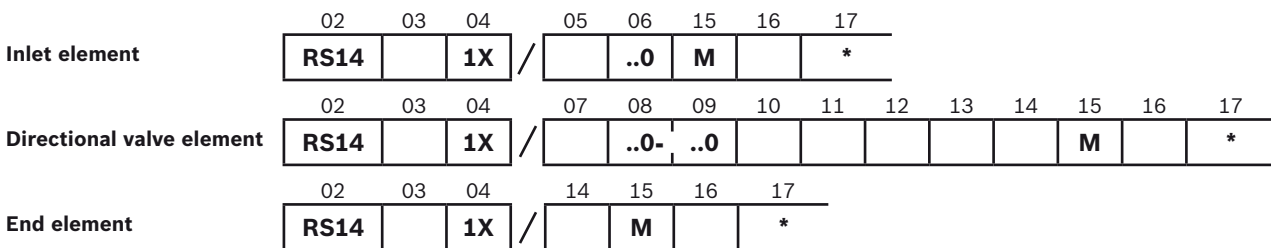
Characteristic curves measured at $\nu = 36 \text{ mm}^2/\text{s}$ and $\theta = 50 \text{ }^\circ\text{C}$.

Ordering code

Ordering codes: RS14 directional control block



Ordering code: separate elements



Ordering code: meaning

Directional valve elements

01	Number or directional valve spools 1 to 9	
----	---	--

Product

02	RS14	RS14
----	------	-------------

Pressure

03	Medium pressure	L
	High pressure	H

Series

04	Series 10 to 19: unchanged installation and connection dimensions	1X
----	---	-----------

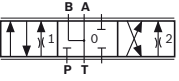
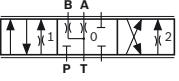
Inlet element

05	Closed center	A
	Closed center with priority flow divider for dynamic servo-steering (with flow in the LS line)	CD
	Closed center with priority flow divider for static servo-steering (without flow in the LS line)	CS
	With flushing valve (use with variable displacement pump)	S

LS pressure

06	Max. pressure in bar, measured at M, adjustable via the LS pressure relief valve ¹⁾	..0
----	--	------------

Spool symbol

07		EA
		JA
		QA
	 2)	WA

Flow at connection ports ³⁾ Other flow values (rated in 10 l/min ranges): please consult us

08	Flow at connection port A in l/min	***
09	Flow at connection port B in l/min	***

Type of actuation

10	Mechanical actuation, spool return via a spring	A2
	Mechanical actuation, spool return via a spring, mechanical detent in spool position 3 (4 th or float position) when spool is pulled	E2
	Mechanical actuation, spool return via a spring, electrical detent when spool is pushed (12 V)	S2
	Mechanical actuation with tongue (Ø 8 or Ø 10)	Z1
	Hydraulic actuation, spool return via a spring	H200
	Hydraulic actuation, spool return via a spring, stroke limitation on connection sides A and B	H230
	Electro-hydraulic actuation, spool return via a spring	W200

Actuation position

11	Without mechanical actuation (no code)	
	Mechanical actuation on connection side A	A
	Mechanical actuation on connection side B	B

Secondary valve, connection port "A"

12	Pressure relief valve with anti-cavitation function ⁴⁾	H..0
	Plug	Q
	Without cavity for secondary valves ⁵⁾	Z

Secondary valve, connection port "B"

13	Pressure relief valve with anti-cavitation function ⁴⁾	H..0
	Plug	Q
	Without cavity for secondary valves ⁵⁾	Z

1) set with a Δp of 15 bar between M and LS

2) for hydraulic actuation, consult us

3) tolerance: consult us

4) pressure value in bar in multiples of 10

5) only if both sides are not machined

End element

14	Blanking plate	L
	End element with tank bridge T	R
	End element with solenoid operated control valve (12 V)	C
	Flushing valve	F
	Electro-hydraulic end element with pressure reducing valve and shut-off ⁶⁾	**

Sealing material  **Attention!** The compatibility of the seals and pressure fluid has to be taken into account!

15	NBR (nitrile rubber)	M
----	----------------------	---

Connection threads

16	Pipe threads to standard ISO 228/1 P, A, B, T3 = G 3/4 T = G 1 LS, DLS, M = G 1/4 D = G 1/2 a, b, T1 = G 1/4	01
	UNF connection threads to standard ISO 11926 P, A, B, T3 = 1-1/16 UNF-2B T = 1-5/16 UNF-2B LS, DLS, M = 9/16 UNF-2B D = 3/4 UNF-2B a, b, T1 = 9/16 UNF-2B	19

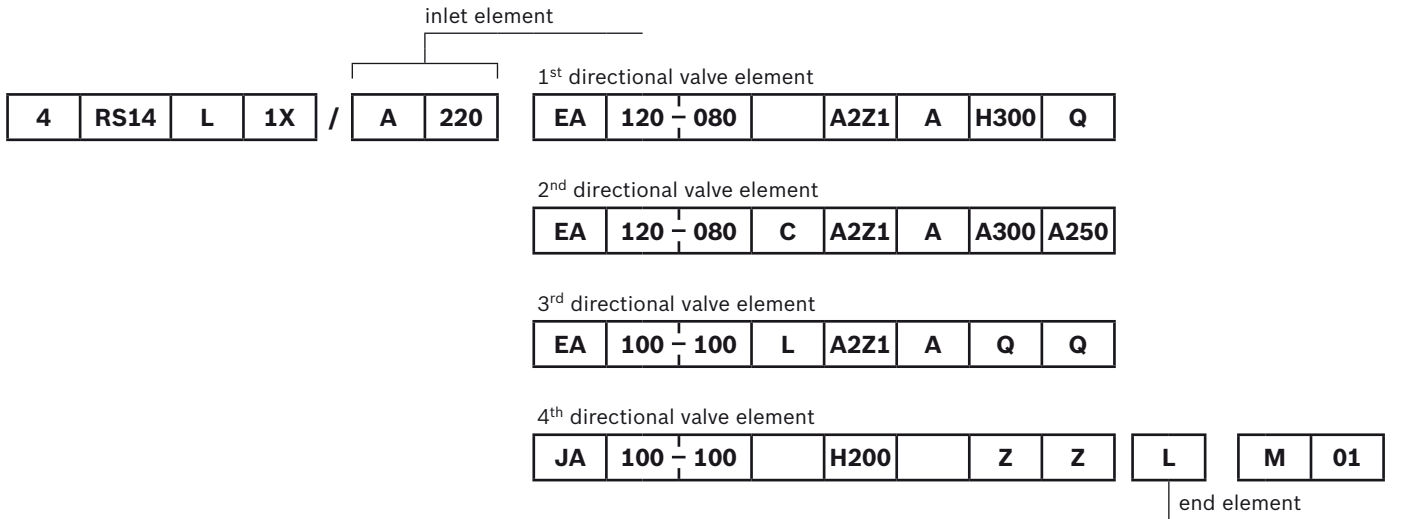
17	Further details in clear text	*
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⁶⁾ for use with actuation W200

Ordering example: complete block RS14

- Desired execution:** – 4 directional valve elements
- inlet element:** – closed center
– max. pressure = 220 bar
- 4 directional valve elements:**
- ▶ 1st element:
 - spool symbol = **EA**
 - flow in **A** = 120 l/min, flow in **B** = 80 l/min
 - mechanical actuation with tongue on connection side **A**, spool return via a spring
 - secondary valve in **A** = pressure relief valve with anti-cavitation function set at 300 bar
 - secondary valve in **B** = plug
 - ▶ 2nd element:
 - spool symbol = **EA**
 - flow in **A** = 120 l/min, flow in **B** = 80 l/min
 - check valve + pressure compensator
 - mechanical actuation with tongue on connection side **A**, spool return via a spring
 - secondary valve in **A** = pressure relief valve with anti-cavitation function set at 300 bar
 - secondary valve in **B** = pressure relief valve with anti-cavitation function set at 250 bar
 - ▶ 3rd element :
 - spool symbol = **EA**
 - flow in **A** = 100 l/min, flow in **B** = 100 l/min
 - check valve
 - mechanical actuation with tongue on connection side **A**, spool return via a spring
 - plugs in **A** and **B**
 - ▶ 4th element :
 - spool symbol = **JA**
 - flow in **A** = 100 l/min, flow in **B** = 100 l/min
 - hydraulic actuation, spool return via a spring
 - without secondary valves holes
- end element:** – blanking plate

Type code



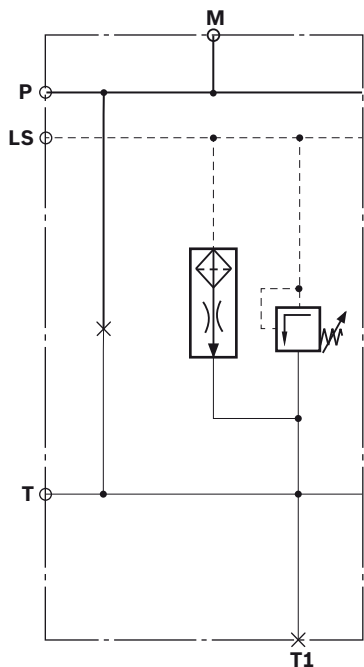
Hydraulic symbols

Inlet elements

Closed center

Ordering code

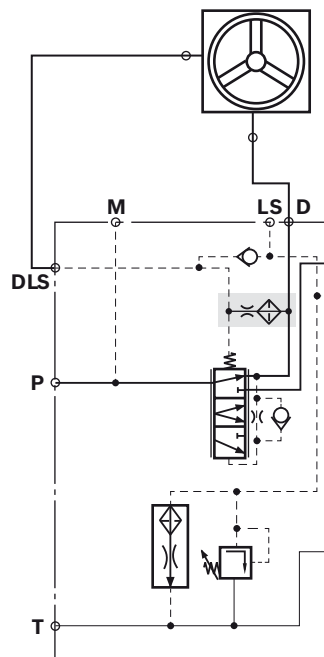
A



Closed center with priority flow divider for dynamic servo-steering

Ordering code

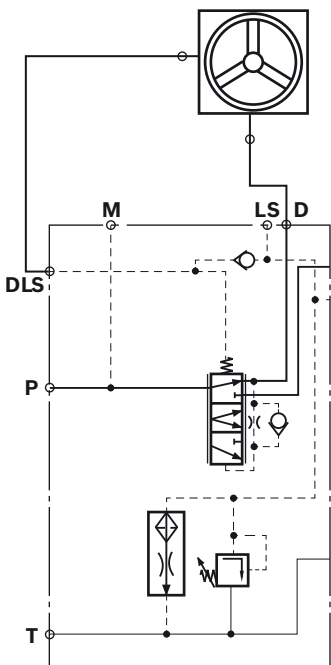
CD



Closed center with priority flow divider for static servo-steering

Ordering code

CS

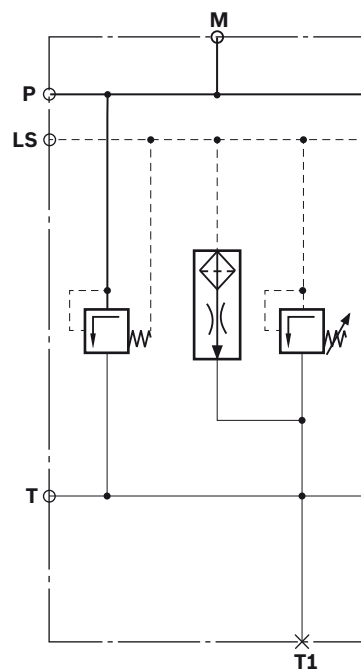


Flushing valve

(use with variable displacement pump and q_{min})

Ordering code

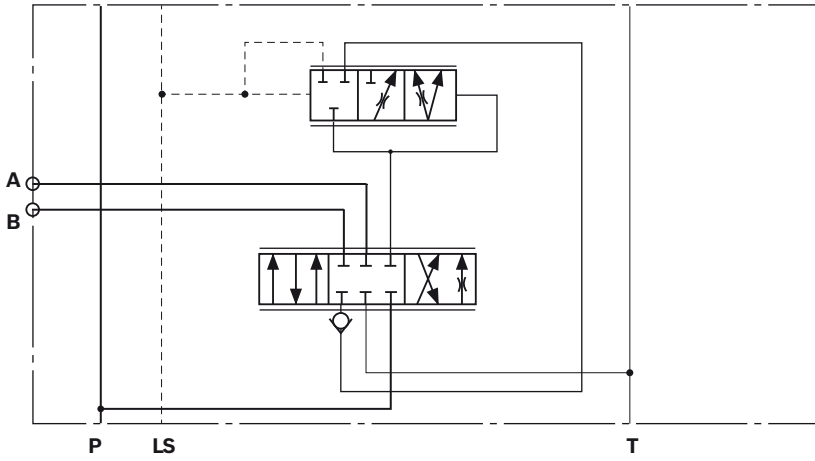
S



Directional valve elements

Representation of the RS directional valve element

▼ Simplified symbol used to illustrate RS directional control circuits



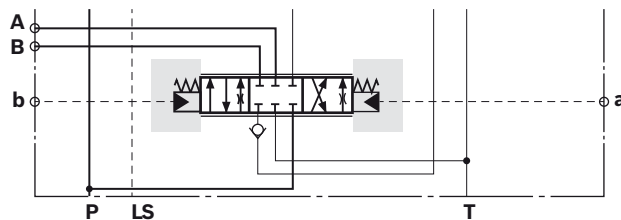
Spool types

Ordering code		
EA ... : :	symbol EA	
JA ... : :	symbol JA	
QA ... : :	symbol QA	
WA ... : :	symbol WA	

Types of actuation

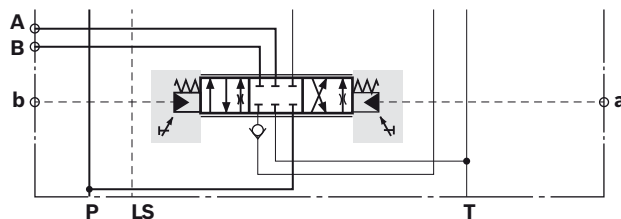
Hydraulic actuation, spool return via a spring

Ordering code
H200



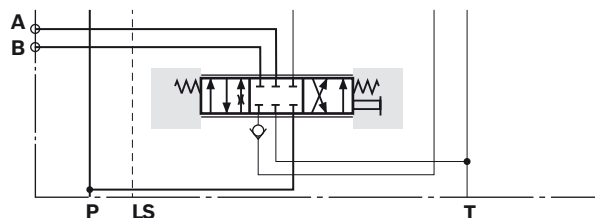
Hydraulic actuation with stroke limitation, spool return via a spring

Ordering code
H230



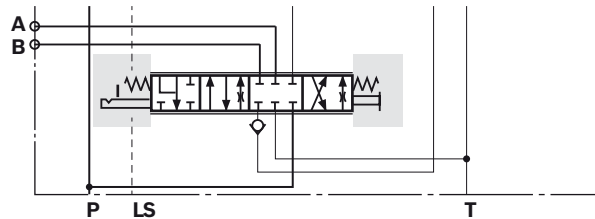
Mechanical actuation with tongue on connection side A, spool return via a spring

Ordering code
A2Z1A



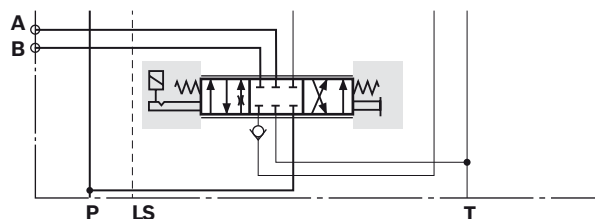
Mechanical actuation with tongue on connection side A, spool return via a spring and mechanical detent when spool is pulled

Ordering code
E2Z1A



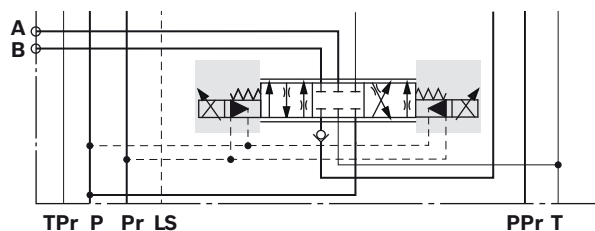
Mechanical actuation with tongue on connection side A, spool return via a spring and electrical detent when spool is pushed

Ordering code
S2Z1A



Electro-hydraulic actuation, spool return via a spring

Ordering code
W200

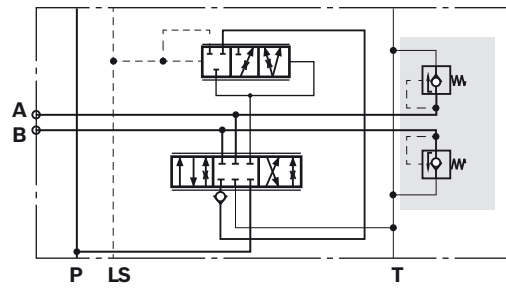


2

Secondary valves

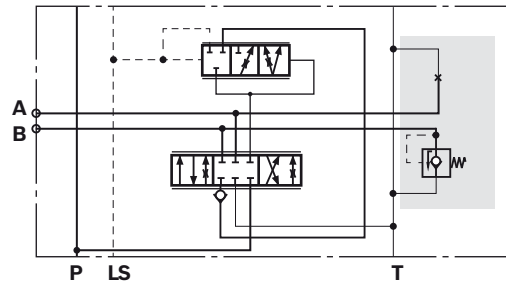
Pressure relief valve with anti-cavitation function (sides A and B)

Ordering code
H...H...



Plug (side A) ; pressure relief valve with anti-cavitation function (side B)

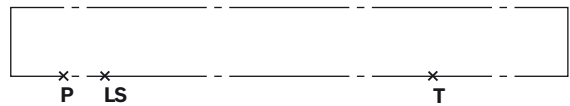
Ordering code
QH...



End elements

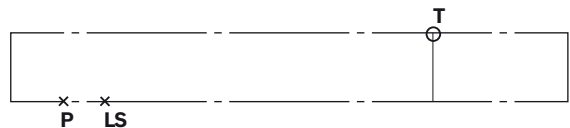
Blanking plate

Ordering code
L



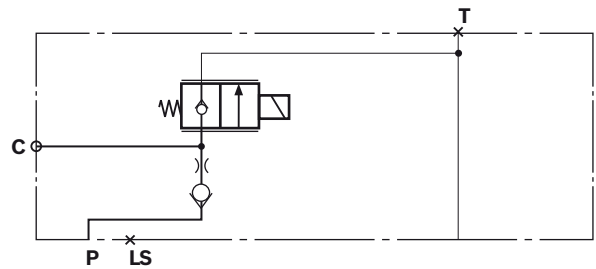
End element with tank bridge T

Ordering code
R



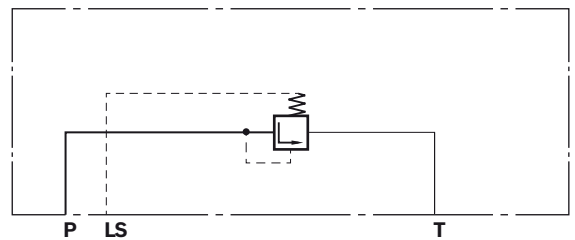
End element with solenoid operated control valve

Ordering code
C



End element with flushing valve
(for use with inlet element CS or CD)

Ordering code
F

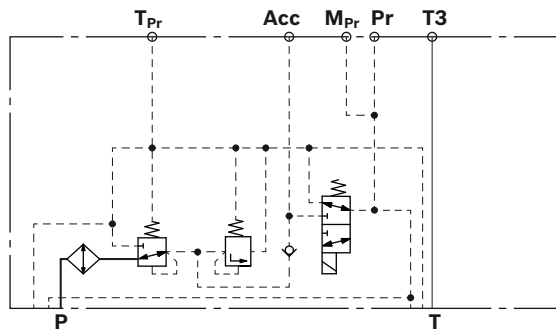


Electro-hydraulic end element with pressure reducing valve and shut-off

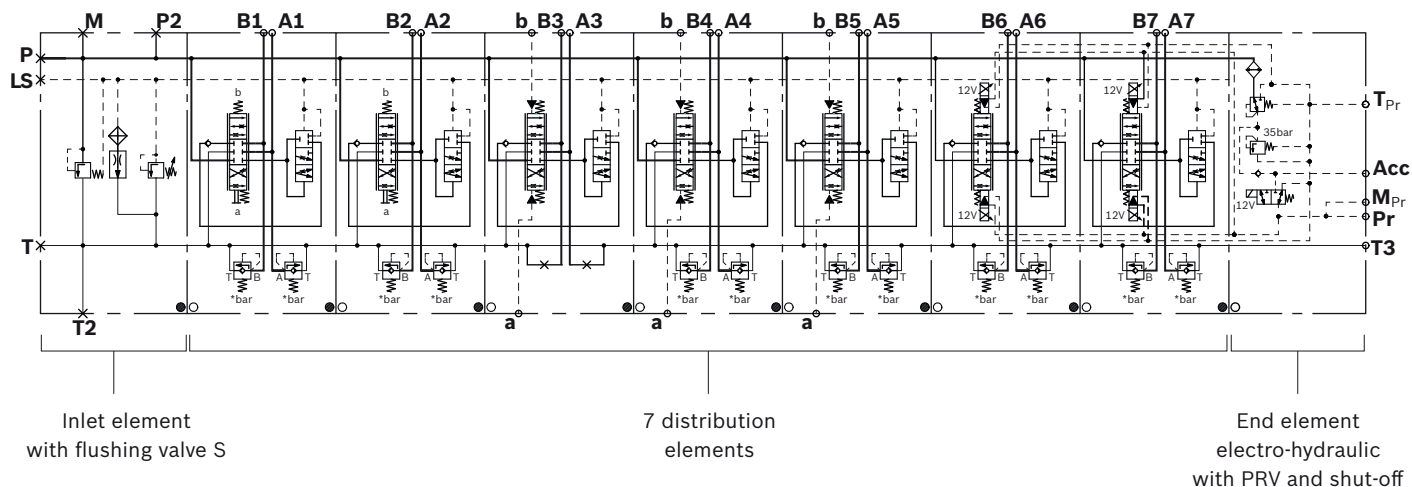
(for use with actuation W200)

Ordering code

**

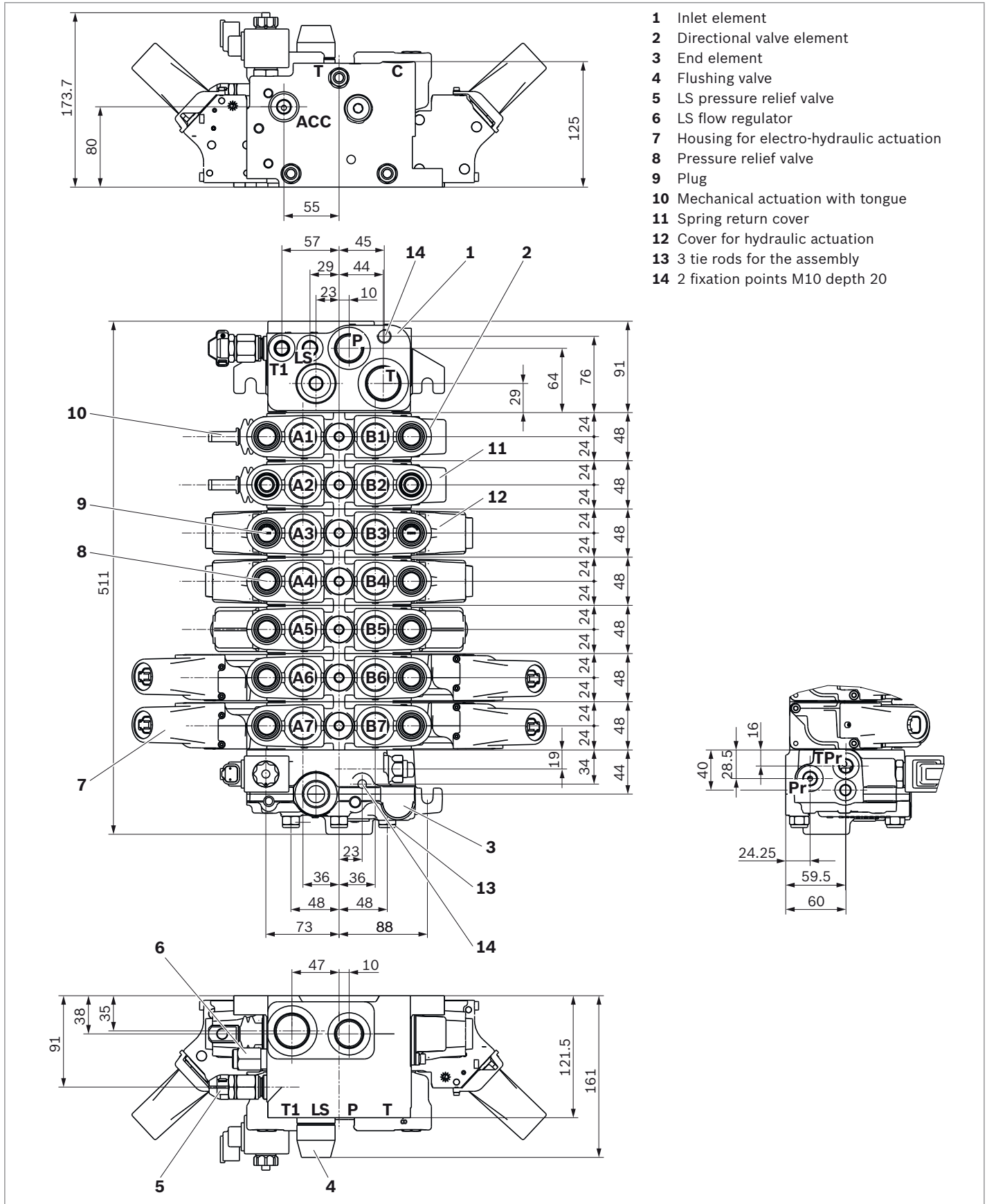


▼ **Circuit example: complete control block**



2

Dimensions

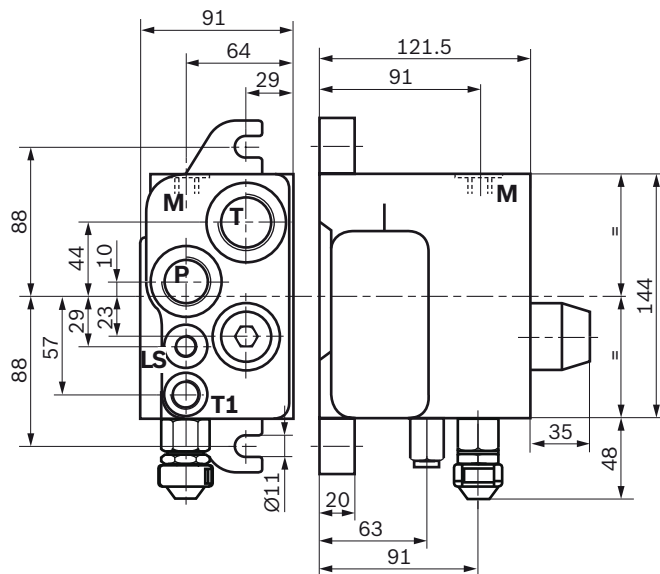


Inlet elements

▼ **Inlet element in closed center execution / with flushing valve**

Ordering code

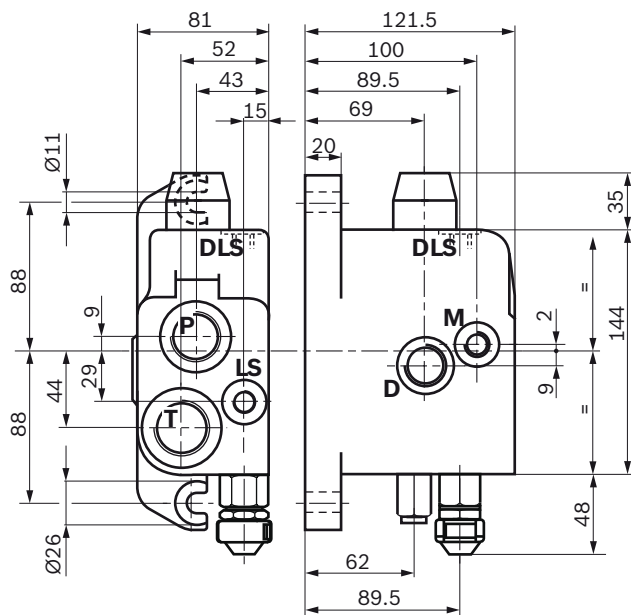
A or S



▼ **Inlet element in closed center execution with priority flow divider**

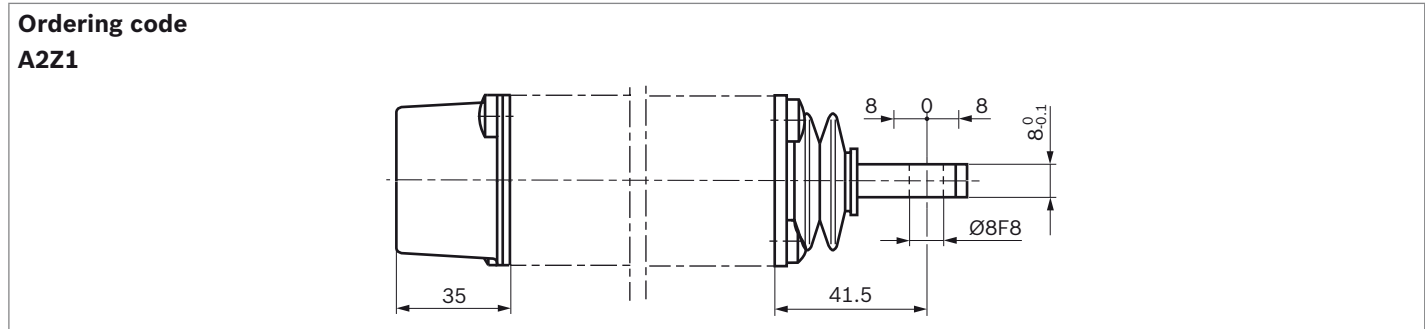
Ordering code

CD or CS

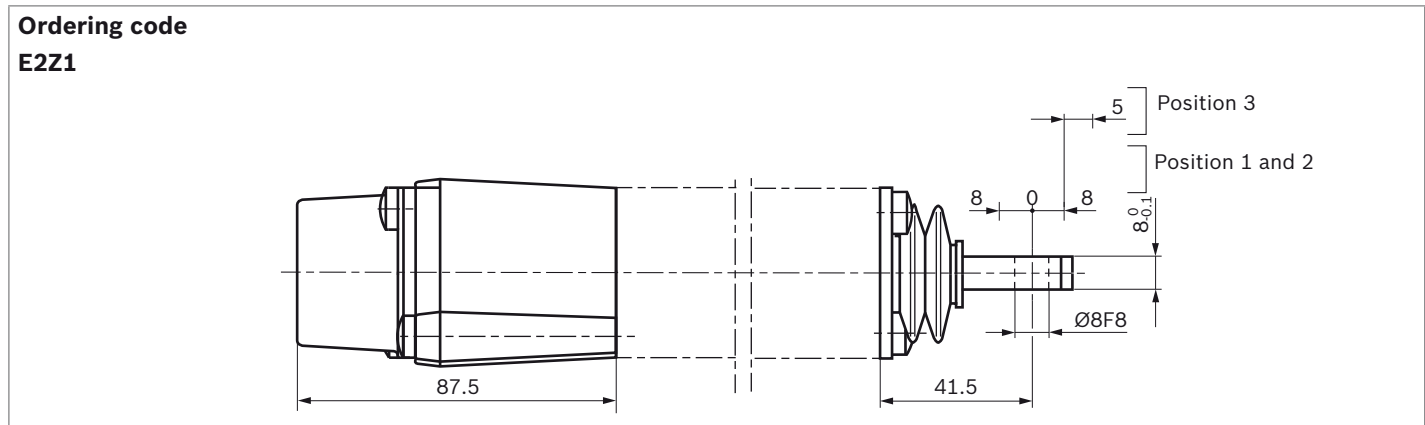


Actuation

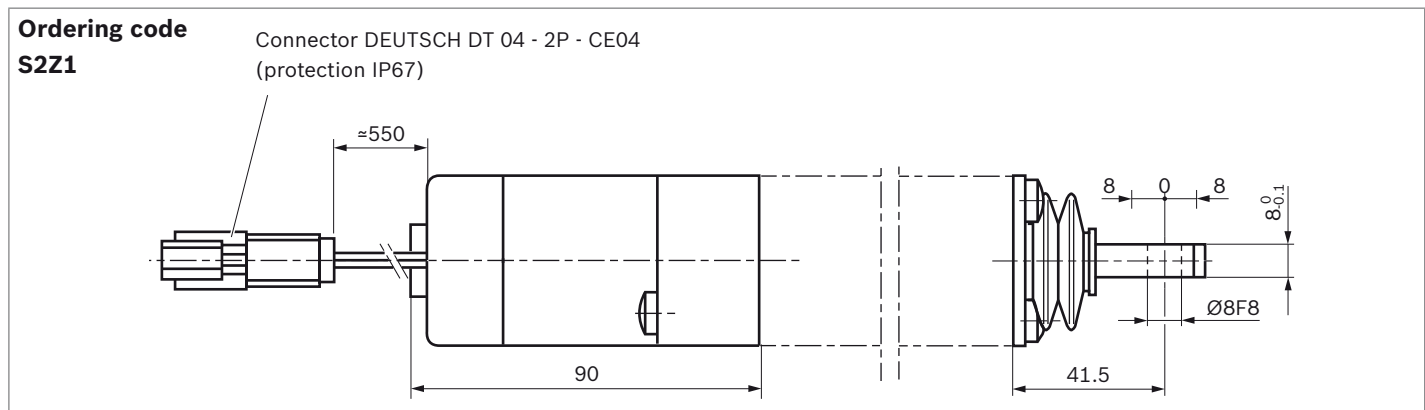
▼ **Mechanical actuation with tongue, spool return via a spring**



▼ **Mechanical actuation with tongue, spool return via a spring and mechanical detent in position 3**

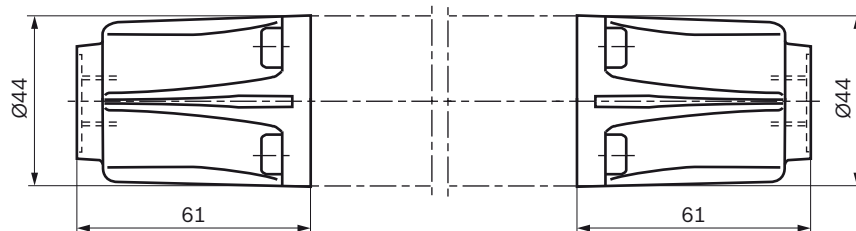


▼ **Mechanical actuation with tongue, spool return via a spring and electrical detent when spool is pushed**



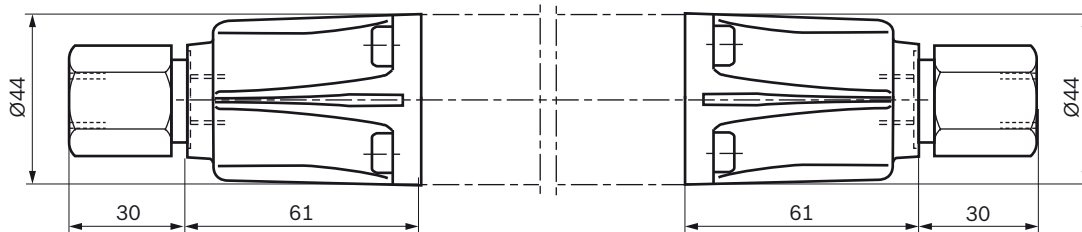
▼ Hydraulic actuation, spool return via a spring

Ordering code
H200



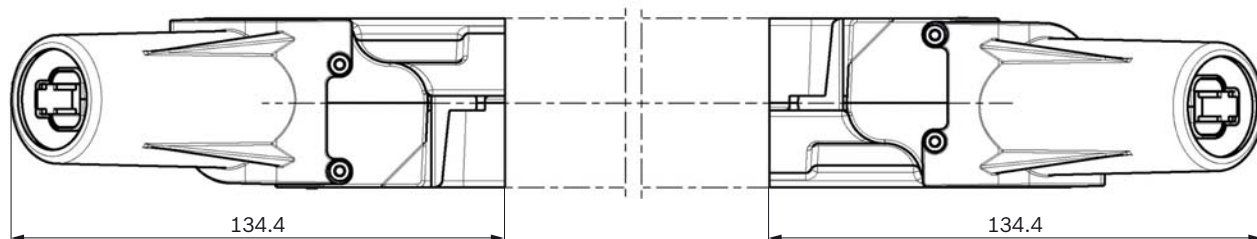
▼ Hydraulic actuation with stroke limitation, spool return via a spring

Ordering code
H230



▼ Electro-hydraulic actuation, spool return via a spring

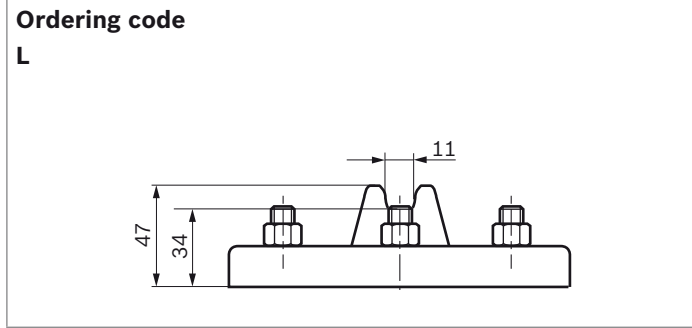
Ordering code
W200



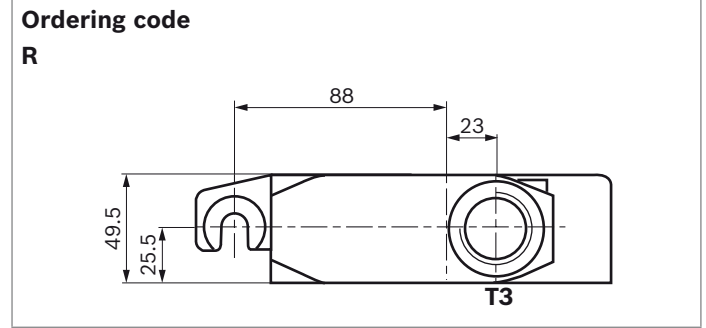
2

End elements

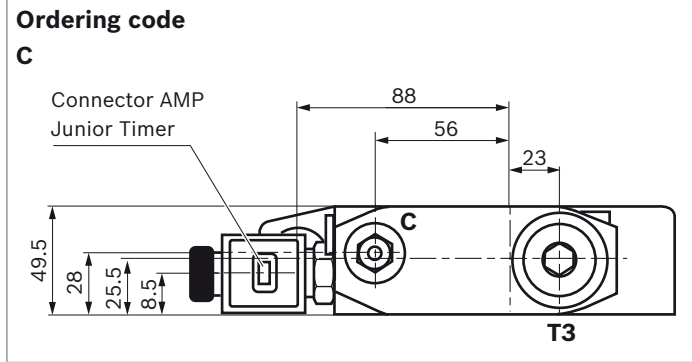
▼ **Blanking plate**



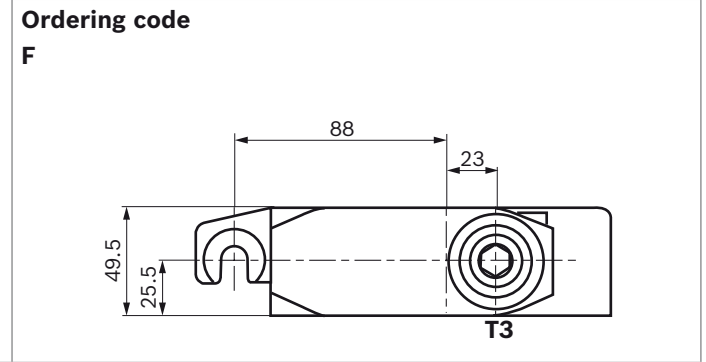
▼ **End element with tank port T**



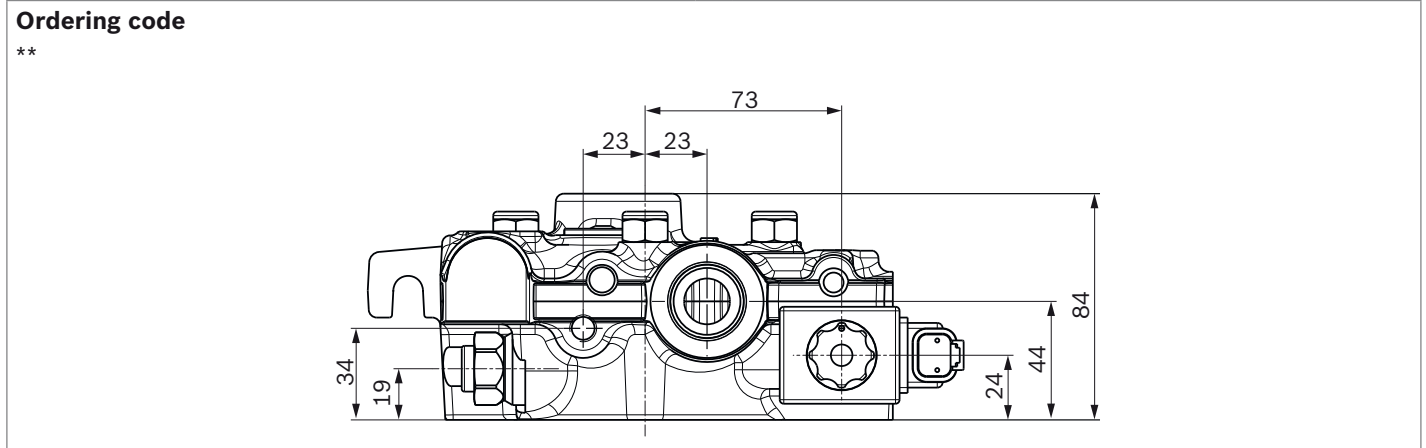
▼ **End element with solenoid operated control valve**



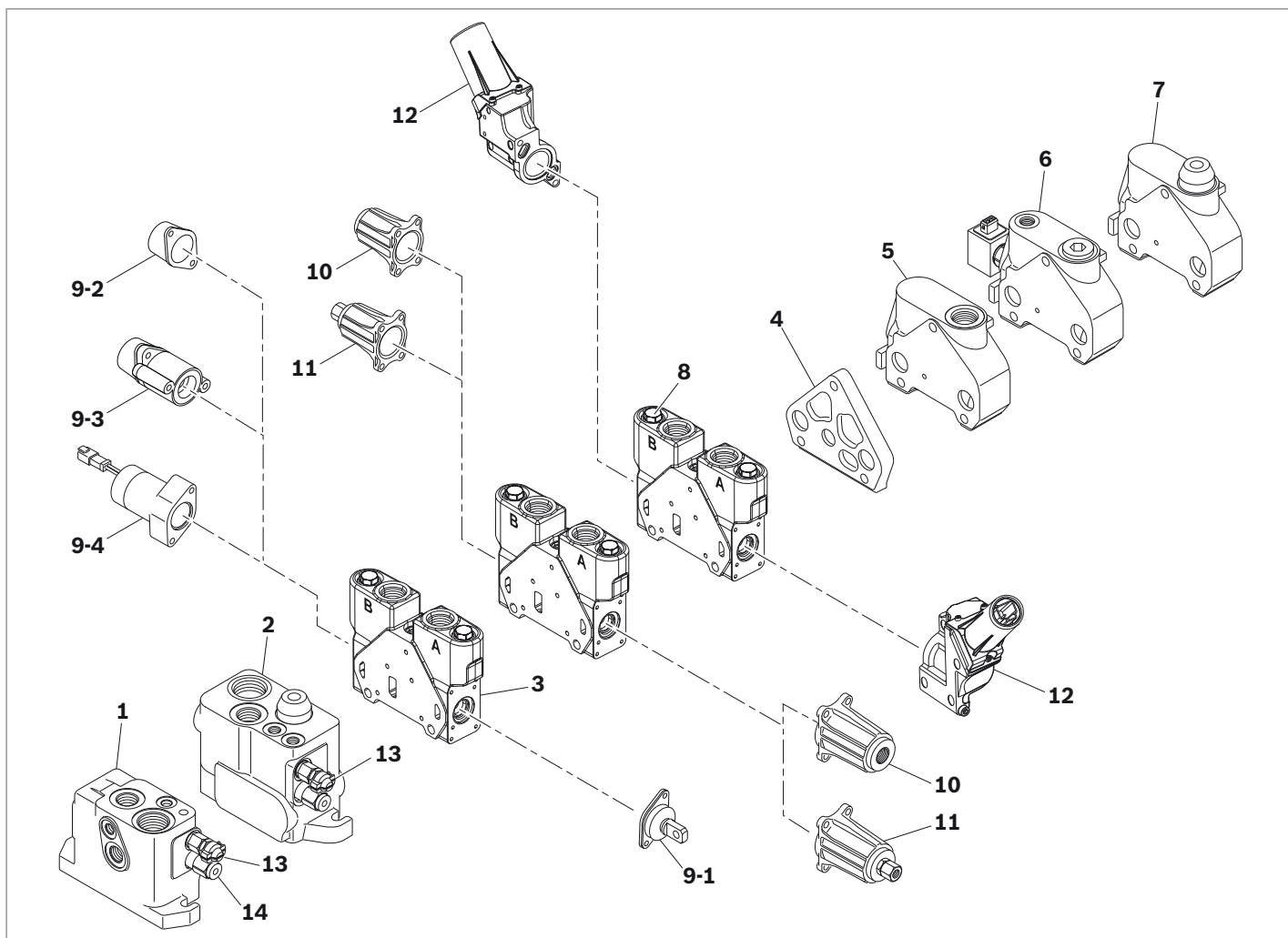
▼ **End element with flushing valve**



▼ **Electro-hydraulic end element with pressure reducing valve and shut-off**

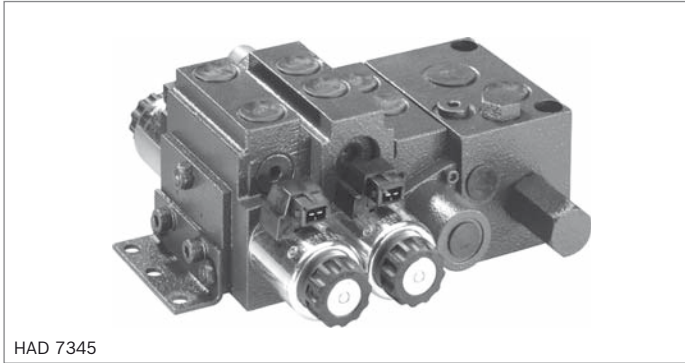


Assembly possibilities



- | | |
|--|--|
| <p>1 Inlet element with priority flow divider: CD or CS</p> <p>2 Inlet element - Closed center: A or with flushing valve: S</p> <p>3 Directional valve element RS14</p> <p>4 Blanking plate L</p> <p>5 End element with tank bridge: R</p> <p>6 End element with solenoid operated control valve C</p> <p>7 Flushing valve F</p> <p>8 Secondary valve</p> <p>9-1 Mechanical actuation with tongue Z1</p> <p>9-2 Spring return arrangement, type A2</p> <p>9-3 Spring return arrangement, mechanical detent in spool position 3, type E2</p> <p>9-4 Spring return arrangement, electrical detent when spool is pushed, type S2</p> | <p>10 Hydraulic actuation with spool return via a spring H200</p> <p>11 Hydraulic actuation with stroke limitation H230</p> <p>12 Electro-hydraulic actuation W200</p> <p>13 LS relief valve</p> <p>14 Flow control valve</p> |
|--|--|

Load-sensing control block of sandwich plate design SP-08



- ▶ Series 2X
- ▶ Maximum operating pressure
 - On the pump side 250 bar
 - On the actuator side 300 bar
- ▶ Maximum flow
 - On the pump side 75 l/min
 - On the actuator side 50 l/min

System

- ▶ Load pressure-independent flow control
 - Open center for fixed displacement pump
 - Closed center for variable displacement pump

Design

- ▶ Sandwich plate design
 - Inlet plate
 - Up to 10 directional valves
 - End plate
- ▶ Types of actuation
 - Mechanical (hand lever)
 - Hydraulic
 - Electro-magnetic: Switchable, proportional

Flow

- ▶ Load pressure-compensated
- ▶ High repetition accuracy
- ▶ Low hysteresis
- ▶ Adjustable by means of variable orifice
(repeated use up to 5 times)

Pressure limitation

- ▶ With primary pressure relief valve in the inlet plate
- ▶ Pilot operated pressure relief/anti-cavitation valve in the directional valve/actuator ports

Fields of application

- ▶ Truck applications
- ▶ Construction machines
- ▶ Drilling machinery
- ▶ Agricultural machinery
- ▶ Aerial work platforms
- ▶ Municipal vehicles
- ▶ Cranes
- ▶ Stationary applications

Contents

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Technical data	4
Characteristic curve	5
Ordering code	6
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Open center inlet plates	11
Closed center inlet plates	12
Directional valves	15
End plates	18
Line connections	18
Dimensions	19
Accessories	25

Function

Control block SP-08

The directional valves are switchable valves or proportional valves according to the load-sensing principle. They can be operated mechanically, hydraulically or electro-magnetically.

Actuator control with electro-magnetic actuation

The position of main spool (2) relative to housing (1) determines the direction and the amount of flow fed to the actuator ports (A or B).

In the non-operated condition, the main spool is centered by compression springs (7). There is no connection between P and A or B.

When the electric control current exceeds the value of the spring force, the main spool starts to move from its central position and the connection P → A or P → B opens.

Releasable check valve

Optionally integrated pilot operated check valves (5) can be used for the leakage oil-free isolation of the actuators.

They can be installed in one actuator line (B) or in both actuator lines.

Flow limitation

The maximum flow can be set mechanically and individually by means of a variable orifice (3).

Pressure limitation

Pressure valves with combined anti-cavitation function (4) protect actuator ports A and B from pressure peaks and negative load cases.

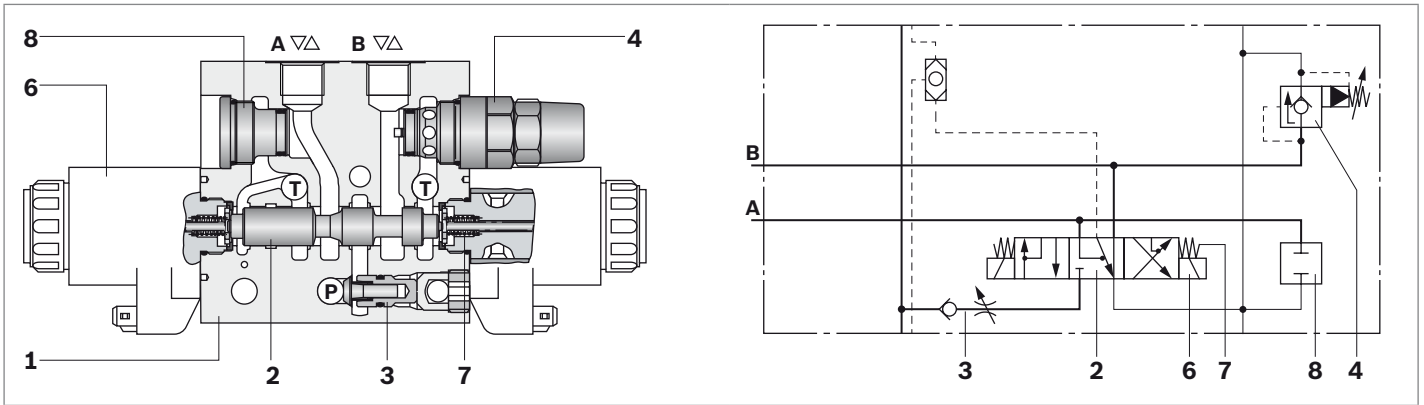
Section pressure compensator

In the central position of the main spool, the connection from P to actuator ports A and B is closed. In this operating state, pressure compensator spool (9) is shifted by the pump pressure to the left against spring (10).

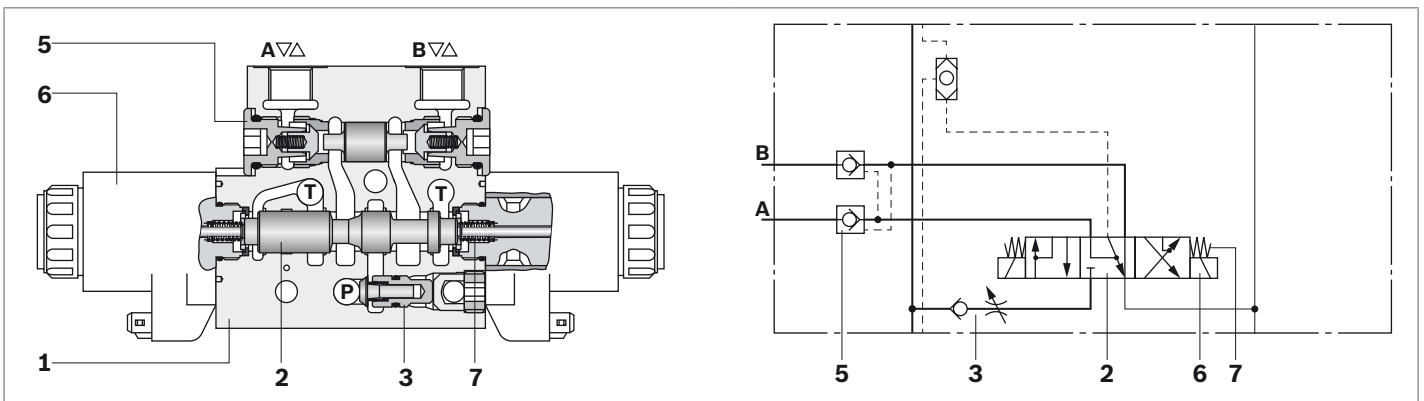
If a function is required, the LS pressure is directed via the main spool to the spring chamber and shifts the pressure compensator spool to the right into the controlled position. The flow is kept constant even when several actuators with different load pressures are operated in parallel.

Sections, symbols

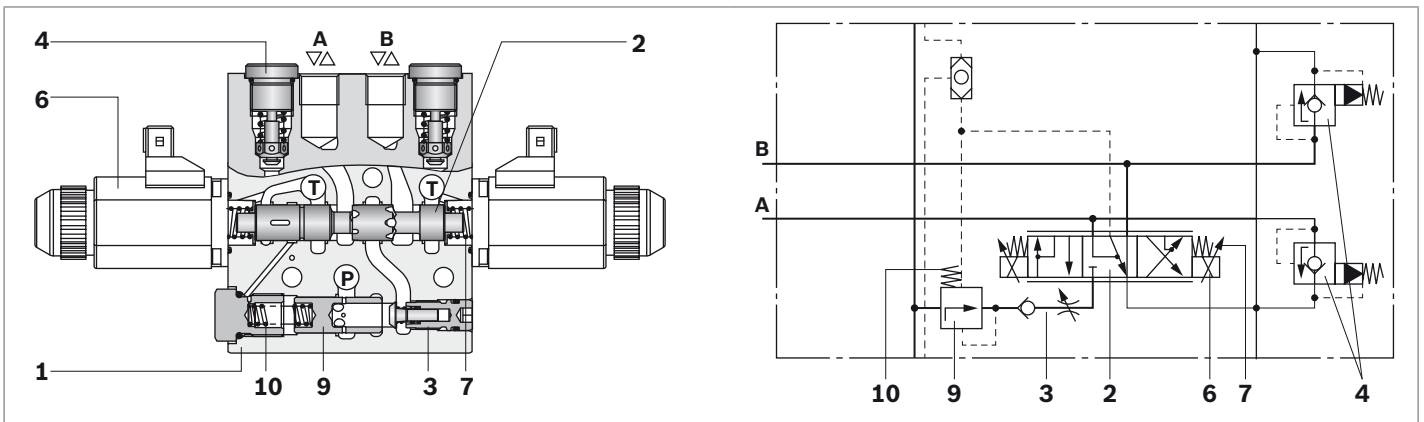
▼ SP-08 directional valve with electro-magnetically switchable actuation (C2) and pressure relief/anti-cavitation valve in actuator port B (A...)



▼ SP-08 directional valve with electro-magnetically switchable actuation (C2) and pilot operated check valves (S)



▼ SP-08 directional valve with electro-magnetic proportional actuation (P5), section pressure compensator and pressure relief/anticavitation valve in actuator ports A and B (H...)



- 1 Housing
- 2 Main spool
- 3 Variable orifice with load holding function
- 4 Pressure relief/anti-cavitation valve
- 5 Pilot operated check valves
- 6 Solenoid
- 7 Compression spring
- 8 Plug screw
- 9 Pressure compensator
- 10 Pressure compensator spring

Connections

P	Pump
T	Tank
A, B	Actuators

Hydraulic symbol according to ISO 1219-1:2005

Technical data

general			
Weight			
Inlet plate	With 3-way pressure compensator P	kg	2.3
	With 2-way pressure compensator M, H	kg	5.2
	Without pressure compensator J, G	kg	4.9
Directional valve	With manual actuation	kg	1.8 to 2.3
	With hydraulic actuation	kg	2.2
	With electro-magnetic actuation	kg	3.0 to 3.5
End plate	LA (without mounting bracket)	kg	0.2
	LU (without mounting bracket)	kg	0.4
	Mounting bracket F, additionally	kg	0.1
	SV (with seat valve)	kg	3.3
Installation position			Any
Type of connection			Pipe thread according to ISO 228/1
Ambient temperature range	θ	°C	-20 to +80
		°C	-20 to +60 with electro-magnetic actuation
Priming			RAL 5010
hydraulic			
Maximum operating pressure at port	P, M, X, LS	bar	250
	A, B	bar	300
	T	bar	20
Nominal pressure p_{nom}		bar	250
Maximum pilot pressure at port	a, b	bar	30
Maximum flow at port	P	l/min	75
Maximum flow	Mechanical, hydraulic	l/min	50 ¹⁾
	Electro-magnetically switchable	l/min	30 ¹⁾
	Electro-magnetically proportional	l/min	25 ¹⁾
Recommended hydraulic pilot control units	Type	2TH6, control curve 06 (data sheet 64552)	
	Type	2TH6R, control curve 06 (data sheet 64551)	
	Type	4TH6, control curve 06 (data sheet 64555)	
Hydraulic fluid		Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet 90221, at request	
Hydraulic fluid temperature range θ		°C	-20 to +80
Viscosity range	ν	mm ² /s	10 to 380
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)			Class 20/18/15, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Leakage A, B → T at an operating pressure of 150 bar	Standard	cm ³ /min	45
	With isolator valve	cm ³ /min	2

1) Greater flows on request

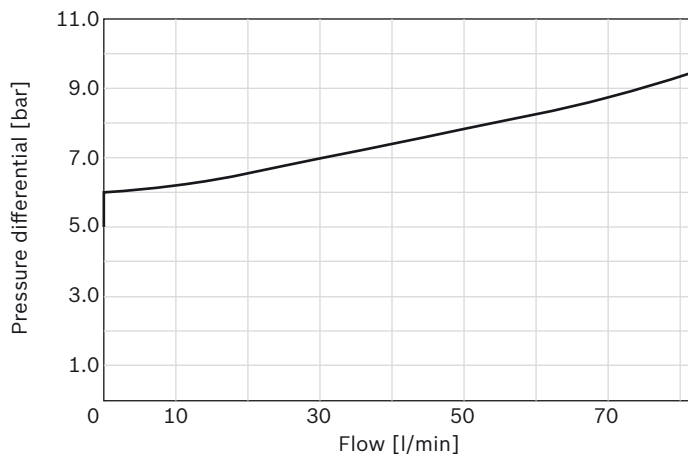
electric (sandwich plate design)				
Switching solenoid		Type	GZ 45, see data sheet 23178	
Proportional solenoid				
Control type			Electro-magnetically, directly	
Relative duty cycle			100 % duty cycle	
Protection class			IP 65	
Plug-in connection			AMP Junior Timer, 2-pole	
Solenoid voltage	U_{nominal}	V	12	24
Solenoid current (regulated)	I_{max}	A	2.3	1.5
Coil resistance at 20 °C	R_L	Ω	3.5 to 3.75	9.6 to 10.2
Coil resistance at 80 °C	R_L	Ω	≤ 4.8	≤ 12.8
Inductivity with nominal stroke (50 Hz)		mH	≈ 87	≈ 220
Current proportional range	I_{prop}	A	0.5 to 2.3	0.25 to 1.5
Dither amplitude (A, B)		A	0.75 ± 0.25	0.48 ± 0.2
Dither frequency (A, B)		Hz	120 ± 5	
Dither form of the current command value (A, B)			Triangular signal	

Notice

- ▶ For applications outside these parameters, please consult us!
- ▶ The technical data was determined at a viscosity range of $\nu = 41 \text{ mm}^2/\text{s}$ and a temperature of $\theta = 50 \text{ °C}$.
- ▶ For further information on the proper handling of control blocks by Bosch Rexroth, please refer to our operating instructions 64025-B “Control blocks for mobile applications”.

Characteristic curve

- ▼ Flow resistance (standard compression spring 5.5 bar)
PE → T (DF = 5.5 bar)

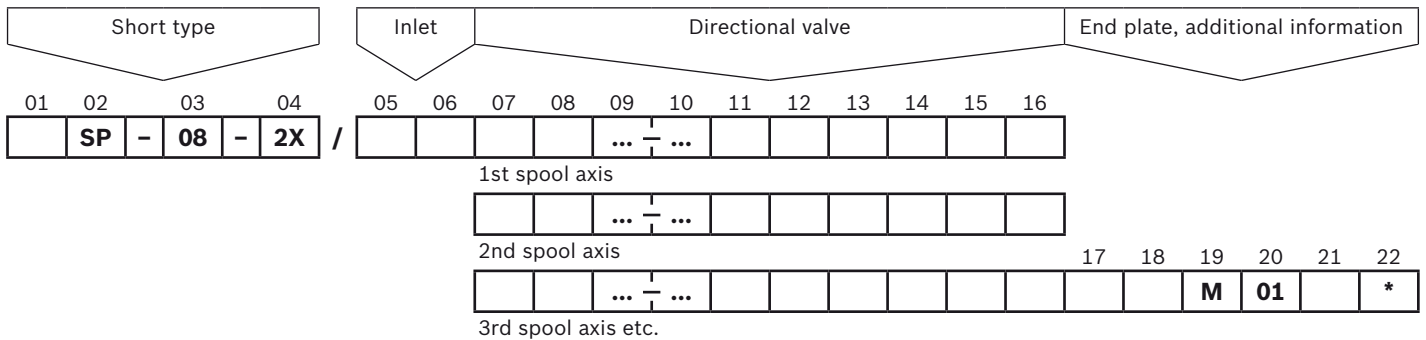
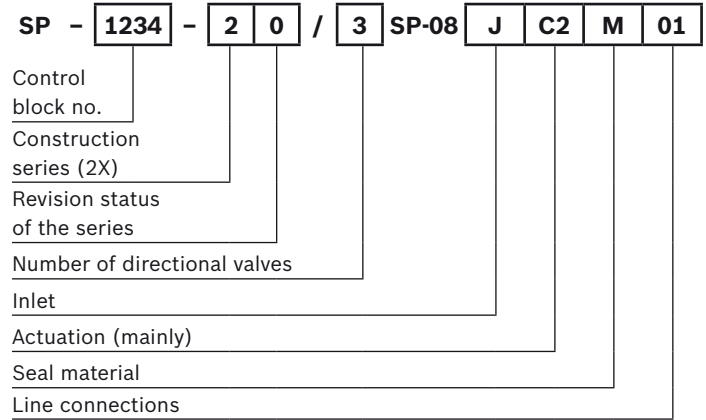


Ordering code

Information on the name plate

The ordering code serves to specify the technical features and requirements. The Rexroth distribution organization derives a short type as well as a material number from the ordering code.

▼ Example of a short type of the SP-08 control block with three directional valves



Short type

01	Total number of spool axes 1 to 10	
02	SP series	SP
03	Size 08	08
04	Series 20 to 29 (unchanged installation and connection dimensions)	2X

Inlet plate

05	Open center	With 3-way pressure compensator	P
	Closed center	Without shuttle valve, without pressure compensator	J
		With shuttle valve, without pressure compensator	G
		With shuttle valve, with 2-way pressure compensator	H
		With priority valve	V
	Adapter plate for M4-12 directional valves (only with primary pressure limitation)		L8
06	Without primary pressure limitation function (retrofitable), with plug screw, without measuring port		Q
	With primary pressure limitation function, without measuring port (pressure to be specified in bar, 3-digit)		...

Directional valves

07	Variable orifice with load holding function	F
	Section pressure compensator and variable orifice with load holding function	S

Spool type

08	Main spool E ¹⁾	E
	Main spool J ¹⁾	J

Flow

09	Actuator port A (to be specified in l/min, 3-digit)	...
10	Actuator port B (to be specified in l/min, 3-digit)	...

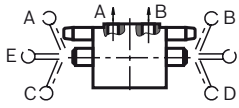
Actuation

11	Mechanical, spool end with tongue ²⁾	Z1
	Mechanical, encapsulated lever	R5
	Mechanical, with 2-axis lever ^{2), 3)}	R9
	Hydraulic	H2
	Electro-magnetically proportional	P5
	Electro-magnetically switchable	C2

Supply voltage, to be specified for C2 and P5 actuation

12	24 Volts ⁴⁾	1
	12 Volts ⁴⁾	3

Manual actuation disposition for versions Z1, R5, R9

13		On connection side A , lever upwards (preferred)	A
		On connection side B , lever upwards	B
		On connection side A , lever downwards	C
		On connection side B , lever downwards	D
		On connection side A , lever forwards	E
		On connection side B , lever forwards	F

Spool return with versions Z1, R5, R9

14	By means of spring	A2
	By means of spring, spool position 2 with detent	B2
	By means of spring, spool position 1 with detent	C2
	By means of spring, spool positions 1, 2 with detent	D2

Secondary valves at actuator ports A and B

15	Without secondary valve (not retrofittable)	Z
16	Without secondary valve (retrofittable), with plug screw	Q
	Pressure relief/anti-cavitation valve, adjustable (pressure to be specified in bar, 3-digit)	A...
	Pressure relief/anti-cavitation valve, not adjustable (pressure to be specified in bar, 3-digit) ⁵⁾	H...
	Pilot operated check valve (if there is only one pilot operated check valve, it is installed at actuator port B – ordering code ZS)	S
	Float function with hydraulic detent, one-sided (at actuator port A – ordering code AZ)	A
	Pilot operated check valves with split opening spool, on both sides ⁶⁾ (float function – ordering code BB)	B

¹⁾ Symbols and preferred types see page 15

²⁾ Only lever positions **A** or **B** are possible

³⁾ **R9** can not be combined with section pressure compensator **S**.

⁴⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006 and page 25

⁵⁾ Only for directional valves with pressure compensator **S**, preferred pressure adjustment see page 16

⁶⁾ Pilot operated check valves with split opening spool (float function) **BB** only in connection with end plate **SV**

End plate

17	End plate ⁷⁾	LA
	End plate with LS connection	LS
	End plate with internal tank connection ⁸⁾	LU
	End plate with seat valve ¹⁰⁾	SV

Additional details

18	With mounting bracket (only in connection with end plates LA and LU)	F
19	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
20	Line connections as pipe thread according to ISO 228/1	01

SO number

21	Aluminum-free	-450
22	Further details in the plain text	

⁷⁾ Up to a return flow volume of 15 l/min.

⁸⁾ For a return flow volume of 15 l/min. or more

Order examples

Open center control block

Example – 2-fold control block of sandwich plate design
– Fixed displacement pump $q_{V\max} = 75$ l/min

Inlet – Open center with primary pressure relief valve, set to 250 bar

1st spool axis – With variable orifice and load holding function
– Spool symbol **J**, flow in A and B 30 l/min
– Type of actuation: Mechanic with encapsulated hand lever on side A
– Spool return by means of spring
– Plug screw on actuator port A (secondary valves can be retrofit)
– Pressure relief/anti-cavitation valve at actuator port B, set to 210 bar

2nd spool axis – With variable orifice and load holding function
– Spool symbol **E**, flow in A and B 30 l/min
– Type of actuation: Mechanic with encapsulated hand lever on side A
– Spool return by means of spring
– Pilot operated check valves on A and B side

End plate – End plate **LA** and mounting bracket
– NBR seals, pipe thread connections

Ordering code:

Inlet plate

01	02	03	04	05	06
2	SP	-	08	-	2X / P 250

1st spool axis

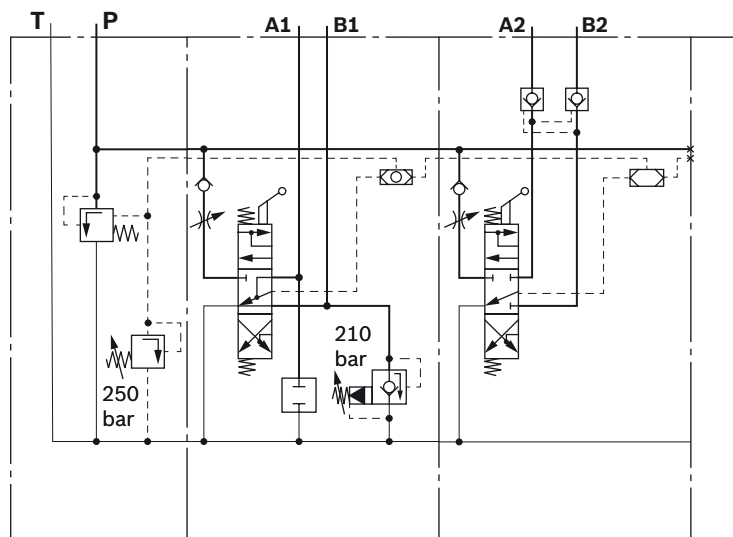
07	08	09	10	11	12	13	14
F	J	030-030	R5	A	A2	Q	H210

2nd spool axis

07	08	09	10	11	12	13	14
F	E	030-030	R5	A	A2	S	S

End plate, additional information

15	16	17	18
LA	F	M	01



Closed center control block of sandwich plate design

- Example** – 3-fold control block of sandwich plate design
 – Variable displacement pump $q_{vmax} = 75$ l/min
- Inlet plate** – Closed center with 2-way pressure compensator with LS shuttle valve, primary pressure limitation function, retrofittable
-
- 1st spool axis** – With variable orifice and load holding function
 – Spool symbol **E**, flow in A and B 30 l/min
 – Type of actuation: Hydraulic
 – Without secondary valve (low housing)
- 2nd spool axis** – With variable orifice and load holding function
 – Spool symbol **E**, flow in A and B 30 l/min
 – Type of actuation: Electro-magnetically proportional, 24 V
 – Electrical connection AMP type Junior Timer
 – Plug screw on actuator port A (secondary valves can be retrofit)
 – Secondary valves at actuator port B, set to 210 bar
- 3rd spool axis** – With variable orifice and load holding function
 – Spool symbol **J**, flow in A and B 30 l/min
 – Type of actuation: Electro-magnetically switchable, 24 V
 – Electrical connection AMP type Junior Timer
 – Pilot operated check valves on A and B side
- End plate** – End plate **LA** and mounting bracket
 – NBR seals, pipe thread connections

Ordering code:

Inlet plate

01	02	03	04	05	06
3	SP	-	08	-	2X / H Q

1st spool axis

07	08	09	10	13	14
F	E	030-030	H2	Z	Z

2nd spool axis

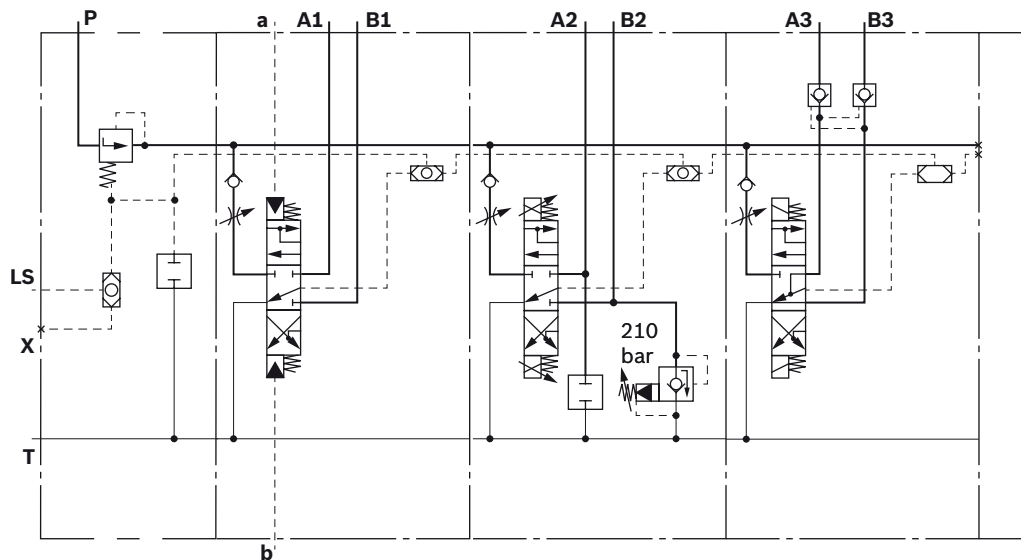
07	08	09	10	11	13	14
F	E	030-030	P5	1	Q	H210

3rd spool axis

07	08	09	10	11	13	14
F	J	030-030	C2	1	S	S

End plate, additional information

15	16	17	18
LA	F	M	01



Open center inlet plates

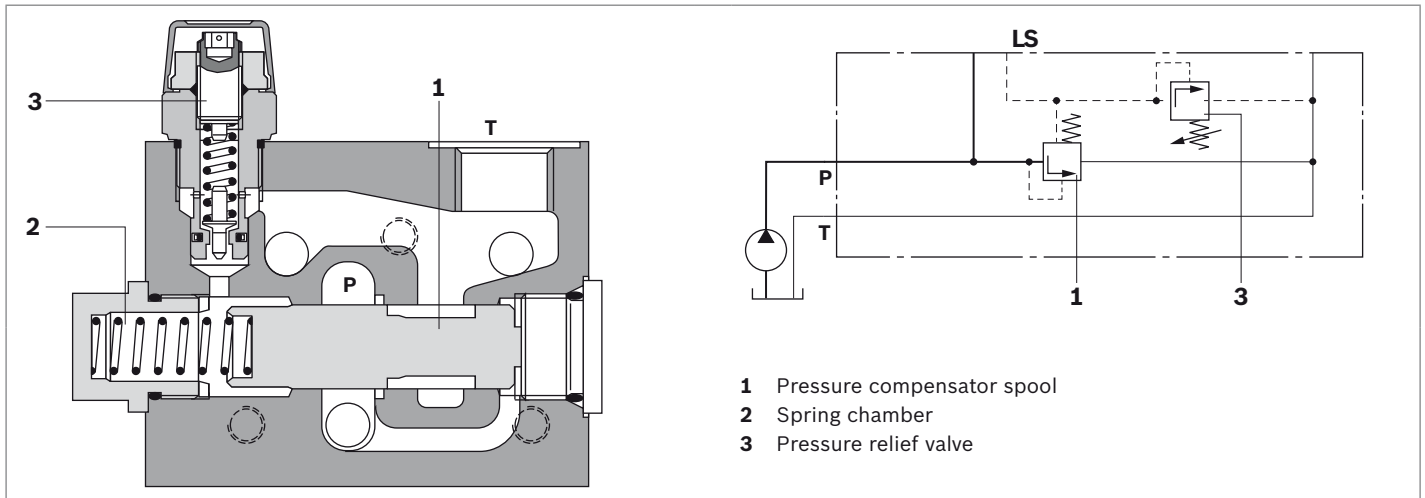
Function with fixed displacement pump (open center)

When all of the directional valve axes are in the non-operated state, the pump flow is directed via the open center pressure compensator to the tank. If one directional valve axis is operated, the load pressure acts via the shuttle valve chain, which is now blocked to the tank, on the left-hand side of the pressure compensator and the pump-to-tank connection is interrupted. The highest actuator pressure acts in spring chamber (2) and on the left-hand side of pressure compensator spool (1).

The pump pressure acts on the right-hand side of this spool.

When the pump pressure rises to a value higher than the control pressure differential Δp plus actuator pressure, the pressure compensator spool is shifted to the left, and a part of the pump flow is directed to the tank until the balance is restored. The pressure in spring chamber (2) is limited by pressure relief valve (3). If the pressure rises further, the pressure compensator acts as main spool of a pilot operated pressure relief valve and limits the system pressure.

▼ Inlet plate P with 3-way pressure compensator



With 3-way pressure compensator

Ordering code:

SP	-	08	-	2X	/	P	Q
----	---	----	---	----	---	---	---

Short description

- ▶ For fixed displacement pump
- ▶ Primary pressure limitation function can be retrofitted
- ▶ Pressure limitation in the system required

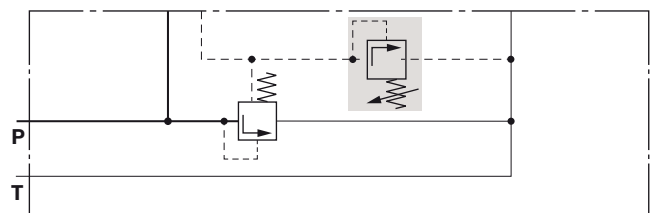
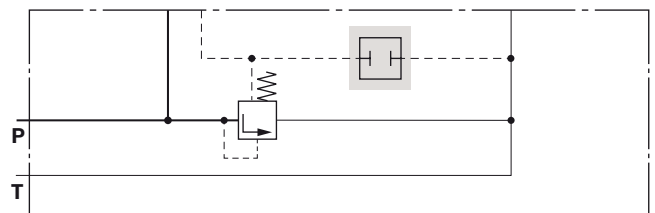
With 3-way pressure compensator

Ordering code:

SP	-	08	-	2X	/	P	...
----	---	----	---	----	---	---	-----

Short description

- ▶ For fixed displacement pump
- ▶ With primary pressure limitation function
- ▶ Pressure must be specified in bar (3-digit)



Closed center inlet plates

Function with variable displacement pump (closed center)

In the neutral position of the directional valve, the shuttle valve chain is unloaded. In the working positions, the load pressure of the actuator with the highest load acts in the LS port via the shuttle valve chain. The hardened shuttle valve seats can be replaced.

The LS port must be connected to the pressure/flow controller (DFR) of the pump. The controller maintains the pressure drop across the control block approximately constant over the entire operating range. The flow is therefore proportional to the cross-section opened by the spool between the pump and the actuator port in the course of the actuating operations – independent of the working pressure.

At the same time, the other actuator port is connected to the tank.

The relation between flow and spool travel, especially the maximum flow, can be adjusted on site to meet the individual requirements by means of an adjustable throttle that is combined with the load-holding valve.

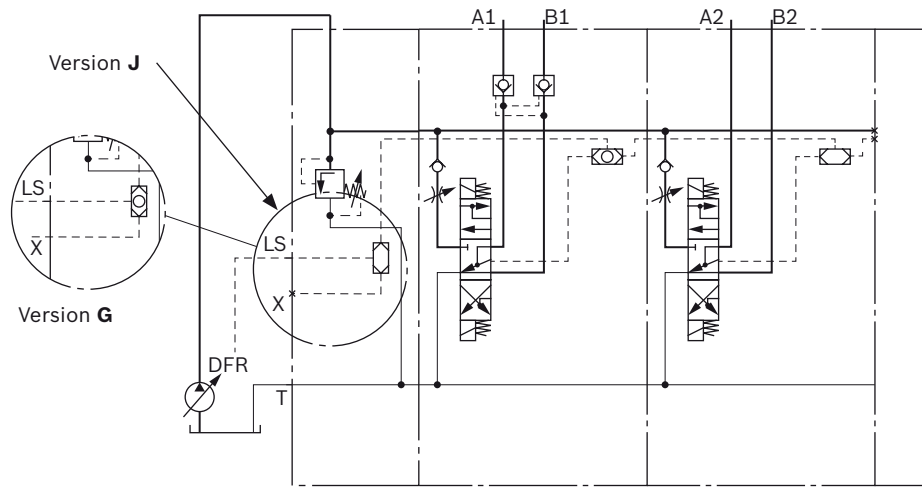
When several actuators are operated simultaneously, the flow depends on the relevant pressure differential between pump pressure and load pressure.

The inlet plates can be fitted with 2-way pressure compensators, if further actuators are to be connected to a pump. In this case, the pressure compensator keeps the pressure differential across the directional valves constant.

Circuit examples

► Version J + G

- P** Pump
- A, B** Actuators
- LS** Load Sensing (LS)
- X** LS feed of an additional control block
- T** Tank

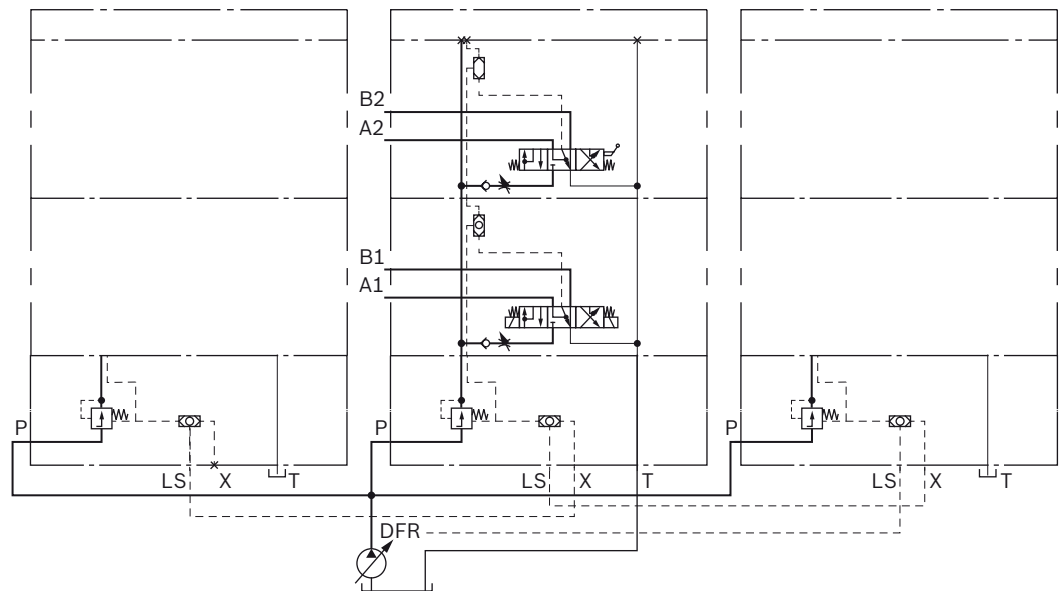


► Version H

Parallel connection of several control blocks

Project planning information for port "X"

LS pressure supply of an additional control block. With this version, a ball must be installed in the shuttle valve.



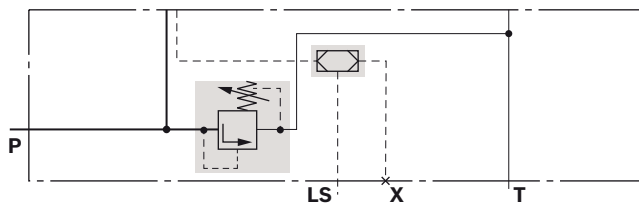
Without pressure compensator, without shuttle valve

Ordering code:

SP	-	08	-	2X	/	J	...
----	---	----	---	----	---	---	-----

Short description

- ▶ LS message to pump (DFR)
- ▶ With primary pressure limitation function
- ▶ Pressures must be specified in bar (3-digit)



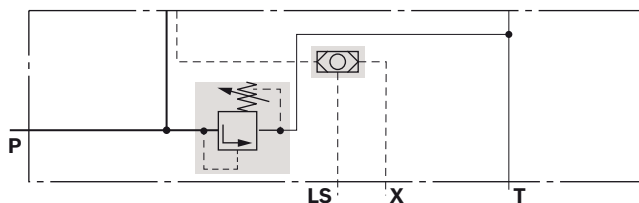
Without pressure compensator, with shuttle valve

Ordering code:

SP	-	08	-	2X	/	G	...
----	---	----	---	----	---	---	-----

Short description

- ▶ LS message to pump (DFR)
- ▶ LS supply of an additional control block at port X
- ▶ With primary pressure limitation function
- ▶ Pressure must be specified in bar (3-digit)



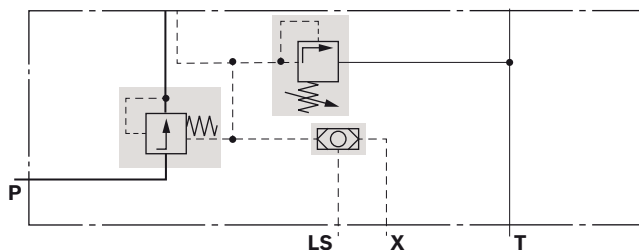
With 2-way pressure compensator, with shuttle valve

Ordering code:

SP	-	08	-	2X	/	H	...
----	---	----	---	----	---	---	-----

Short description

- ▶ LS message to pump (DFR)
- ▶ LS supply of an additional control block at port X
- ▶ With primary pressure cut-off
- ▶ Pressure must be specified in bar (3-digit)



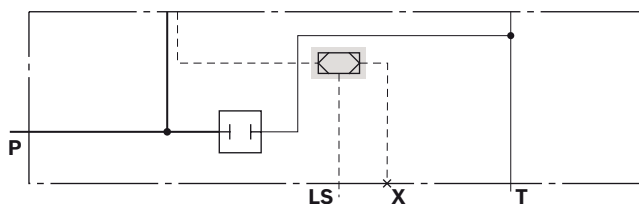
Without pressure compensator, without shuttle valve

Ordering code:

SP	-	08	-	2X	/	J	Q
----	---	----	---	----	---	---	---

Short description

- ▶ LS message to pump (DFR)
- ▶ Primary pressure limitation function can be retrofitted



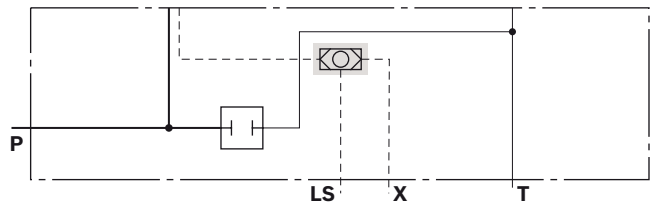
Without pressure compensator, with shuttle valve

Ordering code:

SP	-	08	-	2X	/	G	Q
----	---	----	---	----	---	---	---

Short description

- ▶ LS message to pump (DFR)
- ▶ LS supply of an additional control block at port X
- ▶ Primary pressure limitation function can be retrofitted



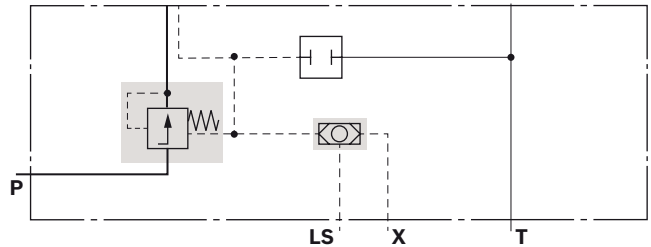
With 2-way pressure compensator, with shuttle valve

Ordering code:

SP	-	08	-	2X	/	H	Q
----	---	----	---	----	---	---	---

Short description

- ▶ LS message to pump (DFR)
- ▶ LS supply of an additional control block at port X
- ▶ Primary pressure limitation function can be retrofitted



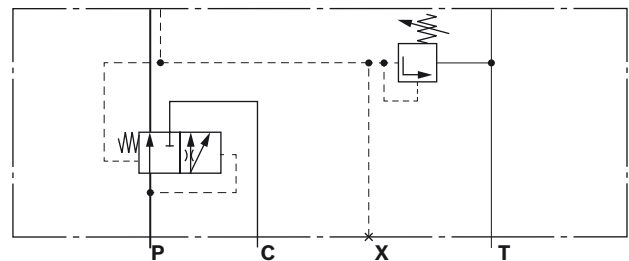
With priority valve

Ordering code:

SP	-	08	-	2X	/	V	...
----	---	----	---	----	---	---	-----

Short description

- ▶ Internal priority function, external subordinate actuators (port C)
- ▶ With primary pressure limitation function
- ▶ Pressure must be specified in bar (3-digit)
- ▶ LS message to flow-controlled pump (port X)



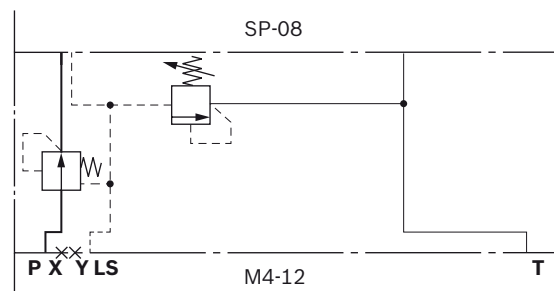
Adapter plate for M4-12 directional valves

Ordering code:

SP	-	08	-	2X	/	L8	210
----	---	----	---	----	---	----	-----

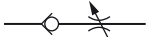
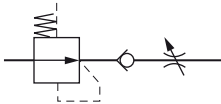
Short description

- ▶ With integrated 2-way pressure compensator
- ▶ With LS pressure relief valve, set to 210 bar
- ▶ Type code for flanged M4-12 directional valves according to data sheet 64276
- ▶ Up to 7 M4-12 directional valves are admissible



Directional valves

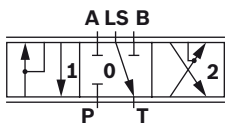
Pressure compensator spool

Ordering code	Short description	Symbol
F	Variable orifice with load holding function	
S	Section pressure compensator and variable orifice with load holding function	

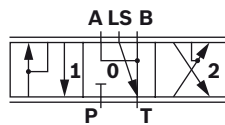
Main spool

The flow is dependent on the type of actuation and the Δp of the pressure compensator.

▼ Spool type E







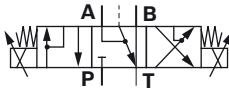
▼ Spool type J



Preferred types (spool types E, J)

Flow in l/min	
Symmetric spool valves	Asymmetric spool valves
010-010	010-020
020-020	020-040
030-030	
040-040	

Types of actuation

Mechanical – spool end with tongue Z1 A A2 	Mechanical – encapsulated lever R5 A B2 
Hydraulic H2 	
Electro-magnetically switchable, without secondary valve C2 	Electro-magnetically proportional, without secondary valve P5 

Secondary valves

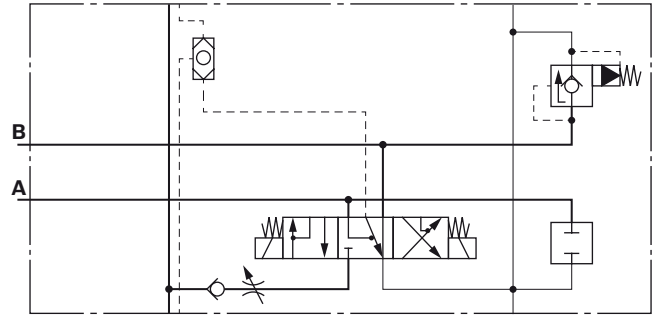
With plug screw and pressure relief/anti-cavitation valve

Ordering code:

S	J	030-030	C2	1	Q	H210
---	---	---------	----	---	---	------

Short description

- ▶ Plug screw on actuator port A, secondary valves can be retrofitted
- ▶ Pressure relief/anti-cavitation valve on actuator side B, permanently set to 210 bar



▼ Preferred pressure settings for pressure relief valves with anti-cavitation function

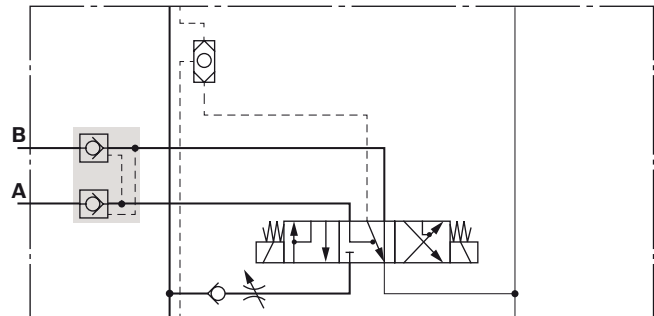
Pressure settings in bar in actuator ports A and B			
H050 = 50 bar	H125 = 125 bar	H175 = 175 bar	H280 = 280 bar
H063 = 63 bar	H140 = 140 bar	H190 = 190 bar	H300 = 300 bar
H080 = 80 bar	H150 = 150 bar	H210 = 210 bar	H240 = 240 bar
H100 = 100 bar	H160 = 160 bar	H230 = 230 bar	H250 = 250 bar

Notice
 Pressure valve settings are fixed!
 Adjustable pressure valves upon request.

With pilot operated check valves

Ordering code:

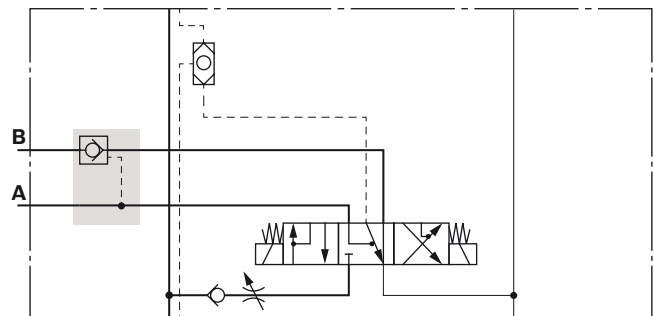
F	J	030-030	C2	1	S	S
---	---	---------	----	---	---	---



With 1 pilot operated check valve

Ordering code:

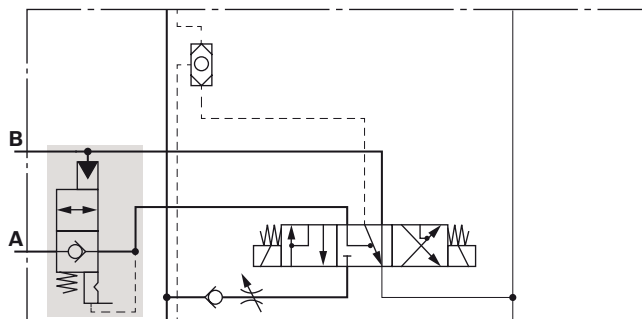
F	J	030-030	C2	1	Z	S
---	---	---------	----	---	---	---



Electro-magnetically switchable, with float function with hydraulic detent

Ordering code:

F	J	030-030	C2	1	A	Z
---	---	---------	----	---	---	---



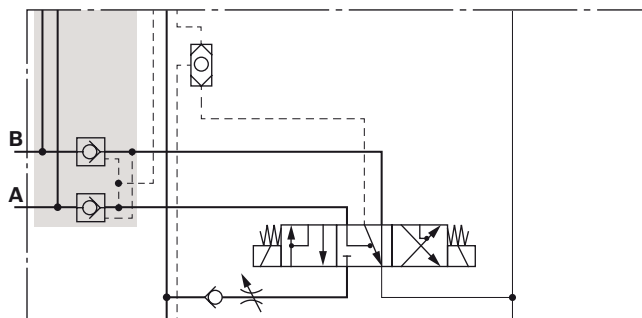
Electro-magnetically switchable, with pilot operated check valves with split opening spool

Ordering code:

F	J	030-030	C2	1	B	B
---	---	---------	----	---	---	---

Short description

- Only in connection with end plate **SV**

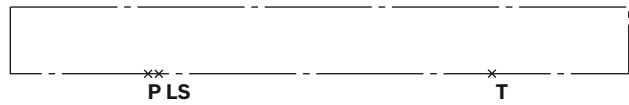


End plates

Without function

Ordering code:

LA



End plate with LS port

Ordering code:

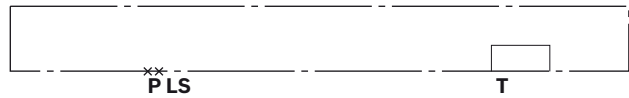
LS



End plate with internal tank connection

Ordering code:

LU



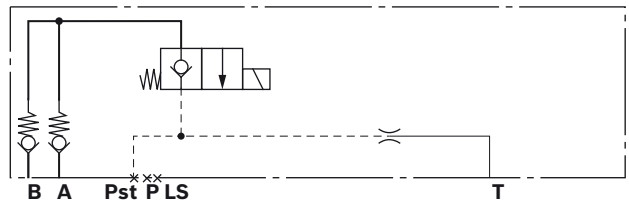
End plate with seat valve

Ordering code:

SV

Short description

- Only in connection with directional valve **BB**

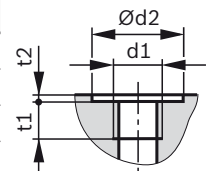


Line connections

Connections as pipe threads according to ISO 228/1

Port	
P	G 3/8
T	G 1/2
A, B	G 3/8
LS	G 1/4
X	G 1/4
a, b	G 1/4

d1	Ø d2	t1	t2
G 3/8	28	12	0.5
G 1/4	25	12	0.5
G 1/2	34	14	0.5



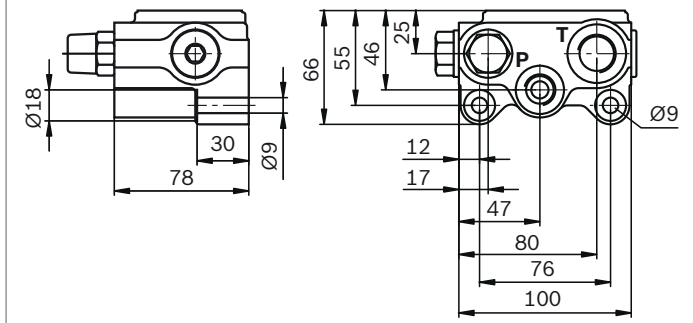
Dimensions

Inlet plates

▼ Open Center

Ordering code:

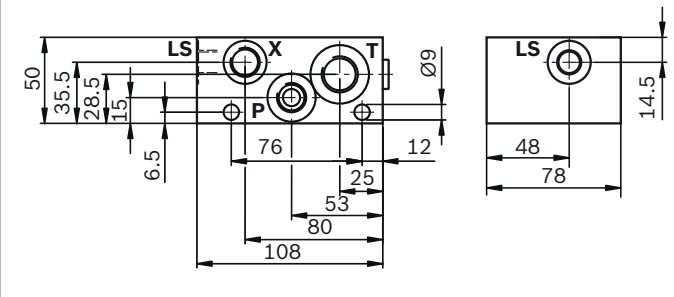
P



▼ Closed Center

Ordering code:

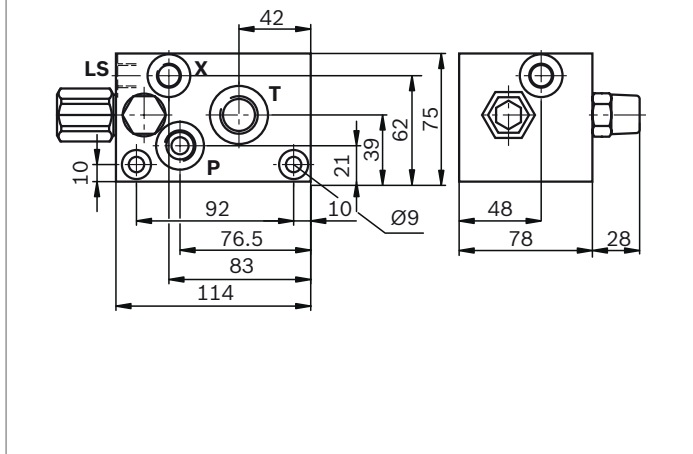
J , **G**



▼ Closed Center

Ordering code:

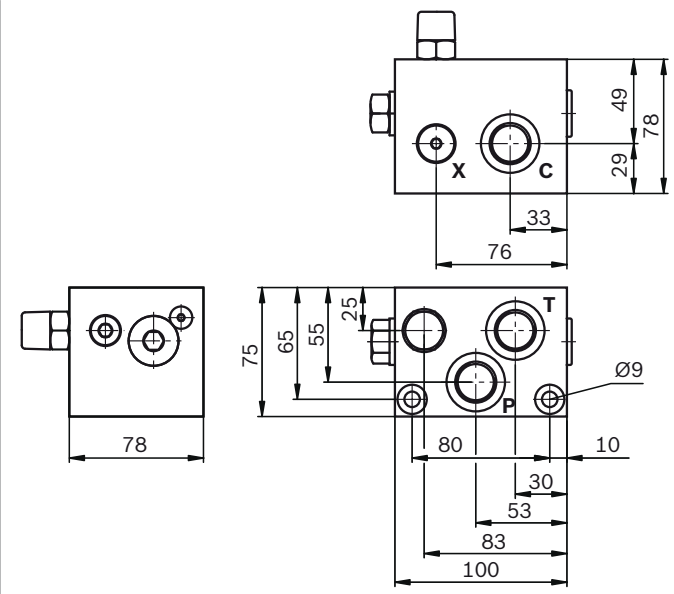
H



▼ Priority valve

Ordering code:

V

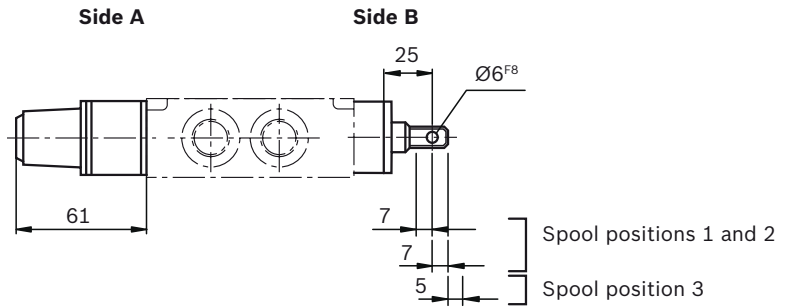


Types of actuation

▼ **Mechanical operation, spool end with tongue**

Ordering code:

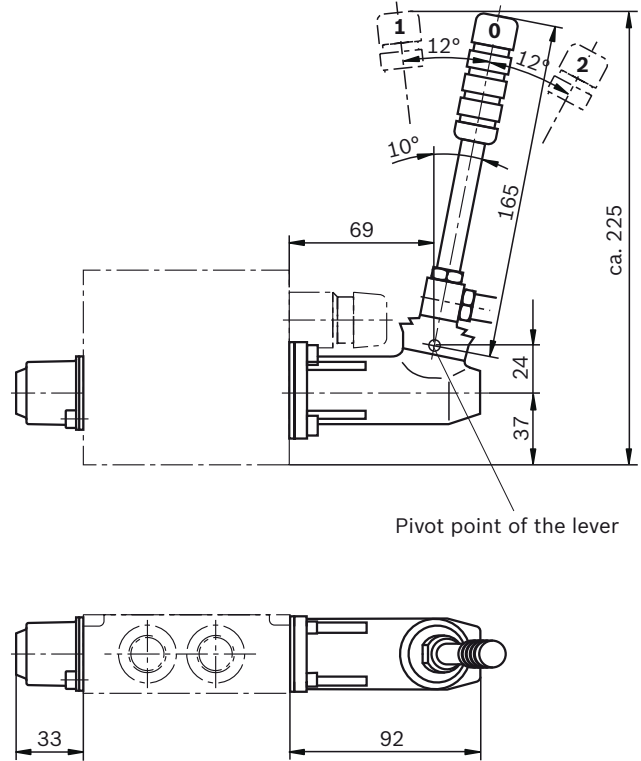
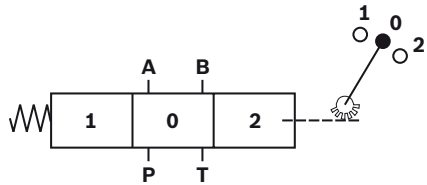
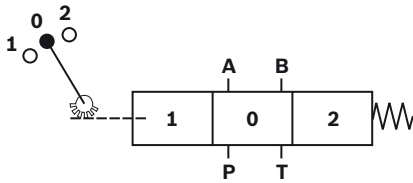
...	Z1	B	B2	...
...	Z1	B	C2	...
...	Z1	B	D2	...



▼ **Mechanical operation, encapsulated lever**

Ordering code:

...	R5	B	A2	...
-----	----	---	----	-----



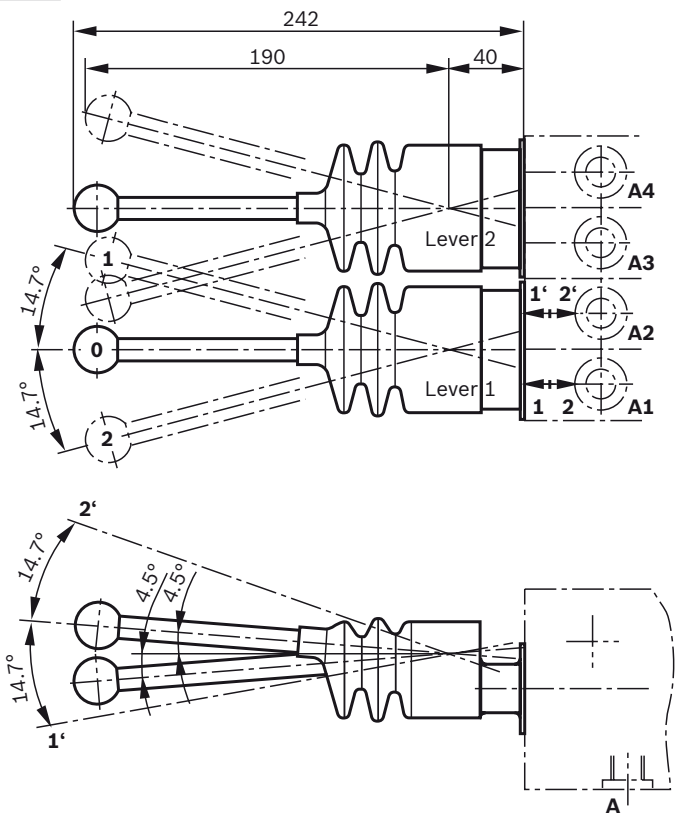
Notice

Other hand lever positions are possible.

▼ Mechanical operation, 2-axis lever

Ordering code:

R9

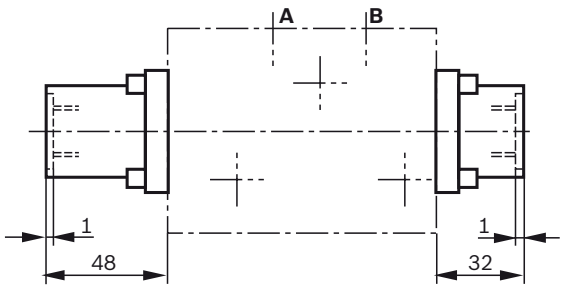


Notice
 Parallel operation of lever 1 and lever 2 is restricted in the overlap area.

▼ Hydraulic actuation

Ordering code:

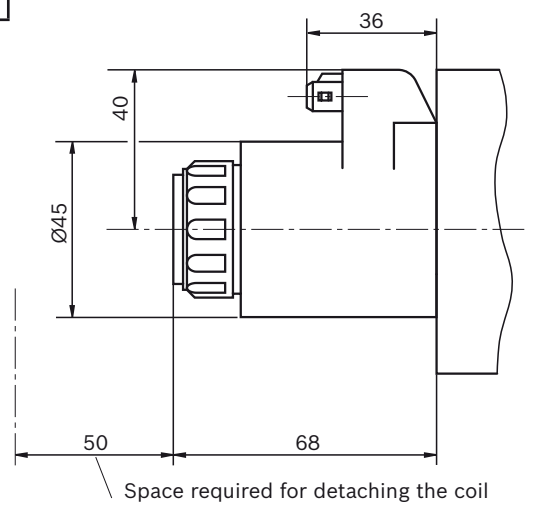
H2



▼ Electro-magnetically switchable actuation

Ordering code:

C2

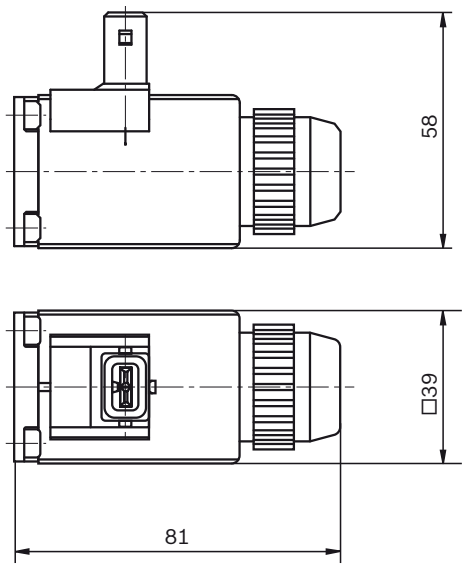


Notice
 Both terminals must be wired for of each solenoid.

▼ Electro-magnetic proportional actuation

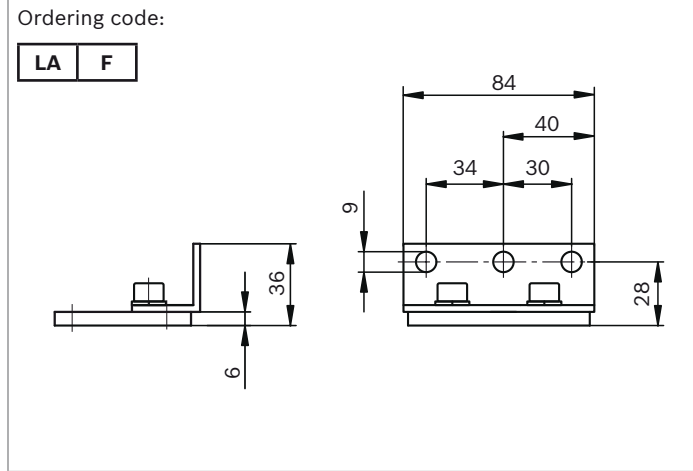
Ordering code:

P5

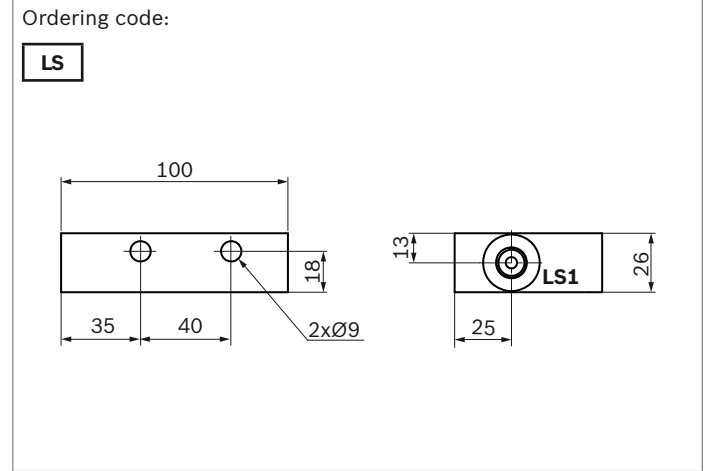


End plates

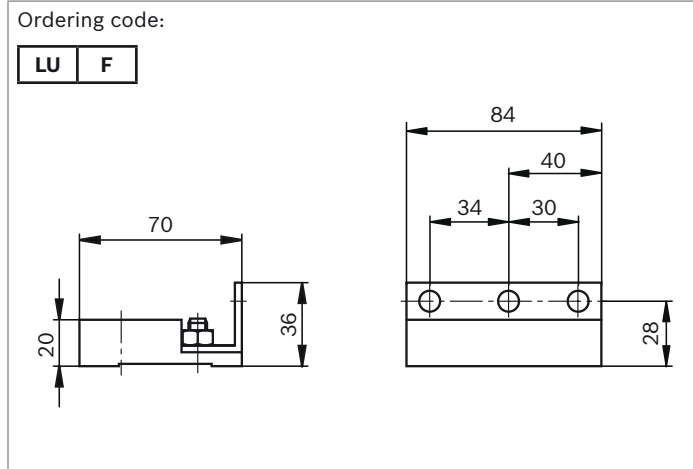
▼ **Without function, with mounting bracket**



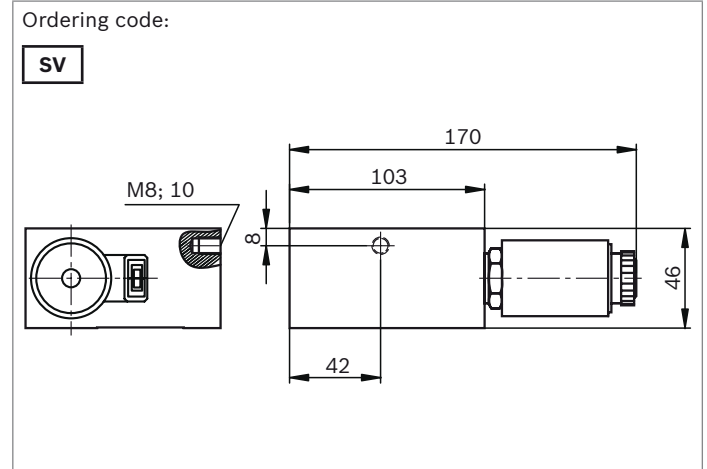
▼ **With LS connection, without mounting bracket**



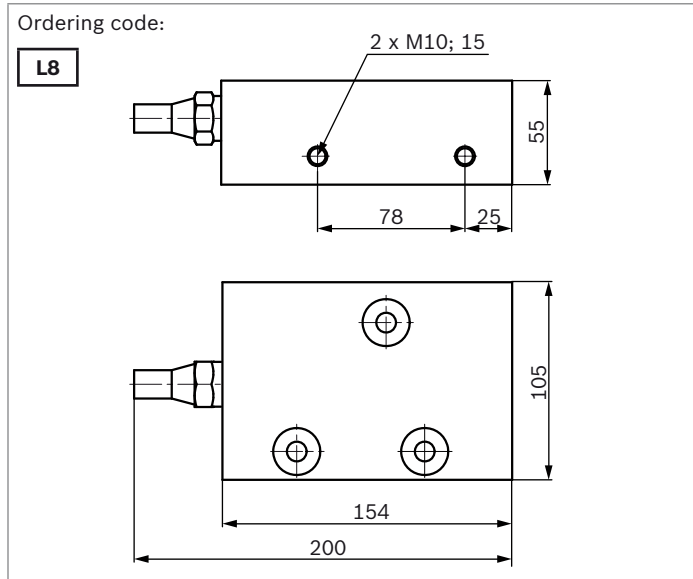
▼ **With internal tank connection, with mounting bracket**



▼ **With seat valve**

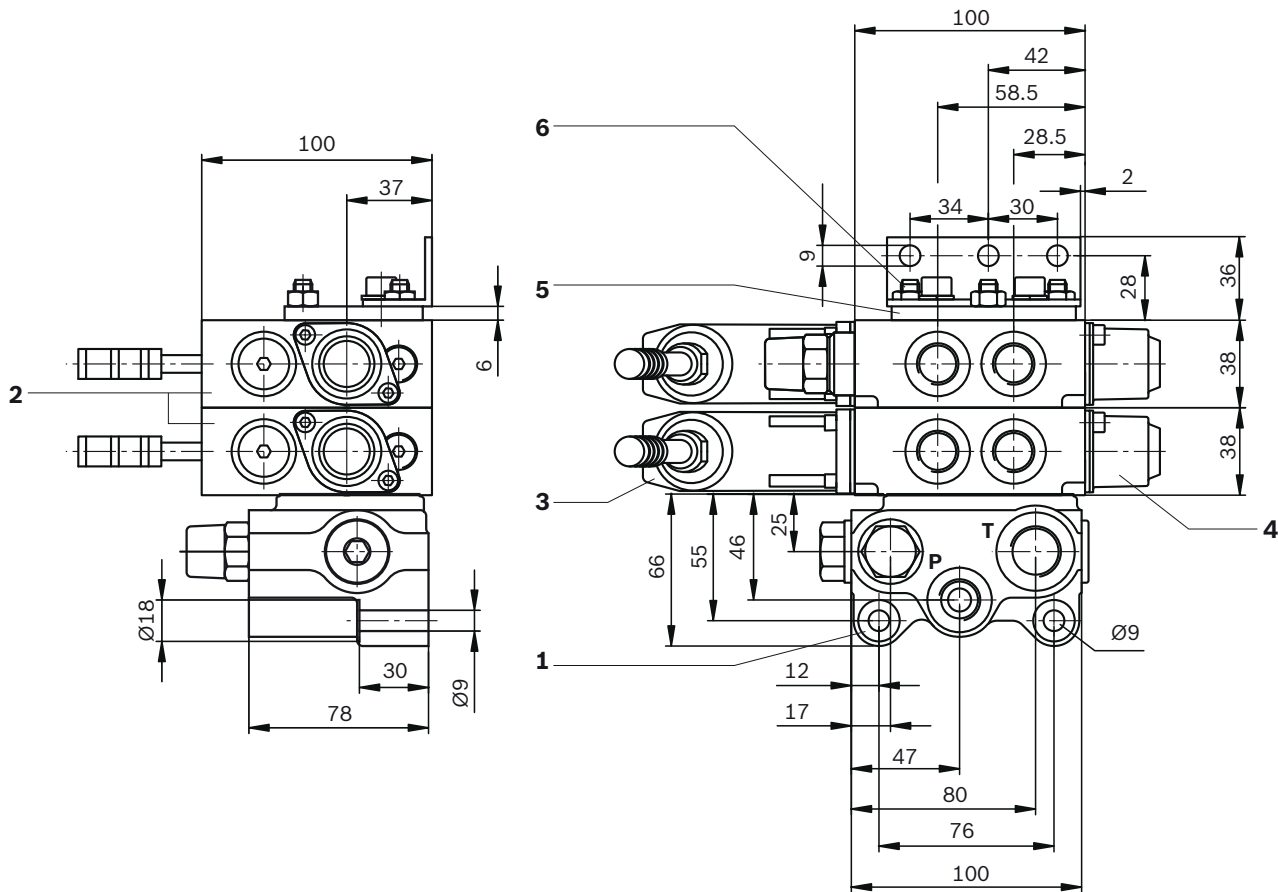


▼ **Adapter plate for M4-12 directional valves**



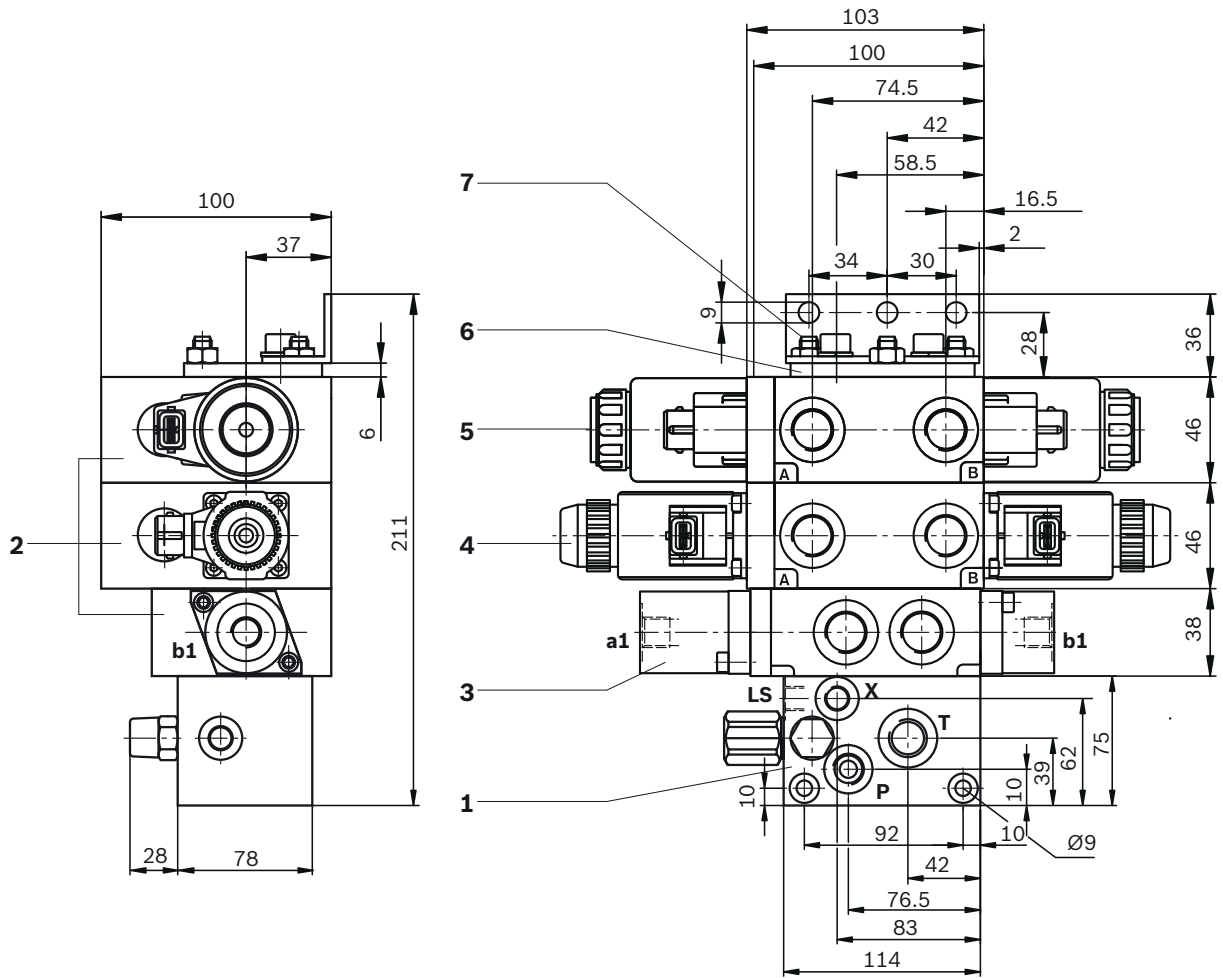
Order examples

▼ Open center control block of sandwich plate design (according to order example on page 9)



- 1 Inlet plate, version **P...** (open center)
- 2 Directional valve elements
- 3 Mechanical operation, version **R5**
- 4 Spool return by means of spring, version **A2**
- 5 End plate, version **LA F**
- 6 Tie rod

▼ Closed center control block of sandwich plate design (according to order example on page 10)



- 1 Inlet plate, version **H...** (closed center)
- 2 Directional valve elements
- 3 Hydraulic actuation, version **H2**
- 4 Electromagnetic proportional actuation, version **P5**
- 5 Electromagnetic proportional actuation, version **C2**
- 6 End plate, version **LA F**
- 7 Tie rod

Accessories

Recommended mating connector for plug-in connector, type Junior Timer 2-pole (AMP)

Mating connector for FTDRE... and FTWE... protection class IP 69K

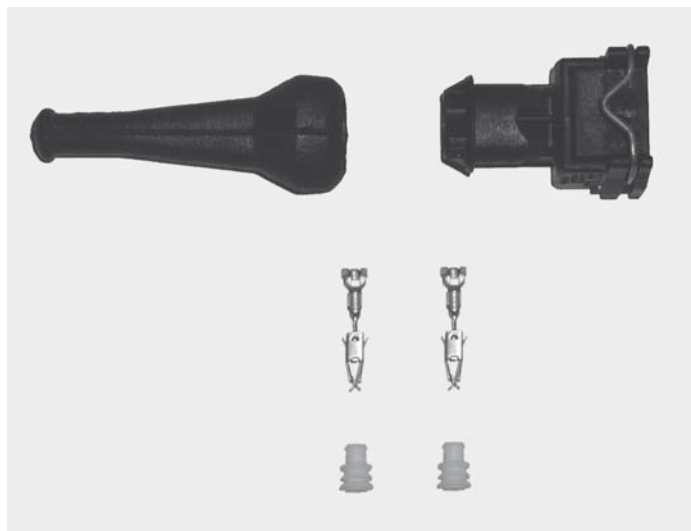
► **Material number: R900313533**

for litz wire cross-sections of 0.5 to 1 mm² and for an insulation diameter of the individual sealings of 1.2 to 2.1 mm

► **Material number: R901022127**

for litz wire cross-sections of 0.5 to 1 mm² and for an insulation diameter of the individual sealings of 2.2 to 3 mm

▼ Recommended mating connector for Junior Timer, 2-pole (AMP)



Notice

Mating connectors are not included in the scope of delivery and must be ordered separately.

Load-sensing control block in mono block/sandwich plate design M4-12



- ▶ Size 12
- ▶ Series 2X
- ▶ Nominal pressure
 - on pump side 400 bar
 - on consumer side 420 bar
- ▶ Maximum flow
 - on pump side 300 l/min
 - 130 l/min on the consumer side with pressure compensator and load holding function

Features

- ▶ Flow control independent of load pressure
 - Open center for fixed pump
 - Closed center for variable pump
- ▶ Sandwich plate design with up to 20 directional valves
- ▶ Mono block with 1 axis, expandable with max. 9 directional valves
- ▶ Type of actuation: mechanical, hydraulic, electrohydraulic (switching, proportional or with on-board electronics)
- ▶ Pressure limitation
 - Inlet plate: pilot operated pressure valves of large nominal width
 - Directional valve/consumer ports: compact shock valves with feed function
- ▶ LS pressure limitation
 - Adjustable per consumer port
 - External pressure setting per consumer port possible
 - Electro-proportional per section

Fields of application

- ▶ Truck applications
- ▶ Drilling equipment
- ▶ Forestry machinery
- ▶ High-capacity forklifts and teleforklifts
- ▶ Municipal vehicles
- ▶ Cranes
- ▶ Construction machines
- ▶ Aerial work platforms
- ▶ Heavy duty vehicles
- ▶ Marine engineering
- ▶ Mining applications
- ▶ Stationary applications

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Functional description

Control block M4-12

The directional valves are proportional valves according to the load sensing principle.

Consumer control

The main spool (2) is used to determine the flow direction and the flow level that reaches the consumer ports (A or B). Pressure reducing valves (10) control the position of the main spool (2). The size of the electric current on the pressure reducing valve determines the level of the pilot pressure in the spring chambers (9) and thereby the stroke of the main spool (P → A; P → B).

The pressure compensator (3) keeps the pressure differential on the main spool (2) and thereby the flow to the consumers constant.

Load pressure compensation

The pressure compensator (3) regulates pressure changes on the consumers or on the pump. The flow to the consumers remains constant, including with varying loads.

Flow limitation

The maximum flow can be individually set mechanically at the factory according to the ordering code using the stroke limitations (7).

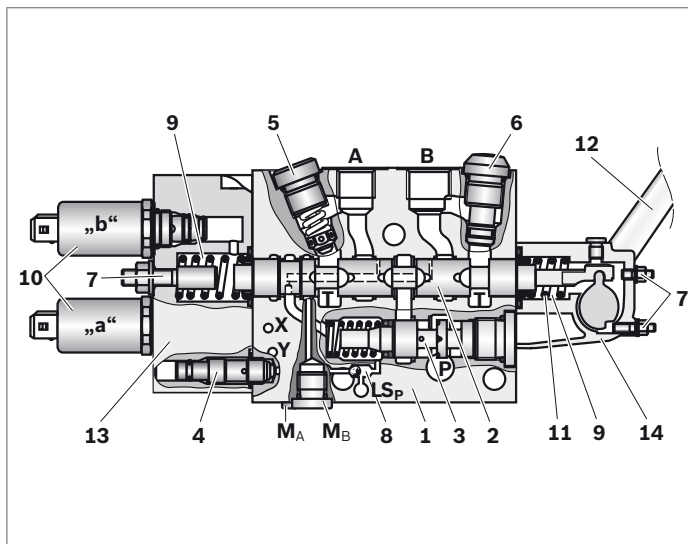
Pressure limitation

The LS pressure for each consumer port can optionally be overridden internally via the LS pressure relief valves (4), electro-proportionally for each spool axis or externally via the LS ports M_A, M_B.

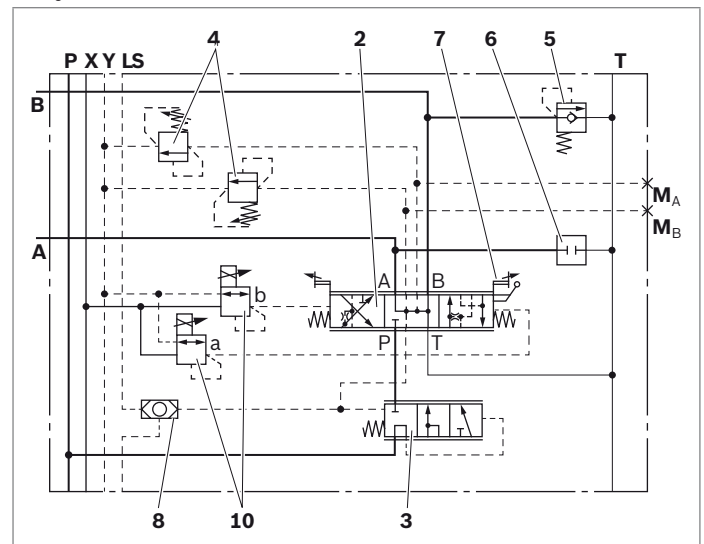
Shock valves with large nominal widths with combined feed function (5) protect consumer ports A and B against pressure peaks.

The highest load pressure on the pump is reported via the LS line and the integrated shuttle valve (8).

▼ Section M4-12



▼ Symbol M4-12



- | | |
|----------------------------|----------------------------------|
| 1 Housing | 5 Shock valve with feed function |
| 2 Main spool | 6 Threaded plug |
| 3 Pressure compensator | 7 Stroke limiter |
| 4 LS pressure relief valve | |

- | | |
|----------------------------|-------------------|
| 8 LS shuttle valve | 12 Hand lever |
| 9 Spring chamber | 13 Cover A side |
| 10 Pressure reducing valve | 14 Control B side |
| 11 Compression spring | |

Technical Data

General								
Weight	Inlet plate	kg	P	SP	J	SJ	JK	
			6	11.4	4.3	11	8.4	11
	Mono block	kg	PM	JM				
			5.6	3.8				
	Directional valve	kg	M	H	W	CBA		
			4.9	4.2	4.5	4.8		
Hand lever surplus weight	kg	0.6						
End plate	kg	LA	LAPT	LA...	LA... ..	LZ	LZPT	
		3	4.3	3.8	3.8	2.8	4.4	
	kg	LU	LU...	L8	TI			
		3.5	4	4.5	6.3			
Installation position		Ideally horizontal to the spool axis. For versions with spool position sensor, horizontal to the spool axis or vertical, with the sensor cable on the bottom.						
Consumer line connections		Pipe thread as per ISO 228/1 (inches), ISO 11926-1 (UNF) or JIS B 2351-1 (on request)						
Ambient temperature range	θ	°C	-20 to 80 (-40° to +100°C on request)					
Priming (standard)		One-coat paint RAL 5010 (more on request)						
Surface protection according to DIN EN 60068-2-11	Standard priming	h	96					
	Special painting	h	480					
	Painting for SO-038	h	1000					
Mechanical								
Actuating force on the hand lever (encapsulated)	Mechanically operated	N	< 20					
	Mechanical override (with parallel hydraulic actuation)	N	< 70					
	Mechanical override (with parallel electrohydraulic actuation)	N	< 50					
Actuating force in spool axis (not encapsulated)	Tongue	N	< 250					
	Detent with tongue	N	< 350					
Hydraulic								
Maximum working pressure at port	P	p_{max}	bar	400 (420 on request)				
	A, B	p_{max}	bar	420				
	LS	p_{max}	bar	350				
	T	p_{max}	bar	30 (20 with mechanical actuation only)				
	Y	p_{max}	bar	Must be routed to reservoir without pressure				
Maximum pilot pressure at port	a, b	p_{St}	bar	35				
	X	p_{St}	bar	35				
Pilot pressure range	Hydraulic	p_{St}	bar	8.5 to 22.5				
	Electrohydraulic	p_{St}	bar	6.5 to 17.2				
Required differential pressure control on the control block	Version S, C	p	bar	18				
Recommended hydraulic pilot controls		TH6 control curve 97, see data sheet 64552 or 64555						

Hydraulic									
Required pump controller		Controller without LS connection to reservoir, e.g., DFR1, DRS							
Maximum primary pressure limitation	p	bar	370 (set at the factory according to ordering code), min. 20 bar above the pressure cut-off value of the pump						
LS pressure limitation	p	bar	50 to 350 (set at the factory according to ordering code) The highest reduce response pressure of the valve block LS pressure relief valves set at the factory must be at least 20 bar lower than the pressure cut-off value of the pump.						
Maximum flow	Inlet plate	Port P	q_{Vmax}	l/min	P	P ... P100	SP	J	SJ
			150		100	120	150	150	
	Directional valve	Port A, B	q_{Vmax}	l/min	JZ	JK	PM	JM	
			200		300	130	150		
	End plate	Port P	q_{Vmax}	l/min	LAPT LZPT				
			100		100				
Hydraulic fluid		Mineral oil (HL, HLP) according to DIN 51524, HEES (synthetic ester) according to ISO 15380 and other hydraulic fluids on request							
Hydraulic fluid temperature range	θ	°C	-20 to 80 -40 to 100 on request						
Viscosity range	ν	mm ² /s	10 to 380						
Maximum admissible degree of contamination of the hydraulic fluid Cleanliness level as per ISO 4406 (c)		Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$							

Electric				
Electrical pilot control valve		FTWE2K...; see data sheet 58007 ¹⁾ FTDRE2K...; see data sheet 58032 ¹⁾		
Recommended amplifier (other actuating options on request)		RA 1-0/10; 1 axis, see data sheet 95230 RA 2-1/10; 4 to 6 axes, see data sheet 95230 RC control units, see data sheet 95200		
Connector version	1 and 3	Junior Timer, 2-pin (AMP)		
	8 and 9	DT04-2P (Deutsch)		
Protection rating as per VDE 0470-1 (DIN EN 60529), DIN 40050-9	Connector version 1 and 3	IP66, IP67 and IP69K (with Rexroth plug-in connector) ¹⁾		
	Connector version 8 and 9	IP66, IP 67 and IP 69K (with installed and locked plug-in connector) ¹⁾		
On-board electronics (EPM2)		Data from page 49; see also instruction manual 64815-B		
Spool position sensor		See data sheet 95190		

Notice

- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{sec}$ (HLP46: 50 °C).

¹⁾ Plug-in connectors are not included and must be ordered separately, see page 52.

Modular system

Control blocks in the M4-12 series have a modular structure. They can be combined to provide the perfect solution for the application at hand.

Control block with lateral inlet plate

1. Inlet plate

- A: Closed center with spool position sensor **SJ**
- B: Mono block **JM**, combined with 1 spool axis
- C: Open center **P**
- D: Closed center **J**

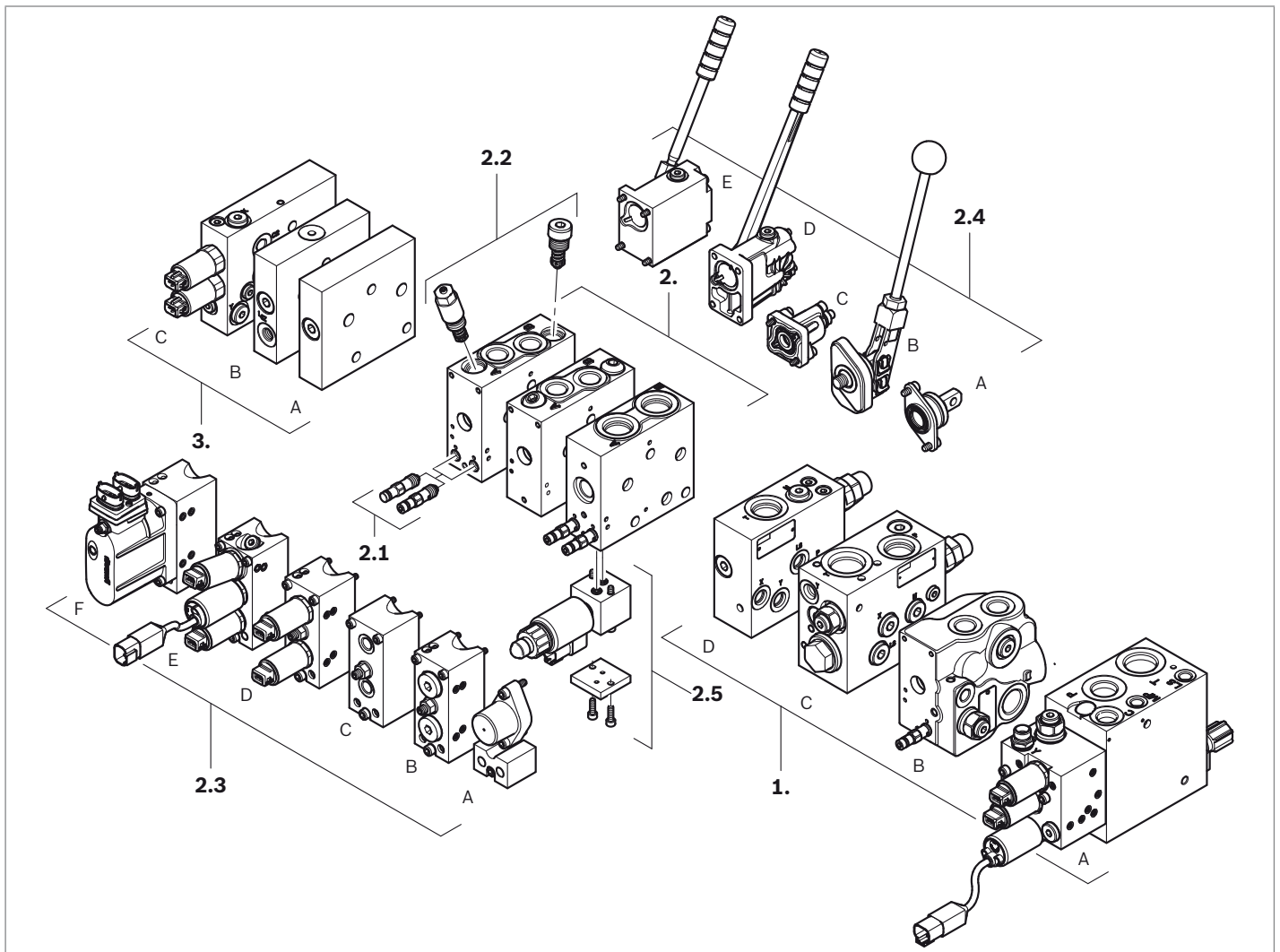
2. Directional valves

- 2.1 LS pressure limitation
- 2.2 Secondary pressure limitation
- 2.3 Actuation A side
 - A: Mechanical actuation **A**
 - B: Mechanical actuation **M**
 - C: Hydraulic actuation **H**

- D: Electrohydraulic actuation **W**
 - E: Electrohydraulic actuation **W** with spool position sensor
 - F: Electrohydraulic actuation with on-board electronics EPM2 **CBA**
- 2.4 Actuation B side
 - A: Mechanical actuation **Z** with tongue
 - B: Mechanical actuation **N** with hand lever
 - C: Standard cover -
 - D: Mechanical actuation **K** with hand lever
 - E: Mechanical actuation **B2** with guide and hand lever (aluminum-free)
 - 2.5 Electro-proportional LS pressure limitation

3. End plate

- A: With LS unloading **LA**
- B: With LS port **LZ**
- C: With two installation bores **LAW...W...**



Control block with central inlet plate

1. Central inlet plate JZ

2. Directional valves

2.1 LS pressure limitation

2.2 Secondary pressure limitation

2.3 Actuation A side

A: Mechanical actuation **A**

B: Mechanical actuation **M**

C: Hydraulic actuation **H**

D: Electrohydraulic actuation **W**

E: Electrohydraulic actuation **W** with spool position sensor

F: Electrohydraulic actuation with on-board electronics EPM2 **CBA**

2.4 Actuation B side

A: Mechanical actuation **Z** with tongue

B: Mechanical actuation **N** with hand lever

C: Standard cover –

D: Mechanical actuation **K** with hand lever

E: Mechanical actuation **B2** with guide and hand lever (aluminum-free)

2.5 Electro-proportional LS pressure limitation

3. End plate

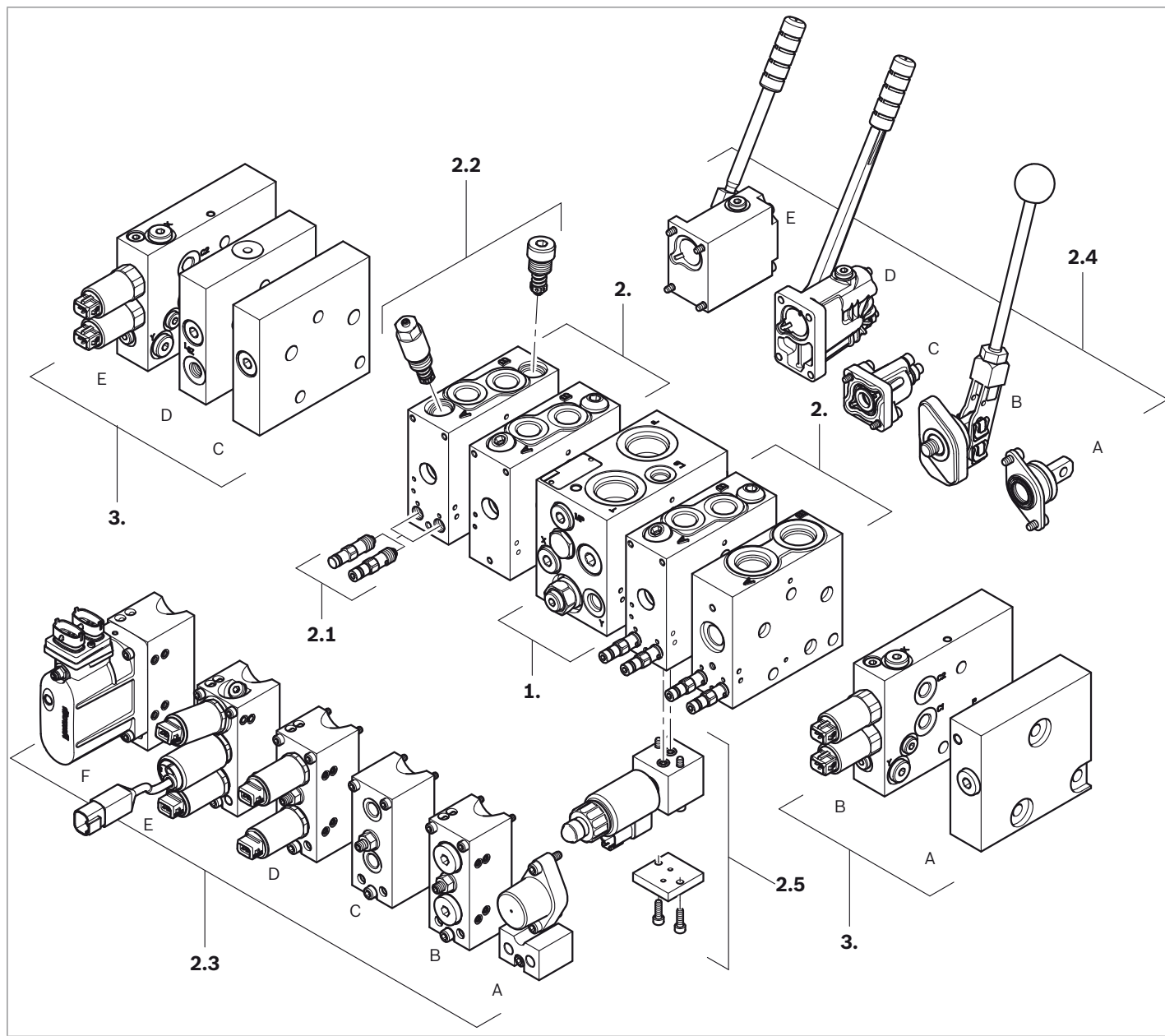
A: Diversion plate **LU**

B: With two installation bores **LUW...W...**

C: With LS unloading **LA**

D: With LS port **LZ**

E: With two installation bores **LAW...W...**



Mono block

1. Mono block PM, JM

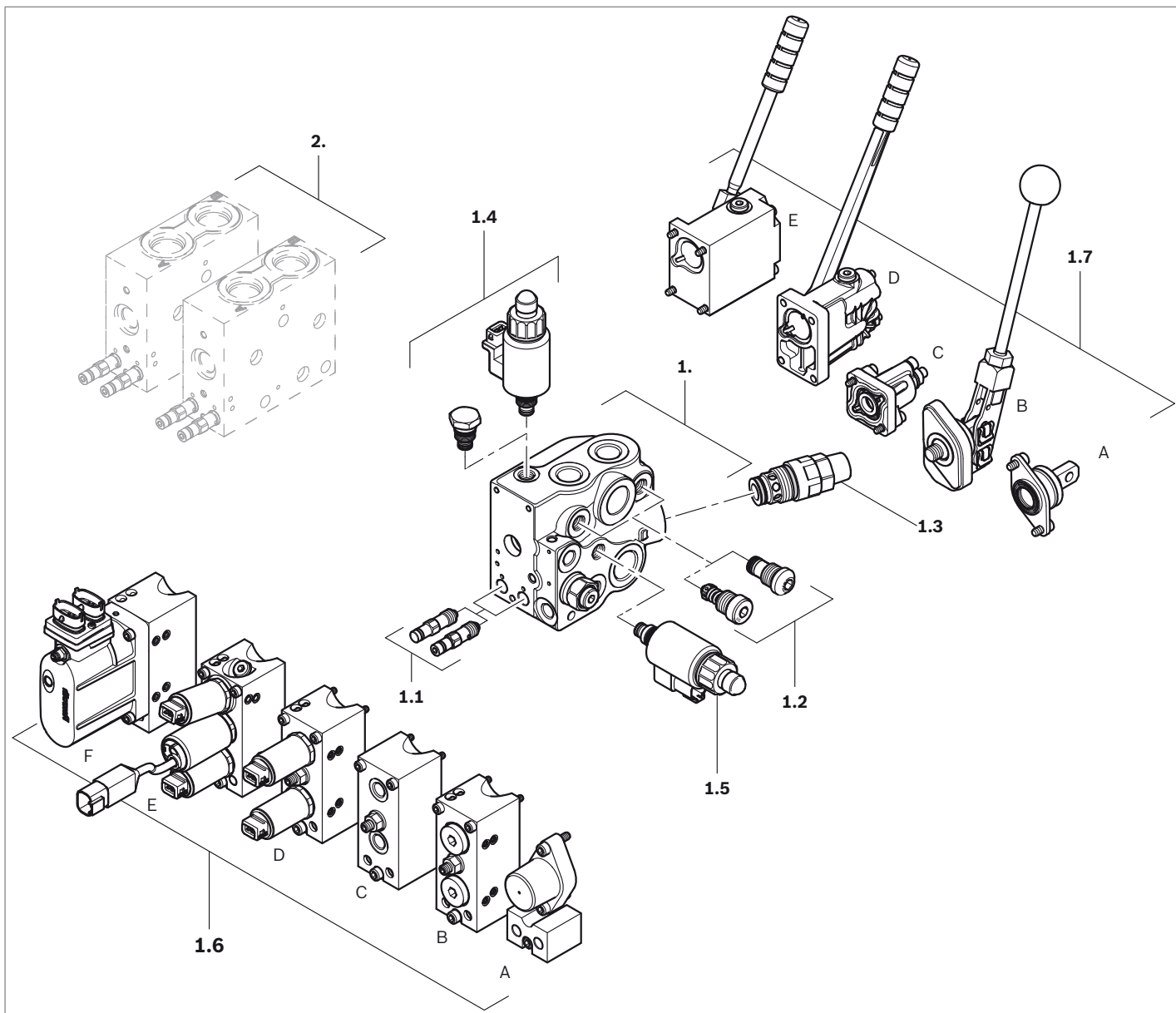
(combined inlet, 1 spool axis and end plate)

- 11 LS pressure limitation
- 1.2 Secondary pressure limitation
- 1.3 Primary pressure limitation
- 1.4 Electro-proportional LS pressure limitation
- 1.5 LS switch-off
- 1.6 Actuation A side
 - A: Mechanical actuation **A**
 - B: Mechanical actuation **M**
 - C: Hydraulic actuation **H**
 - D: Electrohydraulic actuation **W**

- E: Electrohydraulic actuation **W** with spool position sensor
- F: Electrohydraulic actuation with on-board electronics EPM2 **CBA**

- 1.7 Actuation B side
 - A: Mechanical actuation **Z** with tongue
 - B: Mechanical actuation **N** with hand lever
 - C: Standard cover -
 - D: Mechanical actuation **K** with hand lever
 - E: Mechanical actuation **B2** with guide and hand lever (aluminum-free)

2. Flange-mountable directional valves



Ordering code

Specifications on the name plate

The ordering code is used to record the technical features and requirements.

The Rexroth sales organization uses the ordering code to derive a short type and a material number.

The complete control block is defined as per the type code according to DCCS 46001-10.

Example: M4-12 control block with three directional valves

01	02	03	04	05	06	07	08	09	10	11	12			
M4	-	G12345	-	2	0	/	3	M4-12	J	W21	-	V_	01	-450

01	Series: M4 load-sensing control block
02	6-digit control block number
03	Series 2X (unchanged installation and connection dimensions)
04	Series amendment status
05	Total number of spool axes (1 to 20) ¹⁾
06	Size, directional valve
07	Inlet plate
08	Actuation A side (mostly)
09	Actuation B side (mostly)
10	Sealing material
11	Line connections
12	Optional: Special designation

¹⁾ A maximum of 10 directional valves per side is possible. Always indicate "9" for 10 or more directional valves.

Ordering code sequence

M4-12-2X / **Inlet plate**

Directional valves

End plate, additional information

Inlet plate

M4-12-2X /

Design, system

01	Open center	Lateral inlet plate	P
	Closed center	Lateral inlet plate	J
		Lateral inlet plate with integrated switch-over axis	SJ
		Central inlet plate	JZ
		Central inlet plate for combination M4-12/M4-15	JK
	Mono block	Open center (installation of further directional valves is not possible)	PM
Closed center (installation of further directional valves is possible; available only in variants ...M...)		JM	

Primary pressure limitation

02	Without primary pressure relief valve (cannot be retrofitted, only for inlet JZ)	Z
	Without primary pressure relief valve (can be retrofitted, not possible with open center inlet P)	Q
	With primary pressure relief valve (specified pressure in bar, 3-digit, not possible with open center mono block PM)	...

Pilot oil supply

03	With internal pilot oil supply	Y
	For external pilot oil supply	X

Option 1

04	With LS switch-off (only in conjunction with inlet J, P)		A	
	With LS damping nozzles, specification of the nozzle diameter in mm (only in conjunction with inlet P)	LS to pressure compensator d = 0.6	Pressure compensator to LS d = 0.6	S0.6-0.6
		d = 0.6	d = 1.2	S0.6-1.2
		d = 0.4	d = 1.2	S0.4-1.2
		Without LS damping nozzles (can be retrofitted, only in conjunction with inlet P)		N
	With spool position sensor (only in conjunction with inlet SJ)		S	
Without spool position sensor (only in conjunction with inlet SJ)		B		

Option 1 - specification is only required for inlet SJ

05	External flow at port C	8 l/min	Q008
		26 l/min	Q026
		40 l/min	Q040
		90 l/min	Q090
		150 l/min	Q150

Option 2

06	With unloading function, max. flow on the pump side 100 l/min (only in conjunction with inlet P)	P100
----	--	-------------

= Preferred program

Directional valves

M4-12-2X /	01	02	03	04	05	06	07	08	09	10	11	12	13
													*
	Spool axis 1												
Spool axis 2													
													*
Spool axis 3, etc.													

Pressure compensator

01	With pressure compensator, with load holding function	S
	Without pressure compensator, with load holding function (not in conjunction with PM)	C
	Without pressure compensator, without load holding function	Q
	With sensitive pressure compensator, with load holding function	F
	With 3-way pressure compensator (in conjunction with PM only)	D
	Without pressure compensator bore for switch-over axis	Z

LS pressure limitation and housing variant¹⁾

		02	03	04
02	Without LS pressure relief valve (LS-PRV cannot be retrofitted; only Z or U are possible)	Z		Z
04	With threaded plug (Z not possible)	Q		Q
	With LS pressure relief valve (specified pressure in bar, 3-digit; Z not possible)	...		...
	With 1 LS pressure relief valve for same pressure setting in A and B (specified pressure in bar, 3-digit)	=		...
	LS relief plug	B		B
	03	Housing with measuring ports		M
	Housing without measuring ports		Z	
	Housing for switch-over axis (only combination ZU possible) ²⁾		U	
	Housing for electro-proportional pressure limitation or switchable directional valves ³⁾		K	
	– 210 bar, decreasing characteristic curve ³⁾		L	
	– 210 bar, increasing characteristic curve ³⁾		J	
	– 350 bar, decreasing characteristic curve ³⁾		R	
	– 350 bar, increasing characteristic curve ³⁾		N	
	Housing for hydraulic pressure control, with LS and PST outlet ³⁾		C	

Spool type⁴⁾

05	Main spool E	E
	Main spool J	J
	Main spool Q	Q
	Main spool with regeneration function	R
	Plunger cylinder as a consumer ²⁾	P
	Floating position spool ²⁾	W
	Floating position spool ²⁾	Y

Flow

06	Flow in consumer port A and B (parameter in l/min, 3-digit)	...-...
	Main spool with pressure function T (only in conjunction with E , J or Q) ²⁾	...T...
	Main spool with pressure function T (only in conjunction with E) ²⁾	...M...

- 1) For possible housing/secondary valve combinations, see page 33
- 2) Please consult our technical sales department
- 3) Exact specifications in plain text, see information from page 24
- 4) For symbols, see “Main spool” on page 26

= Preferred program

...-... = Preferred program

Actuation A side

07	Mechanical only	Spring-centered	A
		With detent in 1	B1
		With detent in 2	B2
		With detent in 1, 2	B4
	Mechanical ⁵⁾	Encapsulated, spring-centered	M
	Hydraulic ⁶⁾		H
	Electrohydraulically proportional	Standard	W2
		With measuring ports, on both sides	W8
		With damping nozzle + check valve for hydraulic superposition	G2
	Electrohydraulically switchable	Standard	W4
		With damping nozzles, on both sides	W5
		With measuring ports, on both sides	W6
		With damping nozzle, with measuring ports, on both sides	W7
Electrohydraulic actuation with on-board electronics (EPM2)	Standard	CBA	
	With position sensor	CPA	

Supply voltage and connector version⁷⁾

08	Junior Timer, 2-pin (AMP)	24 V	12 V
	DT04-2P (Deutsch)	1	3
		8	9

Actuation B side

09	Mechanical only, spool end with tongue		Z	
	Mechanical only, spool end with tongue and hand lever ²⁾		N	
	Standard cover		-	
	Cover with hand lever ⁸⁾		Revolving	Not revolving
		Without hand lever	R	X
		Hand lever position 60°	K	N
		Hand lever position 0°	L	O
Hand lever position -60°	M	P		

Secondary valves for consumer ports A and B¹⁾

10	None ⁹⁾	Flange surface ²⁾	F
11		Consumer port G 3/4	Z
		Consumer port G 1/2	X
		With threaded plug (secondary valves can be retrofitted)	Q
		With	Shock/feed valve, adjustable	A...
		Shock/feed valve, non-adjustable	H...

Optional special designation

12	One-sided actuation, two switching positions	-011
	With spool position sensor	-S
13	Further specifications in plain text	*

5) Always in conjunction with revolving hand lever

6) For combination with mechanically superposed actuation (B side), Bosch Rexroth recommends a non-revolving hand lever

7) Parameter only required with electrohydraulic actuation and with electro-proportional pressure limitation

8) For more details and explanations, see "Variant overview" on page 30

9) Secondary valves must be present in the hydraulic circuit

	= Preferred program
--	---------------------

End plate, additional information

M4-12-2X /	01	02	03	04	05	06
						*

End plate

01	With LS unloading	LA					
	With additional P and T port	LAPT					
	With two installation bores	LA					
	Threaded plug		Q	Q			
	Electrohydraulically proportional		W2	W2			
	Electrohydraulically switchable		W4	W4			
	With three installation bores	LA					
	Threaded plug		Q	Q	Q	Q	Q
	Pressure reducing valve (specified pressure in bar, 3-digit)		...		...		...
	4/2-way spool valve according to data sheet 18136-09 (specifications in plain text)			KKDER...		KKDER...	
	Without LS unloading	LZ					
	With additional P and T port	LZPT					
	Mono block, no end plate	LM					
	Adapter plate for SP-08 directional valves + inlet pressure limitation (specified pressure in bar, 3-digit)	L8					
	Adapter plate for ED1 and ED2 valves ¹⁾	TI					
	Diversion plate for use with central inlet plate	LU					
	With two installation bores	LU					
	Threaded plug		Q	Q			
	Electrohydraulically proportional		W2	W2			
	Electrohydraulically switchable		W4	W4			

Sealing material

02	FKM (fluoroelastomer)	V_
	NBR (nitrile rubber), FKM (fluoroelastomer)	MV
	NBR (nitrile rubber), FKM (fluoroelastomer) for low temperature range down to -40 °C (on request)	MT

Pipe thread line connections

03	Inches according to ISO 228/1 ²⁾	01
	UNF according to ISO 11926/-1 ³⁾	19
	JIS B 2351-1 (on request)	64

Supply voltage and connector version⁴⁾

04	Junior Timer, 2-pin (AMP)	24 V	12 V
	DT04-2P (Deutsch)	1	3
		8	9

Optional special designation

05	Increased corrosion protection (seawater-resistant) ¹⁾	-038
	Aluminum-free	-450
	For safety-related applications	-S

06	Further specifications in plain text	*
----	--------------------------------------	----------

- 1) Please consult out technical sales department
- 2) See "Line connections" on page 36.
- 3) For UNF thread, see data sheet 64272.
- 4) Parameter only required with electrohydraulic actuation and with electro-proportional pressure limitation

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Order examples

Closed center with mono block and switch-over axis

Example:

- Three-fold control block with 3 directional valves
- Variable pump $q_{V, \max} = 150$ l/min via inlet + 100 l/min via end plate is possible

Inlet, combined with spool axis 1

- Closed center, mono block
- Without primary pressure relief valve
- With internal pilot oil supply

- With pressure compensator, with load holding function
- With LS pressure relief valve for consumer port A 180 bar, consumer port B plugged
- Spool symbol Z
- Flow in A and B 100 l/min
- Type of actuation: electrohydraulically proportional
- With Junior Timer, 2-pin (AMP) 24 V
- Secondary valves: Pressure/feed valve, consumer port A and B 350 bar (not adjustable)

Spool axis 2

- Without pressure compensator, switch-over axis
- Without LS pressure relief valve bore
- Housing for switch-over axis
- Spool symbol J
- Flow in C 65 l/min, 90 l/min for internal consumers
- Type of actuation: electrohydraulic switchable
- With Junior Timer, 2-pin (AMP) 24 V
- Without secondary valve (cannot be retrofitted)

Spool axis 3

- With pressure compensator, with load holding function
- Without LS pressure relief valve bore
- Spool symbol Z
- Flow in A and B 85 l/min
- Type of actuation: digital OBE
- Overriding hand lever (revolving)
- Without secondary valve (cannot be retrofitted)

End plate, additional information

- Without internal LS unloading, with LS port, with P and T port
- FKM seals
- Pipe thread connections

Ordering codes:

Short type, inlet

						01	02	03			
3	M4	-	12	-	2X	/	JM	Z	Y		

Spool axis 1

01	02	03	04	05	06	07	08	09	10	11				
S	180	M	Q	J	100-100	W2	1	-	H350	H350				

Spool axis 2

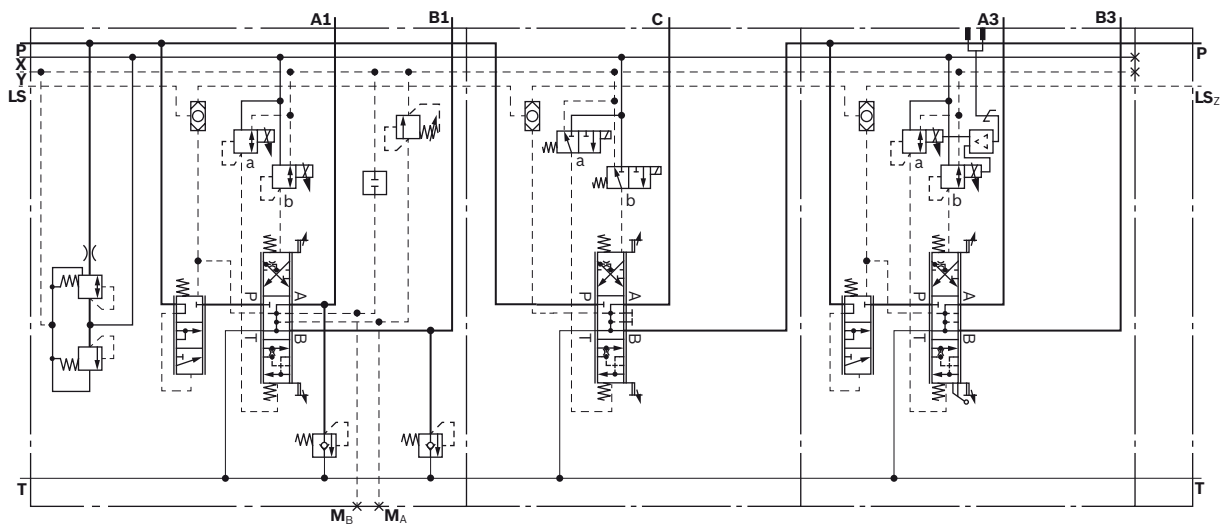
01	02	03	04	05	06	07	08	09	10	11				
Z	Z	U	Z	J	065-090	W4	1	-	Z	Z				

Spool axis 3

01	02	03	04	05	06	07	09	10	11					
S	Z	Z	Z	J	085-085	CBA	K	Z	Z					

End plate, additional information

01	02	03												
LZPT	V	01												



Open center with lateral inlet plate

- Example:**
- Three-fold control block with 3 directional valves
 - Fixed pump $q_{V, \max} = 150$ l/min

- Inlet**
- Open center, lateral
 - With primary pressure relief valve, set to 300 bar
 - With internal pilot oil supply

- Spool axis 1**
- Without pressure compensator, with load holding function
 - With LS pressure relief valve for consumer port A 250 bar and LS relief plug in B
 - Spool symbol E
 - Flow in A 50 l/min, port B plugged
 - Type of actuation: mechanical, spring-centered, not encapsulated, with tongue
 - Secondary valve: adjustable shock/feed valve for actuator port A 230 bar, secondary valve bore B plugged

- Spool axis 2**
- Without pressure compensator, without load holding function
 - With 1 LS pressure relief valve for consumer ports A and B 275 bar
 - Spool symbol E
 - Flow in A and B 100 l/min
 - Type of actuation: hydraulic
 - Secondary valve: non-adjustable shock/feed valve for actuator port A 100 bar, adjustable shock/feed valve for consumer port B 230 bar

- Spool axis 3**
- With pressure compensator, with load holding function
 - Without LS pressure relief valve bore
 - Spool symbol J
 - Flow in A and B 70 l/min
 - Type of actuation: electrohydraulically switchable, with damping nozzle, with measuring ports
 - With DT04-2P connector (Deutsch) 24 V
 - Hand lever cover, not revolving, without hand lever
 - Without secondary valve (cannot be retrofitted)

- End plate, additional information**
- With internal LS unloading
 - FKM seals
 - Pipe thread connections

Ordering codes:

Short type, inlet

							01	02	03
3	M4	-	12	-	2X	/	P	300	Y

Spool axis 1

C	250	M	B	E	050-000	A	Z	A230	Q	

Spool axis 2

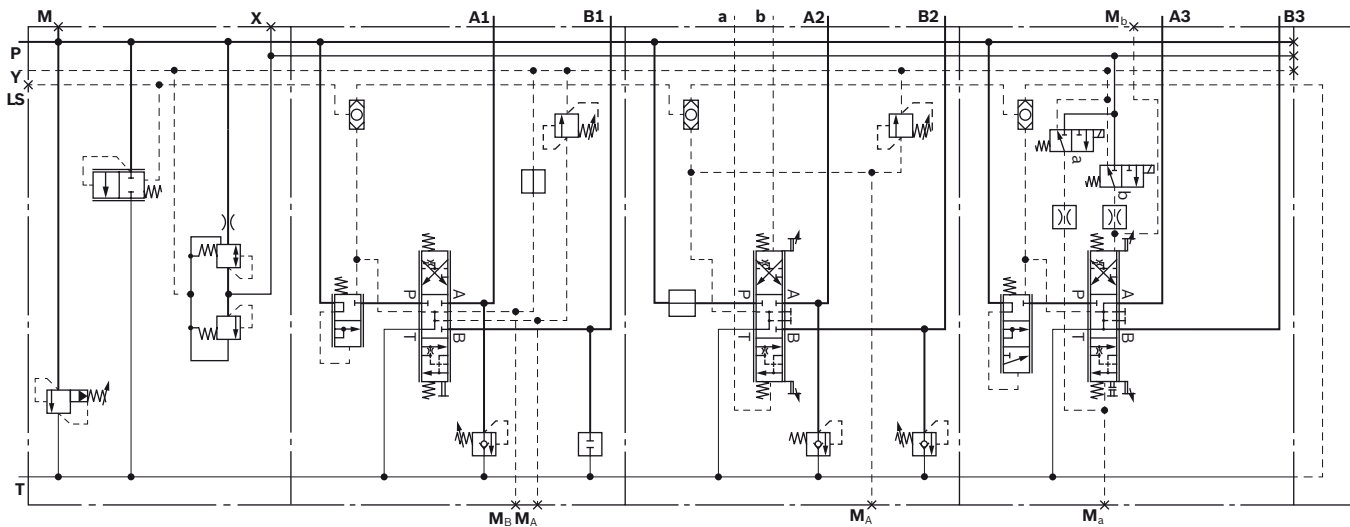
Q	=	M	275	E	100-100	H	-	H100	A230	

Spool axis 3

S	Z	Z	Z	J	070-070	W7	8	X	Z	Z

End plate, additional information

LA	V	01



Closed center with central inlet plate

Example: – Two-fold control block with 2 directional valves
 – Variable pump $q_{V, max} = 200$ l/min

Short type, diversion plate – Diversion plate

Spool axis 1 – With pressure compensator, with load holding function
 – Without LS pressure relief valve bore
 – Spool symbol E
 – Flow in A and B 100 l/min
 – Type of actuation: electrohydraulically proportional with measuring ports on both sides
 – With Junior Timer, 2-pin (AMP) 24 V
 – Overriding hand lever (revolving)
 – Secondary valve bores plugged

Inlet – Closed center, central
 – With primary pressure relief valve, set to 300 bar
 – With internal pilot oil supply

Spool axis 2 – With pressure compensator, with load holding function
 – With LS pressure relief valve for consumer port A 270 bar, consumer port B 300 bar
 – With electro-proportional Pressure limitation, 210 bar (decreasing characteristic curve)
 – Spool symbol E
 – Flow in A and B 90 l/min
 – Type of actuation: digital OBE
 – Overriding hand lever (revolving)
 – Secondary valve bores plugged

End plate, additional information – With internal LS unloading
 – FKM seals
 – Pipe thread connections

Ordering codes:

Short type, diversion plate

01											
2	M4	-	12	-	2X	/	LU				

Spool axis 1

01	02	03	04	05	06	07	08	09	10	11
S	Z	Z	Z	E	100-100	W6	1	K	Q	Q

Inlet

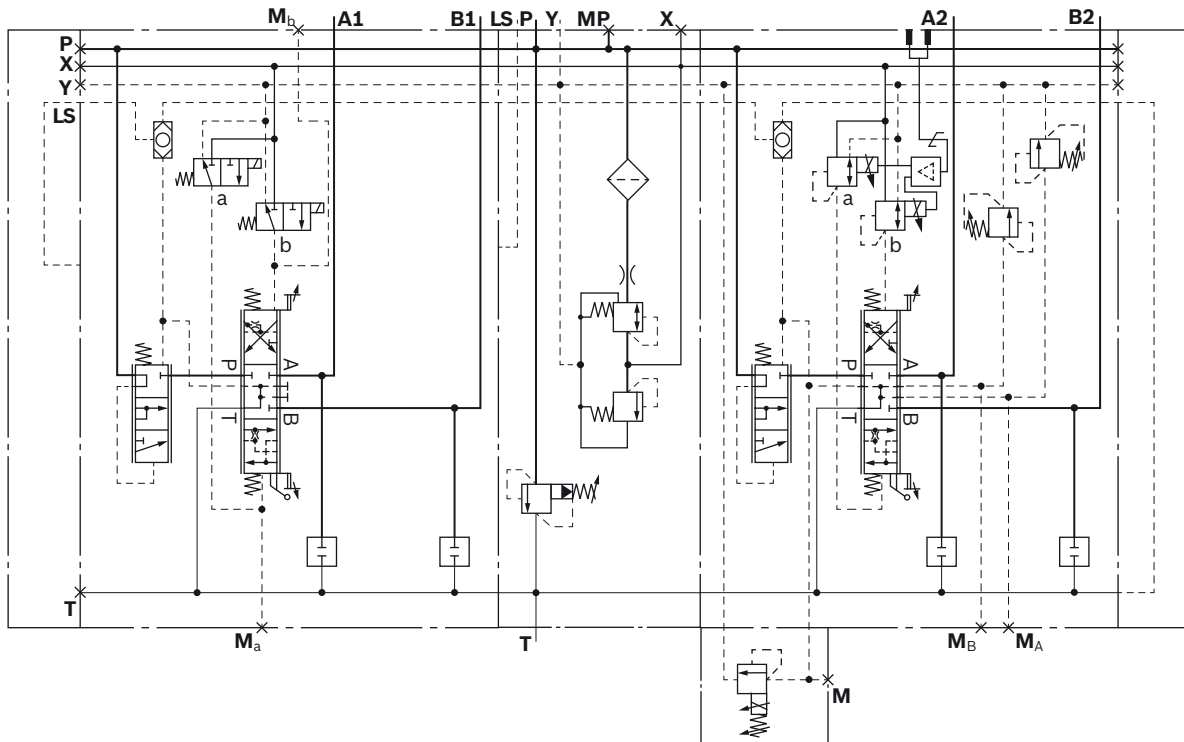
01	02	03
JZ	300	Y

Spool axis 2

01	02	03	04	05	06	07	09	10	11	13
S	270	L	300	E	090-090	CBA	K	Q	Q	KBPSL8BA

End plate, additional information

01	02	03
LA	V	01



Closed center with combination inlet plate for M4-12 and M4-15 directional valves

Example: - Three-fold control block with 3 directional valves
 - Variable pump $q_{V, max} = 200$ l/min

Short type, diversion plate - Diversion plate

M4-15 spool axis 1 - With pressure compensator, without load holding function
 - With LS pressure relief valve for consumer port A 230 bar and LS relief plug in B
 - Spool symbol E
 - Flow in A 190 l/min, port B plugged
 - Type of actuation: digital OBE
 - Overriding hand lever (revolving)
 - Secondary valve bores plugged

Inlet - Central closed center for M4-12/M4-15
 - With primary pressure relief valve, set to 280 bar
 - With internal pilot oil supply

M4-12 spool axis 2 and 3 - With pressure compensator, with load holding function
 - With LS pressure relief valve for consumer port A 180 bar, consumer port B 120 bar
 - Spool symbol E
 - Flow in A and B 90 l/min
 - Type of actuation: digital OBE
 - Without secondary valve bores

End plate, additional information - With internal LS unloading
 - FKM seals
 - Pipe thread connections

Ordering codes:

Short type, diversion plate

							01
3	M4	-	15	-	2X	/	LU

Spool axis 1

01	02	03	04	05	06	07	09	10	11
T	230	M	B	E	190-000	CBA	K	Q	Q

Inlet

01	02	03
JK	280	Y

Spool axis 2

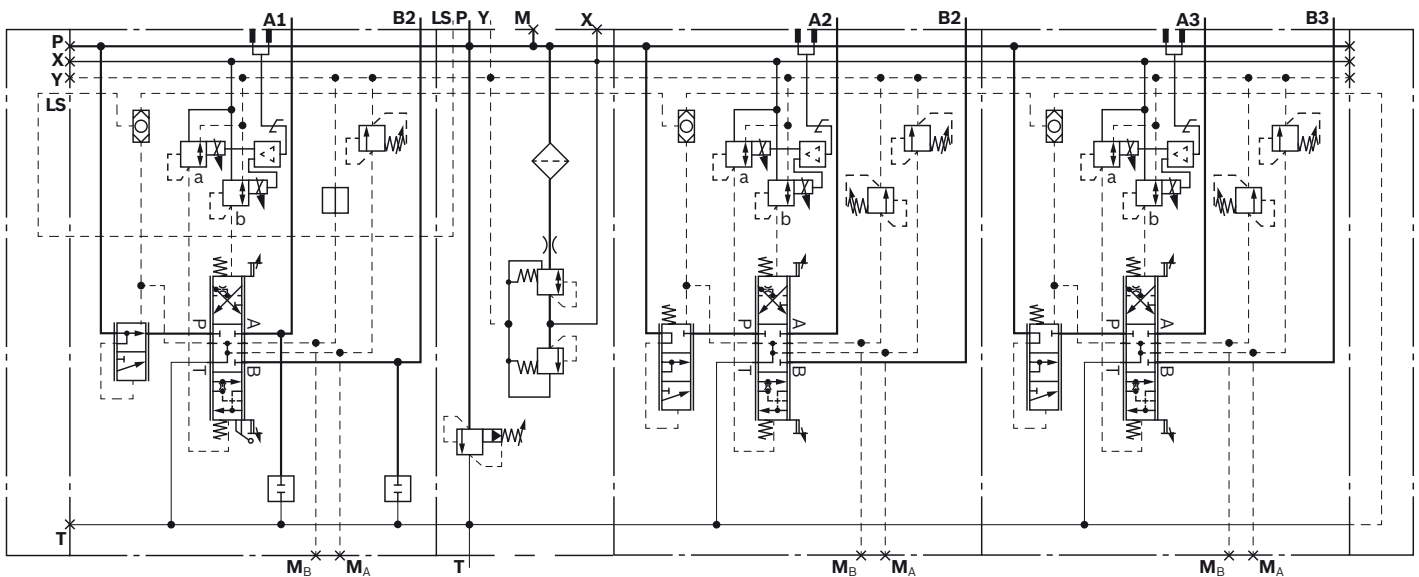
01	02	03	04	05	06	07	09	10	11
S	180	M	120	E	090-090	CBA	-	Z	Z

Spool axis 3

01	02	03	04	05	06	07	09	10	11
S	180	M	120	E	090-090	CBA	-	Z	Z

End plate, additional information

01	02	03
LA	V	01



Inlet plates

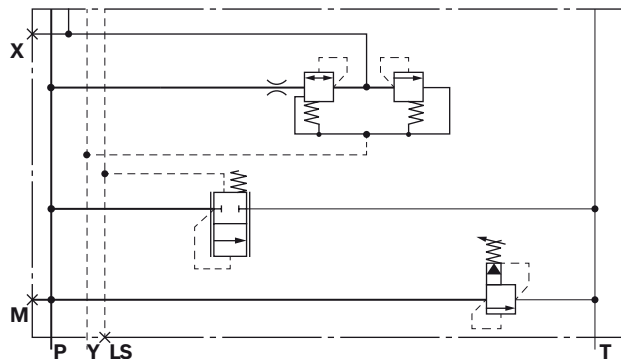
Open center (P)

With primary pressure relief valve, with internal pilot oil supply

Ordering code:

P	...	Y
---	-----	---

- ▶ Specified pressure in bar required after **P** (3-digit)

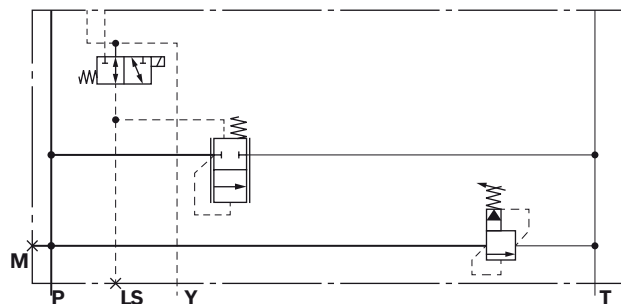


With LS switch off

Ordering code:

P	...	X	A
---	-----	---	---

- ▶ LS line connected to the Y-line to the reservoir in de-energized condition
- ▶ All downstream M4-12 sections remain in load holding

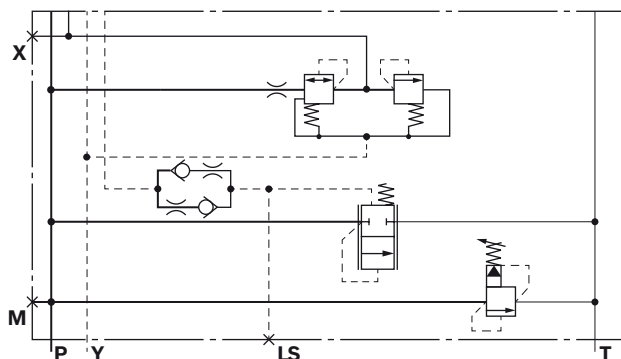


With LS damping nozzle and sensitive pressure compensator

Ordering code:

P	Q	X	S0.6-0.6	P100
---	---	---	----------	------

- ▶ Nozzle diameter parameter in mm required after **S** (standard: 0.6–0.6)
- ▶ Sensitive unloading function
- ▶ Maximum flow 100 l/min on the pump side



Pilot oil supply (Y)

- ▶ Pressure limitation 45 bar
- ▶ Pilot pressure max. 30⁺⁵ bar

Notice

With internal pilot oil supply, pilot oil for other consumers can also be directed via the **X** port. However, this can affect the switching times on the M4-12. Please consult technical sales for information about potential impacts. With an external pilot oil supply, the **X** port is not generally plugged. It must be plugged if it is not in use (e.g. with hydraulic control **H**).

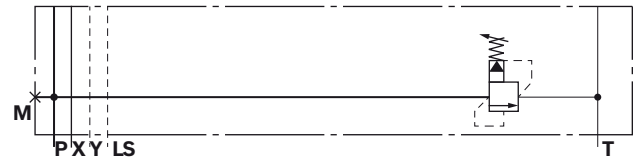
Closed center (J)

With primary pressure relief valve, for external pilot oil supply

Ordering code:

J	...	X
---	-----	---

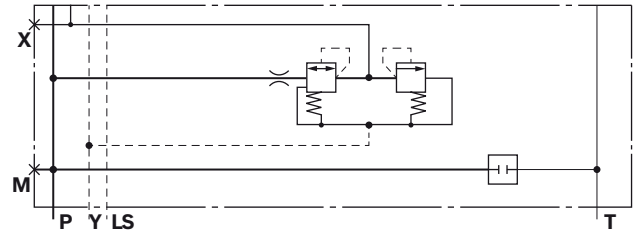
- ▶ Specified pressure in bar required after **J** (3-digit)



Without primary pressure relief valve, with internal pilot oil supply

Ordering code:

J	Q	Y
---	---	---

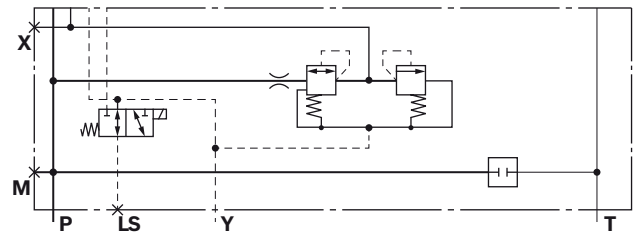


Without primary pressure relief valve, with internal pilot oil supply, with LS switch-off

Ordering code:

J	Q	Y	A
---	---	---	---

- ▶ LS line connected to the Y-line to the reservoir in de-energized condition
- ▶ All downstream M4-12 sections remain in load holding

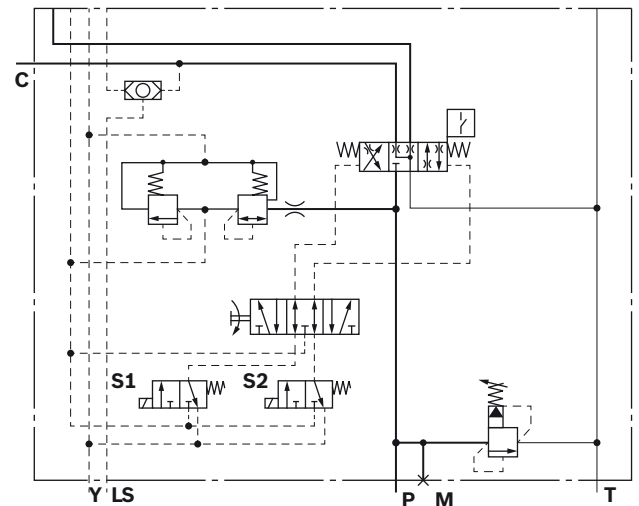


With integrated switch-over axis, primary pressure relief valve and internal pilot oil supply

Ordering code:

SJ	350	Y	D	Q080
----	-----	---	---	------

- ▶ Specified pressure in bar required after **SJ** (3-digit)
- ▶ With switching position detection of the integrated switch-over axis
- ▶ For external flow (port **C**) of 80 l/min
- ▶ Switch-over axis actuation with on/off valves type FTWE2K according to data sheet 58007
- ▶ Further information is available on request



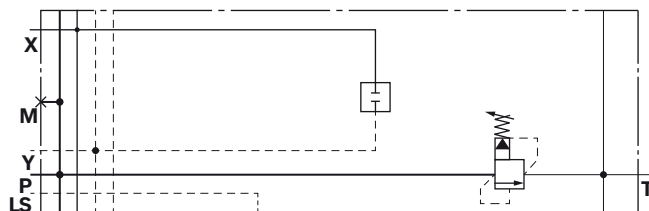
Central closed center inlet plates (JZ, JK)

With primary pressure relief valve, for external pilot oil supply

Ordering code:

JZ	...	X
----	-----	---

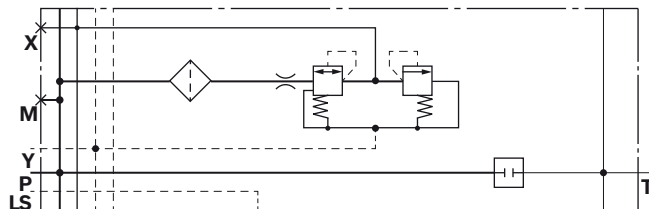
► Specified pressure in bar required after **JZ** (3-digit)



Without primary pressure relief valve, with internal pilot oil supply

Ordering code:

JZ	Q	Y
----	---	---

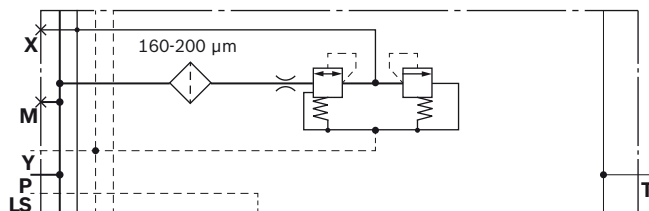


Without primary pressure relief valve, with internal pilot oil supply

Ordering code:

JZ	Z	Y
----	---	---

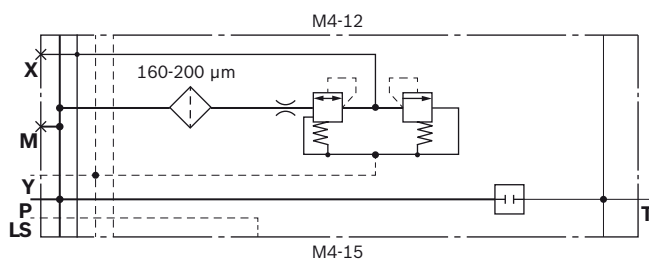
► Primary pressure relief valve is not retrofittable



For connection of directional valves of NG 12 and 15, without primary pressure relief valve, with internal pilot oil supply

Ordering code:

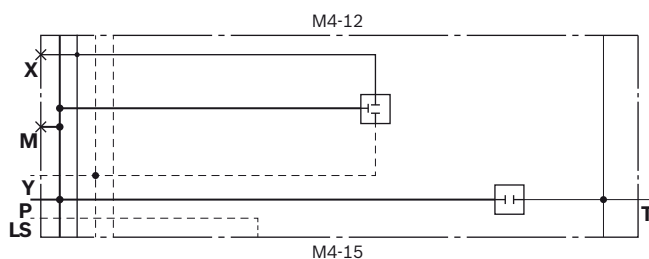
JK	Q	Y
----	---	---



For connection of directional valves of NG 12 and 15, without primary pressure relief valve, for external pilot oil supply

Ordering code:

JK	Q	X
----	---	---



2

Mono block

Mono block open center, with primary pressure relief valve, with internal pilot oil supply

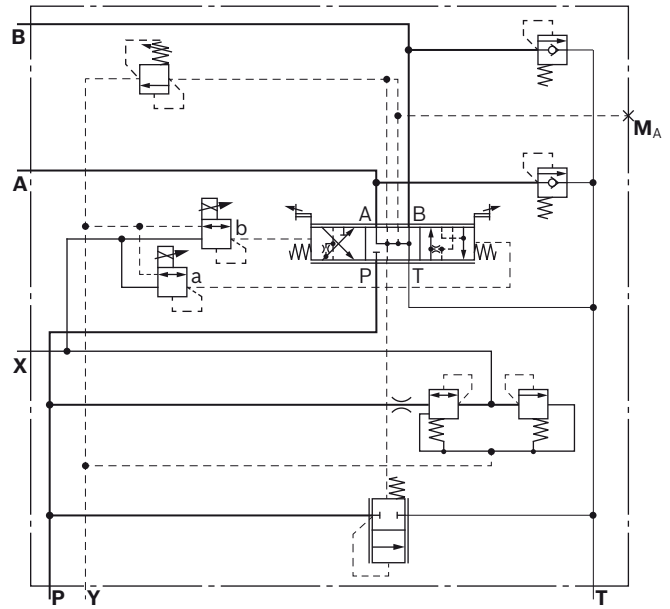
Ordering code:

PM	Z	Y
----	---	---

D	=	M	...	J	W2	1	-	H...	H...
---	---	---	-----	---	------	----	---	---	------	------

LM	V	01
----	---	----

- ▶ Primary pressure limitation via pressure compensator and LS-PRV



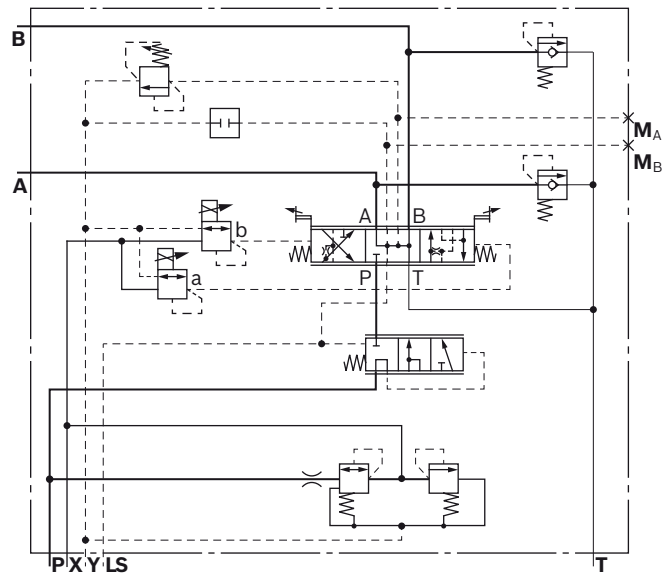
Mono block closed center, without primary pressure relief valve, with internal pilot oil supply

Ordering code:

JM	Z	Y
----	---	---

S	Q	M	...	J	W2	1	-	H...	H...
---	---	---	-----	---	------	----	---	---	------	------

LM	V	01
----	---	----



Mono block closed center, without primary pressure relief valve, for external pilot oil supply, for installation of further directional valves

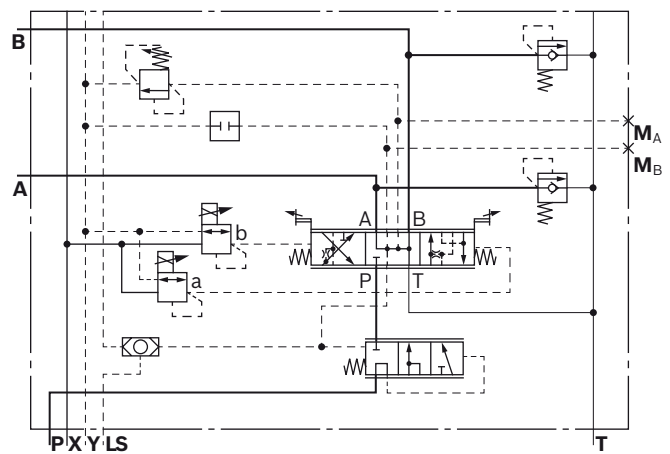
Ordering code:

JM	Z	X
----	---	---

S	...	M	...	J	W2	1	-	H...	H...
---	-----	---	-----	---	------	----	---	---	------	------

Notice

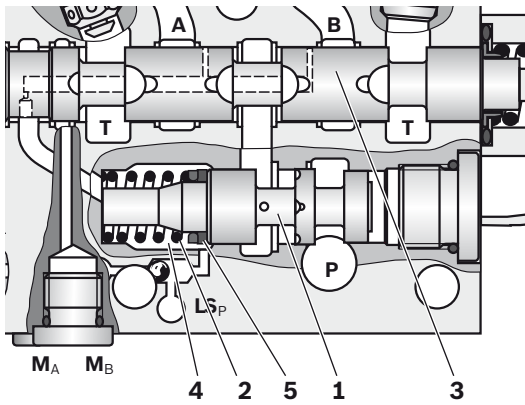
Design by technical sales.



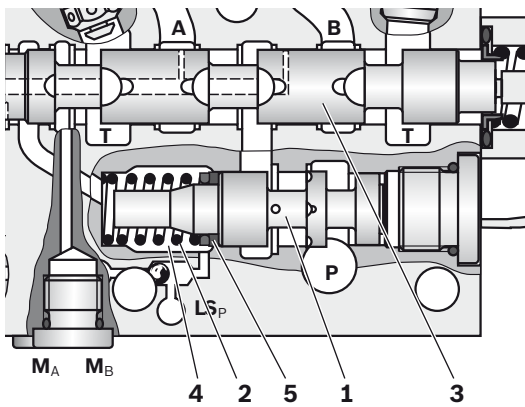
Directional valves

Pressure compensator

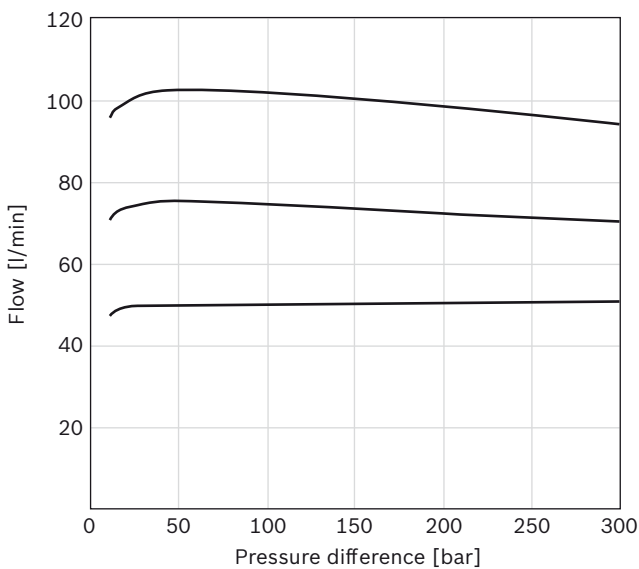
▼ Main spool in central position



▼ Main spool actuated



▼ Flow control by pressure compensator



In the main spool central position there is no connection from **P** to the consumer ports **A** and **B**. Pump pressure shifts the compensator spool (**1**) to the left against the spring (**2**) in this operating condition.

When the main spool (**3**) (= metering orifice) is actuated, the LS pressure reaches the spring chamber (**4**) and shifts the pressure compensator spool to the right into the control position. The flow is also kept constant in parallel operation of consumers with different load pressures.

The pressure compensator **S** is equipped with load holding function. This function is not free of leakage oil.

It is equipped with a disc (**5**) as standard. The number of discs fitted depends on the required flow.

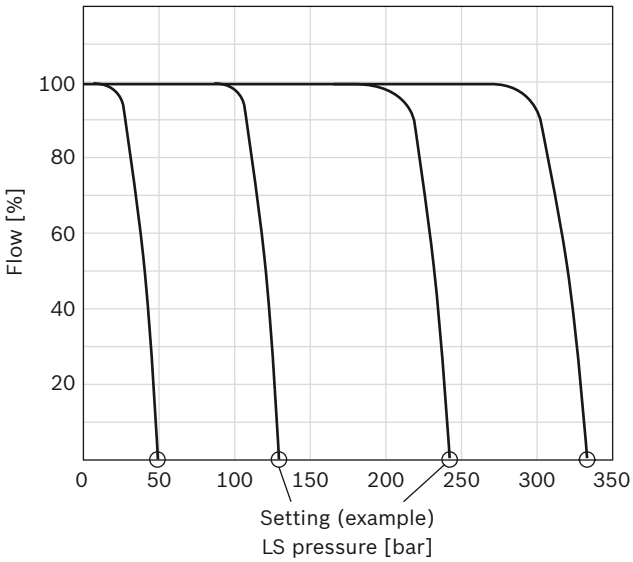
Type	Summary	Symbol
S	<ul style="list-style-type: none"> ▶ With pressure compensator ▶ With load holding function¹⁾ ▶ Maximum flow 130 l/min 	
C	<ul style="list-style-type: none"> ▶ Without pressure compensator ▶ With load holding function¹⁾ ▶ Maximum flow 140 l/min 	
Q	<ul style="list-style-type: none"> ▶ Without pressure compensator ▶ Without load holding function ▶ Maximum flow 140 l/min 	
F	<ul style="list-style-type: none"> ▶ With pressure compensator ▶ With load holding function¹⁾ ▶ Sensitive to flows up to 20 l/min 	
D ²⁾	<ul style="list-style-type: none"> ▶ With open center unloading valve 	

1) This load holding function is not free of leakage oil

2) Only in conjunction with mono block design PM

LS pressure limitation

▼ Consumer flow reduction by LS pressure limitation



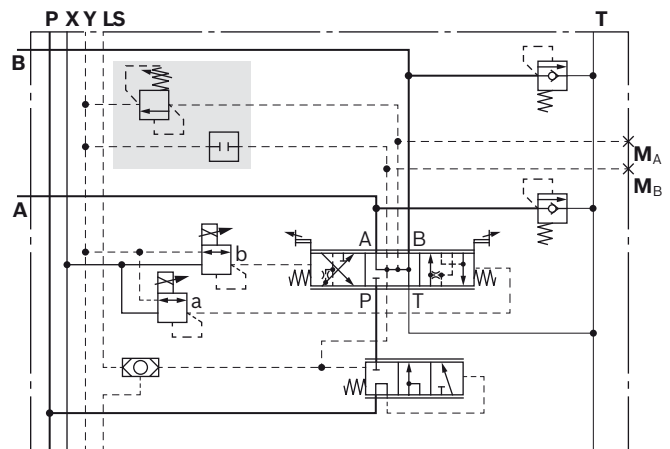
Minimum setting: 50 bar
 Maximum setting: 385 bar

With LS pressure relief valve and LS threaded plug

Ordering code:

S	...	M	Q	J	...-...	W2	1	-	H...	H...
---	-----	---	---	---	---------	----	---	---	------	------

- ▶ Specified pressure in bar for consumer port A (3-digit)
- ▶ Threaded plug for consumer port B
- ▶ With the **QM** design, LS pressure limitation can be retrofitted onto the directional valve.
- ▶ The LS pressure can be influenced externally via ports **M_A** and **M_B**. These ports can also be used as measuring ports.

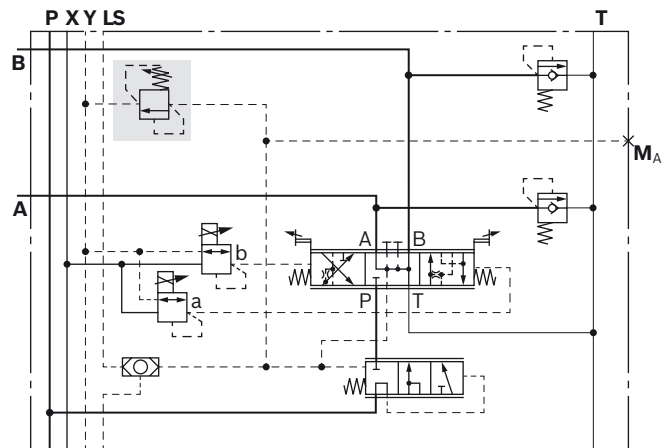


With 1 LS pressure relief valve

Ordering code:

S	=	M	...	J	...-...	W2	1	-	H...	H...
---	---	---	-----	---	---------	----	---	---	------	------

- ▶ Only 1 LS-PRV for the same pressure setting in A and B, specified pressure in bar (3-digit)
- ▶ 1 measuring port

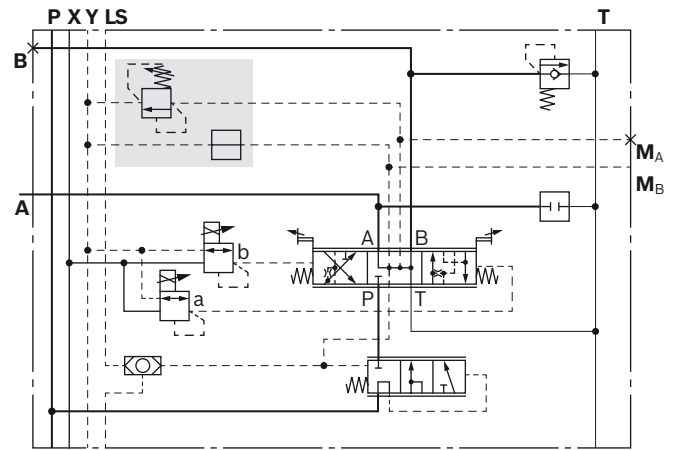


With LS pressure relief valve and relief plug

Ordering code:

S	...	M	B	J	...-000	W2	1	-	H...	Q
---	-----	---	---	---	---------	----	---	---	------	---

- ▶ Specified pressure in bar for consumer port A (3-digit)
- ▶ Relief plug for consumer port B
- ▶ E.g., for cylinders actuated on one side

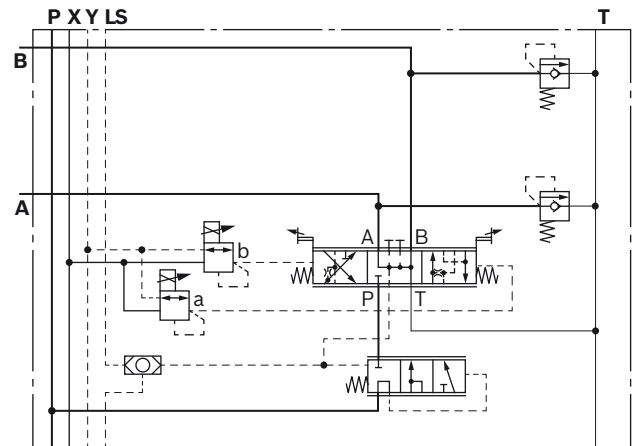


Without LS pressure relief valves

Ordering code:

S	Z	Z	Z	J	...-...	W2	1	-	H...	H...
---	---	---	---	---	---------	----	---	---	------	------

- ▶ LS-PRV cannot be retrofitted
- ▶ Housing without measuring ports

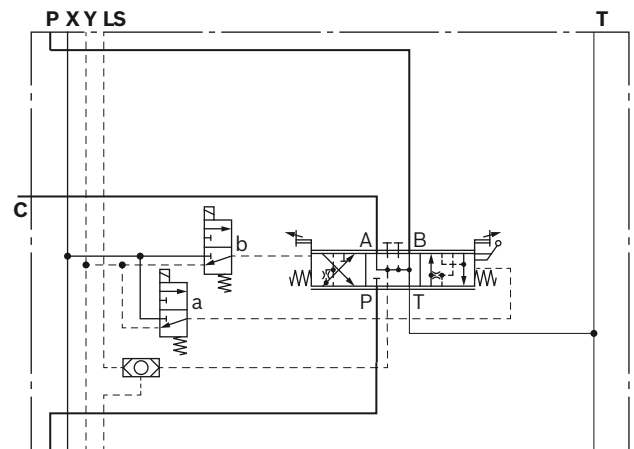


Housing for switch-over axis

Ordering code:

Z	Z	U	Z	J	...-...	W4	1	K	Z	Z
---	---	---	---	---	---------	----	---	---	---	---

- ▶ Housing for switch-over axis
- ▶ Maximum flow of internal consumers 90 l/min

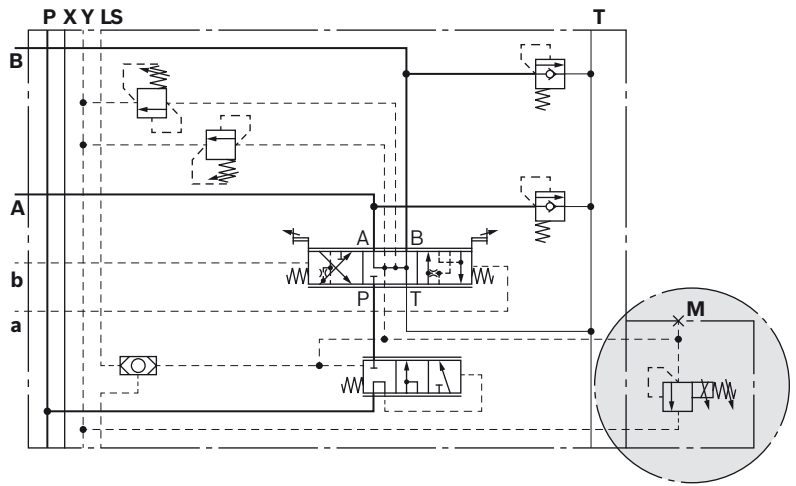


Housing for electro-proportional LS pressure limitation/hydraulically switchable directional valves

Distinction between:

1. Type KBPS
2. KBPS housing and plug
3. KBPS porting pattern and cover plate
4. Type MH2DAD and type KBPS
5. Type KKDE
6. Type MHDRD2

The exact designation of the valve must be specified in plain text as follows.

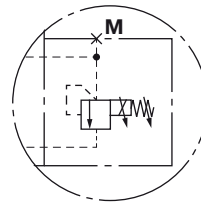


1. Electro-proportional LS pressure relief valve type KBPS

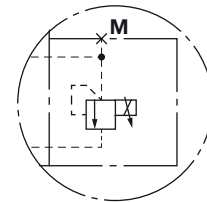
(see also data sheet 18139-04; 18139-05)

Preferred program:

S	...	L	...	J	...-...	H	-	H...	H...	KBPSL8BA
S	...	J	...	J	...-...	H	-	H...	H...	KBPSL8AA
S	...	R	...	J	...-...	H	-	H...	H...	KBPSR8BA
S	...	N	...	J	...-...	H	-	H...	H...	KBPSR8AA



KBPS...BA:
Decreasing characteristic curve



KBPS...AA:
Increasing characteristic curve

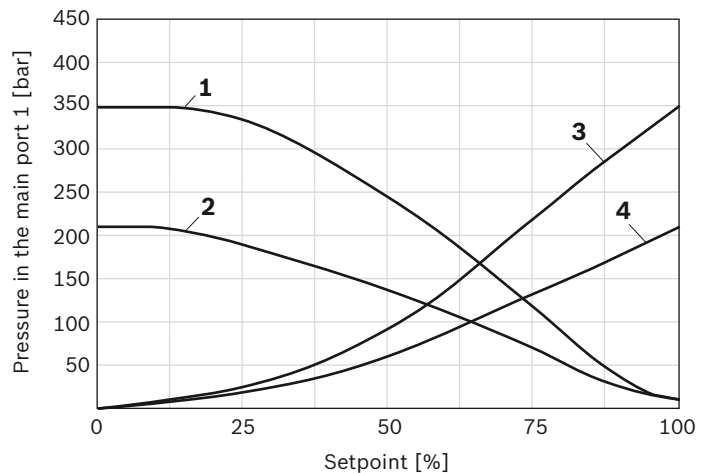
Supplementary program, e.g.:

S	...	K	...	J	...-...	H	-	H...	H...	KBPSH8BA	-033
---	-----	---	-----	---	---------	---	---	------	------	----------	------

	Decreasing characteristic curve	Increasing characteristic curve	Additional SO no. (Option: 24 V; 0.8 A)
50 bar	KBPS C 8BA	KBPS C 8AA	
100 bar	KBPS F 8BA	KBPS F 8AA	
150 bar	KBPS H 8BA	KBPS H 8AA	
210 bar	KBPS L 8BA ⁽²⁾	KBPS L 8AA ⁽⁴⁾	-033
250 bar	KBPS N 8BA	KBPS N 8AA	
315 bar	KBPS P 8BA	KBPS P 8AA	
350 bar	KBPS R 8BA ⁽¹⁾	KBPS R 8AA ⁽³⁾	
420 bar	KBPS T 8BA	KBPS T 8AA	

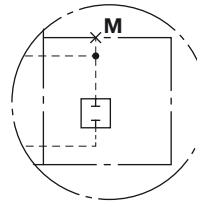
= Preferred program

▼ Pressure control by electro-proportional LS pressure limitation



2. Housing KBPS and plug

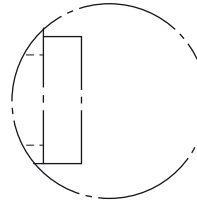
S	...	K	...	J	...-...	H	-	H...	H...	Q
---	-----	---	-----	---	---------	---	---	------	------	---



Plug

3. Porting pattern KBPS and cover plate

S	...	K	...	J	...-...	H	-	H...	H...	A
---	-----	---	-----	---	---------	---	---	------	------	---



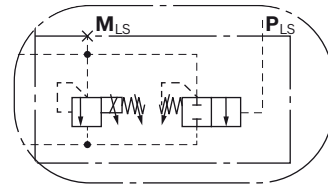
Cover plate

4. Pressure cut-off valve type MH2DAD and electro-proportional LS pressure relief valve type KBPS

(see also data sheet 64586; 18139-04, 18139-05)

S	...	K	...	J	...-...	H	-	H...	H...	MH2DAD+KBPSH8BA
---	-----	---	-----	---	---------	---	---	------	------	-----------------

S	...	K	...	J	...-...	H	-	H...	H...	MH2DAD+Q
---	-----	---	-----	---	---------	---	---	------	------	----------



5. 2/2-way spool valve type KKDE

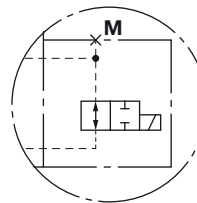
(see also data sheet 18136-08)

S	...	K	...	J	...-...	H	-	H...	H...	KKDER8PA
---	-----	---	-----	---	---------	---	---	------	------	----------

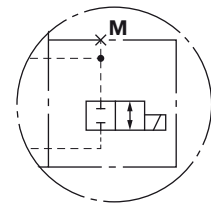
- ▶ Normally open: KKDER8PA
- ▶ Normally closed: KKDER8NA

Notice

The consumer pressure is not depressurized!



KKDE...PA:
Normally open

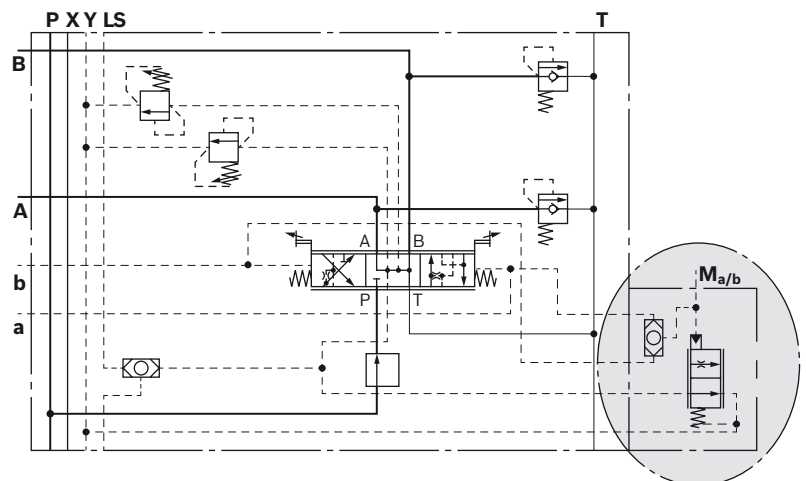


KKDE...NA:
Normally closed

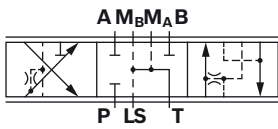
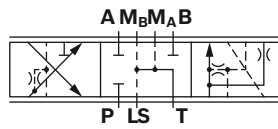
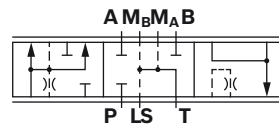
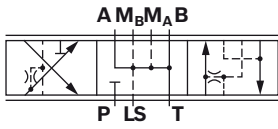
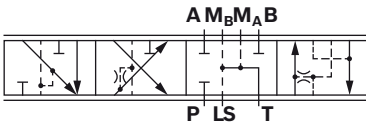
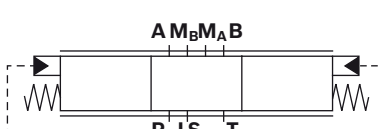
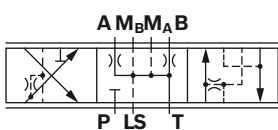
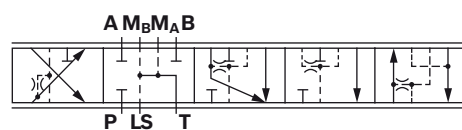
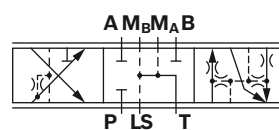
6. Hydraulic pressure control MHDRD2

Q	...	C	...	J	...-...	H	-	H...	H...	MHDRD2
---	-----	---	-----	---	---------	---	---	------	------	--------

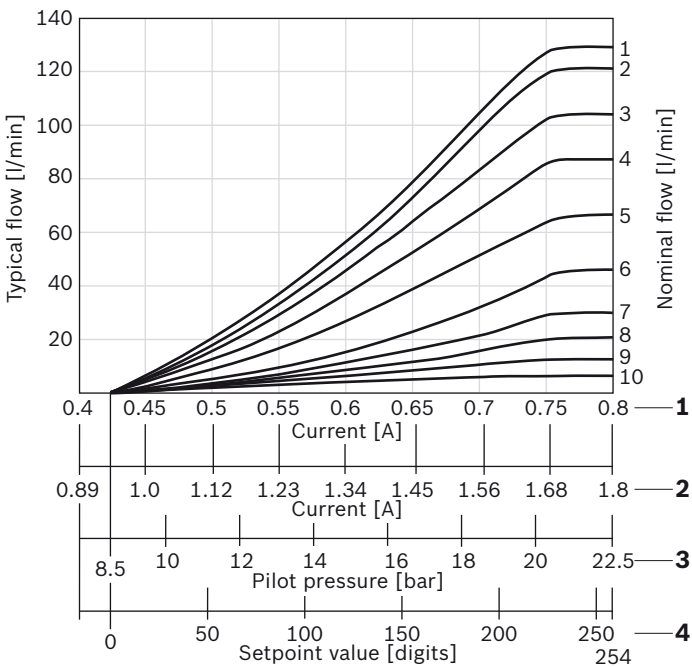
- ▶ Pressure distortion of the LS signal related to the pilot pressure
- ▶ Application example: Slew drive in the crane
- ▶ Design by technical sales



Main spool

<p>Hydraulic cylinder as consumer</p> <p>E</p> 	<p>Regeneration function (P, B → A)</p> <p>R</p> 	<p>Plunger cylinder as a consumer</p> <p>P</p> 
<p>Hydraulic motors as consumers</p> <p>J</p> 	<p>Floating position</p> <p>W</p> 	<p>Spool with pressure function¹⁾</p> <p>(E, J, Q) ...T...</p> 
<p>Application with defined residual opening (A/B → T), consumer port unloaded in neutral position</p> <p>Q</p> 	<p>Floating position¹⁾</p> <p>Y</p> 	<p>Pressure main spool in connection with lowering brake valve¹⁾</p> <p>(E) ...M...</p> 

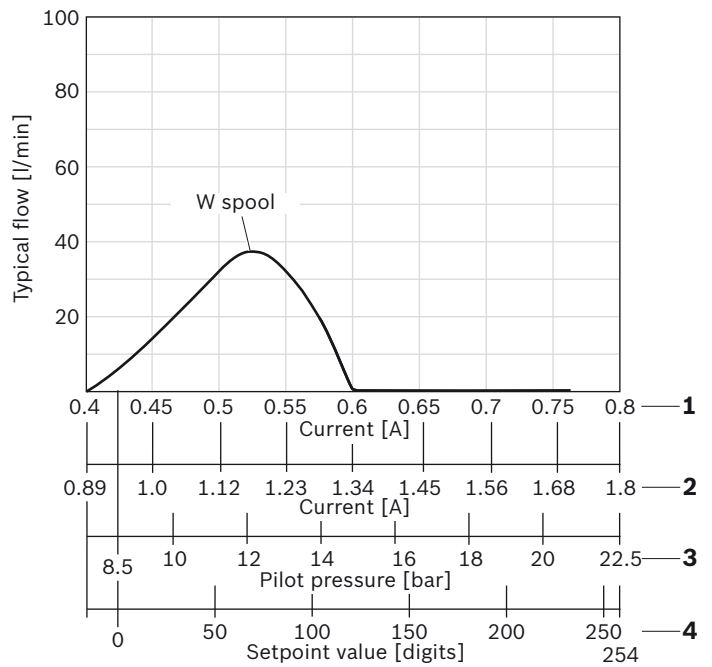
▼ Characteristic curves symmetric main spool P → A/B



- 1 Electrohydraulic actuation, 24 V control
- 2 Electrohydraulic actuation, 12 V control
- 3 Hydraulic actuation
- 4 Digital on-board electronics (EPM2)

¹⁾ Design by technical sales

▼ Characteristic curves floating position spool P → A/B



Flow

Symmetric main spool

Spool type	Pressure compensator	Flow in l/min							
E, J, Q	S	130-130 ⁽¹⁾	100-100	073-073	052-052	034-034	023-023	014-014	007-007
		120-120 ⁽²⁾	085-085 ⁽⁴⁾	065-065 ⁽⁵⁾	045-045 ⁽⁶⁾	030-030 ⁽⁷⁾	020-020 ⁽⁸⁾	012-012 ⁽⁹⁾	006-006 ⁽¹⁰⁾
		100-100 ⁽³⁾	070-070	057-057	038-038	026-026	017-017	010-010	005-005
	C	140-140	115-115	090-090	063-063	042-042	028-028	017-017	008-008

⁽¹⁾... ⁽¹⁰⁾ Note on spool characteristic curve page 26.

Asymmetric main spool

Spool type	Pressure compensator	Flow in l/min				
E, J, Q	S	100-073	100-052	052-034	034-023	023-014
		085-065	085-045	045-030	030-020	020-012
		070-057	070-038	038-026	026-017	017-010
	C	115-090	115-063	063-042	042-028	028-017

Floating position, regeneration and plunger spool¹⁾

Spool type	Pressure compensator	Flow in l/min (others on request)				
W	S	030-030	045-045	065-040		
Y		030-030	065-065	065-045	065-085	085-100
R		130-101	085-030	065-025	130-140	
P		185-000				

Notice

Design by technical sales.

Example:

- ▶ Spool type J
- ▶ Pressure compensator S
- ▶ Setpoint value: $q_{\text{consumers}} = 90$ l/min

Solution:

- ▶ 85-liter spool + 2 discs = 100 l/min
- ▶ Set 90 liters via stroke limiter.

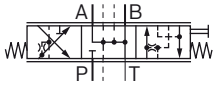
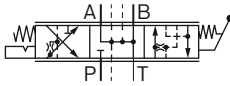
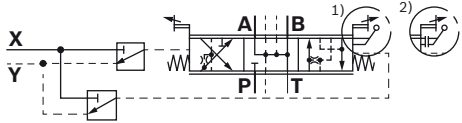

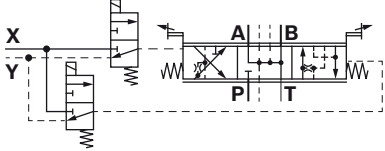
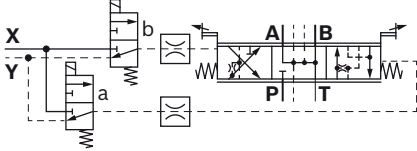
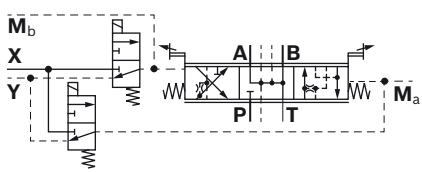
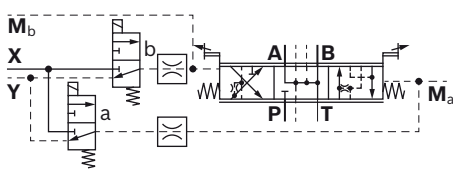
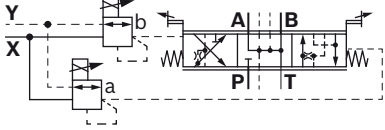
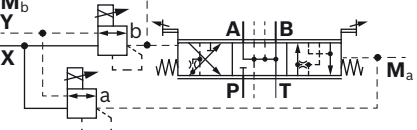
Spool type	Pressure compensator	Flow in l/min	Number of discs
E, J, Q	S	100-100	With 2 discs (pressure compensator $\Delta p = 8.5$ to 11.5 bar)
		085-085	With 1 disc (pressure compensator $\Delta p = 6$ to 9.5 bar)
		070-070	Without disc (pressure compensator $\Delta p = 4$ to 7 bar)

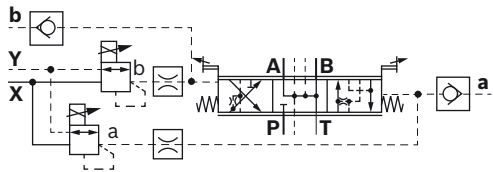
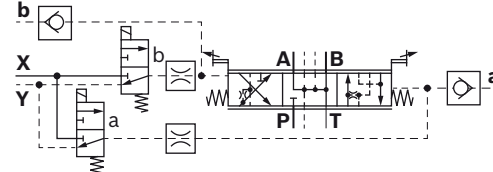
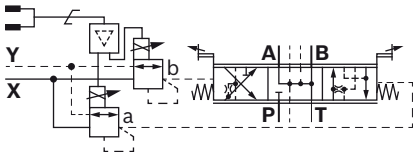
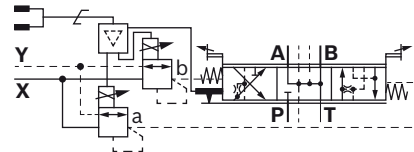
Notice

Place directional valves with maximum flow as close as possible to the inlet plate.





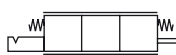

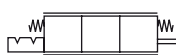

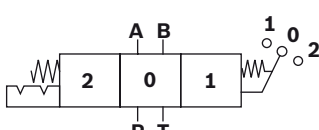
1) Flow parameter corresponds to 1 disc

Types of actuation

Mechanical only (not encapsulated) with tongue	Mechanical only (not encapsulated) with hand lever and detent
<p>AZ</p>  <ul style="list-style-type: none"> ▶ Centering in central position by means of springs in case of non-actuation. 	<p>B1N</p>  <ul style="list-style-type: none"> ▶ Centering in central position by means of springs in case of non-actuation. ▶ For variants, see page 29.
Mechanical (encapsulated)	Hydraulic
<p>M</p>  <ul style="list-style-type: none"> ▶ Centering in central position by means of springs in case of non-actuation. ▶ All hand lever position options are possible, cf. also ordering codes on page 30. <p>1) Revolving hand lever 2) Non-revolving hand lever</p>	<p>H</p>  <ul style="list-style-type: none"> ▶ Centering in central position by means of springs in case of non-actuation. ▶ Recommended hydraulic pilot controls: Type 2TH6 and 4TH6 according to data sheet 64552 or 64555
Electrohydraulically switchable	Electrohydraulically switchable with damping nozzle on both sides
<p>W4</p>  <ul style="list-style-type: none"> ▶ On/off valve type FTWE2K according to data sheet 58007 	<p>W5</p>  <ul style="list-style-type: none"> ▶ On/off valve type FTWE2K according to data sheet 58007
Electrohydraulically switchable with measuring ports on both sides	Electrohydraulically switchable with damping nozzle, with measuring ports on both sides
<p>W6</p>  <ul style="list-style-type: none"> ▶ On/off valve type FTWE2K according to data sheet 58007 	<p>W7</p>  <ul style="list-style-type: none"> ▶ On/off valve type FTWE2K according to data sheet 58007
Electrohydraulically proportional	Electrohydraulically proportional with measuring ports on both sides
<p>W2</p>  <ul style="list-style-type: none"> ▶ FTDRE2K proportional pressure reducing valve as per data sheet 58032 	<p>W8</p>  <ul style="list-style-type: none"> ▶ FTDRE2K proportional pressure reducing valve as per data sheet 58032

Electrohydraulically proportional with damping nozzle and check valve for hydraulic superposition	Electrohydraulically switchable with damping nozzle and check valve for hydraulic superposition
<p>G2</p>  <p>► FTDRE2K proportional pressure reducing valve as per data sheet 58032</p>	<p>G4</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>
Electronic pilot module	Electronic pilot module with position sensor
<p>CBA</p>  <p>► Digital interface, standard, refer to instruction manual 64815-B</p>	<p>CPA</p>  <p>► Digital interface, with position sensor, refer to instruction manual 64815-B</p>

Variant overview for mechanical actuation only (not encapsulated)

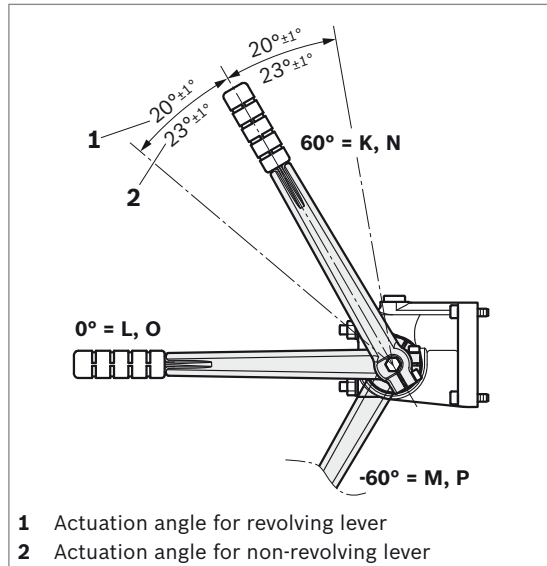
Spring-centered + tongue	Spring-centered + tongue with lever		
		A Z	A N
Detent + tongue	Detent + tongue with lever	Lever position	
		B1 Z	B1 N
		B2 Z	B2 N
		B4 Z	B4 N
 <p> B1 = detent in 1 B2 = detent in 2 B4 = detent in 1, 2 </p>			

Actuating force:

Tongue < 250 N (spool axis)

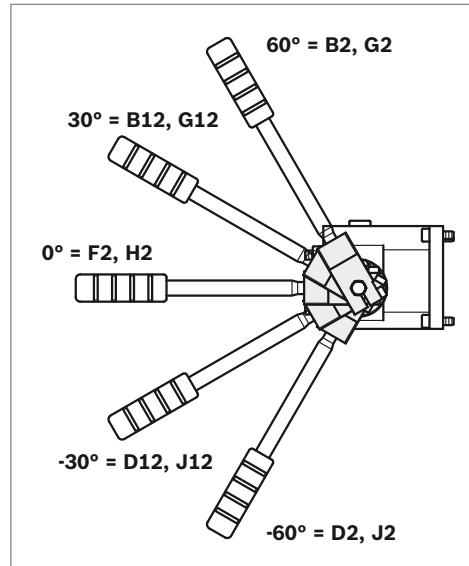
Variant overview for mechanical actuation with hand lever (encapsulated)

▼ Standard cover with hand lever

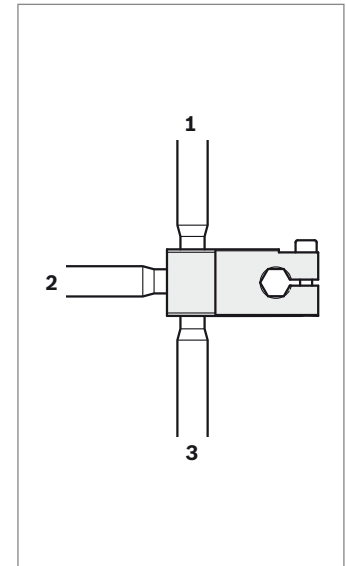


▼ Cover with clamping piece and hand lever, aluminum-free

(e.g., lever screw fitting in position 2)



▼ Lever screw fitting on the mounting piece




Ordering code

Lever	Standard cover		Clamping piece with lever				Clamping piece without lever	
	Revolving	Not revolving	Revolving		Not revolving		Revolving	Not revolving
Upward, 60°	K	N	B	2 3	G	2 3	T	Q
Upward, 30°			B1	2 3	G1	2 3	T1	Q1
Straight, 0°	L	O	F	1 2 3	H	1 2 3	U	S
Downward, -30°			D1	1 2	J1	1 2	V1	C1
Downward, -60°	M	P	D	1 2	J	1 2	V	C
Without lever	R	X						

Actuating force (on the hand lever)

- ▶ Mechanical < 20 N
- ▶ Mechanical superposition (with parallel hydraulic actuation) < 70 N
- ▶ Mechanical superposition (with parallel electrohydraulic actuation) < 50 N

 = Preferred program

Notice

- ▶ Revolving hand lever:
Mechanical actuation can override the electrohydraulic actuation. The hand lever is directly connected to the main spool and follows the spool movement in electrohydraulic control.
- ▶ Non-revolving hand lever:
The hand lever is connected to the main spool via a coupling. If the main spool is in the central position, the hand lever can be snapped into place. With electrohydraulic control, it does not follow the spool movement in this way.

Secondary valves

Shock/feed valves, non-adjustable

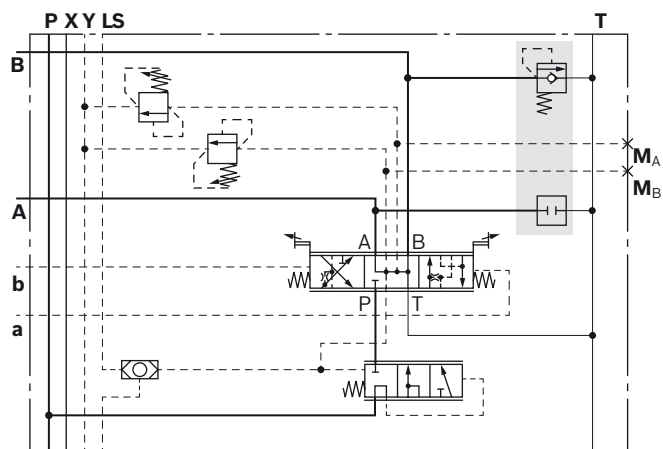
Ordering code:

S	...	M	...	J	...-...	H	-	Q	H...
---	-----	---	-----	---	---------	---	---	---	------

- ▶ Non-adjustable shock/feed valve
- ▶ Specified pressure in bar required after **H** (3-digit), see table below for possible values
- ▶ **Example: Q H150**
Q: Threaded plug for consumer port A H150: Shock/feed valve, fixed setting to 150 bar for consumer port B

Notice

Only suitable for reduction of pressure peaks, not to be used as a pressure relief valve!



Possible pressure settings for shock valves with feed function

Pressure setting in bar for consumer port A and B			
H025 = 25 bar	H125 = 125 bar	H210 = 210 bar	H320 = 320 bar
H035 = 35 bar	H140 = 140 bar	H230 = 230 bar	H350 = 350 bar
H050 = 50 bar	H150 = 150 bar	H240 = 240 bar	H380 = 380 bar
H063 = 63 bar	H160 = 160 bar	H250 = 250 bar	H405 = 405 bar
H080 = 80 bar	H175 = 175 bar	H280 = 280 bar	H420 = 420 bar
H100 = 100 bar	H190 = 190 bar	H300 = 300 bar	

Notice

Shock valves have a fixed setting!

Shock/feed valves, adjustable

Ordering code:

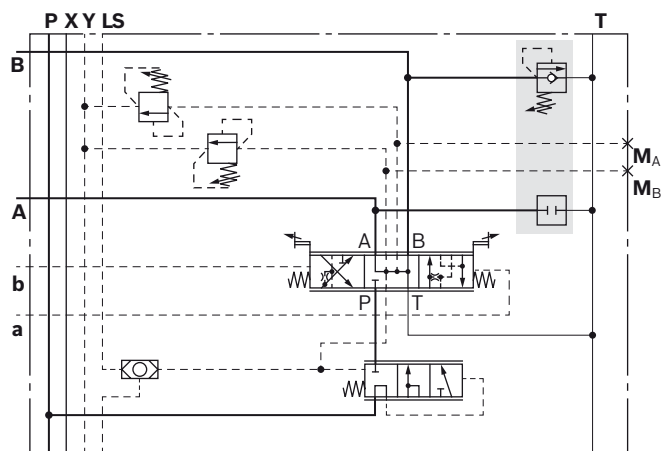
S	...	M	...	J	...-...	H	-	Q	A...
---	-----	---	-----	---	---------	---	---	---	------

- ▶ Adjustable shock/feed valve
- ▶ Specified pressure in bar required after **A** (3-digit)
- ▶ **Example: Q A200**
Q: Threaded plug for consumer port A A200: Shock/feed valve, set to 200 bar for consumer port B

Notice

Only suitable for reduction of pressure peaks, not to be used as a pressure relief valve!

Adjustable pressure stages in bar for consumer port A and B	
10 – 70	201 – 270
71 – 120	271 – 320
121 – 200	321 – 380



Without secondary valves

Ordering code:

S	...	M	...	J	...-...	H	-	Z	Z
---	-----	---	-----	---	---------	---	---	---	---

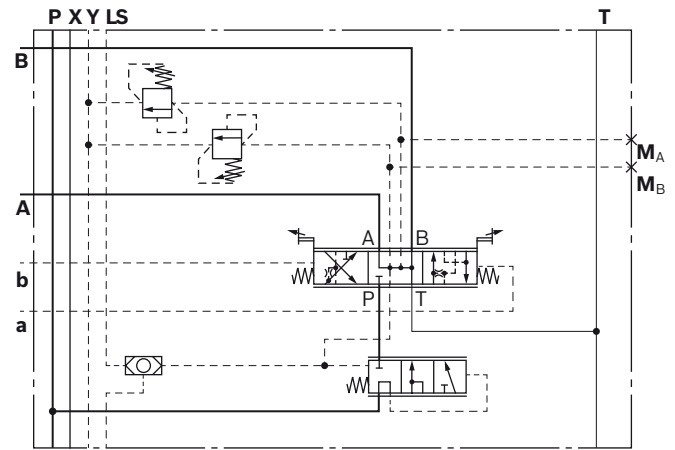
- ▶ Secondary valves are not retrofittable
- ▶ Consumer port G 3/4

Ordering code:

S	...	M	...	J	...-...	H	-	X	X
---	-----	---	-----	---	---------	---	---	---	---

- ▶ Secondary valves are not retrofittable
- ▶ Consumer port G 1/2

Notice
Secondary pressure limitation must be provided by the customer if necessary.



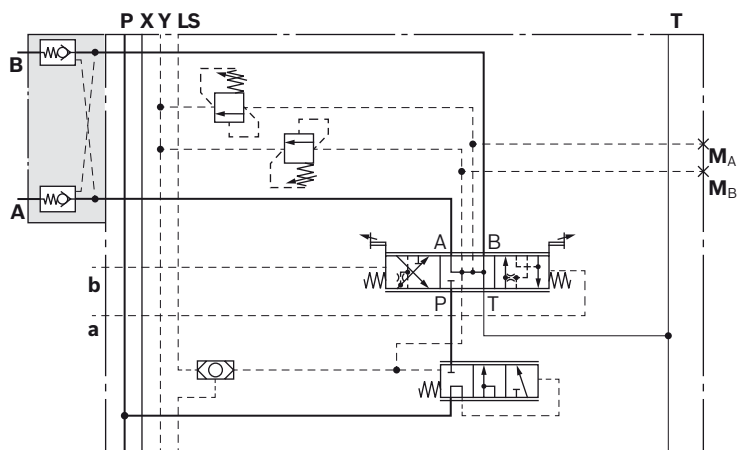
Without secondary valves, secondary valves, with flange surface

Ordering code:

S	...	M	...	J	...-...	H	-	F	F
---	-----	---	-----	---	---------	---	---	---	---	-----	-----

- ▶ Secondary valves are not retrofittable
- ▶ Flange-mountable valves specified in the plain text

Notice
Secondary pressure limitation must be provided by the customer if necessary.
▶ Design by technical sales.



Options

Electrohydraulic, with spool position sensor

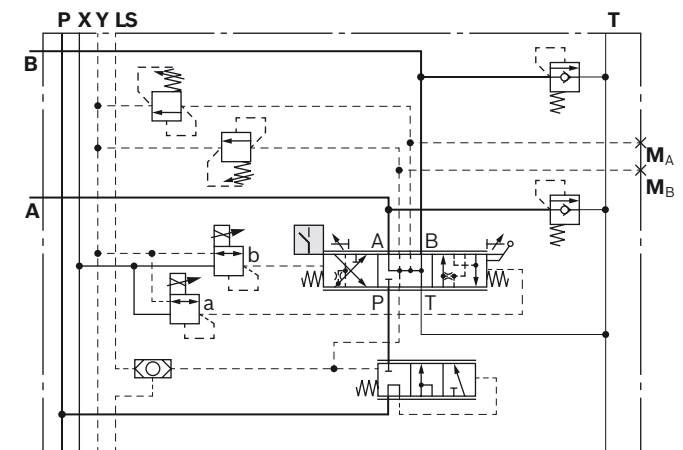
Ordering code:

S	...	M	...	J	...-...	W2	1	K	H...	H...	-S
---	-----	---	-----	---	---------	----	---	---	------	------	----

- ▶ Main spool neutral position and A and B direction of motion detected and monitored by an analog voltage output signal
- ▶ Pin assignment for connector (connector version DT04-4P DEUTSCH)



- Pin 1:** +V_{Batt}
- Pin 2:** GND
- Pin 3:** Sensor signal for flow direction of consumer port B
- Pin 4:** Sensor signal for flow direction of consumer port A



Notice
▶ Design by technical sales.
For further information, see data sheet 95190.

Available housing variants

			With secondary valve option (can be retrofitted)	Without secondary valve (cannot be retrofitted)	Without secondary valve (cannot be retrofitted)	Flange surface without secondary valve option (cannot be retrofitted)
		A, B =	Q, A..., H...	XX	ZZ	FF
			G 1/2	G 1/2	G 3/4	
Standard	Without LS pressure relief valve (LS-PRV cannot be retrofitted)	ZZZ	•	•	•	
	Without LS pressure relief valves for switch-over axis (LS-PRV cannot be retrofitted)	ZUZ			•	
	With only 1 LS pressure relief valve for same pressure setting in A and B	= M...	•	•		
	With 2 LS pressure relief valves, (specified pressure in bar, 3-digit)	...M...	•	•	•	•
	With LS pressure relief valves (specified pressure in bar, 3-digit) Housing for electro-proportional or switchable pressure limitation	...K...	•		•	
Mechanical only	Without LS pressure relief valve (LS-PRV cannot be retrofitted)	ZZZ	•		•	
	With only 1 LS pressure relief valve for same pressure setting in A and B	= M...				
	With 2 LS pressure relief valves, (specified pressure in bar, 3-digit)	...M...	•		•	•
	With LS pressure relief valves (specified pressure in bar, 3-digit) Housing for electro-proportional or switchable pressure limitation	...K...				
	Without LS pressure relief valve (LS-PRV cannot be retrofitted) Housing for electro-proportional or switchable pressure limitation	ZKZ		•		
	Housing for hydraulic pressure control, with LS and PST outlet	...C...	•			

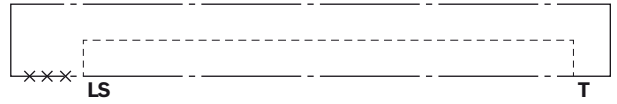
• = available

End plates

With LS unloading

Ordering code:

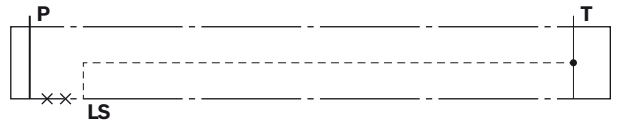
LA



End plate LA with additional P and T port

Ordering code:

LAPT



With LS port

Ordering code:

LZ

▶ LS unloading must be provided externally

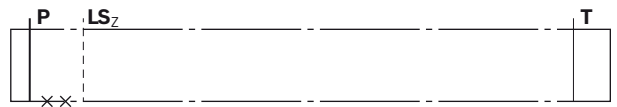


End plate LZ with additional P and T port

Ordering code:

LZPT

▶ LS unloading must be provided externally

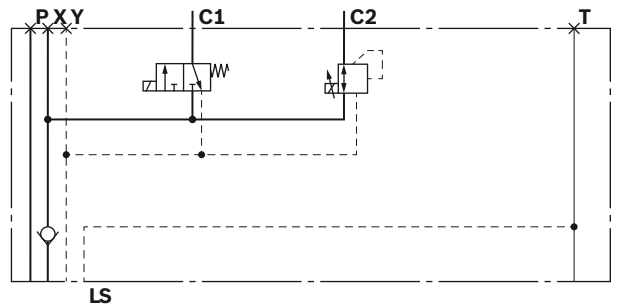


LA end plate with two installation bores for FTDRE4K, FTWE4K¹⁾

Ordering code:

LA W4 W2

- ▶ For 30 bar pilot pressure
- ▶ See also data sheet 58038 and/or 58008

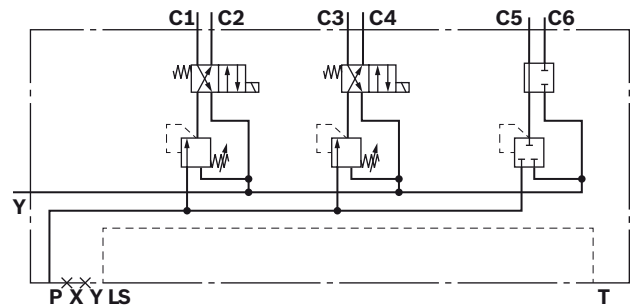


End plate LA with two installation bores for pressure reducing valve, KKDER...¹⁾

Ordering code:

LA ... KKDER... ... KKDER... Q Q

- ▶ Max. 40 l/min per working port
- ▶ See also data sheet 18136-09



¹⁾ Please consult our technical sales department

Diversion plate for use with central inlet plate

Ordering code:

LU

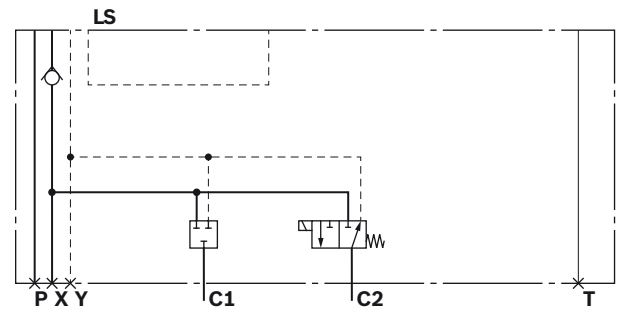


Diversion plate LU with two installation bores for FTDRE4K, FTWE4K¹⁾

Ordering code:

LU Q W4

- ▶ For 30 bar pilot pressure
- ▶ See also data sheet 58038 and/or 58008

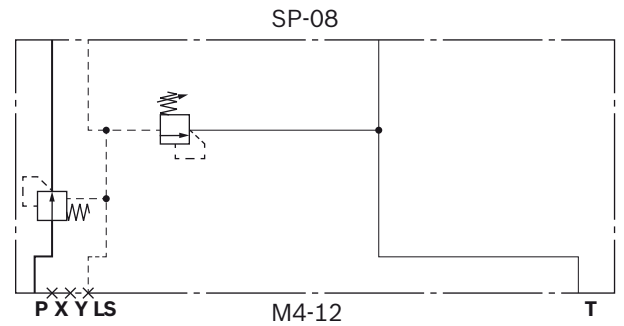


Adapter plate for SP-08 directional valves

Ordering code:

L8 210

- ▶ With integrated 2-way pressure compensator
- ▶ With LS pressure relief valve, set to 210 bar
- ▶ Ordering code for flanged SP-08 directional valves in accordance with data sheet 64139
- ▶ A maximum of 7 directional valves M4-12 is permissible

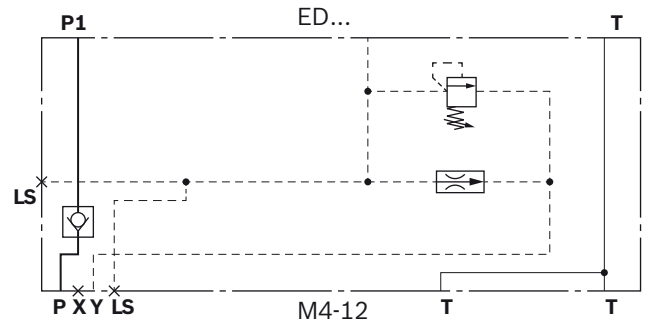


Adapter plate for Bosch Rexroth Oil Control ED valves

Ordering code:

TI

- ▶ Please consult technical sales for ordering code for flanged ED directional valves.



Dimensions

Line connections

Ports			
P	Pump	LS	Load sensing signal
A, B	Consumer	LS_Z	LS supply
a, b	Pilot oil	M	Measuring port, pump
T	Reservoir	M_A, M_B	Measuring port, LS pressure
X	Pilot oil supply	M_b, M_b	Measuring port, pilot pressure
Y	Pilot oil return	C	External consumers

Line connections as pipe threads (code 01)

		P	T	A, B	a, b	LS	X, Y	M, M_A, M_B	M_a, M_b	C, C1...C6
Inlet	P	G 3/4	G 1	-	-	G 1/4	G 1/4	G 1/4	-	-
	J	G 3/4	G 3/4	-	-	G 1/4	G 1/4	G 1/4	-	-
	JZ	G 1	G 1	-	-	G 1/4	G 1/4	G 1/4	-	-
	JK	G 1 1/4	G 1 1/4	-	-	G 1/4	G 1/4	G 1/4	-	-
Mono block	PM, JM	G 3/4	G 3/4	G 1/2	G 1/4	G 1/4	G 1/4	G 1/4	-	-
Directional valve	With secondary valves	-	-	G 1/2	G 1/4	-	-	G 1/4	G 1/8	-
	Without secondary valve (ZZ)	-	-	G 3/4	G 1/4	-	-	G 1/4	G 1/8	G 3/4
	Without secondary valve (XX)	-	-	G 1/2	G 1/4	-	-	G 1/4	G 1/8	-
End plate	LZ	-	-	-	-	G 1/4	-	-	-	-
	LAPT, LZPT	G 3/4	G 3/4	-	-	G 1/4	-	-	-	-
	LA... ..	G 1/2	G 3/8	-	-	G 1/4	G 1/4	-	-	G 1/4
	LU... ..	G 1/2	G 3/8	-	-	G 1/4	G 1/4	-	-	G 1/4

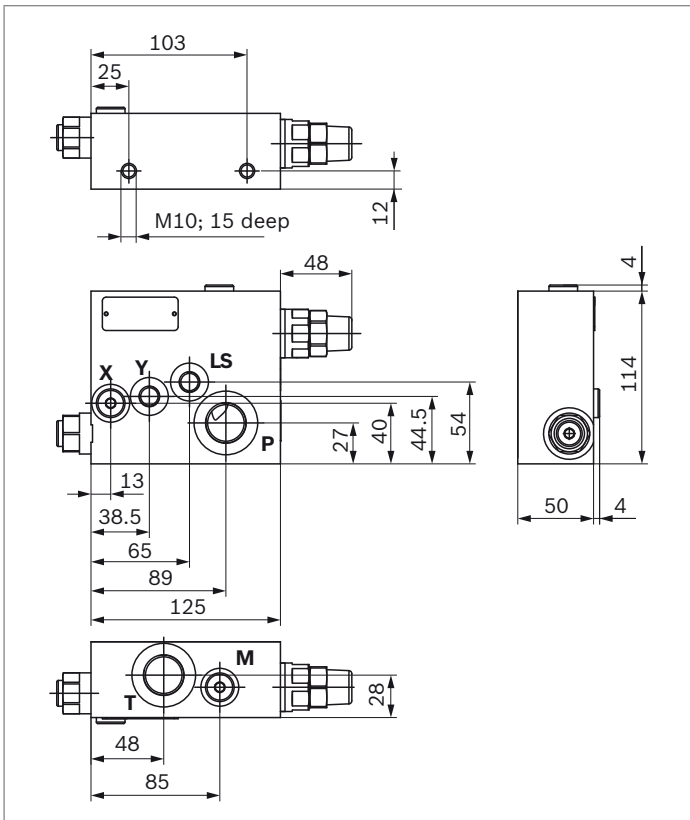
Mounting bolts M10 as per EN ISO 4762 or EN ISO 4014:

Tensile strength class	8.8	10.9
Tightening torque	41 ^{±2} Nm	60 ^{±3} Nm

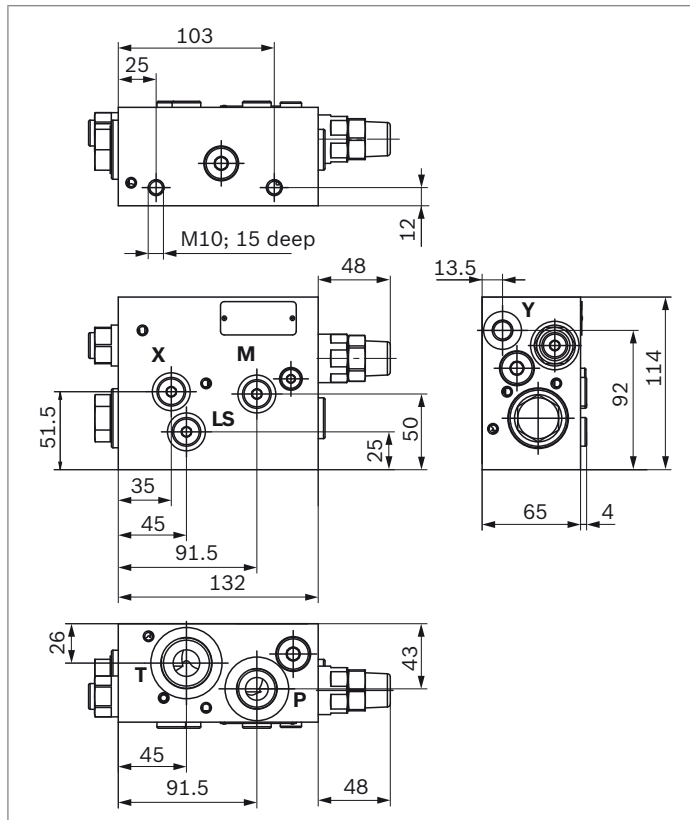
Ports as per ISO 1179-1

Inlet plates

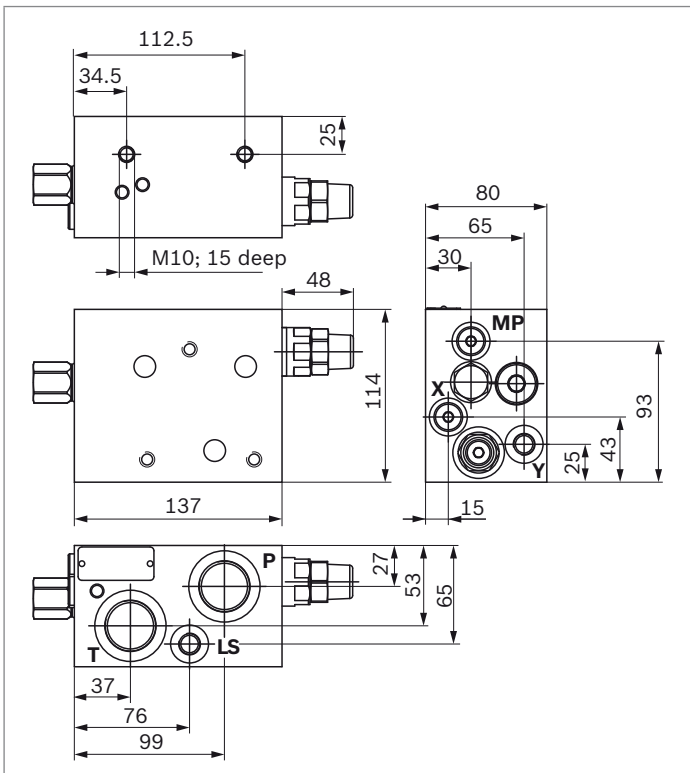
▼ **Lateral inlet plate J...Y**



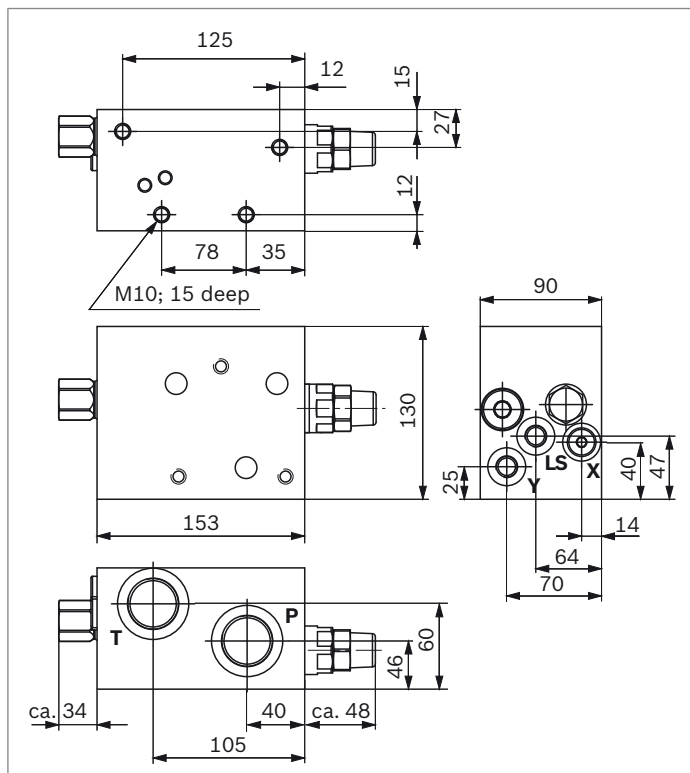
▼ **Lateral inlet plate P...Y**



▼ **Central inlet plate JZ**

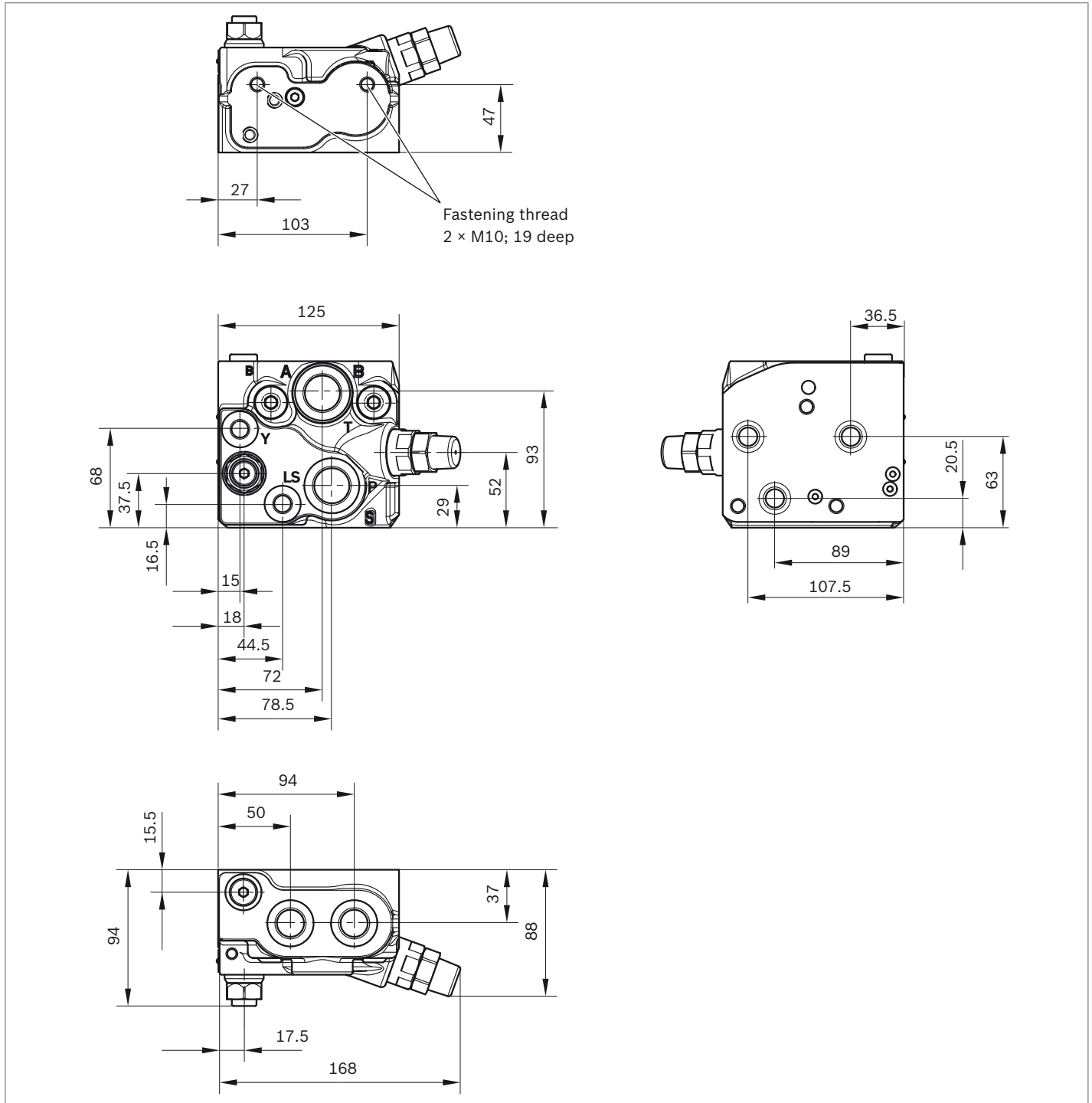


▼ **Central inlet plate JK**

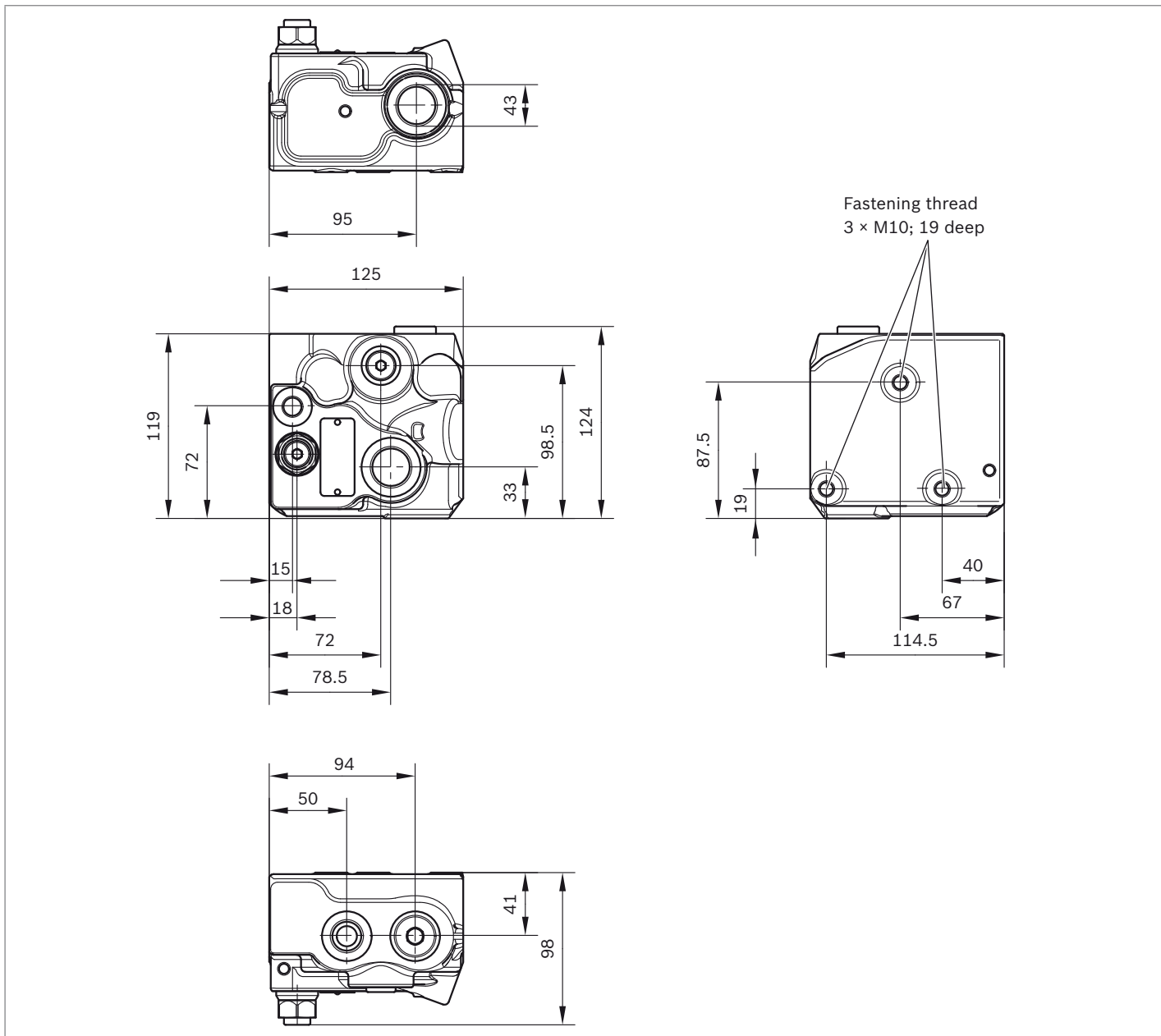


Mono block

▼ Standard mono block Closed Center JM as input plate combined with 1 axis; further directional valves are flange-mountable



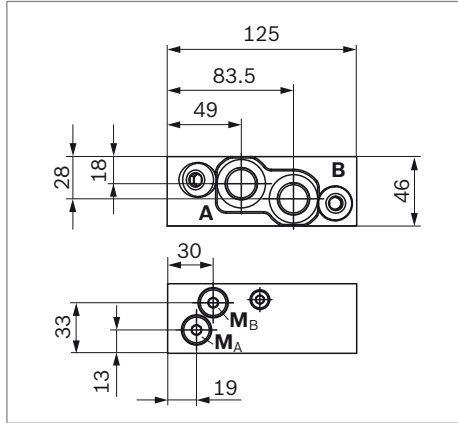
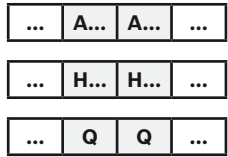
▼ **Standard mono block Open Center PM** (installation of further directional valves is not possible)



Directional valves

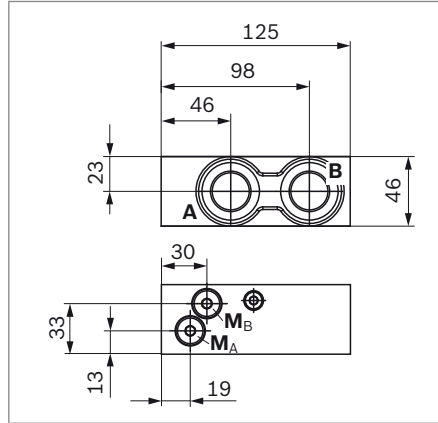
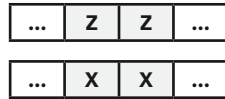
▼ **Housing with secondary valve bore, consumer port G 1/2**

Ordering code:



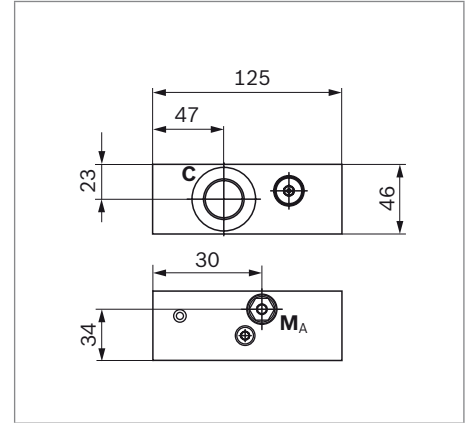
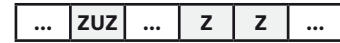
▼ **Housing without secondary valve bore, consumer port G 3/4 or G 1/2**

Ordering code:



▼ **Housing for switch-over axis, consumer port G 3/4**

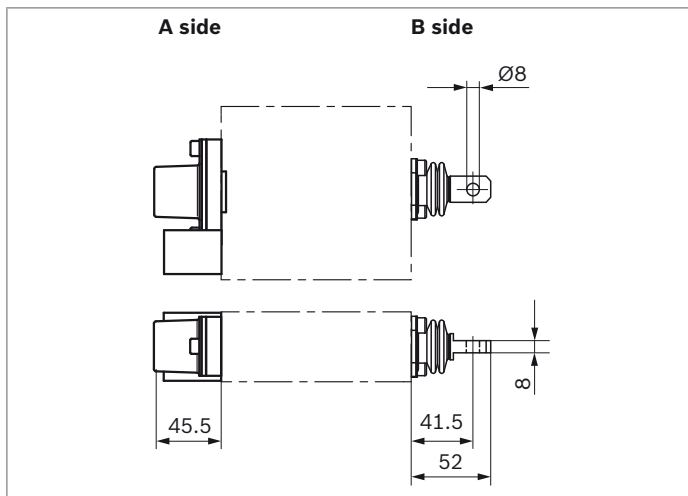
Ordering code:



Actuation

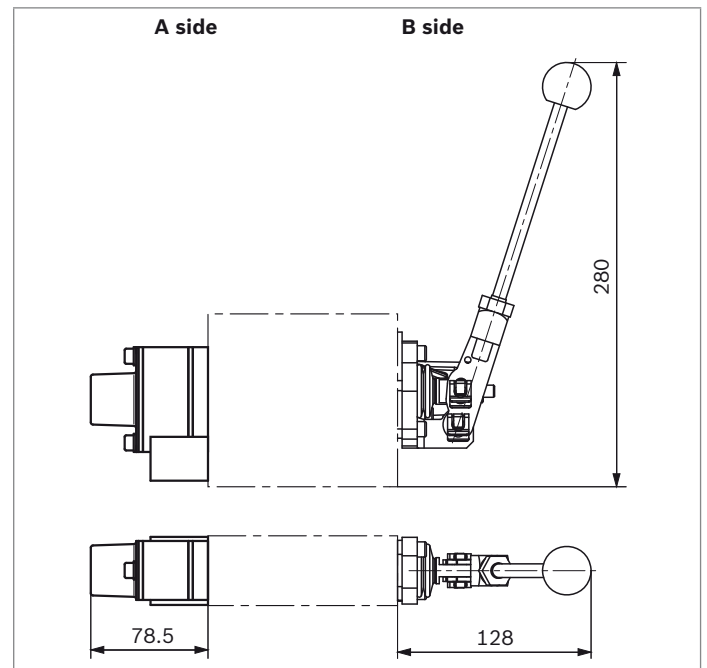
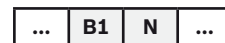
▼ **Mechanical actuation only, spring-centered with tongue**

Ordering code:



▼ **Mechanical actuation only with detent, tongue and lever**

Ordering code:

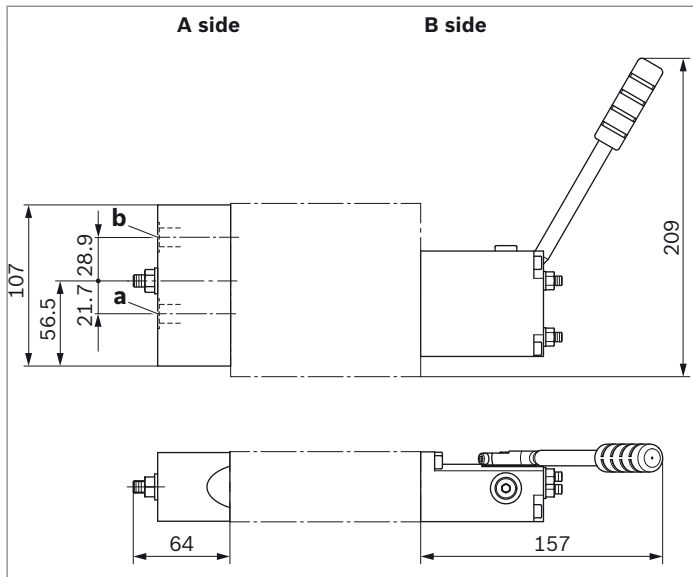


▼ Mechanical/hydraulic actuation with cover with clamping piece and hand lever (encapsulated), aluminum-free

Ordering code:

...	M	B2	...
-----	---	----	-----

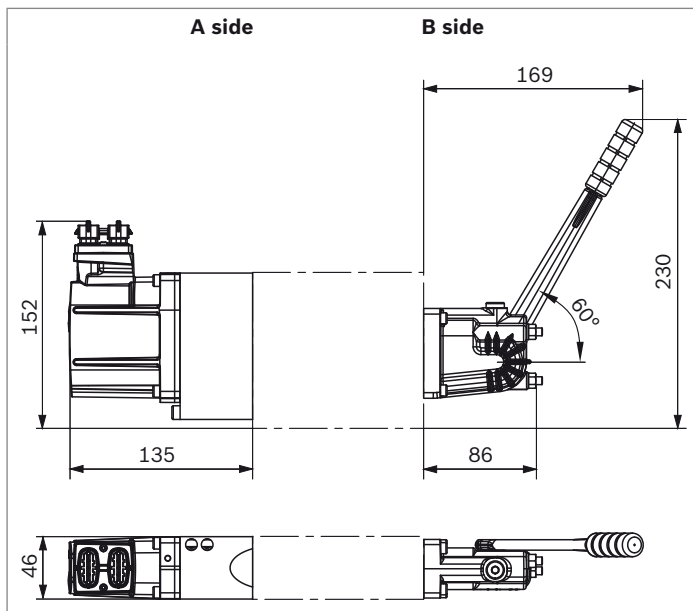
...	H	B2	...
-----	---	----	-----



▼ Electronic pilot module EPM2 with hand lever (encapsulated)

Ordering code:

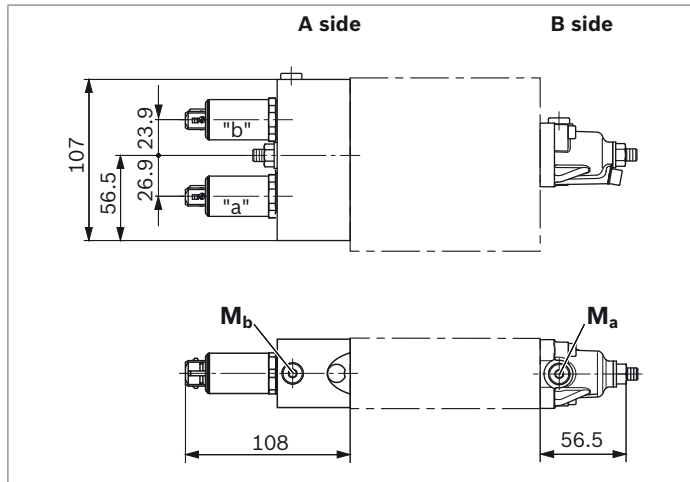
...	C.A	K	...
-----	-----	---	-----



▼ Electrohydraulic actuation with standard cover

Ordering code:

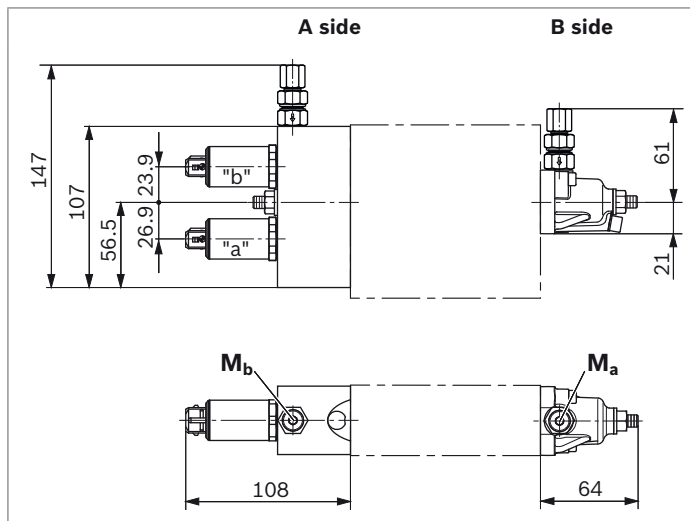
...	W.	-	...
-----	----	---	-----



▼ Electrohydraulic actuation with check valve for hydraulic superposition

Ordering code:

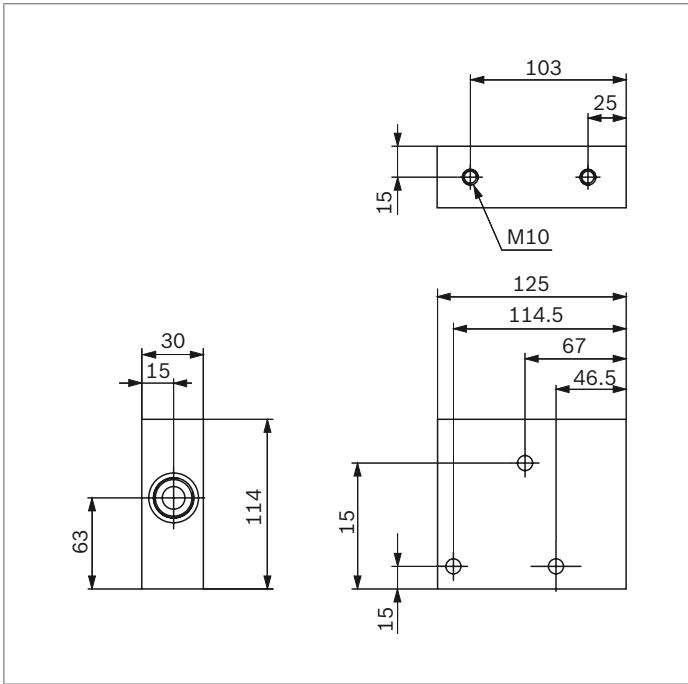
...	G.	-	...
-----	----	---	-----



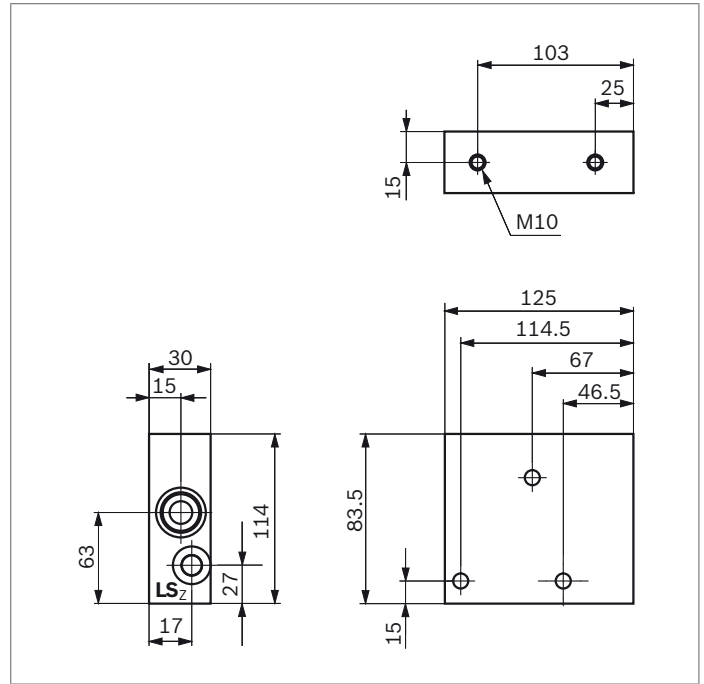
2

End plates

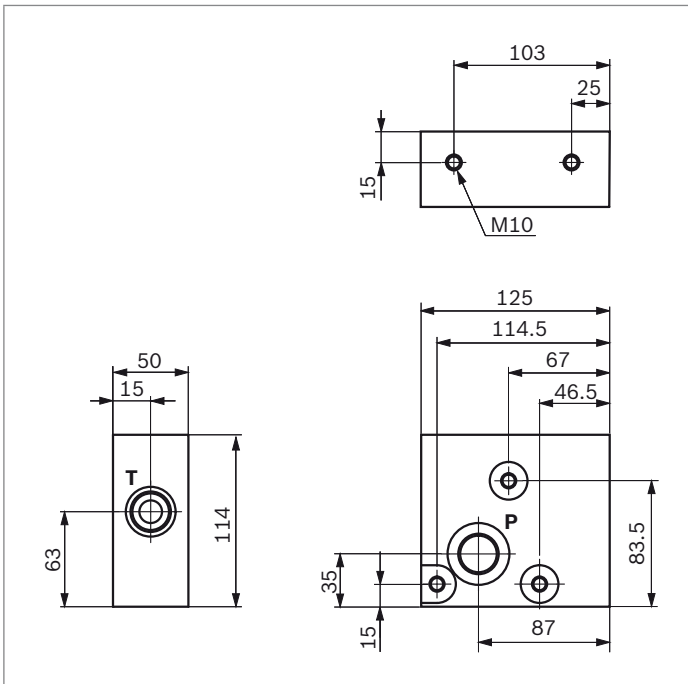
▼ **End plate LA**



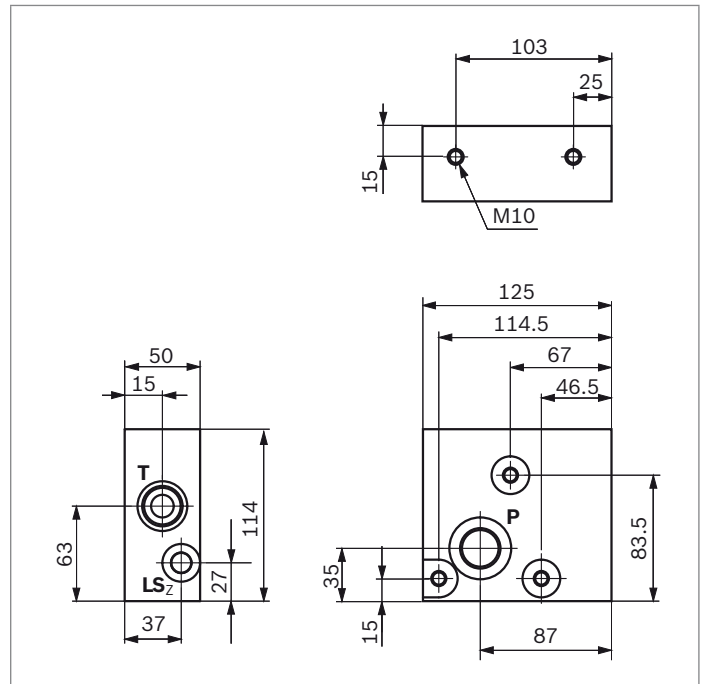
▼ **End plate LZ**



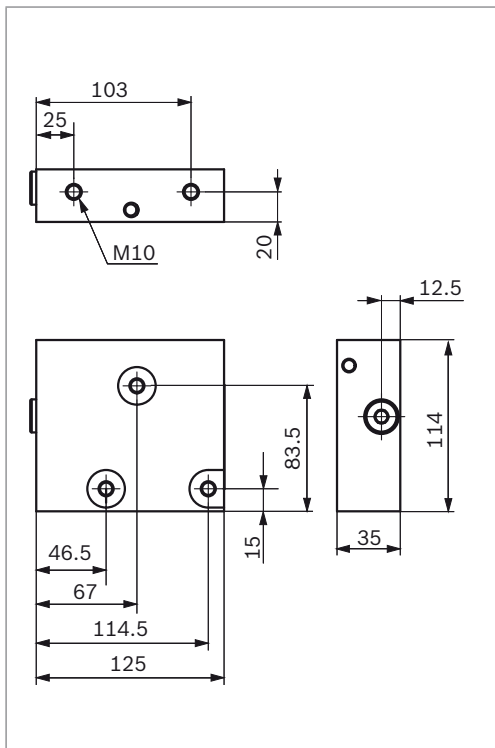
▼ **End plate LAPT**



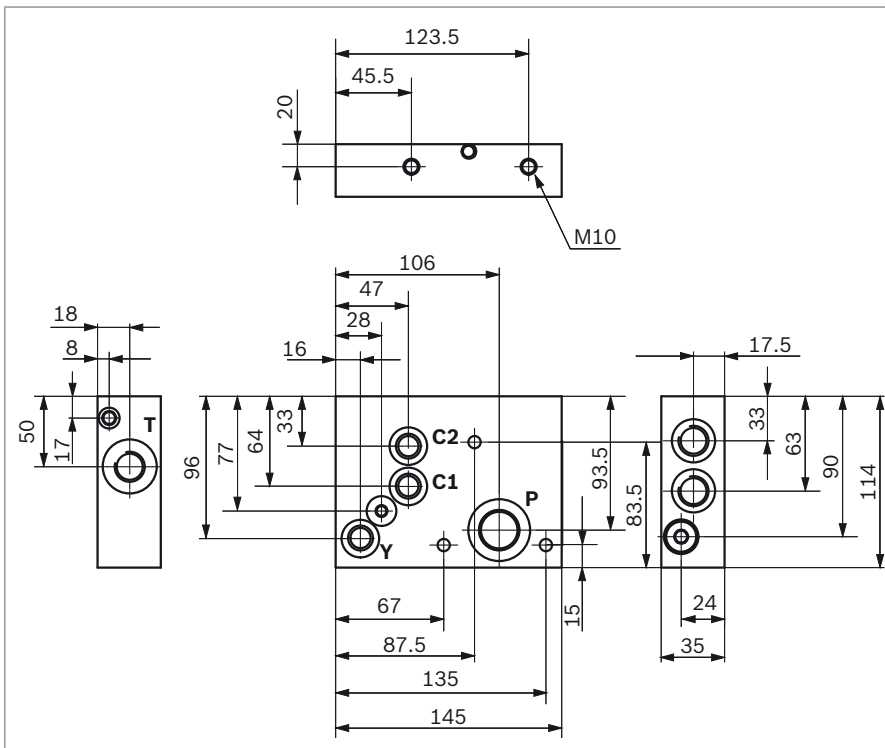
▼ **End plate LZPT**



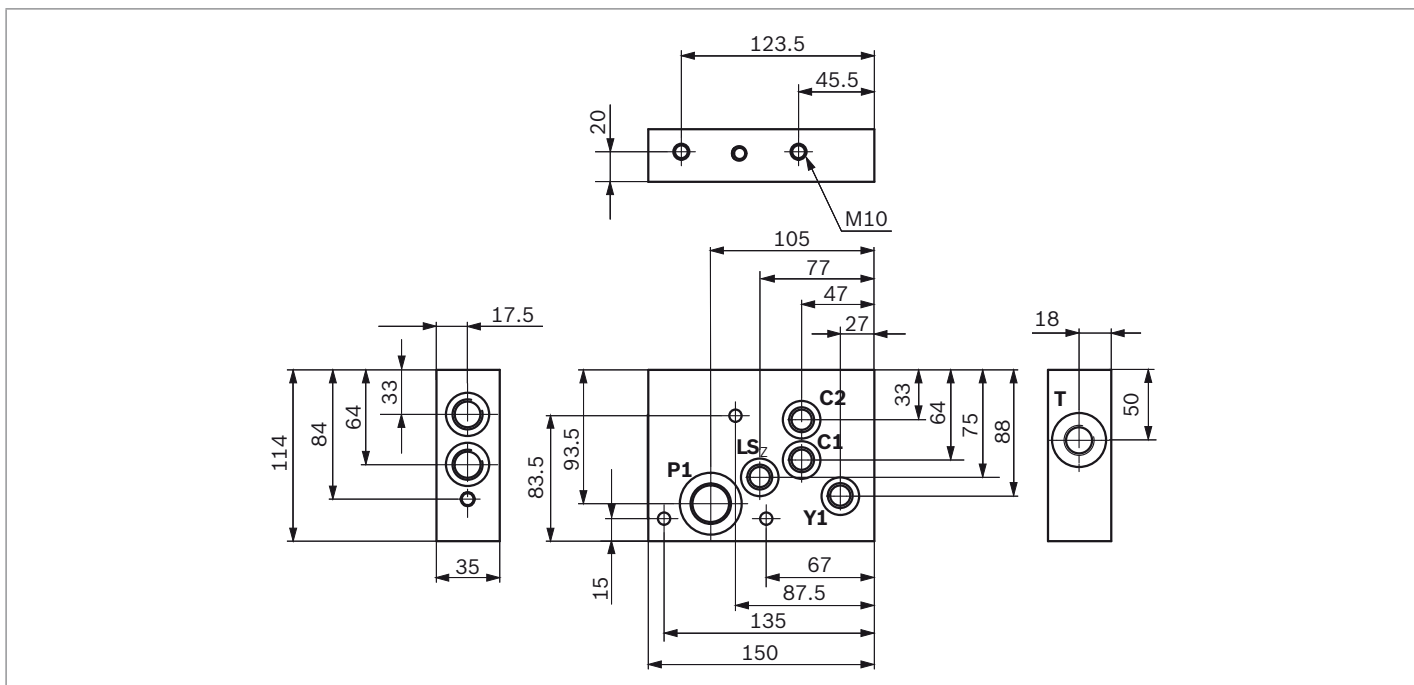
▼ Diversion plate LU



▼ Diversion plate LU with two installation bores

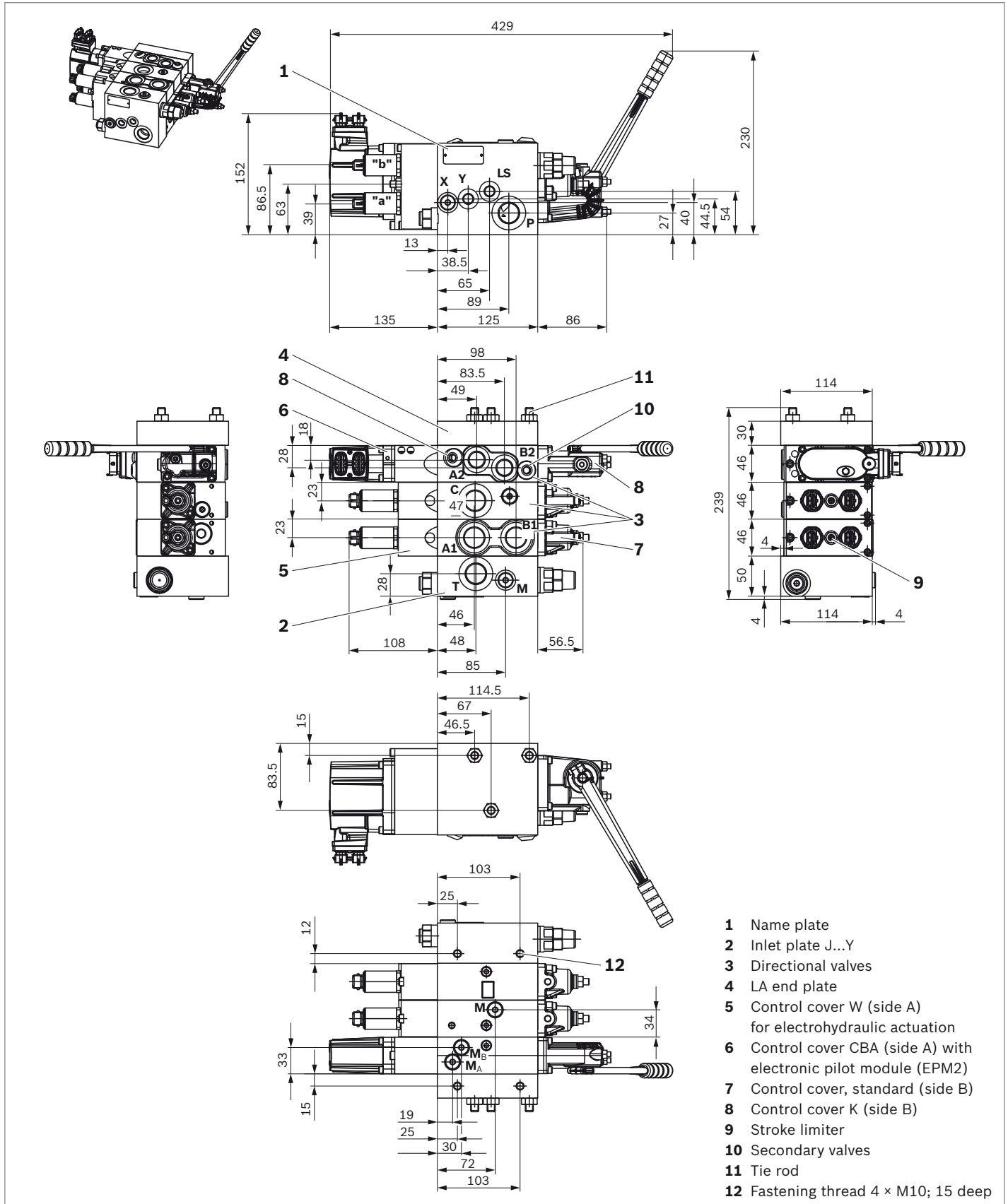


▼ End plate LA with two installation bores

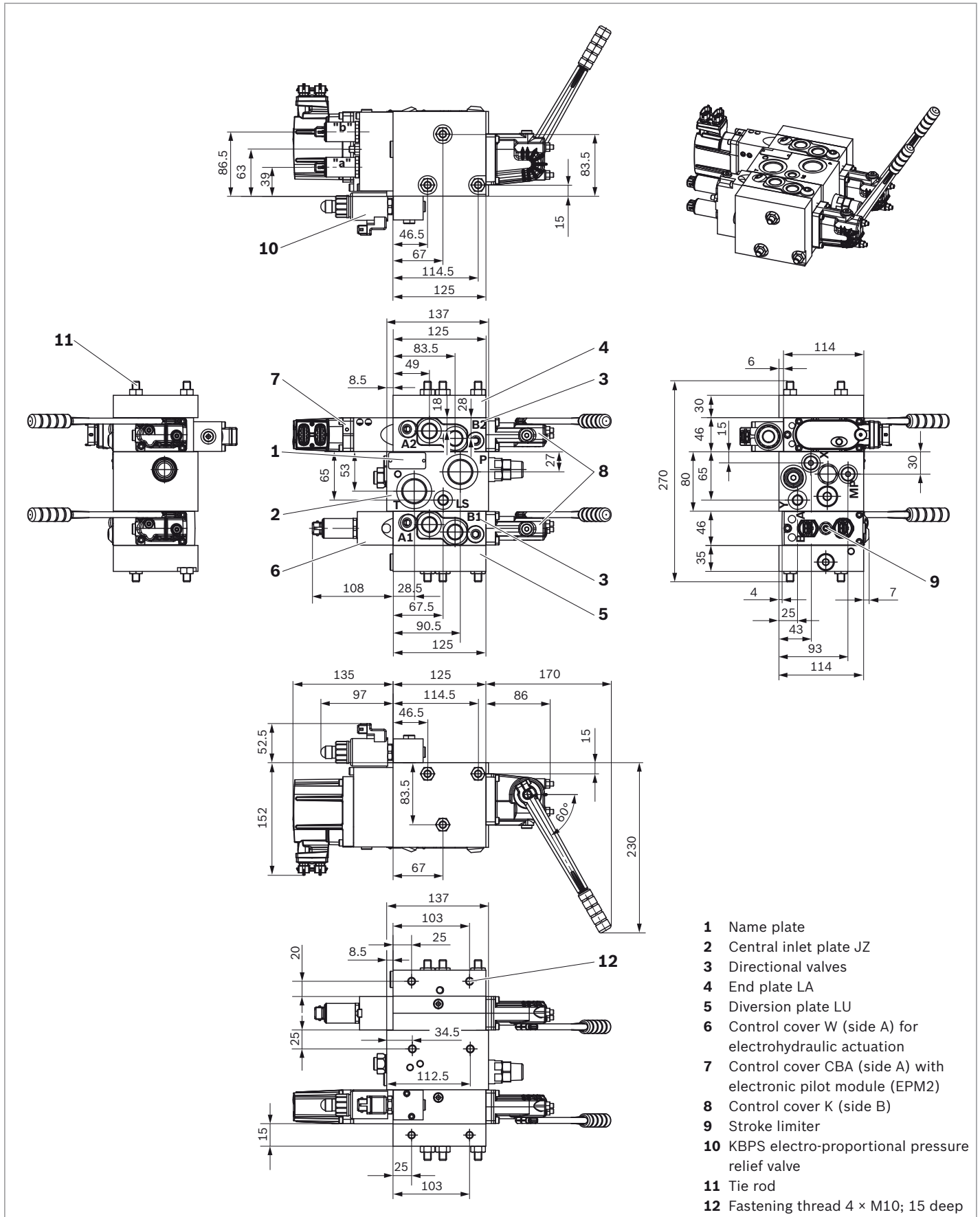


Order examples

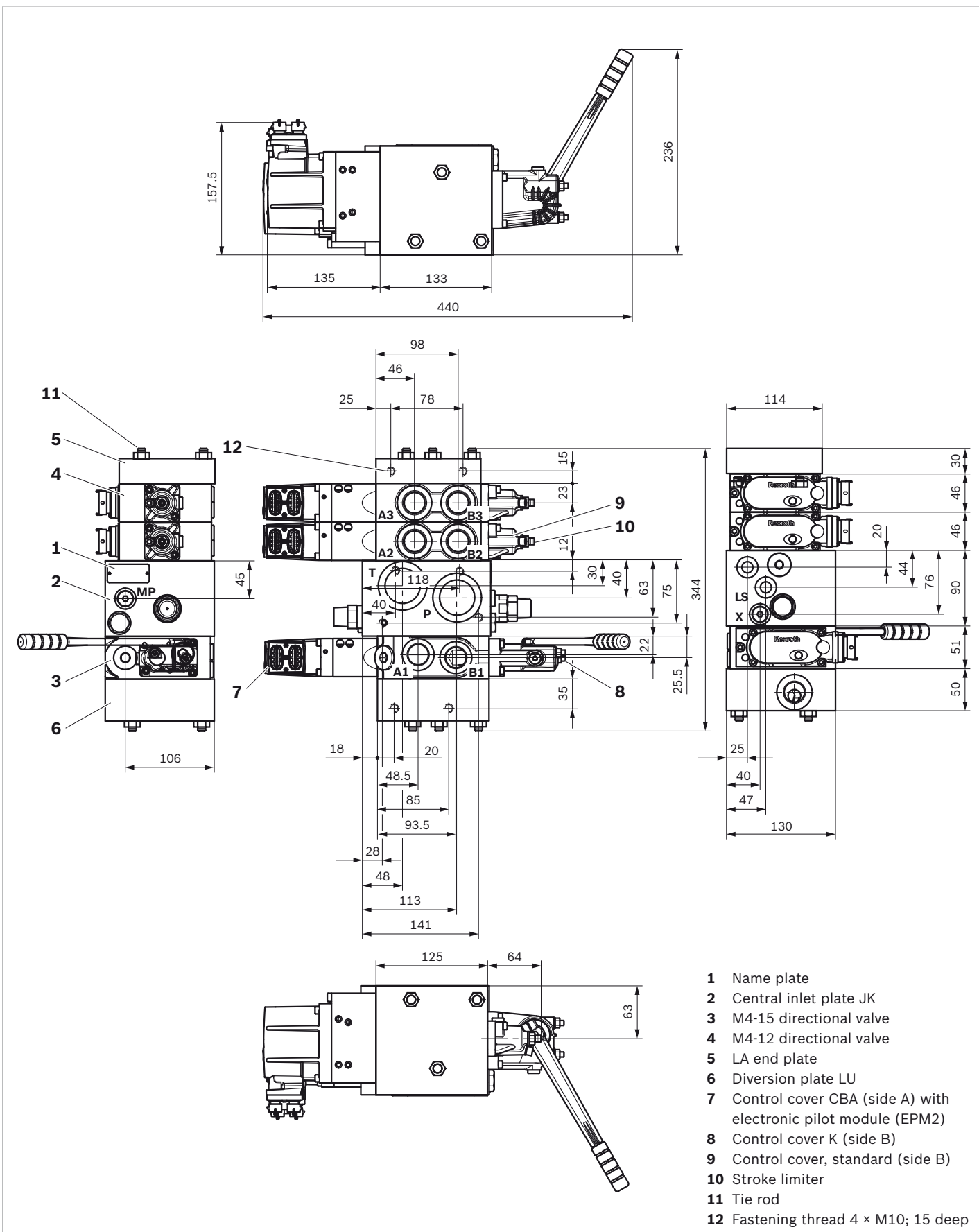
▼ Closed center control block with lateral inlet plate (as per order example on page 13)



▼ Closed center control block with central inlet plate (as per order example on page 15)

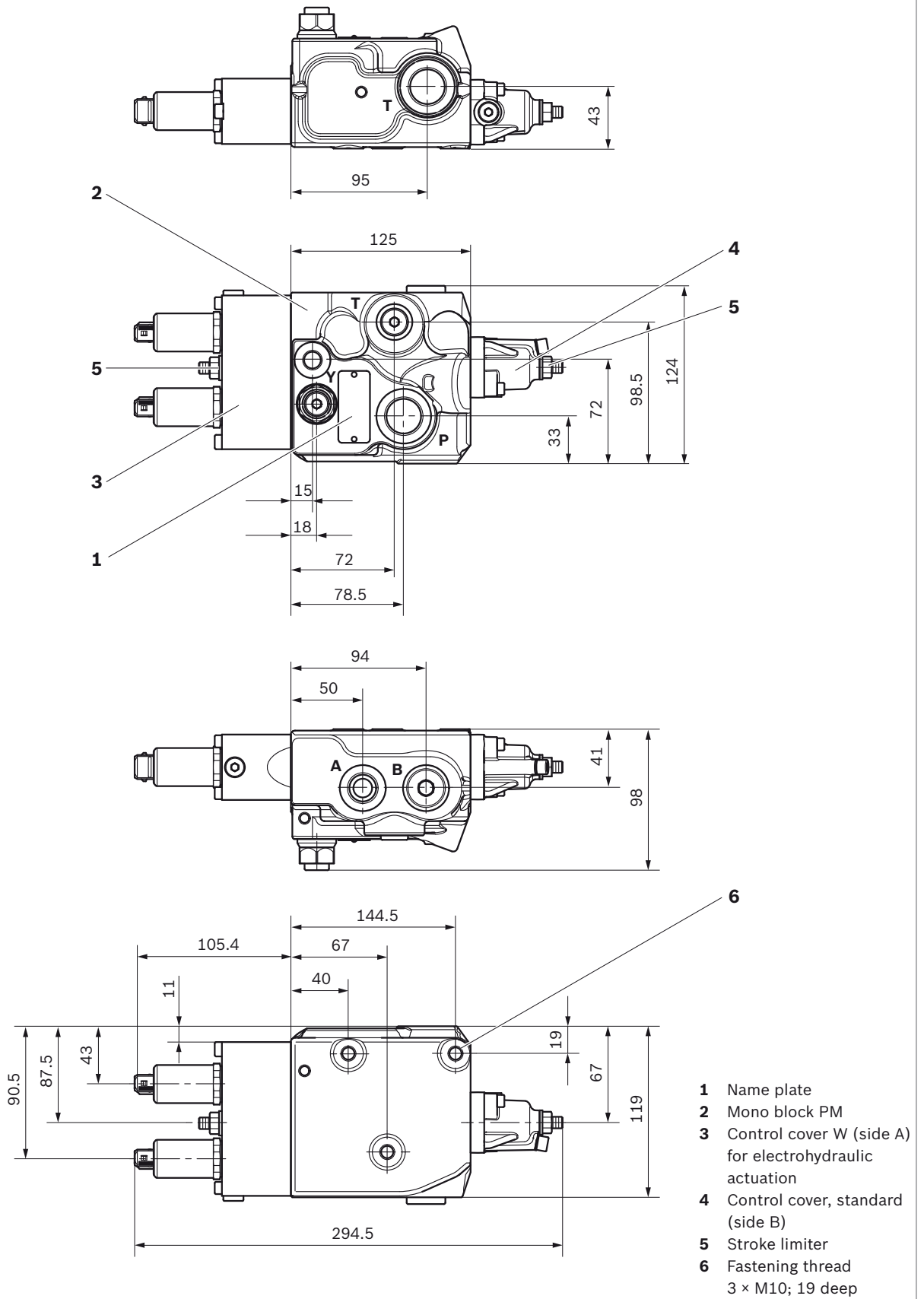


▼ Closed center control block with combination inlet plate (as per order example on page 16)



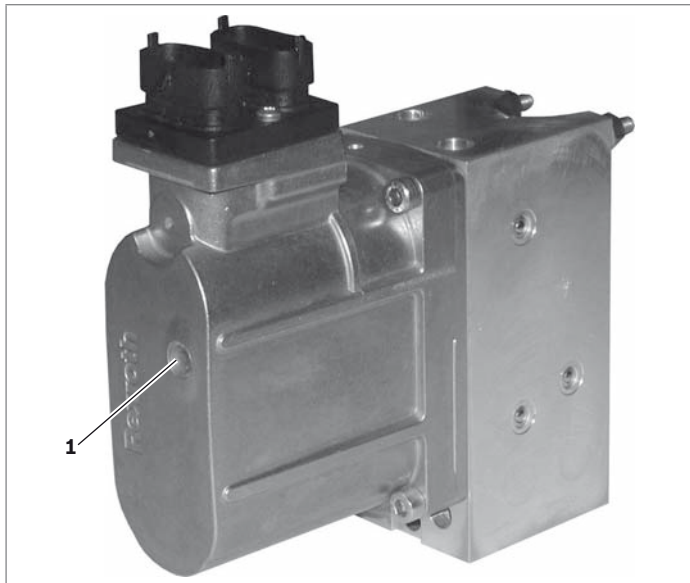
RE 4.16.14.11 B. sc. Re. ro. (A)

▼ **PM open center mono block** (installation of further directional valves is not possible)



On-board electronics: Electronic pilot module (EPM)

▼ Electronic pilot module EPM2



Function

The electronic pilot module provides the flow control on M4-12 control block via a digital electrical signal.

The digital (CAN bus) input signal is converted into a pilot pressure by the pilot module by means of two electrohydraulic pressure reducing valves.

With the CAN bus control, a looping of the electrical connection via the second plug-in connection to the next pilot module is possible (daisy-chain wiring). The entire control block is then connected via the 4-pin Bosch Compact 1 connector of the first pilot module to the machine control.

It is possible to connect further CAN bus devices to the output of the last pilot module (see also RE 64815-B).

Features

Time functions (ramp functions), characteristic curve form and increase can be configured or changed directly via the CAN bus during the working cycle. Various diagnostic functions monitor the correct functioning of the pilot module.

The following are monitored in the basic version:

- ▶ The correct receipt of a valid setpoint signal
- ▶ Stability of the connection to the transmitter
- ▶ Compliance with the defined limits of the supply voltage
- ▶ Function of the pilot valves (short circuit, cable break)

Malfunctions are displayed externally via a visible light-emitting diode (LED) (1) displayed in the form of an error code (flashing code) on the housing.

The CAN bus version transfers the error code in the pilot module status telegram to the open loop control, which can evaluate it.

- ▶ Low wiring costs with CAN wiring as a result of the (daisy-chain) assembly
- ▶ Low flow rate hysteresis through clocked output stages with superimposed dither
- ▶ Processor-independent watchdog
- ▶ Separate selectable time ramps for each valve output A and B, opening and closing
- ▶ Separate changeable characteristic curves from linear to progressive sequence for A and B
- ▶ Linear characteristic curve reduction in operation and consequent linear reduction of total quantity
- ▶ Selectable monitoring limits of the operating voltage can be configured via CAN bus
- ▶ Extensive parameterizability according to customer requirements from the plant by Bosch Rexroth

Options

- ▶ Position sensor
- ▶ Measuring port

Parameterization specifications

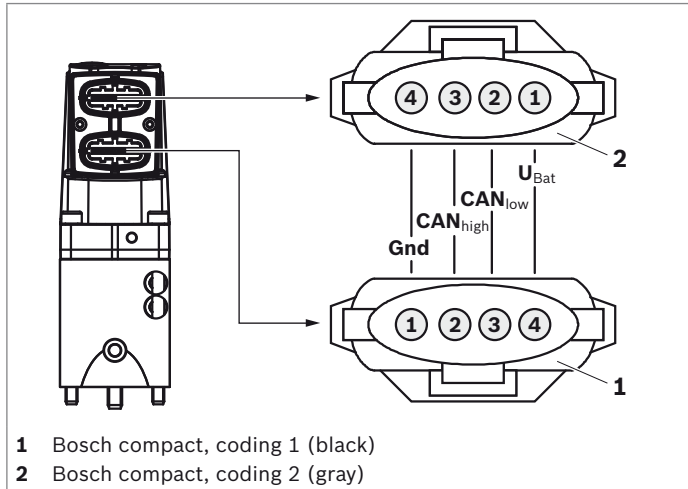
For the parameterization specifications form, see project planning help 64815-02.

It is used for setting the electronic pilot module supplied according to the customer's requirements.

CAN connector pin assignment

Connection via Bosch compact connector, coding 1. When using the CAN control, a connection to the next module or to another CAN participant is possible via the second Bosch compact connector, coding 2.

Pin assignment on the Bosch compact connector

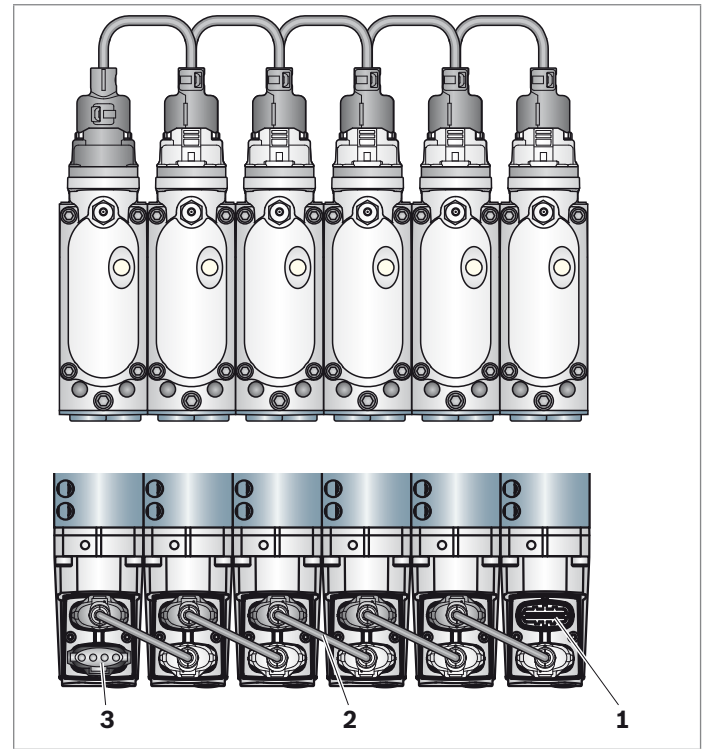


Notice

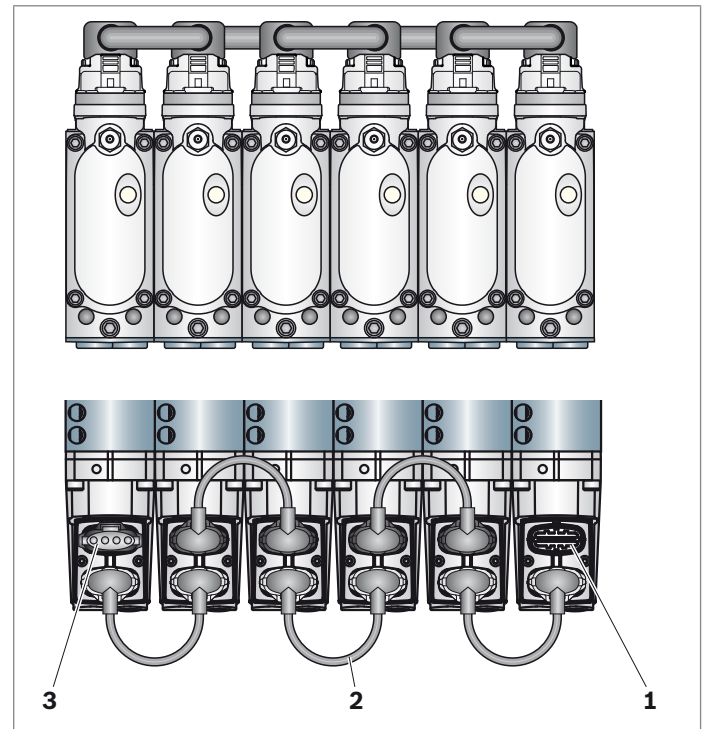
Connection cables and connectors are not included and must be ordered separately (see "Accessories" on page 51).
Rexroth guarantees the correct function of the device, as described in instruction manual 64815-B. Rexroth assumes no liability for the safe operation of the machine or system of which this device forms part.

All control blocks with EPM2 can be optionally equipped with mounted daisy-chain wiring and terminal resistor connector. Terminal resistor is mounted in the last section of the block.
Recommended cable for connection to the machine electronics: Material number: R917c02724

Daisy-chain wiring, standard version



Daisy-chain wiring, compact version



- 1 Open connector for connection to the machine electronics
- 2 Daisy-chain wiring
- 3 Connector with terminal resistor

Accessories

Cables and connectors for EPM

	Material number	Type	Description	Length
Daisy-chain cable, standard version				
	R917c02581	Cable	For connection of two pilot modules (standard)	190 mm
	R917c02599	Cable	For connection of two pilot modules	240 mm
	R917c02628	Cable	For connection of two pilot modules via central inlet	370 mm
Daisy-chain cable, compact version				
	R917c05332	Cable	With two connectors, coding 1 (black) 90°	
	R917c05333	Cable	With two connectors, coding 2 (gray) 90°	
Connection cable				
	R917c02724	Cable	With one connector, coding 1 (black)	4000 mm
	R917c04484	Cable	With one connector, coding 2 (gray)	4000 mm
Connector and connector sets				
	R917c05459	Connector	Coding 1 (black), dummy connector	
	R917c02627	Connector	Coding 2 (gray), dummy connector	
	R917c05458	Connector	Coding 1 (black), dummy connector with integrated terminal resistor	
	R900785606	Connector set	Bosch compact, coding 1 (black)	
	R900785607	Connector set	Bosch compact, coding 2 (gray)	

Plug-in connector for FTDRE... and FTWE...

Recommended plug-in connector 1 and 3 Junior Timer, 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended plug-in connector for Junior Timer, 2-pin (AMP)



Recommended plug-in connector 8 and 9 DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

▼ Recommended plug-in connector for DT04 (DEUTSCH)



M4 configurator

The M4 configurator is available online. It helps to efficiently utilize the flexibility and versatility of the valve right from the design and engineering phase for new machines. This user-friendly and intuitive program asks systematic questions about the specific requirements for the system. It then assembles the corresponding control block from individual components. Technical data sheets, parts lists, schematics, and both 2D and 3D information are instantly available and speed up the development process for the machine. The M4 configurator is linked to the Bosch Rexroth eShop. The order of the configured control block can be placed immediately.



Related documents

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Instruction manual
Load-sensing control block M4-12	64276-E	Spare parts list
Load-sensing control block M4-12	64276-01-R	Repair manual
Load-sensing control block M4-12 for explosive areas	64276-01-B	Instruction manual
Electronic pilot module EPM2	64815-B	Instruction manual
Ordering information for electronic pilot module EPM2	64815-02	Project planning help
Spool position sensor PSM for control blocks for mobile applications	95190	Data sheet
Hydraulic pilot controllers 2TH6	64552	Data sheet
Hydraulic pilot controllers 4TH5, 4TH6, 4TH6N	64555	Data sheet
Directional spool valve FTWE2K	58007	Data sheet
Directional spool valve FTWE4K	58008	Data sheet
Proportional pressure reducing valve FTDRE2K	58032	Data sheet
Proportional pressure reducing valve FTDRE4K	58038	Data sheet
Analog amplifier RA	95230	Data sheet
BODAS series 20 RC controller	95200	Data sheet
2/2-way spool valve KKDE	18136-08	Data sheet
3/2-way spool valve KKDE	18136-09	Data sheet
Proportional pressure relief valve, increasing characteristic curve KBPS.8A	18139-04	Data sheet
Proportional pressure relief valve, decreasing characteristic curve KBPS.8B	18139-05	Data sheet
2-way logic element MH2DAD	64586	Data sheet
Load-sensing control block SP-08	64139	Data sheet
Hydraulic fluids based on mineral oils and related hydrocarbons	90220	Data sheet
Environmentally acceptable hydraulic fluids	90221	Data sheet

Load-sensing control block in sandwich plate design M4-15



- ▶ Size 15
- ▶ Series 2X
- ▶ Nominal pressure
 - on pump side 350 bar
 - on consumer side 420 bar
- ▶ Maximum flow
 - on pump side 400 l/min
 - on consumer side 200 l/min

Features

- ▶ Flow control independent of load pressure
 - Open center for fixed pump
 - Closed center for variable pump
- ▶ Sandwich plate design with up to 18 directional valves
- ▶ Type of actuation: mechanical, hydraulic, electrohydraulic (switching, proportional or with on-board electronics)
- ▶ Pressure limitation
 - Inlet plate: pilot operated pressure valves of large nominal width
 - Directional valve/consumer ports: compact pressure valves with feed function
- ▶ LS pressure limitation
 - Adjustable per consumer port
 - External pressure setting per consumer port possible
 - Electro-proportional per section

Fields of application

- ▶ Cranes
- ▶ High-capacity forklifts and teleforklifts
- ▶ Stone crusher
- ▶ Forestry machinery
- ▶ Drilling equipment
- ▶ Truck applications
- ▶ Municipal vehicles
- ▶ Stationary applications

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Functional description

Control block M4-15

The directional valves are proportional valves according to the load sensing principle.

Consumer control

The control spool (2) is used to determine the flow direction and the flow level that reaches the consumer ports (A or B). Pressure reducing valves (10) control the position of the control spool (2). The size of the electric current on the pressure reducing valve determines the level of the pilot pressure in the spring chambers (9) and thereby the stroke of the control spool (P → A; P → B).

The pressure compensator (3) keeps the pressure differential on the control spool (2) and thereby the flow to the consumers constant.

Load pressure compensation

The pressure compensator (3) regulates pressure changes on the consumers or on the pump. The flow to the consumers remains constant, including with varying loads.

Flow limitation

The maximum flow can be individually set mechanically at the factory according to the ordering code using the stroke limitations (7).

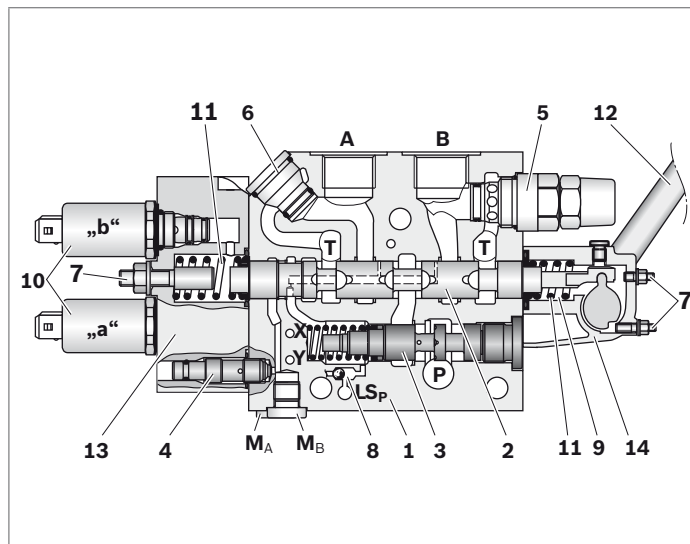
Pressure limitation

The LS pressure for each consumer port can optionally be overridden internally via the LS pressure relief valves (4), electro-proportionally for each spool axis or externally via the LS ports M_A, M_B.

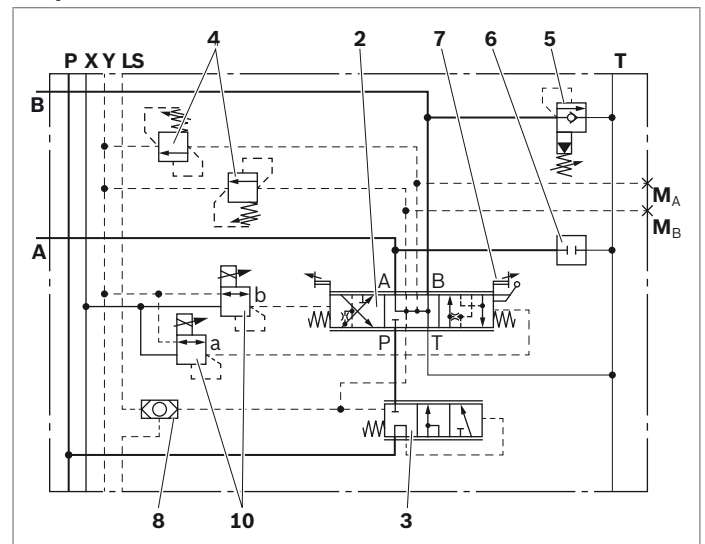
Pressure relief valves with combined feed function (5) protect the consumer ports A and B from pressure peaks and from external forces.

The highest load pressure on the pump is reported via the LS line and the integrated shuttle valve (8).

▼ Section M4-15



▼ Symbol M4-15



- | | |
|----------------------------|-------------------------------------|
| 1 Housing | 5 Pressure valve with feed function |
| 2 Control spool | 6 Threaded plug |
| 3 Pressure compensator | 7 Stroke limiter |
| 4 LS pressure relief valve | |

- | | |
|----------------------------|-----------------|
| 8 LS shuttle valve | 12 Hand lever |
| 9 Spring chamber | 13 Cover A side |
| 10 Pressure reducing valve | 14 Cover B side |
| 11 Compression spring | |

Technical data

General								
Weight	Inlet plate		J	P	VL, VR	JZ	VZ	JK
		kg	6.6	10	10.7	8.5	10.7	11
	Directional valve		M	H	W	CBA		
		kg	7.1	7.1	7.5	7.8		
	Hand lever surplus weight	kg	0.6					
End plate		LA	LAPT	LAY	LAYPT	LAX	LAXPT	
	kg	5.8	6.3	5.6	5.6	5.8	6.2	
		LZ	LZPT	LZY	LZYPT	LZX	LZXPT	
	kg	5.8	6.3	5.8	5.2	5.6	6.3	
		LU	LUT	LVZ	TI			
kg	5.6	5.7	5.6	9.3				
Installation position			Ideally horizontal to the spool axis. For versions with spool position sensor, horizontal to the spool axis or vertical, with the sensor cable on the bottom.					
Consumer line connections			Pipe thread as per ISO 228/1 (inches), ISO 11926-1 (UNF) or JIS B 2351-1 (on request)					
Ambient temperature range		θ	°C	-20 to +80 (-40° to +100 °C on request)				
Priming (standard)			One-coat paint RAL 5001 (more on request)					
Surface protection	Standard priming		h	96 according to DIN EN 60068-2-11				
	Special painting		h	480 according to DIN EN 60068-2-11				
	Painting for SO-038		h	1000 according to DIN EN 60068-2-11				
Mechanical								
Actuating force on the hand lever (encapsulated)	Mechanically operated		N	< 20				
	Mechanical override (with parallel hydraulic actuation)		N	< 70				
	Mechanical override (with parallel electrohydraulic actuation)		N	< 50				
Actuating force in spool axis (not encapsulated)	Tongue		N	< 250				
	Detent with tongue		N	< 350				
Hydraulic								
Maximum working pressure at port	P	p_{max}	bar	350				
	A, B	p_{max}	bar	420				
	LS	p_{max}	bar	420				
	T	p_{max}	bar	30 (20 with mechanical actuation only)				
	Y	p_{max}	bar	Must be routed to reservoir without pressure				
Maximum pilot pressure at port	a, b	p_{St}	bar	35				
	X	p_{St}	bar	35				
Pilot pressure range	Hydraulic	p_{St}	bar	8.5 to 22.5				
	Electrohydraulic	p_{St}	bar	6.5 to 17.2				
Required differential pressure control on the control block	Version S, C	p	bar	18				
	Version T	p	bar	25				
Recommended hydraulic pilot controls			TH6 control curve 97, see data sheet 64552 or 64555					

Hydraulic									
Required pump controller		Controller without LS connection to reservoir, e.g., DFR1, DRS							
Maximum primary pressure limitation		p	bar	370 (set at the factory according to ordering code), min. 20 bar above the pressure cut-off value of the pump					
LS pressure limitation		p	bar	50 to 330 (set at the factory according to ordering code) The highest reduce response pressure of the valve block LS pressure relief valves set at the factory must be at least 20 bar lower than the pressure cut-off value of the pump.					
Maximum flow	Inlet plate			J	P	VL, VR	JZ	VZ	JK
	Port P	q_{Vmax}	l/min	200	200	200	300	300	300
	Directional valve								
	Port A, B	q_{Vmax}	l/min	160 with pressure compensator S and load holding function					
		q_{Vmax}	l/min	200 with pressure compensator T and without load holding function					
		q_{Vmax}	l/min	200 without pressure compensator					
End plate				LAPT	LAYPT	LAXPT	LZPT	LZYPT	LZXPT
	Port P	q_{Vmax}	l/min	100	100	100	100	100	100
Hydraulic fluid		Mineral oil (HL, HLP) according to DIN 51524, HEES (synthetic ester) according to ISO 15380 and other hydraulic fluids on request							
Hydraulic fluid temperature range		θ	°C	-20 to +80 -40 to 100 on request					
Viscosity range		ν	mm ² /s	10 to 380					
Maximum admissible degree of contamination of the hydraulic fluid		Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$							
Cleanliness level as per ISO 4406 (c)									
Electric									
Electrical pilot control valve		FTWE2K...; see data sheet 58007 ¹⁾ FTDRE2K...; see data sheet 58032 ¹⁾							
Recommended amplifier (other actuating options on request)		RA 1-0/10; 1 axis, see data sheet 95230 RA 2-1/10; 4 to 6 axes, see data sheet 95230 RC control units, see data sheet 95200							
Connector version	1 and 3		Junior Timer, 2-pin (AMP)						
	8 and 9		DT04-2P (Deutsch)						
Type of protection according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Connector version 1 and 3		IP66, IP67 and IP69K (with Rexroth plug-in connector) ¹⁾						
	Connector version 8 and 9		IP66, IP67 and IP69K (with installed and locked plug-in connector) ¹⁾						
On-board electronics (EPM2)		Data from page 43; see also instruction manual 64815-B							
Spool position sensor		See data sheet 95190							

Notice

Please contact us if the unit is to be used outside the specified range of values.
The technical data were determined at a viscosity of $\nu = 32 \text{ mm}^2/\text{s}$ (HLP46: 50 °C).

¹⁾ Plug-in connectors are not included in the scope of delivery and must be ordered separately, see page 46.

Modular system

Control blocks in the M4-15 series have a modular structure. They can be combined to provide the perfect solution for the application at hand.

Control block with lateral inlet plate

1. Inlet plate

- A: Closed center **VR** with external priority consumer
- B: Open center **P**
- C: Closed center **J**

2. Directional valves

- 2.1 LS pressure limitation
- 2.2 Secondary valves
- 2.3 Actuation A side
 - A: Mechanical actuation **A**
 - B: Mechanical actuation **M**
 - C: Hydraulic actuation **H**
 - D: Electrohydraulic actuation **W**
 - E: Electrohydraulic actuation **W** with spool position sensor
 - F: Electrohydraulic actuation with on-board electronics EPM2 **CBA**

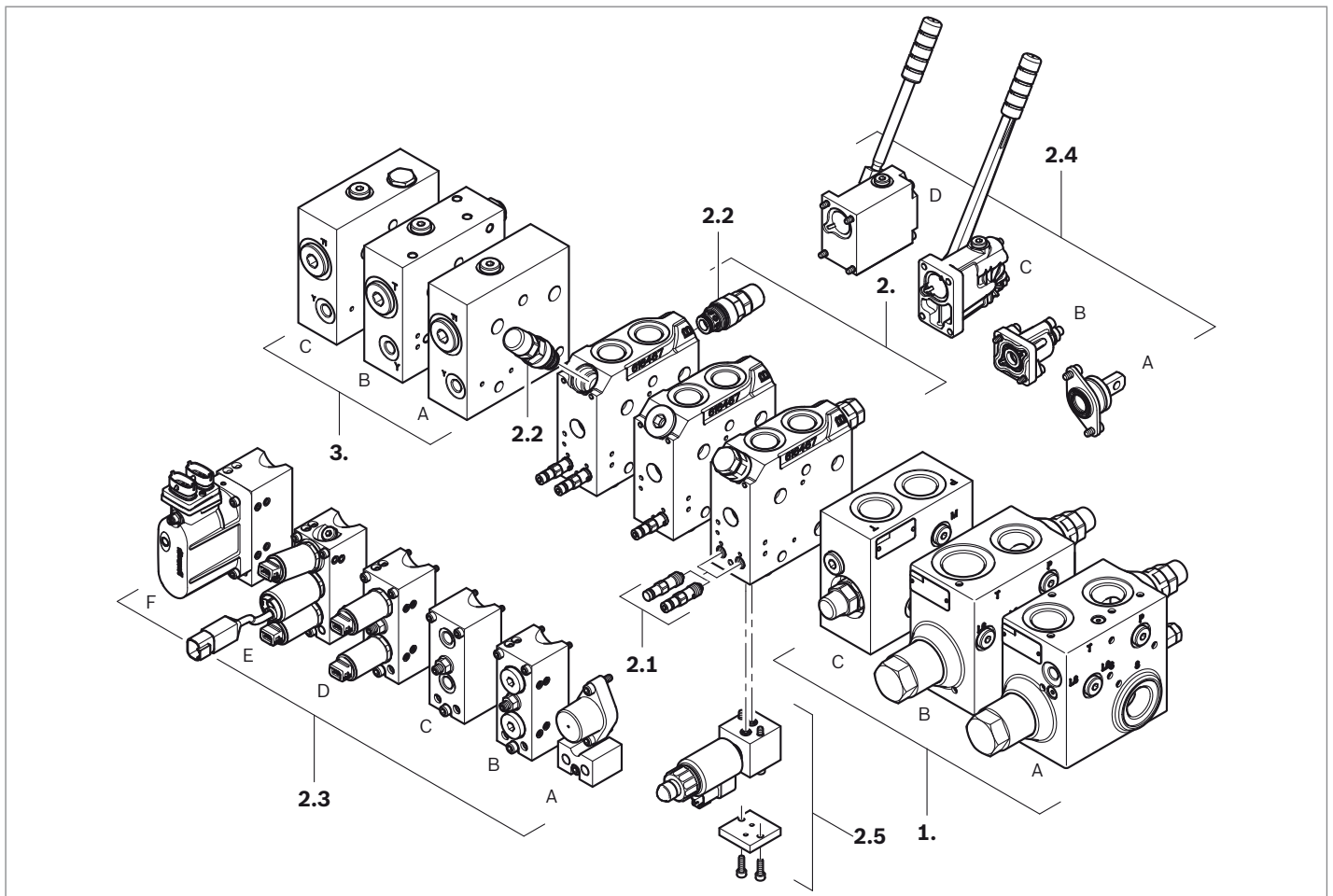
2.4 Actuation B side

- A: Mechanical actuation **Z** with tongue
- B: Standard cover –
- C: Mechanical actuation **K** with hand lever
- D: Mechanical actuation **B2** with guide and hand lever (aluminum-free)

2.5 Electro-proportional LS pressure limitation

3. End plate

- A: End plate **LA, LZ**
- B: With internal pilot oil supply **LAY, LZY**
- C: With external pilot oil supply **LAX, LZX**



Control block with central inlet plate

1. Central inlet plate

A: Closed center **JZ**

B: Closed center **VZ** with priority valve

2. Directional valves

2.1 LS pressure limitation

2.2 Secondary valves

2.3 Actuation A side

A: Mechanical actuation **A**

B: Mechanical actuation **M**

C: Hydraulic actuation **H**

D: Electrohydraulic actuation **W**

E: Electrohydraulic actuation **W** with spool position sensor

F: Electrohydraulic actuation with on-board electronics EPM2 **CBA**

2.4 Actuation B side

A: Mechanical actuation **Z** with tongue

B: Standard cover –

C: Mechanical actuation **K** with hand lever

D: Mechanical actuation **B2** with guide and hand lever (aluminum-free)

2.5 Electro-proportional LS pressure limitation

3. End plate

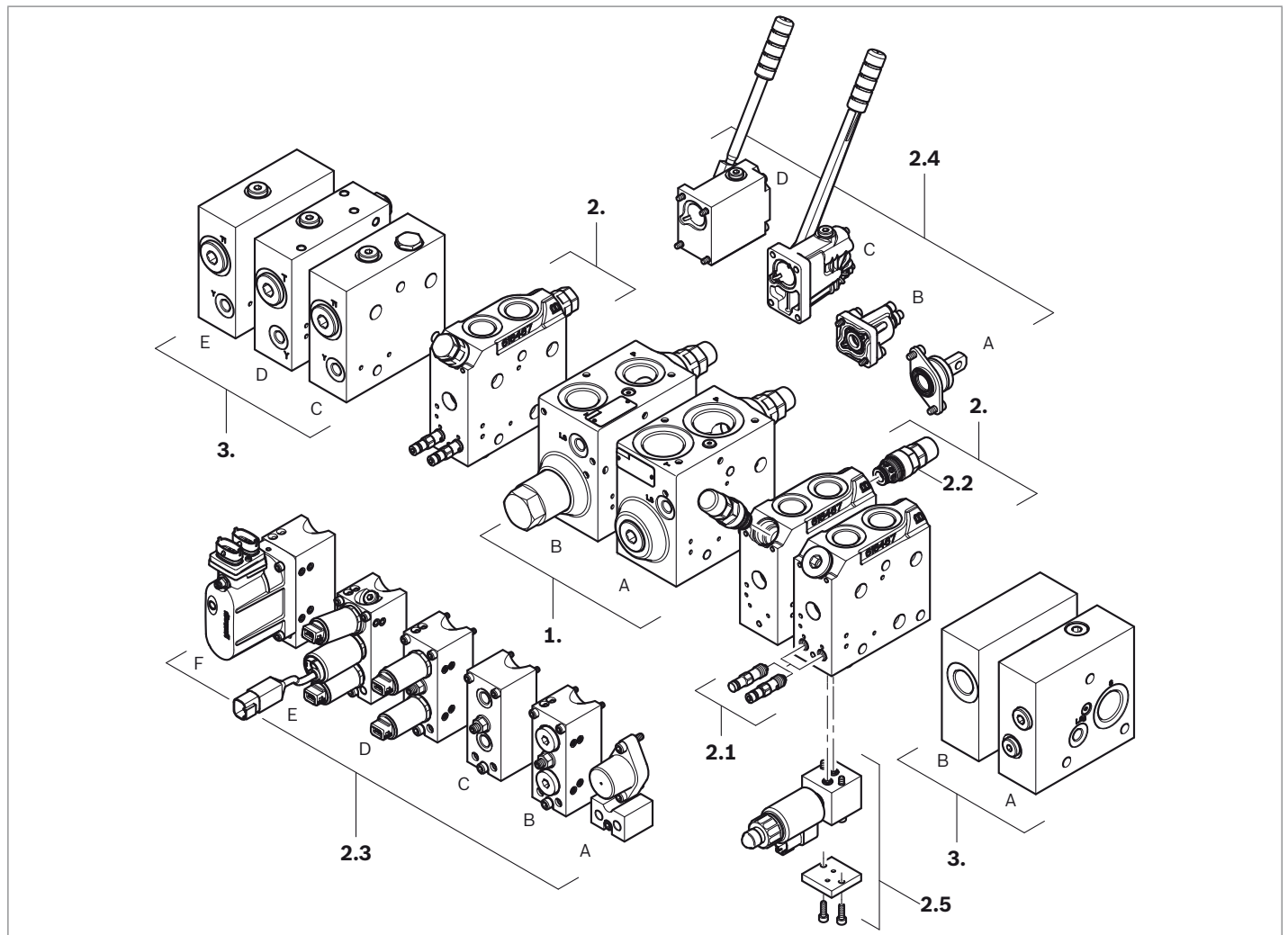
A: Diversion plate with external priority connection **LVZ**

B: Diversion plate **LUT**

C: With LS unloading **LA, LZ**

D: With LS port and pilot oil supply **LAY, LZY**

E: With LS port and pilot oil supply **LAX, LZX**



Ordering code

Specifications on the name plate

The ordering code is used to record the technical features and requirements.

The Rexroth sales organization uses the ordering code to derive a short type and a material number.

The complete control block is defined as per the type code according to DCCS 46001-10.

Example: M4-15 control block with three directional valves

01	02	03	04	05	06	07	08	09	10	11	12			
M4	-	G12345	-	2	0	/	3	M4-15	J	W21	-	V	01	-450

01	Series: M4 load-sensing control block
02	6-digit control block number
03	Series 2X (unchanged installation and connection dimensions)
04	Series amendment status
05	Total number of spool axes (1 to 18) ¹⁾
06	Size, directional valve
07	Inlet plate
08	Actuation A side (mostly)
09	Actuation B side (mostly)
10	Sealing material (mostly)
11	Line connections
12	Optional: Special designation

¹⁾ A maximum of 9 directional valves per side is possible. Always indicate "9" for 10 or more directional valves.

Ordering code sequence

M4-15-2X / **Inlet plate**

Directional valves

End plate, additional information

Inlet plate

M4-15-2X /

Design, system

01	Open center	Lateral inlet plate	P
	Closed center	Lateral inlet plate	J
		Lateral inlet plate, internal priority consumer, external subordinate consumer	VL
		Lateral inlet plate, external priority consumer, internal subordinate consumer	VR
		Central inlet plate	JZ
		Central inlet plate with priority valve	VZ
		Central inlet plate for combination M4-12/M4-15 ¹⁾	JK
		Central inlet plate with logic valve for connecting or switching off a main function with high flow (no other ordering codes required)	XZ

Primary pressure limitation

02	Without primary pressure relief valve (can be retrofitted, not possible with open center version P)	Q
	With primary pressure relief valve, specified pressure in bar, 3-digit	...

Priority valve (information only required with version **V**.)

03	Static priority valve	A
	Dynamic priority valve	B

LS pressure relief priority valve

04	Specified pressure in bar, 3-digit	...
----	------------------------------------	-----

Optional

05	With LS damping nozzles, specification of the nozzle diameter in mm, e.g. S0.6-0.6 (not in conjunction with inlet P)	S...-...
----	--	-----------------

¹⁾ For details see data sheet 64276

= preferred program

Directional valves

M4-15-2X /	01	02	03	04	05	06	07	08	09	10	11	12	13
	*												
	1st spool axis												
	*												
2nd spool axis													
*													
3rd spool axis, etc.													

Pressure compensator

01	With pressure compensator, with load holding function	S
	With pressure compensator, without load holding function	T
	Without pressure compensator, with load holding function	C
	Without pressure compensator, without load holding function	Q

LS pressure relief and housing variant

		02	03	04
02	Without LS pressure relief valve (LS-PRV cannot be retrofitted; M not possible)	Z		Z
04	With threaded plug (Z not possible) ¹⁾	Q		Q
	With LS pressure relief valve (specified pressure in bar, 3-digit; Z not possible) ¹⁾
	With 1 LS pressure relief valve for same pressure setting in A and B (specified pressure in bar, 3-digit) ¹⁾	=		...
	LS relief plug	B		B
03	Housing with measuring ports		M	
	Housing without measuring ports		Z	
	Housing for electro-proportional pressure relief or switchable directional valves ²⁾		K	
	– 210 bar, decreasing characteristic curve ²⁾		L	
	– 210 bar, increasing characteristic curve ²⁾		J	
	– 350 bar, decreasing characteristic curve ²⁾		R	
	– 350 bar, increasing characteristic curve ²⁾		N	

Spool type³⁾

05	Control spool E	E
	Control spool J	J
	Control spool Q	Q
	Control spool with regeneration function	R
	Floating position spool ⁴⁾	W
	Floating position spool ⁴⁾	Y

Flow

06	Flow in consumer port A and B (parameter in l/min, 3-digit)	...-...
	Control spool with pressure function T , only in conjunction with E , J or Q ⁴⁾	...T...

1) Only in combination with pressure compensator S and T
 2) Exact specifications in plain text, see information from page 22
 3) For symbols, see "Control spool" on page 24
 4) Please consult out technical sales department

= preferred program

Actuation A side

07	Mechanical only	Spring-centered	A
		With detent in 1	B1
		With detent in 2	B2
		With detent in 1, 2	B4
	Mechanical ⁵⁾	Encapsulated, spring-centered	M
	Hydraulic ⁶⁾		H
	Electrohydraulically proportional	Standard	W2
		With measuring ports, on both sides	W8
		With damping nozzle + check valve for hydraulic superposition	G2
	Electrohydraulically switchable	Standard	W4
		With damping nozzles, on both sides	W5
		With measuring ports, on both sides	W6
		With damping nozzle, with measuring ports, on both sides	W7
	Electrohydraulic actuation with digital on-board electronics (EPM2)	Standard	CBA
With position sensor		CPA	

Supply voltage and connector type⁷⁾

		24 V	12 V
08	Junior Timer, 2-pin (AMP)	1	3
	DT04-2P (Deutsch)	8	9

Actuation B side

09	Mechanical only, spool end with tongue		Z	
	Standard cover		-	
	Cover with hand lever ⁸⁾		Revolving	Not revolving
		Without hand lever	R	X
		Hand lever position 60°	K	N
		Hand lever position 0°	L	O
Hand lever position -60°	M	P		

Secondary valves for consumer ports A and B

10	None ⁹⁾	With threaded plug (secondary valves can be retrofitted)	Q
11	With	Feed valve	E
		Pressure relief / feed valve, adjustable	H...

Optional special designation

12	One-sided actuation, two switching positions	-011
	With spool position sensor	-S

Optional

13	Further specifications in plain text	*
----	--------------------------------------	----------


5) Always in conjunction with revolving hand lever

6) For combination with mechanically superposed actuation (B side), Bosch Rexroth recommends a non-revolving hand lever

7) Parameter only required with electrohydraulic actuation and with electro-proportional pressure limitation

8) For more details and versions, see "Variant overview" on page 28

9) Secondary valves must be present in the hydraulic circuit

 = preferred program

End plate, additional information

	01	02	03	04	05
M4-15-2X /			01		*

End plate

01	With LS unloading	Without LS unloading	External pilot oil supply	Internal pilot oil supply	With additional P and T port	
	•					LA
	•				•	LAPT
	•			•		LAY
	•			•	•	LAYPT
	•		•			LAX
	•		•		•	LAXPT
		•				LZ
		•			•	LZPT
		•		•		LZY
		•		•	•	LZYPT
		•	•			LZX
		•	•		•	LZXPT
Diversion plate for use with central inlet plate						LU
With additional T port						LUT
With additional LS, P and T port						LUPT
Adapter plate	for M4-12 directional valves with pilot oil supply					L12Y
	for M4-12 directional valves without pilot oil supply					L12Q
External priority connection (option for connecting another LS control block)						LVZ

Sealing material

02	FKM (fluoroelastomer)	V_
	NBR (nitrile rubber), FKM (fluoroelastomer)	MV
	NBR/FKM (nitrile rubber and fluoroelastomer) for low temperature range down to -40 °C (on request)	MT

Pipe thread line connections

03	Inches according to ISO 228/1 ¹⁾	01
	UNF according to ISO 11926/-1 ²⁾	19
	JIS B 2351-1 (on request)	64

Optional special designation

04	Increased corrosion protection (seawater-resistant) ³⁾	-038
	Aluminum-free	-450
	For safety-related applications	-S

Optional

05	Further specifications in plain text	*
----	--------------------------------------	----------

1) See "Line connections" on page 33.
 2) For UNF thread, see data sheet RA 64283.
 3) Please consult out technical sales department

 = preferred program

Order examples

Closed center with lateral inlet plate

Example:	<ul style="list-style-type: none"> Three-fold control block with 3 directional valves Variable pump $q_{v, \max} = 200$ l/min via inlet + 100 l/min via end plate is possible
Inlet	<ul style="list-style-type: none"> Closed center, lateral With primary pressure relief valve, set to 250 bar With internal pilot oil supply
1st spool axis	<ul style="list-style-type: none"> With pressure compensator, without load holding function With 1 LS pressure relief valve for consumer ports A and B 200 bar Spool symbol J Flow in A and B 190 l/min Type of actuation: hydraulic Secondary valves: Pressure/feed valve, consumer port A and B 320 bar
2nd and 3rd spool axis	<ul style="list-style-type: none"> With pressure compensator, with load holding function With LS pressure relief valve for consumer port A 180 bar, consumer port B 120 bar Spool symbol E Flow in A 85 l/min, in B 60 l/min Type of actuation: hydraulic Secondary valves: Pressure/feed valve, consumer port A and B 320 bar
End plate, additional information	<ul style="list-style-type: none"> With internal LS unloading and additional P and T port FKM seals Pipe thread connections

Ordering codes:

Short type, inlet

								01	02
3	M4	-	15	-	2X	/	J	250	

1st spool axis

01	02	03	04	05	06	07	09	10	11	
T	=	M	200	J	190-190	H	-	H320	H320	

2nd spool axis

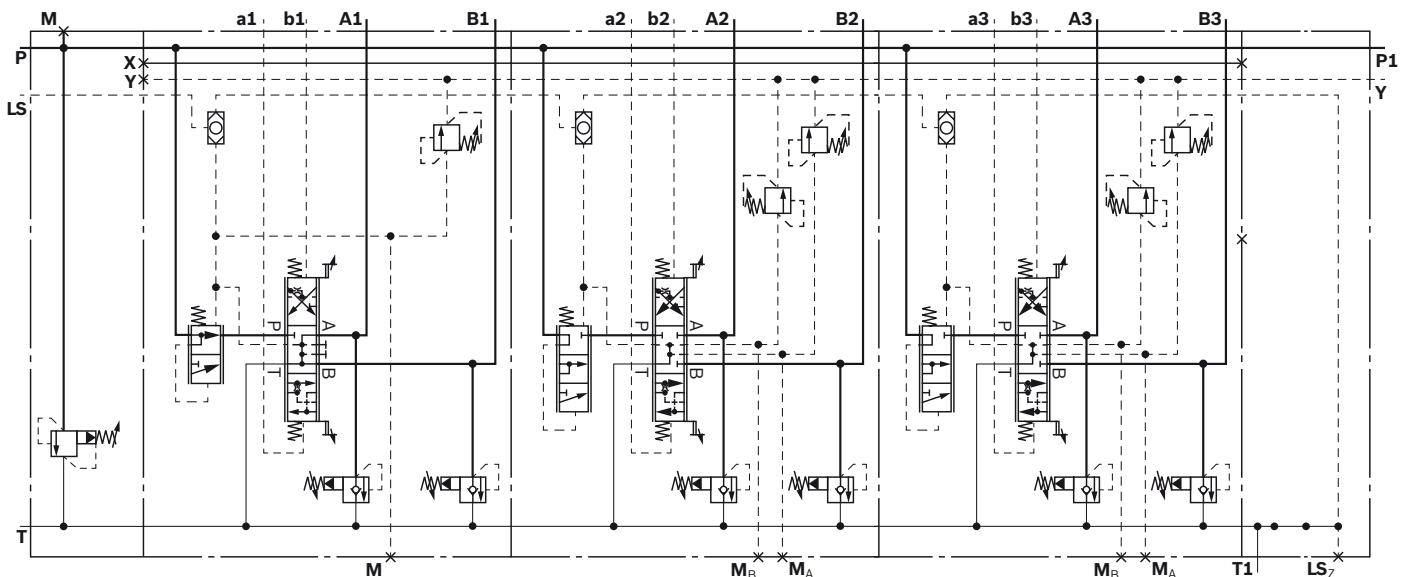
01	02	03	04	05	06	07	09	10	11	
S	180	M	120	E	085-060	H	-	H320	H320	

3rd spool axis

01	02	03	04	05	06	07	09	10	11	
S	180	M	120	E	085-060	H	-	H320	H320	

End plate, additional information

01	02	03	
LAPT	V	01	



Closed center with central inlet plate

Example: – Two-fold control block with 2 directional valves
 – Variable pump $q_{V, \max} = 300$ l/min

Short type, diversion plate – Diversion plate

1st spool axis – With pressure compensator, with load holding function
 – Without LS pressure relief valve bore
 – Spool symbol E
 – Flow in A and B 140 l/min
 – Type of actuation: electrohydraulically proportional
 – With Junior Timer, 2-pin (AMP) 24 V
 – Overriding hand lever (revolving)
 – Secondary valve bores plugged

Inlet – Closed center, central
 – With primary pressure relief valve, set to 300 bar
 – With priority valve (dynamic), set to 250 bar

2nd spool axis – With pressure compensator, with load holding function
 – With LS pressure relief valve for consumer port A 270 bar, consumer port B 300 bar
 – With electro-proportional Pressure limitation, 210 bar (decreasing characteristic curve)
 – Spool symbol E
 – Flow in A and B 90 l/min
 – Type of actuation: digital OBE
 – Overriding hand lever (revolving)
 – Secondary valve bores plugged

End plate, additional information – With internal LS unloading and pilot oil supply
 – FKM seals
 – Pipe thread connections

Ordering codes:

Short type, diversion plate

01										
2	M4	-	15	-	2X	/	LU			

1st spool axis

01	02	03	04	05	06	07	08	09	10	11
S	Z	Z	Z	E	140-140	W2	1	K	Q	Q

Inlet

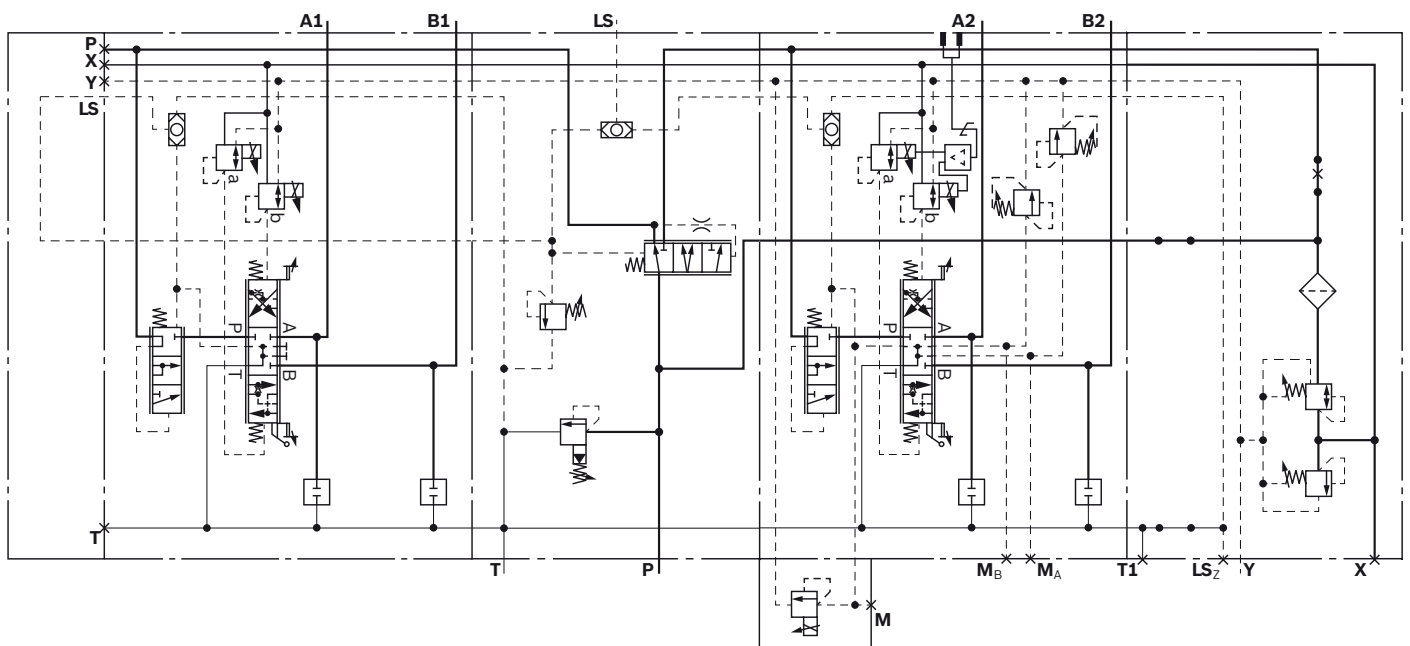
01	02	03	04
VZ	300	B	250

2nd spool axis

01	02	03	04	05	06	07	09	10	11	13
S	270	L	300	E	090-090	CBA	K	Q	Q	KBPSL8BA

End plate, additional information

01	02	03
LAY	V	01



Hydraulic schematic diagram of a closed center valve with two spool axes (A1/B1 and A2/B2). The diagram shows the internal flow paths, including pressure relief valves (LS, PI), pressure compensators, and load holding functions. It also depicts the inlet section with a central inlet (P) and a priority valve (VZ). The end plate section shows connections for pilot oil supply (LS2) and unloading (M).

Inlet plates

Open center

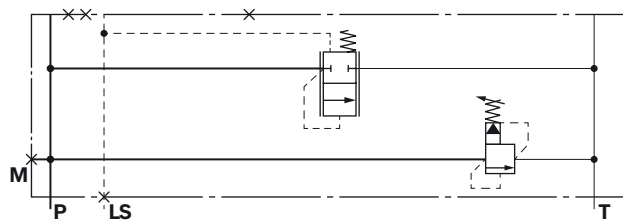
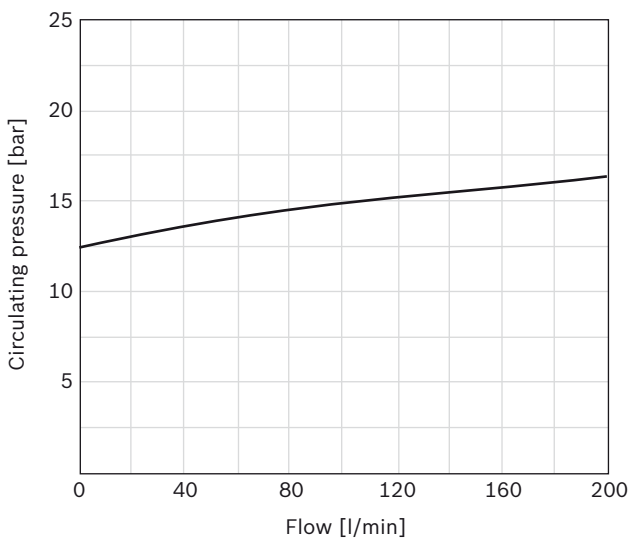
With primary pressure relief valve

Ordering code:

P ...

► Specified pressure in bar required after **P** (3-digit)

▼ Circulating pressure P → T

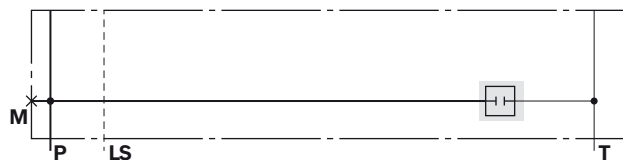


Closed center

Without primary pressure relief valve

Ordering code:

J **Q**

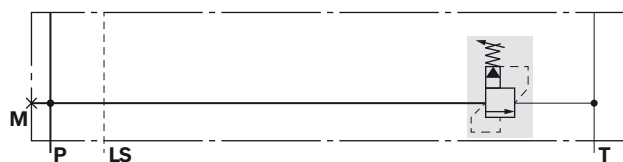


With primary pressure relief valve

Ordering code:

J ...

► Specified pressure in bar required after **J** (3-digit)

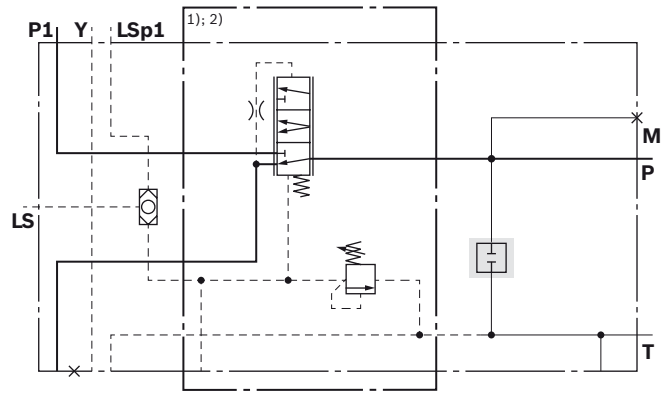


Without primary pressure relief valve, internal priority consumer, external subordinate consumer

Ordering code:

VL	Q	A	...
----	---	---	-----

- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar

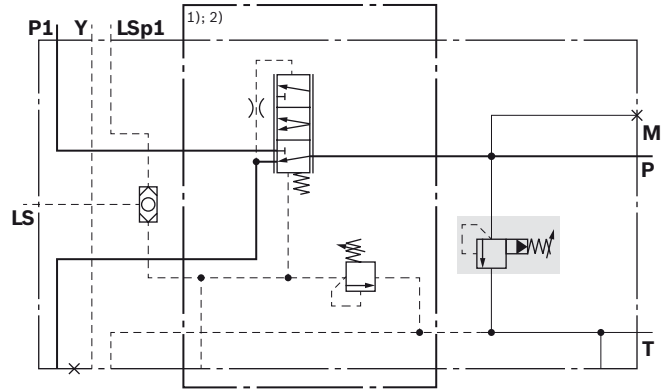


With primary pressure relief valve, internal priority consumer, external subordinate consumer

Ordering code:

VL	...	A	...
----	-----	---	-----

- ▶ Specified pressure in bar required after **VL** for primary pressure relief valve (3-digit)
- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar

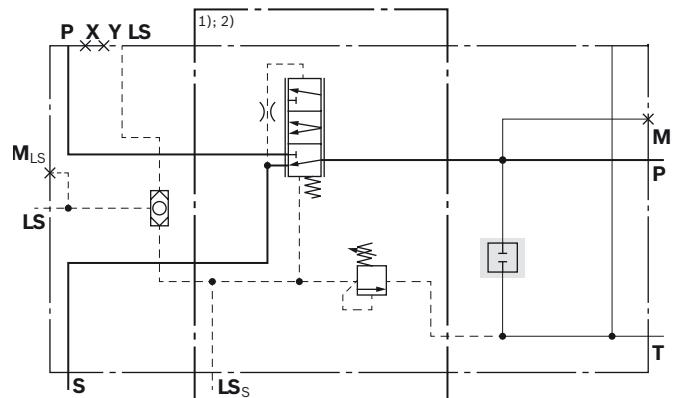


Without primary pressure relief valve, external priority consumer, internal subordinate consumer

Ordering code:

VR	Q	A	...
----	---	---	-----

- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar

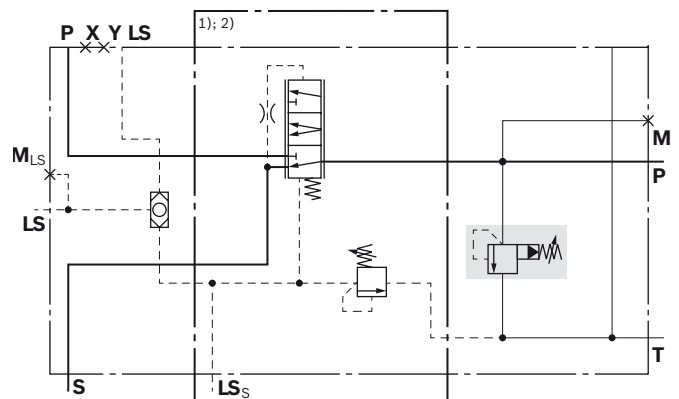


With primary pressure relief valve, external priority consumer, internal subordinate consumer

Ordering code:

VR	...	A	...
----	-----	---	-----

- ▶ Specified pressure in bar required after **VR** for primary pressure relief valve (3-digit)
- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar



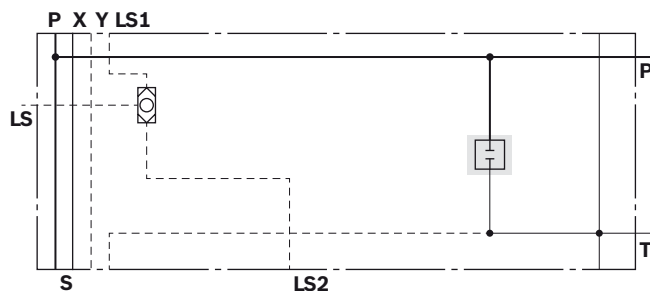
1); 2) Priority valve version, see page 18

Central closed center inlet plates

Without primary pressure relief valve

Ordering code:

JZ	Q
----	---

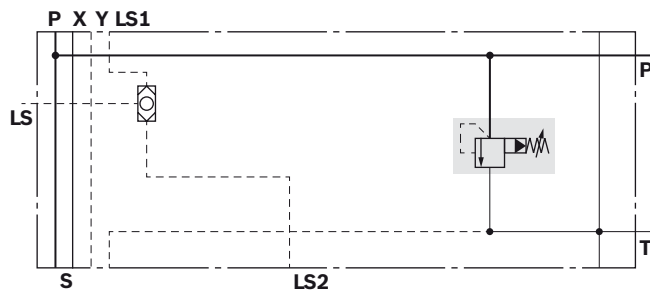


With primary pressure relief valve

Ordering code:

JZ	...
----	-----

- ▶ Specified pressure in bar required after **JZ** (3-digit)

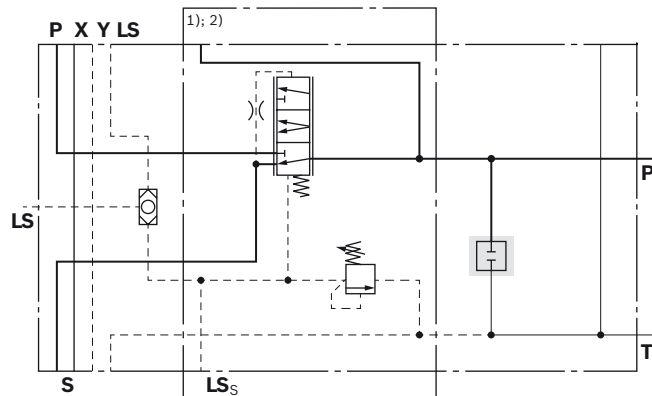


Without primary pressure relief valve, with priority valve

Ordering code:

VZ	Q	A	...
----	---	---	-----

- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar
- ▶ Refer also to the end plate **LVZ** on page 32.

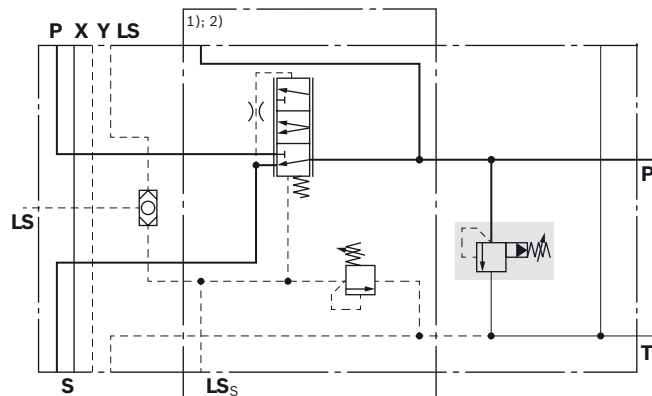


With primary pressure relief valve, with priority valve

Ordering code:

VZ	...	A	...
----	-----	---	-----

- ▶ Specified pressure in bar required after **VZ** for primary pressure relief valve (3-digit)
- ▶ Specified pressure in bar required after **A** for LS pressure relief priority valve (3-digit)
- ▶ Priority consumer is limited to a pressure compensator Δp of max. 14 bar
- ▶ Refer also to the end plate **LVZ** on page 32.



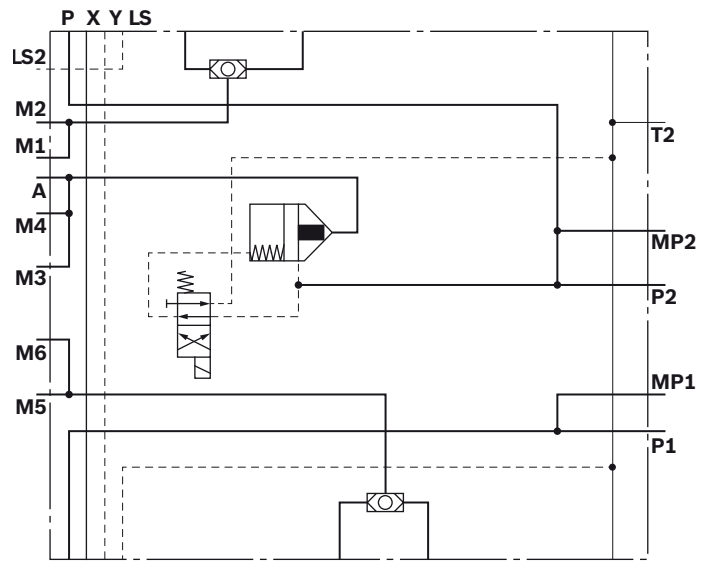
1); 2) Priority valve version, see page 18

With logic valve for connecting or switching off a main function with high flow

Ordering code:

XZ

- ▶ For two individual pump circuits **P1** and **P2** (<10 bar at 200 liters in single operation) and a shared tank port
- ▶ With load sensing for both consumer ports for the left and right directional valves
- ▶ Design by technical sales

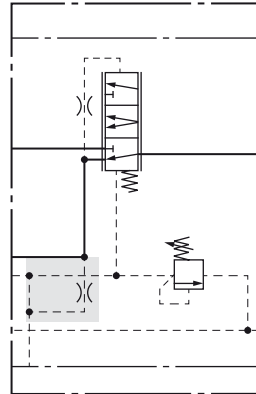
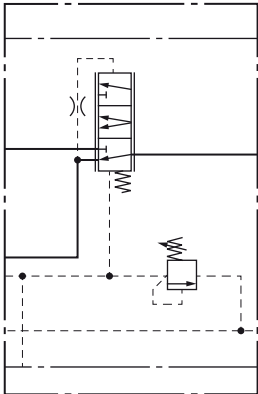


1) For priority consumers with constant flow, version **V ... A** is recommended.

2) For dynamic priority consumers (e.g. control), version **V ... B** is recommended.

▼ **Version V ... A**

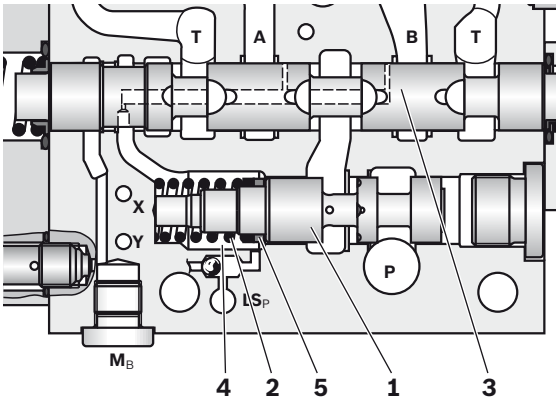
▼ **Version V ... B**



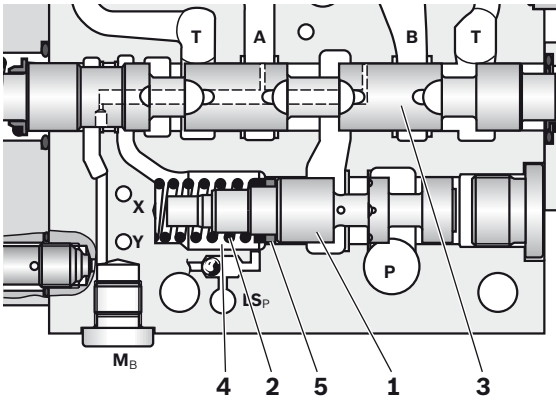
Directional valves

Pressure compensator

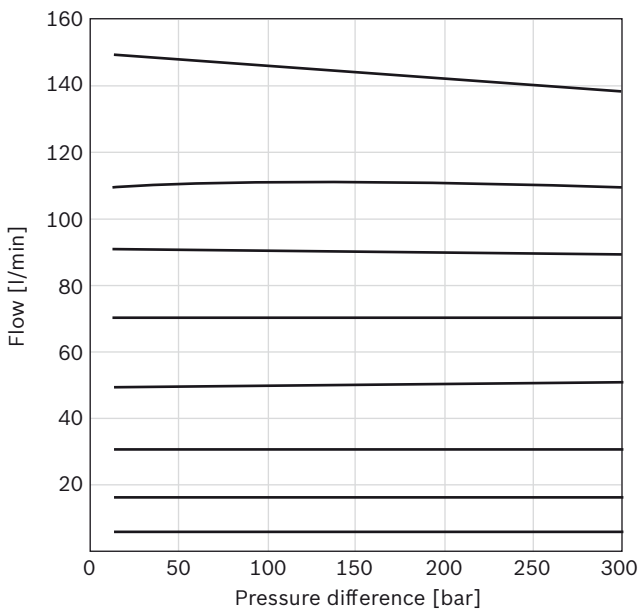
▼ Control spool in central position



▼ Control spool actuated



▼ Flow control by pressure compensator



In the control spool central position there is no connection from **P** to the consumer ports **A** and **B**. Pump pressure shifts the compensator spool (**1**) to the left against the spring (**2**) in this operating condition.

When the control spool (**3**) (= metering orifice) is actuated, the LS pressure reaches the spring chamber (**4**) and shifts the pressure compensator spool to the right into the control position. The flow is also kept constant in parallel operation of consumers with different load pressures.

The pressure compensator **S** is equipped with load holding function. This function is not free of leakage oil.

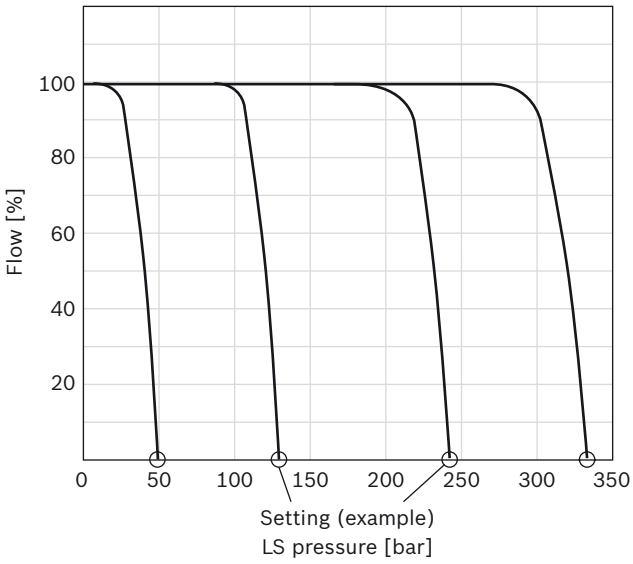
It is equipped with a ring (**5**) as standard. The number of rings fitted depends on the required flow.

Type	Summary	Symbol
S	<ul style="list-style-type: none"> ▶ With pressure compensator ▶ With load holding function¹⁾ ▶ Maximum flow 160 l/min 	
T	<ul style="list-style-type: none"> ▶ With pressure compensator ▶ Without load holding function ▶ Maximum flow 200 l/min 	
C	<ul style="list-style-type: none"> ▶ Without pressure compensator ▶ With load holding function¹⁾ ▶ Maximum flow 200 l/min 	
Q	<ul style="list-style-type: none"> ▶ Without pressure compensator ▶ Without load holding function ▶ Maximum flow 200 l/min 	

1) This load holding function is not free of leakage oil

LS pressure limitation

▼ Consumer flow reduction by LS pressure limitation



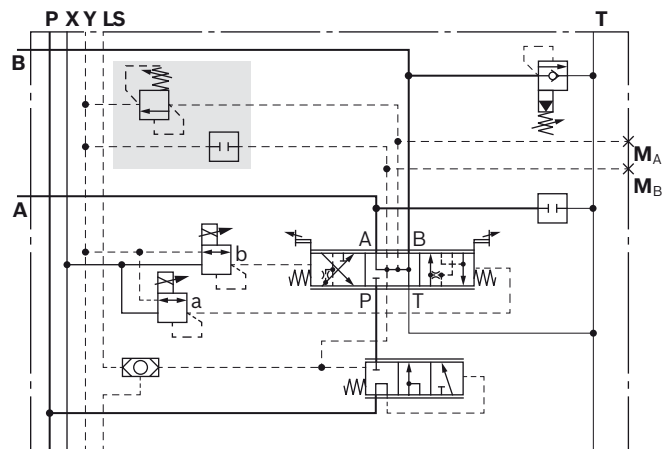
Minimum setting: 50 bar
 Maximum setting: 330 bar

With LS pressure relief valve and LS threaded plug

Ordering code:

S	...	M	Q	J	...-...	W2	1	-	Q	H...
---	-----	---	---	---	---------	----	---	---	---	------

- ▶ Specified pressure in bar for consumer port A (3-digit)
- ▶ Threaded plug for consumer port B
- ▶ With the **QM** version, LS pressure relief can be retrofitted onto the directional valve.
- ▶ The LS pressure can be influenced externally via ports **M_A** and **M_B**. These ports can also be used as measuring ports.

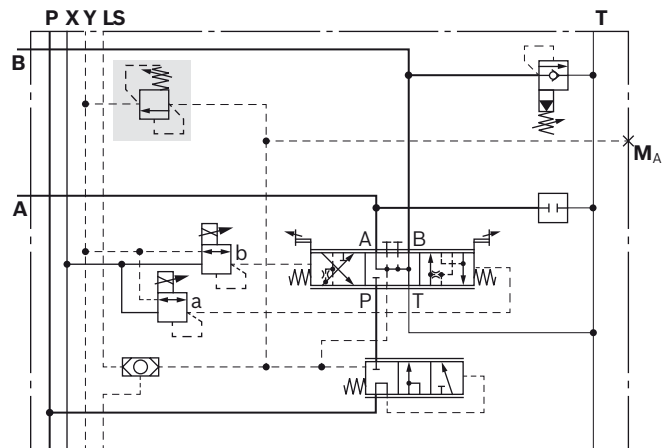


With 1 LS pressure relief valve

Ordering code:

S	=	M	...	J	...-...	W2	1	-	Q	H...
---	---	---	-----	---	---------	----	---	---	---	------

- ▶ Only 1 LS-PRV for the same pressure setting in A and B, specified pressure in bar (3-digit)
- ▶ 1 measuring port

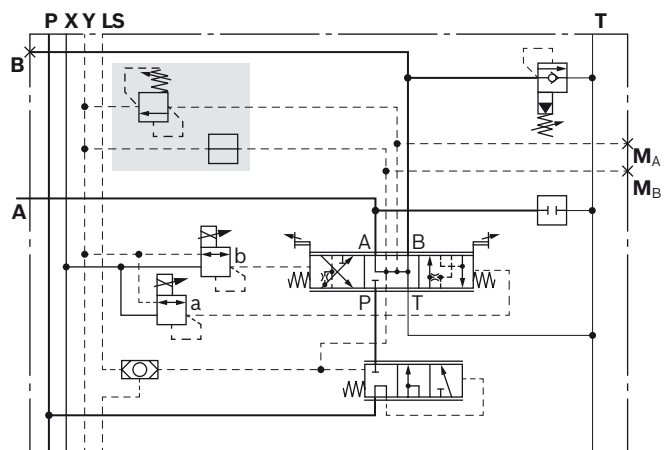


With LS pressure relief valve and relief plug

Ordering code:

S	...	M	B	J	...-000	W2	1	-	Q	H...
---	-----	---	---	---	---------	----	---	---	---	------

- ▶ Specified pressure in bar for consumer port A (3-digit)
- ▶ Relief plug for consumer port B
- ▶ E.g., for cylinders actuated on one side

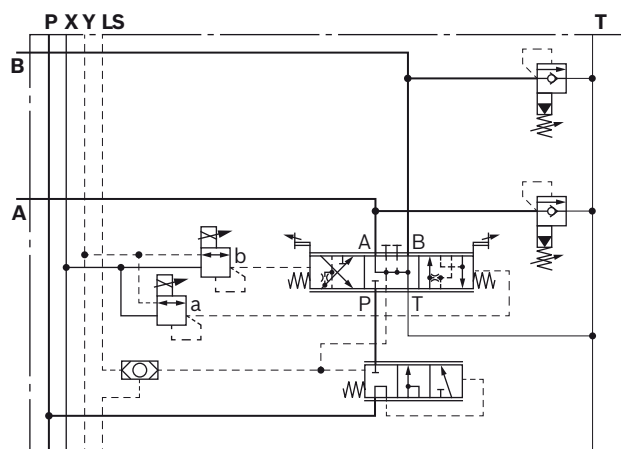


Without LS pressure relief valves

Ordering code:

S	Z	Z	Z	J	...-...	W2	1	-	H...	H...
---	---	---	---	---	---------	----	---	---	------	------

- ▶ LS-PRV cannot be retrofitted
- ▶ Housing without measuring ports

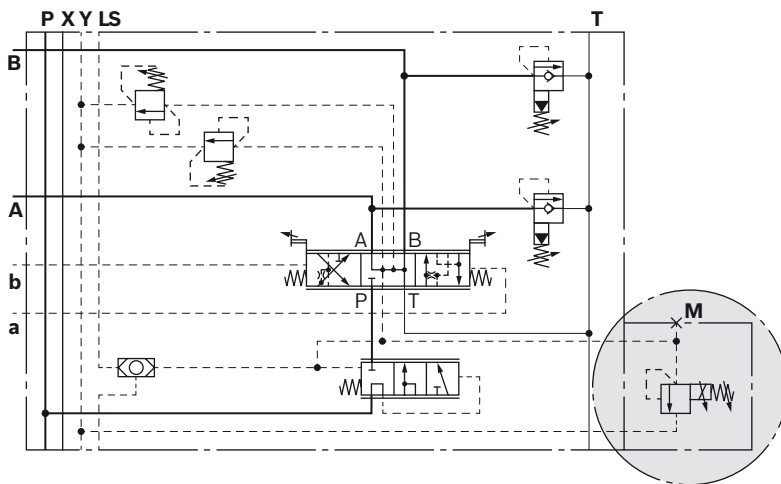


Housing for electro-proportional LS pressure relief/ hydraulically switchable directional valves

Distinction between:

1. Type KBPS
2. Housing KBPS and plug
3. Porting pattern KBPS and cover plate
4. Type MH2DAD and type KBPS
5. Type KKDE

The exact designation of the valve must be specified in plain text as follows.

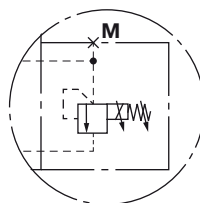


1. Electro-proportional LS pressure relief valve type KBPS

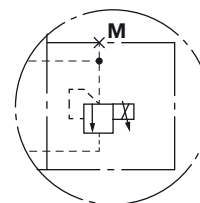
(see also data sheet 18139-04; 18139-05)

Preferred program:

S	...	L	...	J	...-...	H	-	H...	H...	KBPSL8BA
S	...	J	...	J	...-...	H	-	H...	H...	KBPSL8AA
S	...	R	...	J	...-...	H	-	H...	H...	KBPSR8BA
S	...	N	...	J	...-...	H	-	H...	H...	KBPSR8AA



KBPS...BA:
Decreasing characteristic curve



KBPS...AA:
Increasing characteristic curve

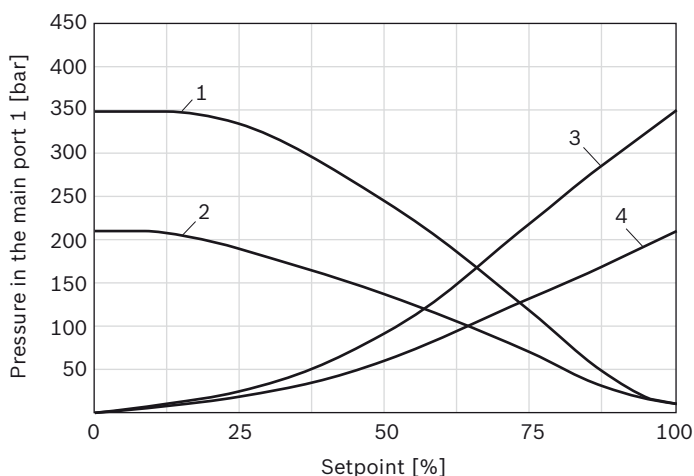
Supplementary program, e.g.:

S	...	K	...	J	...-...	H	-	H...	H...	KBPSH8BA	-033
---	-----	---	-----	---	---------	---	---	------	------	----------	------

	Decreasing characteristic curve	Increasing characteristic curve	Additional SO no. (Option: 24 V; 0.8 A)
50 bar	KBPS C 8BA	KBPS C 8AA	
100 bar	KBPS F 8BA	KBPS F 8AA	
150 bar	KBPS H 8BA	KBPS H 8AA	
210 bar	KBPS L 8BA ⁽²⁾	KBPS L 8AA ⁽⁴⁾	-033
250 bar	KBPS N 8BA	KBPS N 8AA	
315 bar	KBPS P 8BA	KBPS P 8AA	
350 bar	KBPS R 8BA ⁽¹⁾	KBPS R 8AA ⁽³⁾	
420 bar	KBPS T 8BA	KBPS T 8AA	

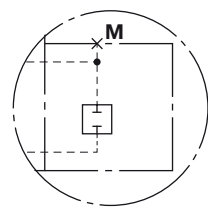
 = preferred program

▼ Pressure control by electro-proportional LS pressure relief



2. Housing KBPS and plug

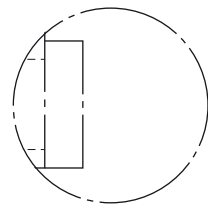
S	...	K	...	J	...-...	H	-	H...	H...	Q
---	-----	---	-----	---	---------	---	---	------	------	---



Plug

3. Porting pattern KBPS and cover plate

S	...	K	...	J	...-...	H	-	H...	H...	A
---	-----	---	-----	---	---------	---	---	------	------	---



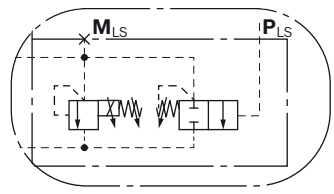
Cover plate

4. Pressure cut-off valve type MH2DAD and electro-proportional LS pressure relief valve type KBPS

(see also data sheet 64586; 18139-04; 18139-05)

S	...	K	...	J	...-...	H	-	H...	H...	MH2DAD+KBPSH8BA
---	-----	---	-----	---	---------	---	---	------	------	-----------------

S	...	K	...	J	...-...	H	-	H...	H...	MH2DAD+Q
---	-----	---	-----	---	---------	---	---	------	------	----------



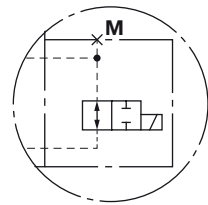
5. 2/2-way spool valve type KKDE

(see also data sheet 18136-08)

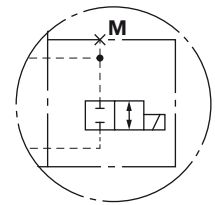
S	...	K	...	J	...-...	H	-	H...	H...	KKDER8PA
---	-----	---	-----	---	---------	---	---	------	------	----------

- ▶ Normally open: KKDER8PA
- ▶ Normally closed: KKDER8NA

Notice
The consumer pressure is not depressurized!



KKDE...PA:
Normally open



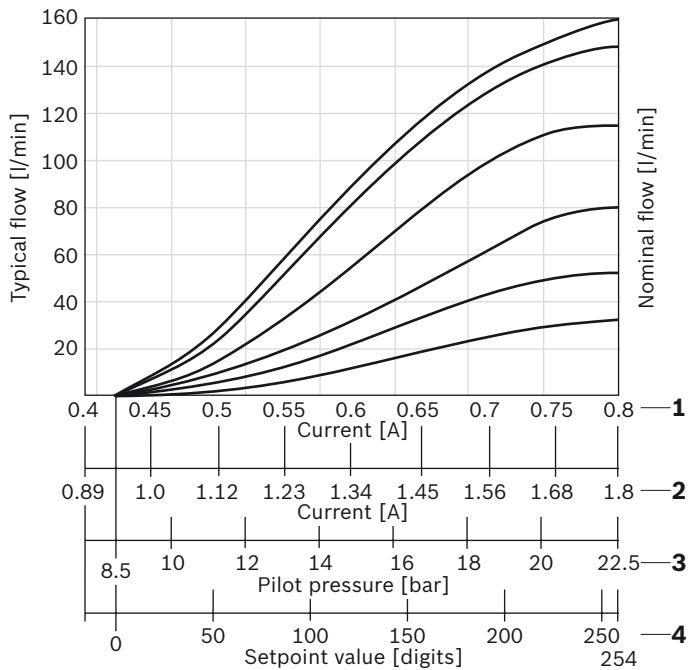
KKDE...NA:
Normally closed

Control spool

Hydraulic cylinder as consumer		Regeneration function (P, B → A)	
E		R	
Hydraulic motors as consumers		Floating position	
J		W	
Application with defined residual opening (A/B → T), consumer port unloaded in neutral position		Floating position¹⁾	
Q		Y	
		Spool with pressure function¹⁾ pilot-pressure dependent consumer supply pressure	
		(E, J, Q) ... T ...	

▼ **Characteristic curves (symmetric control spool)**

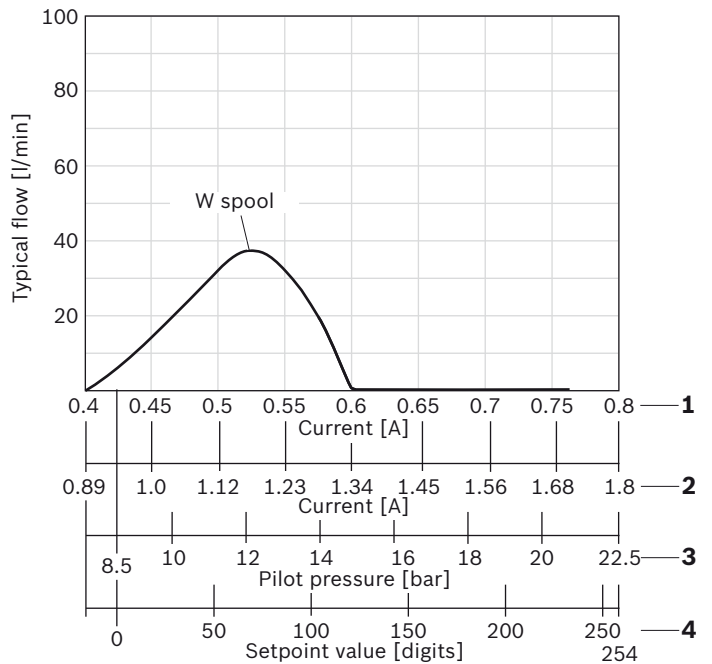
P → A/B



- 1 Electrohydraulic actuation, 24 V control
- 2 Electrohydraulic actuation, 12 V control
- 3 Hydraulic actuation
- 4 Digital on-board electronics (EPM2)

▼ **Characteristic curves floating position spool P → B**

(floating position with maximum actuation)



¹⁾ Design by technical sales

Flow

This is an overview of the preferred spool types. Further spool types are available on request. Individual adaptation

of the spool and groove geometry for the desired control behavior is possible.

Symmetric control spool

Spool type	Pressure compensator	Flow in l/min						
E, J, Q	S	160-160	150-150	120-120	080-080	050-050	032-032	023-023
		140-140	130-130	100-100	070-070	045-045	028-028	020-020
		120-120	110-110	085-085	060-060	040-040	025-025	017-017
	C	200-200	175-175	145-145	110-110	080-080	045-045	028-028
	T	200-200	190-190	160-160	100-100	065-065	040-040	

Asymmetric control spool

Spool type	Pressure compensator	Flow in l/min			
E, J, Q	S	150-120	120-080	080-050	050-032
		130-100	100-070	070-045	045-028
		110-085	085-060	060-040	040-025
	C	175-145	145-110	110-080	080-045
	T	190-160	160-100	100-065	065-040

Floating position and regeneration spool

Spool type	Pressure compensator	Nominal flow in l/min (others on request)	
W	S	065-065	
Y		045-045	
R		130-100	100-140

Notice

Design by technical sales.

Example:

- ▶ Spool type J
- ▶ Pressure compensator S
- ▶ Setpoint value: $q_{\text{consumers}} = 140$ l/min

Solution:

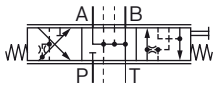
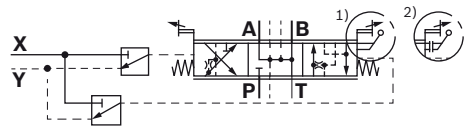
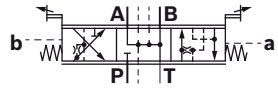
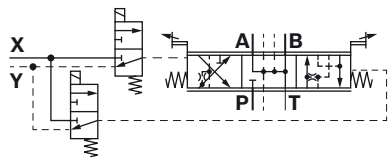
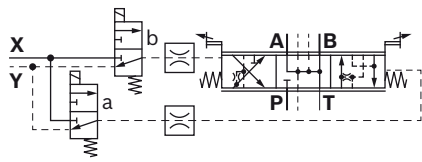
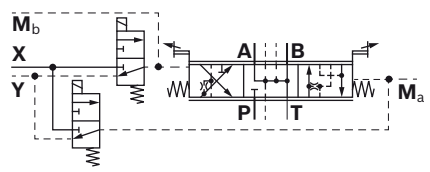
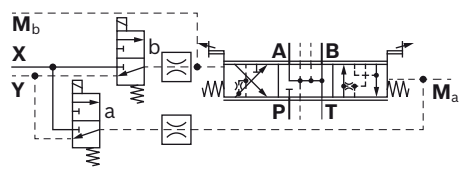
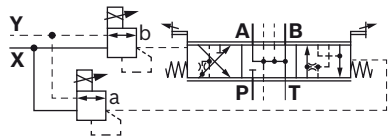
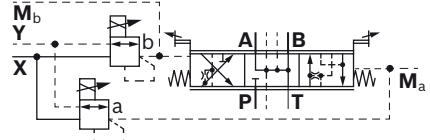
- ▶ 130-liter spool + 2 discs = 150 l/min
- ▶ Set 140 liters via stroke limiter.

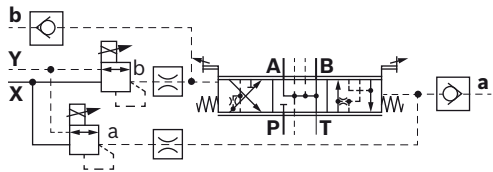
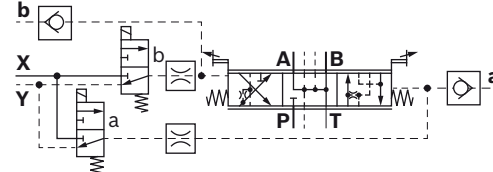
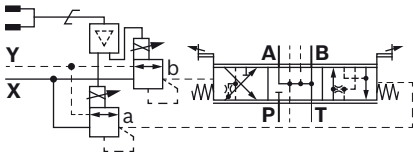
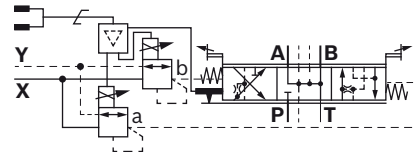
Spool type	Pressure compensator	Flow in l/min	Number of discs
E, J, Q	S	150-150	With 2 discs (pressure compensator $\Delta p = 9$ to 12 bar)
		130-130	With 1 disc (pressure compensator $\Delta p = 7.5$ to 10.5 bar)
		110-110	Without disc (pressure compensator $\Delta p = 6$ to 9 bar)

Notice




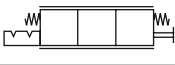
Place directional valves with maximum flow as close as possible to the inlet plate.

Operating methods

Mechanical only (not encapsulated) with tongue	
<p>AZ</p>  <p>► Centering in central position by means of springs in case of non-actuation.</p>	
Mechanical (encapsulated)	
<p>M</p>  <p>► Centering in central position by means of springs in case of non-actuation.</p> <p>► All hand lever position options are possible, cf. also ordering codes on page 28.</p> <p>1) Revolving hand lever 2) Non-revolving hand lever</p>	<p style="background-color: #e0e0e0;">Hydraulic</p> <p>H</p>  <p>► Centering in central position by means of springs in case of non-actuation.</p> <p>► Recommended hydraulic pilot controls: Type 2TH6 and 4TH6 according to data sheet 64552 or 64555</p>
Electrohydraulically switchable	
<p>W4</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>	<p style="background-color: #e0e0e0;">Electrohydraulically switchable with damping nozzle on both sides</p> <p>W5</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>
Electrohydraulically switchable with measuring ports on both sides	
<p>W6</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>	<p style="background-color: #e0e0e0;">Electrohydraulically switchable with damping nozzle, with measuring ports on both sides</p> <p>W7</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>
Electrohydraulically proportional	
<p>W2</p>  <p>► FTDRE2K proportional pressure reducing valve as per data sheet 58032</p>	<p style="background-color: #e0e0e0;">Electrohydraulically proportional with measuring ports on both sides</p> <p>W8</p>  <p>► FTDRE2K proportional pressure reducing valve as per data sheet 58032</p>

<p>Electrohydraulically proportional with damping nozzle and check valve for hydraulic superposition</p>	<p>Electrohydraulically switchable with damping nozzle and check valve for hydraulic superposition</p>
<p>G2</p>  <p>► FTDRE2K proportional pressure reducing valve as per data sheet 58032</p>	<p>G4</p>  <p>► FTDRE2K on/off valve as per data sheet 58007</p>
<p>Electronic pilot module</p>	<p>Electronic pilot module with position sensor</p>
<p>CBA</p>  <p>► Digital interface, standard, refer to instruction manual 64815-B</p>	<p>CPA</p>  <p>► Digital interface, with position sensor, refer to instruction manual 64815-B</p>

Variant overview for mechanical actuation only (not encapsulated)

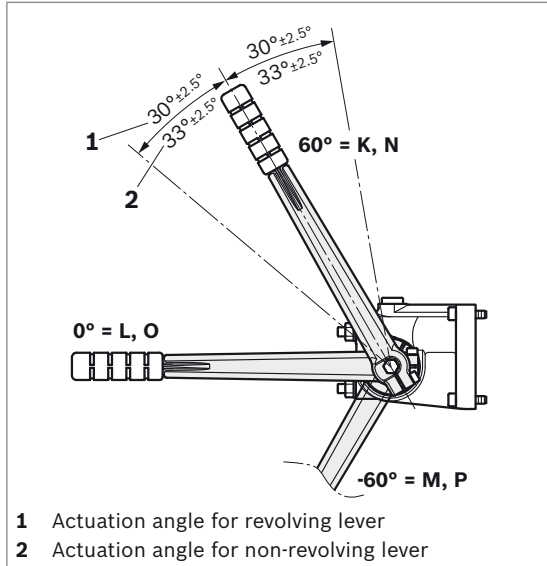
<p>Spring-centered + tongue</p>	
	<p>A Z</p>
<p>Detent + tongue</p>	
	<p>B1 Z</p>
	<p>B2 Z</p>
	<p>B4 Z</p>

Actuating force:

Tongue < 250 N (spool axis)

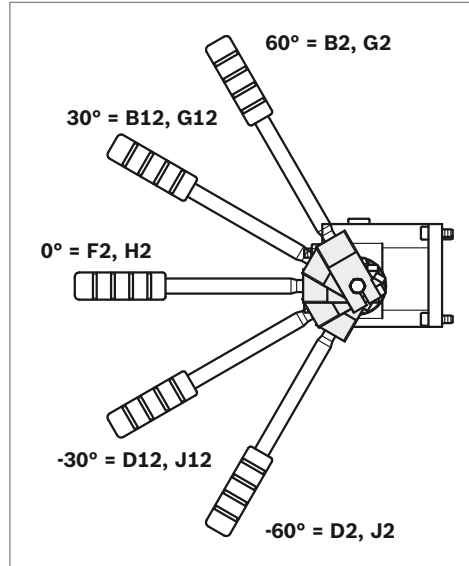
Variant overview for mechanical actuation with hand lever (encapsulated)

▼ **Standard cover with hand lever**

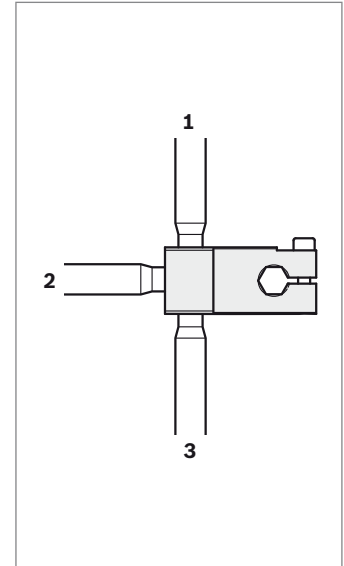


▼ **Cover with clamping piece and hand lever, aluminum-free**

(e.g.: lever screw fitting in position 2)



▼ **Lever screw fitting on the clamping piece**



Ordering code

Lever	Standard cover		Clamping piece with lever				Clamping piece without lever	
	Revolving	Not revolving	Revolving		Not revolving		Revolving	Not revolving
Upward, 60°	K	N	B	2 3	G	2 3	T	Q
Upward, 30°			B1	2 3	G1	2 3	T1	Q1
Straight, 0°	L	O	F	1 2 3	H	1 2 3	U	S
Downward, -30°			D1	1 2	J1	1 2	V1	C1
Downward, -60°	M	P	D	1 2	J	1 2	V	C
Without lever	R	X						

Actuating force (on the hand lever)

- ▶ Mechanical < 20 N
- ▶ Mechanical superposition (with parallel hydraulic actuation) < 50 N
- ▶ Mechanical superposition (with parallel electrohydraulic actuation) < 70 N

= preferred program

Notice

- ▶ Revolving hand lever:
Mechanical actuation can override the electrohydraulic actuation. The hand lever is directly connected to the control spool and follows the spool movement in electrohydraulic control.
- ▶ Non-revolving hand lever:
The hand lever is connected to the control spool via a coupling. If the control spool is in the central position, the hand lever can be snapped into place. With electrohydraulic control, it does not follow the spool movement in this way.

Secondary valves

Pressure relief / feed valve, adjustable

Ordering code:

S	...	M	...	J	...-...	W2	1	-	Q	H...
---	-----	---	-----	---	---------	----	---	---	---	------

- ▶ Adjustable pressure relief / feed valve, pilot operated
- ▶ Specified pressure in bar required after **H** (3-digit)
- ▶ **Example: Q H200**
Q: Threaded plug for consumer port A H200: Pressure relief/feed valve, set to 200 bar for consumer port B
- ▶ See data sheet 18318-35

Feed valves

Ordering code:

S	...	M	...	J	...-...	W2	1	-	E	E
---	-----	---	-----	---	---------	----	---	---	---	---

- ▶ See data sheet 64642

Options

Electrohydraulic, with spool position sensor

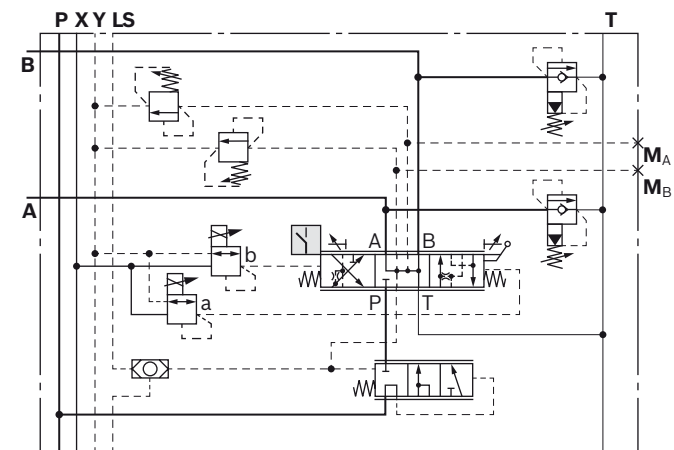
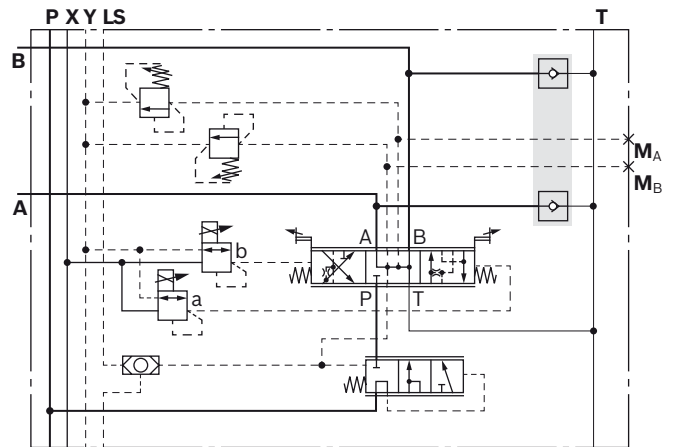
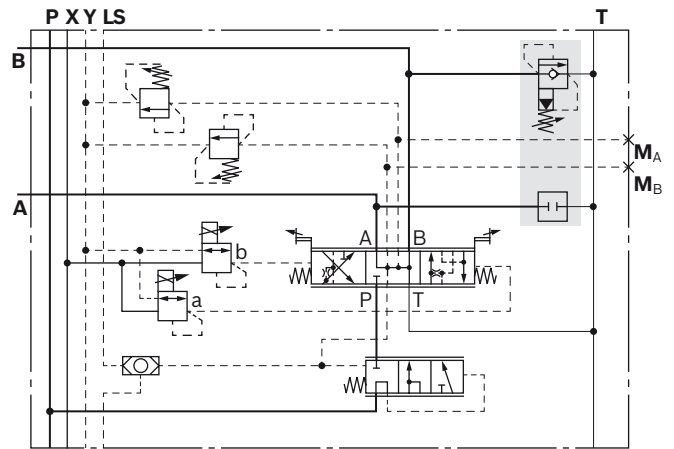
Ordering code:

S	...	M	...	J	...-...	W2	1	K	H...	H...	-S
---	-----	---	-----	---	---------	----	---	---	------	------	----

- ▶ Control spool neutral position and A and B direction of motion detected and monitored by an analogue voltage output signal
- ▶ Pin assignment for connector (connector version DT04-4P DEUTSCH)



- Pin 1: +U_{Batt}
- Pin 2: GND
- Pin 3: Sensor signal for flow direction of consumer port B
- Pin 4: Sensor signal for flow direction of consumer port A



Notice

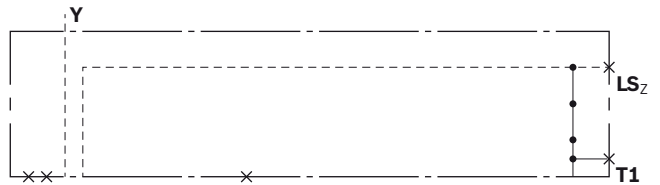
- ▶ Design by technical sales.
For further information, see data sheet 95190.

End plates

End plate with LS unloading

Ordering code:

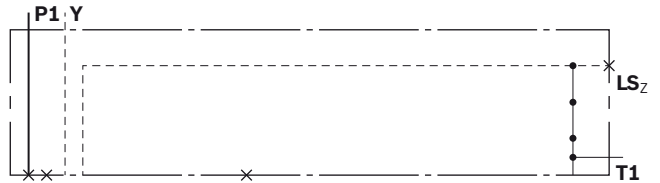
LA



End plate with LS unloading and additional P and T port

Ordering code:

LAPT

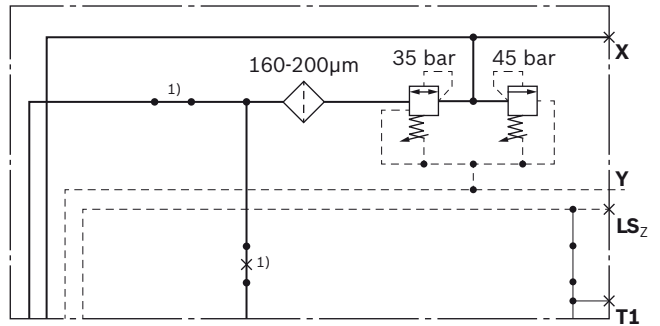


End plate with LS unloading and internal pilot oil supply

Ordering code:

LAY

- Takes oil from **P** line, pressure reduced to 35 bar (fixed), pressure relief valve set to 45 bar

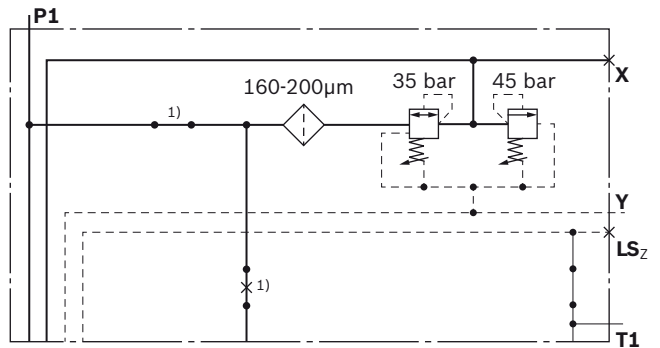


End plate with LS unloading and internal pilot oil supply and additional P and T port

Ordering code:

LAYPT

- Takes oil from **P** line, pressure reduced to 35 bar (fixed), pressure relief valve set to 45 bar

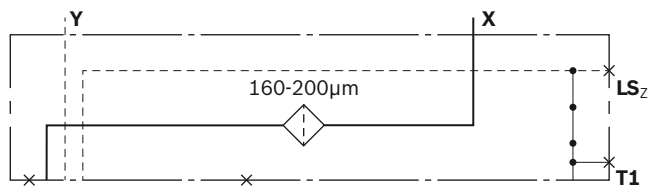


End plate with LS unloading and pilot oil supply

Ordering code:

LAX

- External pilot oil supply required
 $p_{st \max} = 35 \text{ bar constant}$



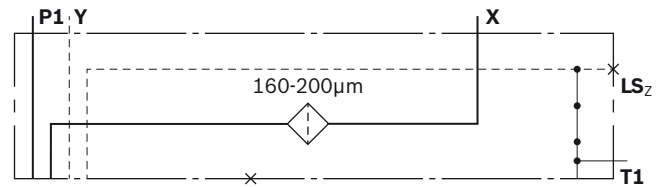
1) When using an inlet plate with priority VR... or VZ... the plug is changed.

End plate with LS unloading and pilot oil supply and additional P and T port

Ordering code:

LAXPT

- ▶ External pilot oil supply required
 $p_{st \max} = 35 \text{ bar constant}$

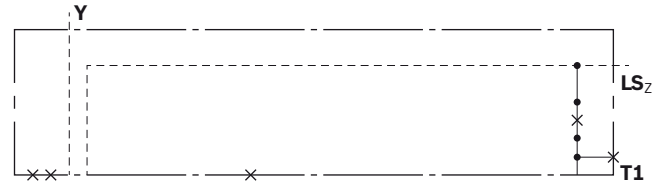


End plate without LS unloading

Ordering code:

LZ

- ▶ Supply of parallel switched LS signals
- ▶ LS unloading must be provided externally

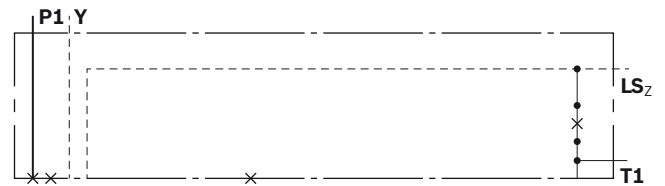


End plate without LS unloading and additional P and T port

Ordering code:

LZPT

- ▶ Supply of parallel switched LS signals
- ▶ LS unloading must be provided externally

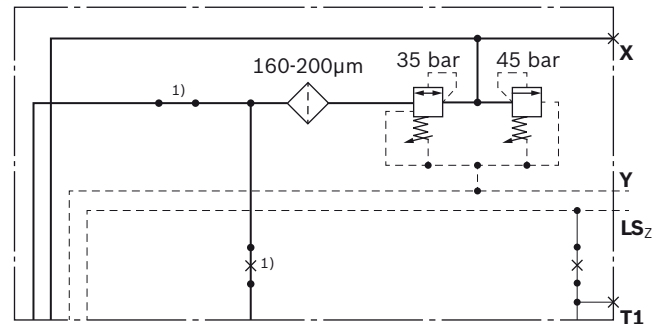


End plate without LS unloading and with internal pilot oil supply

Ordering code:

LZY

- ▶ Takes oil from P line, pressure reduced to 35 bar (fixed), pressure relief valve set to 45 bar
- ▶ Supply of parallel switched LS signals
- ▶ LS unloading must be provided externally

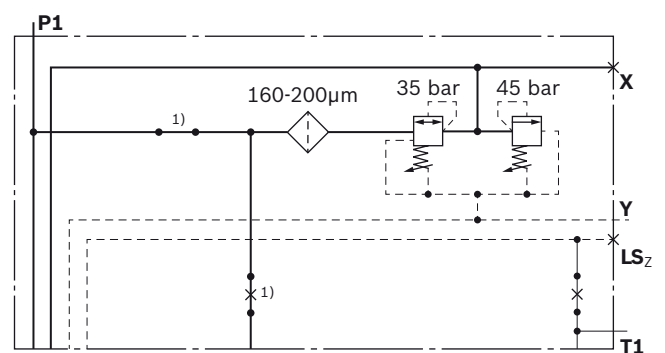


End plate without LS unloading and with internal pilot oil supply and additional P and T port

Ordering code:

LZYPT

- ▶ Takes oil from P line, pressure reduced to 35 bar (fixed), pressure relief valve set to 45 bar
- ▶ Supply of parallel switched LS signals
- ▶ LS unloading must be provided externally



1) When using an inlet plate with priority VR... or VZ... the plug is changed.

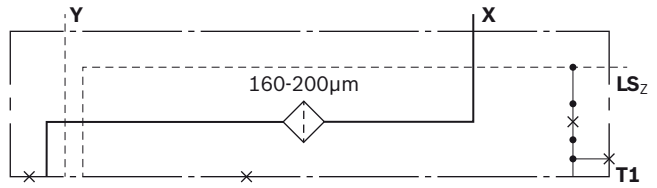
End plate without LS unloading, with pilot oil supply

Ordering code:

LZX

- ▶ Supply of parallel switched LS signals
- ▶ External pilot oil supply required

$p_{st \max} = 35 \text{ bar}$



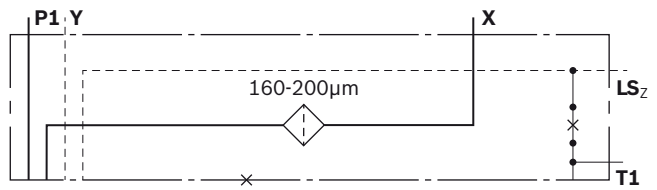
End plate without LS unloading, with pilot oil supply and additional P and T port

Ordering code:

LZXPT

- ▶ Supply of parallel switched LS signals
- ▶ External pilot oil supply required

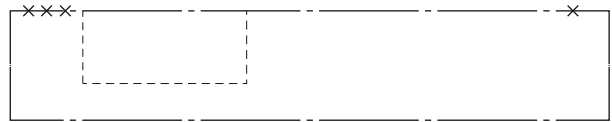
$p_{st \max} = 35 \text{ bar}$



End plate for use with central inlet plate

Ordering code:

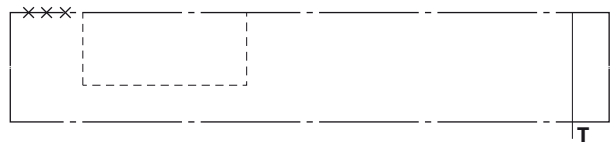
LU



End plate for central inlet plate with additional T port

Ordering code:

LUT

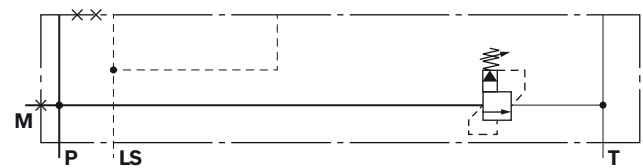


End plate for central inlet plate with additional LS, P and T port

Ordering code:

LUPT ...

- ▶ Specified pressure in bar required (3-digit)

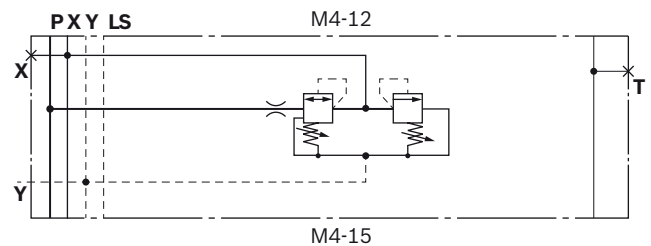


Adapter plate for M4-12 directional valves

Ordering code:

L12Y

- ▶ With integrated pilot oil supply
- ▶ For flange-mounting additional M4-12 directional valves, see data sheet 64276

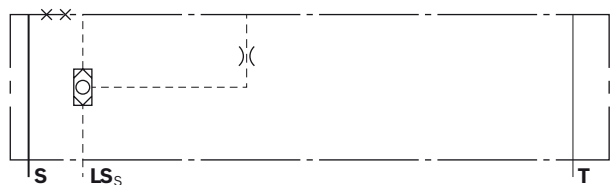


End plate with external priority connection

Ordering code:

LVZ

- ▶ For connecting external priority consumers



Dimensions

Line connections

Ports	
P	Pump port
A, B	Consumer port
a, b	Pilot oil port
T	Tank port
X	Pilot oil supply
Y	Pilot oil return
LS	Load sensing signal
LS_Z	LS supply
M, MP	Measuring port, pump
M_A, M_B	Measuring port, LS pressure
M_b, M_b	Measuring port, pilot pressure
S	Priority consumer

Pipe thread line connections (code 01)

		P	T	A, B	a, b	LS	X, Y	M, M_A, M_B	M_a, M_b	S
Inlet	P	G 1	G 1 1/4	-	-	G 1/4	G 1/4	G 1/4	-	-
	J	G 1	G 1	-	-	G 1/4	G 1/4	G 1/4	-	G 1/4
	JZ	G 1 1/4	G 1 1/4	-	-	G 1/4	G 1/4	-	-	-
	JK	G 1 1/4	G 1 1/4	-	-	G 1/4	G 1/4	-	-	-
	VZ	G 1	G 1	-	-	G 1/4	G 1/4	-	-	-
	XZ	G 1 1/4	G 1 1/2	G 1 1/4	-	G 1/4	-	G 1/4	-	-
Directional valve		-	-	G 3/4	G 1/4	-	-	G 1/4	G 1/8	-
End plate		G 3/4	G 3/4	-	-	G 1/4	G 1/4	-	-	-

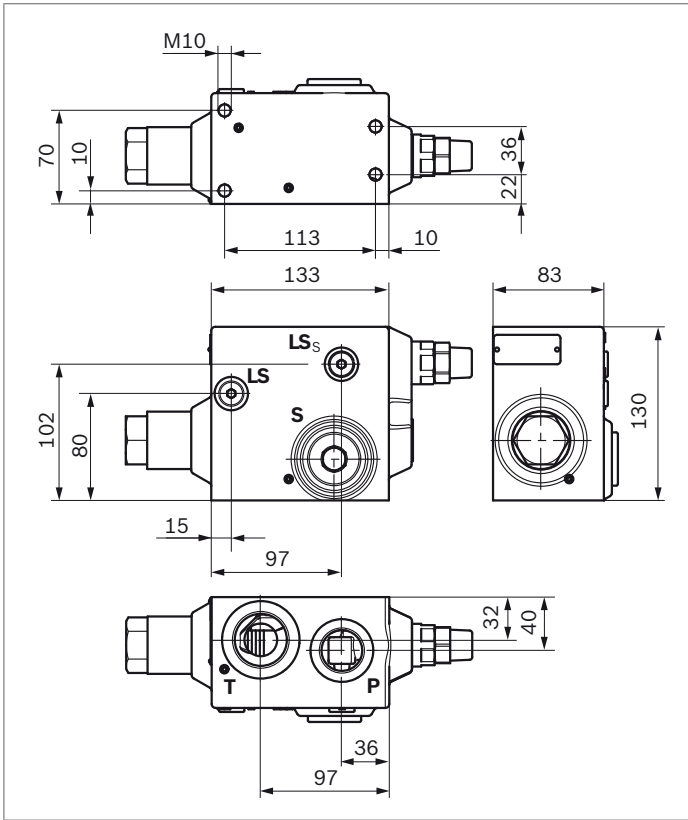
Mounting bolts M10 according to EN ISO 4762 or EN ISO 4014:

Property class	8.8	10.9
Tightening torque	41 ^{±2} Nm	60 ^{±3} Nm

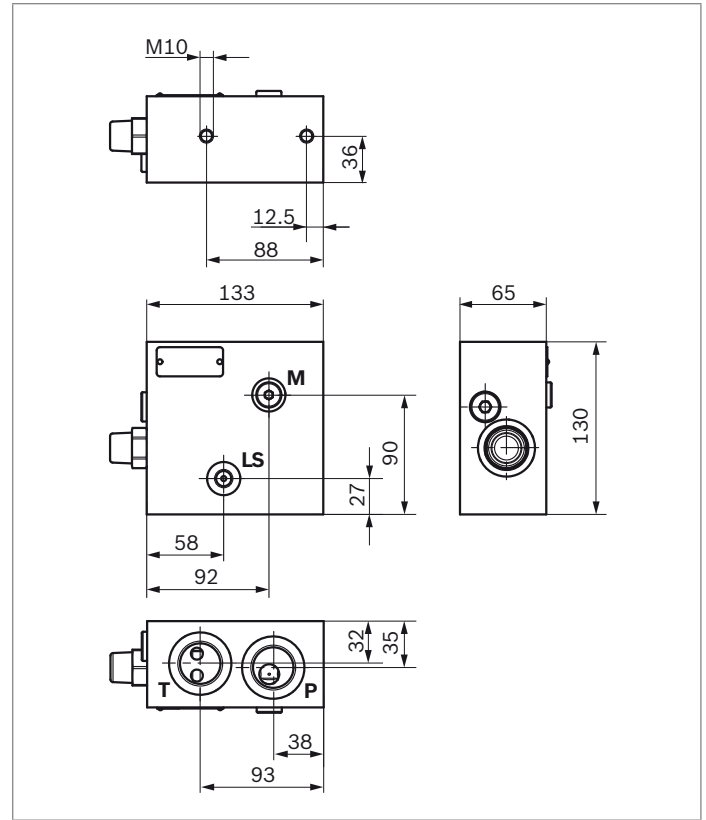
Ports as per ISO 1179-1

Inlet plates

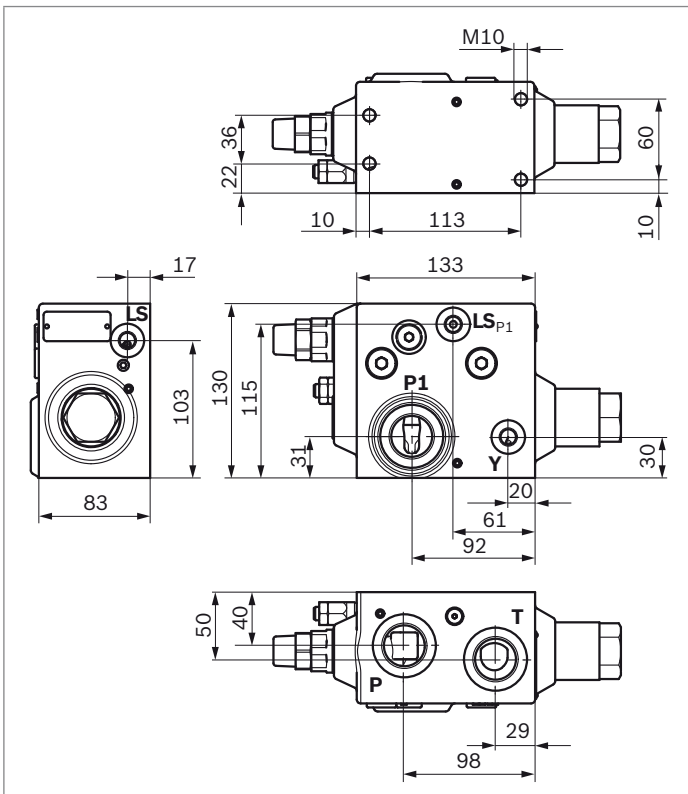
▼ **Lateral inlet plate P**



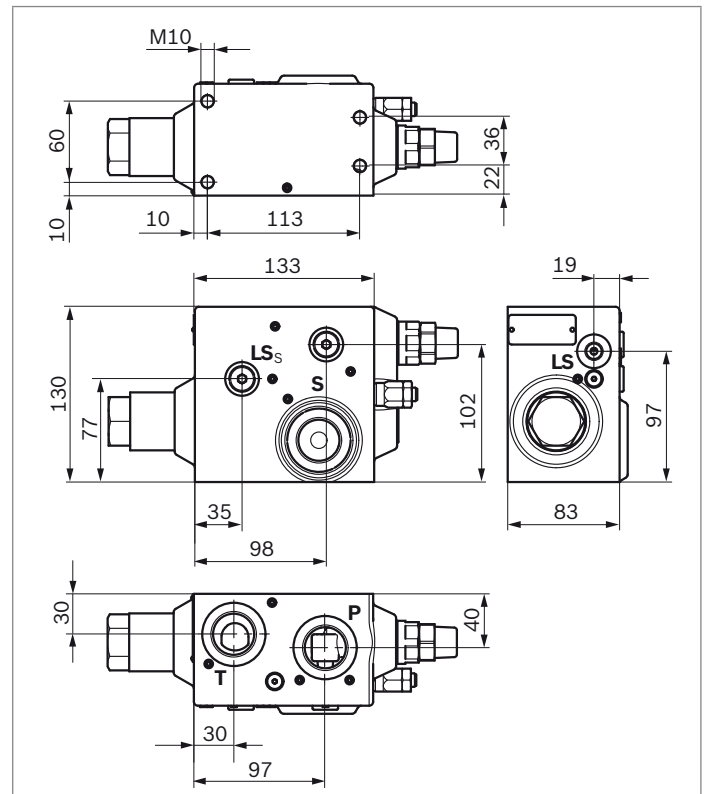
▼ **Lateral inlet plate J**



▼ **Lateral inlet plate VL**



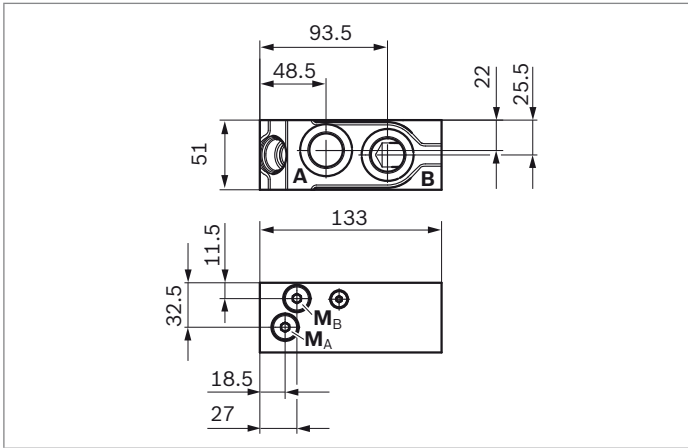
▼ **Lateral inlet plate VR**



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Directional valves

▼ **Housing with secondary valve bore, consumer port G 3/4**

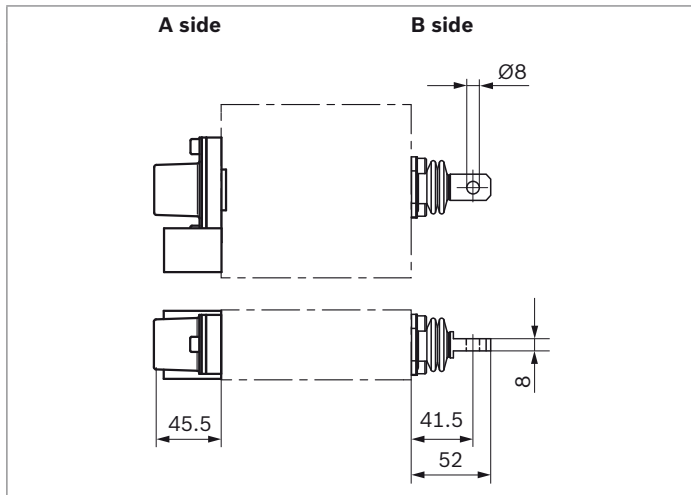


Actuation

▼ **Mechanical actuation only, spring-centered with tongue**

Ordering code:

...	A	Z	...
-----	---	---	-----

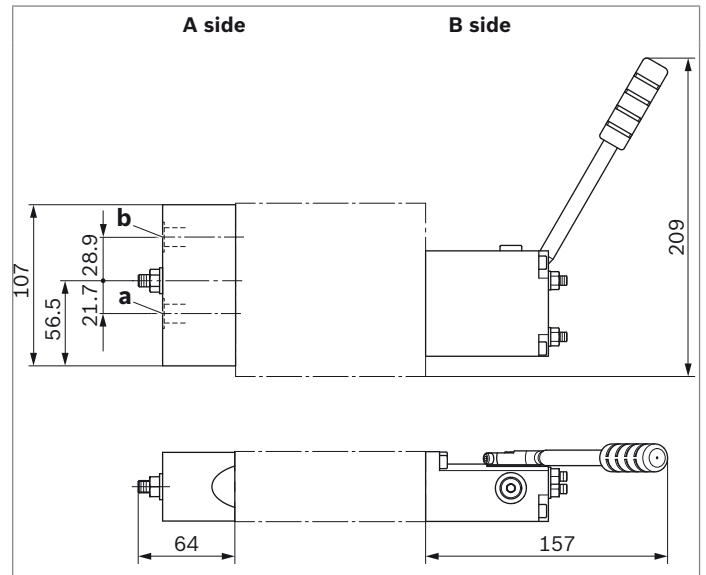


▼ **Mechanical/hydraulic actuation with cover with clamping piece and hand lever (encapsulated), aluminum-free**

Ordering code:

...	M	B2	...
-----	---	----	-----

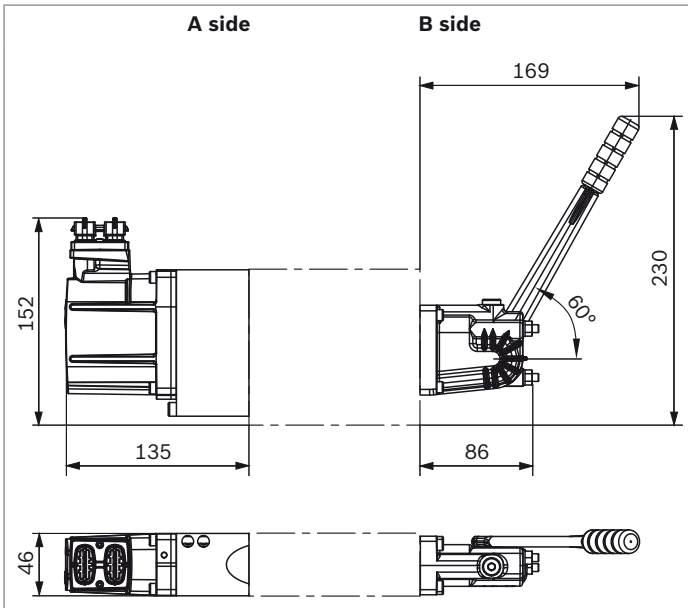
...	H	B2	...
-----	---	----	-----



▼ **Electronic pilot module EPM2 with hand lever (encapsulated)**

Ordering code:

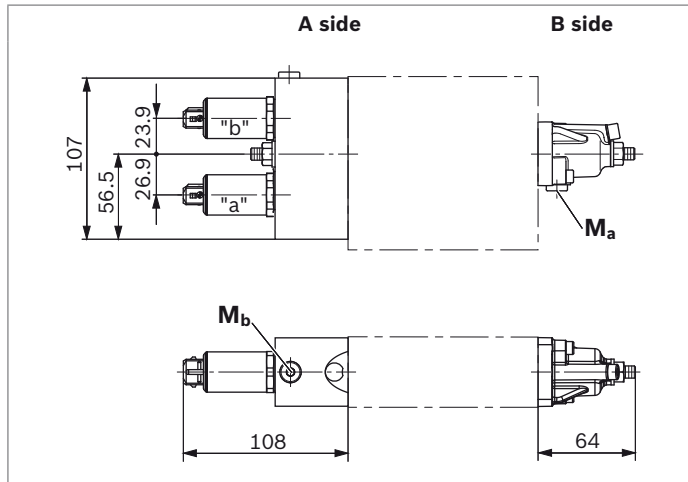
...	C . A	K	...
-----	-------	---	-----



▼ **Electrohydraulic actuation with standard cover**

Ordering code:

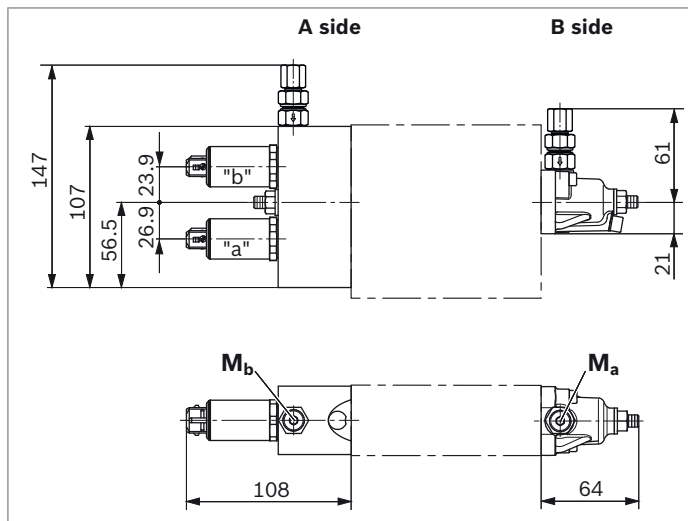
...	W.	-	...
-----	----	---	-----



▼ **Electrohydraulic actuation with check valve for hydraulic superposition**

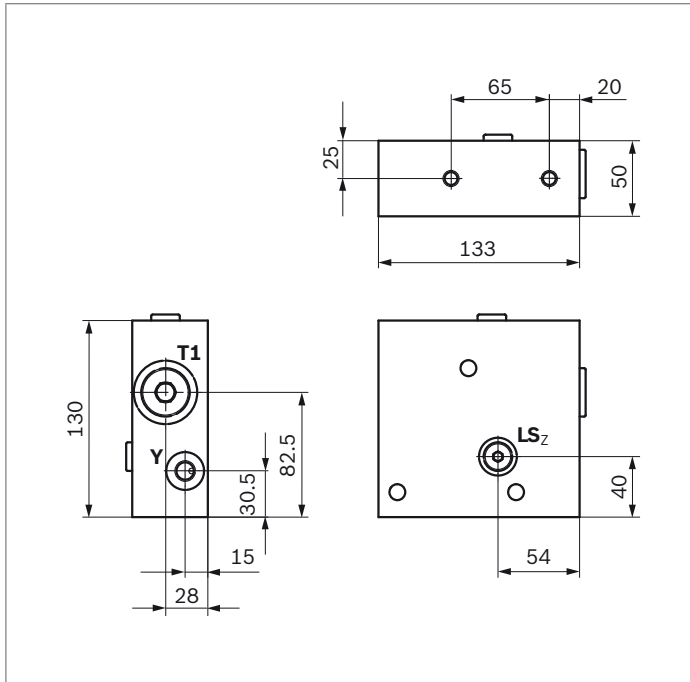
Ordering code:

...	G.	-	...
-----	----	---	-----

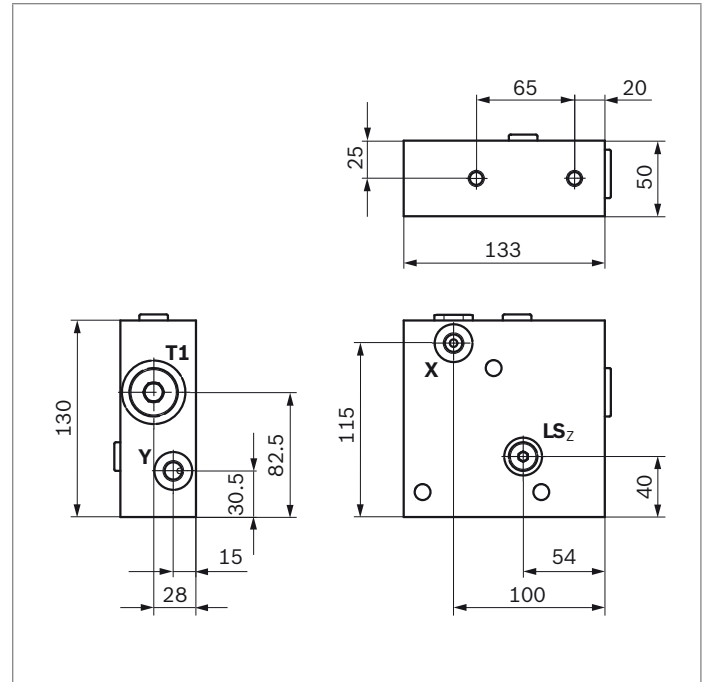


End plates

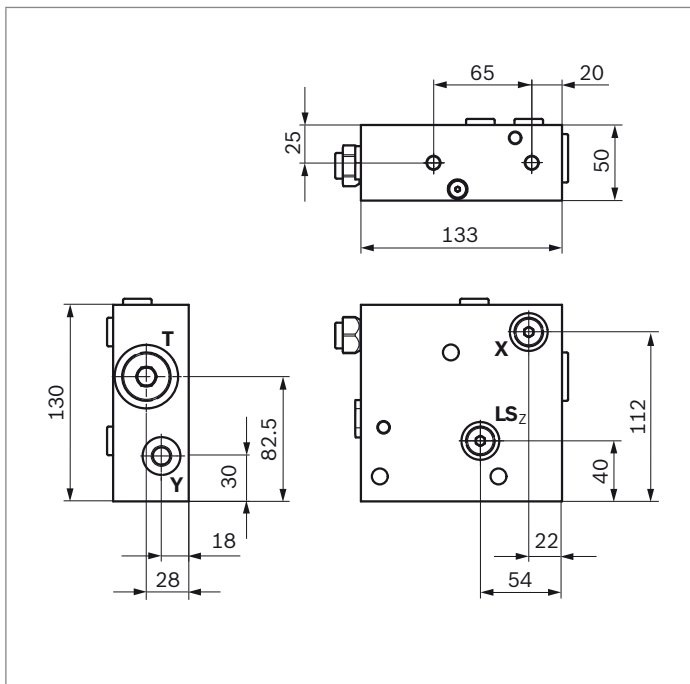
▼ **End plate LA, LZ**



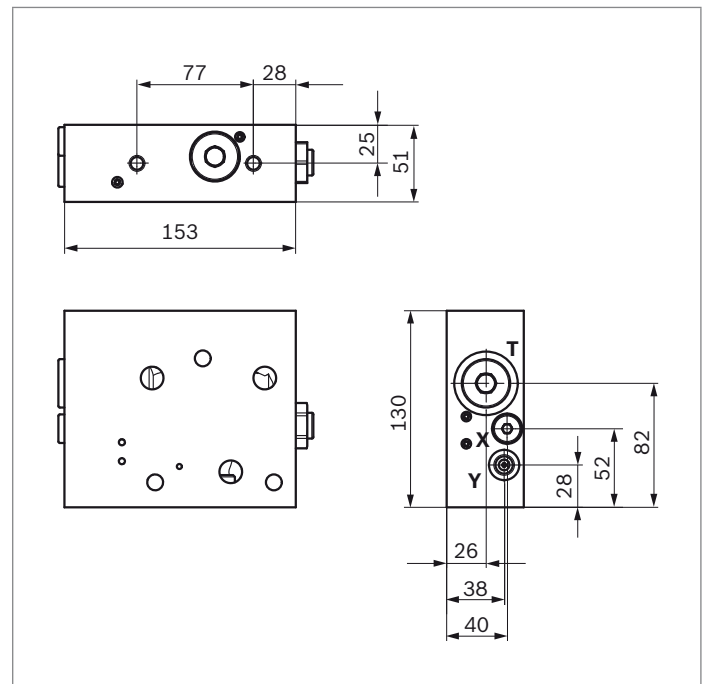
▼ **End plate LAX, LZ**



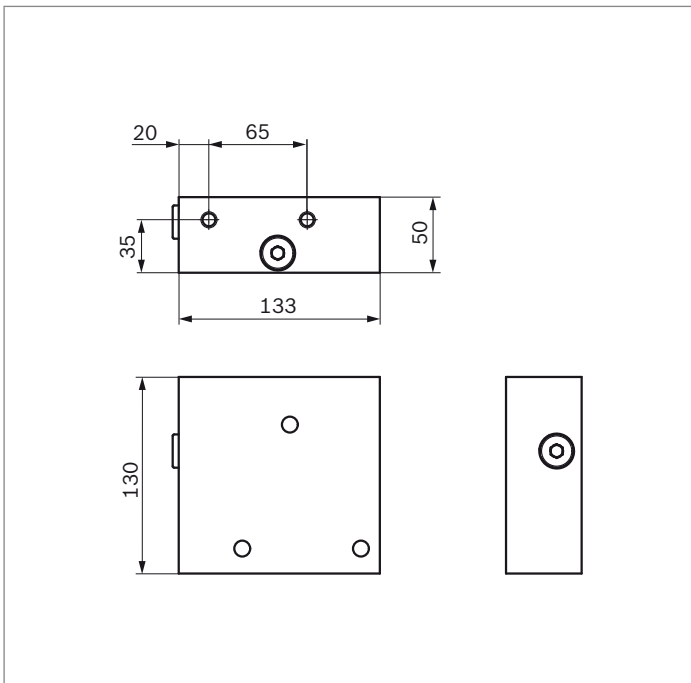
▼ **End plate LAY, LZ**



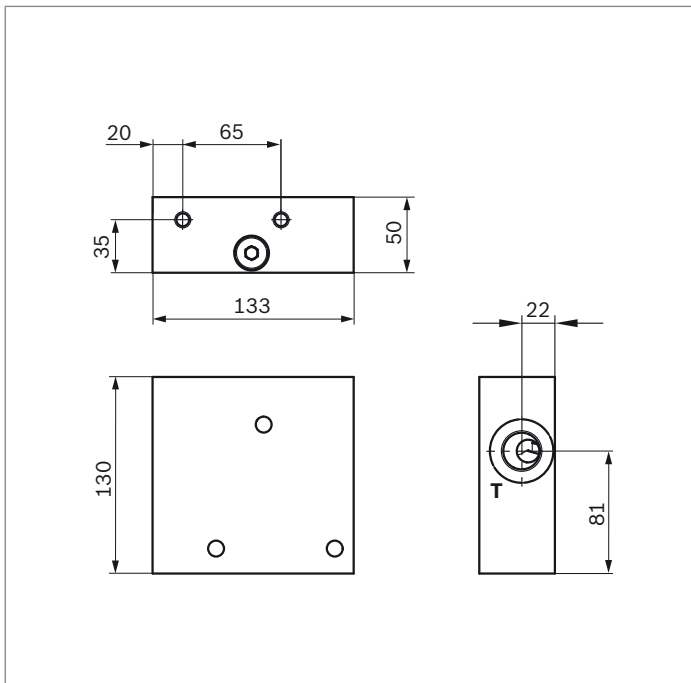
▼ **End plate L12**



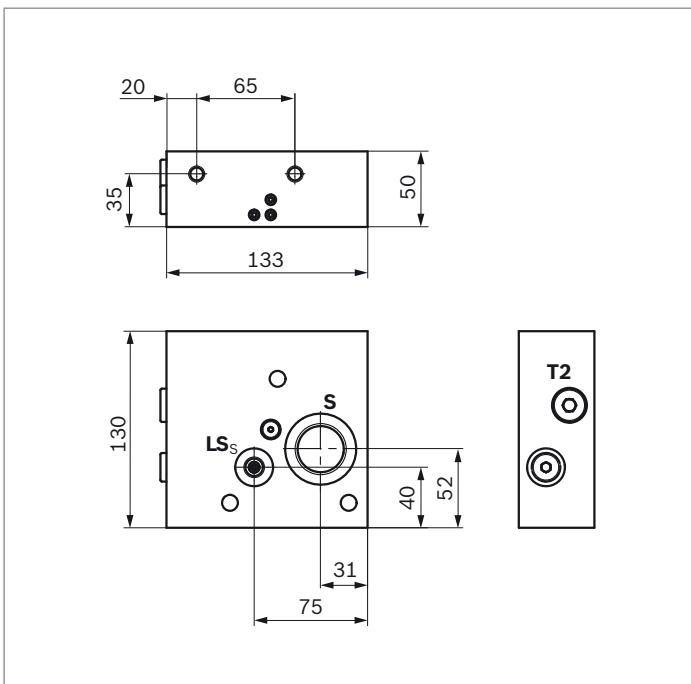
▼ End plate LU



▼ End plate LUT



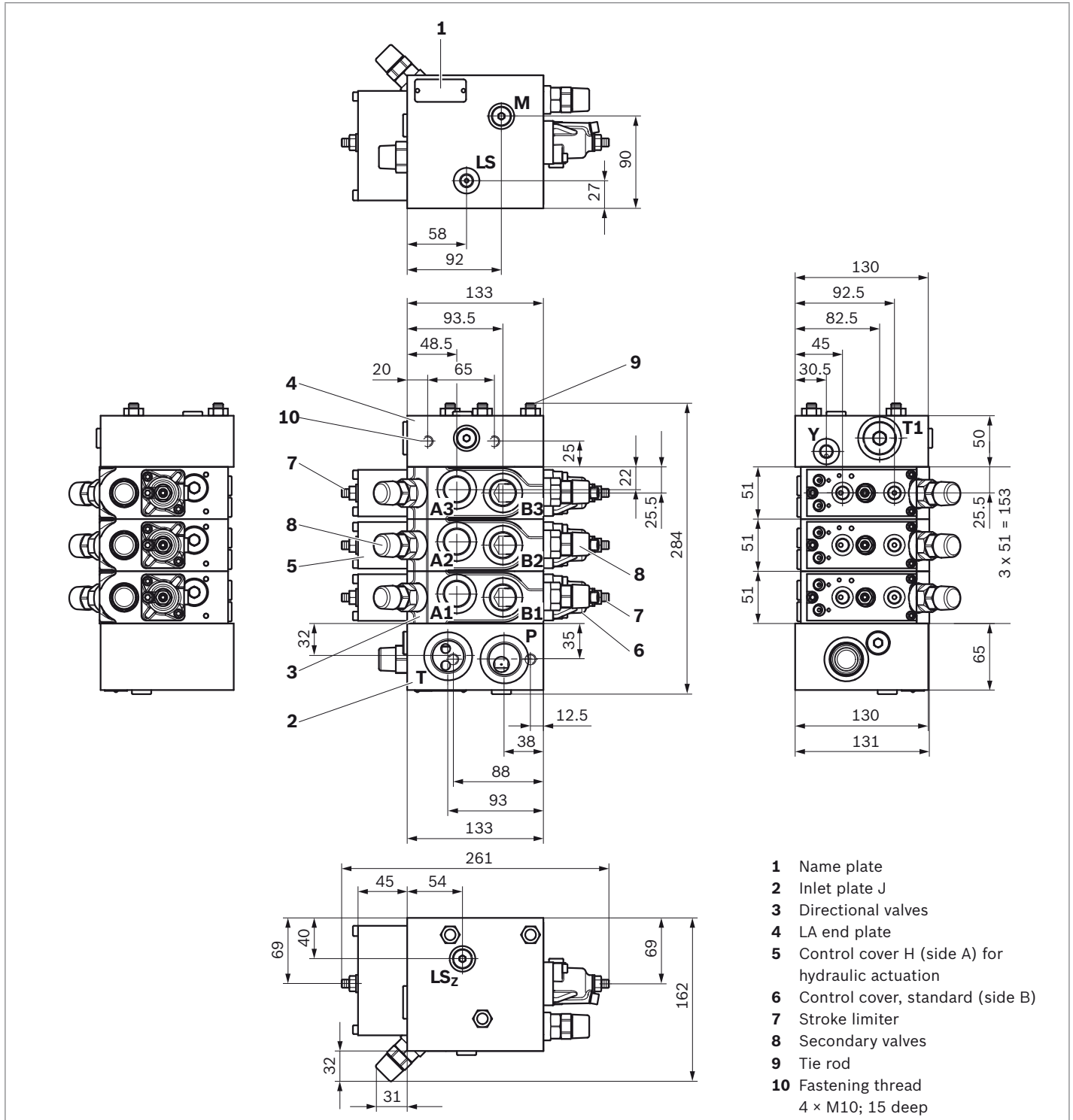
▼ End plate LVZ



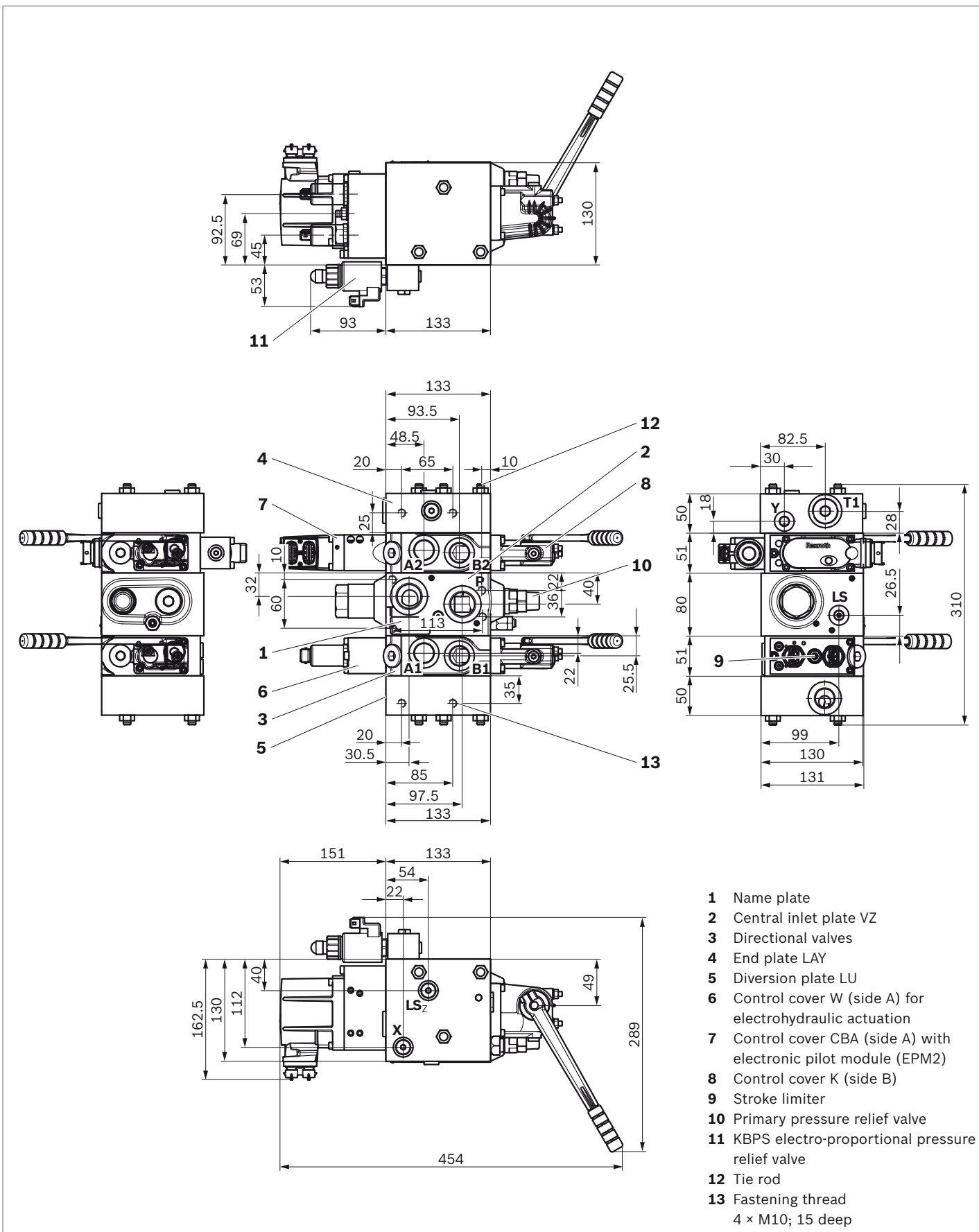
2

Order examples

▼ Closed center control block with lateral inlet plate (as per order example on page 12)



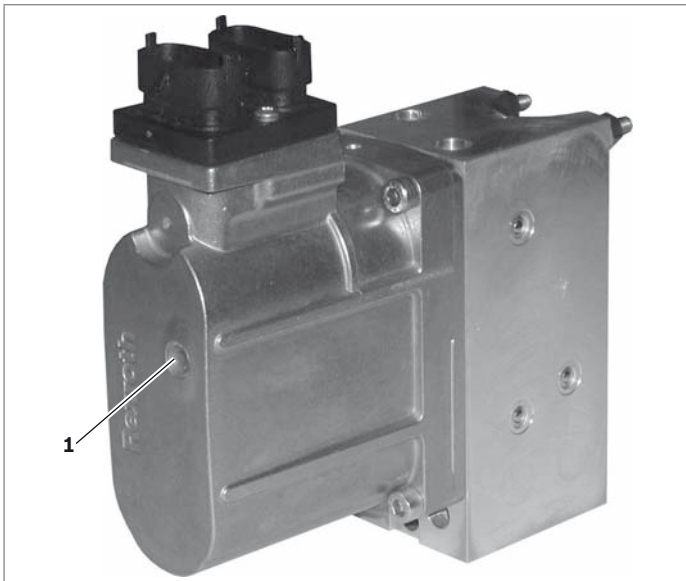
▼ Closed center control block with central inlet plate (as per order example on page 13)



Hydraulische Zylinder

On-board electronics: Electronic pilot module (EPM)

▼ M4-12 with EPM2



Function

The electronic pilot module provides the flow control on M4-12 control block via a digital electrical signal. The digital (CAN bus) input signal is converted into a pilot pressure by the pilot module by means of two electrohydraulic pressure reducing valves. With a CAN bus control, a looping of the electrical connection via the second plug connection to the next pilot module is possible (daisy-chain wiring). The entire control block is then connected via the 4-pin Bosch Compact 1 connector of the first pilot module to the machine control. It is possible to connect further CAN bus devices to the output of the last pilot module (see also RE 64815-B).

Features

Time functions (ramp functions), characteristic curve form and increase can be configured or changed directly via the CAN bus during the working cycle. Various diagnostic functions monitor the correct functioning of the pilot module.

The following are monitored in the basic version:

- ▶ The correct receipt of a valid setpoint signal
- ▶ Stability of the connection to the transmitter
- ▶ Compliance with the defined limits of the supply voltage
- ▶ Function of the pilot valves (short circuit, cable break)

Malfunctions are displayed externally via a visible light-emitting diode (LED) (1) displayed in the form of an error code (flashing code) on the housing.

The CAN bus version transfers the error code in the pilot module status telegram to the open loop control, which can evaluate it.

- ▶ Low wiring costs with CAN wiring as a result of the (daisy-chain) assembly
- ▶ Low flow rate hysteresis through clocked output stages with superimposed dither
- ▶ Processor-independent watchdog
- ▶ Separate selectable time ramps for each valve output A and B, opening and closing
- ▶ Separate changeable characteristic curves from linear to progressive sequence for A and B
- ▶ Linear characteristic curve reduction in operation and consequent linear reduction of total quantity
- ▶ Selectable monitoring limits of the operating voltage can be configured via CAN bus
- ▶ Extensive parameterizability according to customer requirements from the plant by Bosch Rexroth

Options

- ▶ Position sensor
- ▶ Measuring port

Parameterization specifications

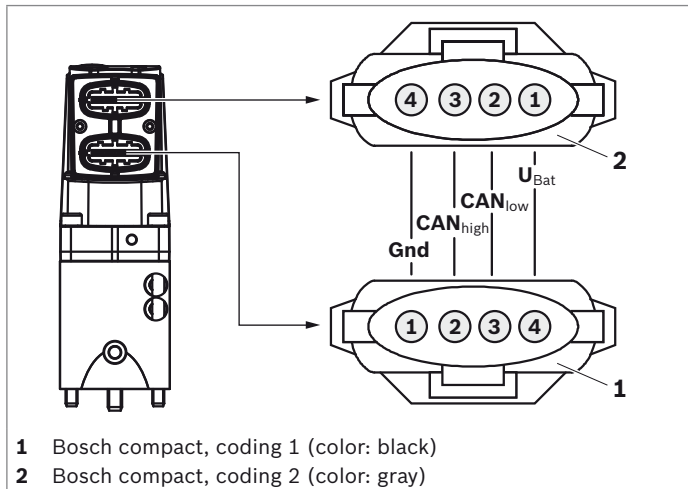
For the parameterization specifications form, see project planning help 64815-02.

It is used for setting the electronic pilot module supplied according to the customer's requirements.

CAN connector pin assignment

Connection via Bosch compact connector, coding 1. When using the CAN control, a connection to the next module or to another CAN participant is possible via the second Bosch compact connector, coding 2.

Pin assignment on the Bosch compact connector



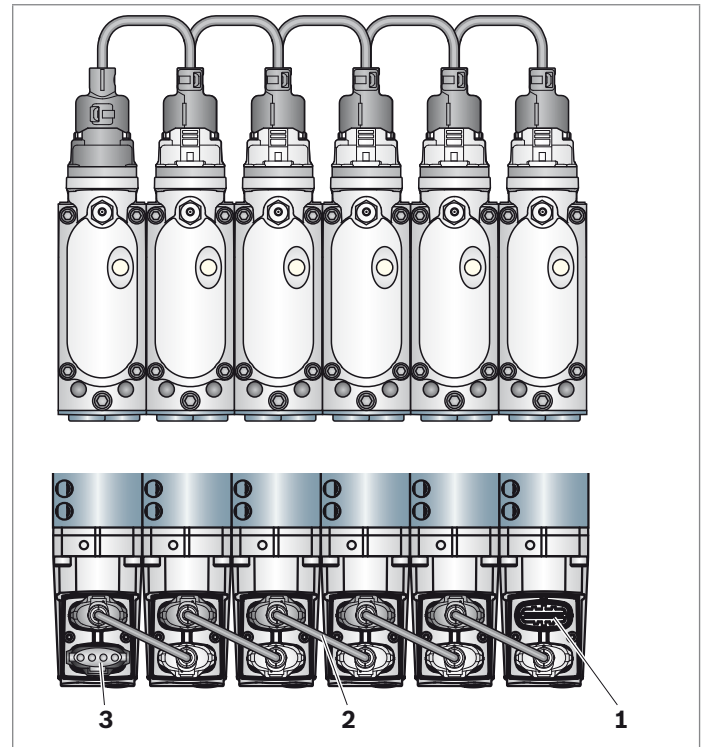
Notice

Connection cables and connectors are not included and must be ordered separately (see "Accessories" on page 45). Rexroth guarantees the correct function of the device, as described in instruction manual 64815-B. Rexroth assumes no liability for the safe operation of the machine or system of which this device forms part.

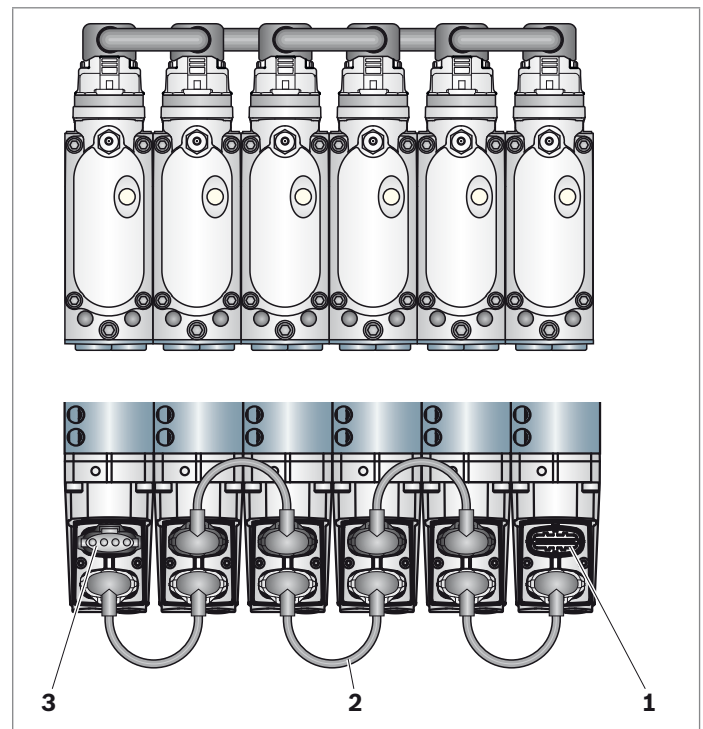
All control blocks with EPM2 can be optionally equipped with mounted daisy-chain wiring and terminal resistor connector. Terminal resistor is mounted in the last section of the block.

Recommended cable for connection to the machine electronics: Material number: R917c02724

▼ Daisy-chain wiring, standard version



▼ Daisy-chain wiring, compact version



- 1 Open connector for connection to the machine electronics
- 2 Daisy-chain wiring
- 3 Connector with terminal resistor

Accessories

Cables and connectors for EPM

	Material number	Type	Description	Length
Daisy-chain cable, standard version				
	R917c02581	Cable	For connection of two pilot modules (standard)	190 mm
	R917c02599	Cable	For connection of two pilot modules	240 mm
	R917c02628	Cable	For connection of two pilot modules via central inlet	370 mm
Daisy-chain cable, compact version				
	R917c05332	Cable	With two connectors, coding 1 (black) 90°	
	R917c05333	Cable	With two connectors, coding 2 (gray) 90°	
Connection cable				
	R917c02724	Cable	With one connector, coding 1 (black)	4,000 mm
	R917c04484	Cable	With one connector, coding 2 (gray)	4,000 mm
Connector and connector sets				
	R917c05459	Connector	Coding 1 (black), dummy connector	
	R917c02627	Connector	Coding 2 (gray), dummy connector	
	R917c05458	Connector	Coding 1 (black), dummy connector with integrated terminal resistor	
	R917c04605	Connector	Coding 2 (gray), dummy connector with integrated terminal resistor	
	R900785606	Connector set	Bosch compact, coding 1 (black)	
	R900785607	Connector set	Bosch compact, coding 2 (gray)	

Plug-in connector for FTDRE... and FTWE...

Recommended plug-in connector 1 and 3 Junior Timer, 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended plug-in connector for Junior Timer, 2-pin (AMP)



Recommended plug-in connector 8 and 9 DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

▼ Recommended plug-in connector for DT04 (DEUTSCH)



M4 configurator

The M4 configurator is available online. It helps to efficiently utilize the flexibility and versatility of the valve right from the design and engineering phase for new machines. This user-friendly and intuitive program asks systematic questions about the specific requirements for the system. It then assembles the corresponding control block from individual components. Technical data sheets, parts lists, circuit diagrams, and both 2D and 3D information are instantly available and speed up the development process for the working machine.

The M4 configurator is linked to the Bosch Rexroth eShop. The order of the configured control block can be placed immediately.



Related documents

Title	Document number	Document type
Control blocks for mobile applications	64025-B	Instruction manual
Load-sensing control block M4-15	64283-E	Spare parts list
Load-sensing control block M4-15	64283-01-R	Repair manual
Electronic pilot module EPM2	64815-B	Instruction manual
Ordering information for electronic pilot module EPM2	64815-02	Project planning help
Spool position sensor PSM for control blocks for mobile applications	95190	Data sheet
Hydraulic pilot controllers 2TH6	64552	Data sheet
Hydraulic pilot controllers 4TH5, 4TH6, 4TH6N	64555	Data sheet
Directional spool valve FTWE2K	58007	Data sheet
Proportional pressure reducing valve FTDRE2K	58032	Data sheet
Analog amplifier RA	95230	Data sheet
BODAS series 20 RC controller	95200	Data sheet
2/2-way spool valve KKDE	18136-08	Data sheet
Proportional pressure relief valve, increasing characteristic curve KBPS.8A	18139-04	Data sheet
Proportional pressure relief valve, decreasing characteristic curve KBPS.8B	18139-05	Data sheet
2-way logic element MH2DAD	64586	Data sheet
Hydraulic fluids based on mineral oils and related hydrocarbons	90220	Data sheet
Environmentally acceptable hydraulic fluids	90221	Data sheet

High-pressure load-sensing control block of sandwich plate design

Type M4-22

Nominal size 22

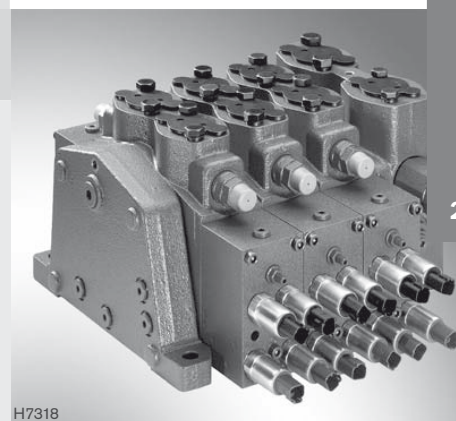
Series 1X

Nominal pressure 350 bar (pump side)

Nominal pressure 420 bar (actuator side)

Nominal flow

- Pump side:
 - 400 L/min (Inlet element)
 - 600 L/min (with P1 and P2 ports)
- Actuator side: • 400 L/min



H7318

Table of contents

Contents	Page
Features	1
Function, section, symbols	2
Technical data	3
Ordering code	4 and 5
Order examples	6 and 7
Inlet, directional valve and end element (symbols, circuit features, characteristic curves)	8 to 16
Unit dimensions, ports	17 and 18

Features

System

- Load pressure-independent flow control
 - Open center for fixed displacement pump
 - Closed center for variable displacement pump

Design

- Sandwich plate design
 - Inlet element
 - Up to 8 directional valve elements
 - End element

Features

- Types of actuation
 - mechanical
 - hydraulic
 - electrohydraulic (on/off, proportional)

Flow

- Load pressure-compensated
- High repeatability
- Low hysteresis
- Adjustable via stroke limiter

Pressure relief function

- Inlet element
 - Pilot operated pressure relief valves of large nominal width
- Directional valve element / actuator ports
 - Relief valves with anti-cavitation function
- LS pressure limitation
 - Adjustable for each actuator port
 - External pressure adjustment possible for each actuator

Fields of Application

- Cranes
- Drilling machines
- Forestry machines
- Others

Function, section

M4-22 control block

The directional valves are proportional valves according to the load-sensing principle. They can be operated mechanically, hydraulically or electrohydraulically.

Actuator control with electrohydraulic operation

The position of the main spool (2) in relation to the housing (1) determines the direction and magnitude of a flow that is fed to the actuator ports (A or B).

In the non-operated condition, the main spool is centred by compression springs (11). There is no connection from „P“ to „A“ or „B“.

The intensity of the electrical control current determines the amount of the pilot pressure in the spring chambers and thus the stroke of the main spool (P → A; P → B).

The pressure compensator (3) keeps the pressure differential across the main spool (2) and thus the flow to the actuator constant.

Load pressure compensation

Changes in pressure at the actuators or the pump are compensated for by the pressure compensator (3). The flow to the actuator remains constant even under differing loads.

Flow limitation

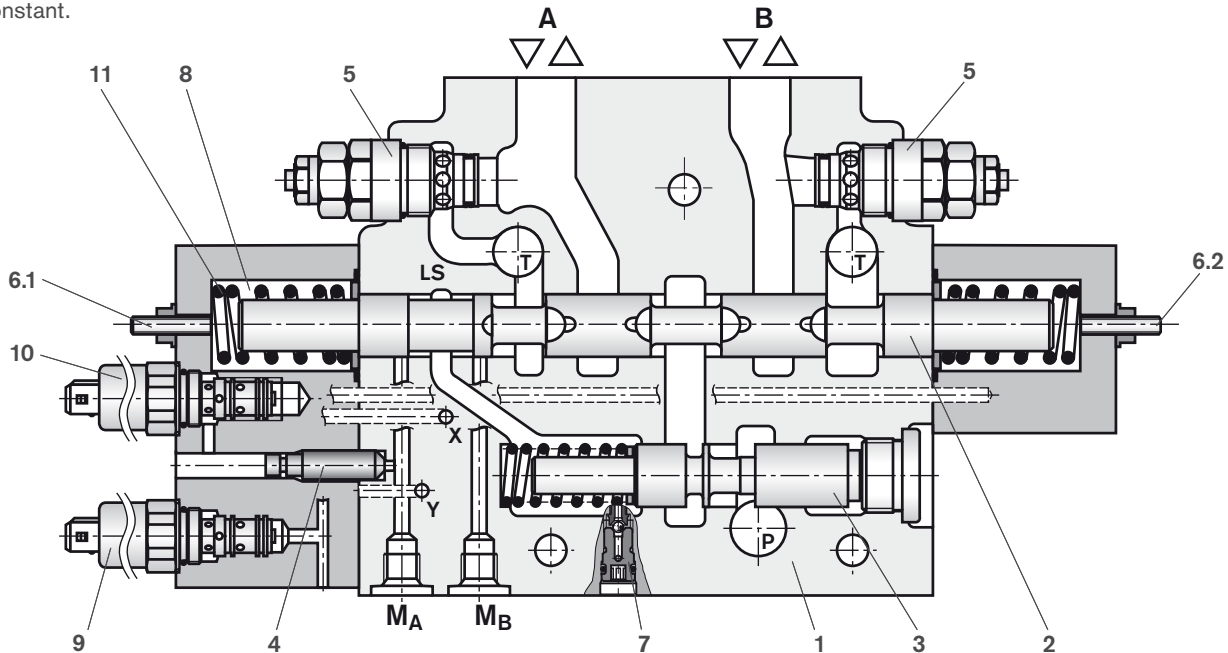
The maximum flow can be individually, mechanically adjusted by means of stroke limiters (6.1/6.2).

Pressure relief function

The LS pressure per actuator port can be influenced for each actuator port by means of LS pressure relief valves (4) or externally via the LS ports MA, MB.

Relief valves with integrated anti-cavitation function (5) protect the actuator ports A and B against pressure peaks.

The highest load pressure is signalled to the pump via the LS line and integrated shuttle valves (7).

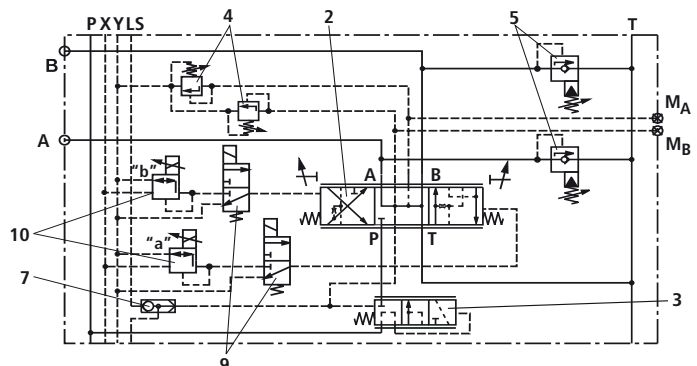


- | | | |
|--|----------------------------|---|
| 1 Housing | 6.1 Stroke limiter, A-side | 9 Pilot pressure switch-off (pilot „a“ and „b“) |
| 2 Main spool | 6.2 Stroke limiter, B-side | 10 Pressure reducing valve (pilot valve a, b) |
| 3 Pressure compensator | 7 LS shuttle | 11 Compression springs |
| 4 LS pressure relief valve | 8 Spring chamber | |
| 5 Secondary pressure / anti-cavitation valve | | |

Symbol

Ports

- | | |
|--------|-------------------|
| P | Pump |
| A, B | Actuator |
| T | Tank |
| X | Pilot oil supply |
| Y | Pilot oil drain |
| LS | Load-Sensing (LS) |
| MA, MB | Measuring ports |



Technical data (for applications outside these parameters, please consult us!)

general

Design	Sandwich plate design		
System	Load-Sensing (LS)		
Type	M4		
Size	22		
Installation position	optional		
Type of connection	SAE		
Weight	Inlet element: Open center	kg	28
	Closed center	kg	28
	Directional valve element, mechanical	kg	24
	Directional valve element, hydraulic	kg	29
	Directional valve element, electrohydr.	kg	33
	End element	kg	13
Hydraulic fluid and ambient temperature range ϑ	°C	-20 to +80	

hydraulic

Flow	Port P	$q_{V, \max}$	L/min	400 600 with P1 and P2 ports
	Port A, B	$q_{V, \max}$	L/min	400 with pressure compensator and load-holding function
Nominal pressure max.		p_{nom}	bar	350
Operating pressure max. in port	P / LS	p	bar	350
	A / B	p	bar	420
	T	p	bar	30
	Y	p	bar	at zero pressure to tank
Pilot pressure max. in port	X	p	bar	35
	a, b	p	bar	35
Pilot pressure range	hydraulic	p	bar	8.5 to 22.5
	elektrohydraulic	p	bar	8.7 to 26
Recommended hydraulic pilot control devices	TH 6... characteristic curve 97, see RE 64552			
LS pressure relief function (adjustment ranges) (selected in the factory)			bar	50 to 149 150 to 350
Hydraulic fluid	Mineral oil (HL, HLP) to DIN 51524 Other fluid on enquiry, e.g. HEES (synthetic esthers) to VDMA 24568 as well as hydraulic fluids as specified in RE 90221			
Viscosity range	ν	mm ² /s	10 to 380	
hydraulic fluid max. permissible degree of contamination to ISO 4406 (c)	class 20/18/15			


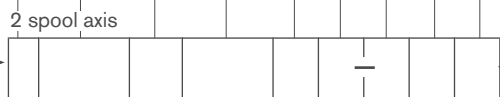
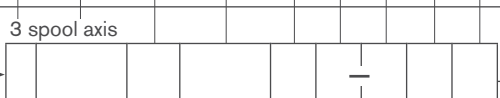
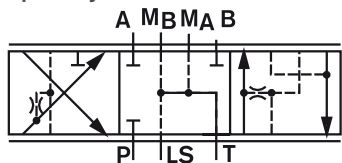
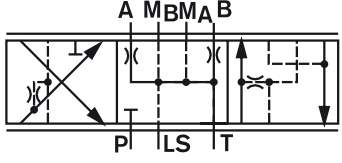
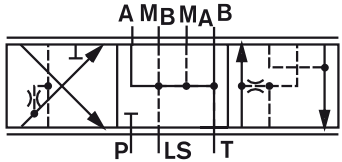
electric

Electrical pilot control valves	FTWE 4 K...; see RE 58008 FTDRE 4 K...; see RE 58038
Recommended amplifiers (other control options on enquiry)	Analogue amplifier: RA 1.0 and 2.1 (in preparation) Digitalamplifier: RC-Family (RE 95200)

Note!

The technical data was determined at a viscosity range of $\nu = 30 \text{ mm}^2/\text{s}$ (HLP46: 50°C).

Ordering code

Short code	Inlet element	Directional valve elements
M4-22-1X/		  
No. of directional valves 1 to 8 Size 22 = 22 Series 10 to 19 = 1X (10 to 19: unchanged installation and connection dimensions) Open Center = P Closed Center = J Without primary pressure relief valve (not with version „P“) = Q With primary pressure relief valve (pressure details in bar, 3-digits) = ... Pilot oil supply With internal pilot oil supply = Y For external pilot oil supply = X Without pilot pressure switch-off and LS damping shuttle = 1 With pilot pressure switch-off = 2 With LS damping shuttle = 3 With pilot pressure switch-off and LS damping shuttle = 4 With pressure compensator, with load-holding function (standard) = S Without pressure compensator, with load-holding function = C With LS pressure relief valve (pressure details in bar, 3-digits) = ... M ... With LS pressure relief plug screw (LS pressure relief valve can be retrofitted) = Q M Q Without LS pressure relief valve (LS pressure relief valve can not be retrofitted) = Z Z Z ¹⁾ Housing with measuring ports = M Housing without measuring ports = Z Spool symbol  = E  = Q  = J		Continued on page 5 Actuator port "A" Actuator port "B" Secondary valves H...H... = Pressure relief anti-cavitation valves, pre-operated (see table) Q = Plug screw (Secondary valves can be retrofitted) Details required only for type of operation „H“ and „H3“ Damping shuttle 00 = Without (Standard) 06 = With Ø 0.6 mm 07 = With Ø 0.7 mm 08 = With Ø 0.8 mm Details required only for type of operation „H3“, „W2“, „W3“ and „W4“ Junior Timer 2-pin (AMP)²⁾ 1 = Supply voltage 24 V 3 = Supply voltage 12 V DT04-2P (Deutsch)²⁾ 8 = Supply voltage 24 V 9 = Supply voltage 12 V Operation cover A M = Mechanical ¹⁾ H = Hydraulic W2 = Electrohydraulic proportional W4 = Electrohydraulic switchable H3 = Hydraulic with pilot oil switch-off W3 = Electrohydraulic proportional with pilot oil switch-off ...-... = Flow in L/min, 3-digits, e.g. 320-320 ; Actuator ports „A“ and „B“

¹⁾ Mechanical is only without LS pressure relief valve (ZZZ)
²⁾ Mating plugs are **not** included in the scope of supply and must be ordered separately

Ordering code

End element



Additional details



11 =

Further details in clear text

Ports as SAE

End element

A =
Z =
P =
R =
T =

End element without ports, with internal LS unloading
End element with LS port, without internal LS unloading
End element with P2 port
End element with P2 and LS port
End element with T2 port

Pressure setting in bar in actuator ports A and B

H050 = 50 bar	H140 = 140 bar	H210 = 210 bar	H280 = 280 bar
H063 = 63 bar	H150 = 150 bar	H230 = 230 bar	H300 = 300 bar
H080 = 80 bar	H160 = 160 bar	H240 = 240 bar	H320 = 320 bar
H100 = 100 bar	H175 = 175 bar	H250 = 250 bar	H350 = 350 bar
H125 = 125 bar	H190 = 190 bar		

= Preferred type

Preferred spool types

Symetric spools

Spool type	Pressure compensator	Flow in L/min (other flows can be set on the stroke limiter)				
		E, J, Q	S	400-400	300-300	200-200	130-130	080-080
360-360	270-270			180-180	115-115	072-072
320-320	240-240			160-160	100-100	065-065

Complete control blocks are to be defined in accordance with the type code.

The order text is used to collate the technical features and requirements.

The Rexroth Sales Organisation derives a short code and a material number from the order text.

Example of a short code of an M4-22 control block with three directional valve elements.

M4 - 6789 - 1 0 / 3 M4 - 22

Control block no.

Series of type (1X)

No. of directional valve elements

revision index of series

Order example: Open center

- Example:**
- Fixed displacement pump $q_{V,max} = 400$ L/min
 - 3 actuators
 - Electrohydraulic operation

Assembled control block

- Inlet element:**
- Open center with primary valve set to 250 bar, with internal pilot oil supply, without pilot pressure switch-off and LS damping shuttle,

Directional valve elements:

1. spool axis
- With pressure compensator, with load-holding function
 - Without LS pressure relief valves
 - Spool symbol J, flow in A and B 400 L/min
 - Type of operation: hydraulic with pilot oil switch off
 - with Junior Timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B plugged
2. spool axis
- With pressure compensator, with load-holding function
 - With LS pressure relief valves, actuator port A and B set to 180 bar
 - Spool symbol J, flow in A and B 400 L/min
 - Type of operation: electrohydraulic proportional
 - with Junior timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B 350 bar
3. spool axis
- With pressure compensator, with load-holding function
 - With LS pressure relief valves, actuator port A set to 180 bar, actuator port B set to 120 bar
 - Spool symbol J, flow in A and B 85 L/min
 - Type of operation: electrohydraulic proportional with pilot oil switch-off
 - with Junior timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B 350 bar

- End element** • LS unloading, ports as SAE

Ordering code:

3	M4-22-1X/P250	Y	1
---	---------------	---	---

1. spool axis

S	ZZZ	J	400-400	H3	1-00	Q	Q
---	-----	---	---------	----	------	---	---

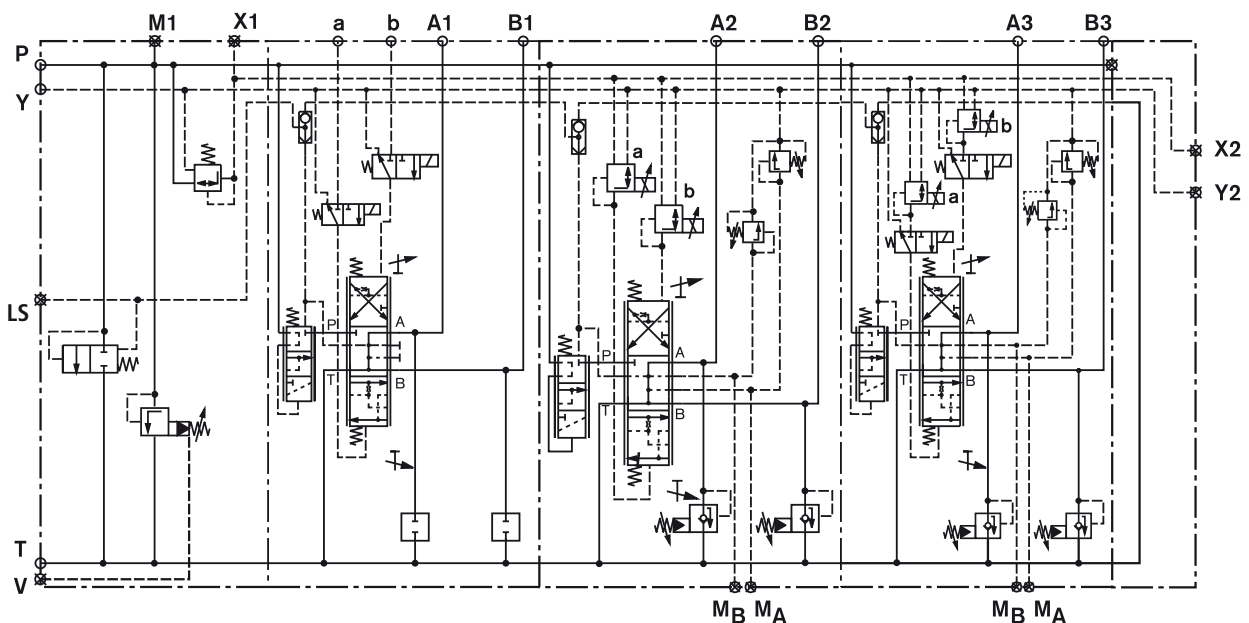
2. spool axis

S	180M180	J	400-400	W2	1	H350	H350
---	---------	---	---------	----	---	------	------

3. spool axis

S	180M120	J	085-085	W3	1	H350	H350
---	---------	---	---------	----	---	------	------

LA	V	11
----	---	----



Order example: Closed Center

- Example:**
- Variable displacement pump $q_{V,max} = 400$ L/min
 - 3 actuators
 - Electrohydraulic operation

Assembled control block:

- Inlet element:**
- Closed center with primary valve set to 250 bar with internal pilot oil supply, with LS damping shuttle

Directional valve elements:

1. spool axis
- With pressure compensator, with load-holding function
 - Without LS pressure relief valves
 - Spool symbol J, flow in A and B 400 L/min
 - Type of operation: hydraulic with pilot oil switch-off
 - with Junior Timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B plugged
2. spool axis
- With pressure compensator, with load-holding function
 - With LS pressure relief valves, actuator port A and B set to 180 bar
 - Spool symbol J, flow in A and B 400 L/min
 - Type of operation: electrohydraulic proportional
 - With Junior timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B 350 bar
3. spool axis
- With pressure compensator, with load-holding function
 - With LS pressure relief valves, actuator port A set to 180 bar, actuator port B set to 120 bar
 - Spool symbol J, flow in A and B 200 L/min
 - Type of operation: electrohydraulic proportional with pilot oil switch-off
 - with Junior timer 2-pin (AMP) 24 V
 - Secondary valve: actuator port A and B 350 bar

- End element** • LS unloading, ports as SAE

Ordering code

3	M4-22-1X	/	J250	Y	3
---	----------	---	------	---	---

1. spool axis

S	ZZZ	J	400-400	H3	1-00	Q	Q
---	-----	---	---------	----	------	---	---

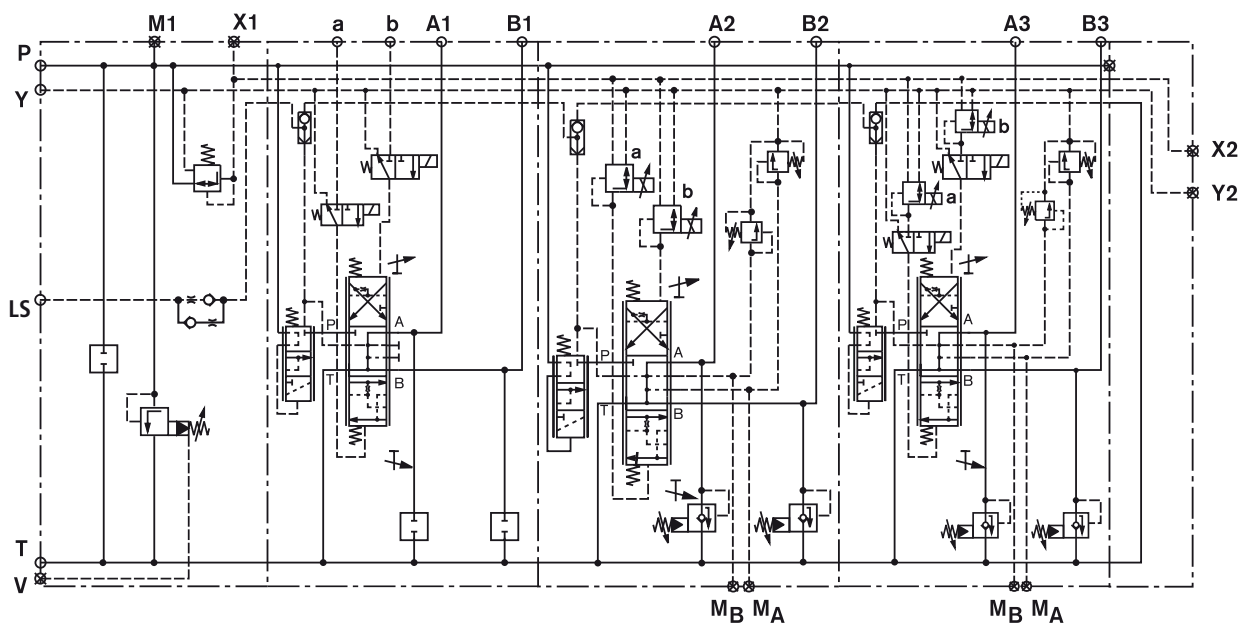
2. spool axis

S	180M180	J	400-400	W2	1	H350	H350
---	---------	---	---------	----	---	------	------

3. spool axis

S	180M120	J	200-200	W3	1	H350	H350
---	---------	---	---------	----	---	------	------

LA	V	11
----	---	----



Inlet elements

Inlet element

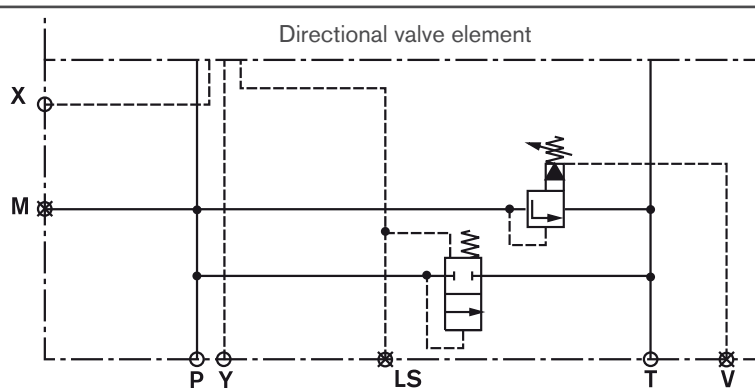
Open Center with primary valve for external pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail P...X1

Short description

- For fixed displacement pump
- Pressure details to be given after P... (3 digits)



Inlet element

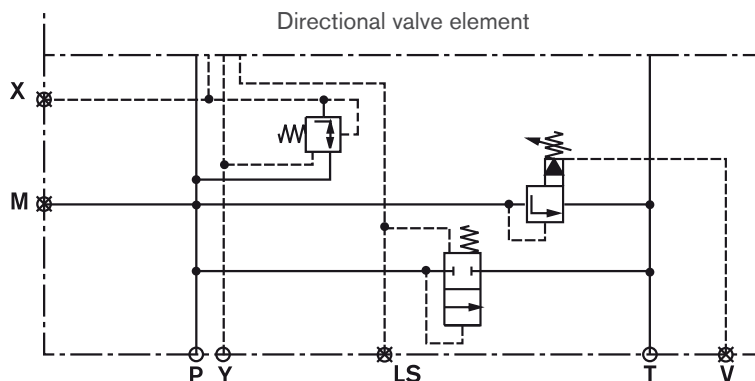
Open center with primary valve with internal pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail P...Y1

Short description

- For fixed displacement pump
- Pressure details to be given after P... (3 digits)



Inlet element

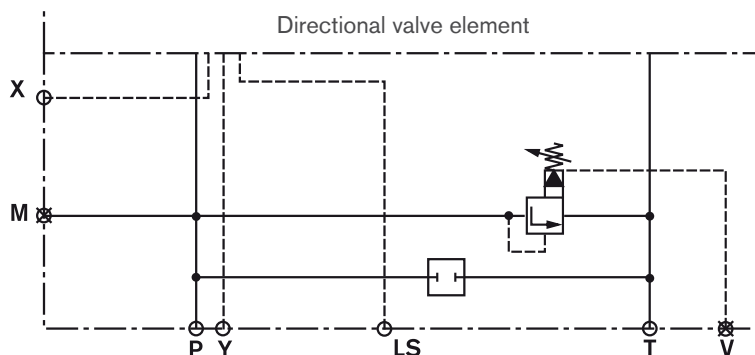
Closed Center with primary valve for external pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail J...X1

Short description

- For variable displacement pump
- Pressure details to be given after J...



Inlet element

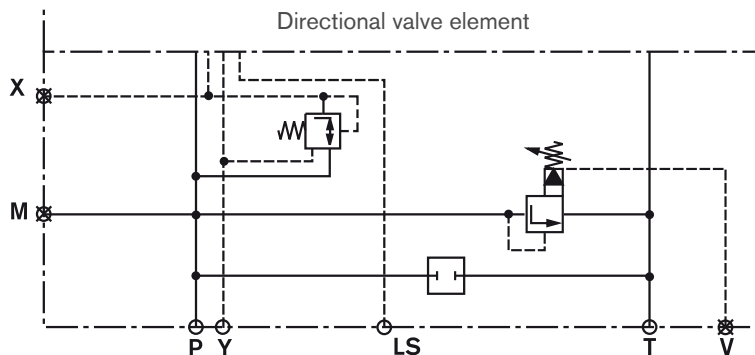
Closed Center with primary valve with internal pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail J...Y1

Short description

- For variable displacement pump
- Pressure details to be given after J... (3 digits)



⚠ Attention!

With internal pilot oil supply, pilot oil of other actuators may also be drained via the X port. This may however have an influence on the switching times of the M4-22. Please contact the technical sales department for possible effects.

With external pilot oil supply, port „X“ is generally not plugged. If it is not used (e.g. with hydraulic control „H“), it must be plugged.

Inlet elements

Inlet element

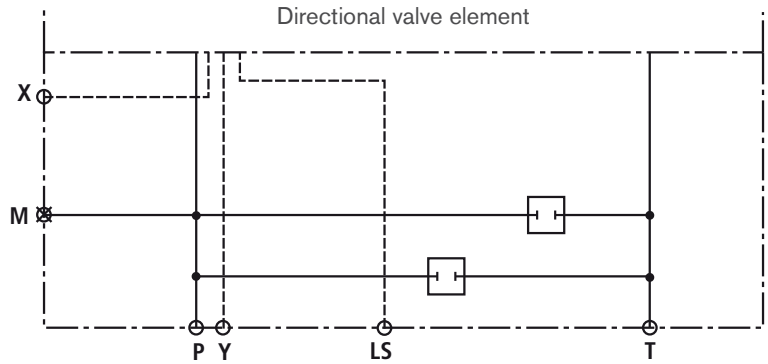
Closed center without primary valve for external pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail JQX1

Short description

- For LS variable displacement pump
- Pressure details not required



Inlet element

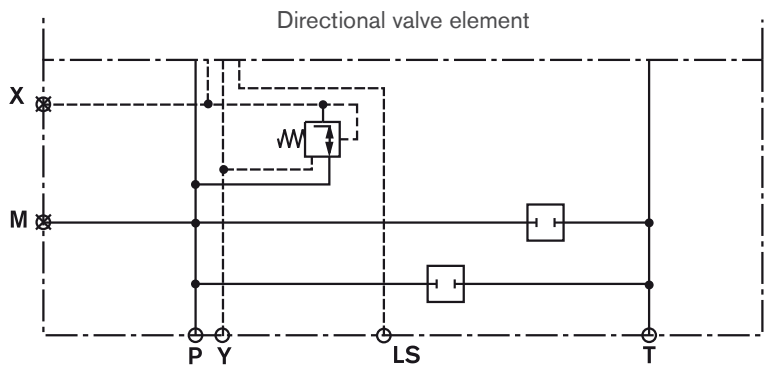
Closed Center without primary valve with internal pilot oil supply

- without pilot pressure switch-off and LS damping shuttle

Ordering detail JQY1

Short description

- For LS variable displacement pump
- Pressure details not required



Inlet element

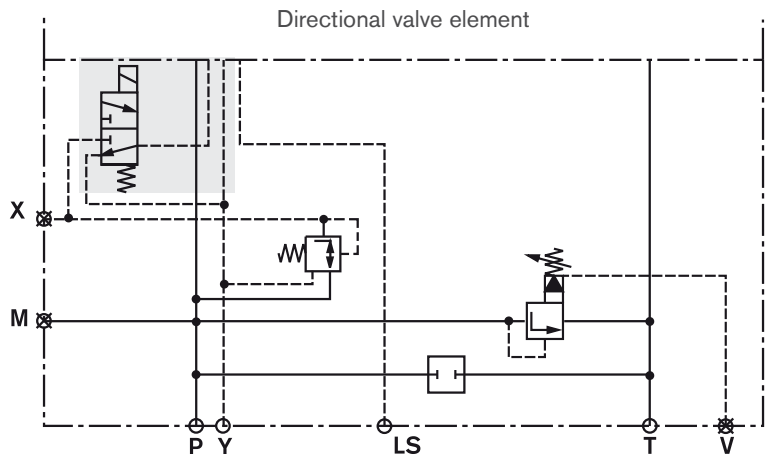
Closed Center with primary valve with internal pilot oil supply

- with pilot pressure switch-off and LS damping shuttle

Ordering detail J ... Y2

Short description

- For LS variable displacement pump
- Pressure details to be given after J...



Inlet element

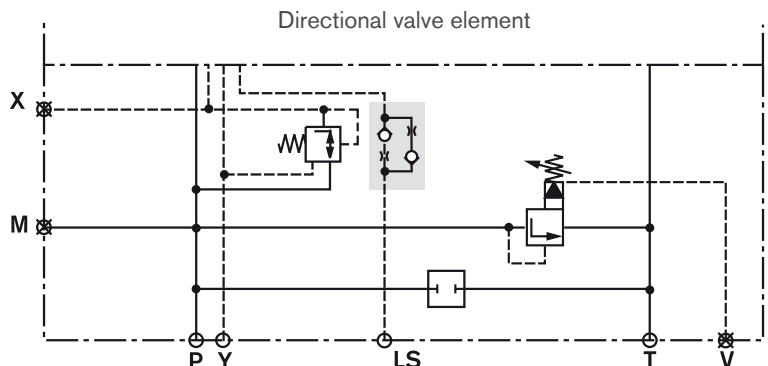
Closed Center with primary valve with internal pilot oil supply

- with LS damping shuttle

Ordering detail J ... Y3

Short description

- For LS variable displacement pump
- Pressure details to be given after J...



Directional valve elements: Spools

Spool symbol

Ordering detail Flow in L/min	Main application	Symbol
E ...-...	Hydraulic cylinders as actuator	
J ...-...	Hydraulic motors as actuator	
Q ...-...	Application with defined residual opening (A/B → T) Actuator port unloaded in the neutral position	

Directional valve elements: Pressure compensator

Directional valve elements: Pressure compensator

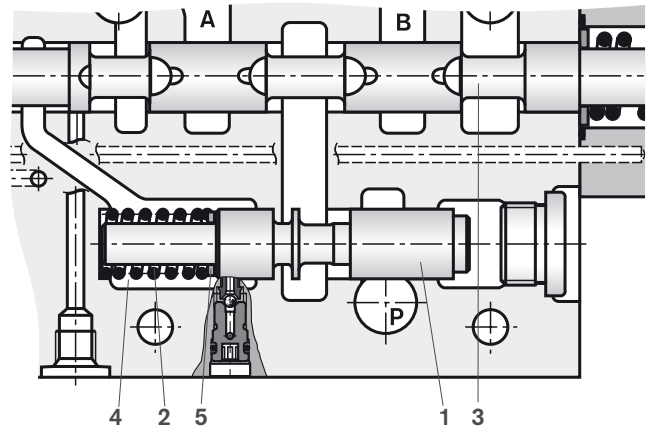
When the main spool (3) is in the central position, there is no connection between P and the actuator ports A and B. In this operating state, the pump pressure pushes the pressure compensator spool (1) to the left against the spring (2).

When the main spool (3) (= metering orifice) is operated the LS pressure is fed to the spring chamber (4) and pushes the pressure compensator spool (1) to the right to the control position. The flow is kept constant, even with parallel operation of actuators with different load pressures.

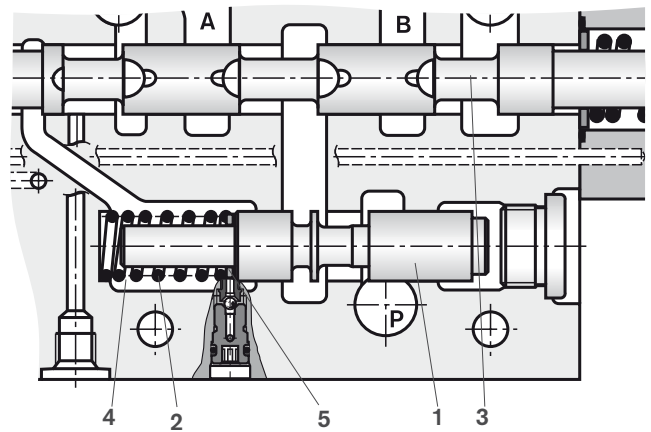
Pressure compensator variant "S" is provided with a load-holding function. This function is not leak-free.

The number of washers (5) inserted determines the pressure difference and thereby the required flow.

Central position of the main spool



Operation of the main spool



Preferred types

Flow in L/min (other flows can be set on the stroke limiter)					
Symmetric spools	400-400	300-300	200-200	130-130	080-080
	360-360	270-270	180-180	115-115	072-072
	320-320	240-240	160-160	100-100	065-065

Flow without washer (pressure compensator $\Delta p = 6$ to 9 bar) ←

Flow with 1 washer (pressure compensator $\Delta p = 7.5$ to 10 bar) ←

Flow with 2 washers (pressure compensator $\Delta p = 9$ to 12 bar) ←

Example:

Command value: $Q_{\text{actuator}} = 380$ L/min → 360 Liter spool + 2 washers = 400 L/min

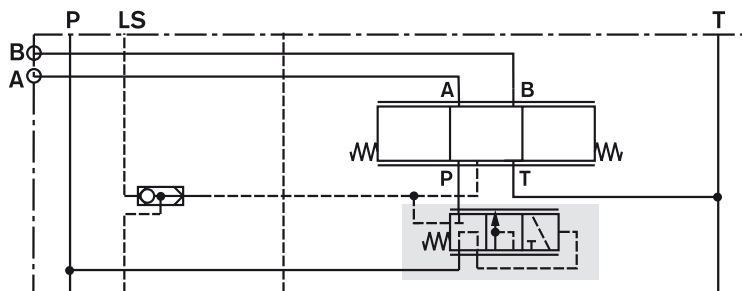
→ set 380 L by means of stroke limiter

Directional valve elements: Pressure compensator, load-holding function

Ordering detail S

Short description

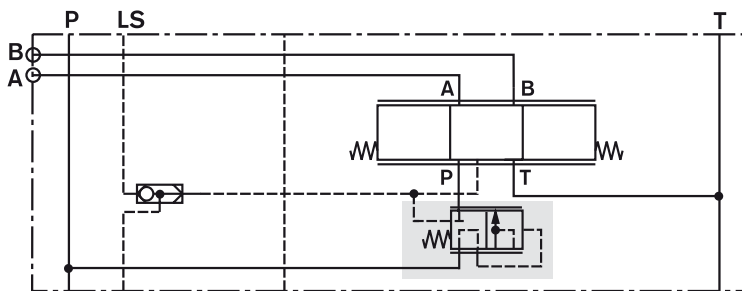
- With pressure compensator
- With load-holding function ¹⁾
- Max. flow 400 L/min



Ordering detail C

Short description

- Without pressure compensator
- With load-holding function ¹⁾
- At $\Delta p = 18$ bar



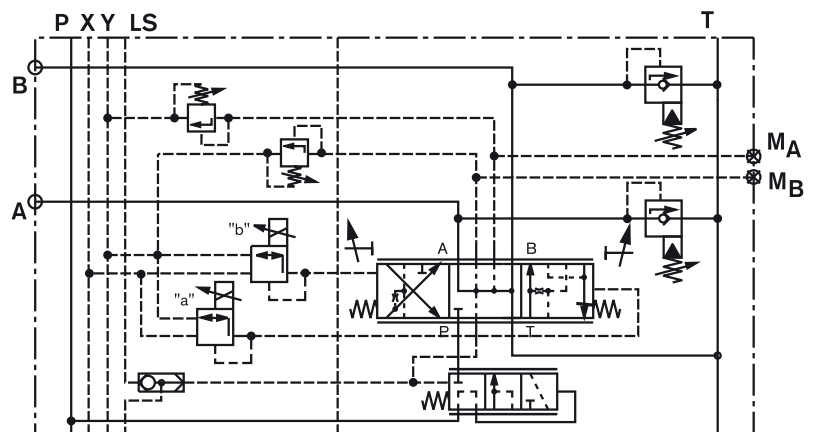
¹⁾ The load-holding function is not leak-free.

With LS pressure relief valve

Ordering detail ... M ...

Short description

- Pressure to be detailed for actuator ports „A“ and „B“ (3 digits), e.g. 180M120
- With version „QMQ“ the LS pressure relief function can be retrofitted to the directional valve element.
- The LS pressure can be externally influenced via ports MA and MB. These ports can also be used as measuring points.

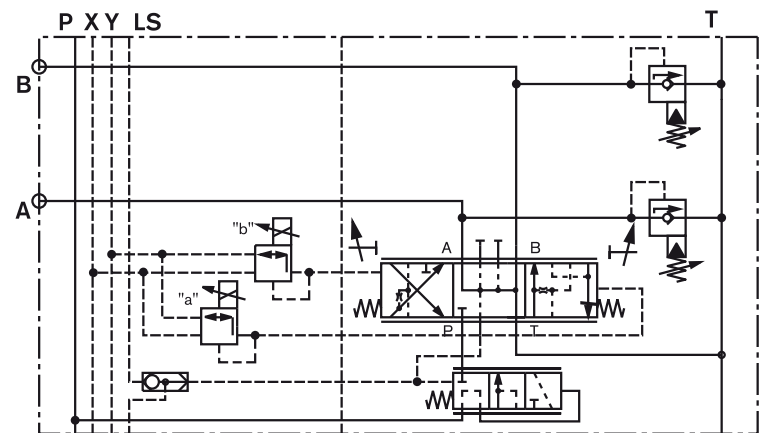


Without LS pressure relief valve

Ordering detail ZZZ

Short description

- LS pressure relief valve cannot be retrofitted
- Housing without measuring ports

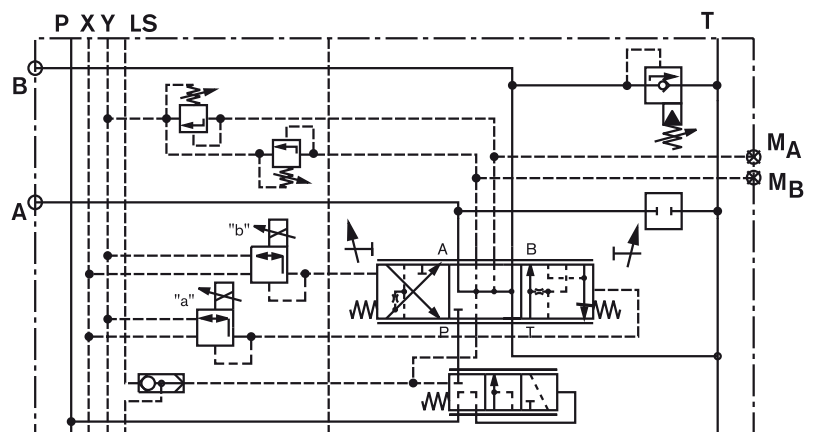


Secondary valves

Ordering detail QH ...

Short description

- Plug for port A
- Pressure relief / anti-cavitation valve port B
- Example: QH200
- The directional valve is provided for retrofitting secondary valves



⚠ Attention!

Pressure relief valves are restricted suitable as pressure limiters!

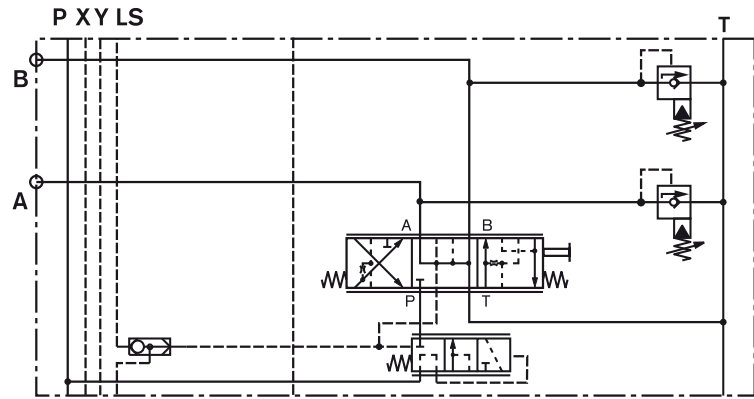
Directional valve elements: Types of operation

Mechanical

Ordering detail M

Short description

- Tongue without hand lever



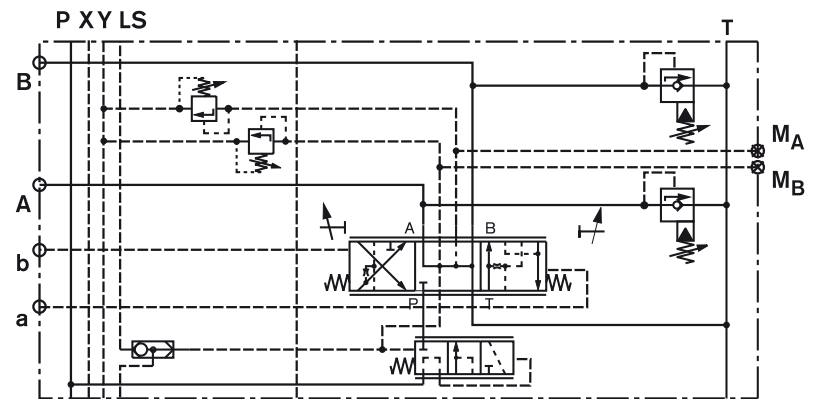
Hydraulic

Ordering detail H

Short description

Recommended hydraulic pilot control devices:

- Type TH6 to RE 64555,
- Control curve 97

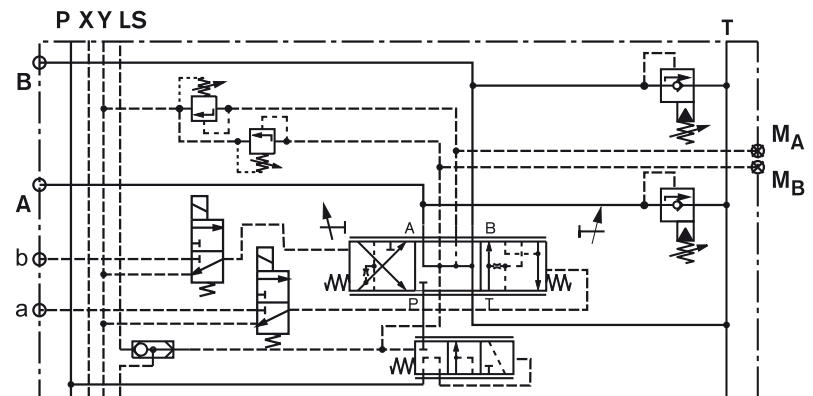


Hydraulic with pilot oil switch-off

Ordering

Short description

- | | |
|-----|---------------------|
| H31 | 24 V (AMP-plug) |
| H33 | 12 V (AMP-plug) |
| H38 | 24 V (Deutsch-plug) |
| H39 | 12 V (Deutsch-plug) |



Directional valve elements: Types of operation

Electrohydraulic proportional

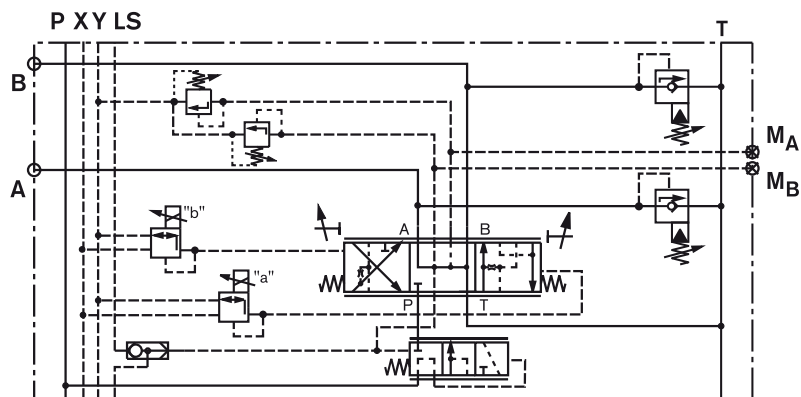
Ordering Short description

W21 Electrohydraulic proportional 24 V

W23 Electrohydraulic proportional 12 V

Proportional valve type FTDRE 4 K to RE 58038

Plug: Junior Timer 2-pin (AMP)¹⁾



Electrohydraulic proportional with pilot oil switch-off

Ordering Short description

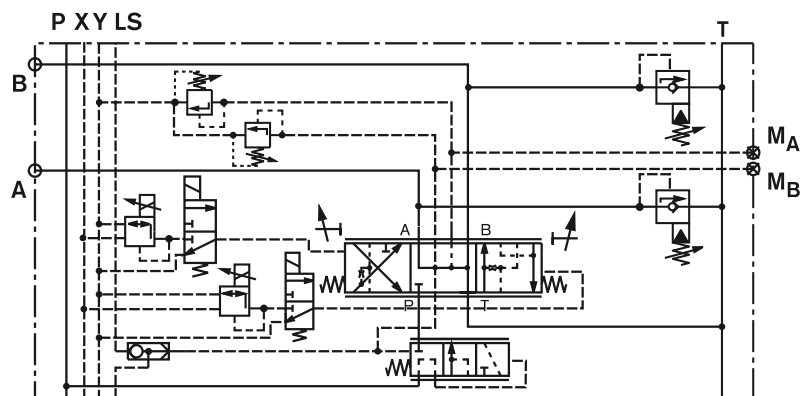
W38 Electrohydraulic proportional 24 V

W39 Electrohydraulic proportional 12 V

On/off valves type FTWE 4 K to RE 58008

Proportional valve type FTDRE 4 K to RE 58038

Plug: DT04-2P (Deutsch)¹⁾



Electrohydraulic switchable

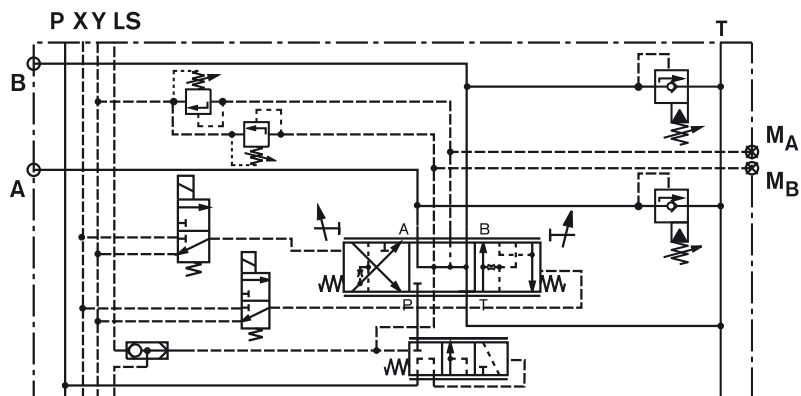
Ordering Short description

W41 Electrohydraulic switchable 24 V

W43 Electrohydraulic switchable 12 V

On/off valves type FTWE 4 K to RE 58008

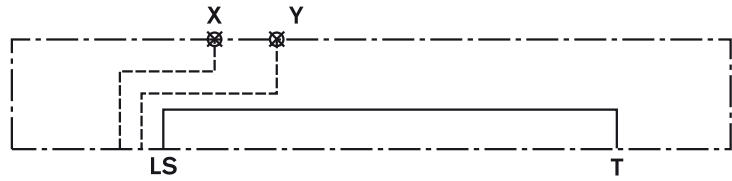
Plug: Junior Timer 2-pin (AMP)¹⁾



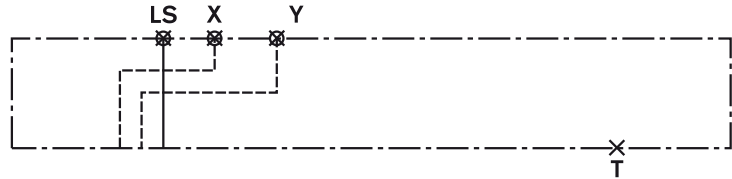
¹⁾ Mating plugs are not included in the scope of supply and must be ordered separately !

End elements

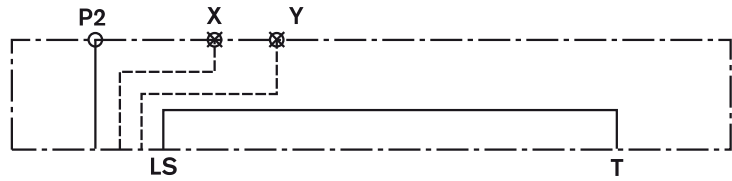
End element with LS unloading
Ordering detail LA



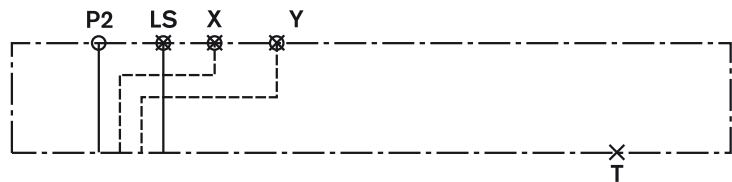
End element with LS port
(LS unloading must be ensured externally)
Ordering detail LZ
For the connection of additional LS actuators



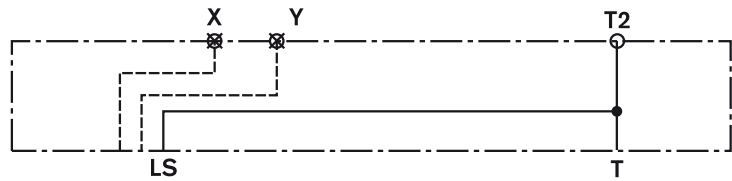
End element with P2 port
Ordering detail LP



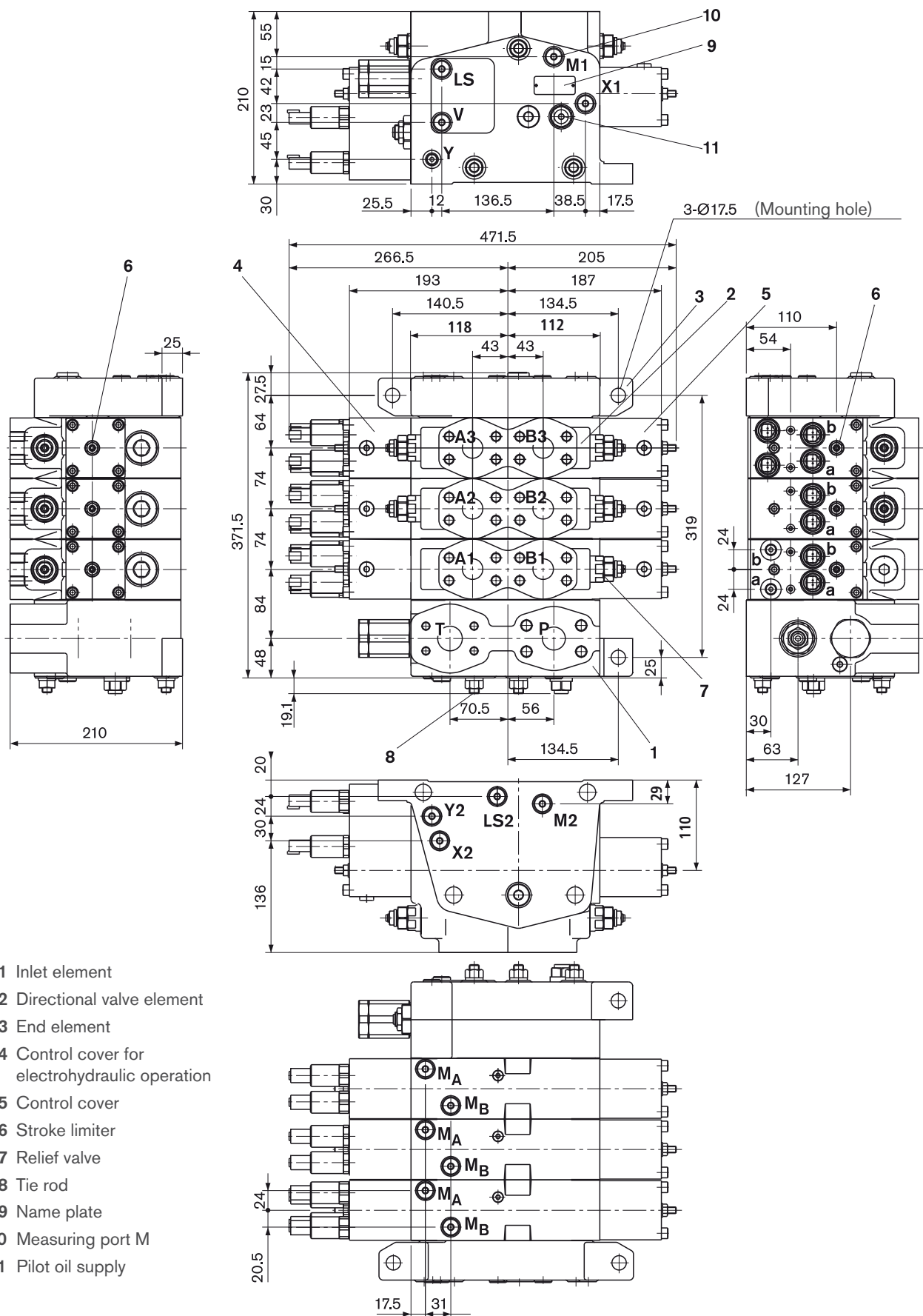
End element with P2 port and with LS port
Ordering detail LR



End element with T2 port
Ordering detail LT

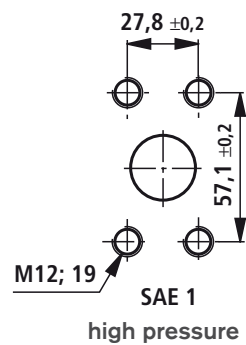
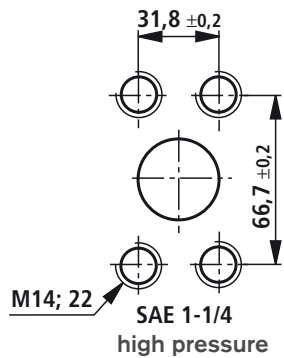
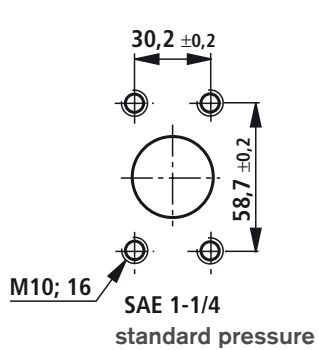


Unit dimensions: Control block as open center version (Unit dimensions in mm)



Ports (Unit dimensions in mm)

Master gage for SAE connecting flange

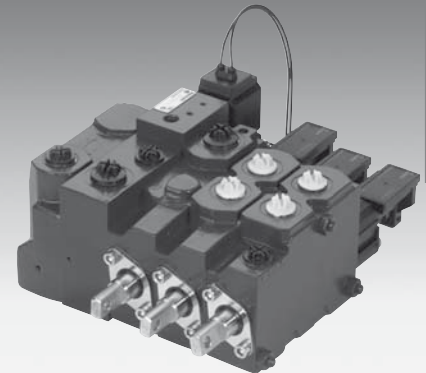


Ports	
T	SAE 1 1/4" (standard pressure)
P	SAE 1 1/4" (high pressure)
A1 ... A3 B1 ... B3	SAE 1" (high pressure)
LS1, LS2, M1, M2, X1, X2, Y1, Y2, M _A , M _B , a, b, V	G 1/4

Load-Sensing Control Block SB12

SB12-M mechanical actuation
SB12-EM direct operated electromagnetic actuation

Nominal pressure: $p_{\text{nom}} = 250 \text{ bar}$
Flow: $Q_{\text{max}} = 100 \text{ l/min}$



2

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Mechanical actuation – M:	
Technical data	4
Direct operated electromagnetic actuation – EM:	
Technical data	5
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End plate	11
Subplate	12
Accessories	12
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Unit dimensions	17–24
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Operating instructions

- Part 1: General information: RE 64 020-B1
- Part 2: SB12 directional control valves for mobile applications: RE 64 386-B2

Features

System

- “load sensing” system

Design

- plate construction
- up to 10 directional control valve elements

Actuation types

- mechanical
- electromagnetic

Flow

- load-pressure compensated
- high accuracy of repeatability
- low hysteresis

Pressure safeguarding

- port plate for fixed pump

Application areas

- fork lift trucks
- construction machines
- municipal vehicles
- harvesters

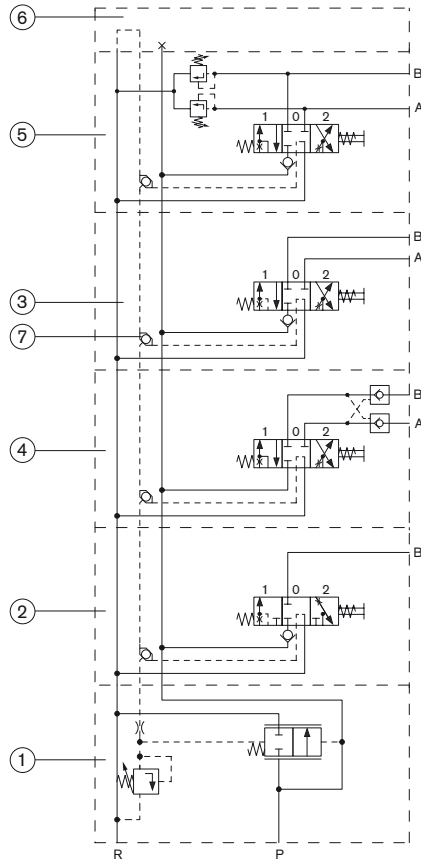
Repair instructions

- directional control valve block, series SB12: RDE 64 386-R1

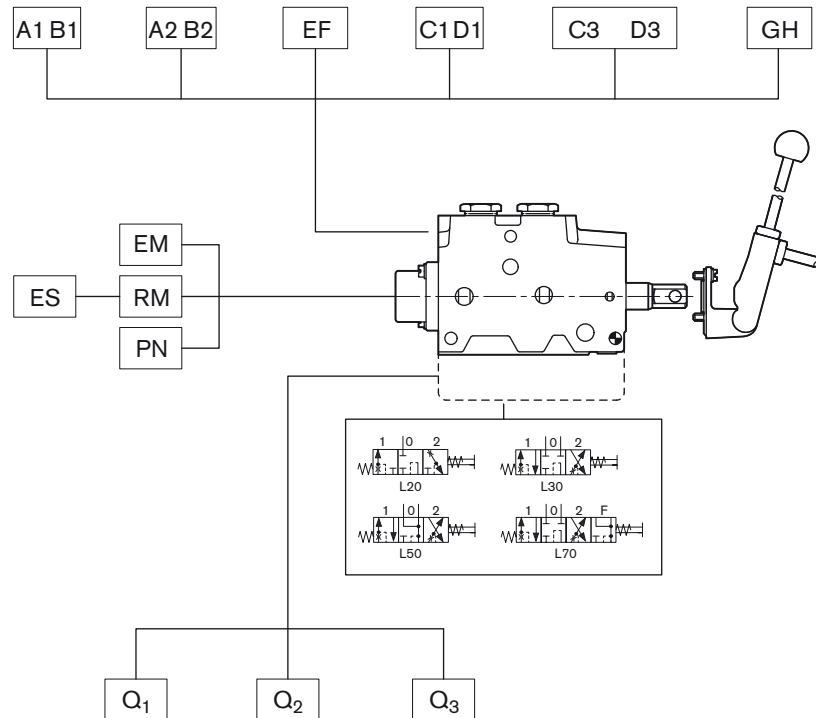
SB12 control block (example)

“Load sensing” system, for minimization of throttle losses and load-independent flow control.

- ① Port plate with pressure compensator and pressure-relief valve
- ② Directional control valve, single-acting
- ③ Directional control valve, double-acting
- ④ Directional control valve with check valves
- ⑤ Directional control valve with secondary pressure-relief valve
- ⑥ End plate
- ⑦ Shuttle valve for load-pressure selection



Modular system



The desired model variant of a directional control valve is described using this order code.

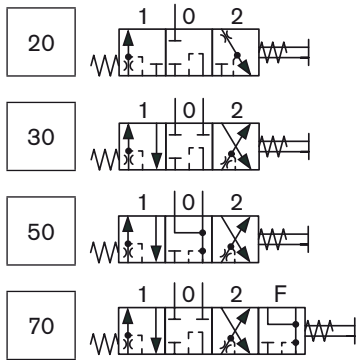
Order code, e.g.

1.	2.	3.	4.	5.	6.	7.
L	30	-	A1 B2	Q1	-	RM

1. Circuit type

L	Load sensing
---	--------------

2. Spool symbol



4. Auxiliary functions in the upper axis

A1 B1	Shock valve	in A in B
A2 B2	Anticavitation valve	in A in B
C1 D1	Check valve, hydr. actuated	in A in B
C3 D3	Check valve, el. actuated	in A in B
E F	Secondary PRV adjustable	in A in B
G H	Pilot pressure insert	in A in B
N	Connection D1 to check valve switching valve contained in subplate.	

5. Auxiliary functions in the lower axis

Q1	Metering restrictor, inflow	in P
Q2	2-way flow control valve	in P
Q3	2-way pressure compensator	in P

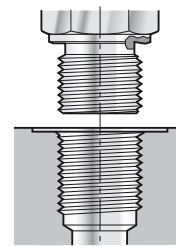
7. Auxiliary function in the main axis

PN	Pneumatic actuation
EM	direct operated electromagnetic actuation
1	Switching
2	Proportional
RM	Detent, mechanical release
ES1	Electrical switch
ES2	Position sensor

Customer ports

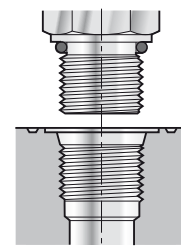
Ports A and B, threaded version
Type I: DIN 3852, part 1
Type III: ISO 6149

Type 1:
DIN 3852-1



Cutting edge,
flat seal ring,
copper ring

Type 3:
ISO 6149-1



O-ring sealing

Operating element

Accessories are to be ordered separately.
See page 13.

Mechanical actuation – M

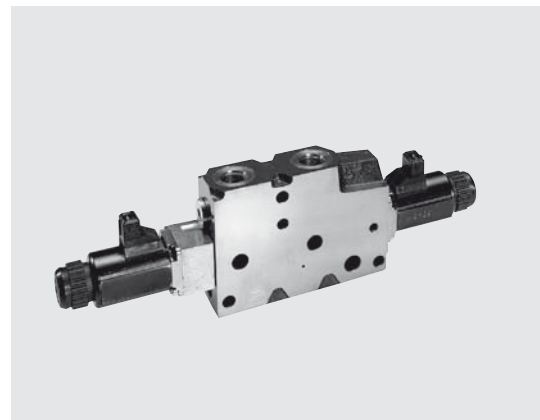


Characteristics

General		Valve blocks consisting of: 1 port plate, 1 end plate 1...10 directional control valve elements and shuttle valves 3 tie bolts
Mass		Directional control valve, mechanically actuated: 3.0 kg Directional control valve, electrically actuated: 3.8 kg Port plate: 2.7 kg End plate: 1.8 kg
Fixing		Thread in port plate and end plate (standard: M8)
Line ports		Internal thread, see order details
Installation position		As desired
Port plate configuration		Standard: left-hand version
Ambient temperature		-30°C...+80°C
Hydraulic		
Hydraulic fluid		Mineral oil based hydraulic oil acc. to DIN/ISO, other fluids, e.g. environmentally acceptable fluids, on request
Viscosity		10...800 mm ² /s permitted range 20...100 mm ² /s recommended range ...2000 mm ² /s range permitted for start-up
Temperature of hydraulic fluid		In operation +20°C...+90°C, for short periods -30°C...+100°C
Filtration		Oil contamination class 19/16 acc. to ISO/DIS 4406 or class 10 acc. to NAS 1638, obtained with filter $\beta_{25} \geq 75$ ¹⁾
Operating pressure at port	P A, B R W	$p_{\max} = 250$ bar (pump side) $p_{\max} = 280$ bar (consumer side), in combination with check valves 300 bar $p_{\max} = 20$ bar (return side) $p_{\max} = 250$ bar
Leakage A, B → R at $p = 125$ bar, $\nu = 33$ mm ² /s $\vartheta = 50$ °C		Standard: $Q_L = 18$ cm ³ /min with check valve: $Q_L = 2$ cm ³ /min with shock valve: $Q_L = 20$ cm ³ /min
Nominal flow		see diagram "Operating limits", page 16
Mechanical		
Spool strokes		Symbol L20: ±8 mm L30, L50: ±6 mm L70: ±6 + 5 mm
Actuating forces		< 200 N in spool axis direction
Type of protection		IP 69 K, with ES1 IP 54, with ES2 IP 64

¹⁾ Retention rate for dirt particles >25 µm is 1:75, i.e. 98.67%

Direct operated electromagnetic actuation – EM



Characteristics	Direct operated electromagnetic actuation
General hydraulic characteristics	See mechanically actuated directional control valves, page 4
Installation position *)	Spool axis horizontal. Maximum acceleration in spool axis direction 10g
Ambient temperature	-20 °C...+60 °C
Temperature of fluid in operation	+20 °C...+80 °C
Valve type	4/3-, 4/2- and 3/3-way switching / proportional
Control type	Electromagnetic, direct
Solenoid working stroke (s)	≈ 3.5 mm
Actuated time	100 % ED
Type of protection	IP 65
Plug connection	AMP Junior Timer, 2-pole

Characteristics	EM 1 (switching)		EM 2 (proportional)	
Leakage A, B → R at $p = 125 \text{ bar}$, $v = 33 \text{ mm}^2/\text{s}$ $\vartheta = 50 \text{ °C}$	Standard $Q_L \leq 40 \text{ cm}^3/\text{min}$ (without check valve)		Standard $Q_L \leq 64 \text{ cm}^3/\text{min}$ (without check valve)	
Hysteresis			< 15 %	
Spark suppression	Integrated in solenoid		-	
Solenoid voltage U_{nom}	12V	24V	12V	24V
Solenoid voltage U_{max} permitted	14V	28V		
Solenoid current min required	2.3 A	1.1 A		
Solenoid current (controlled) I_{max}			2.3 A	1.5 A
Coil resistance (R_L) at 20 °C	3.5 Ω – 3.75 Ω	13.8 Ω – 14.6 Ω	3.5 Ω – 3.75 Ω	9.6 Ω – 10.2 Ω
Coil resistance (R_L) at 80 °C	≤ 4.8 Ω	≤ 18.2 Ω	≤ 4.8 Ω	≤ 12.8 Ω
Inductivity at nominal stroke (50 Hz)			≈ 87 mH	≈ 220 mH
Current – proportional range (A), (B) I_{prop}			0.5 A – 2.3 A	0.25 A – 1.5 A
Dither signal (A), (B)			0.75 A ss ± 0.25 A	0.48 A ss ± 0.2 A
Dither frequency (A), (B)			120 Hz ± 5 Hz	
Dither shape of the current setpoint (A), (B)			Triangular signal	

*) Another installation position can be permitted only after positive conclusion of a user validation co-ordinated with Bosch Rexroth

Note

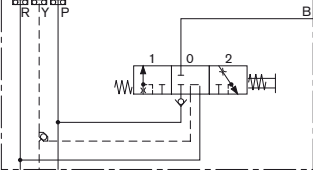
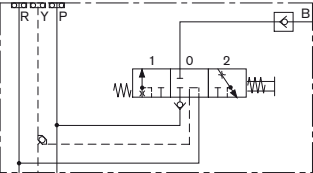
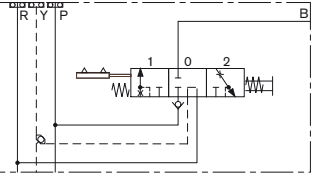
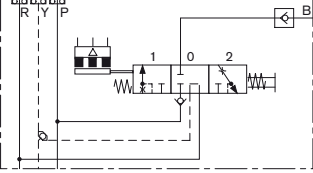
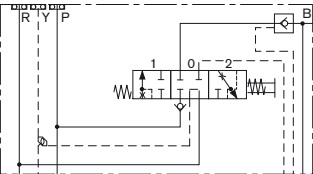
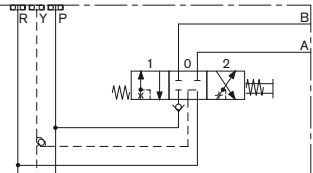
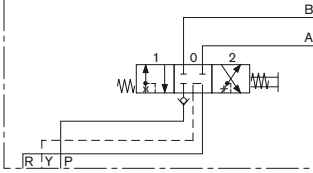
Definition of the proportional range:
 $0.02 \times Q_{\text{nom}}$ to Q_{nom} . Current decay for the specified dither signals via a spark-suppression diode ($U_f < 1 \text{ V}$).

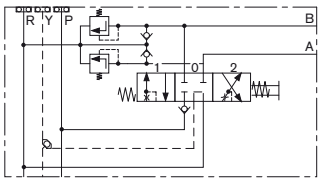
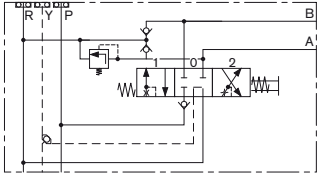
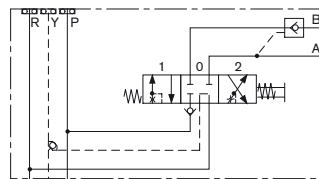
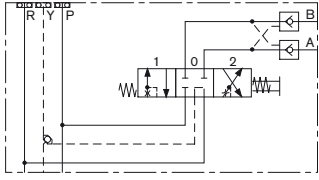
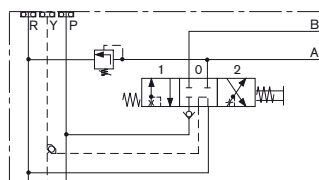
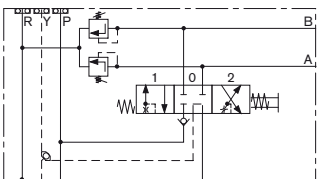
The dither values are to be interpreted as values for minimum hysteresis. All dither data are guide values.

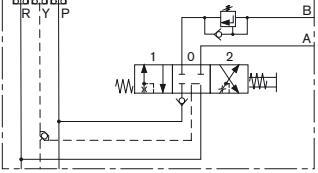
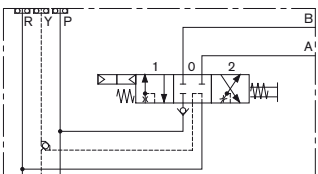
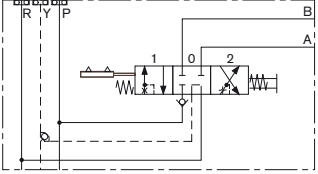
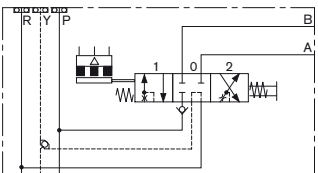
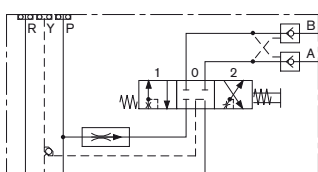
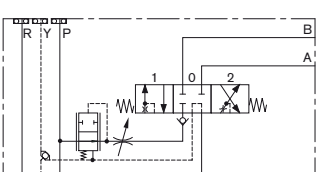
The dither data may need to be examined with respect to the given system and, if necessary, reoptimized.

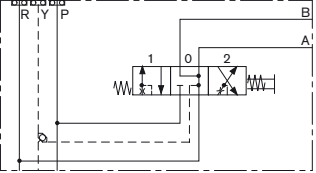
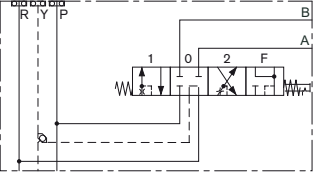
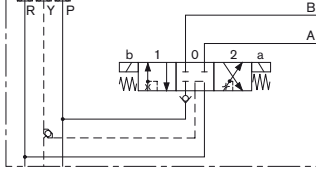
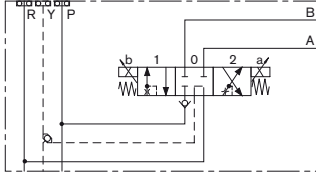
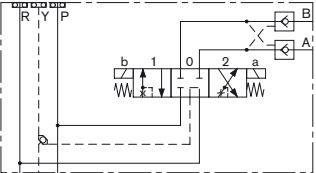
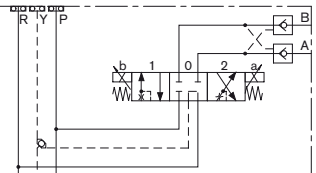
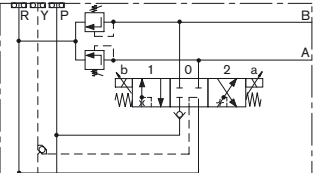
Order details

Directional control valves

Symbol	Comments	Port A	Port B	Q_{nom} with Δp [l/min / bar]	Order number
L20 		M18 x 1.5 / 1 without	M18 x 1.5 / 1 M22 x 1.5 / 1	50 / 3 50 / 3	0 521 608 004 0 521 608 073
L20 D1 		without without	G1/2 / 1 M22 x 1.5 / 3	70 / 3 70 / 3	0 521 608 028 R 917 005 371
L20 ES1 	with switch hub and spare parts set E-switch incl.	M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 024
L20 D1 ES2 		without without	M22 x 1.5 / 1 M22 x 1.5 / 3	120 / 8.4 100 / 6	R 917 003 192 R 917 004 505
L20 D1 N 	for connection of the subplate with cut-out function	without	M22 x 1.5 / 3	70 / 3	R 917 005 356
L30 		M18 x 1.5 / 1 M22 x 1.5 / 1 M18 x 1.5 / 3	M18 x 1.5 / 1 M22 x 1.5 / 1 M18 x 1.5 / 3	50 / 3 50 / 3 50 / 3	0 521 608 003 0 521 608 034 R 917 005 358
L30 end plate valve unit 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	R 917 004 171

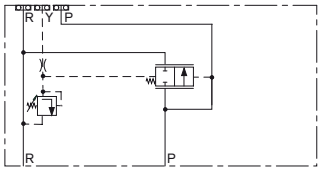
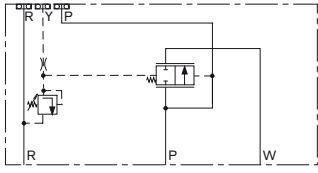
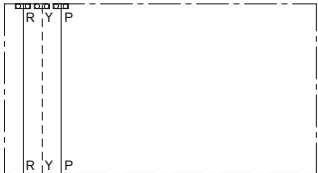
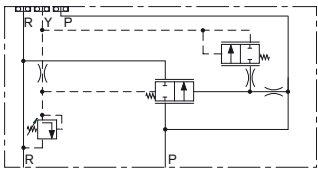
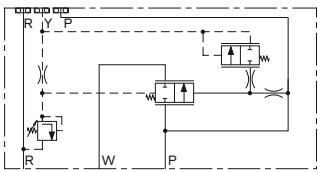
Symbol	Comments	Port A	Port B	Q_{nom} with AP Δp [l/min / bar]	Order number
L30 A1 B1 	A1 B1 $p = 300$ bar M18 x 1.5 / 1 M18 x 1.5 / 1 50 / 3 0 521 608 008	M18 x 1.5 / 1 M22 x 1.5 / 1	M18 x 1.5 / 1 M22 x 1.5 / 1	50 / 3 50 / 3	0 521 608 032
	A1 $p = 250$ bar M22 x 1.5 / 1 M22 x 1.5 / 1 50 / 3 0 521 608 032				
	B1 $p = 125$ bar M22 x 1.5 / 1 M22 x 1.5 / 1 50 / 3 0 521 608 032				
L30 A1 B2 	A1 $p = 300$ bar M18 x 1.5 / 1 M18 x 1.5 / 1 50 / 3 0 521 608 009	M18 x 1.5 / 1 M22 x 1.5 / 1	M18 x 1.5 / 1 M22 x 1.5 / 1	50 / 3 50 / 3	0 521 608 043
	A1 $p = 90$ bar M22 x 1.5 / 1 M22 x 1.5 / 1 50 / 3 0 521 608 043				
L30 D1 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 006
L30 C1D1 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 005
L30 E 	E $p = 120$ bar (100...150 bar) M18 x 1.5 / 1 M18 x 1.5 / 1 50 / 3 0 521 608 022	M18 x 1.5 / 1 M22 x 1.5 / 1	M18 x 1.5 / 1 M22 x 1.5 / 1	50 / 3 50 / 3	0 521 608 023
F $p = 120$ bar (100...150 bar) M22 x 1.5 / 1 M22 x 1.5 / 1 50 / 3 0 521 608 023					
L30 EF 	E F $p = 175$ bar (150...230 bar) M18 x 1.5 / 1 M18 x 1.5 / 1 50 / 3 0 521 608 011	M18 x 1.5 / 1 M22 x 1.5 / 1	M18 x 1.5 / 1 M22 x 1.5 / 1	50 / 3 50 / 3	0 521 608 069
	E F $p = 175$ bar (150...230 bar) M22 x 1.5 / 1 M22 x 1.5 / 1 50 / 3 0 521 608 069				

Symbol	Comments	Port A	Port B	Q_{nom} with AP Δp [l/min / bar]	Order number
L30 H 	<div style="border: 1px solid black; padding: 2px; display: inline-block;">H</div> $p = 125 \text{ bar}$	M18 x 1.5 / 3	M18 x 1.5 / 3	50 / 3	R 917 005 357
L30 PN 	$p_{N \max} = 4 \text{ bar}^*)$ $p_{\min} = 1 \text{ bar}$ $^*) \text{ proportional control}$	M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 066
L30 ES1 	with switch hub and spare parts set E-switch incl.	M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 025
L30 ES2 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	R 917 003 194
L30 C1D1 Q2 	$Q = 34 \text{ l/min (2...34)}$	M18 x 1.5 / 1	M18 x 1.5 / 1	34 / 3	0 521 608 071
L30 Q3 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 079



Symbol	Comments	Port A	Port B	Q_{nom} with AP Δp [l/min / bar]	Order number
L50 		M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 012
L70 RM 	detent engagement in F	M18 x 1.5 / 1	M18 x 1.5 / 1	50 / 3	0 521 608 013
L30 EM1 	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 833
L30 EM2 	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 827
L30 C1D1 EM1 	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 834
L30 C1D1 EM2 	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	7 / 3	0 521 608 841
L30 EF EM2 	12 V Jet E F $p = 230$ bar (150...230 bar)	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	R 917 002 484

Symbol	Comments	Port A	Port B	Q_{nom} with AP Δp [l/min / bar]	Order number
<p>L30 Q3 EM2</p>	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 859
<p>L50 EM1</p>	24 V Jet 12 V Jet	M18 x 1.5 / 1 M18 x 1.5 / 1	M18 x 1.5 / 1 M18 x 1.5 / 1	30 / 3 30 / 3	0 521 608 831 0 521 608 847
<p>L50 EM2</p>	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	10 / 3	R 917 001 607
<p>L50 C3 D3 EM1</p>	12 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 821
<p>L50 Q3 EM1</p>	12 V Jet	M22 x 1.5 / 1	M22 x 1.5 / 1	30 / 3	0 521 608 829
<p>L50.2 Q3 EM1</p>	12 V Jet	M22 x 1.5 / 1	M22 x 1.5 / 1	36 / 3	0 521 608 830
<p>L50.2 Q3 EM2</p>	24 V Jet	M18 x 1.5 / 1	M18 x 1.5 / 1	30 / 3	0 521 608 837

Port plates

Symbol	Δp bar	Q_{max} l/min	Ports P, R, W, Y, S	Order number
A1 	3	50	P: M18 x1.5 R: M22 x1.5	1 525 503 390
	3	50	P: M18 x1.5 R: plugged	1 525 503 524
	6	75	P: M18 x1.5 R: M22 x1.5	1 525 503 528
	3	50	P: M18 x1.5 R: M22 x1.5 Y: G1/4	1 525 503 503
A3 	3	50	P: M18 x1.5 R: M22 x1.5 W: M18 x1.5	1 525 503 394
A6 		100	P: M22 x1.5 R: M26 x1.5 Y: M12 x1.5	1 525 503 779
A2 	2.5/7	80	P: M22 x1.5 R: M26 x1.5	1 525 503 392
	3/8.4	90	P: M22 x1.5 R: M26 x1.5	1 525 503 525
	3/11	95	P: M22 x1.5 R: M26 x1.5	1 525 503 531
	6/16	100	P: M22 x1.5 R: M26 x1.5	1 525 503 505
A4 	2.5/7	80	P: M22 x1.5 R: M26 x1.5 W: M22 x1.5	1 525 503 396

End plates

E2 		S: M22 x1.5 plugged	1 525 503 474
		S: M22 x1.5	1 525 503 475
E8 		W: M18 x1.5 Y: M12 x1.5 S: M22 x1.5	R 917 000 886

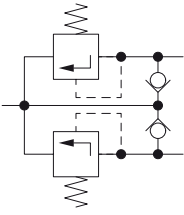
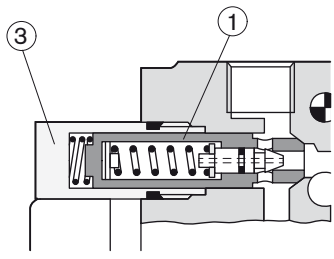

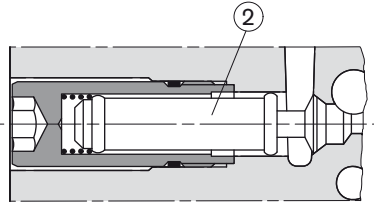
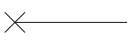
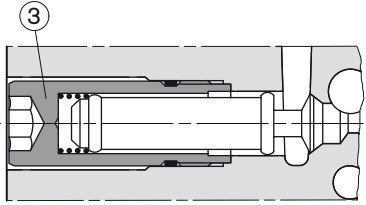
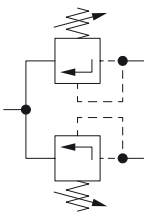
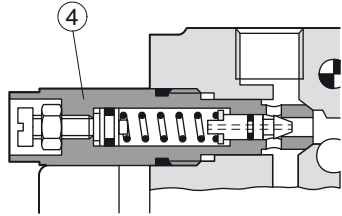
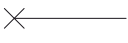
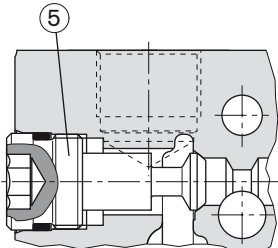
Subplate

	<p>LS switching valve – Connection of load sensing to return flow. Check valve switching valve – prevents / allows relief of check valve of the bordering directional control valve L20 D1 N. Manual lowering function.</p>	<p>R 917 003 111</p>
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Accessories

	<p>Shuttle valve for load tap (left-hand version)</p>		<p>1 527 419 006</p>																							
	<p>Tie bolt (1 tie bolt with nut)</p>	<table border="1"> <tr> <td rowspan="10">Number of directional control valves (port plate and end plate are taken into account)</td> <td>mm</td> <td></td> </tr> <tr> <td>1</td> <td>1 523 502 075</td> </tr> <tr> <td>2</td> <td>1 523 502 076</td> </tr> <tr> <td>3</td> <td>1 523 502 077</td> </tr> <tr> <td>4</td> <td>1 523 502 078</td> </tr> <tr> <td>5</td> <td>1 523 502 079</td> </tr> <tr> <td>6</td> <td>1 523 502 080</td> </tr> <tr> <td>7</td> <td>1 523 502 081</td> </tr> <tr> <td>8</td> <td>1 523 502 082</td> </tr> <tr> <td>9</td> <td>1 523 502 083</td> </tr> <tr> <td>10</td> <td>1 523 502 084</td> </tr> </table>	Number of directional control valves (port plate and end plate are taken into account)	mm		1	1 523 502 075	2	1 523 502 076	3	1 523 502 077	4	1 523 502 078	5	1 523 502 079	6	1 523 502 080	7	1 523 502 081	8	1 523 502 082	9	1 523 502 083	10	1 523 502 084	
Number of directional control valves (port plate and end plate are taken into account)	mm																									
	1	1 523 502 075																								
	2	1 523 502 076																								
	3	1 523 502 077																								
	4	1 523 502 078																								
	5	1 523 502 079																								
	6	1 523 502 080																								
	7	1 523 502 081																								
	8	1 523 502 082																								
	9	1 523 502 083																								
10	1 523 502 084																									
	<p>Operating element and bracket</p>	<p>Pos.</p>	<p>1 527 000 097</p>																							
	<p>Bracket with wiping ring</p>	<p>①</p>	<p>1 527 000 098</p>																							
	<p>Hand lever</p>	<p>③</p>	<p>1 522 027 306</p>																							
	<p>Cover plate with wiping ring</p>	<p>④</p>	<p>1 527 010 326</p>																							
	<p>Electrical switch, retrofit kit, complete</p>		<p>1 527 010 332</p>																							
	<p>Service part Fixing clip with electrical switch</p>	<p>① + ②</p>	<p>1 527 010 293</p>																							
<p>DIN/ISO Jet</p>	<p>Plug connector 2-pin, EM</p> <p>DIN/ISO Jet 1 834 484 057</p> <p>Jet 1 834 484 094</p> <p>+ individual wire seals R 900 313 533</p> <p> 1 834 484 095</p> <p>Plug connector 4-pin, EHS</p> <p>Jet R 917 002 006</p>																									

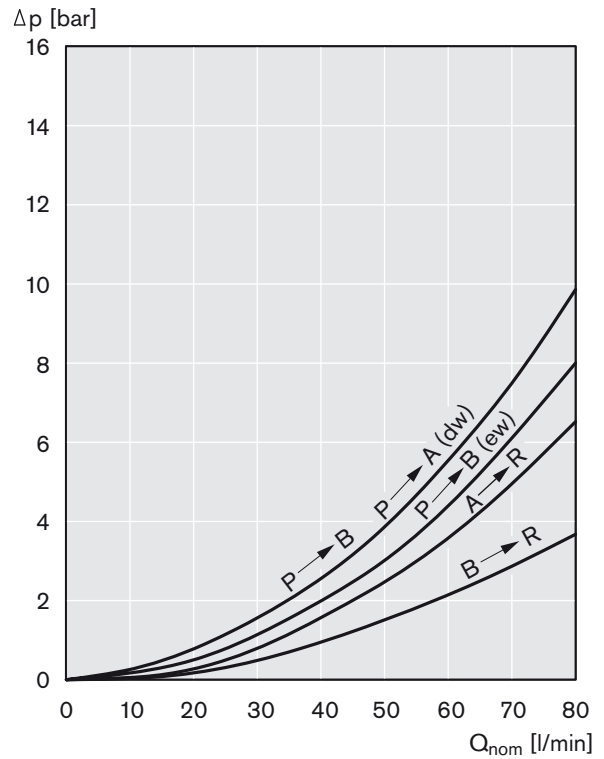
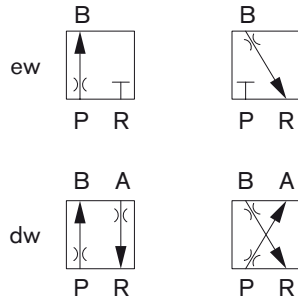
Retrofitting kits for **A1**, **B1**, **A2**, **B2**, **E**, **F**

	<p>Shock valve</p> <p>A1 B1</p> 	<p><i>p</i> [bar]</p> <p>30 50 80 90 100 120 140 160 180 200 220 250 280 300</p>	<p>Pos. ①</p> <p>1 527 410 084 1 527 410 082 1 527 410 079 1 527 410 078 1 527 410 081 1 527 410 083 1 527 410 077 1 527 410 080 1 527 410 076 1 527 410 070 1 527 410 073 1 527 410 076 1 527 410 072 1 527 410 061</p>
	<p>Anticavitation valve</p> <p>A2 B2</p> 		<p>Pos. ②</p> <p>1 523 105 083</p>
	<p>Spare parts set: locking screw for</p> <p>A1 B1 A2 B2</p> 		<p>Pos. ③</p> <p>1 527 010 355</p>
	<p>Secondary PRV, adjustable</p> <p>E F</p> 	<p><i>p</i> [bar]</p> <p>25... 60 60...100 100...150 150...230</p>	<p>Pos. ④</p> <p>1 527 410 089 1 527 410 123 1 527 410 069 1 527 410 063</p>
	<p>Spare parts set, leakage dummy plug, no function</p> 		<p>Pos. ⑤</p> <p>1 527 010 356</p>

Characteristics, directional control valves

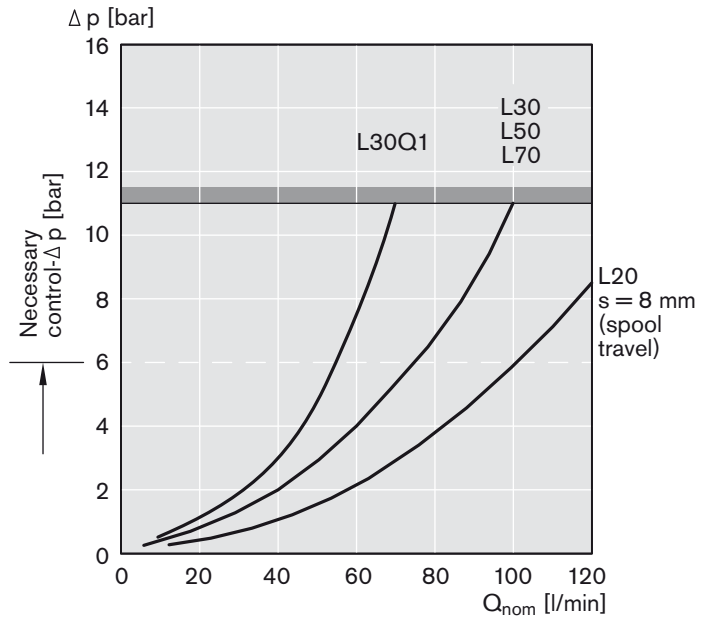
$\nu = 35 \text{ mm}^2/\text{s}$, $\vartheta = 50^\circ\text{C}$

Flow resistance for fully open directional control valve (characteristic curve)



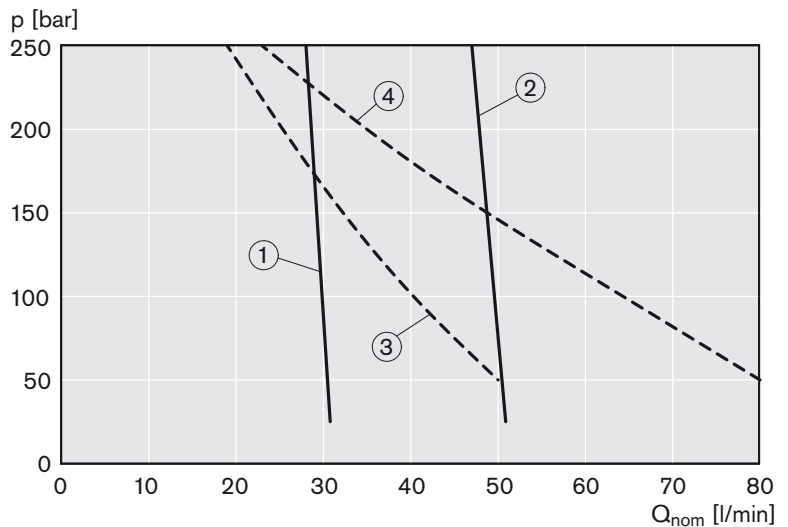
Operating limits Mechanical actuation

$\Delta p \geq 6 \text{ bar}$ only with Δp switchover
Control Δp on pressure compensator



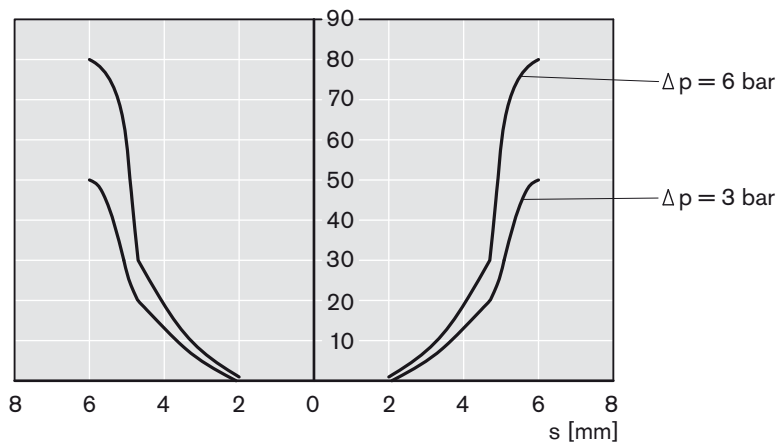
Operating limits direct operated electromagnetic actuation

- ① Braking load, i.e. lifting or pressing at control $\Delta p = 3 \text{ bar}$
- ② Braking load, i.e. lifting or pressing at control $\Delta p = 8.4 \text{ bar}$
- ③ Driving load, i.e. lowering or pulling, $A \rightarrow R$
- ④ Driving load, i.e. lowering or pulling, $B \rightarrow R$



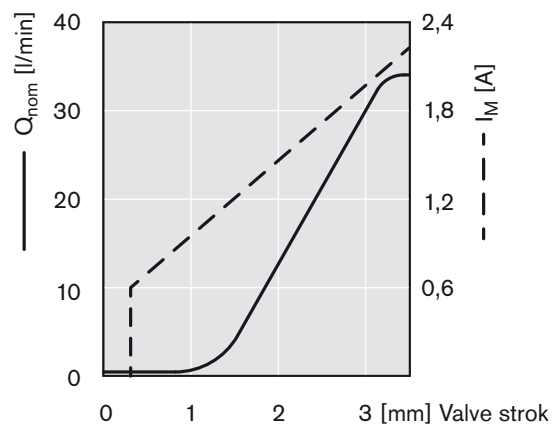
Flow versus spool travel

(characteristic curve)



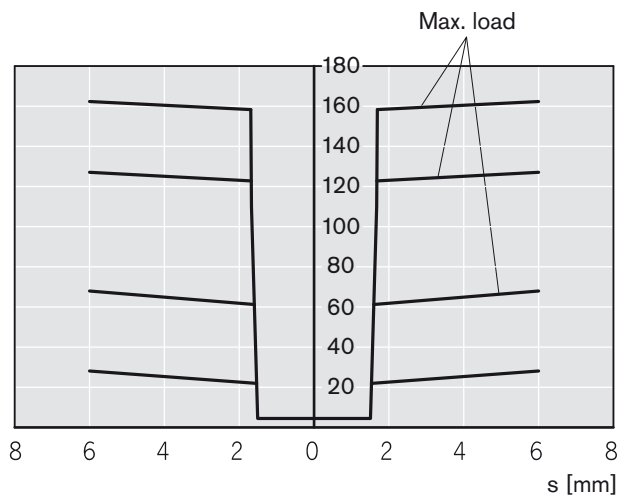
Flow Q and solenoid current I versus spool travel

(characteristic curve)

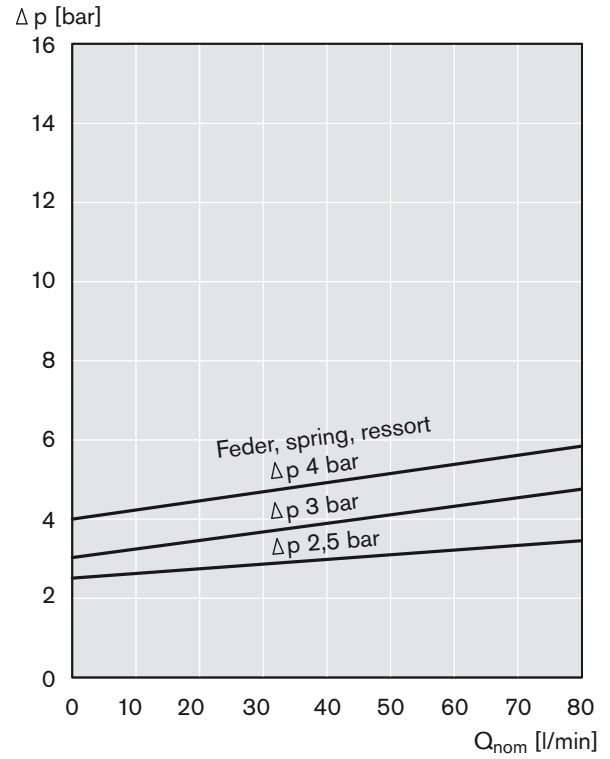
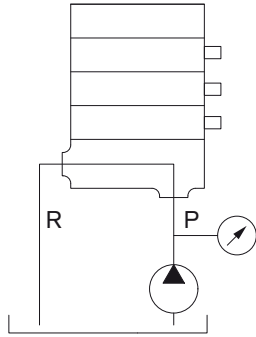


Pressure build-up versus spool travel

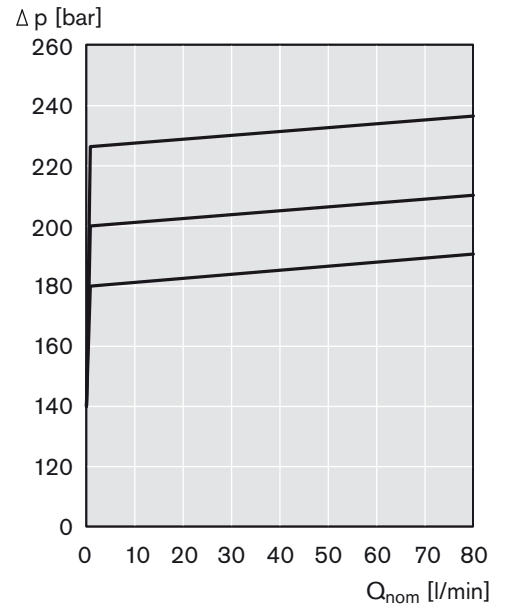
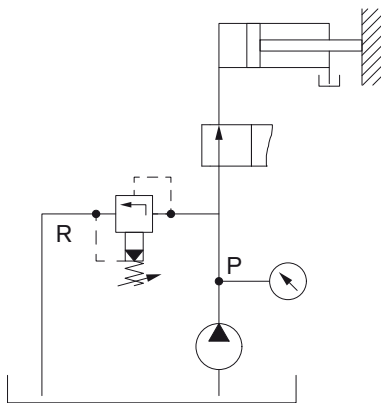
(characteristic curve)



Characteristics, port plates
Open center pump control P → R
 (characteristic curve)



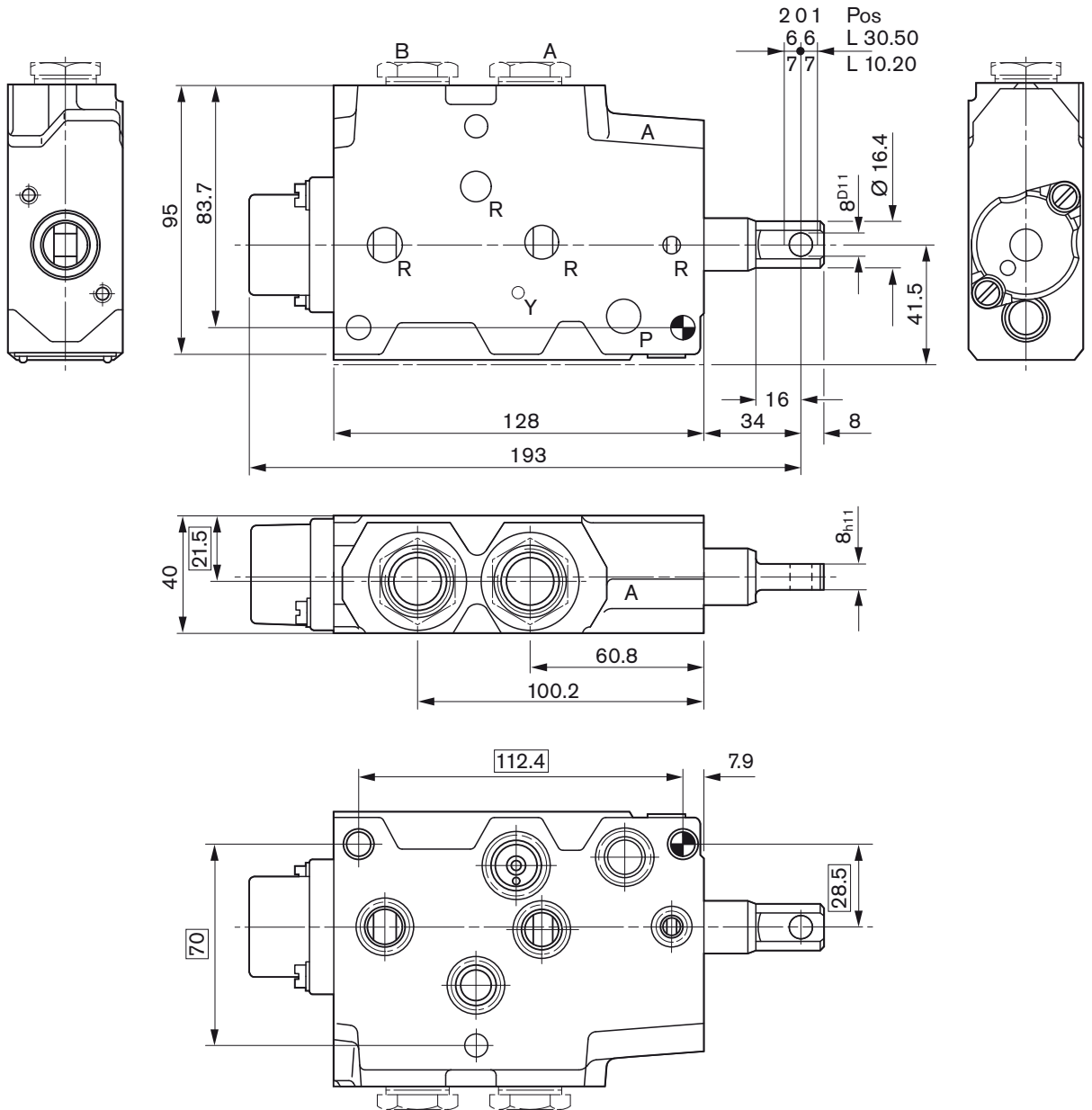
Pressure-relief valve
 (characteristic curve)



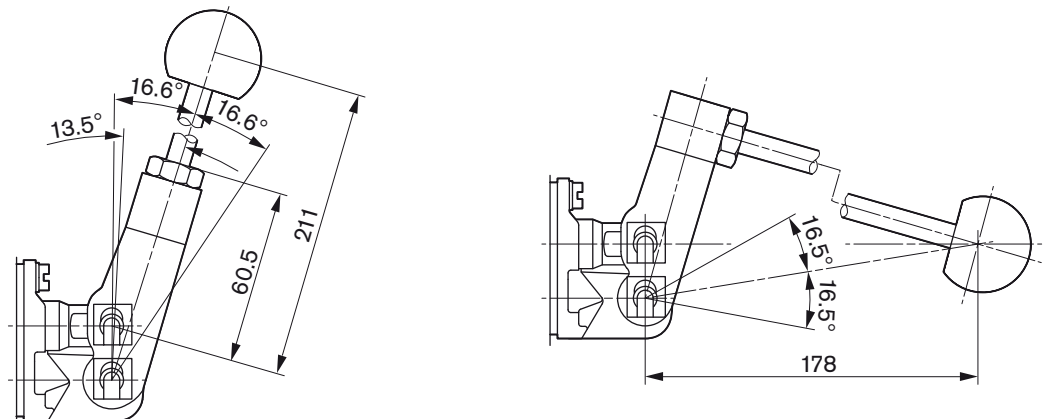
Dimensions

SB12-M directional control valve, mechanically actuated

Base valve: L 10, L 20, L 30, L 50



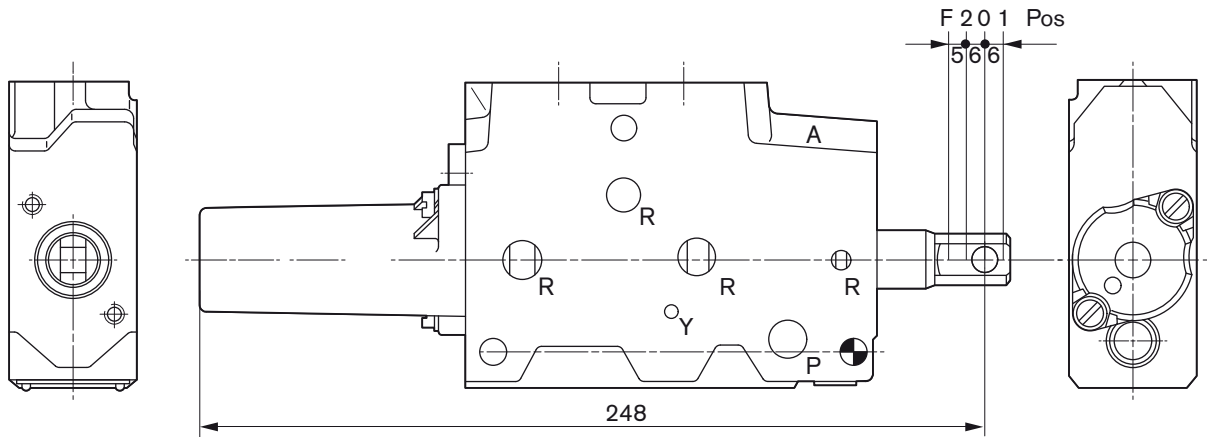
Operating element



Dimensions

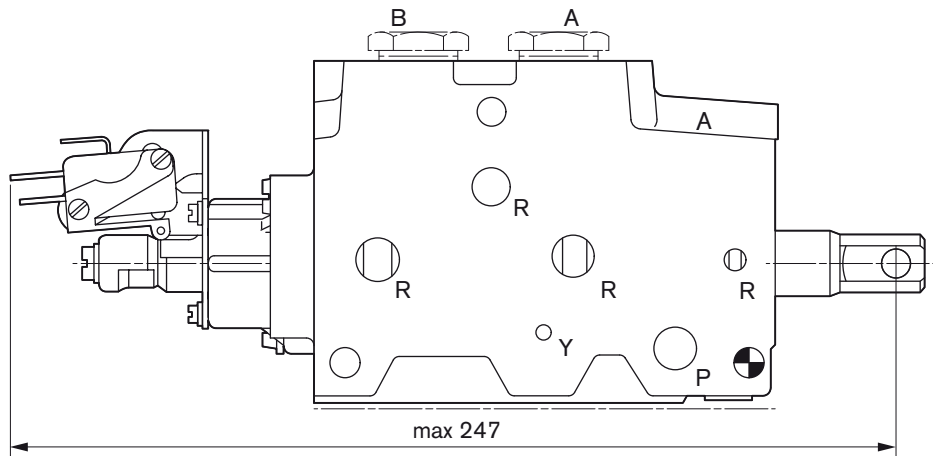
Directional control valve with auxiliary function

RM



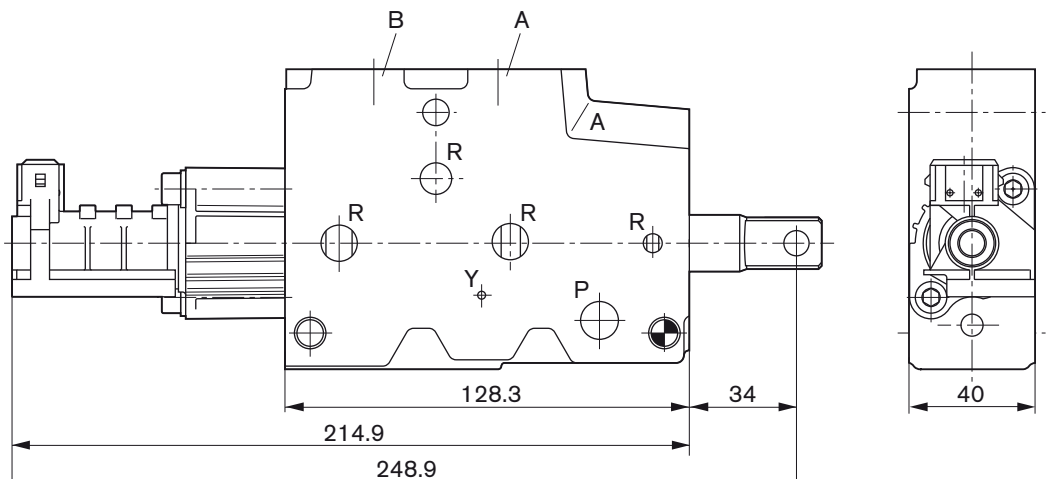
Directional control valve with auxiliary function

ES 1



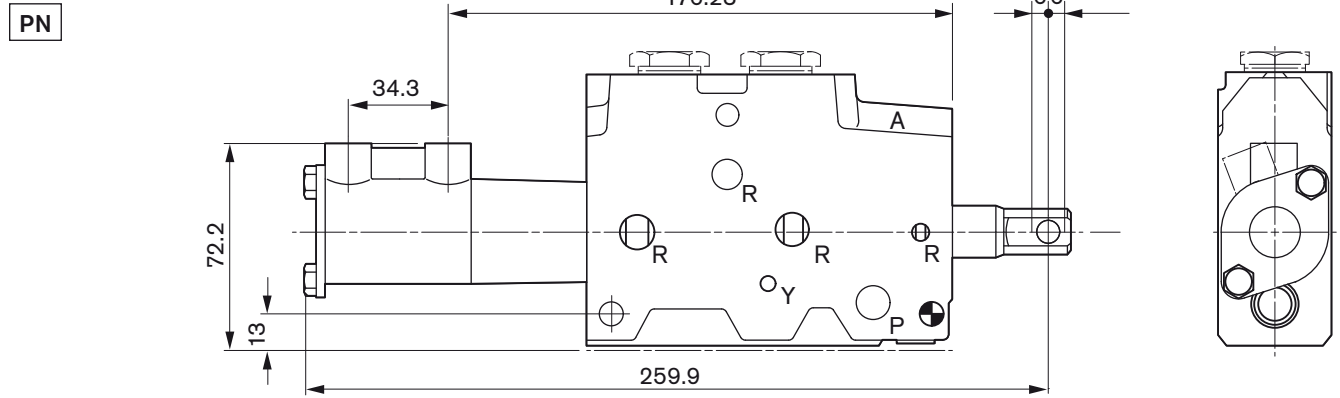
Directional control valve with auxiliary function

ES 2

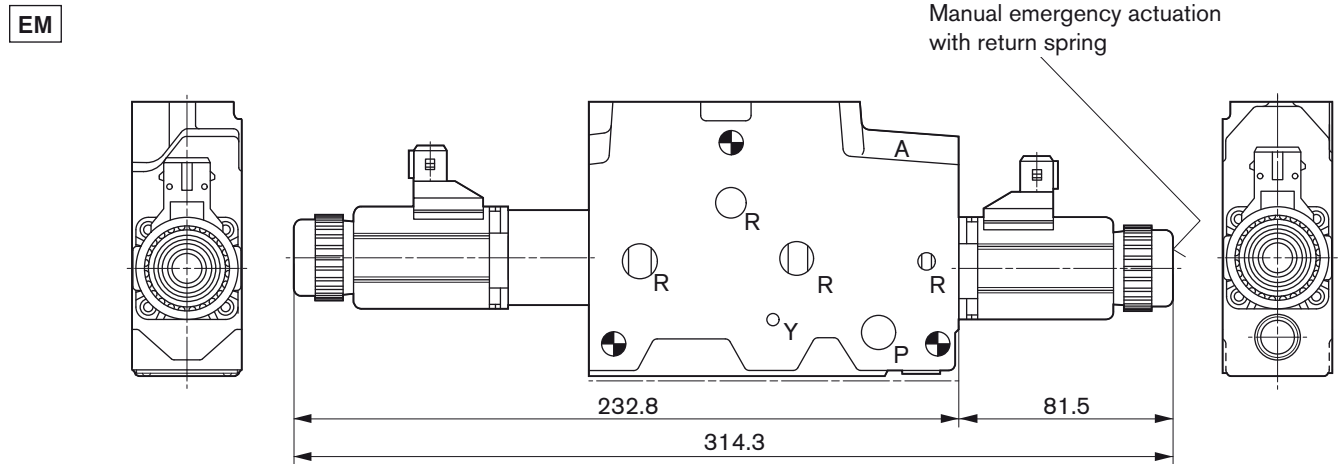


Dimensions

Directional control valve with auxiliary function



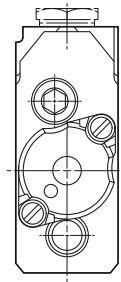
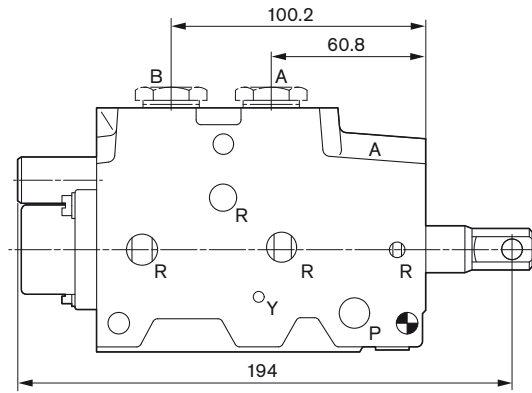
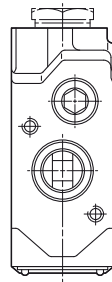
Directional control valve with auxiliary function



Dimensions

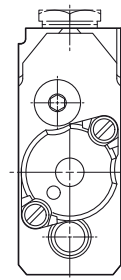
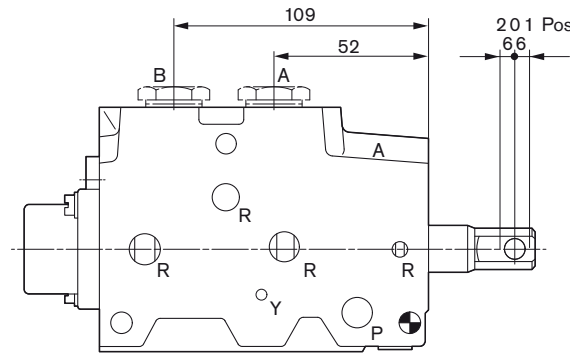
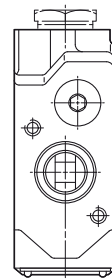
Directional control valve with auxiliary function

A1 B1 A2 B2



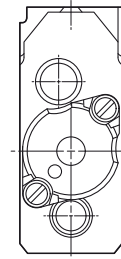
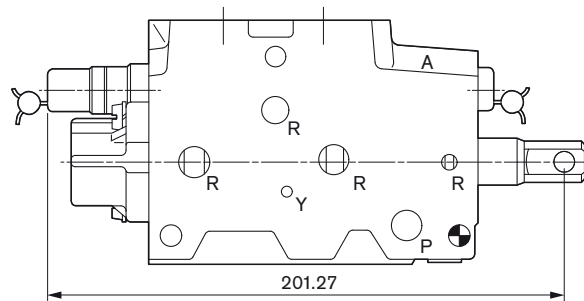
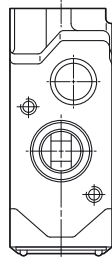
Directional control valve with auxiliary function

C1 D1



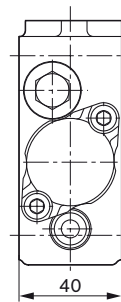
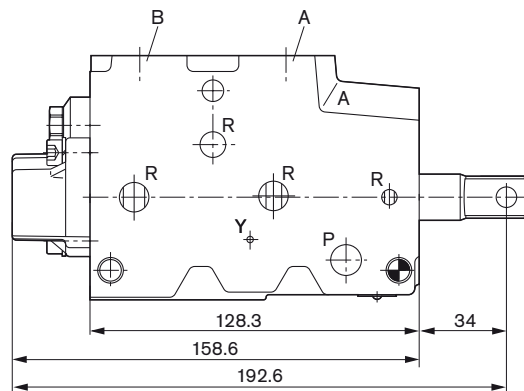
Directional control valve with auxiliary function

E F



Directional control valve with auxiliary function

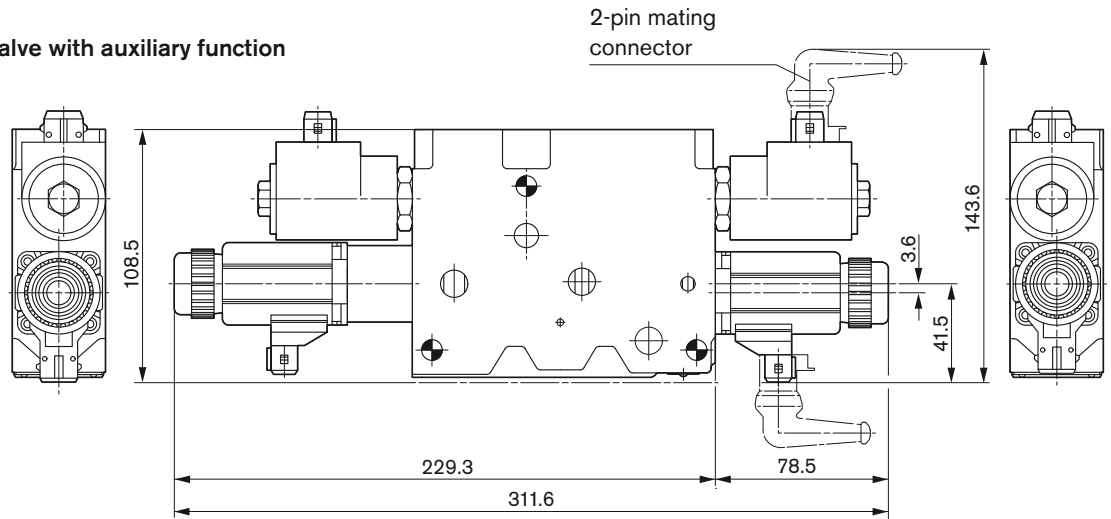
G H



Dimensions

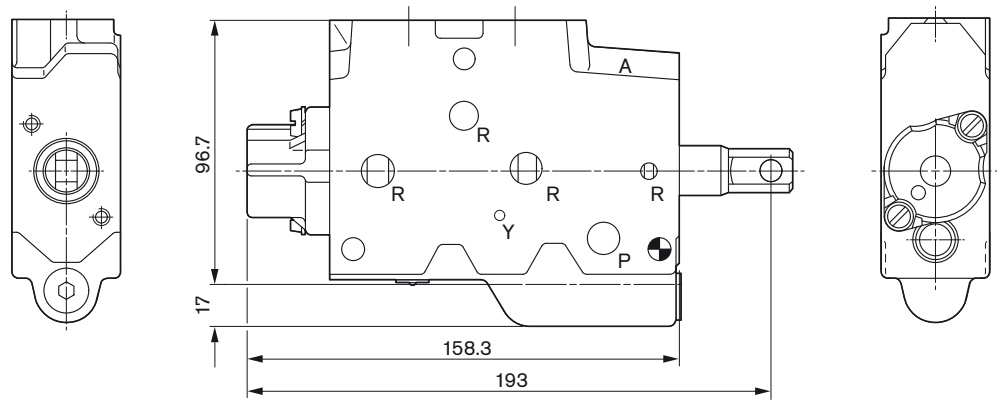
Directional control valve with auxiliary function

C3 D3 EM



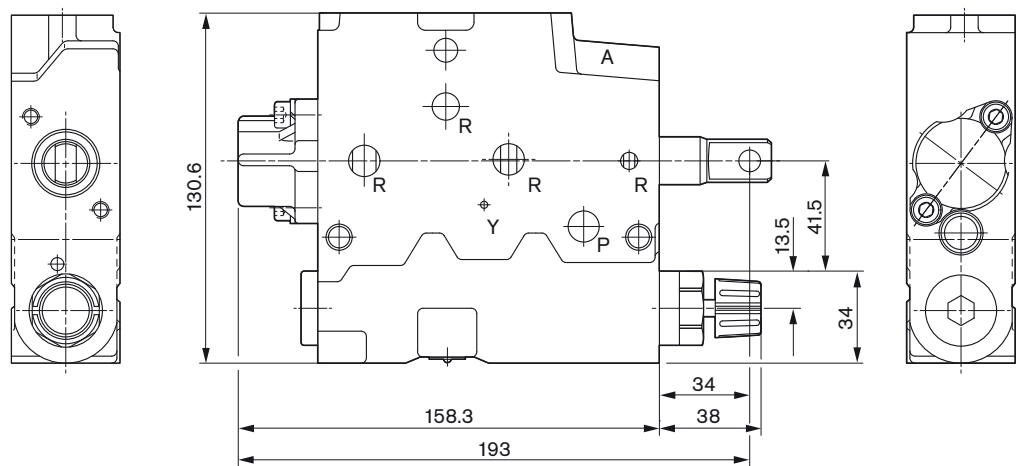
Directional control valve with auxiliary function

Q1



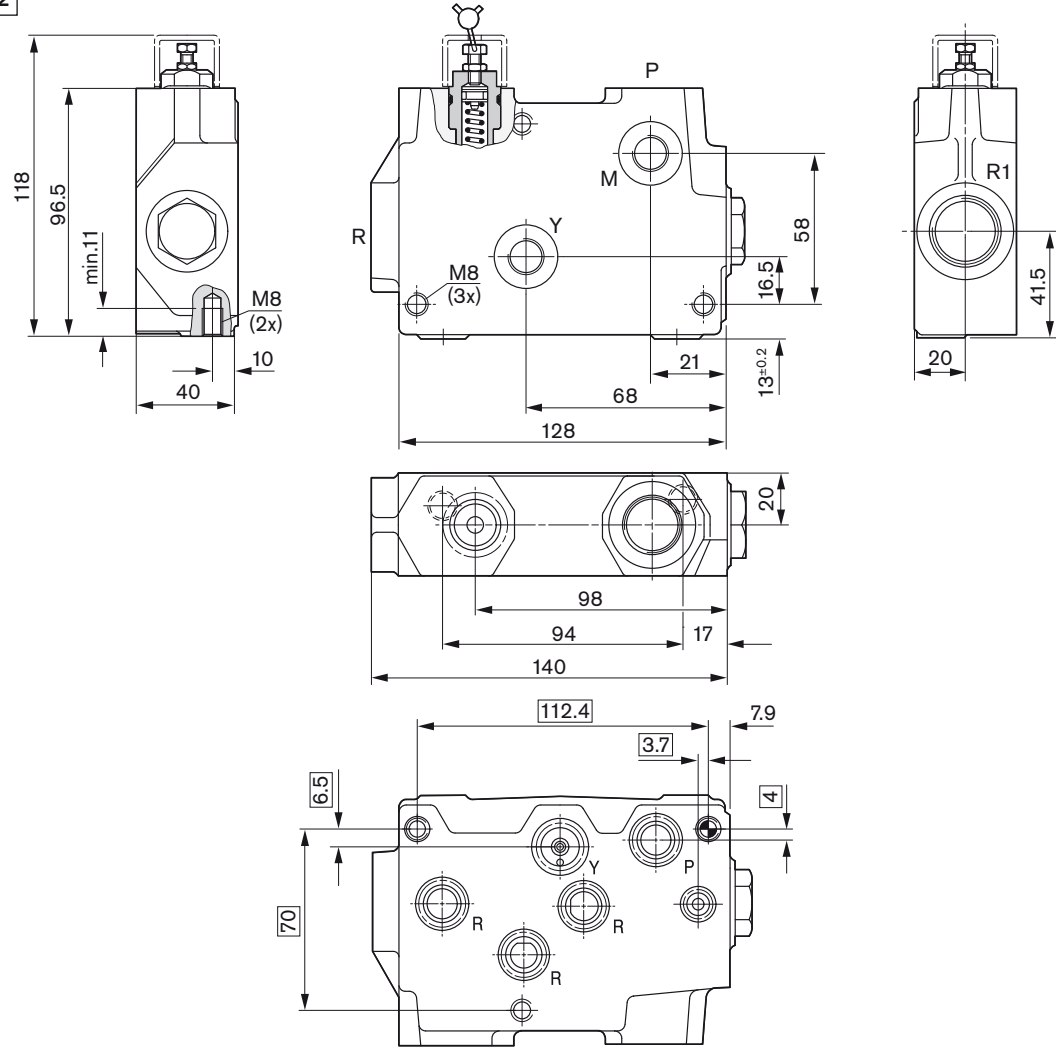
Directional control valve with auxiliary function

Q3

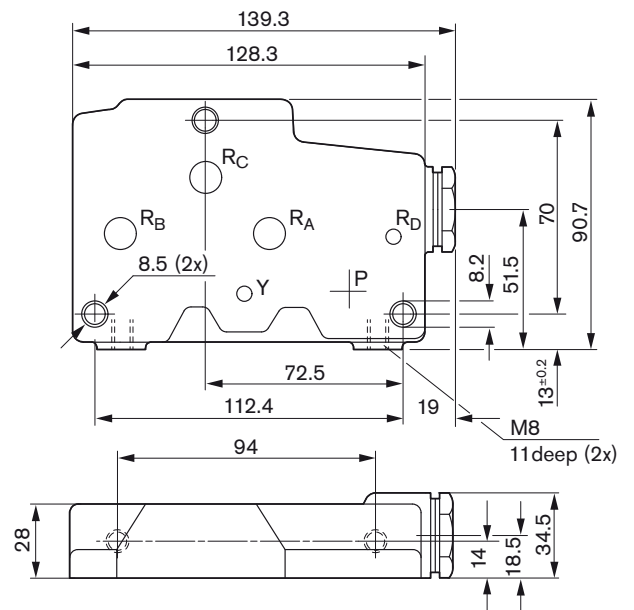


Dimensions

Port plates A1 A2
 Left-hand version

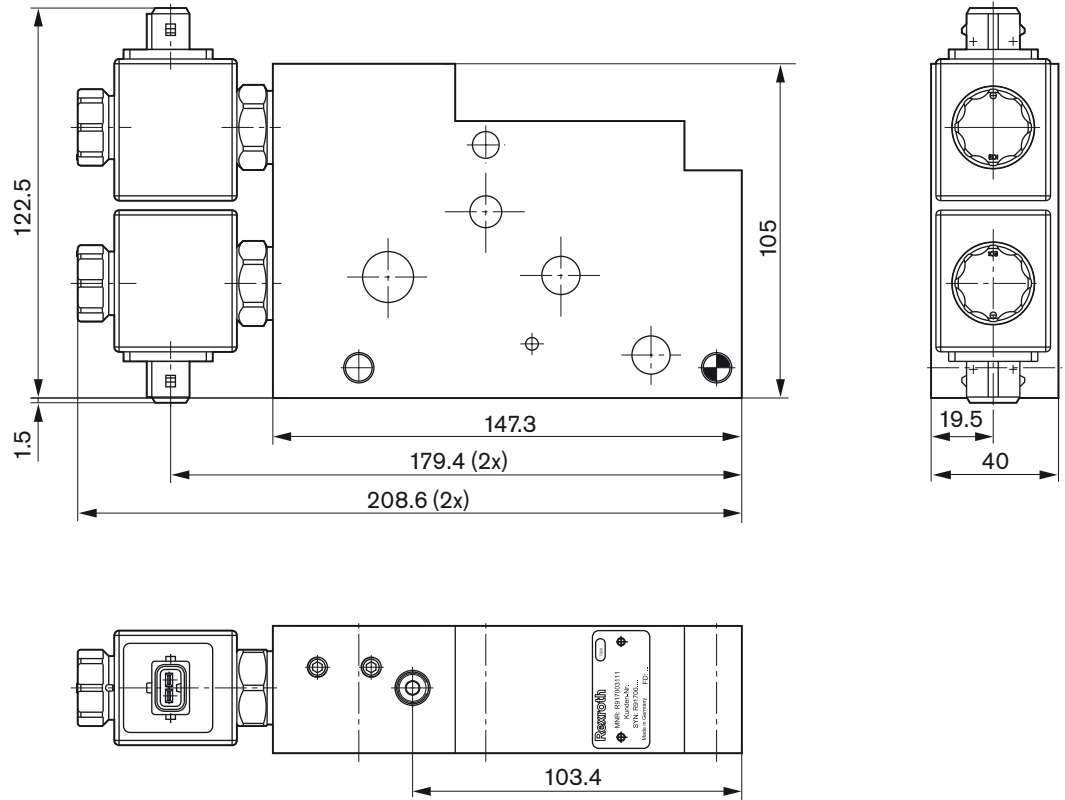


End plate E2
 Left-hand version



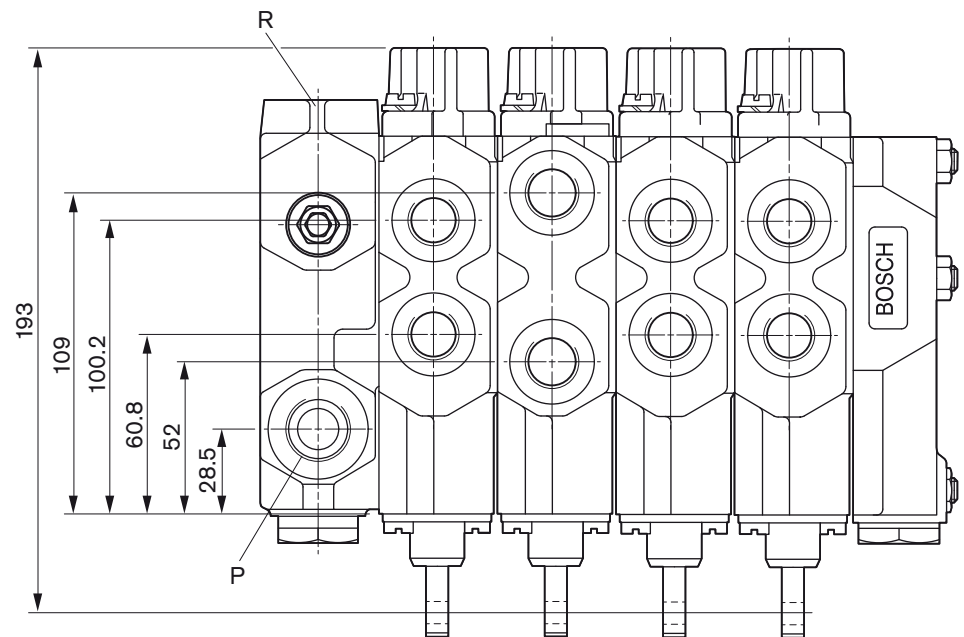
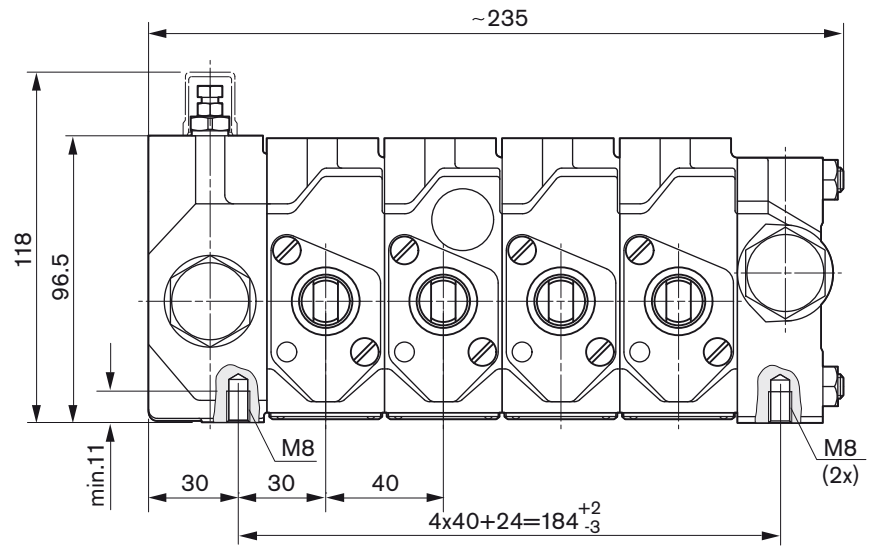
Dimensions

Subplate, cut-out function



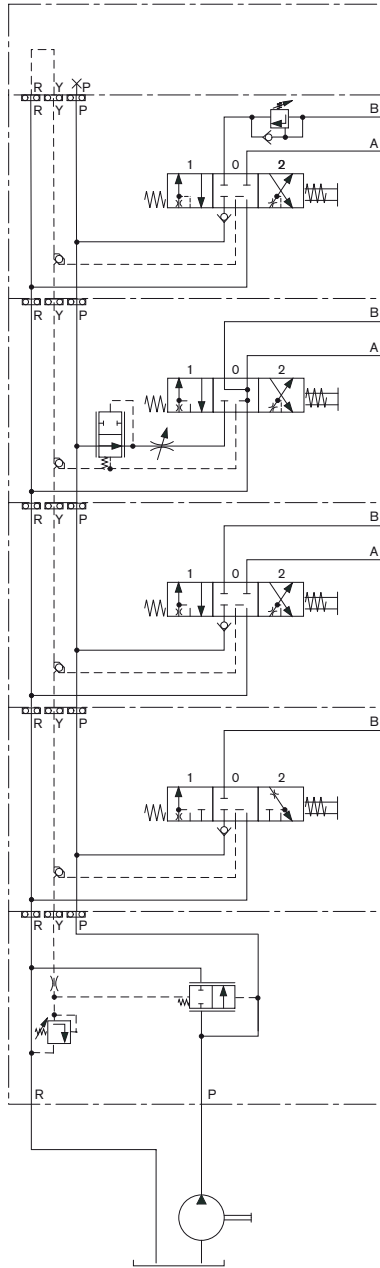
Dimensions

Complete control block

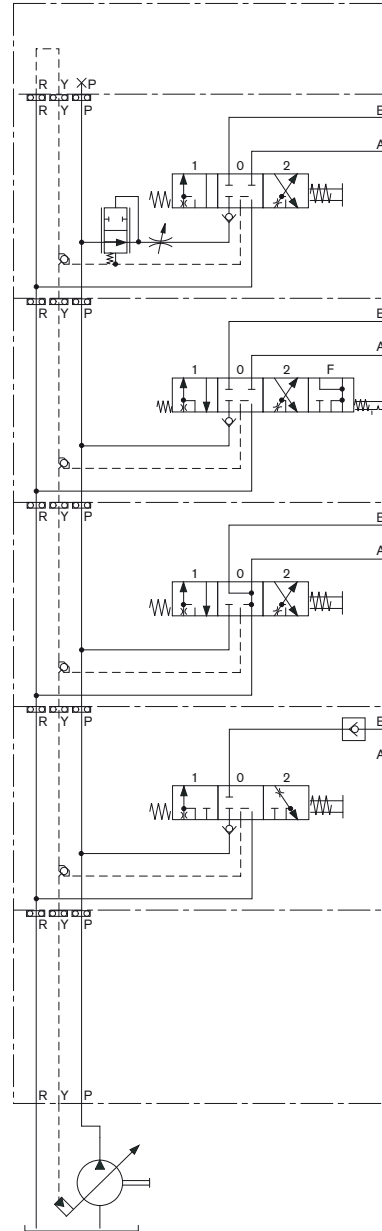


LS circuit examples

Standard control block with fixed pump

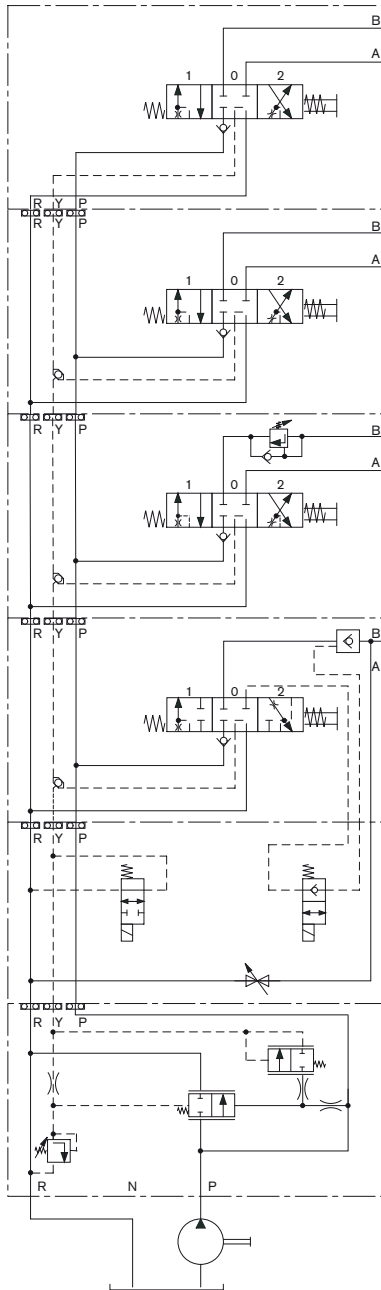


Standard control block with variable pump



Example circuit diagram:

Control block with fixed pump, SB12-M for fork lift truck applications



Endplate valve unit, double acting, as block termination.
The end plate is not necessary.

Double acting valve for the auxiliary function

Double-acting valve with integrated pilot pressure insert
for a continuous transition from pushing load to pulling load
during tilting.

Single-acting valve with integrated check valve for leak-free
load holding with the lift/lower function

Subplate with LS switching valve for connection of load sensing to check flow,
check valve switching valve for relief of check valve of bordering directional control
valve L20 D1 N and manual lowering function.

Port plate with Δp switchover for reducing the open center
pump control

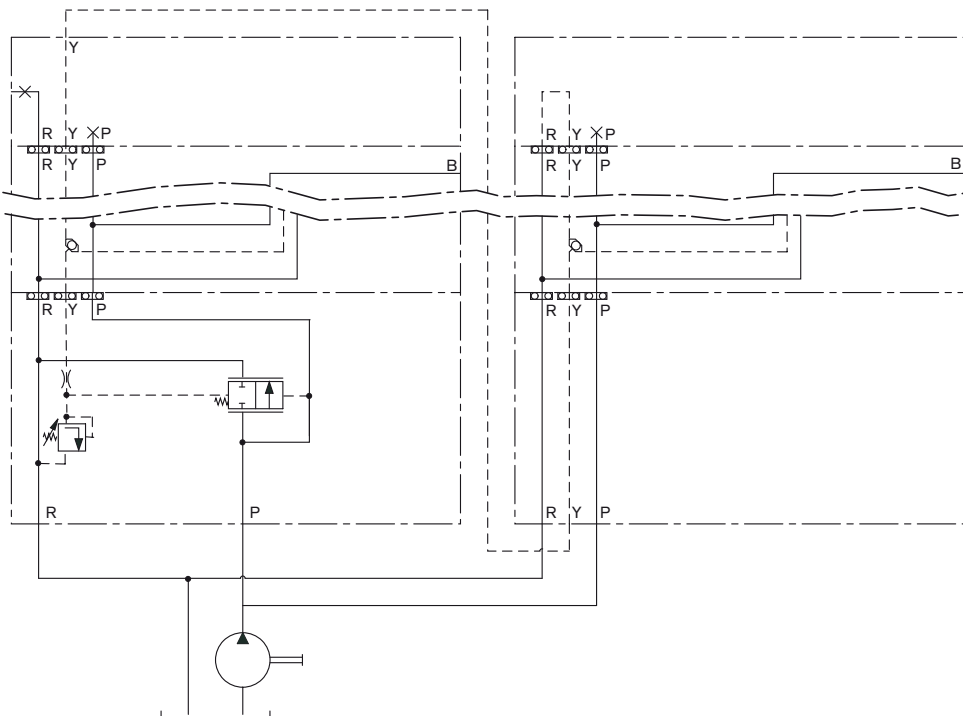
Parallel switching of two LS blocks

Open center pump control, fine-control residual flow and primary PRV function via pressure compensator in block 1, i.e. block II does not require a pressure compensator of its own.

Connection:
Control line Y via port plate from block 2 to end plate block 1.
P and R via pipeline with branch before block 1.

Block 1

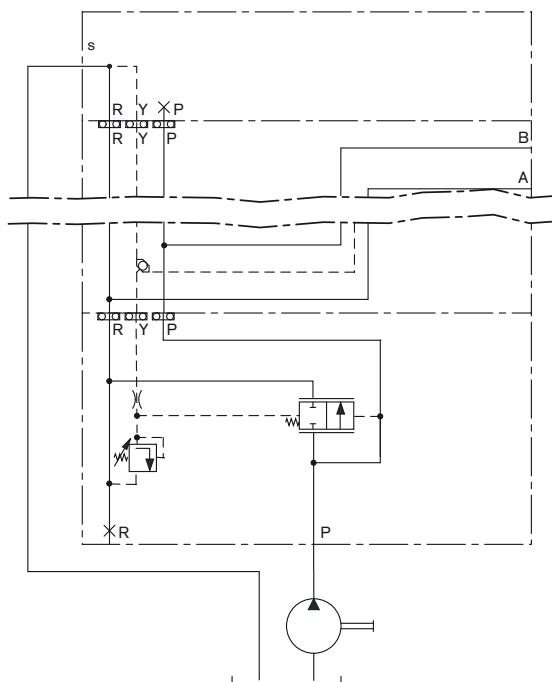
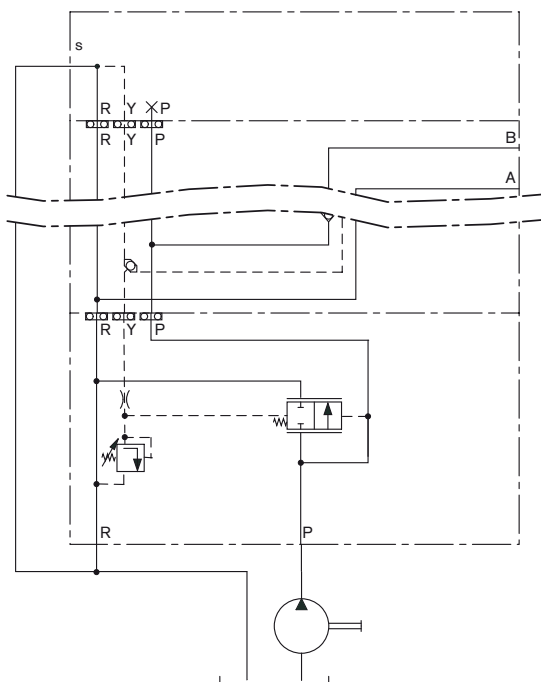
Block 2



SB12 - EM

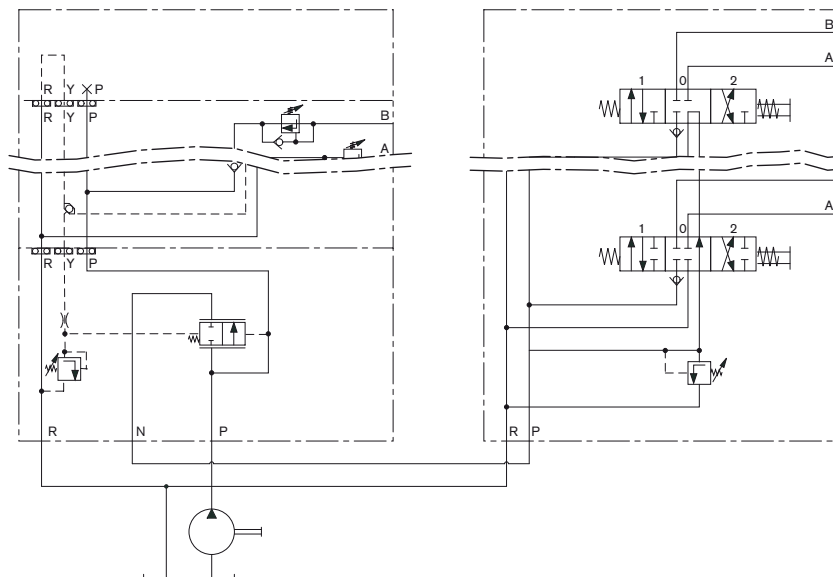
Return port in the end plate at port plate with Q greater than 30l/min.
Port plate symb. A3/A4 not usable.

Return port only in end plate up to $Q = 30$ l/min.
Port plate symb. A3/A4 not usable.



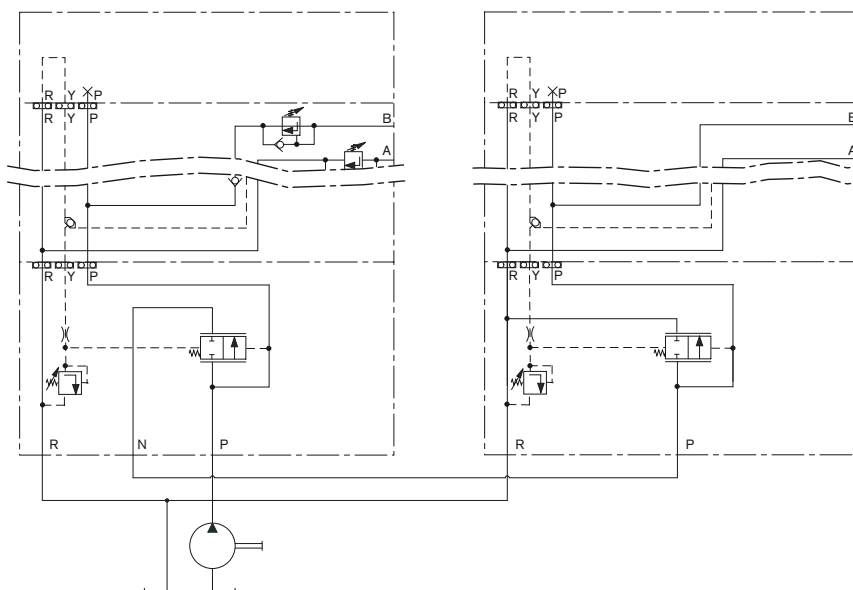
Relay link, LS block to OC block

Block II is connected in series to block I.
 Block II must have own primary pressure limitation.
 Open center pump control by means of block II.



Relay link with two LS blocks

Block II is connected in series to block I.



Functional description

“Load sensing” principle

Load sensing, i.e. the variable load pressure, is detected and fed to a pressure compensator or a pump controller. This principle offers the following advantages over other systems:

1. Load-independent flow control

The pressure differential Δp at the variable throttle cross-section of the directional control valve is kept constant. As a result, load fluctuations are compensated and the flow or cylinder speed is kept constant. This only applies for the cylinder with the highest load pressure which is accessed via shuttle valves.

2. Power drops in the fine control range

Flow control through throttling inevitably has losses. These losses are minimized through the “load sensing” principle. A comparison with other systems illustrates this advantage.

2.1 Fixed pump with open center pump control

The excess flow is removed via the pressure-relief valve. Because its set value p_1 exceeds the load pressure p_2 , there is excess pressure. Thus, there is excess power which is shared between the throttle and the pressure-relief valve

and converted to heat. With negative switching overlap of the open center pump control, the excess pressure can be reduced.

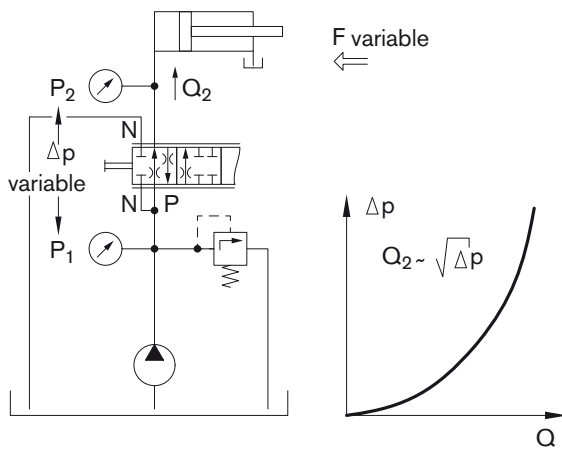
2.2 Fixed pump with “load sensing”

The excess flow is not removed by means of the maximum pressure valve, but instead via a parallel pressure compensator. This does not open at p_1 , but instead at the measured load pressure p_2 plus the spring precharge pressure, which determines the pressure difference Δp at the throttle. This configuration corresponds to a 3-way flow control valve and ensures not only improved power balance, but also a consumer flow which is independent of load fluctuations.

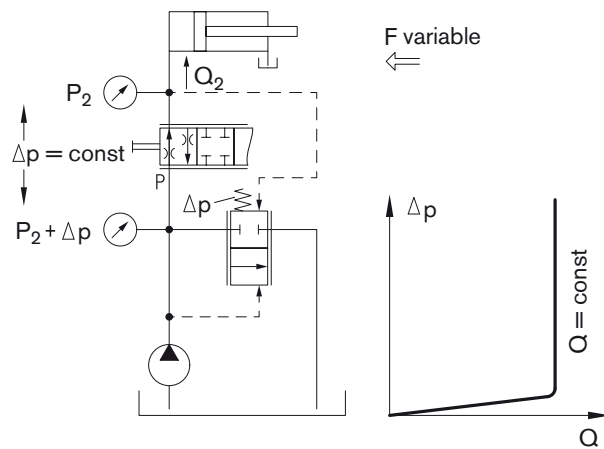
2.3 Variable pump with “load sensing”

The pressure compensator is a component of the pump control system and controls the delivery according to the opening cross section of the throttle. This adaptation occurs when the load pressure is detected, i.e. neither excess pressure nor excess delivery occurs. Only the pressure difference Δp at the throttle, determined by the spring of the pressure compensator, still generates a slight dissipation power. This system requires a variable pump with corresponding controller.

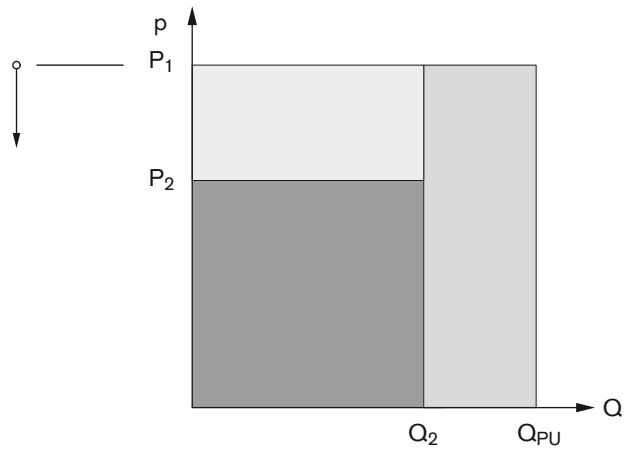
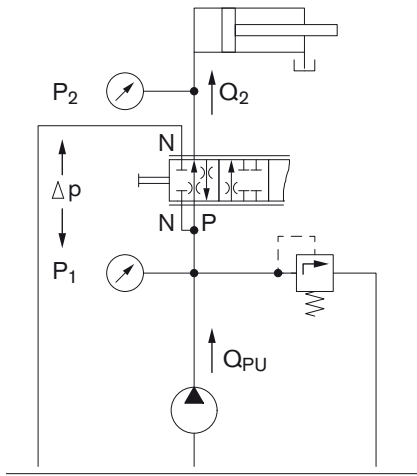
OC system



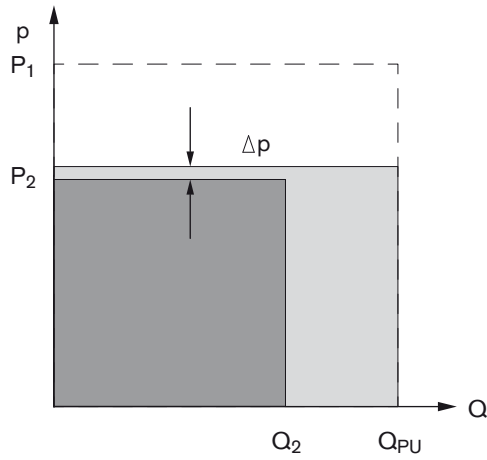
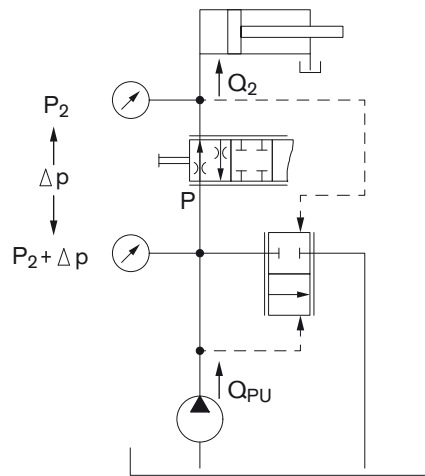
LS system



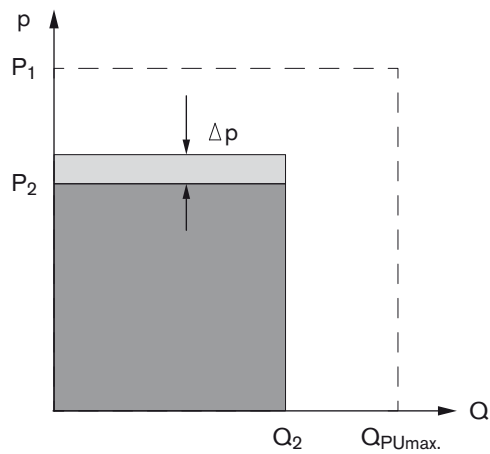
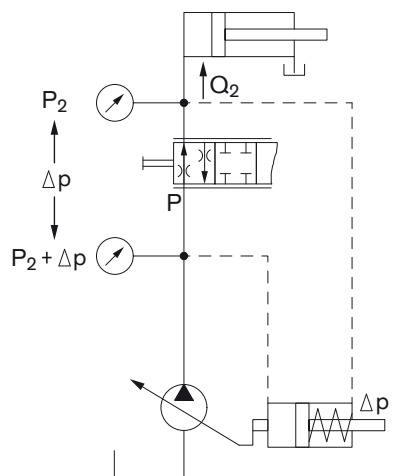
Fixed pump with open center pump control N



Fixed pump with "load sensing"



Variable pump with "load sensing"

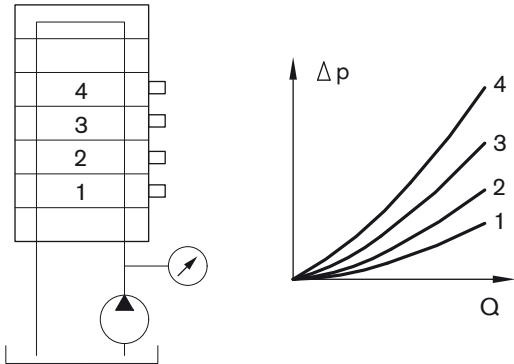


3. Power drops in the open center pump control

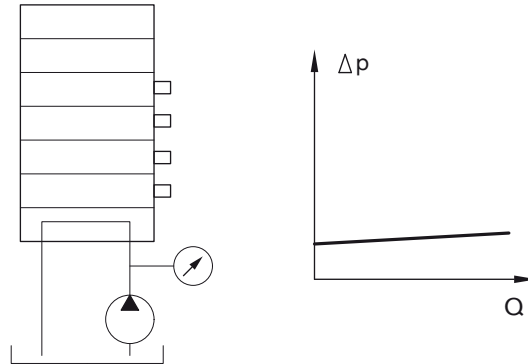
In standard systems with open center pump control by means of the valve block, the open center pump control pressure is dependent on the number of directional control valve segments.

For LS systems, the open center pump control occurs with minimal pressure directly in the port plate. With the Δp switch-over (optional), this pressure can also be minimized.

OC system



LS system

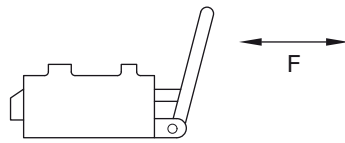
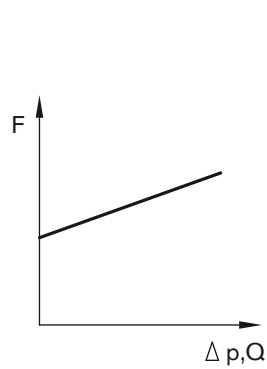


4. Actuation force at the valve spool

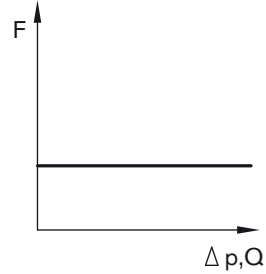
In standard systems, the flow forces, and thus the actuating forces at the valve spool, increase with the transmitted

hydraulic power. For LS systems, the actuating forces are smaller and remain constant.

OC system



LS system

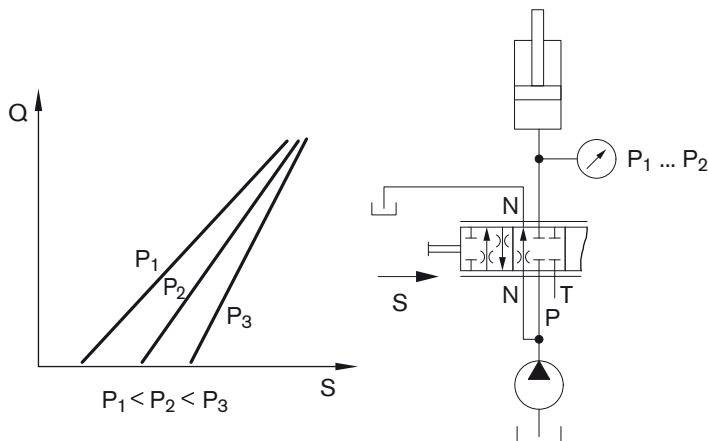


5. Control characteristic

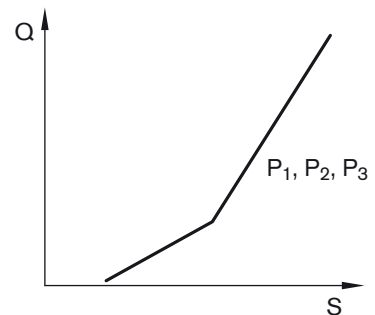
With conventional systems, the flow is load dependent. Moreover, the connection to the consumer at higher load pressures is opened only with a larger spool travel since the connec-

tion to the open center pump control must be more strongly throttled. LS systems are characterized by a control characteristic which is independent of load pressure.

OC system



LS system

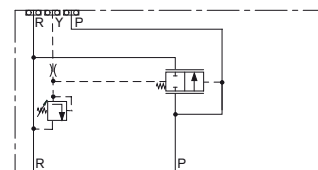
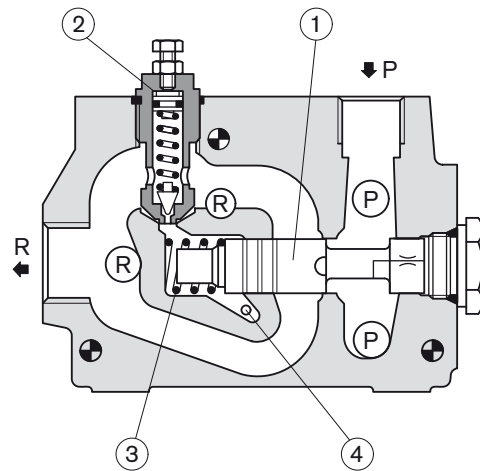


Port plate

Basic version $\Delta p = 3 \text{ bar}$

In addition to the infeed and return ports of the valve block for use with fixed pumps, the port plate contains a pressure compensator as well as an adjustable pressure-relief valve. The pressure compensator performs 3 functions:

- In combination with the instantaneous throttle cross sections at the directional-control-valve pilot spools, it functions as a 3-way flow regulator. The load pressure acts on the spring side of the pressure compensator via control line Y. The spring determines the pressure differential at the throttle cross sections of the directional control valves. This is held constant by the pressure compensator ($\Delta p = 3 \text{ bar}$).
- When the control line is depressurized (all directional control valves in the home position), the pressure compensator opens due to the effect of the inflow pressure and releases the open center pump control.
- Together with the adjustable pilot valve, the pressure compensator forms the main level of a pilot controlled pressure-relief valve for ensuring the maximum operating pressure.



Port plate

with Δp switchover 2.5 bar/7 bar

The flow at one throttling point is dependent on the pressure differential according to $Q \sim \sqrt{\Delta p}$.

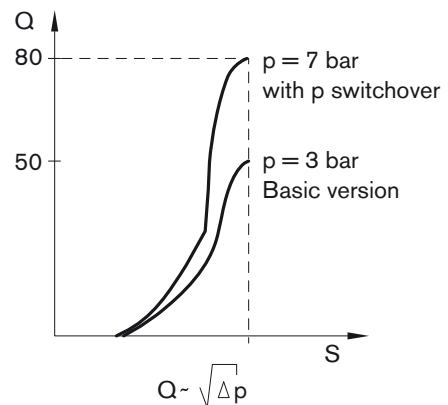
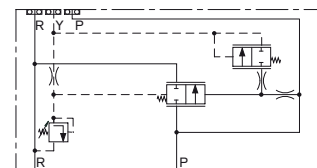
If the pressure differential is increased from $\Delta p_1 = 2.5 \text{ bar}$ to $\Delta p_2 = 7 \text{ bar}$, the nominal flow $Q_1 = 50 \text{ l/min}$ can be increased to

$$Q_2 = Q_1 \sqrt{\frac{\Delta p_2}{\Delta p_1}}$$

$$Q_2 = 50 \sqrt{\frac{7}{2.5}} = 80 \text{ l/min}$$

The increased pressure differential does, however, mean increased power drops, which are to be avoided particularly during open center pump control.

A switchover from $\Delta p = 2.5 \text{ bar}$ during open center pump control to $\Delta p = 7 \text{ bar}$ with opened directional control valves is realized with a special port plate. The switchover occurs via a switching valve which is integrated in the pressure compensator.



SB12-M directional control valve

Basic version

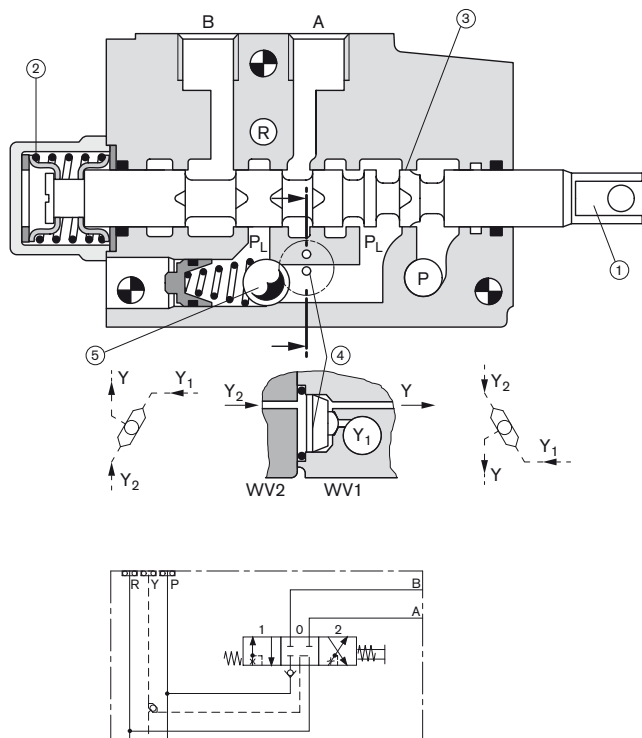
The basic version shown here is a double-acting directional control valve with 2 service line ports A and B. The valve spool (1) is held in the middle position by means of a return spring (2). In addition to the regular metering notches between ports P, A, B and R, the valve spool also controls the opening cross section (3) of the inflow P-PL, which, together with the pressure compensator in the port plate, determines the speed of the consumer (flow control valve function). A shuttle valve for the load tap (4) is arranged vertically with respect to the spool axis in the flange surface.

A check valve (5) in channel PL prevents an undesired lowering of the load in the fine control range and during simultaneous actuation of multiple directional control valves.

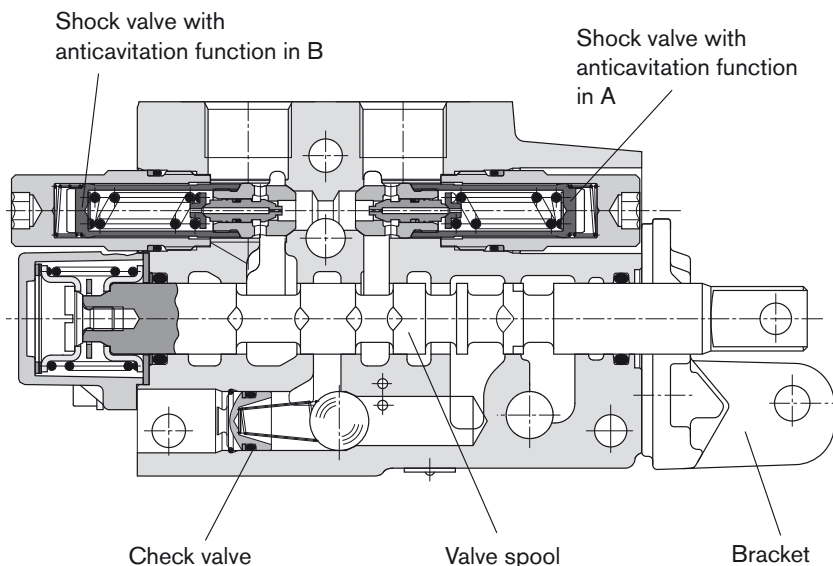
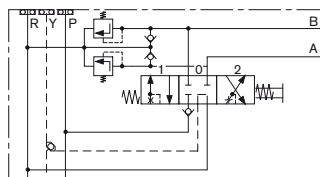
- ① Valve spool
- ② Return spring
- ③ Opening cross section
- ④ Shuttle valve
- ⑤ Check valve

Ports

- P Pump
- A, B Consumers
- R Tank
- Y Load Sensing (LS)



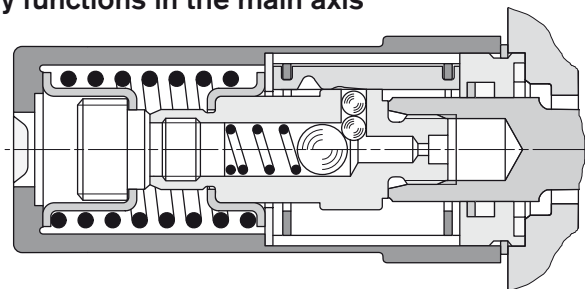
Left-hand version of SB12-M directional control valve, mechanically actuated L30-A1 B



Directional control valve – actuation types, auxiliary functions in the main axis

Mechanical actuation **RM**

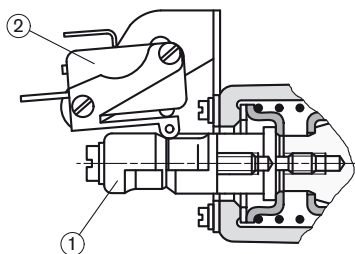
Detent, mechanical release



Electrical switch **ES1**

Various switching points can be set by turning the switch hub ① and the electrical switch ②. Either 1 or 2 electrical switches may be used.

Adjust by turning ① and ②.



Switch as changeover contact with plug connections.

Type of protection IP 00 DIN 40050.

Load capacity, AC current:

10 A 250 V~, 125 V~/0.25 kW inductive.

Load capacity, DC current:

Inductive loading at NN

0.5 A 125 V=, 0.25 A 250 V=, 5 A 30 V=*

Ohm's load: 5 A 30 V=**).

Electric engine, continuous current 5 A 30 V=**).

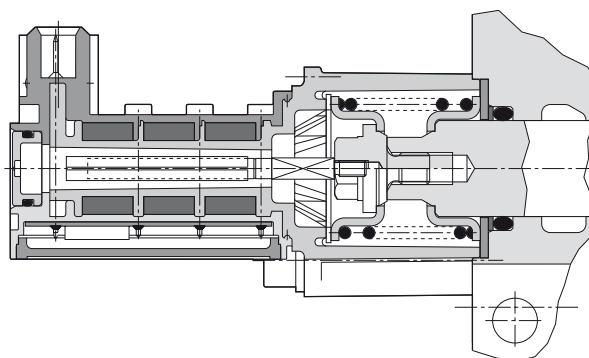
Mechanical service life > 10⁷ switching cycles.

*) Inductive switching capacity acc. to AN 3179.

***) Switch-on peak must not exceed 6x the specified continuous current.

Position sensor **ES2**

Conversion of the mechanical spool stroke to a proportional electric signal
Supply voltage $U_S = 4.75...16.5\text{ V}$



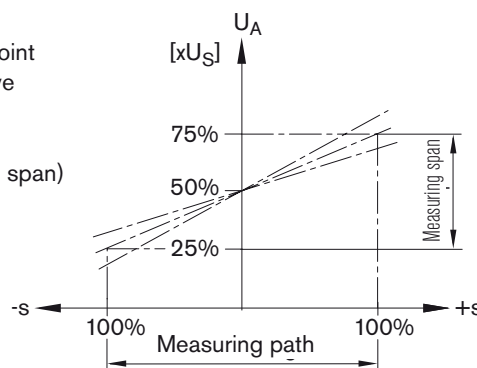
Characteristic

following ideal zero-point calibration on the valve

Sensitivity: $\pm 6\%$

Linearity: $\pm 1.5\%$

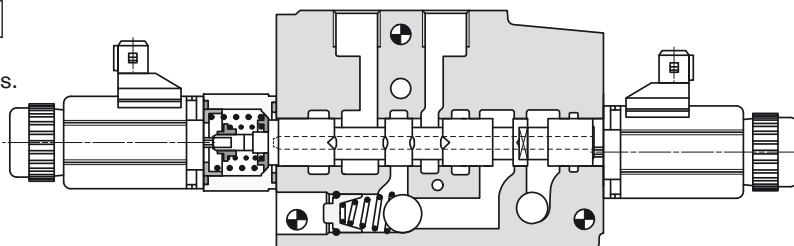
(relative to measuring span)



Direct operated electromagnetic actuation **EM**

Solenoids mounted on both sides of the spool ends.

Actuation via joystick potentiometer with integrated electronics or switching.

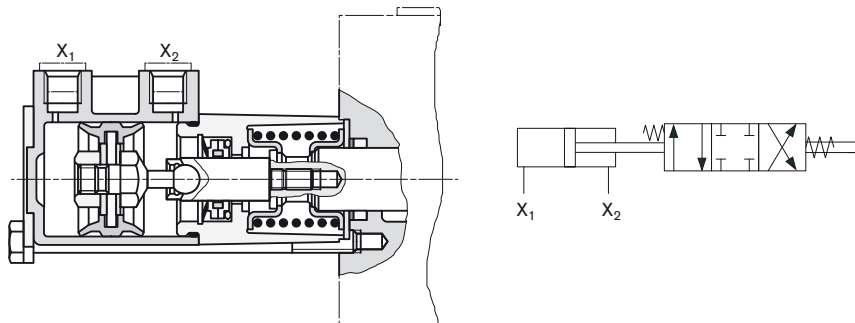


Auxiliary functions in main axis, actuation types

Pneumatic actuation **PN**

Auxiliary actuation with respect to hand lever.
Actuation via pneumatic switching valve.

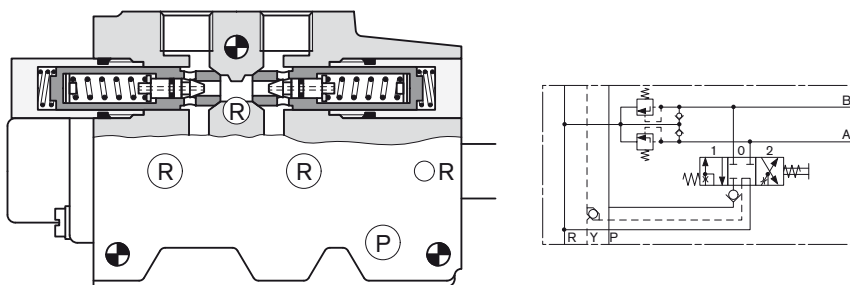
p_{st} min. 1 bar
 p_{st} max. 4 bar



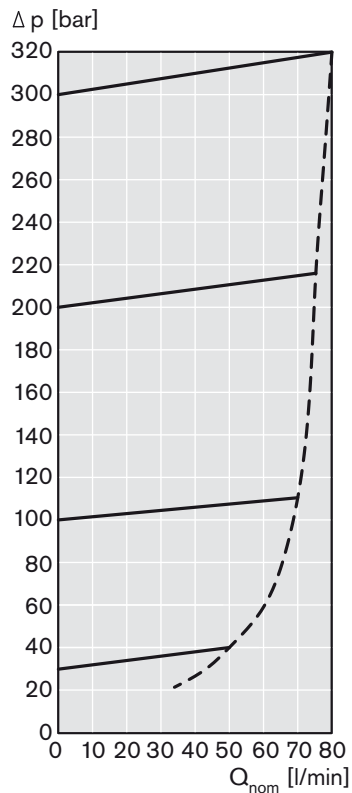
Auxiliary functions of upper axis

Shock valves **A1 B1 A2 B2**

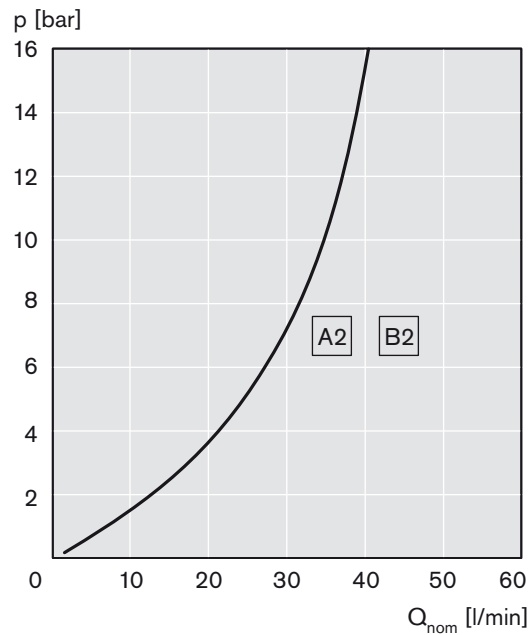
Shock valves, a combination of pressure relief valve and anticavitation valve, are used to safeguard against peak pressures caused by impacts or acceleration forces on the consumer. This auxiliary equipment can be located in one or both service line ports, e.g. **A1 B1**.



Shock valves **A1 B1**



Flow resistance of the anticavitation valve **A2 B2**



Auxiliary functions of upper axis

Hydraulically disengaging check valve

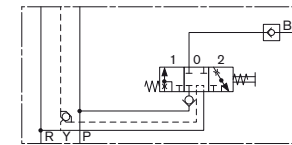
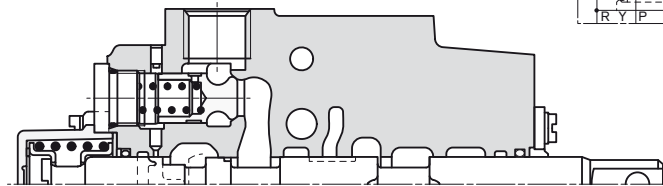
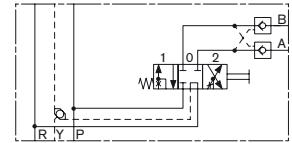
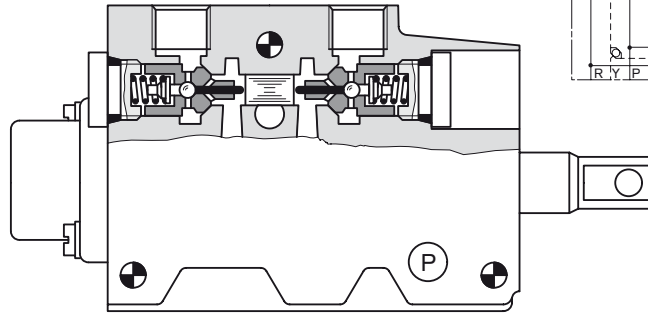
C1 **D1**

The pilot pressure for disengaging is generated by the pump. The pilot controlled sealing cone is disengaged via a spool and a plunger.

The area ratio of spool to pilot cone is 8:1.

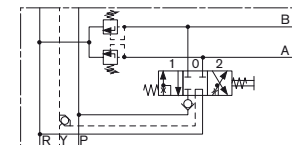
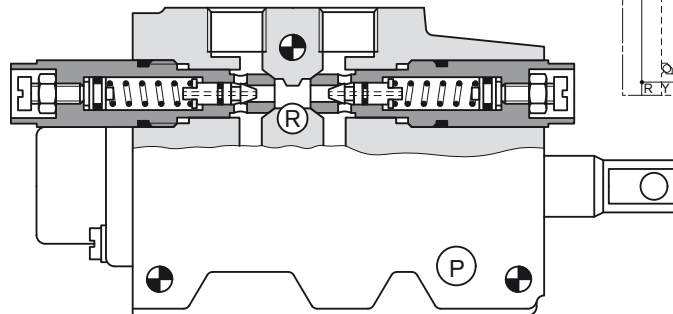
The opening pressures are calculated accordingly.

For an L20-D1 single-acting directional control valve, the sealing cone can also be disengaged by the load pressure. For this purpose, the spring chamber of the sealing cone is disengaged while lowering into the back flow.



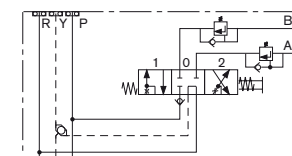
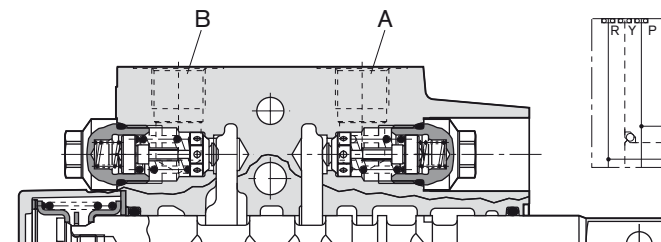
Secondary pressure limiting **E** **F**

Adjustable pressure-relief valves in the service line ports limit the inflow pressure of the respective consumer to a value which is less than the pressure safeguarding of the directional control valve block. It can be located in one or both service line ports.



Pilot pressure inserts **G** **H**

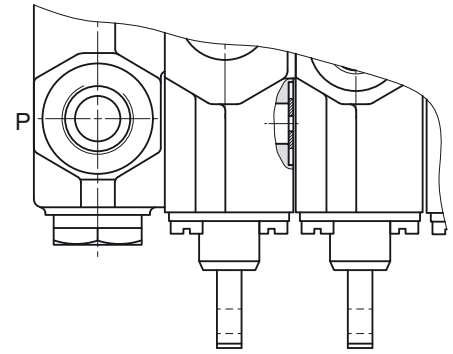
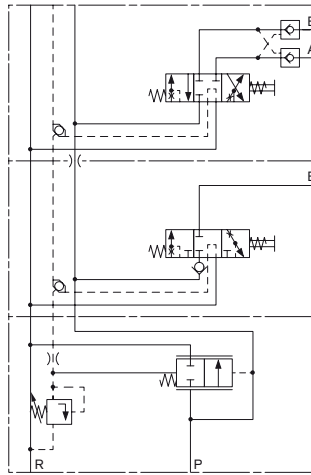
Pilot pressure inserts are used on the return side of double-acting consumers. They act against the load pressure with a permanently set value, thereby preventing the load from advancing. The valves can be located in one or both service line ports.



Auxiliary functions of lower axis

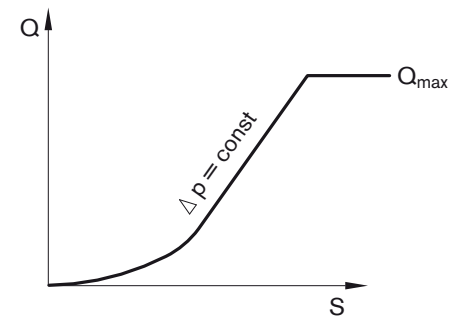
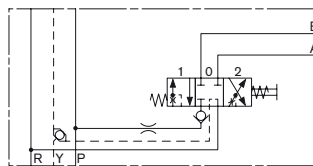
Metering restrictor in the P-channel

For limiting Q_{max} in independent operation of the directional control valves of the downstream block section.



Metering restrictor in the inflow Q1

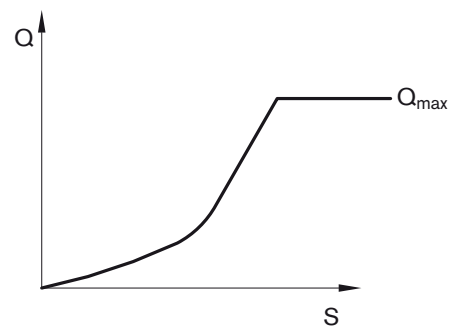
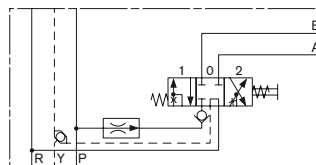
For limiting Q_{max} in independent operation. It acts together with the pressure compensator of the port plate as a 3-way flow control valve. During parallel operation, the highest load pressure is reported to the pressure compensator. May either be fixed or adjustable.



2-way flow control valve in the inflow Q2

For limiting Q_{max} in parallel operation. Also effective if the load pressure of the other consumers is higher.

Permanently set $Q_{max} \cong 34 \text{ l/min}$.



Auxiliary functions of lower axis

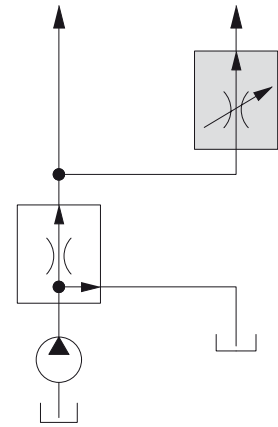
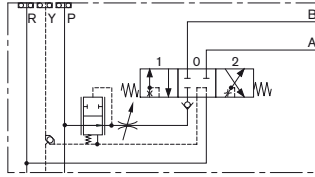
2-way pressure compensator

in the inflow **Q3**

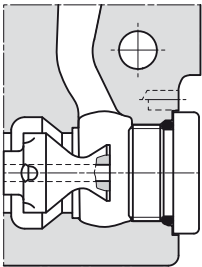
(Individual pressure compensator)

For load-independent speed control over the entire actuation range, even during parallel operation.

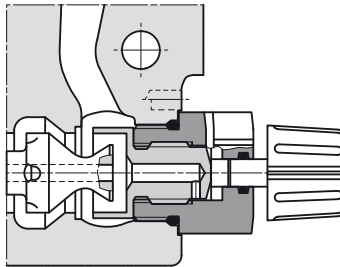
Metering restrictor for Q_{max} limiting, fixed or adjustable.



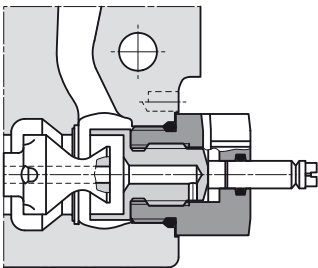
Metering restrictor adjustment Q3, overview



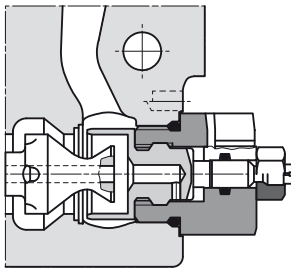
None



Manual adjustment



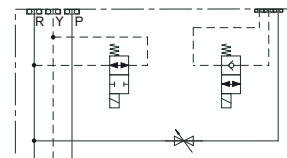
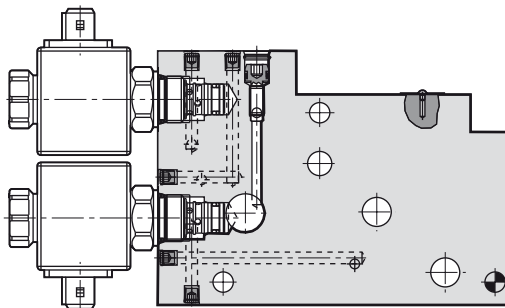
Control shaft



Adjustable restrictor

Subplate

Subplate with LS switching valve for connection of load sensing to return flow, check valve switching valve for relief of check valve of bordering directional control valve L20 D1 N and manual lowering function.

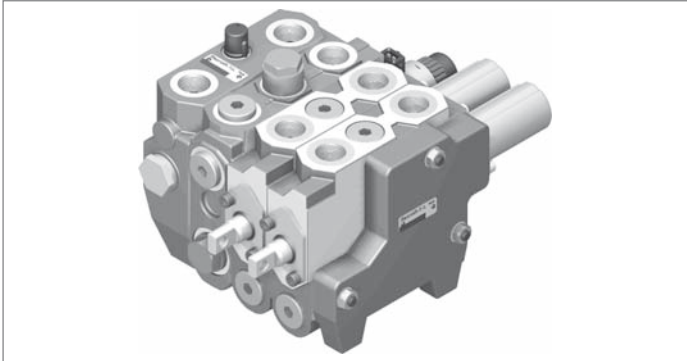


Notes



Notes

Load-sensing control block in sandwich plate design SB23-M



- ▶ Series 1X
- ▶ Maximum operating pressure 250 bar
- ▶ Flow up to 100 l/min

Features

- ▶ Load-independent flow control
- ▶ Load sensing system
- ▶ Type of actuation
 - Mechanical
 - Optional with hydraulic kick-out
- ▶ Flow
 - Load pressure-compensated
 - High repetition accuracy
 - Low hysteresis
- ▶ Pressure limitation subplate for fixed displacement pump

Fields of application

- ▶ Agricultural machinery
- ▶ Tractor applications

Contents

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Related documents	23
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Spare parts	24

Functional description

The control block SB23-M consists of:

- ▶ Subplate
- ▶ 1 to 10 directional valves with shuttle valves
 - Control valves SB23-M
 - High-response valve EHR23-EM2
- ▶ 3 tie rods
- ▶ End plate

Mechanically actuated directional valves SB23-M can be generally combined with EHS valves.

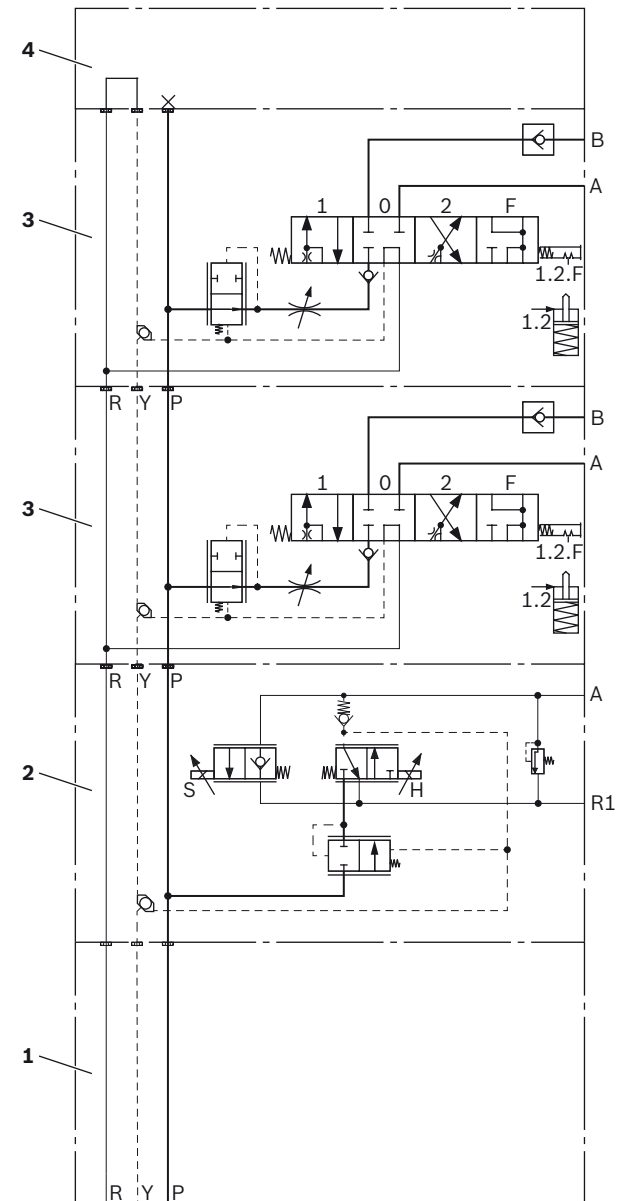
Please contact our technical sales department to ensure functionality.

For further information on

- ▶ SB23-EHS1, see data sheet 66134,
- ▶ EHR23-EM2, see data sheet 66125.

Ports	
P	Pump
A, B	Actuator
Y	LS signal
R	Tank return flow

▼ Control block SB23-M (example)



- 1 Subplate for variable displacement pump
- 2 High-response valve EHR23-EM2, single-acting, proportionally electrically actuated, with 2-way pressure compensator and secondary pressure relief valve
- 3 Directional valve SB23-M, double-acting, mechanically actuated, with 2-way pressure compensator and isolator valve, mechanically actuated
- 4 End plate

Load sensing principle

Load sensing, i.e. the variable load pressure is scanned and directed to a pressure compensator or pump control. In comparison to other systems, this principle offers the following advantages:

Load-independent flow control

The pressure drop Δp at the variable throttle cross-section of the directional valve is kept constant. This way, load fluctuations are compensated and the flow or cylinder velocity is kept constant. However, this only applies for the cylinder with the highest load pressure tapped off via shuttle valves.

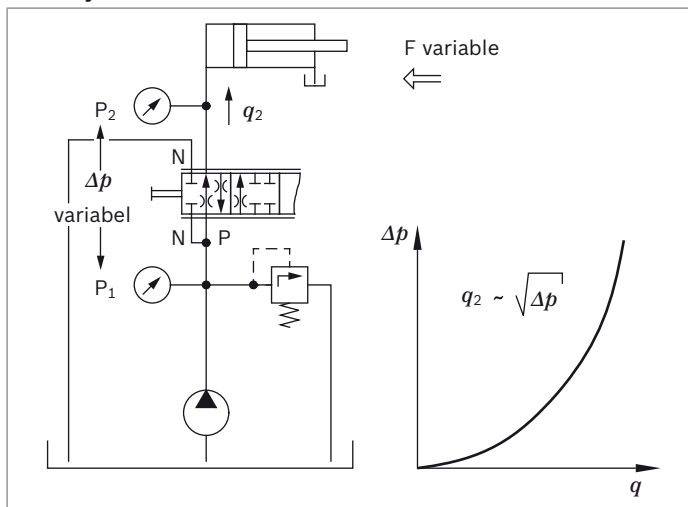
Power loss in the fine control range

Flow control by means of throttling always leads to losses. These losses are minimized by the load sensing principle. A comparison to other systems illustrates this advantage.

Fixed displacement pump with neutral circulation

Excessive flow is discharged by means of the pressure relief valve. As the settings of the pressure relief valve p_1 exceed the load pressure p_2 , excess pressure occurs. This respectively leads to an excess of power which is converted into heat partly at the throttle and partly at the pressure relief valve. The excess pressure can be reduced by negative spool overlap of neutral circulation.

▼ OC system



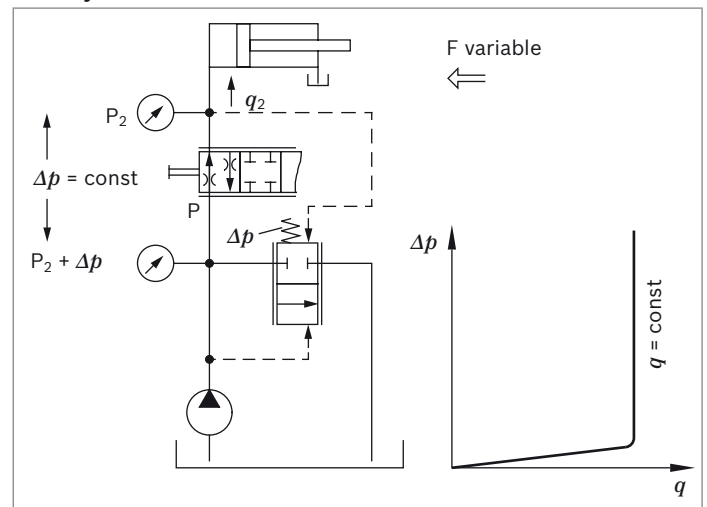
Fixed displacement pump with "load sensing"

The excess flow is not discharged via the maximum pressure valve but via a parallel pressure compensator. This pressure compensator opens not only at p_1 but at the scanned load pressure p_2 including the spring preload pressure defining the pressure differential Δp at the throttle. This arrangement corresponds to a 3-way directional flow control valve and ensures improved performance as well as an actuator flow that is not influenced by load fluctuations.

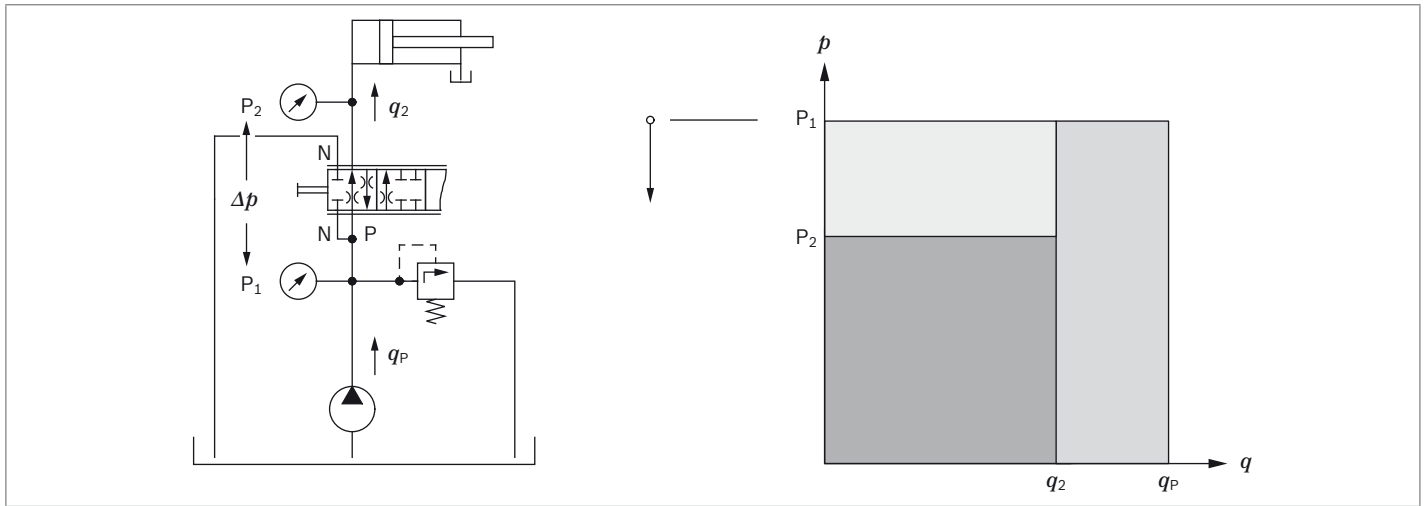
Variable displacement pump with "load sensing"

The pressure compensator is part of the pump control system and controls the flow according to the opening cross-section of the throttle. This adjustment is carried out at the scanned load pressure, i.e. neither excess pressure nor excess flow occurs. Just the pressure differential Δp over the throttle that is defined by the spring of the pressure compensator causes a small power loss. This system requires a variable displacement pump with respective controllers.

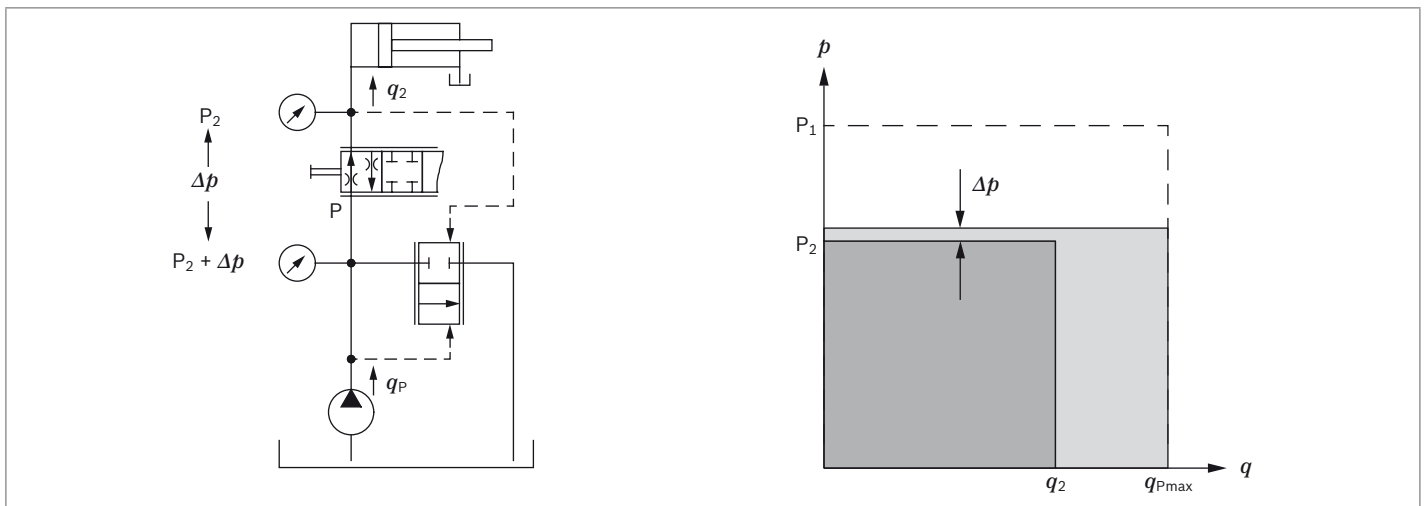
▼ LS system



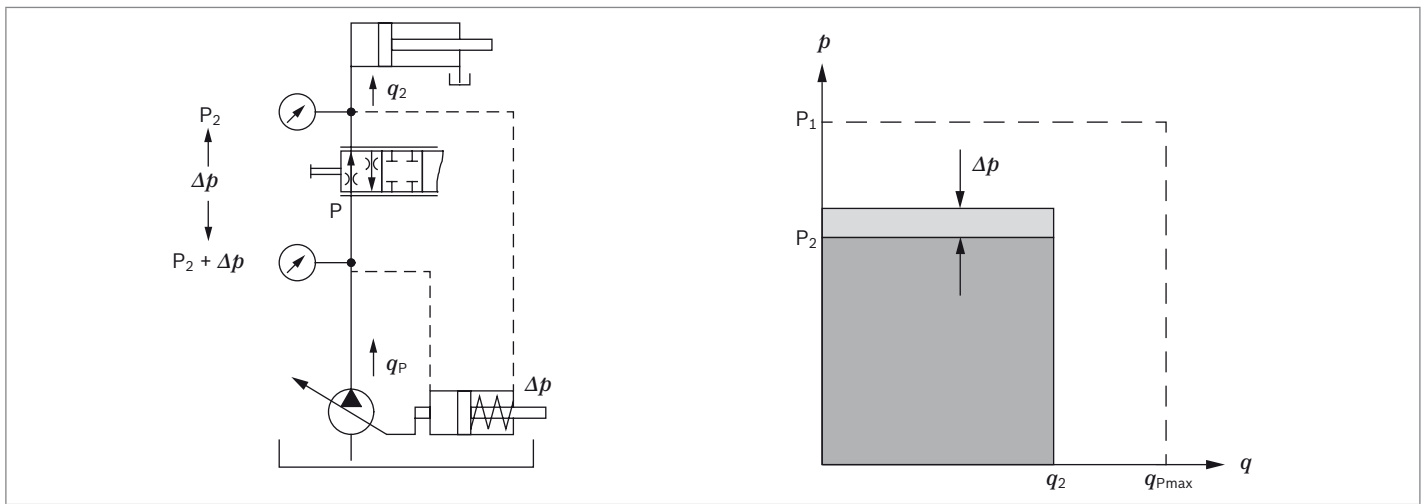
▼ Fixed displacement pump with neutral circulation N



▼ Fixed displacement pump with load sensing



▼ Variable displacement pump with load sensing

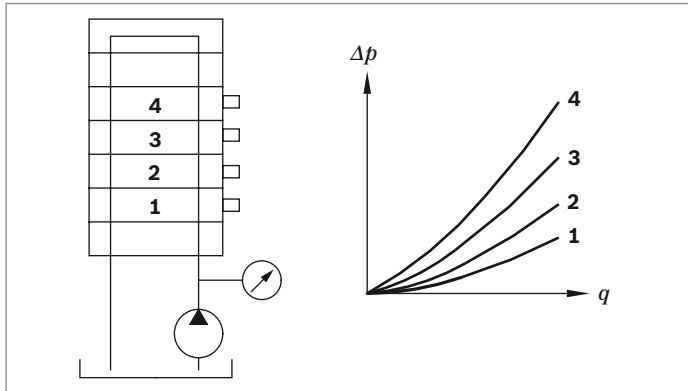


Power loss in neutral circulation

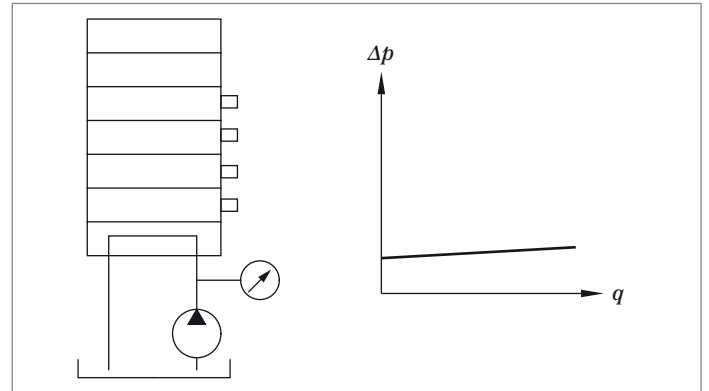
The neutral circulation pressure of conventional systems with neutral circulation through the valve block depends on the number of directional valve segments.

Neutral circulation in LS systems takes place at minimum pressure directly in the subplate. This pressure can be additionally minimized by means of Δp switch-over (option).

▼ **OC system**



▼ **LS system**

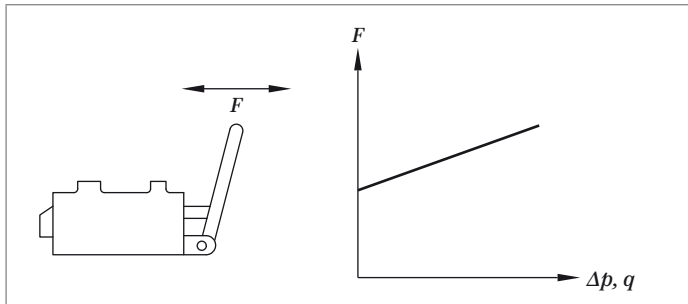


Actuating force at the control spool

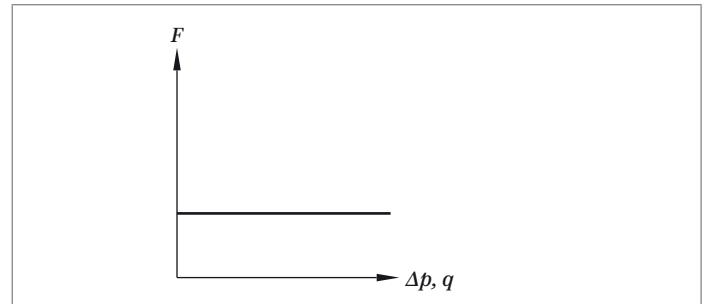
In conventional systems, the flow forces and respectively the actuating forces increase at the control spool with

transmission of hydraulic power. In LS systems, the actuating forces are lower and remain constant.

▼ **OC system**



▼ **LS system**

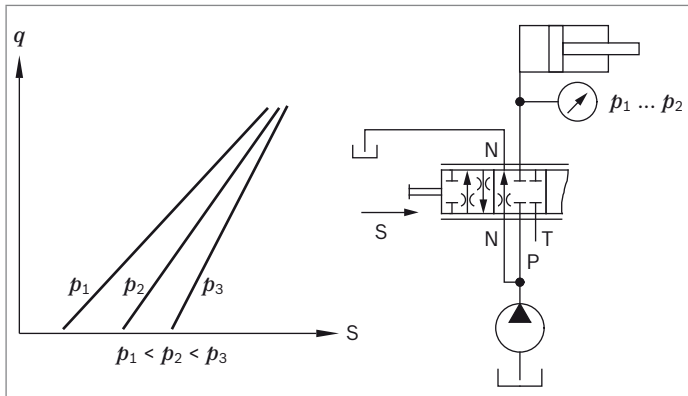


Control characteristics

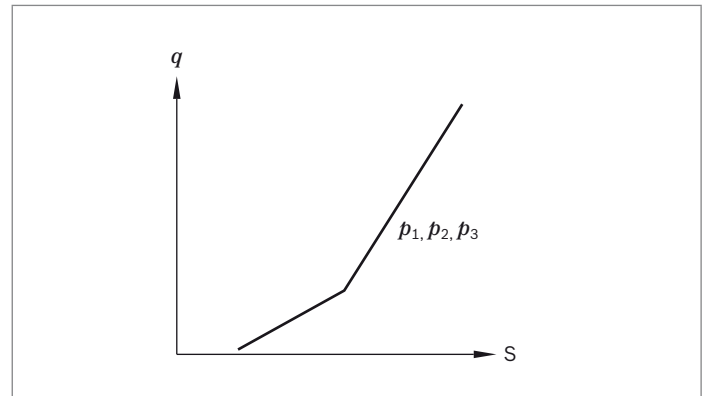
In conventional systems, the flow is load-dependent. Additionally, opening the connection to the actuator at increased load requires higher spool stroke as the

connection to neutral circulation has to be increasingly throttled. LS systems distinguish themselves by control characteristics independent from the load pressure.

▼ **OC system**



▼ **LS system**



Basic subplate design

Example: $\Delta p = 3 \text{ bar}$

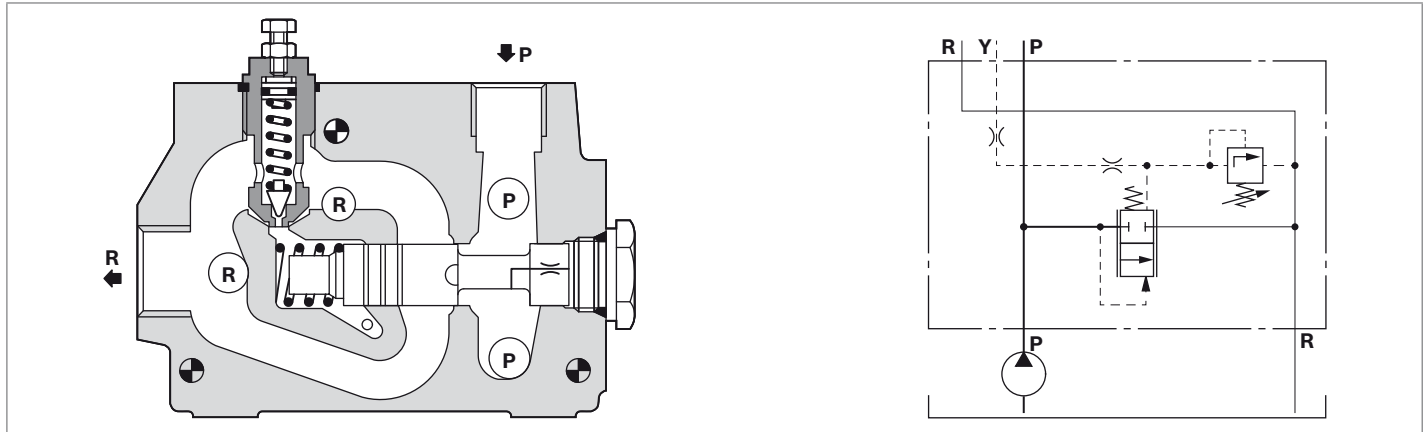
Besides the supply and return flow port of the control block for use in combination with a fixed displacement pump, the subplate includes a pressure compensator as well as an adjustable pressure relief valve.

The pressure compensator has three functions:

- ▶ In combination with the current throttle cross-sections at the directional valve control spools, it works as a 3-way flow controller. Via the control line **Y**, the load pressure acts on the spring side of the pressure compensator.

The spring defines the pressure drop at the throttle cross-sections of the directional valves. It is kept constant by the pressure compensator ($\Delta p = 3 \text{ bar}$).

- ▶ If the control line is unloaded (all directional valves in basic position), the pressure compensator opens under the effect of the supply pressure and enables neutral circulation.
- ▶ In combination with the adjustable pilot control valve, the pressure compensator forms the main stage of a pilot operated pressure relief valve to protect the maximum operating pressure.



Subplate with Δp switch-over

Example: 4 bar/11 bar

The flow at one side of a throttle depends on the pressure drop according to $q \sim \sqrt{\Delta p}$.

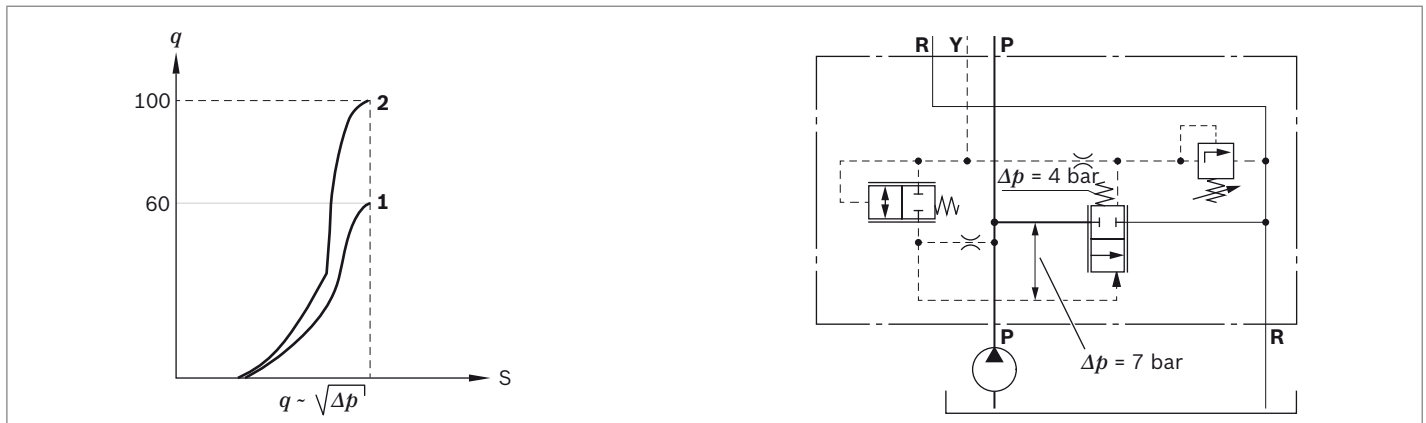
If the pressure drop is increased from $\Delta p_1 = 4 \text{ bar}$ to $\Delta p_2 = 11 \text{ bar}$, the nominal flow $q_1 = 60 \text{ l/min}$ can be increased to

$$q_2 = q_1 \sqrt{\frac{\Delta p_2}{\Delta p_1}}$$

$$q_2 = 60 \sqrt{\frac{11}{4}} = 100 \text{ l/min.}$$

However, the increased pressure drop is also related to increased power losses that are to be avoided particularly in neutral circulation.

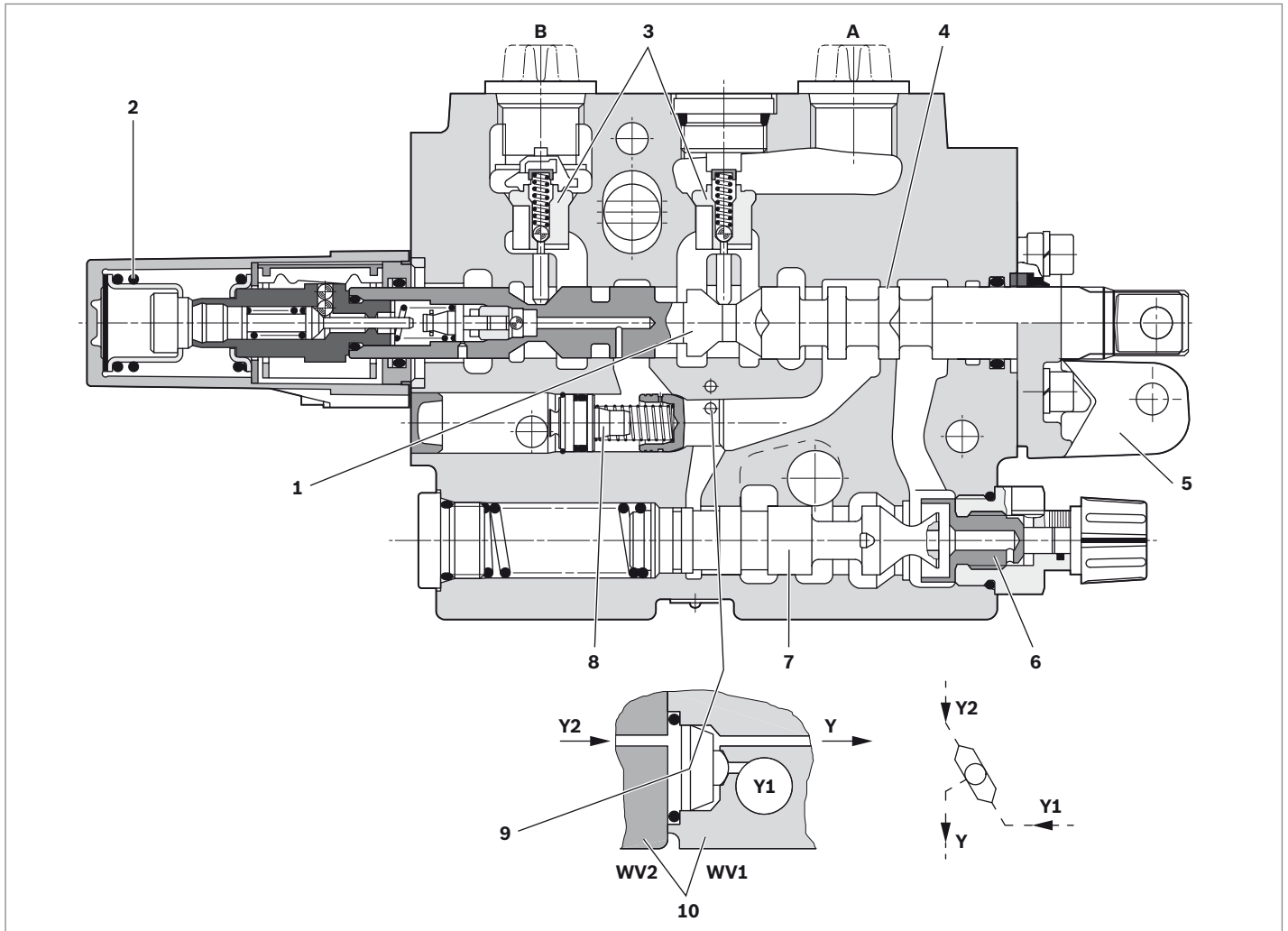
Switch-over from $\Delta p = 4 \text{ bar}$ during neutral circulation to $\Delta p = 11 \text{ bar}$ at open directional valves is achieved with a special subplate. The switch-over is carried out by means of a on/off valve integrated in the pressure compensator.



Mechanical actuation SB23-M

The illustrated design is a double-acting directional valve with 2 working ports **A** and **B**. The control spool (1) is kept in central position by a return spring (2). Besides the usual control edges between the ports **P**, **A**, **B** and **R**, the control spool also controls the opening cross-section (3) of the supply **P** → **P_L** that defines the actuator velocity in

combination with the pressure compensator in the subplate (flow control valve function). A shuttle valve for load application (4) is integrated in the flange surface vertically to the spool axis. A check valve (5) in channel **P_L** prevents undesired load drops in the fine control range and if several directional valves are simultaneously actuated.

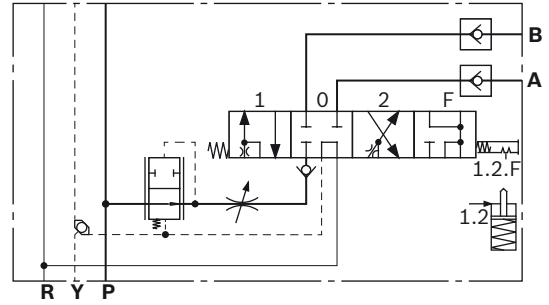
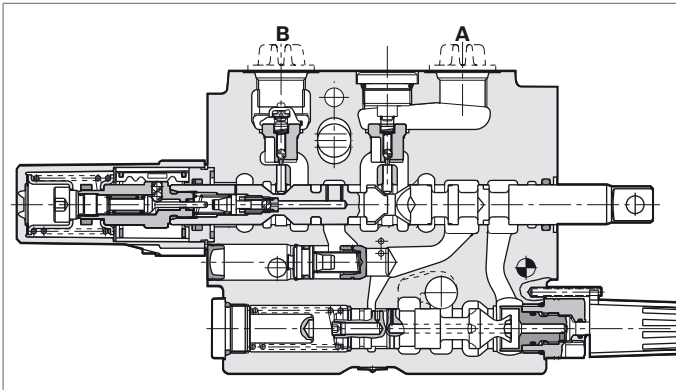
▼ Directional valve in left design

- 1 Control spool
- 2 Return spring
- 3 Isolator valve
- 4 Opening cross-section
- 5 Bearing block
- 6 Flow controller
- 7 Pressure compensator
- 8 Check valve
- 9 Shuttle valve
- 10 Directional valve segments

Directional valve in left design

Example: 4-position spools, 2 isolator valves, individual pressure compensator, hydraulic kick-out

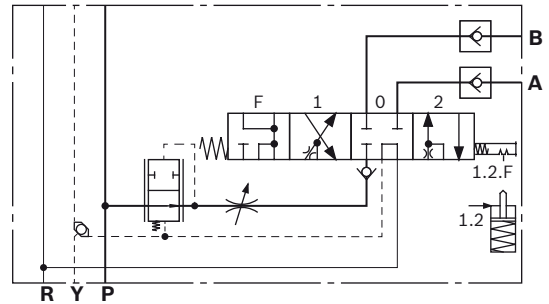
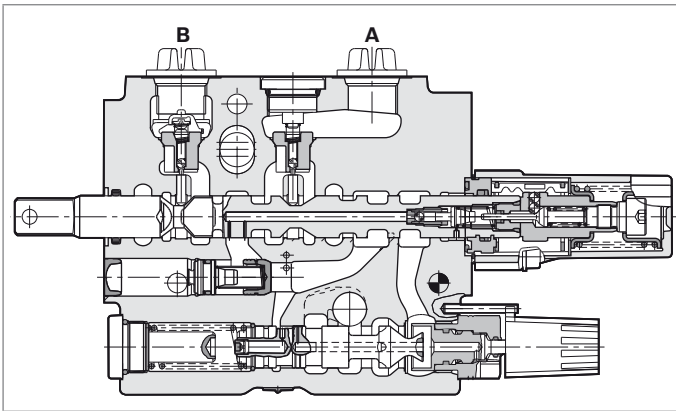
If the control spool is **pulled out**, a connection between **P → B** is achieved.



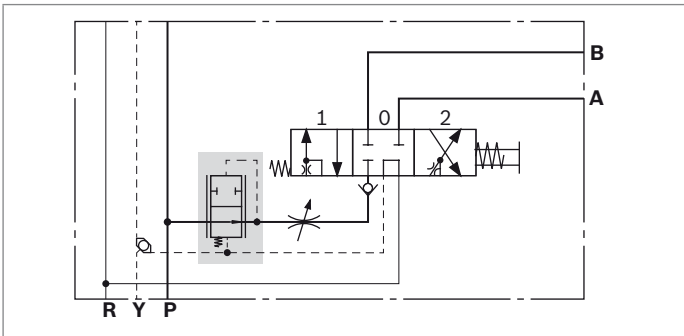
Directional valve in right design

Example: 4-position spools, 2 isolator valves, individual pressure compensator, hydraulic kick-out

If the control spool is **pulled in**, a connection between **P → B** is achieved.



▼ **2-way individual pressure compensator**



For further information, see operating instructions 66 130-B2, chapter 5.4 "Function and configuration of pressure compensators".

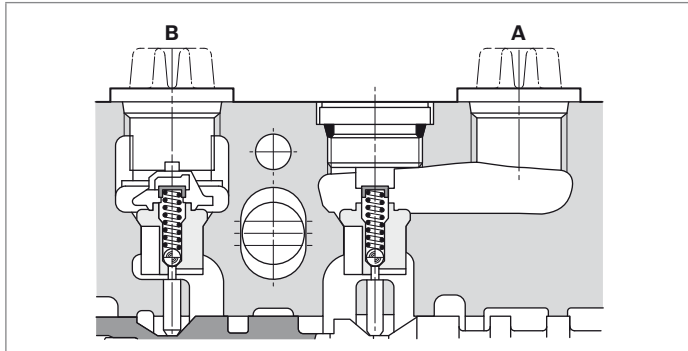
Isolator valves, mechanical

The pilot pressure for kick-out is provided by the pump. The pilot operated sealing cone is unlocked by an inclined surface at the control spool and a plunger. Isolator valves can be arranged in port **B** or in the ports **A** and **B**.

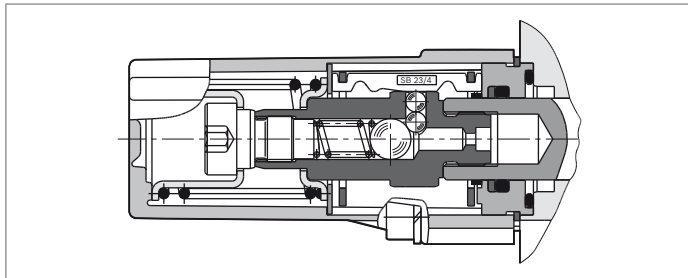
Optionally available with thermal pressure relief valve.
 Purpose: Unloading of the trapped oil volume between the mechanical isolator valve and the plug-in coupling in case of heat increase.

Notice

Vehicle tests are recommended.



Detent, mechanical kick-out MRM

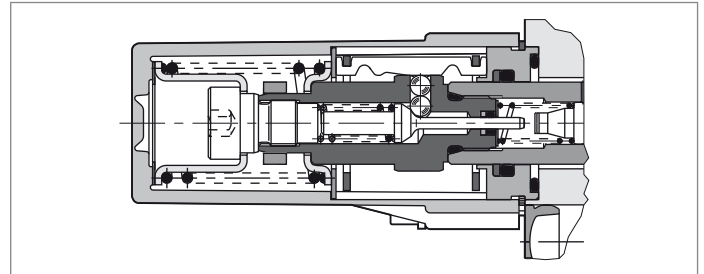


Detent, hydraulic kick-out MRH

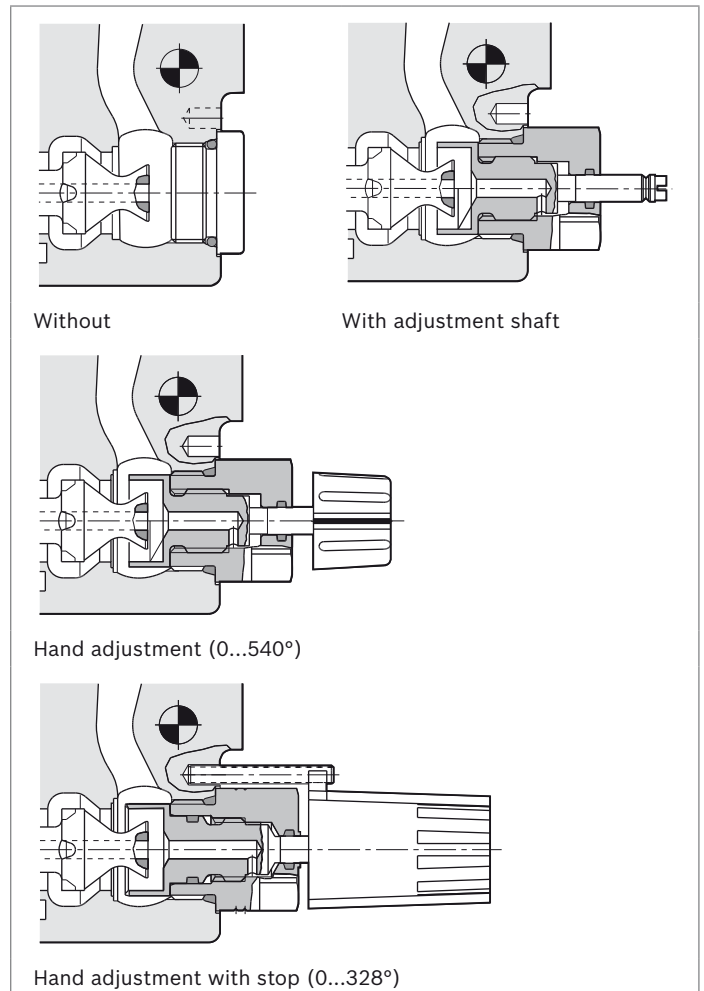
Detent locking is possible in working positions **1** and **2** and/or in spool position **F**.

The standard detent locking pressure of hydraulic kick-out is 175⁻¹⁵ bar. Other kick-out pressures on request.

For further information, see operating instructions 66 130-B2, chapter 5.2 "Valves with mechanical actuation".



Flow control



Technical data

general				
Weight	Subplate		kg	4.8
	Directional valve SB23-M		kg	3.8 to 5.2
	End plate		kg	2.1
Installation position				Any
Subplate arrangement				Standard: left design
Line connections				Screw-in thread, see page 18
Fastening				Thread in subplate and end plate (standard: M8)
Ambient temperature range	θ	°C	-30 to +80	
hydraulic				
Maximum operating pressure at the port	P	p_{\max}	bar	250
	A, B	p_{\max}	bar	280
	R	p_{\max}	bar	20
Maximum flow at port	P → A, B	q_{\max}	l/min	100 (Q3), depending on the control Δp of the individual pressure compensator
		q_{\max}	l/min	90 (Q4), depending on the control Δp of the individual pressure compensator
		q_{\max}	l/min	> 100 (without Q)
Leakage	A, B → R	q_L	ml/min	≤ 2 with isolator valves in A, B ≤ 18 without isolator valves in A
Hydraulic fluid				Hydraulic oil based on mineral oil according to DIN 51524, different fluids, e.g. environmentally friendly fluids, on request
Hydraulic fluid temperature range	Admissible range	θ	°C	+20 to +90
	Admissible range for start	θ	°C	-30 to +100
Viscosity range	Admissible range	ν	mm ² /s	10 to 800
	Recommended range	ν	mm ² /s	20 to 100
	Admissible range for start	ν	mm ² /s	up to 2000
Max. admissible degree of contamination of the hydraulic fluid	Cleanliness class according to ISO 4406 (c)			Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$
	Cleanliness class according to SAE AS 4059			Class 10A/10B/9C
Kick-out pressure	Standard		bar	175 ⁻¹⁵ (others on request)
mechanical				
Spool strokes	L3, L5, L10, L20, L30, L50		mm	±7
	L6, L70		mm	±7 ⁺⁵
Actuating forces				N < 200 in spool axis
Protection class				IP 69 K

Notice

For applications outside these parameters, please consult us!

The technical data were determined at a pressure of $p = 125$ bar, a viscosity range of $\nu = 33$ mm²/s and a temperature of $\theta = 50$ °C.

Type key

This type key describes the requested design variation of an SB23-M directional valve.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
SB	23	1	0				M							3	5	0						

Type

01	SB directional valve	SB
02	Version	23

Series

03	Series 1 (unchanged installation and connection dimensions)	1
----	---	----------

Version

04	Unchanged	0
----	-----------	----------

Spool type

05	Double-acting, right design		L3
	Double-acting, right design		L5
	Double-acting, right design		L6
	Single-acting, left design		L10
	Single-acting, left design		L20
	Double-acting, left design		L30
	Double-acting, left design		L50
	Double-acting, left design		L70

Actuation

06	Mechanical, hydraulic kick-out	MRH
	Mechanical, mechanical kick-out	MRM
	Mechanical, without detent unit	MEA

Flow

07	80 l/min	080
	100 l/min	100

Manual operation

08	With manual operation (standard)	M
----	----------------------------------	----------

Actuator ports

09	Seal ring sealing according to DIN 3852-2 (Whitworth thread)	01
	Seal ring sealing according to DIN 3852-1 (metric thread)	02
	O-ring sealing with threaded hole marking according to ISO 6149-1 (metric thread)	06
	O-ring sealing without threaded hole marking according to ISO 6149-1 (metric thread)	07
	Flange design	16

Port A additional function

10	Without	N
	Mechanical isolator valve	M

Port A pressure limitation

11	Without	-
	With thermal pressure relief valve	1

Port B additional function

12	Without	N
	Mechanical isolator valve	M

Port B pressure limitation

13	Without	-
	With thermal pressure relief valve	1

Pressure compensator

14	Without	-
	2-way pressure compensator in P, individual pressure compensator, type of flow control can be selected ¹⁾	C30

Tie rod

15	3 tie rods	3
----	------------	----------

Flange side ports

16	Basic flange layout of sealing surface (P, R, Y)	5
----	--	----------

Pilot oil line

17	No sealing or line from X, Rx	0
----	-------------------------------	----------

Detent locking

18	Without	-
	With detent locking	D

Detent position

19	Without	-
	Detent locking in working position 1 and F	1F
	Detent locking in working position 1 and 2	12
	Detent locking in working position F	0F
	Detent locking in working position 1, 2 and F	0A
	Detent locking in working position F and pressure point 2	0B
	Detent locking in working position 1, F and pressure point 2	1B

Flow control

20	Without	O
	One-part design	E
	Two-part design	Z

Friction ring at flow control

21	Without flow controller	-
	Without friction ring at flow controller	O
	With friction ring at flow controller	1

Rotary knob at flow control

22	Without flow controller	-
	Without rotary knob at flow controller	O
	With rotary knob at flow controller	D
	With adapter at flow controller	A

Bearing block

23	Without	O
	Bearing block in standard position	L
	Bearing block installed in reverse position (eye facing upwards)	U

Order overview

Directional valves

Type	Porting pattern A, B / version ¹⁾	Comments	Material number
Spool type L30, without detent locking MEA			
	M22 x 1.5 / I	Flow $q_{max} > 100$ l/min	0 521 610 045
Spool type L30, without detent locking MEA, 1 isolator valve M in port B, individual pressure compensator C30			
	M22 x 1.5 / I	Flow $q_{max} = 80$ l/min Adjustment shaft	0 521 610 054
Spool type L70, with hydraulic kick-out MRH			
	M22 x 1.5 / I	Flow $q_{max} > 100$ l/min MRH in 1, 2 Kick-out pressure $p = 175^{15}$ bar	0 521 610 044
Spool type L70, with hydraulic kick-out MRH, individual pressure compensator C30			
	M22 x 1.5 / II	Flow $q_{max} = 80$ l/min Adjustment shaft Detent locking in 1, 2, F MRH in 1, 2 Kick-out pressure $p = 175^{15}$ bar	0 521 610 007

1) For design variations, see "Line connections" on page 18

Type	Porting pattern A, B / version ¹⁾	Comments	Material number
Spool type L70, hydraulic kick-out MRH, 1 isolator valve M in port B, individual pressure compensator C30			
		Flow $q_{max} = 100$ l/min Hand adjustment Detent locking in 1, 2, F MRH in 1, 2 Kick-out pressure $p = 175^{15}$ bar	R917005614
		M22 x 1.5 / II	

Flow grading depending on the control Δp

▼ **Application with fixed displacement pump**

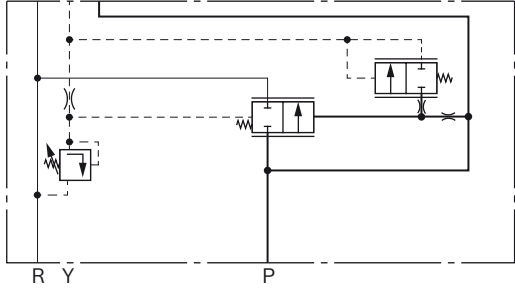




	Directional valve in C30 design	Subplate for fixed displacement pump
Flow q [l/min]	Control Δp of the individual pressure compensator [bar]	Control Δp of the pressure compensator (recommended) [bar]
50	3	3/8.4
80	6	4/11
100	10	5/13.7

▼ **Application with variable displacement pump**

	Directional valve in C30 design	Subplate for variable displacement pump
Flow q [l/min]	Control Δp of the individual pressure compensator [bar]	Without pressure compensator
50	3	-
80	6	-
100	10	-


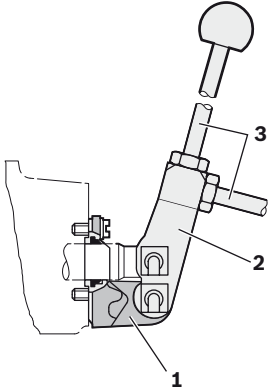


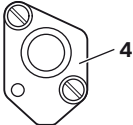
1) For design variations, see "Line connections" on page 18

Subplates and end plates

Type	Ports ¹⁾	Δp [bar]	q_{max} [l/min]	Material number
Subplate for fixed displacement pump				
	P, R1, R2: M22 x 1.5 / I R1 closed	3/8.4	90	1 525 503 535
	P, R1: M22 x 1.5 / II R1 closed R2: M27 x 2 / II	4/11	120	1 525 503 680
Subplate for variable displacement pump				
	P, R: M22 x 1.5 Y: M12 x 1.5 / I		160	1 525 503 536
For control blocks with EHR23-EM2: Allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y.				
End plate				
				1 525 503 537
End plate				
	Yw: M12 x 1.5 / II closed			1 525 503 776

1) For design variations, see "Line connections" on page 18

Accessories

Type	Number of directional valves	mm	Material number
 Tie rod	1	115	1 523 502 075
	2	155	1 525 502 076
	3	195	1 525 502 077
	4	235	1 525 502 078
	5	275	1 525 502 079
	6	315	1 525 502 080
	7	355	1 525 502 081
	8	395	1 525 502 082
	9	435	1 525 502 083
	10	475	1 525 502 084
 Switching element and bearing block ²⁾	1		1 527 000 097
	+		
	2		
 Bearing block with wiper ring ²⁾	1		1 527 000 098
 Hand lever	3		1 522 027 306
 Cover plate with wiper ring	4		1 527 010 326

Line connections

Version I

DIN 3852-1 (metric thread), DIN 3852-2 (Whitworth thread)

- ▶ For seal ring sealing

Version II

ISO 11926-1 (UNF thread)

- ▶ For O-ring sealing

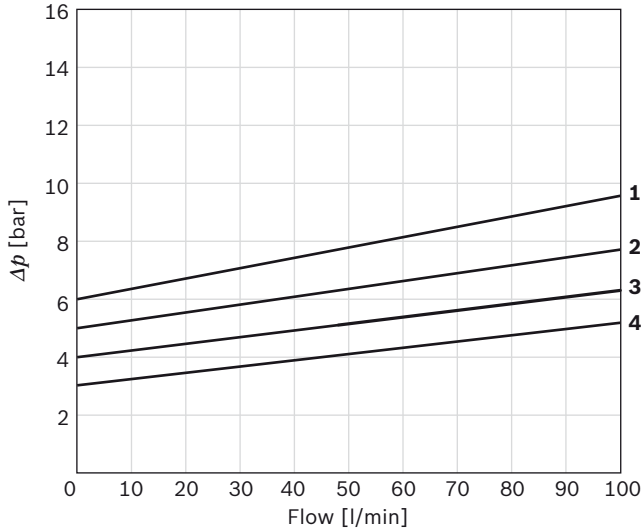
EN ISO 6149-1 (metric thread)

- ▶ Without threaded hole marking
- ▶ For O-ring sealing

²⁾ Only for directional valves in left design

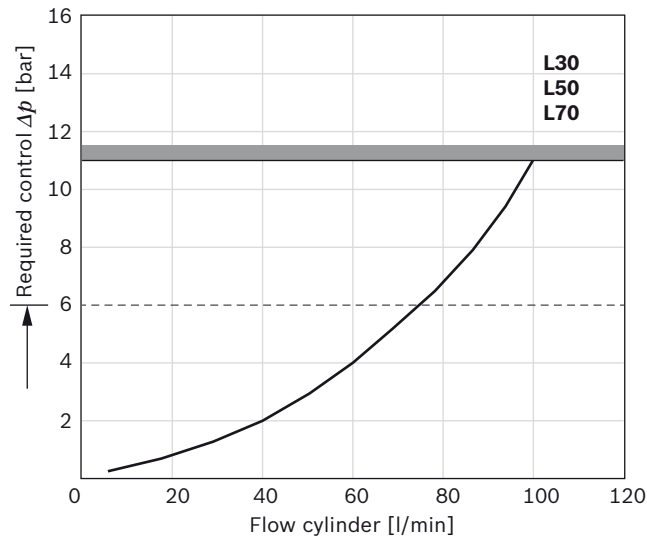
Characteristic curves

▼ Neutral circulation P → R



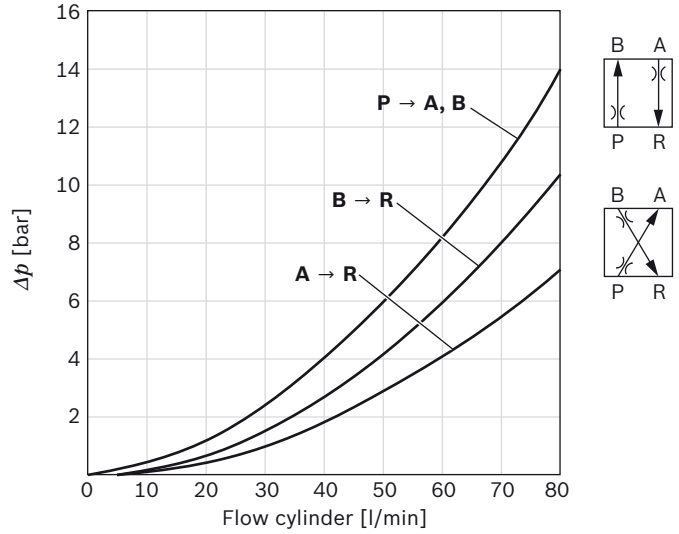
- 1 Δp 6 bar (spring)
- 2 Δp 5 bar
- 3 Δp 4 bar
- 4 Δp 3 bar

▼ Limitations of use



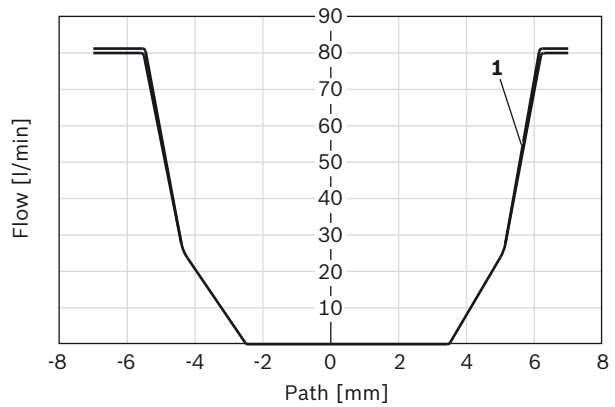
$\Delta p \geq 6$ bar only with Δp switch-over
Control Δp at pressure compensator

▼ Flow resistance at fully opened directional valve



Example: Spool type L70, isolator valves in A and B, individual pressure compensator, hydraulic kick-out

▼ Flow via spool stroke



- 1 Control $\Delta p = 8.4$ bar

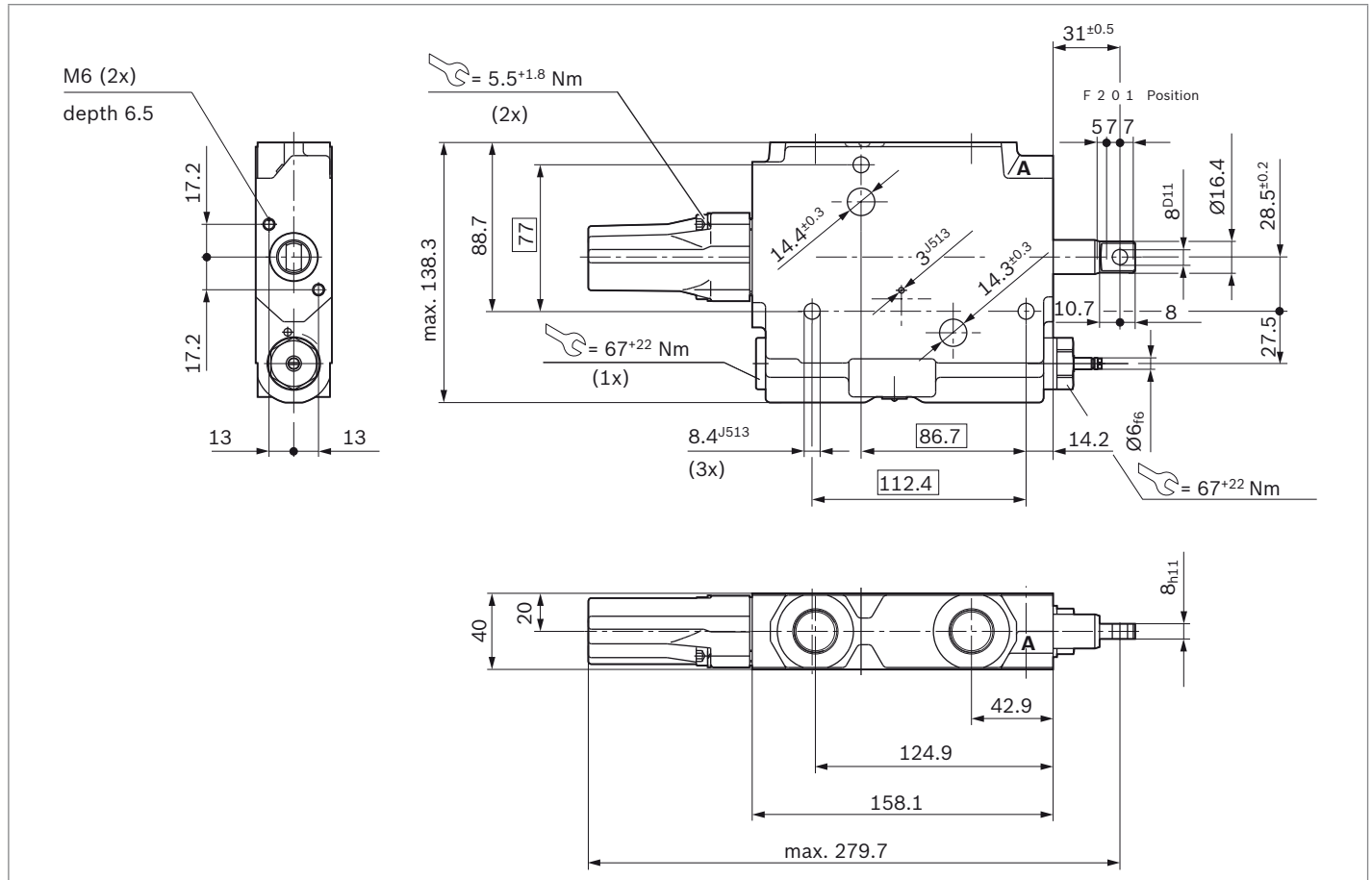
Example: Directional valve with $q_{max} = 80$ l/min

Notice

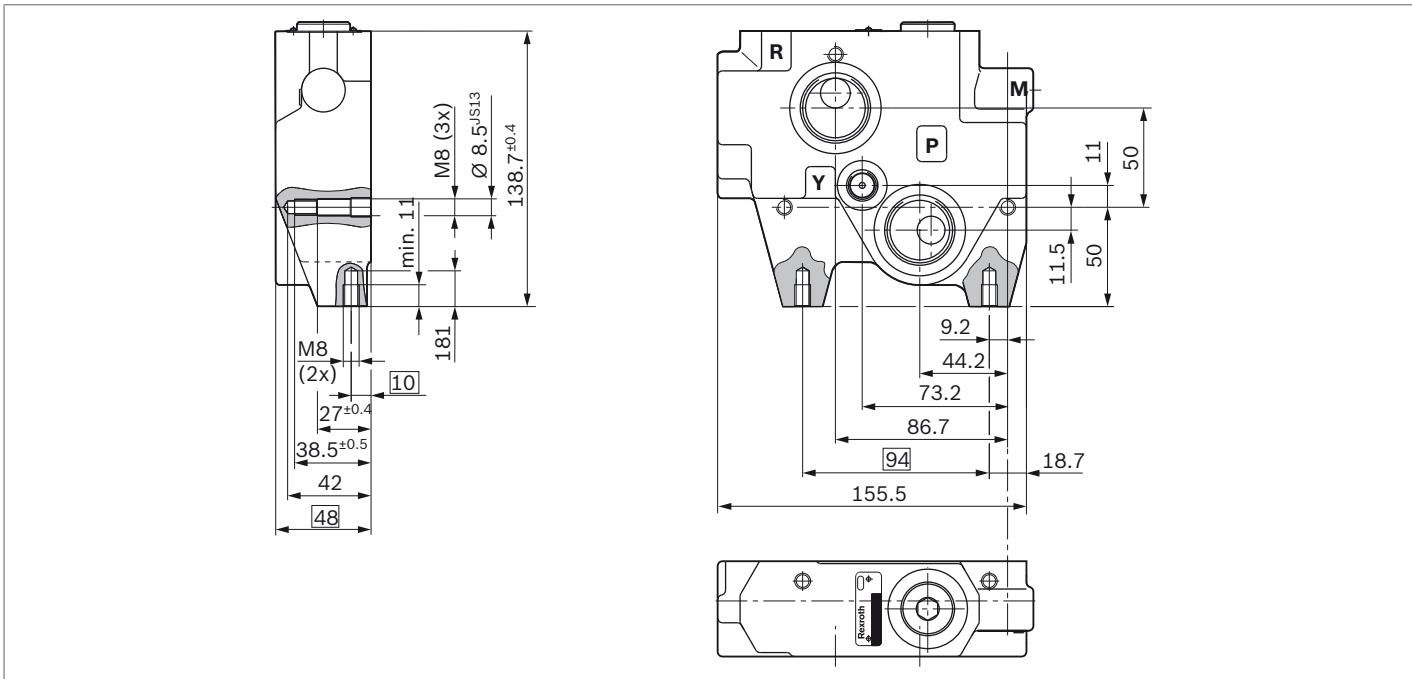
Characteristic curves measured with $\nu = 35$ mm²/s, $\theta = 50$ °C.

Dimensions

▼ Directional valve SB23-M, mechanical actuation



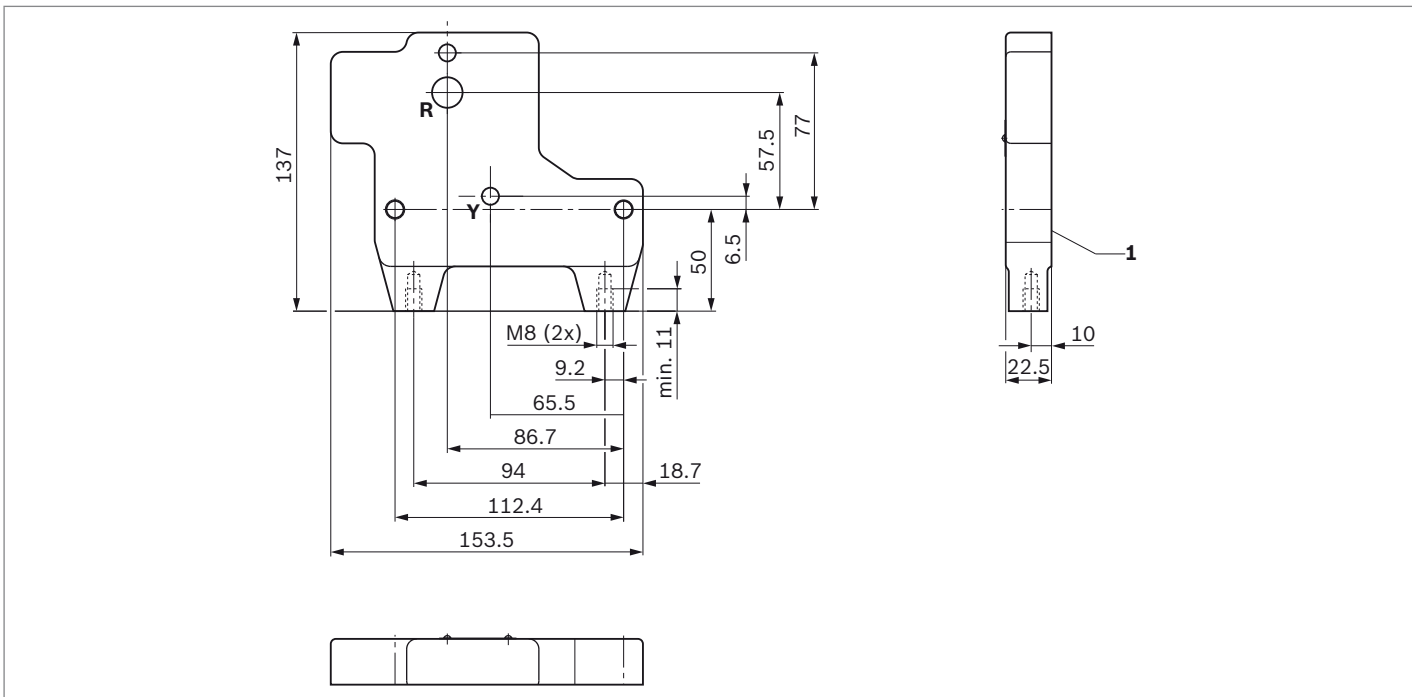
▼ Subplate



Notice

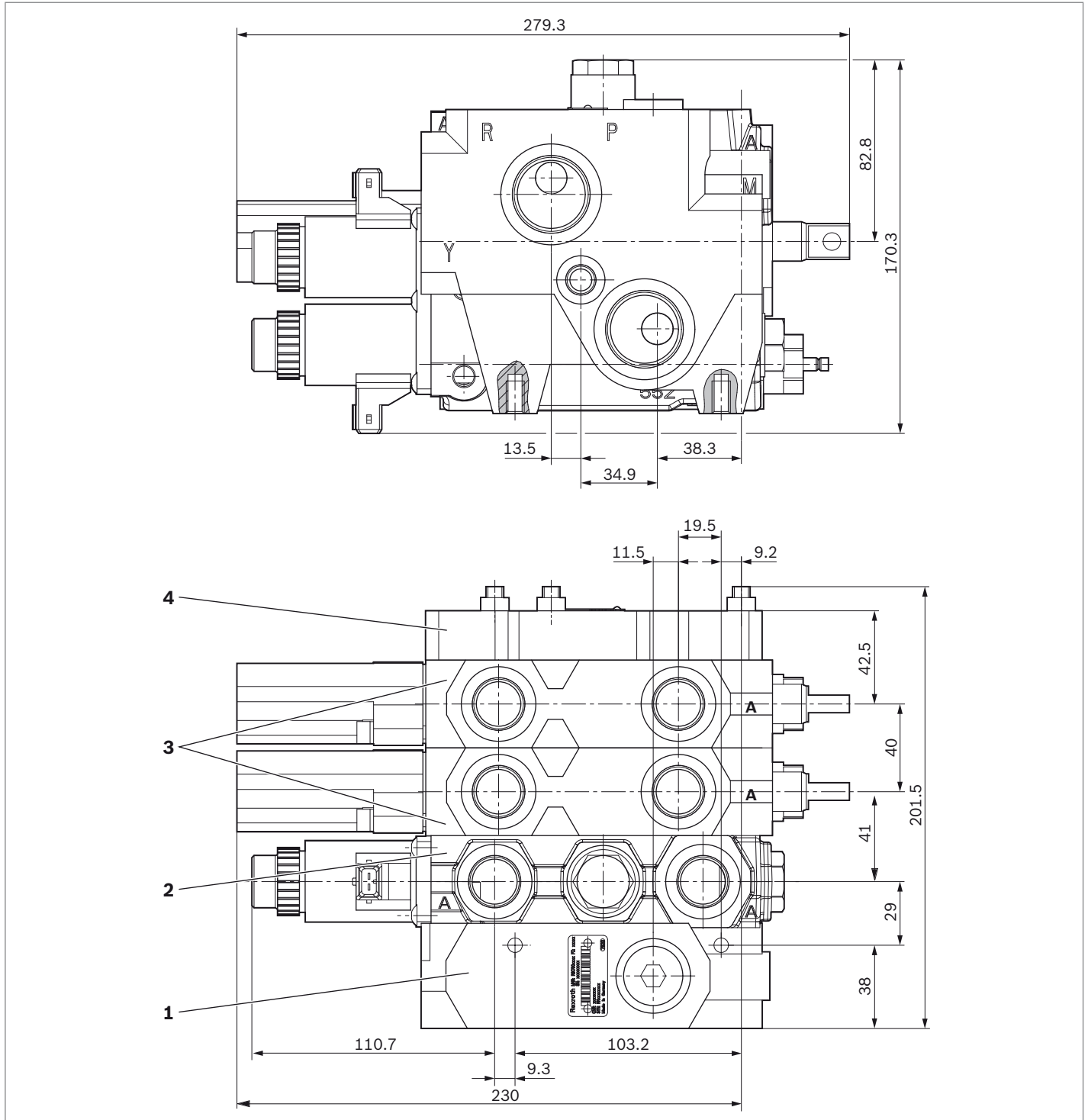
For control blocks with EHR23-EM2:
allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y.

▼ End plate for directional valves with mechanical actuation



1 Sealing surface

▼ Example: Control block in left design (analogous to symbol on page 2)



- 1 Subplate for variable displacement pump
- 2 High-response valve EHR23-EM2, single-acting, proportionally electrically actuated
- 3 Directional valve SB23-M, double-acting, mechanically actuated
- 4 End plate

Related documents

Title	Document number	Document type
Directional valves SB23-LS for mobile applications	66130-B	Operating instructions
Control block SB23, basic document	66133-01-R	Repair instructions
Control valves SB23, assembly	66133-10-R	Repair instructions
Control valves SB23-M, repair	66130-20-R	Repair instructions
Bleeding directional valves	MH 121	Commissioning information
Supplied installation drawing/hydraulic scheme	Available from your machine or plant manufacturer	Quotation drawing
Hydraulic fluids on mineral oil basis	90220	Data sheet

Abbreviations

The following abbreviations are used in this documentation:

Abbreviation	Meaning
EHR	Electro-hydraulic lifting unit control
EHS1	Pilot operated electro-hydraulic actuating unit
LS	Load sensing
OC	Open center
SB23	Load-sensing control block in sandwich plate design

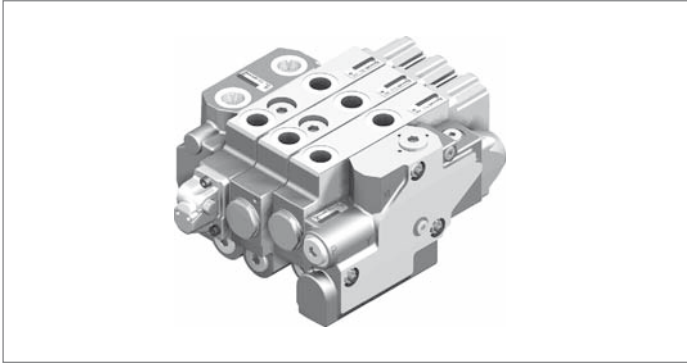
Spare parts

Contacts for accessories and spare parts

Accessories and spare parts are available

- ▶ From the vehicle manufacturer (specialty retailer),
- ▶ From the system manufacturer, and
- ▶ From your Bosch Rexroth specialty retailer.

Load-sensing control block in sandwich plate design SB23-EHS1



- ▶ Series 1X
- ▶ Maximum operating pressure 250 bar
- ▶ Flow up to 100 l/min

Features

- ▶ Load pressure-independent flow control
- ▶ Load sensing system
- ▶ Type of actuation
 - Electro-hydraulic
- ▶ Flow
 - Load pressure-compensated
 - High repetition accuracy
 - Low hysteresis
- ▶ Optional pressure limitation contained in the subplate

Fields of application

- ▶ Tractor applications

Contents

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Hydraulic functions	19
Electronic functions	25
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Related documents	31
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Functional description

The control block SB23-EHS1 consists of:

- ▶ Subplate
- ▶ 1 to 5 directional valves (> 5 directional valves on request)
 - Control valves SB23-EHS1
 - High-response valve EHR23-EM2
- ▶ 3 tie rods
- ▶ End plate

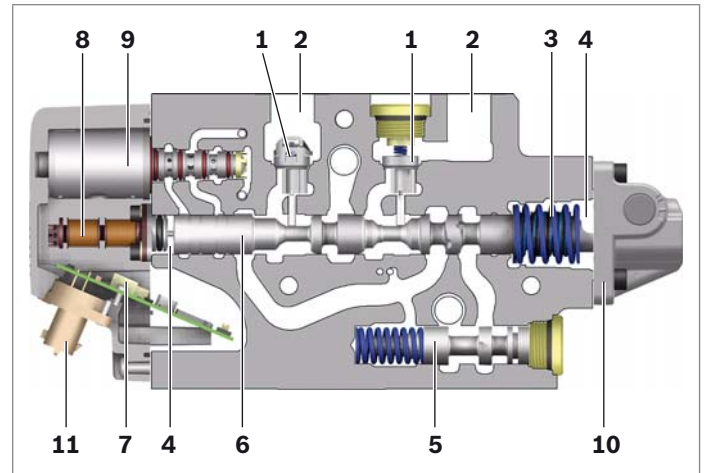
The SB23-EHS1 is a pilot operated, electro-hydraulically actuated directional valve with 4 switching positions. The control spool is controlled via a 4/3 pilot control valve that pressurizes the actuating chambers to move the control spool. The movement of the control spool is returned to the control electronics with a position transducer. The electronics then control the control spool position via the pilot control valve current, depending on the command value.

The mechanically controlled isolator valves in the two actuator ports act as check valves in the supply.

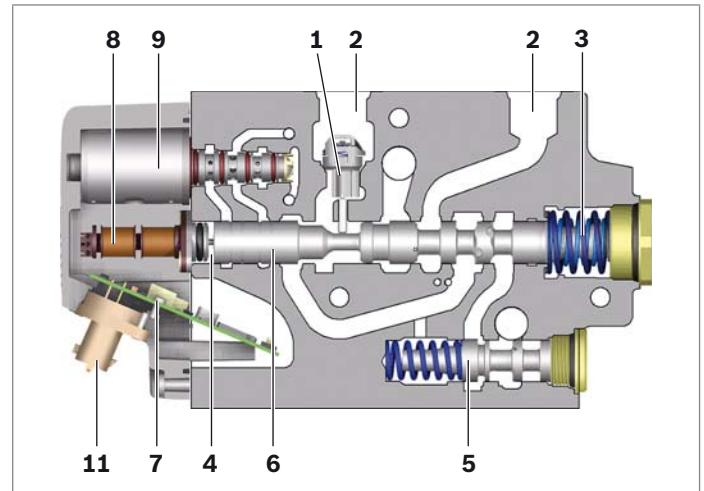
Load compensation in the supply is carried out via the individual pressure compensator.

The electronics are used for position control and communication with the CAN bus. They are equipped with a diagnosis function.

▼ SB23-EHS1



▼ SB23-EHS1 with 1 isolator valve

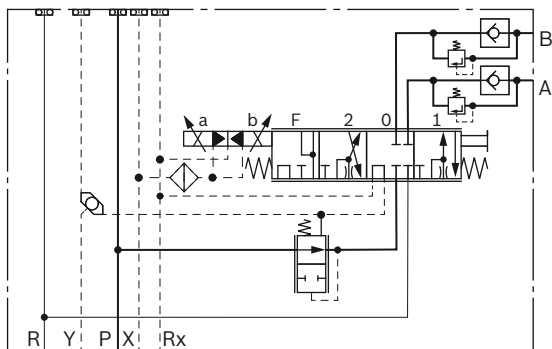


- 1** Isolator valves
- 2** Actuator ports
- 3** Return springs
- 4** Actuating chamber
- 5** Individual pressure compensator
- 6** Control spool
- 7** Printed circuit board (PCB)
- 8** Position transducer
- 9** Pilot control valve
- 10** Spring cap or spring cap with manual override
- 11** CAN control

Electro-hydraulically controlled LS directional valve

- ▶ Double-acting with 4 switching positions
- ▶ Mechanically operated isolator valves in B and optionally A
- ▶ 2-way individual pressure compensator in the supply
- ▶ Optional flange surface for customer-specific coupling housings
- ▶ Isolator valves are open in release without load pressure

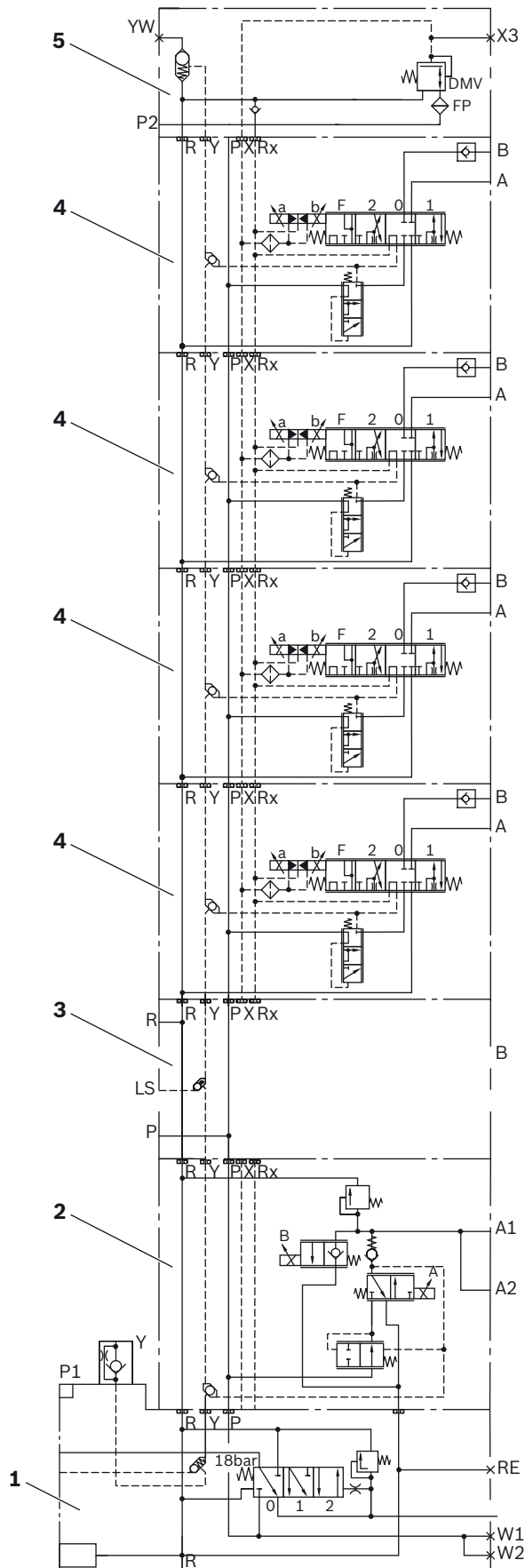
▼ SB23-EHS1 with 2 isolator valves, thermal pressure relief valve and manual override



Ports	
P	Pump
A, B	Actuator
X	Pilot oil supply
Rx	Pilot oil return
Y	LS signal
R	Tank return flow

- 1 Subplate
- 2 High-response valve, single-acting, proportionally electrically operated, with 2-way pressure compensator, with secondary pressure relief valve
- 3 Sandwich plate
- 4 Directional valves, double-acting, with 2-way pressure compensator, with isolator valves, hydraulically operated
- 5 End plate with coarse and fine filter and pilot oil processing

▼ Control block SB23-EHS1 (example)



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Technical data

general				
Weight	Subplate	kg	5.4	
	Directional valve SB23-EHS1	kg	7.5	
	End plate	kg	6.3	
Installation position	See page 30			
Line connections	Screw-in thread and/or flange connection, see page 9			
Fastening	Thread in the subplate (standard: M8)			
Ambient temperature range	θ	°C	-35 to +110	
hydraulic				
Maximum operating pressure at the port	P	p_{max}	bar	250
	A, B	p_{max}	bar	250
	R, Rx	p_{max}	bar	20
	X	p_{max}	bar	50
Neutral circulation pressure for opening the individual pressure compensator from the check function	P → R	p	bar	6.5 for $q_{v rated} = 100$ l/min (1 isolator valve)
		p	bar	4 for $q_{v rated} = 80$ l/min (1 isolator valve)
Flow at the port	P → A, B	$q_{v rated}$	l/min	100
	A, B → R	$q_{v max}$	l/min	120
Leakage	A, B → R	q_L	ml/min	≤ 2 with isolator valves in A, B ≤ 60 without isolator valve in A
Hydraulic fluid	<ul style="list-style-type: none"> ▶ Hydraulic oil based on mineral oil according to DIN 51524 ▶ HLP according to DIN 51524 ▶ Hydraulic oils HVLP 32/46/68 according to DIN 51524 ▶ HD SAE 10 W 40 ▶ HETG Fuchs Plantohyd 40/Fragol TR46 ▶ HEPG Fuchs Renolin PG ▶ HEES Fuchs Plantosyns Super S40/Fragol Hydraulic HE 15+46 ▶ Motor oils according to API-C ▶ Motor oils according to API-CD ▶ Motor oils according to API-CF ▶ Colorant Renolin FST 101 Other hydraulic fluids such as STOU/UTTO multi-purpose oils on request.			
Hydraulic fluid temperature range	Admissible range	θ	°C	+35 to +110 (with limited life cycle)
	Admissible range for start	θ	°C	-35
Viscosity range	Admissible range	ν	mm ² /s	7 to 500
	Recommended range	ν	mm ² /s	20 to 100
	Admissible range for start	ν	mm ² /s	8000
Max. admissible degree of contamination of the hydraulic fluid	Cleanliness class according to ISO 4406 (c)	Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$		
	Cleanliness class according to SAE AS 4059	Class 10A/10B/9C		
Thermal pressure relief valve optionally as a cartridge on the actuator port side	Cracking pressure at 150 ml/min, 33 mm ² /s		bar	257 to 293
Spring cap with manual override	<ul style="list-style-type: none"> ▶ Active bi-directional, mechanical actuation of the control spool ▶ Actuating torques (see quotation drawing) 			

electro-hydraulic			
Relative duty cycle			100 % duty cycle to +110 °C ¹⁾
Protection class			IPX6, IPX9K (with connected CAN connector)
Plug-in connection			Compact connector or jet connector
Electrical power consumption	p_{max}	W	17 with 12 V system
Voltage supply	U_{rated}	V	12 vehicle on-board power supply ISO 16750-2: Code C (24 V on request)
Actuating time for 100 % deflection			See actuating time/dynamics
Pilot oil pressure		bar	18 ^{±1} , referring to the return flow pressure
Pilot flow per directional valve	Neutral	l/min	0.25
	Control position lifting/lowering	l/min	0.5
	At max. actuating speed for a short time	l/min	4.5
Actuating time/dynamics	Step function (incl. dead time)		0 to 100 % from position 0 to position 1 or 2: approx. 50 ms
			0 to position F: approx. 70 ms
			50 °C, 30 mm ² /s, VG46, for the average valve actuating time taking viscosity into account, see Z 206 803 930 EHS1 interface description
Hysteresis regarding flow			Typically approx. 1 % of q_{rated} (in flow range up to 80 % of q_{rated})

Notice

- ▶ For applications outside these parameters, please consult us!
- ▶ The technical data were determined at a pressure of $p = 125$ bar, a viscosity range of $\nu = 33$ mm²/s and a temperature of $\theta = 50$ °C.
- ▶ For additional technical data, see
 - EHS1 interface description Z 206 803 930

¹⁾ Detailed information is available on request.

Type key

This type key describes the requested design variation of an SB23 directional valve.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
SB	23	1	0	L70	EHS						M			3	5	2		

Type

01	SB directional valve	SB
02	Version	23

Series

03	Series 1 (unchanged installation and connection dimensions)	1
----	---	----------

Version

04	EHS1 control unit	0
----	-------------------	----------

Spool type

05	4 positions (lifting – neutral – lowering – release)	L70
----	--	------------

Actuation

06	Electro-hydraulic, pilot operated	EHS
----	-----------------------------------	------------

Flow

07	80 l/min	080
	100 l/min	100

Manual override

08	Without	-
	With manual override	M

Actuator ports

09	Seal ring sealing according to DIN 3852-2 (Whitworth thread)	01
	Seal ring sealing according to DIN 3852-1 (metric thread)	02
	O-ring sealing with threaded hole marking according to ISO 6149-1 (metric thread)	06
	O-ring sealing without threaded hole marking according to ISO 6149-1 (metric thread)	07
	M6 flange	16
	O-ring sealing according to ISO 11926-1 (UNF thread)	19

Port A additional function

10	Without	N
	Mechanical isolator valve	M

Port A pressure limitation

11	Without	0
	With thermal pressure relief valve	1

Port B additional function

12	Mechanical isolator valve	M
----	---------------------------	----------

Port B pressure limitation

13	Without	0
	With thermal pressure relief valve	1

Pressure compensator

14	2-way individual pressure compensator (for 2 isolator valves)	C30
	3-way individual pressure compensator with integrated check function (for 1 isolator valve)	C50

Number of tie rods

15	3 tie rods	3
----	------------	----------

Flange side ports

16	Basic flange layout	5
----	---------------------	----------

Pilot oil line

17	Seal diameter 11.4 mm	2
----	-----------------------	----------

Connector

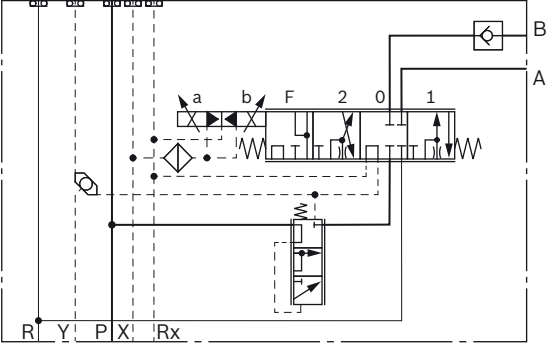
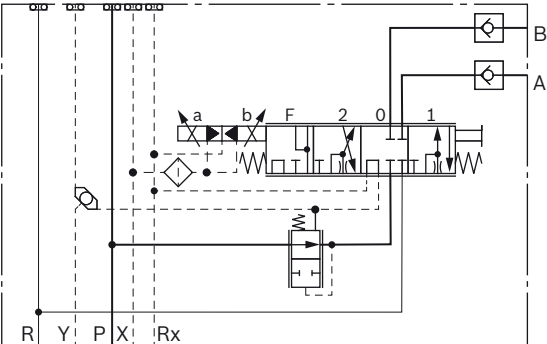
18	Bosch compact connector	K
	Jet connector	J

Supply voltage for valves

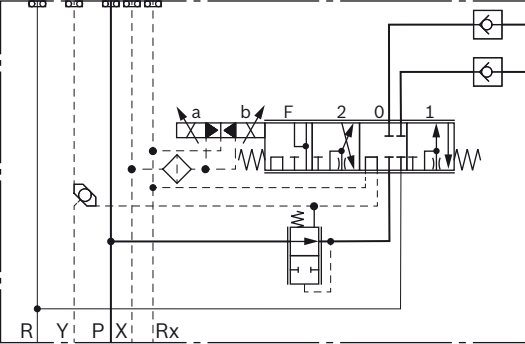
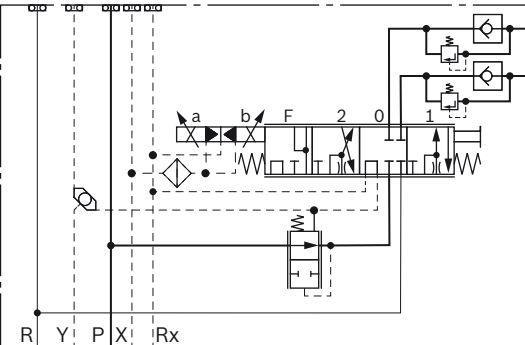
19	12 V	1
	24 V	2
	12 V to 24 V	3

Order overview

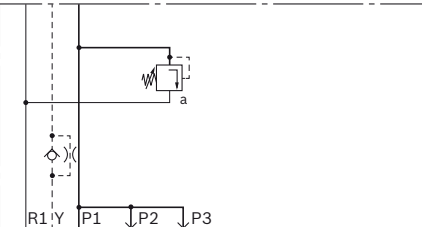
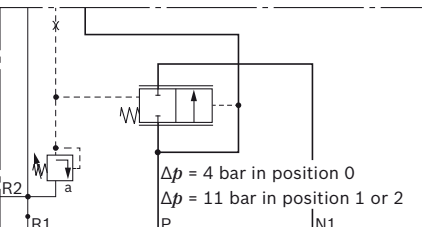
Directional valves

Type	Ports/version ¹⁾	Comments	Material number
SB23-EHS1			
	A, B = M22 x 1.5 / I	Flow $q_v = 100$ l/min ► CAN-ID 3 ► Isolator valve in B	R917007116
	M6 coupling flange	Flow $q_v = 80$ l/min ► CAN-ID 3	R917007117
SB23-EHS1			
	A, B = M22 x 1.5 / III	Flow $q_v = 100$ l/min ► Manual override of the control spool ► CAN-ID 2 ► Isolator valves in A and B	R917008933

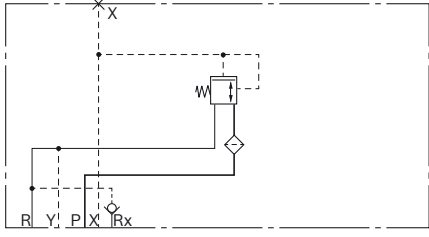
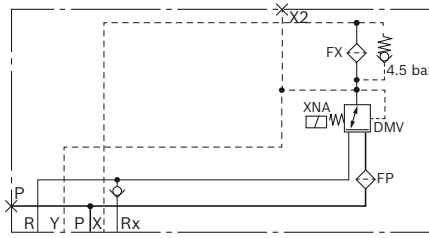

1) For design variations, see chapter "Line connections" on page 9

Type	Ports/version ¹⁾	Comments	Material number
SB23-EHS1	A, B = M22 x 1.5 / III	Flow $q_v = 100$ l/min ▶ CAN-ID 2 ▶ Isolator valves in A and B	R917008934
			
SB23-EHS1	A, B = M22 x 1.5 / I	Flow $q_v = 100$ l/min ▶ Manual override of the control spool ▶ Thermal pressure relief valve in A and B ▶ M6 coupling flange ▶ Isolator valves in A and B ▶ CAN-ID	R917...²⁾
			

Subplates, sandwich plates and end plates

Type	Ports/version ¹⁾	Comments	Material number
Subplate for variable displacement pump	P1 = M27 x 2 / III P2 = M27 x 2 / III P3 = M10 x 1 / I R1 = M33 x 2 / III Y = M12 x 1.5	▶ With pressure relief valve ▶ P2 port closed ▶ P3 port open ▶ Screw-in thread for tie rod ▶ Mounting bases with M8 thread ▶ For control blocks with EHR23-EM2: Allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y	R917007235
			
Subplate for fixed displacement pump	P = M22 x 1.5 / II R1 = M27 x 2 / II R2 = M27 x 2 / II N1 = M22 x 1.5 / II	▶ With pressure relief valve	R917007203
			

1) For design variations, see chapter "Line connections" on page 9
2) Please consult us regarding technical issues and requirements

Type	Ports/version ¹⁾	Comments	Material number
End plate for variable displacement pump 	X: M12 x 1.5 / III	<ul style="list-style-type: none"> ▶ 18 bar pilot pressure (fixed) ▶ Control pressure port: port X closed; with sintered stainless steel filter element in line P ▶ Optionally with fine filter 	R917007578
End plate for fixed displacement pump 	X: M10 x 1 / I P = M22 x 1.5 / III	<ul style="list-style-type: none"> ▶ Pilot pressure 18 bar (individually switched on or off) ▶ Control pressure port: port X closed; with sintered stainless steel filter element in line P ▶ Fine filter 	R917007249
Sandwich plate 		<ul style="list-style-type: none"> ▶ Plate width: L = 13 mm ▶ Plate width: L = 15 mm ▶ Plate width: L = 22 mm 	R917005302 R917006220 R917007130

Line connections

Version I

DIN 3852-1 (metric thread), DIN 3852-2 (Whitworth thread)

- ▶ For seal ring sealing

Version II

ISO 11926-1 (UNF thread)

- ▶ For O-ring sealing

EN ISO 6149-1 (metric thread)

- ▶ Without threaded hole marking
- ▶ For O-ring sealing

Version III

EN ISO 6149-1 (metric thread)

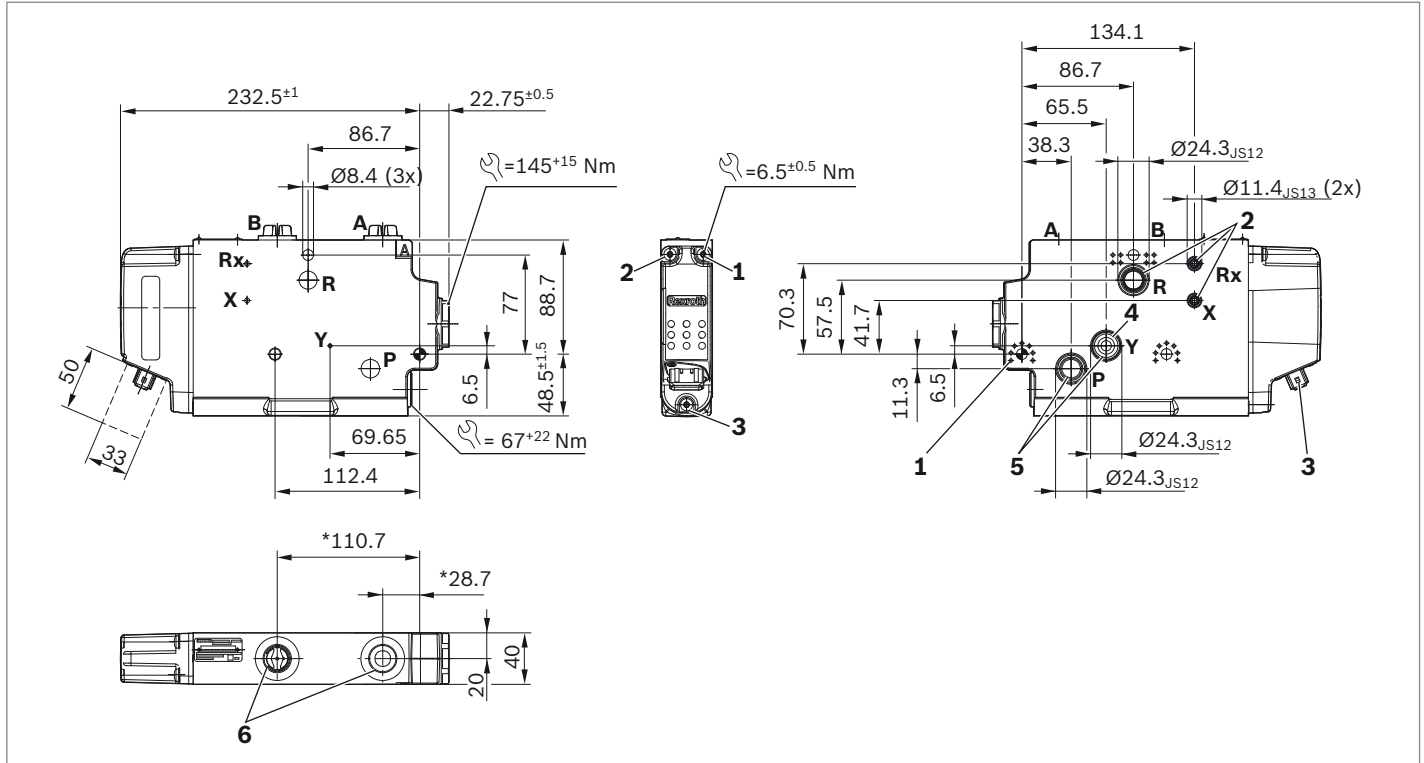
- ▶ Without threaded hole marking
- ▶ For O-ring sealing

¹⁾ For design variations, see chapter "Line connections" on page 9

Dimensions

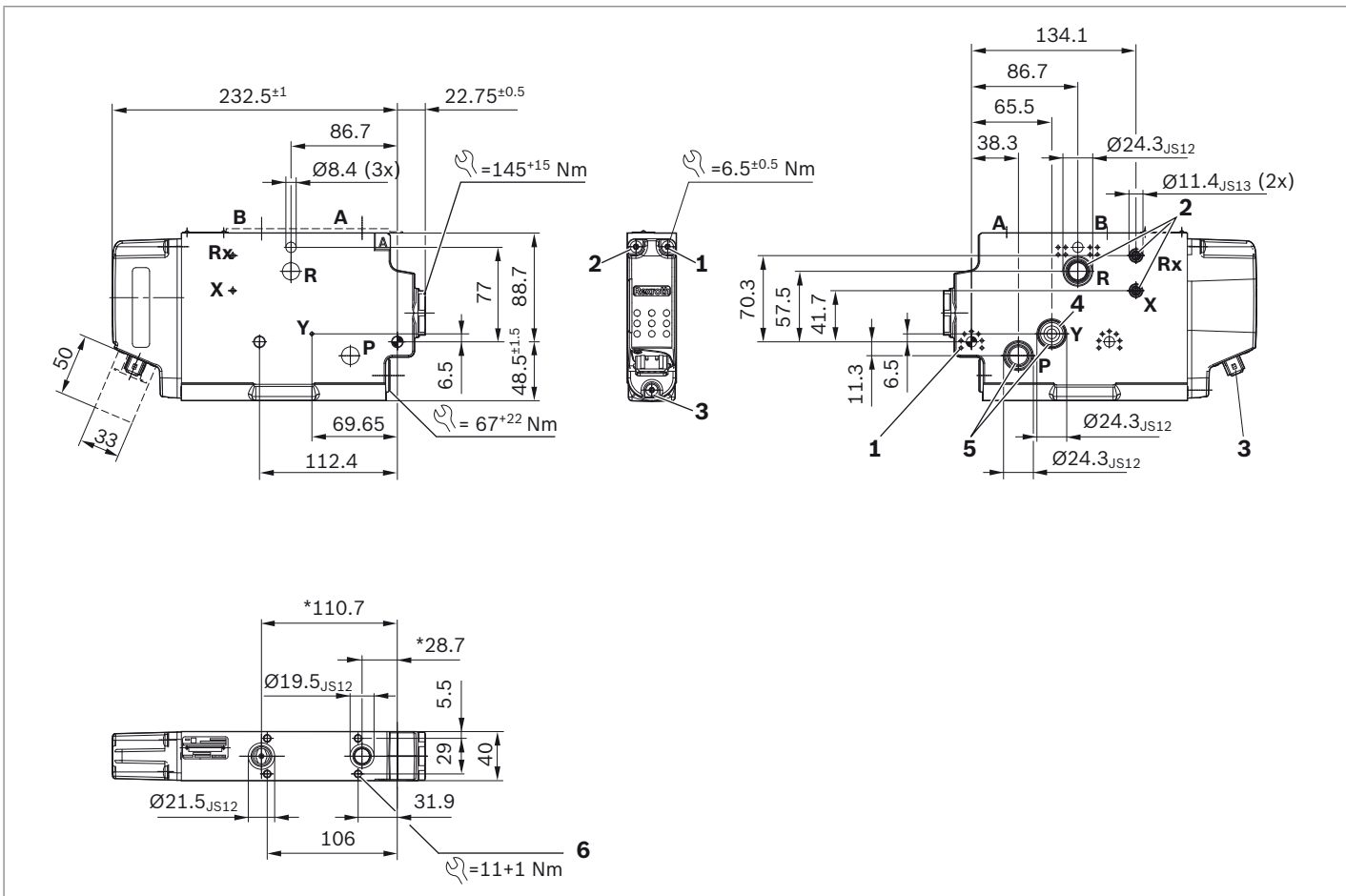
Directional valves

▼ Control valve SB23-EHS1, R917007116



- 1 Embossed
- 2 O-ring is included in the scope of delivery
- 3 Remove protective cap R917001694 prior to connecting
- 4 Shuttle valve is included in the scope of delivery
- 5 O-ring and support ring are included in the scope of delivery
- 6 M22 x 1.5 / I

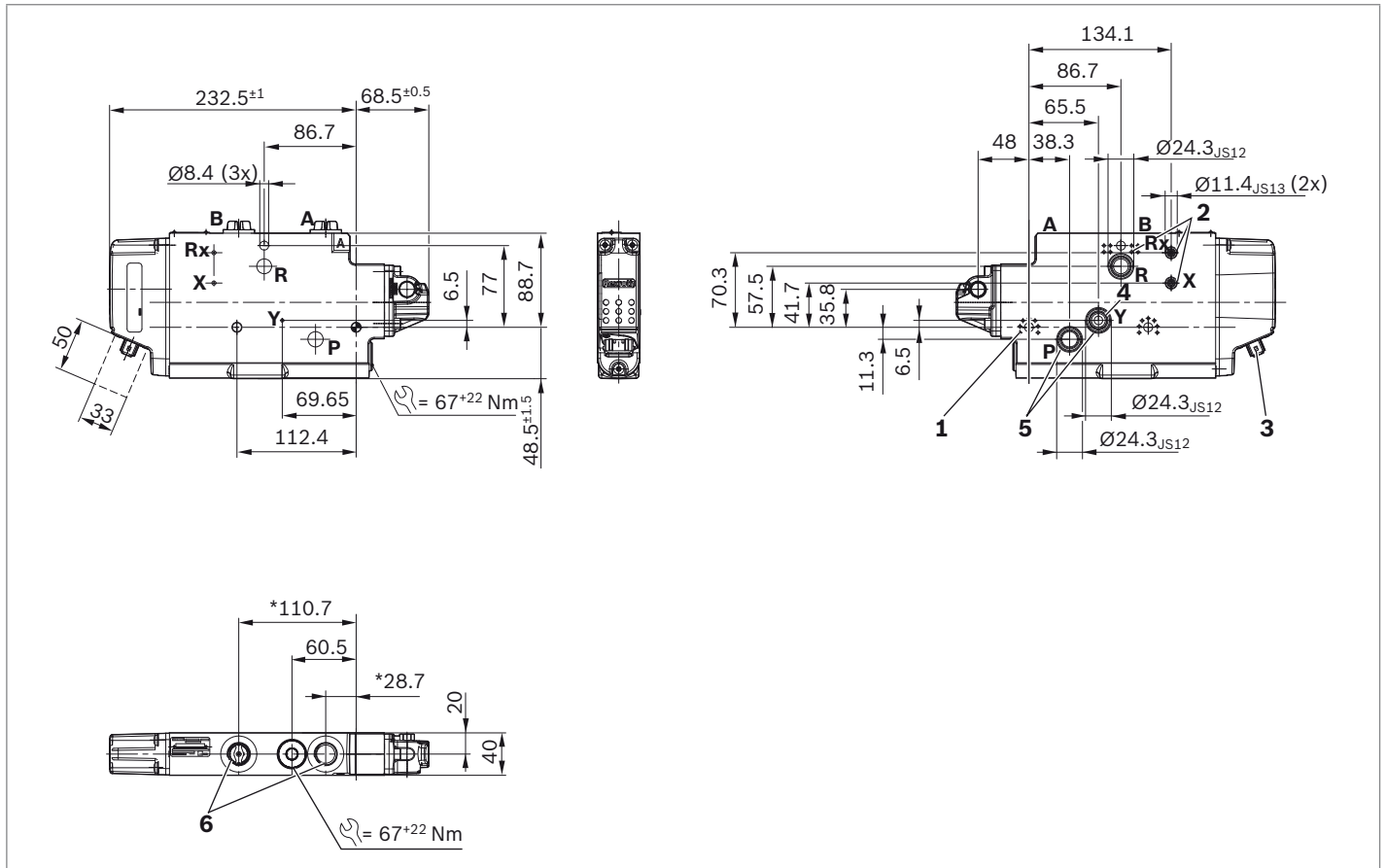
▼ Control valve SB23-EHS1, R917007117



- 1 Embossed
- 2 O-ring is included in the scope of delivery
- 3 Remove protective cap R917001694 prior to connecting
- 4 Shuttle valve is included in the scope of delivery
- 5 O-ring and support ring are included in the scope of delivery
- 6 4 x M6, at least 8.7 deep



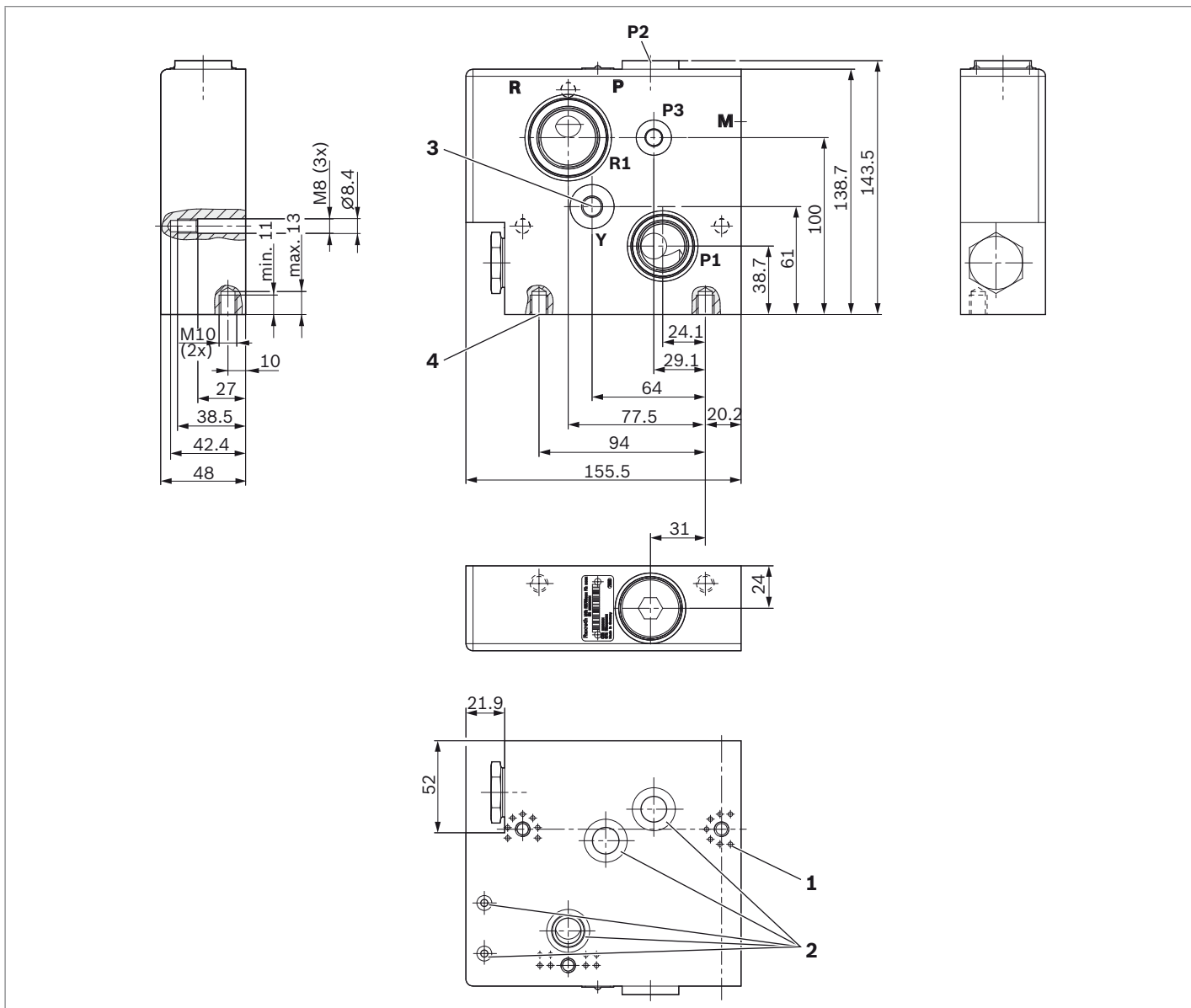
▼ Control valve SB23-EHS1 with manual override, R917008933 (without manual override, R917008934)



- 1 Embossed
- 2 O-ring is included in the scope of delivery
- 3 Remove protective cap R917001694 prior to connecting
- 4 Shuttle valve is included in the scope of delivery
- 5 O-ring and support ring are included in the scope of delivery
- 6 M22 x 1.5 / III

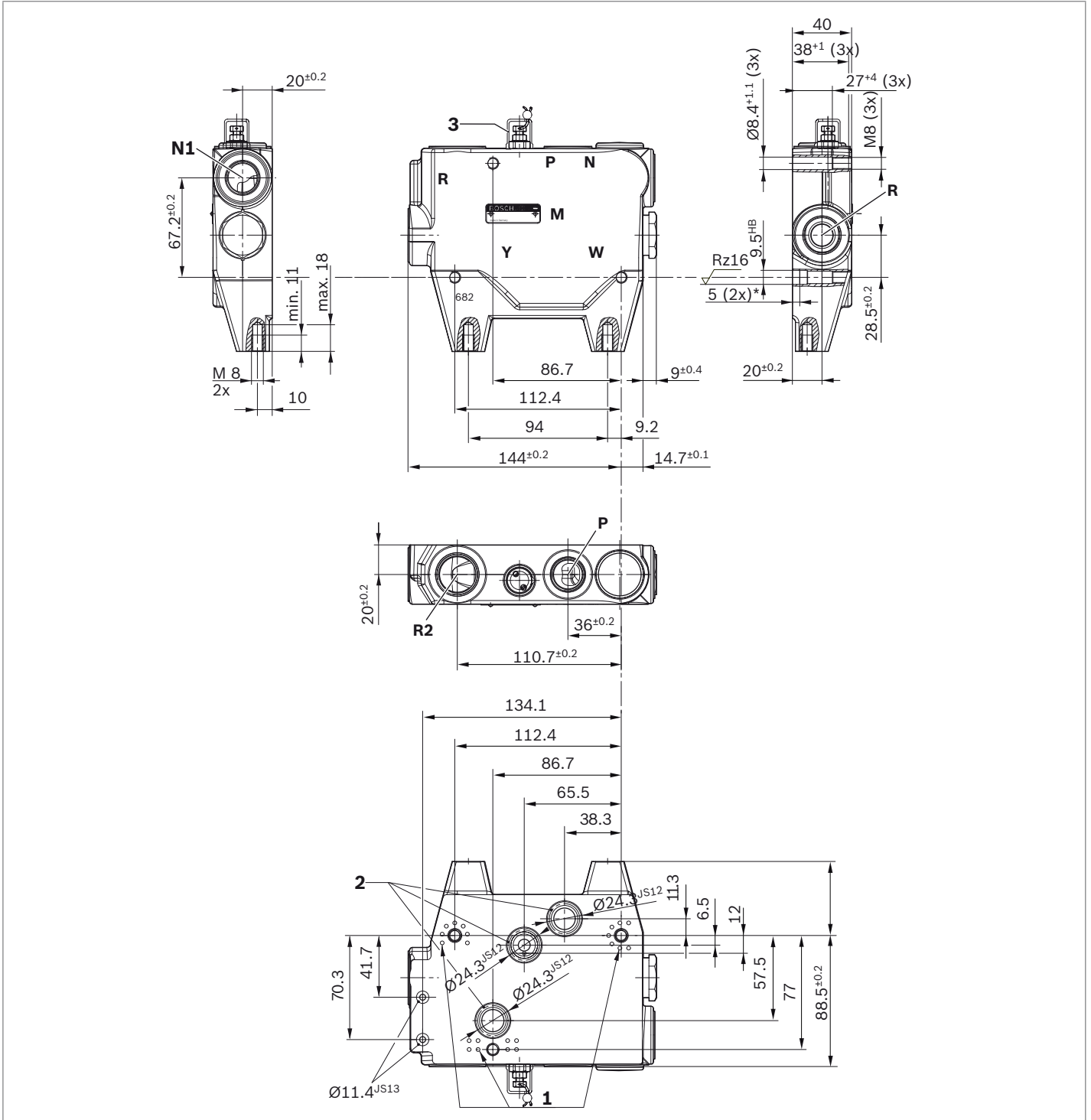
Subplates, sandwich plates and end plates

▼ Subplate for variable displacement pump, R917007235



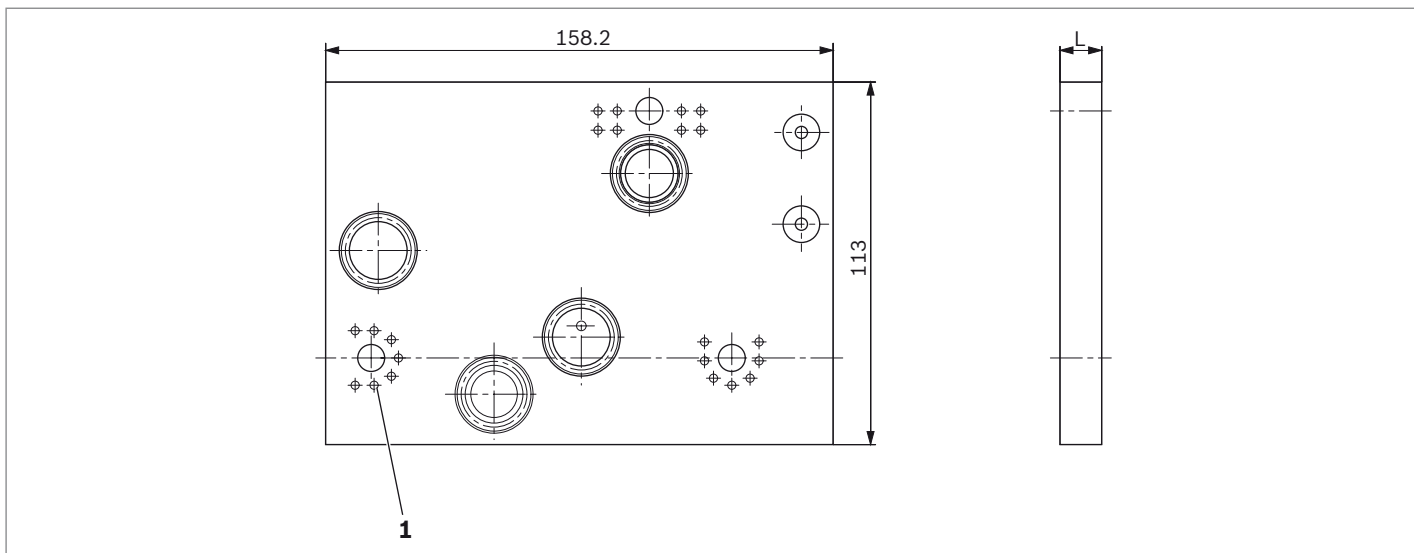
- 1 Embossed
- 2 Seal rings are included in the scope of delivery
- 3 For control blocks with EHR23-EM2:
Allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y
- 4 Two M10 mounting threads

▼ Subplate for fixed displacement pump, R917007203



- 1 Embossed
- 2 Seal rings are included in the scope of delivery
- 3 Protective cap

▼ Sandwich plate



1 Embossed

Material number	Dimension L [mm]
R917005302	13
R917006220	15
R917007130	22



Tie rod

If a subplate is used			
R917007235, R917002924, R917007203			
End plate			
R917007578, R917005923			
Directional valves Length L [mm]		Tie rods Material number	Tie rod length [mm]
from	to		
40	42	1 523 502 096	131
44	44	R917000013	133
80	80	1 523 502 097	171
91	98	R917000538	187
99	106	1 523 502 087	195
107	114	R917005260	203
115	122	1 523 502 098	211
128	133	1 523 502 125	223
140	145	1 523 502 088	235
146	149	R917005261	239
156	161	1 523 502 099	251
162	167	R917003101	257
168	172	R917005949	263
174	178	R917004775	269
180	184	1 523 502 089	275
196	200	1 523 502 100	291
209	212	1 523 502 129	304
215	218	R917005950	310
220	223	1 523 502 090	315
236	239	1 523 502 101	331
249	251	1 523 502 130	344
260	262	1 523 502 091	355
276	278	1 523 502 102	371

Assembling the control block in the machine

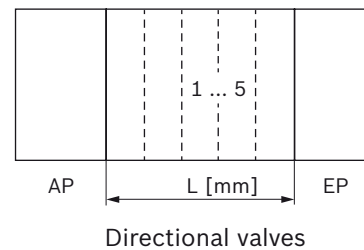
Control block SB23-EHS1 consisting of:

- ▶ Subplate
- ▶ 1 to 5 directional valves (> 5 directional valves on request)
- ▶ 3 tie rods
- ▶ End plate

The subplate, directional valves and end plate are held by tie rods during control block assembly.

The control block is mounted at the subplate and/or the end plate in the machine.

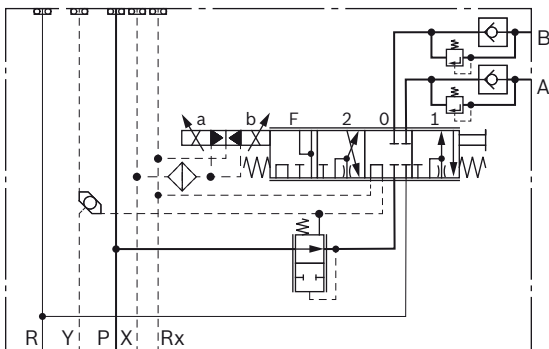
The number of mounting points and the number of tie rods depend on the number of directional valves and the vibration load to be expected in the machine. At least three tie rods are necessary to hold a control block.



Hydraulic functions

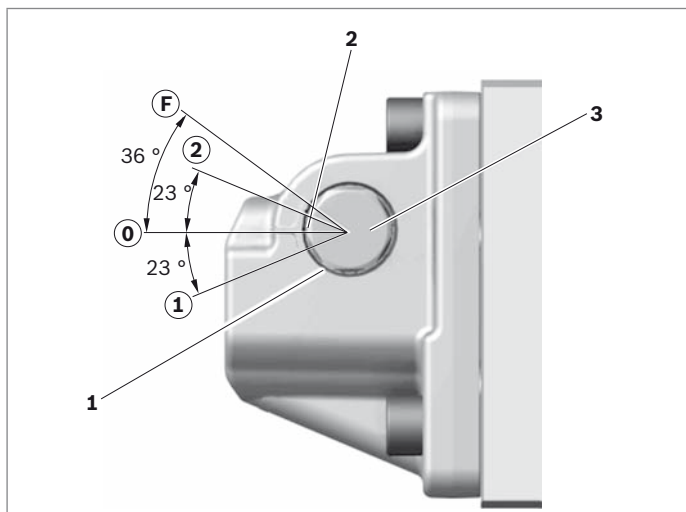
Standard	Optional
Isolator valve for oil flow from B to R	A → R
Actuator ports/threaded ports: M22 x 1.5 / ISO 6149, O-ring sealing	M22 x 1.5 / DIN 3852, profile seal ring Quick-release couplings: Flange surface for coupling housing with M6 mounting thread
Spring cap	Manual override
Control spool with 4 switching positions	Varying oil flows
2-way individual pressure compensator	Thermal pressure relief valve: Integrated into the isolator valve for ports A and B. It prevents excessively high pressure build-up resulting from thermal expansion in an enclosed volume.
Position sensor for position control of the control spool and for diagnostic purposes	

▼ SB23-EHS1 with manual override, 2 isolator valves and thermal pressure relief valve



Manual override for directional valve spool with 2 isolator valves (optional)

- ▶ Mechanical manual actuation
- ▶ Can be operated with standard tools (hexagon SW13)
- ▶ Locking of the control spool is not possible



Notice

The valves in the tractor are to be arranged to prevent accumulation of dirt at the actuating shaft, which could result in jamming of the control spool.

- ① = Lifting
- ② = Lowering
- ③ = Neutral
- ④ = Float/Release

- 1 Cover the gap on both sides during painting. Alternatively, carry out several mechanical operations after painting
- 2 Position display, milled-off hexagon corner
- 3 SW13, max. tool width 6.5 mm, max. admissible actuating torque 10.5 Nm

Pilot oil supply

This is no component of the directional valve (block or system component).

Pilot flow requirement per SB23 directional valve

Values at a viscosity of 30 mm²/s:

In neutral position:	Typically 250 ml/min, maximum 360 ml/min
When lifting or lowering:	Typically 500 ml/min, maximum 820 ml/min
In release:	Typically 250 ml/min, maximum 400 ml/min
During step function (lifting or lowering):	Typically 3.5 l/min
During step function (release):	Typically 4.5 l/min

Peak demands of pilot oil can be limited by preventing simultaneous activation of several actuators (delay by actuating time + safety distance) or programming the time ramps.

Control pressure referencing

The pilot oil pressure p_X is to be referenced on the highest return flow pressure of all SB23/EHR23 valves.

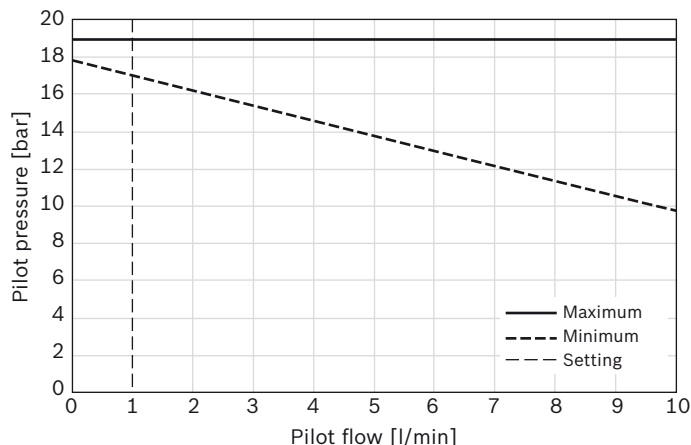
$$(p_{X \text{ absolute}} = p_X + p_{R \text{ max}})$$

Pilot pressure

$$p_X = 18^{±1} \text{ bar}$$

(adjustment point with a pilot flow from 0.8 to 1.2 l/min)

The pilot pressure according to the diagram has to be completely available to the SB23 valves. Otherwise, complete valve performance is not guaranteed.

▼ Pilot pressure characteristic curve**Pilot oil fine filter**

Oil cleanliness is particularly important with regard to pilot oil supply. Use an additional pilot oil fine filter, if required.

Flows

Standard:

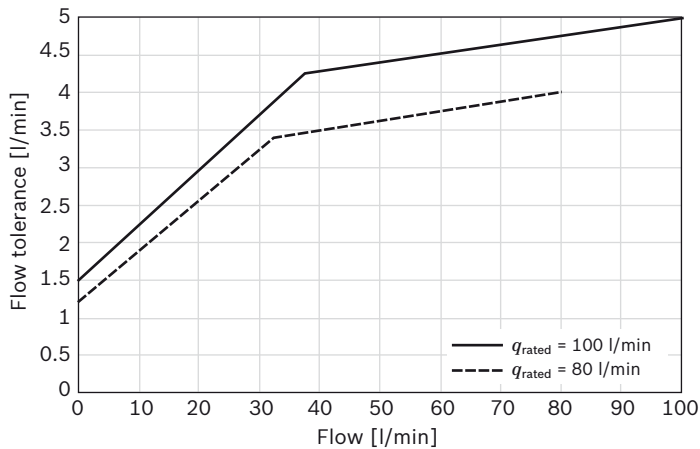
	Rated flow	Tolerance	Max. flow
P → A, B	80 l/min	±4 l/min	
A, B → R	100 l/min		120 l/min
P → A, B	100 l/min	±5 l/min	
A, B → R	100 l/min		120 l/min

Flow tolerance

The tolerance curves are applicable to the supply flow in standard versions with supply flow edge comparison. When using return flow edge comparison, larger tolerances are derived for the supply flow at driving loads in the small flow range.

Special versions may offer different tolerances.

▼ **Characteristic curve of the flow tolerance**



Hysteresis

Regarding flow:

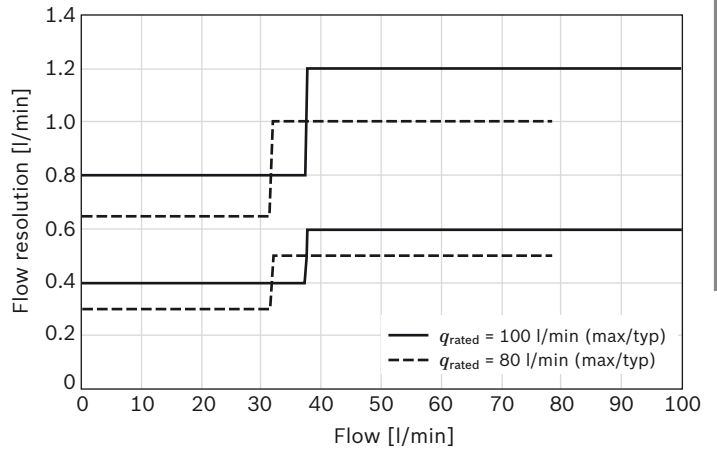
- ▶ Typically approx. 1 % of q_{rated} (in flow range up to 80 % of q_{rated})
- ▶ Max. 2 % of q_{rated}

Flow resolution

The characteristic curves apply for standard versions (supply flow edge comparison).

For special versions or special spool versions, other tolerances may apply.

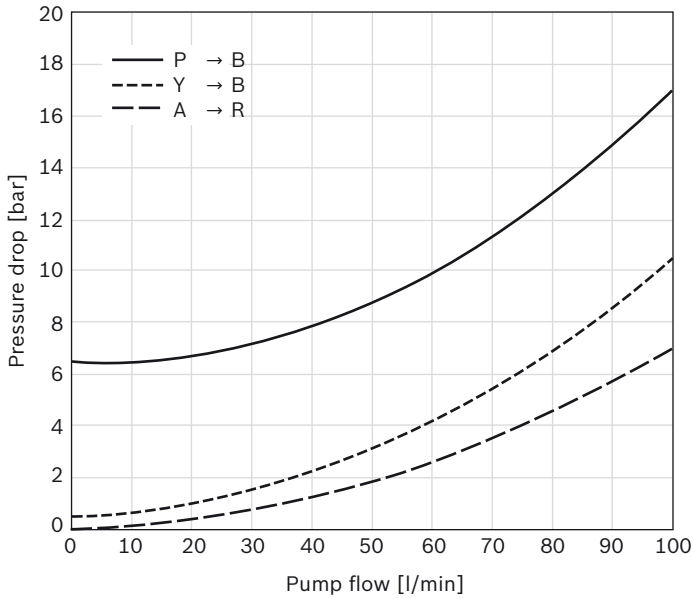
▼ **Characteristic curve of flow resolution**



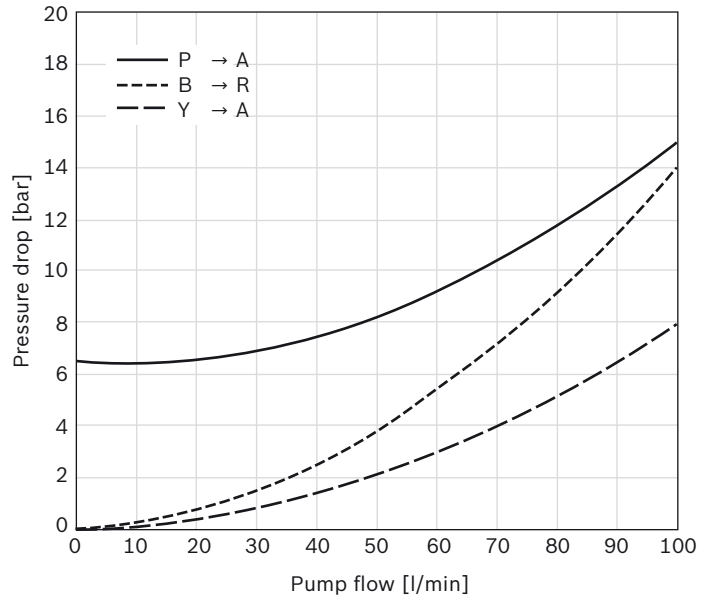
Flow resistance (typical values)

SB23-EHS1, 1 isolator valve

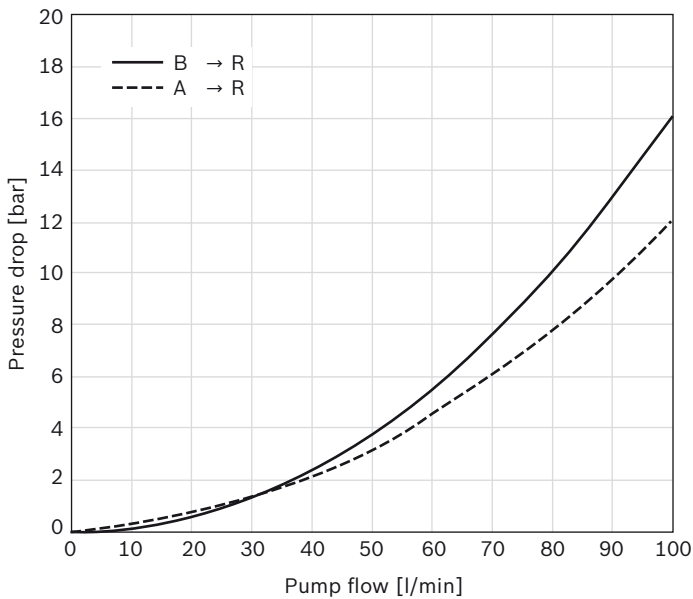
▼ **Position 1 (lifting)**



▼ **Position 2 (lowering)**



▼ **Position F (release)**



Flow temperature drift

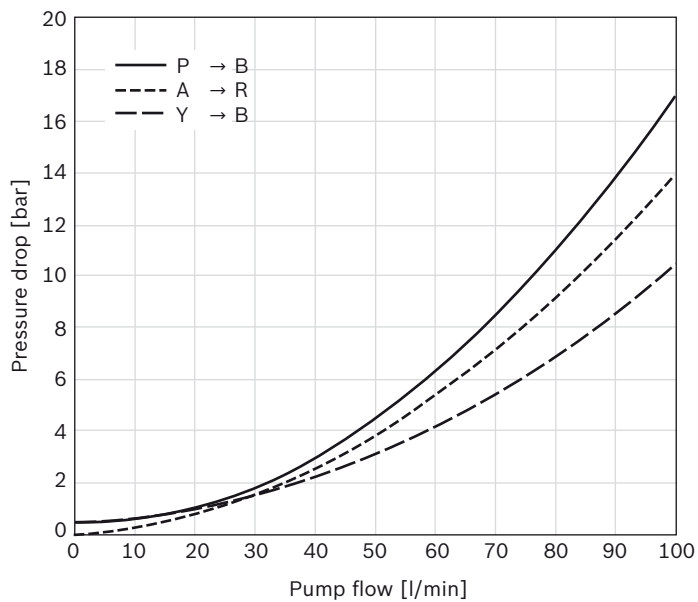
The temperature dependence of the flow is electronically compensated in the temperature range of 30 °C to 90 °C.

Flow pressure drift

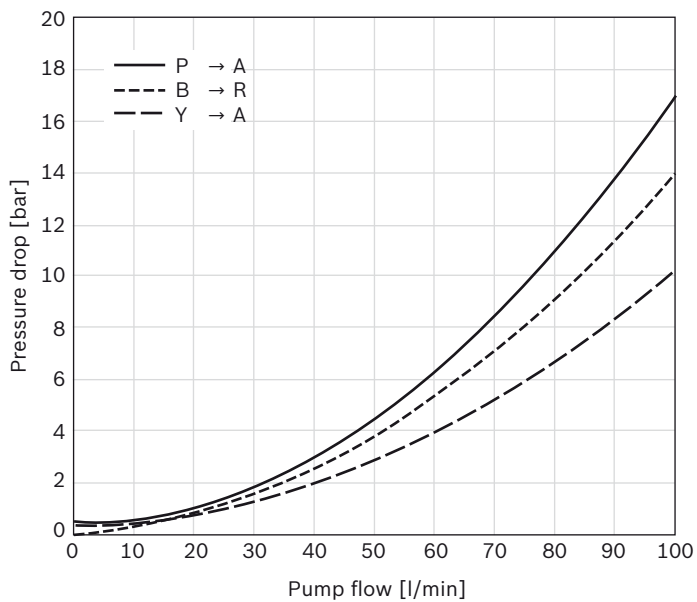
The pressure drift of the flow (pressure increase due to parallel operation) is compensated by the individual pressure compensator.

SB23-EHS1, 2 isolator valves

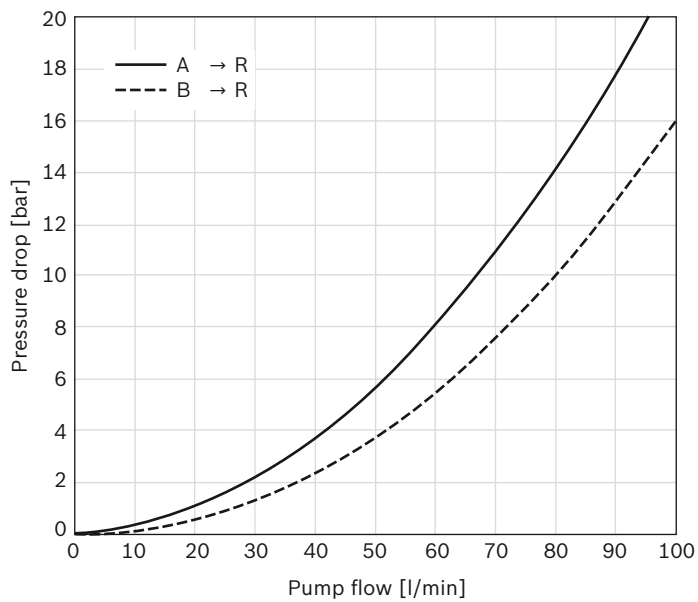
▼ Position 1 (lifting)



▼ Position 2 (lowering)



▼ Position F (release)



Internal leakage

Leakage at working port for basic design with 1 isolator valve

- ▶ **B** → **R** in position 0: 2 ml/min
- ▶ **A** → **R** in position 0: 60 ml/min (standard)
- ▶ **A** → **R** in position 2: 150 ml/min (typical)
(check function) 300 ml/min (max.)

Leakage at working port at versions with optional isolator valve function in A and B

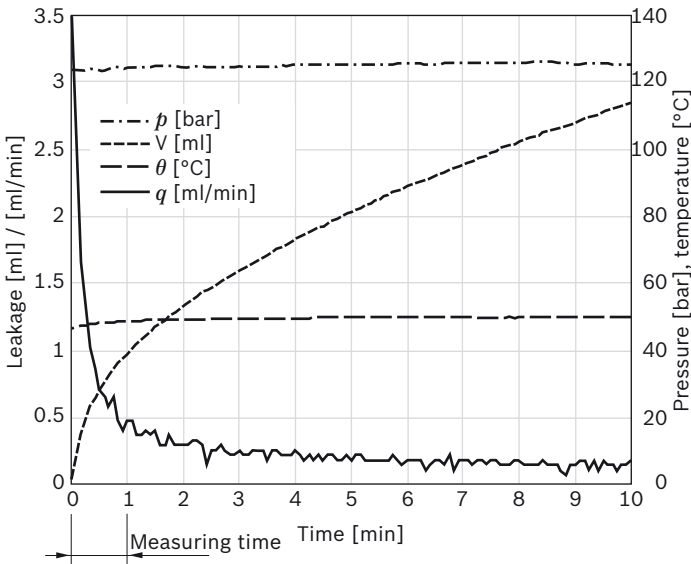
- ▶ **A, B** → **R** in position 0: 2 ml/min

Further leakage values on request.

Notice

Measured at $p = 125 \text{ bar}$, $v = 30 \text{ mm}^2/\text{s}$, $\theta = 50 \text{ }^\circ\text{C}$,
 $t_{\text{waiting time}} = 15 \text{ s}$, $t_{\text{measuring time}} = 60 \text{ s}$.

▼ **Typical leakage behavior, leakage behavior with time at the isolator valve**



Leakage P to R in various switching positions

- ▶ **P** → **R** in position 0: 60 ml/min (typical)
250 ml/min (max.)
- ▶ **P** → **R** in position 1, 2: 100 ml/min (typical)
250 ml/min (max.)
- ▶ **P** → **R** in position F: 60 ml/min (typical)
250 ml/min (max.)

There may be higher values for special spool variants.

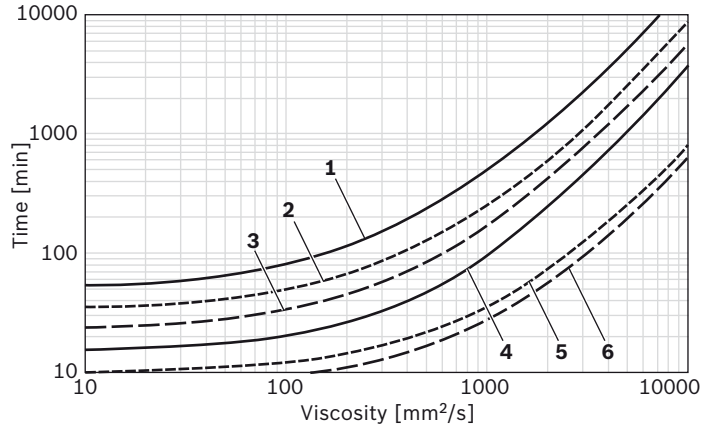
Notice

Measured at $p = 200 \text{ bar}$, $v = 30 \text{ mm}^2/\text{s}$, $\theta = 50 \text{ }^\circ\text{C}$.

Actuating time/dynamics

Corner frequency regarding spool travel is approx. 17 Hz for a command value modification from 0 to 100 %

▼ **Characteristic curve of the step function**



- 1 Actuating time: neutral after release
- 2 Actuating time: neutral after lowering
- 3 Actuating time: neutral after lifting
- 4 Dead time: neutral after release
- 5 Dead time: neutral after lowering
- 6 Dead time: neutral after lifting

Electronic functions

Standard: CAN control

General electric information																
Supply voltage	As a standard with 12 V vehicle on-board power supply; on request: 24 V															
Overvoltage protection	Supply: 48 V for 5 min															
Reverse polarity protection	Test voltage -48 V for 5 min															
Short-circuit protection	Short-circuit protected against 36 V, against ground, and between the individual inputs and outputs.															
Protection class	IP69K (electronics), with connected mating connector															
Electromagnetic interference	ISO 11452-2 Measurement of electromagnetic interference 0.2 MHz to 1000 MHz, frequency according to ISO 14982: 1998 Reference values: ▶ Absorber chamber 100 V/m ▶ Stripline 150 V/m															
Electromagnetic emissions	ISO 14982: 1998															
ESD	ISO 10605: 2008 Unpowered test: relay discharge: ± 8 kV, air discharge ± 15 kV, $R_i = 2000 \Omega$, $C = 150 pF$ (table C1, category 1) Powered up test: relay discharge: ± 8 kV, air discharge ± 15 kV, $R_i = 2000 \Omega$, $C = 330 pF$ (table C2, category 1)															
Conducted interferences	ISO 7637-2:2004															
Electrical power consumption	$U_{Bat} = 14 V$															
	<table border="1"> <thead> <tr> <th></th> <th>typ. [W]</th> <th>max. [W]</th> </tr> </thead> <tbody> <tr> <td>In neutral position</td> <td>0.4</td> <td>0.6</td> </tr> <tr> <td>With max. regulating speed</td> <td></td> <td>12</td> </tr> <tr> <td>In switching or interim position</td> <td>3.6</td> <td>5.0</td> </tr> <tr> <td>In release</td> <td>6</td> <td>12</td> </tr> </tbody> </table>		typ. [W]	max. [W]	In neutral position	0.4	0.6	With max. regulating speed		12	In switching or interim position	3.6	5.0	In release	6	12
	typ. [W]	max. [W]														
In neutral position	0.4	0.6														
With max. regulating speed		12														
In switching or interim position	3.6	5.0														
In release	6	12														
Input signal	CAN, physical layer according to ISO 11898 "High Speed", standard transmission rate of 250 kBaud															
Pin assignment	<table border="0"> <tr> <td>Compact connector</td> <td>Jet connector</td> </tr> <tr> <td>Pin 1 = ground</td> <td>Pin 1 = U_{Bat}</td> </tr> <tr> <td>Pin 2 = CAN high</td> <td>Pin 2 = CAN low</td> </tr> <tr> <td>Pin 3 = CAN low</td> <td>Pin 3 = CAN high</td> </tr> <tr> <td>Pin 4 = U_{Bat}</td> <td>Pin 4 = ground</td> </tr> </table>	Compact connector	Jet connector	Pin 1 = ground	Pin 1 = U_{Bat}	Pin 2 = CAN high	Pin 2 = CAN low	Pin 3 = CAN low	Pin 3 = CAN high	Pin 4 = U_{Bat}	Pin 4 = ground					
Compact connector	Jet connector															
Pin 1 = ground	Pin 1 = U_{Bat}															
Pin 2 = CAN high	Pin 2 = CAN low															
Pin 3 = CAN low	Pin 3 = CAN high															
Pin 4 = U_{Bat}	Pin 4 = ground															
Sinus vibration test	DIN EN 60068-2-6, 10 Hz – 2000 Hz, 57.5 → 2000 Hz, 6.93 g rms 10 Hz → 57.5 Hz, 1.5 mm pp															
Broadband noise test	DIN EN 60068-2-64, 5 Hz – 2000 Hz, a_{eff} 86.9 m/s ²															
Shock test	DIN EN 60068-2-27, $a = 500 m/s^2$, 11 ms, 60 cycles DIN EN 60068-2-29, $a = 400 m/s^2$, 6 ms, 300 cycles															

Reading error codes with EHS diagnostic tool, error interpretation

The EHS diagnostic tool is a software that was specifically designed to detect errors in EHS systems in the vehicle or in the test stand. The diagnostic tool is used to identify and diagnose individual valves or all valves in the block/tractor. The characteristics and error memories of the valves can be read via RS232 (only individual valves) or CAN (all valves). The baud rate is fixed at 9600 Bd with RS232. With CAN, the baud rate is determined automatically.

Notice

Fail-safe: In case of power failure, short-circuit or oil supply failure, the actuating unit automatically sets the control spool to neutral (the spool is spring-centered).

Overview on internal diagnosis

Special protection measures against malfunctions due to contamination, material defects, etc. are not provided. The device does not fulfill any safety functions without the user taking additional measures.

Error detection	Error	Error reaction
Internal errors	Control spool is not in neutral position during switch on	▶ CAN: diagnostic message via CAN bus Attention: There may be uncontrolled load movements, the system has to be shut off.
	Spool valve is deflected too little	▶ Valve is switched to neutral; optionally, there is only an error message.
	The control spool is deflected too far and/or does not return to neutral (e.g. spool is retained or stuck)	▶ If it cannot be switched into the opposite direction, the actuating unit is de-energized. ▶ CAN: diagnostic message via CAN bus. Attention: There may be uncontrolled load movements, the system has to be shut off.
	Defective position transducer	▶ The valve is not actuated
	Defective current measurement	▶ The valve is not actuated
	Defective output stage	▶ The valve is not actuated
	Checksum error regarding ▶ Main program ▶ EEPROM customer area	▶ The valve is not actuated ▶ Checksum test; optionally, only error message or shut-off
	RAM error	▶ Test; optionally, only error message or shut-off
	Computer error	▶ Error due to noise pulses: Restart is only permitted if the command value was set to neutral before. ▶ Other computer errors: CAN: diagnostic message via CAN bus. Attention: There may be uncontrolled load movements, the system has to be shut off.
	External errors	Supply voltage is below the admissible range	▶ The valve is not actuated (for CAN: if it is above the Bosch limit, only an error message is created as an option).
Supply voltage is above the admissible range		▶ The valve is not actuated (for CAN: if it is below the Bosch limit, only an error message is created as an option).
Command value voltage is below the admissible range		▶ The valve is not actuated
Command value voltage is above the admissible range		▶ The valve is not actuated
No command value message (only for CAN)		▶ The valve is not actuated
Implausible command value message (only for CAN)		▶ The valve is not actuated
No configuration message (only for CAN)		▶ The valve is not actuated
Manual actuation (using the hand lever of the valve)		▶ Valve remains switched off, no counter-reaction, no electric actuation possible
Visual error display	Diagnostic LED in the connector	The flashing code displays the error type (see flashing code)
CAN error diagnosis	The error is transmitted via CAN using an error code. Immediately when the error occurs, the diagnostic message is sent up to 5 times, and then every 100 ms (adjustable). The error code is transmitted (see description of the CAN messages).	

General information on the CAN control

The EHS valve can be easily actuated via the serial CAN interface. Using a message, the operating modes "neutral", "lifting", "lowering", "release" and the flow command value can be set. Using a second message, characteristic curve form, characteristic curve rise and ramp times may be set separately for "lifting" and "lowering". At the same time, the valve can report any errors in detail to the superior operating unit using the error code.

Furthermore, the valve can be permanently reprogrammed using the parameterization messages (CAN baud rate and identifier, battery voltage limits, valve number, etc.).

General CAN settings

	Standard setting
Baud rate	250 kBaud, up to ≤ 1 MBaud is possible
Scanning	Single scan
Scan time	At $\frac{3}{4}$ of the bit length
Synchronization edges	Only edges from recessive to dominant
Size of synchronization steps	SJW = 1 BTL cycles

Notice

The maximum baud rate has to be always tested in the vehicle and is determined by:

- ▶ Data traffic in the bus
- ▶ Efficiency of the internal hardware identifier filter which is determined by e.g.
 - Assignment of CAN identifiers that do not concern the valves
 - CAN identifier set, see TKU: Electrics interface description Z 206 E00 444

Characteristic curves for command value generation and time ramps

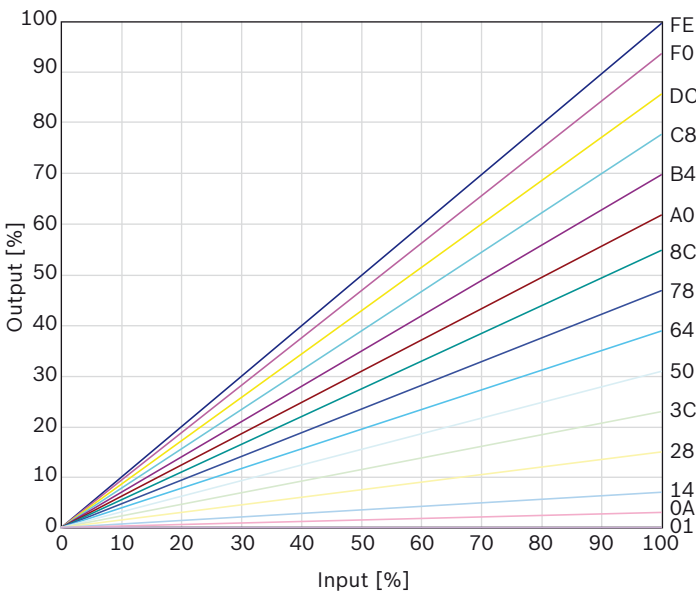
Characteristic curve rise

Due to the characteristic curve rise, the degree of valve opening can be reduced linearly from 100 % to 0 %.

255 steps may be programmed:
 00hex, 01hex, 02hex.....FEhex
 0 %, 0.39 %, 0.78 %, ...100 %

The value for the characteristic curve rise is transmitted in the configuration message in CAN mode. The standard setting is 100 %. The characteristic curve rise should be selected with the values shown.

▼ **Characteristic curve rise**



With CAN control, the input corresponds to the flow command value. The output corresponds to the flow at the directional valve.

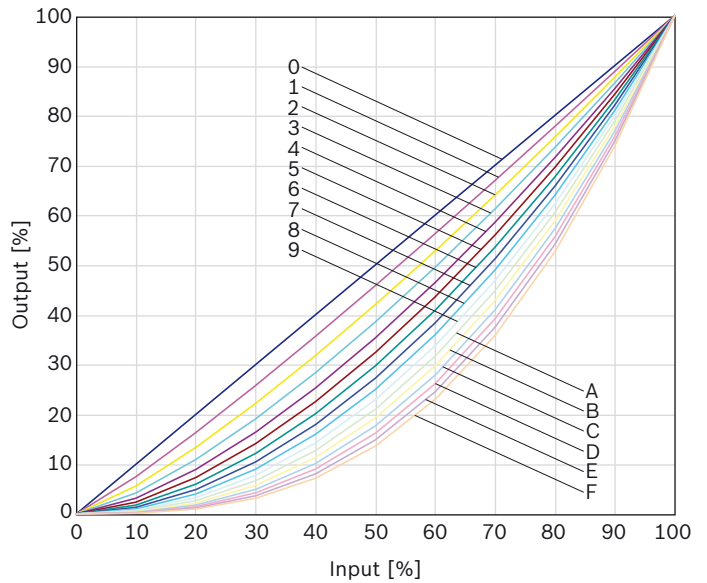
Characteristic curve form

The characteristic curve form may be changed from linear to highly progressive. In this way, the fine control behavior of the valve can be changed if required.

15 steps may be programmed for lifting and lowering respectively:
 0hex, 1hex, 2hex.....Ehex
 linear.....progressive

The value for the characteristic curve form is transmitted in the configuration message in CAN mode.

▼ **Characteristic curve form**



With CAN control, the input corresponds to the flow command value. The output corresponds to the flow at the directional valve.

Time ramps

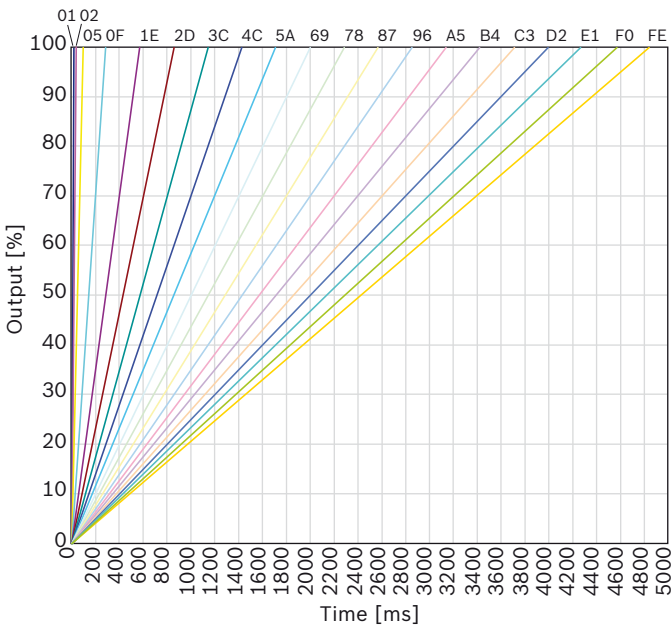
By using time ramps, the valve dynamics can be reduced in a targeted way. Ramp time is the time required to complete the entire stroke (from 0 % to 100 % or from 100 % to 0 % lifting or lowering).

255 steps may be programmed for lifting and lowering as well as switching on and off respectively.

00hex, 01hex, 02hex.....FEhex
 0, 16, 32,.....4064 ms

The values for the time ramps are transmitted in the configuration message in CAN mode.

▼ **Time ramps**



Commissioning, installation position

Notice

The valve fulfills no safety function. It may fail. The tractor manufacturer (customer) has to take suitable safety measures, if required.

Additional operating and commissioning information for block assembly and installation into the tractor:

- ▶ Do not lose or damage O-rings, support rings or the shuttle valve.
- ▶ Shock-like loads exceeding the specified values may cause invisible damages and are to be avoided at all costs.
- ▶ The valves have to be installed into the machine in such a way that mechanical damage is avoided, e.g. due to stones, etc. which could cause the housing to deform, jamming, damage actuation elements or tear off or damage cables.
- ▶ Risk of pilot pressure loss, e.g. if more oil is supplied to the system than can exit the system via the isolator valves and the control spool, inadmissible pressure peaks may be caused. Critical operating states are to be examined during commissioning.
- ▶ ESD was tested according to ISO 10605: 2008 tables C1 and C2 for category 1, see "General electric information". This standard also has to be complied with during assembly and painting.
- ▶ If a hydraulic motor is operated with a directional valve in release position, the motor can turn freely. If the hydraulic motor is turned by an external force and stopped abruptly by switching the directional valve into the blocked position, extremely high pressure peaks may be generated due to the moment of inertia of the hydraulic motor which may damage the hydraulic system. This may happen when the machine or the pilot pressure are turned off, for example. The isolator valves in the directional valve close and the control spool moves to neutral.

Installation position	Admissible rotation around the axis, vertical to the image axis ¹⁾
1	
2	
3	
4	
5	
6	

¹⁾ Please find the admissible installation positions in the applicable quotation drawings.

Related documents

Title	Document number	Document type
Control block SB23-EHS1, SB33-EHS1, EHR33-EHS1	66132-B	Operating instructions
Control block SB23-EHS1, basic document	66134-01-R	Repair instructions
Control block SB23-EHS1, assembly	66134-10-R	Repair instructions
Control valve SB23-EHS1	66134-20-R	Repair instructions
On-board electronics SB23-EHS1	66134-40-R	Repair instructions
SB23-EHS1 Interface description, hydraulics	Z 206 803 930	Technical information
SB23-EHS1 Interface description, electronics	Z 206 E00 444	Technical information
Bleeding directional valves	MH 121	Commissioning information
Supplied installation drawing/hydraulic scheme	Available from your machine or plant manufacturer	Quotation drawing
Hydraulic fluids on mineral oil basis	90220	Data sheet

Abbreviations

The following abbreviations are used in this documentation:

Abbreviation	Meaning
CAN	Controller Area Network
EHR	Electro-hydraulic lifting unit control
EHS1	Pilot operated electro-hydraulic actuating unit
LS	Load sensing
SB23	Load-sensing control block in sandwich plate design
TKU	Technical documents by the customer

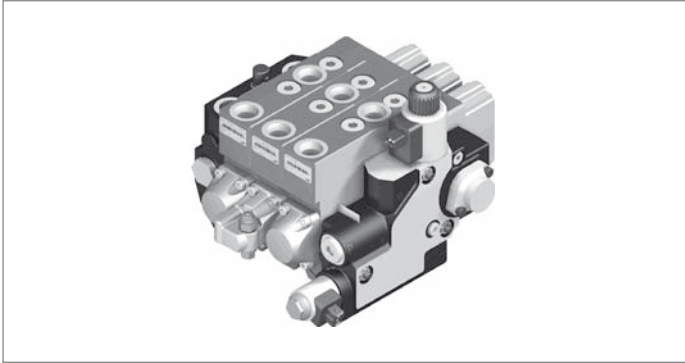
Spare parts

Contacts for accessories and spare parts

Accessories and spare parts are available

- ▶ From the vehicle manufacturer (specialty retailer),
- ▶ From the system manufacturer, and
- ▶ From your Bosch Rexroth specialty retailer.

Load-sensing control block in sandwich plate design SB33-EHS1



- ▶ Series 2X
- ▶ Maximum operating pressure 250 bar
- ▶ Flow up to 170 l/min

Features

- ▶ Load pressure-independent flow control
- ▶ Load-sensing system
- ▶ Types of actuation
 - Electro-hydraulic
- ▶ Flow
 - Load pressure-compensated
 - High repetition accuracy
 - Low hysteresis
- ▶ Optional pressure limitation contained in the subplate

Fields of application

- ▶ Tractor applications

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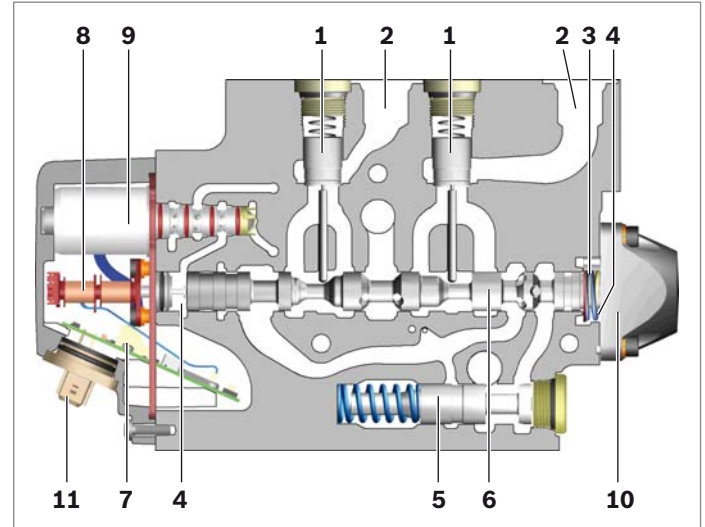
Functional description

The control block SB33-EHS1 consists of:

- ▶ Subplate
- ▶ 1 to 6 directional valves
 - Control valves SB33-EHS1
 - Hitch control valve EHR33-EHS1, EHR23-EM2
- ▶ 3 tie rods, optionally 5 tie rods
- ▶ End plate

The SB33-EHS1 is a pilot operated, electro-hydraulically actuated directional valve with 4 switching positions. The main spool is controlled via a 4/3 pilot control valve that pressurizes the actuating chambers to move the main spool. The movement of the main spool is returned to the control electronics with a position transducer. The electronics then control the main spool position via the pilot control valve current, depending on the command value. The mechanically controlled check valves in the two actuator ports act as check valves in the supply. Load compensation in the supply is carried out via the IDW. The electronics serve for position control and communication with the CAN bus. It is equipped with a diagnosis function.

▼ SB33-EHS1

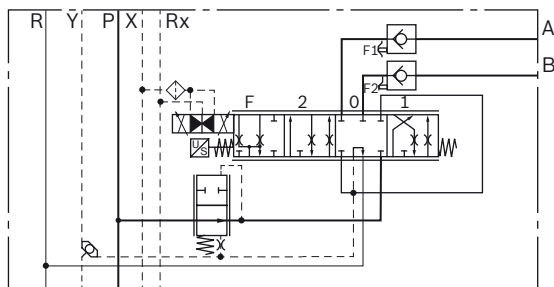


- 1 Check valves
- 2 Actuator ports
- 3 Return springs
- 4 Actuating chamber
- 5 Individual pressure compensator
- 6 Main spool
- 7 Electronic unit
- 8 Position transducer
- 9 Pilot control valve
- 10 Spring cap or spring cap with manual auxiliary actuation
- 11 CAN control

Electro-hydraulically controlled LS directional valve

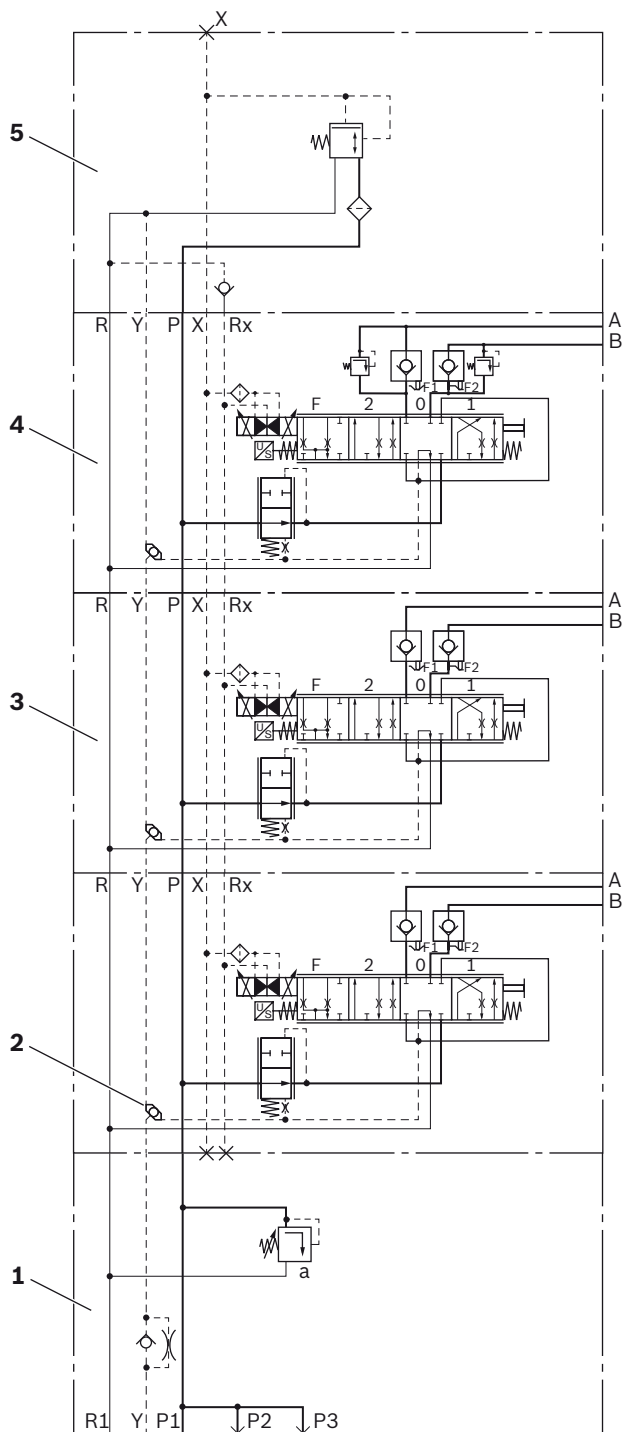
- ▶ Double-acting with 4 switching positions
- ▶ Mechanically operated check valves in A and B
- ▶ 2-way individual pressure compensator in the supply
- ▶ Optional flange surface for customer-specific coupling housings
- ▶ Check valves are open in release without load pressure

▼ **Electro-hydraulic directional valve**



Ports	
P	Pump
A, B	Actuator
X	Pilot oil supply
Rx	Pilot oil return
Y	LS signal
R	Tank for return flow

▼ **Control block SB33 (example)**



- 1 Subplate
- 2 Shuttle valve for load pressure selection
- 3 Directional valve, double-acting, with 2-way pressure compensator, with check valves, mechanically operated
- 4 Directional valve with manual auxiliary actuation, thermal pressure relief valve
- 5 End plate with coarse filter

Technical data

general				
Weight	Subplate		kg	5.4
	Directional valve SB33-EHS1		kg	9.0
	End plate		kg	6.3
Installation position	See page 26			
Line connections	Screw-in thread and/or flange connection, see page 8			
Fastening	Thread in the subplate (standard: M8)			
Ambient temperature range	θ	°C	-35 to +110	
hydraulic				
Maximum operating pressure at the port	P	p_{\max}	bar	250
	A, B	p_{\max}	bar	250
	R, Rx	p_{\max}	bar	20
	X	p_{\max}	bar	50
Flow at the port	P → A, B	$q_{v \text{ rated}}$	l/min	100, 140, 170
	A, B → R	$q_{v \text{ max}}$	l/min	200, 250
Leakage	A, B → R	q_L	ml/min	≤2 with check valves in A, B
Hydraulic fluid	<ul style="list-style-type: none"> ▶ Mineral oil-based hydraulic oil according to DIN 51524 ▶ HLP according to DIN 51524 ▶ Hydraulic oils HVLP 32/46/68 according to DIN 51524 ▶ HD SAE 10 W 40 ▶ HETG Fuchs Plantohyd 40/Fragol TR46 ▶ HEPG Fuchs Renolin PG ▶ HEES Fuchs Plantosyns Super S40/Fragol Hydraulic HE 15+46 ▶ Motor oils according to API-C ▶ Motor oils according to API-CD ▶ Motor oils according to API-CF ▶ Colorant Renolin FST 101 Other hydraulic fluids such as STOU/UTTO multi-purpose oils on request.			
Hydraulic fluid temperature range	Admissible range	θ	°C	+35 to +110; +125 for a short time
	Admissible range for start	θ	°C	-35
Viscosity range	Admissible range	ν	mm ² /s	7 to 500
	Recommended range	ν	mm ² /s	20 to 100
	Admissible range for start	ν	mm ² /s	8000
Max. admissible degree of contamination of the hydraulic fluid	Cleanliness class according to ISO 4406 (c)	Class 20/18/15, for this we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$		
	Cleanliness class according to SAE AS 4059	Class 10A/10B/9C		
Thermal pressure relief valve optionally integrated into the check valve	Cracking pressure at 150 ml/min, 33 mm ² /s		bar	242 to 293
Spring cap with manual auxiliary actuation	<ul style="list-style-type: none"> ▶ Active bi-directional, mechanical operation of the main spool ▶ Possibility to block the main spool in the neutral position ▶ Actuating torques (see quotation drawing) 			

electro-hydraulic			
Relative duty cycle			100% duty cycle to +110 °C ¹⁾
Protection class			IPX6, IPX9K (with connected CAN connector)
Plug-in connection			Compact connector or jet connector
Electrical power consumption	p_{max}	W	17 with 12 V system
Voltage supply	U_{rated}	V	12 vehicle on-board power supply ISO 16750-2: Code C (24 V on request)
Actuating time for 100% deflection			See actuating time/dynamics
Pilot oil pressure		bar	18 ^{±1} , referring to the return flow pressure
Pilot flow per directional valve	Neutral	l/min	0.25
	Control position lifting/lowering	l/min	0.6
	With max. actuating speed for a short time	l/min	4.4
Actuating time/dynamics	Step function (incl. dead time)		0 to 100% from position 0 to position 1 or 2: Approx. 50 ms
			0 to position F: Approx. 70 ms 50 °C, 30 mm ² /s, VG46, for the average valve actuating time taking viscosity into account, see Z 206 803 930 EHS1 interface description
Hysteresis regarding flow			Typically approx. 1% of q_{rated} (in flow range up to 80% of q_{rated})

Notice

- ▶ For applications outside these parameters, please consult us.
- ▶ The technical data were determined at a pressure of $p = 125$ bar, a viscosity range of $\nu = 33$ mm²/s and a temperature of $\theta = 50$ °C.
- ▶ For additional technical data, see
 - Interface description Z 206 804 877

¹⁾ Detailed information is available on request.

Pressure compensator

14	2-way individual pressure compensator	C30
----	---------------------------------------	------------

Flange side ports

15	Basic flange figure	BC
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Pilot oil line

16	Seal diameter 11.4 mm	2
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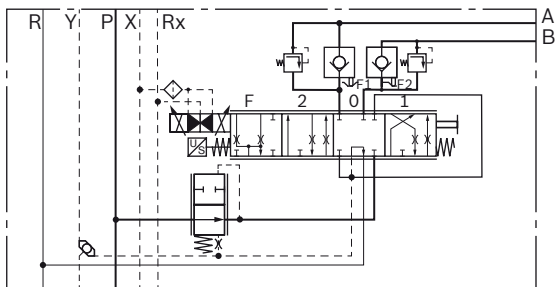
Connector

17	Bosch compact connector	K
	Jet connector	J

Order overview

Directional valves

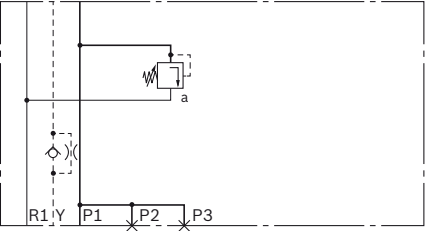
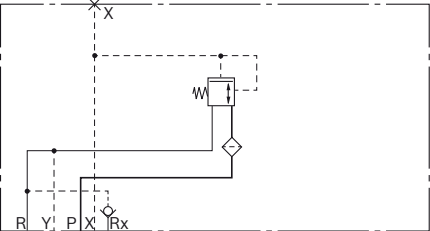

Type	Ports/ version ¹⁾	Comments	Material number
SB33-EHS1	A, B = M22 x 1.5	Flow $q_v = 140$ l/min Optional: <ul style="list-style-type: none"> ▶ Manual auxiliary actuation of the main spool ▶ Thermal pressure relief valve ▶ Compact connector ▶ M6 coupling flange ▶ 5 tie rods 	R917... ²⁾



1) For the design variations, see chapter "Line connections" on page 8

2) Please consult us regarding the technical issues and requirements

Subplates, sandwich plates and end plates

Type	Ports/ version ¹⁾	Comments	Material number
SBx3-EHS1, subplate for variable displacement pump	 <p>P1 = M27 x 2 / III P2 = M27 x 2 / III P3 = M10 x 1 / I R1 = M33 x 2 / III Y = M12 x 1.5</p>	<ul style="list-style-type: none"> ▶ With pressure relief valve ▶ P2 port closed ▶ P3 port open ▶ Screw-in thread for tie rod ▶ Mounting bases with M8 thread ▶ For control blocks with EHR23-EM2: Allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y 	R917007235
SBx3-EHS1, end plate for variable displacement pump	 <p>X: M12 x 1.5 / III</p>	<ul style="list-style-type: none"> ▶ 18 bar pilot pressure (fixed) ▶ Control pressure port: Port X closed; with sintered stainless steel filter element in line P ▶ Optionally with fine filter 	R917007578
SBx3-EHS1, sandwich plate		<p>Plate width: L = 13 mm</p> <p>Plate width: L = 15 mm</p> <p>Plate width: L = 22 mm</p>	<p>R917005302</p> <p>R917006220</p> <p>R917007130</p>

Line connections

Version I

DIN 3852-1, DIN 3852-2

- ▶ For seal ring sealing

Version II

ISO 11926-1

- ▶ For O-ring sealing

EN ISO 6149-1

- ▶ Without threaded hole marking
- ▶ For O-ring sealing

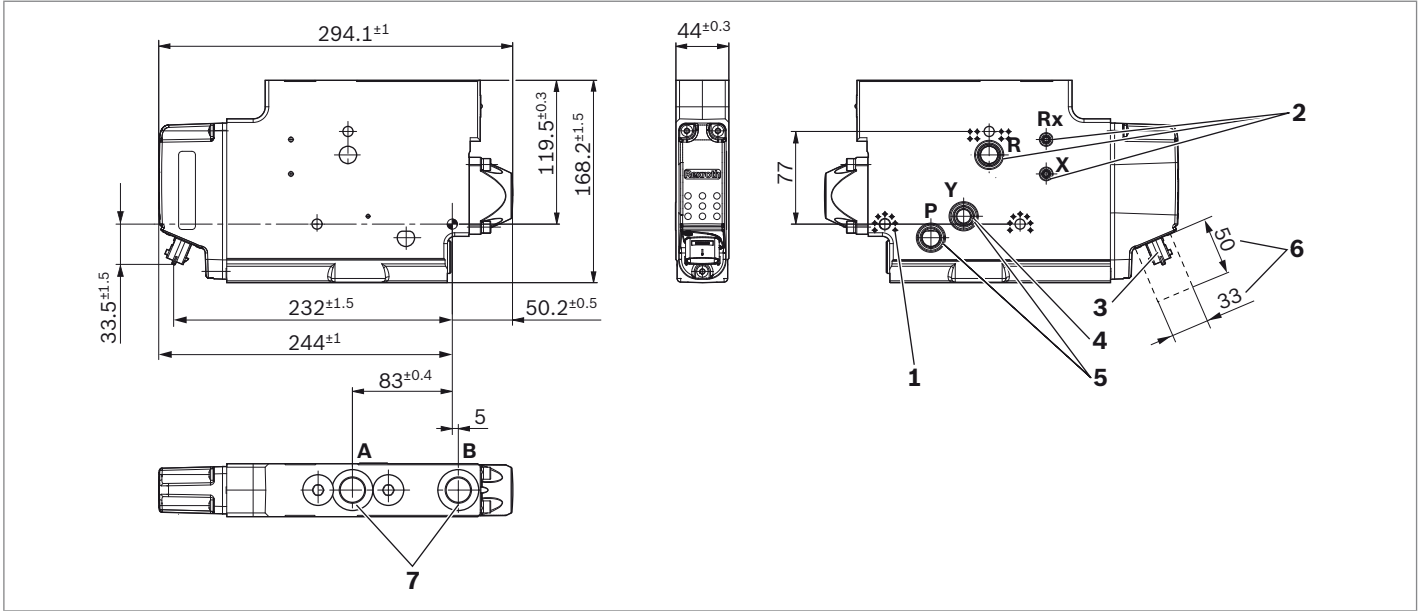
Version III

EN ISO 6149-1

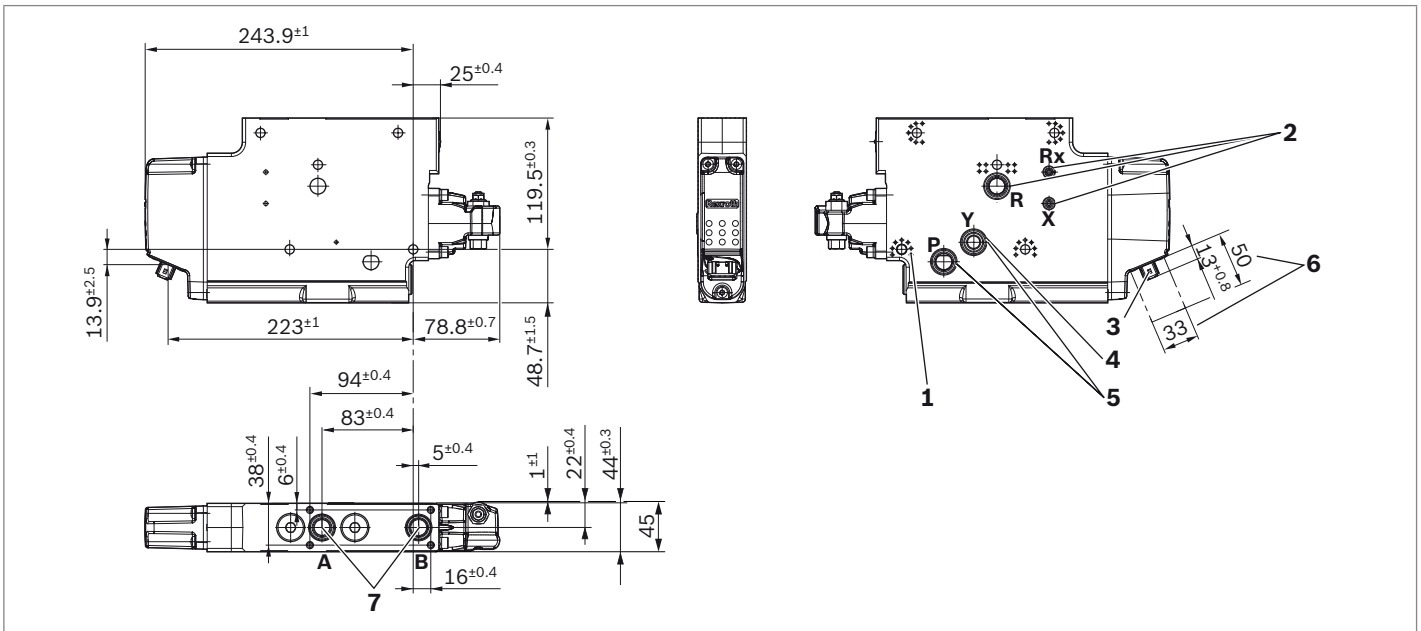
- ▶ With threaded hole marking
- ▶ For O-ring sealing

¹⁾ For the design variations, see chapter "Line connections" on page 8

▼ Control valve SB33-EHS1, standard with compact connector, R917...¹⁾



▼ Control valve SB33-EHS1, with 5 tie rods, manual auxiliary actuation, M6 flange connection, R917...¹⁾

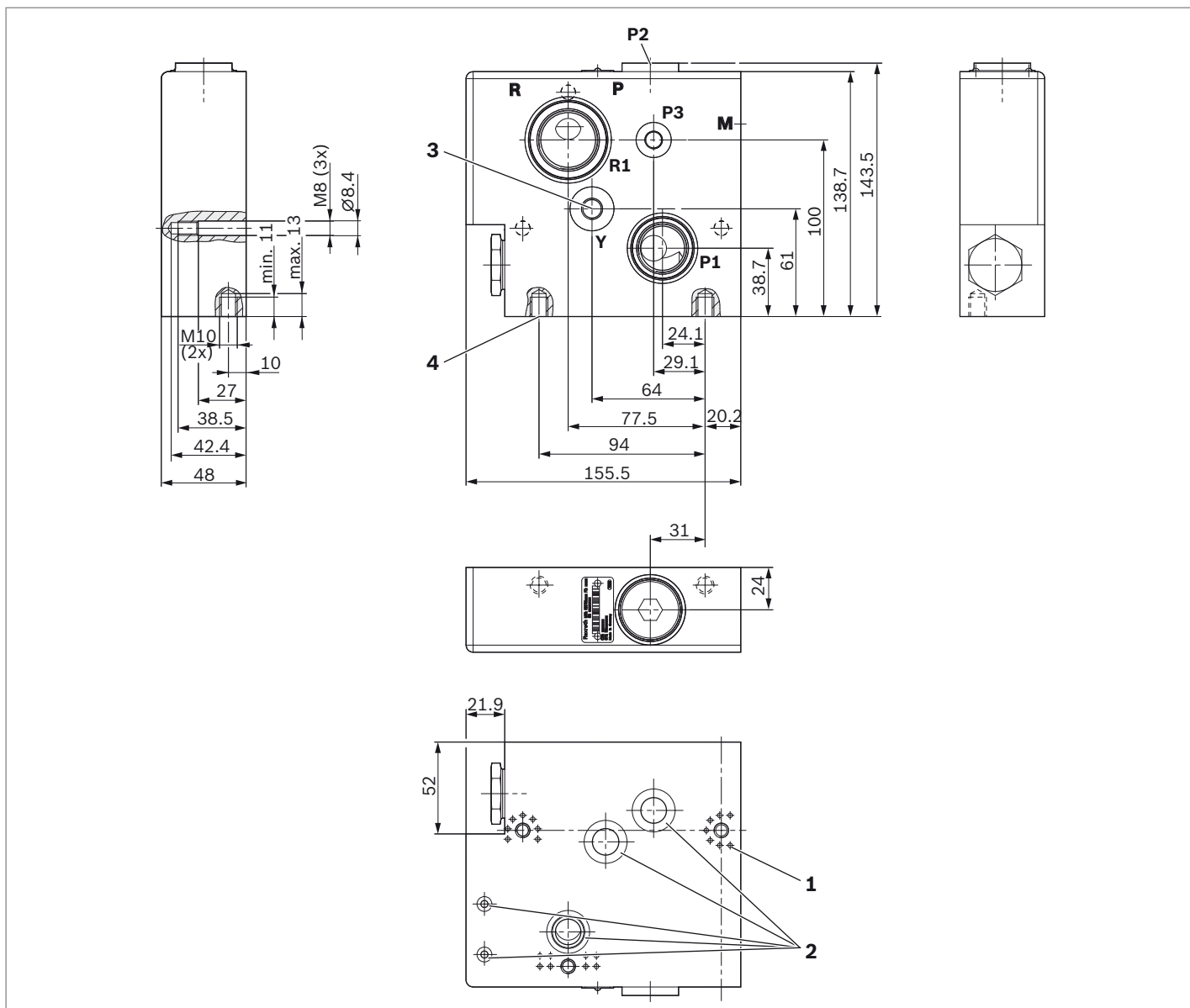


- 1 Embossed
- 2 O-ring is included in the scope of delivery
- 3 Remove protective cap R917001694 prior to connecting
- 4 Shuttle valve is included in the scope of delivery
- 5 O-ring and support ring are included in the scope of delivery
- 6 Recommended minimum connector handling space
- 7 M22 x 1.5

¹⁾ Please consult us regarding the technical issues and requirements

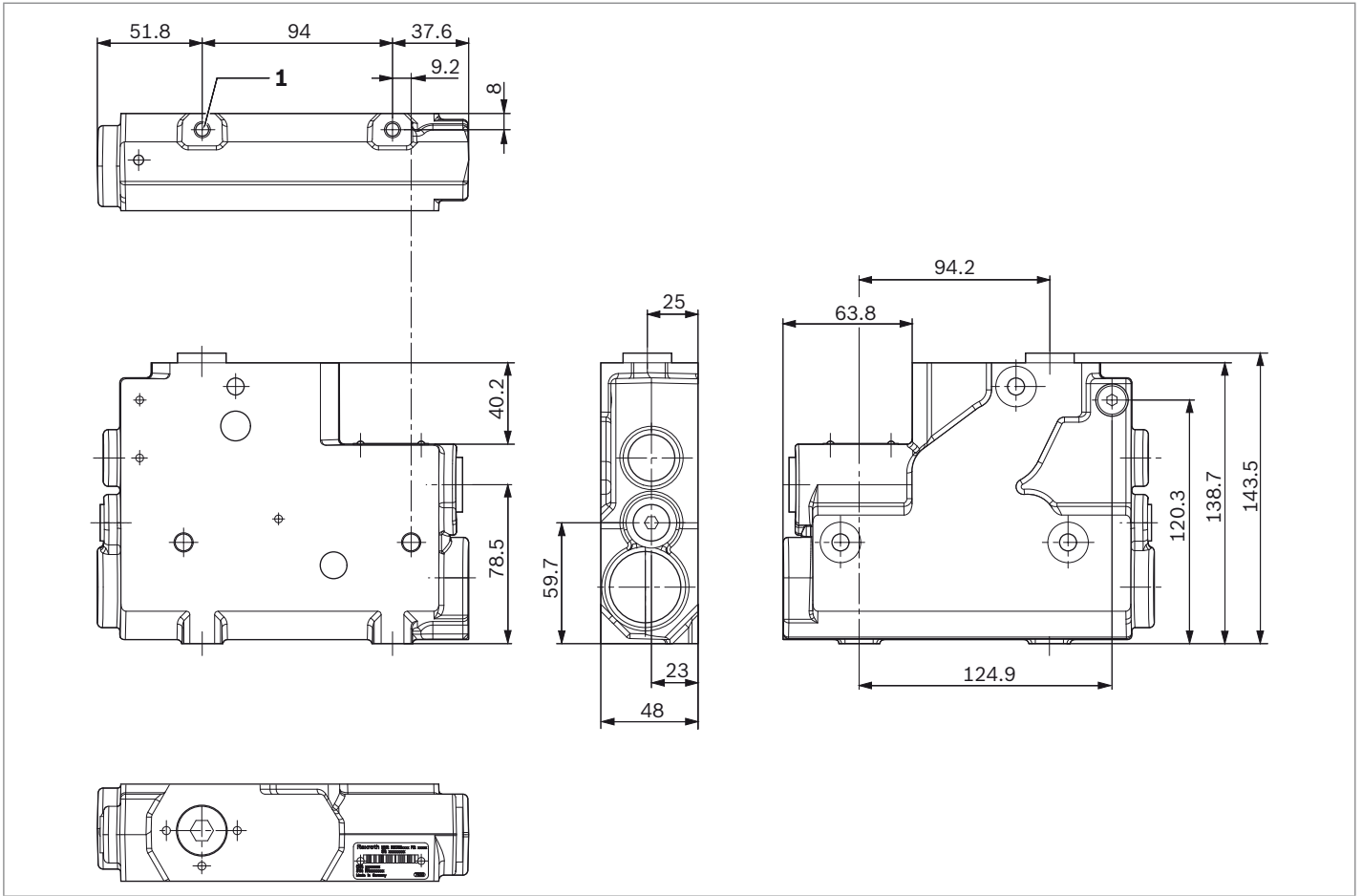
Subplates, sandwich plates and end plates

▼ Subplate for variable displacement pump, R917007235



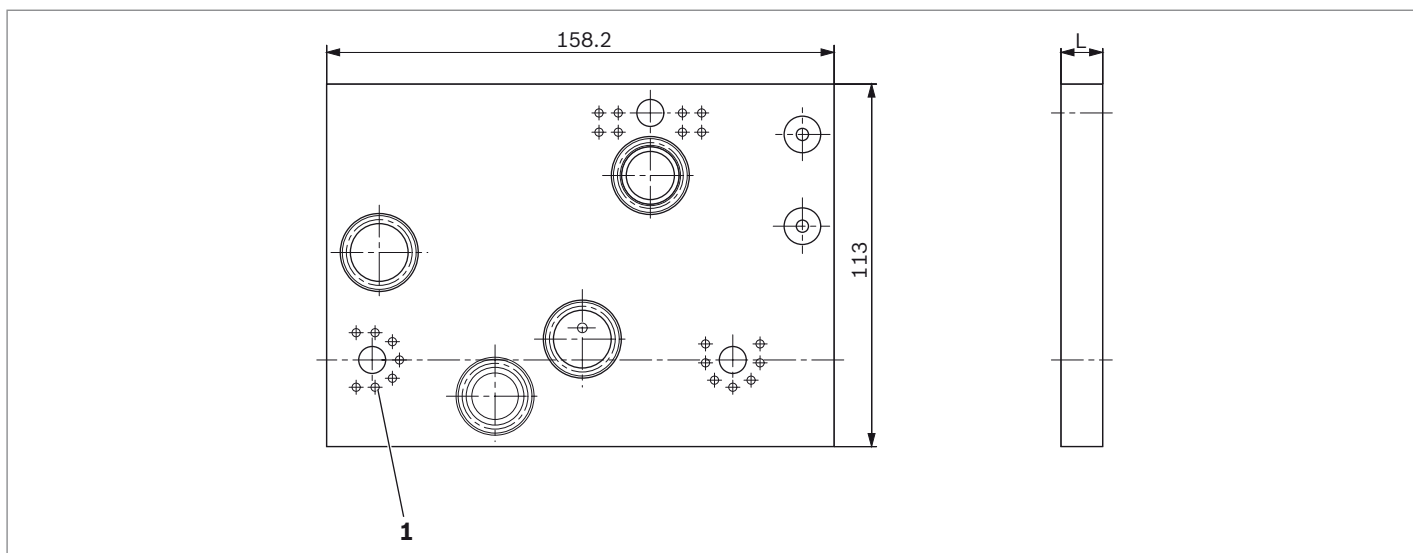
- 1 Embossed
- 2 Seal rings are included in the scope of delivery
- 3 For control blocks with EHR23-EM2:
Allow for throttle check valve (material no. 1527410132 or 1527410106) in port Y
- 4 Two M10 mounting threads

▼ End plate for variable displacement pump, R917007578



1 Two M8 mounting threads, 13 deep

▼ Sandwich plate



1 Embossed

Material number	Dimension L [mm]
R917005302	13
R917006220	15
R917007130	22

Tie rod

If a subplate is used			
End plate		R917007235	
Directional valve Length L [mm]		Tie rods Material number	
Tie rod length [mm]			
Von	To		
40	42	1 523 502 096	131
44	44	R917000013	133
80	80	1 523 502 097	171
91	98	R917000538	187
99	106	1 523 502 087	195
107	114	R917005260	203
115	122	1 523 502 098	211
128	133	1 523 502 125	223
140	145	1 523 502 088	235
146	149	R917005261	239
156	161	1 523 502 099	251
162	167	R917003101	257
168	172	R917005949	263
174	178	R917004775	269
180	184	1 523 502 089	275
196	200	1 523 502 100	291
209	212	1 523 502 129	304
215	218	R917005950	310
220	223	1 523 502 090	315
236	239	1 523 502 101	331
249	251	1 523 502 130	344
260	262	1 523 502 091	355
276	278	1 523 502 102	371

Assembling the control block in the machine

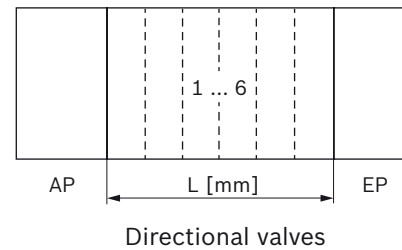
Control block SB33-EHS1 consists of:

- ▶ Subplate
- ▶ 1 to 6 directional valves
- ▶ 3 tie rods, optionally 5 tie rods
- ▶ End plate

The subplate, directional valves and end plate are held by tie rods during control block assembly.

The control block is mounted at the subplate and/or the end plate in the machine.

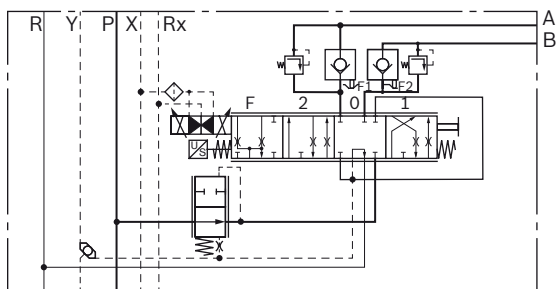
The number of mounting points and the number of tie rods depend on the number of directional valves and the vibration load to be expected in the machine. At least three tie rods are necessary to hold a control block. Depending on the load, five tie rods might be necessary.



Hydraulic functions

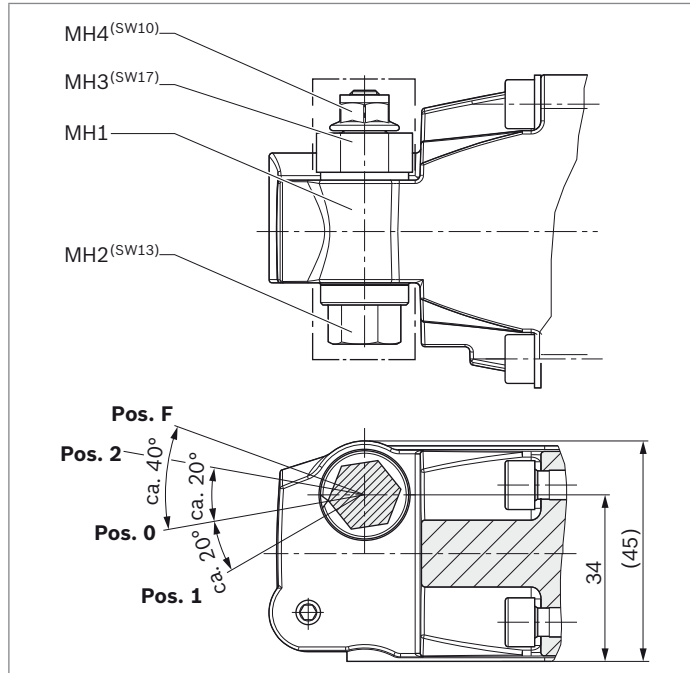
Standard	Optional
Check valve for oil flow from A, B to R	
Actuator ports/threaded ports: M22 x 1.5 / ISO 6149, O-ring sealing	M22 x 1.5 / DIN 3852, profile seal ring Quick-release couplings: Fange surface for coupling housing with M6 mounting thread preferred, optionally M8
Spring cap	Manual auxiliary actuation
Main spool with 4 switching positions	Varying oil flows
2-way individual pressure compensator	Thermal pressure relief valve: Integrated into the check valve for ports A and B. It prevents excessively high pressure build-up resulting from thermal expansion in an enclosed volume.
Position sensor for position control of the main spool and for diagnostic purposes	

▼ **SB33-EHS1 with manual auxiliary actuation and thermal pressure relief valve**



Manual auxiliary actuation for directional valve spool (optional)

- ▶ Mechanical manual actuation
- ▶ Can be operated with standard tools (hexagon SW13)
- ▶ It is possible to lock the main spool in neutral position



Notice

Valves with manual auxiliary actuation need to be mechanically operated after painting. The actuating force required to break open the paint between the turning actuating shaft and the housing might be too great for electro-hydraulic operation.

The arrangement of the valves in the tractor has to be selected so that no dirt can accumulate at the actuating shaft that could jam the main spool.

Normal operation	MH3 against MH4
Actuation	MH2 without pilot pressure, $M_A = 4^{\pm 1.0}$ Nm MH2 against pilot pressure, $M_A = 7^{\pm 1.0}$ Nm
Clamping	MH3 against MH1, $M_A = 20$ Nm
Resuming normal operation	MH4 against MH2, $M_A = 9$ Nm

Pilot oil supply

This is no component of the directional valve (block or system component).

Pilot flow requirement per SB33 directional valve

Values at a viscosity of 30 mm²/s:

In neutral position:	Typically 250 ml/min, maximum 460 ml/min
When lifting or lowering:	Typically 600 ml/min, maximum 900 ml/min
In release:	Typically 250 ml/min, maximum 460 ml/min
During step function (lifting or lowering):	Typically 3.5 l/min (actuating time approx. 40 ms, no time ramp)
During step function (release):	Typically 4.4 l/min (actuating time approx. 75 ms)

Peak demands of pilot oil can be limited by preventing simultaneous activation of several actuators (delay by actuating time + safety distance) or programming the time ramps.

Control pressure referencing

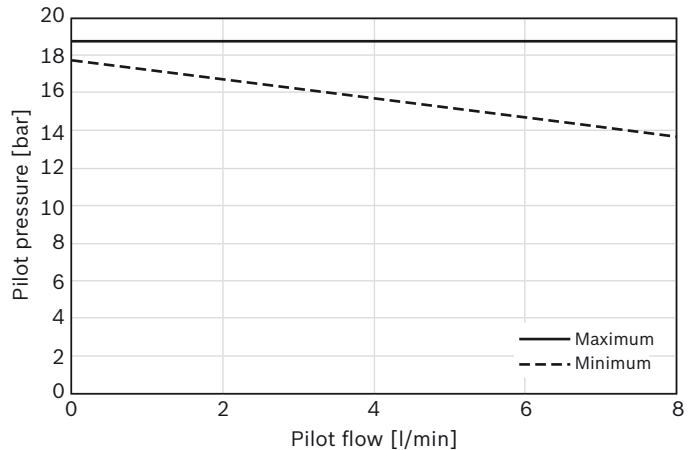
The pilot oil pressure p_x has to be referenced to the pilot oil return flow. As an alternative, provide for depressurized pilot oil return flow.

Pilot pressure

$$p_x = 18^{\pm 0.8} \text{ bar}$$

(adjustment point with a pilot flow from 0.8 to 1.2 l/min)

The pilot pressure according to the graph has to be completely available to the SB33 valves. Otherwise, complete valve performance is not guaranteed.

▼ Pilot pressure characteristic curve**Pilot oil fine filter**

Oil cleanliness is particularly important with pilot oil supply. Use an additional pilot oil fine filter if required.

Flows

Standard valve flow variants:

- ▶ Standard:
 - P** → **A, B** = 140 l/min,
 - A, B** → **R** = 250 l/min
- ▶ Optionally:
 - P** → **A, B** = 100 l/min / = 170 l/min,
 - A, B** → **R** = 200 l/min / = 250 l/min

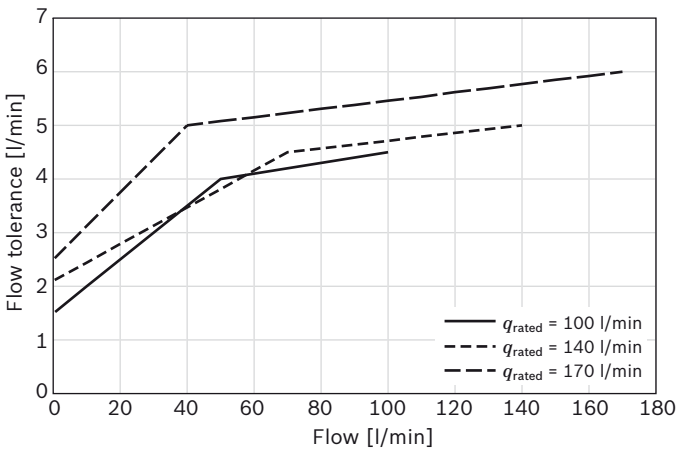
Unless specified otherwise, the following data apply to an oil viscosity of $\nu = 30 \text{ mm}^2/\text{s}$.

Flow tolerance

The tolerance curves are applicable to the supply flow in a standard comparison.

Other comparisons (return flow) are possible. The tolerances of special versions may deviate.

▼ **Characteristic curve of the flow tolerance**



Hysteresis

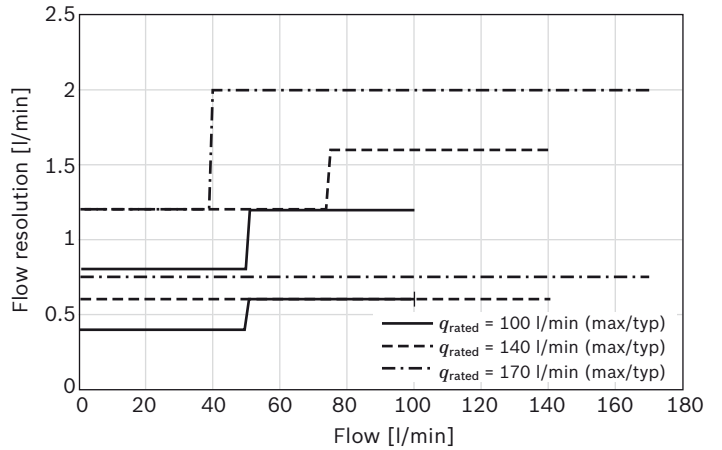
Regarding flow: typically approx. 1% of q_{rated} (in a flow range of up to 80% of q_{rated})

Flow resolution

The characteristic curves are applicable to the supply flow in a standard comparison.

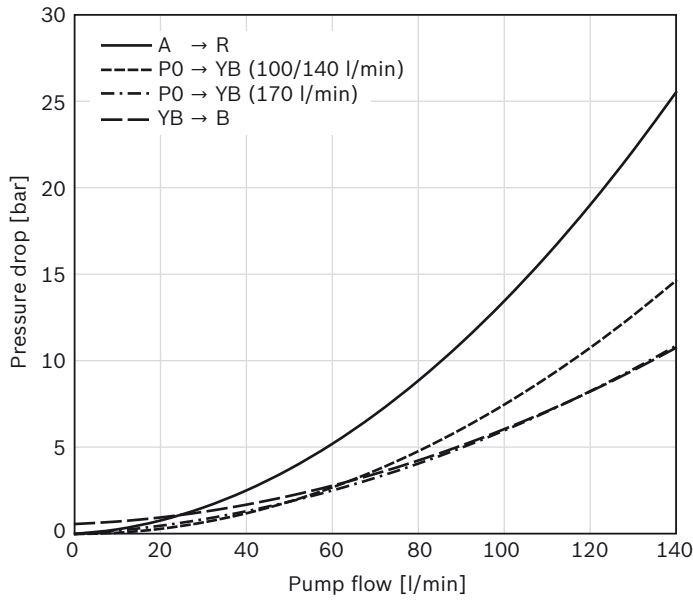
The tolerances of special versions may deviate.

▼ **Characteristic curve of flow resolution**

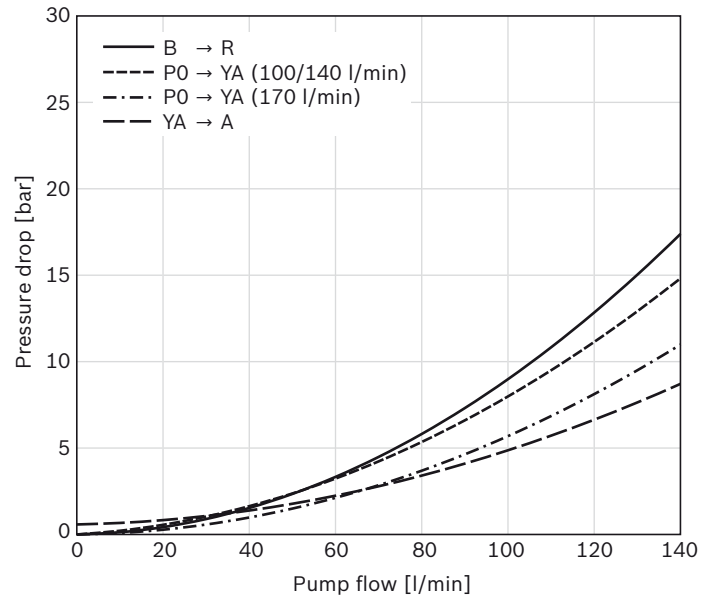


Flow resistance (typical values)

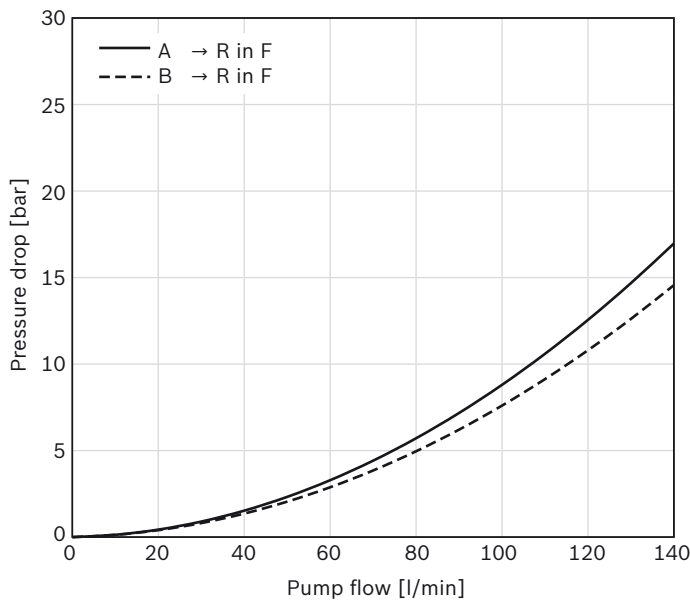
▼ **Position 1 (lifting)**



▼ **Position 2 (lowering)**



▼ **Position F (release)**



Flow temperature drift

The temperature dependence of the flow is electronically compensated in the temperature range of 30 °C to 90 °C.

Flow pressure drift

The pressure drift of the flow (pressure increase due to parallel operation) is compensated by the IDW.

Internal leakage

A, B to R

- ▶ In neutral position: <math>< 2 \text{ cm}^3/\text{min}</math>

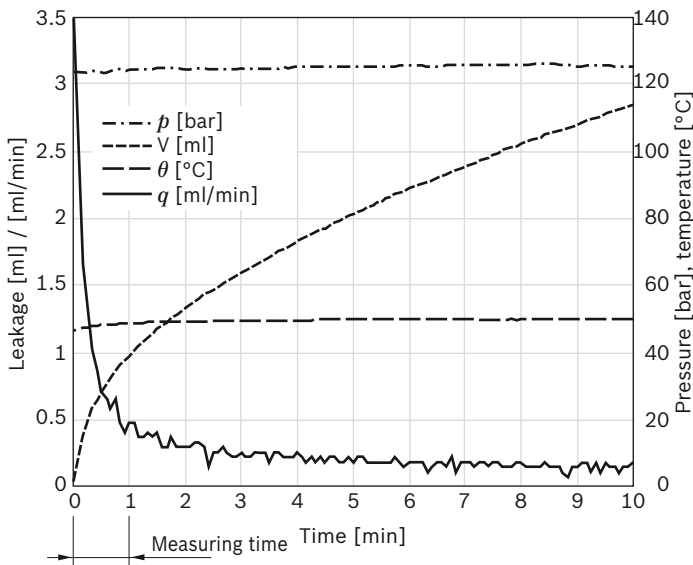
There are higher values for variants with:

- ▶ Thermal pressure relief valve: $\sim +0.3 \text{ cm}^3/\text{min}$

Notice

Measured at $p = 125 \text{ bar}$, $v = 30 \text{ mm}^2/\text{s}$, $\theta = 50 \text{ }^\circ\text{C}$,
 $t_{\text{waiting time}} = 15 \text{ s}$, $t_{\text{measuring time}} = 60 \text{ s}$.

▼ **Typical leakage behavior, leakage behavior with time at the check valve**



Leakage P to R in various switching positions

- ▶ P → R in position 0: 60 cm³/min (typical), 110 cm³/min (max.)
- ▶ P → R in position 1, 2: 250 cm³/min (typical), 450 cm³/min (max.)
- ▶ P → R in position F: 60 cm³/min (typical), 200 cm³/min (max.)

There may be higher values for special spool variants.

- ▶ Y → R all positions: 60 cm³/min (typical), 110 cm³/min (max.)

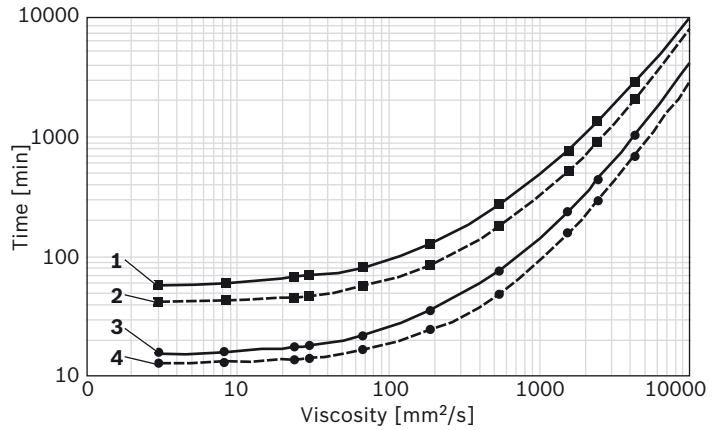
Notice

Measured at $p = 200 \text{ bar}$, $v = 30 \text{ mm}^2/\text{s}$, $\theta = 50 \text{ }^\circ\text{C}$.

Actuating time/dynamics

Corner frequency regarding spool travel is approx. 17 Hz for a command value modification from 0 to 100%

▼ **Characteristic curve of the step function**



- 1 Actuating time: Neutral after release
- 2 Actuating time: Neutral after lifting/lowering
- 3 Dead time: Neutral after release
- 4 Dead time: Neutral after lifting/lowering

Electric functions

Standard: CAN control

Optional: PWM (pulse-width modulated voltage signal) on request

General electric information																		
Supply voltage	As a standard with 12 V vehicle on-board power supply; on request: 24 V																	
Overtoltage protection	Supply: 48 V for 5 min																	
Reverse polarity protection	Test voltage -48 V for 5 min																	
Short-circuit protection	Short-circuit protected against 36 V, against ground, and between the individual inputs and outputs.																	
Protection class	IP69K (electronics), with connected mating connector																	
Electromagnetic interference	ISO 11452-2 Measurement of electromagnetic interference 0.2 Mhz to 1000 Mhz, frequency according to ISO 14982: 1998 Reference values: ▶ Absorber chamber 100 V/m ▶ Stripline 150 V/m																	
Electromagnetic emissions	ISO 14982: 1998																	
ESD	ISO 10605: 2008 Unpowered test: Relay discharge: ±8 kV, air discharge ±15 kV, $R_i = 2000 \Omega$, $C = 150 pF$ (table C1, category 1) Powered up test: Relay discharge: ±8 kV, air discharge ±15 kV, $R_i = 2000 \Omega$, $C = 330 pF$ (table C2, category 1)																	
Conducted interferences	ISO 7637-2:2004																	
Electrical power consumption	<table border="1"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">$U_{Bat} = 14 V$</th> </tr> <tr> <th>Typ. [W]</th> <th>Max. [W]</th> </tr> </thead> <tbody> <tr> <td>In neutral position</td> <td>0.4</td> <td>0.6</td> </tr> <tr> <td>With max. regulating speed</td> <td></td> <td>12</td> </tr> <tr> <td>In switching or interim position</td> <td>3.6</td> <td>5.0</td> </tr> <tr> <td>In release</td> <td>6</td> <td>12</td> </tr> </tbody> </table>		$U_{Bat} = 14 V$		Typ. [W]	Max. [W]	In neutral position	0.4	0.6	With max. regulating speed		12	In switching or interim position	3.6	5.0	In release	6	12
	$U_{Bat} = 14 V$																	
	Typ. [W]	Max. [W]																
In neutral position	0.4	0.6																
With max. regulating speed		12																
In switching or interim position	3.6	5.0																
In release	6	12																
Input signal	CAN, physical layer according to ISO 11898 "High Speed", standard transmission rate of 250 kBaud																	
Pin assignment	<table border="1"> <thead> <tr> <th>Compact connector</th> <th>Jet connector</th> </tr> </thead> <tbody> <tr> <td>Pin 1 = ground</td> <td>Pin 1 = U_{Bat}</td> </tr> <tr> <td>Pin 2 = CAN high</td> <td>Pin 2 = CAN low</td> </tr> <tr> <td>Pin 3 = CAN low</td> <td>Pin 3 = CAN high</td> </tr> <tr> <td>Pin 4 = U_{Bat}</td> <td>Pin 4 = ground</td> </tr> </tbody> </table>	Compact connector	Jet connector	Pin 1 = ground	Pin 1 = U_{Bat}	Pin 2 = CAN high	Pin 2 = CAN low	Pin 3 = CAN low	Pin 3 = CAN high	Pin 4 = U_{Bat}	Pin 4 = ground							
Compact connector	Jet connector																	
Pin 1 = ground	Pin 1 = U_{Bat}																	
Pin 2 = CAN high	Pin 2 = CAN low																	
Pin 3 = CAN low	Pin 3 = CAN high																	
Pin 4 = U_{Bat}	Pin 4 = ground																	
Sinus vibration test	DIN EN 60068-2-6, 10 Hz – 2000 Hz, 57.5 → 2000 Hz, 6.93 g rms 10 Hz → 57.5 Hz, 1.5 mm pp																	
Broadband noise test	DIN EN 60068-2-64, 5 Hz – 2000 Hz, $a_{eff} 86.9 m/s^2$																	
Shock test	DIN EN 60068-2-27, $a = 500 m/s^2$, 11 ms, 60 cycles DIN EN 60068-2-29, $a = 400 m/s^2$, 6 ms, 300 cycles																	

Reading error codes with EHS diagnostic tool, error interpretation

The EHS diagnostic tool is a software that was specifically designed to detect errors in EHS systems in the vehicle or in the test stand. The diagnostic tool is used to identify and diagnose individual valves or all valves in the block/tractor. The characteristics and error memories of the valves can be read via RS232 (only individual valves) or CAN (all valves). The baud rate is fixed at 9600 Bd with RS232. With CAN, the baud rate is determined automatically.

Notice

Fail-safe: In case of power failure, short-circuit or oil supply failure, the actuating unit automatically sets the main spool to neutral (the spool is spring-centered).

Overview on internal diagnosis

Special protection measures against malfunctions due to contamination, material defects, etc. are not provided. The device does not fulfill any safety functions without the user taking additional measures.

Error detection	Error	Error reaction	
Internal errors	Main spool is not in neutral position during switch on	▶ CAN: Diagnostic message via CAN bus Attention: There may be uncontrolled load movements, the system has to be shut off.	
	Spool valve is deflected too little	▶ Valve is switched to neutral, optionally there is only an error message.	
	The main spool is deflected too far and/or does not return to neutral (e.g. spool is retained or stuck)	▶ If it cannot be switched into the opposite direction, the actuating unit is de-energized. ▶ CAN: Diagnostic message via CAN bus Attention: There may be uncontrolled load movements, the system has to be shut off.	
	Defective position transducer	▶ The valve is not actuated	
	Defective current measurement	▶ The valve is not actuated	
	Defective output stage	▶ The valve is not actuated	
	Checksum error regarding	▶ The valve is not actuated	
	▶ Main program	▶ Checksum test, optionally only error message or shut-off	
	▶ EEPROM customer area		
	RAM error	▶ Checksum test, optionally only error message or shut-off	
	Computer error	▶ Error due to noise pulses: Restart is only permitted if the command value was set to neutral before. ▶ Other computer errors: CAN: Diagnostic message via CAN bus Attention: There may be uncontrolled load movements, the system has to be shut off.	
	External errors	Supply voltage is below the admissible range	▶ The valve is not actuated (for CAN: If it is above the Bosch limit, only an error message is created as an option)
		Supply voltage is above the admissible range	▶ The valve is not actuated (for CAN: If it is below the Bosch limit, only an error message is created as an option)
Command value voltage is below the admissible range		▶ The valve is not actuated	
Command value voltage is above the admissible range		▶ The valve is not actuated	
No command value message (only for CAN)		▶ The valve is not actuated	
Implausible command value message (only for CAN)		▶ The valve is not actuated	
No configuration message (only for CAN)		▶ The valve is not actuated	
Manual actuation (using the hand lever of the valve)		▶ Valve remains switched off, no counter-reaction, no electric actuation possible	
Visual error display	Diagnostic LED in the connector	The flashing code displays the error type (see flashing code)	
CAN error diagnosis	The error is transmitted via CAN using an error code Immediately when the error occurs, the diagnostic message is sent up to 5 times, and then every 100 ms (can be adjusted). The error code is transmitted (see description of the CAN messages).		

General information on the CAN control

The EHS valve can be easily actuated via the CAN interface. Using a message, the operating modes "neutral", "lifting", "lowering", "release" and the flow command value can be set. Using a second message, characteristic curve form, characteristic curve rise and ramp times may be set separately for "lifting" and "lowering". At the same time, the valve can report any errors in detail to the superior operating unit using the error code.

Furthermore, the valve can be permanently reprogrammed using the parameterization messages (CAN baud rate and identifier, battery voltage limits, valve number, etc.).

General CAN settings

	Standard setting
Baud rate	250 kBaud, up to ≤ 1 MBaud is possible
Scanning	Single scan
Scan time	At $\frac{3}{4}$ of the bit length
Synchronization edges	Only edges from recessive to dominant
size of synchronization steps	SJW = 1 BTL cycles

Notice

The maximum baud rate always has to be tested in the vehicle and is determined by:

- ▶ Data traffic in the bus
- ▶ Efficiency of the internal hardware identifier filter which is determined by e.g.
 - Assignment of CAN identifiers that do not concern the valves
 - CAN identifier set, see TKU: Z 206 E00 444

Characteristic curves for command value generation and time ramps

Characteristic curve rise

Due to the characteristic curve rise, the degree of valve opening can be reduced linearly from 100% to 0%.

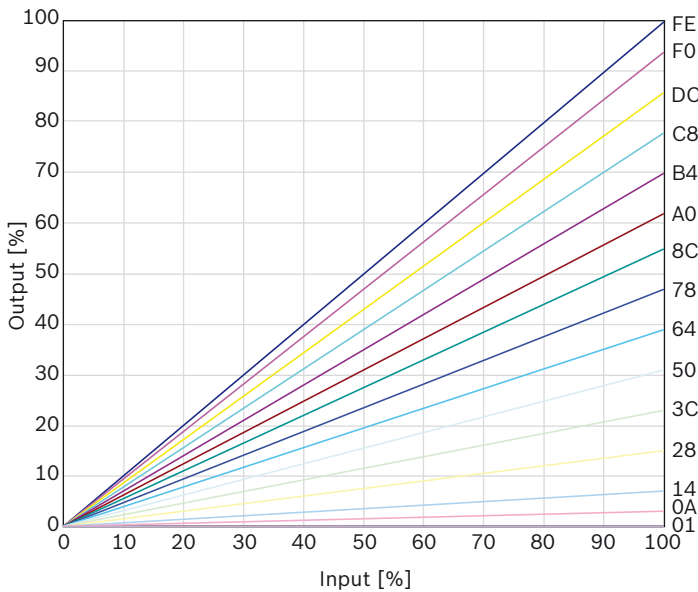
255 steps may be programmed:

00hex, 01hex, 02hex.....FEhex

0%, 0.39%, 0.78%, ...100%

The value for the characteristic curve rise is transmitted in the configuration message in CAN mode. In the PWM mode, it is stored in the EEPROM of the valve and can be programmed. The standard setting is 100%. The characteristic curve rise should be selected with the values shown.

▼ Characteristic curve rise



With CAN control, the input corresponds to the flow command value. With PWM control, input = 0...100% corresponds to a PWM duty cycle of 53...85% for lowering and 47...15% for lifting (with standard characteristic curve corner points). The output corresponds to the flow at the directional valve.

Characteristic curve form

The characteristic curve form may be changed from linear to highly progressive. Doing this will allow the fine control behavior of the valve to be changed if required.

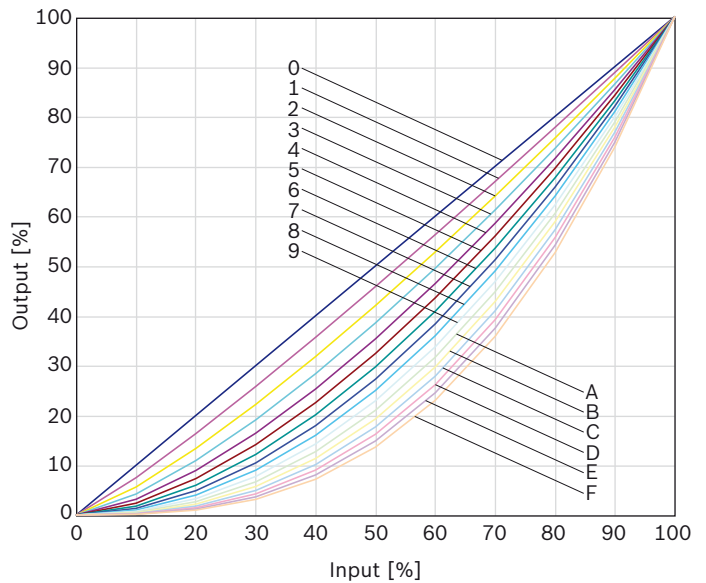
15 steps may be programmed for lifting and lowering respectively:

0hex, 1hex, 2hex.....Ehex

Linear.....progressive

The value for the characteristic curve form is transmitted in the configuration message in CAN mode. In the PWM mode, it is stored in the EEPROM of the valve and can be programmed.

▼ Characteristic curve form



With CAN control, the input corresponds to the flow command value. With PWM control, input = 0...100% corresponds to a signal voltage and/or a PWM duty cycle of 53...85% for lowering and 47...15% for lifting (with standard characteristic curve corner points). The output corresponds to the flow at the directional valve.

Time ramps

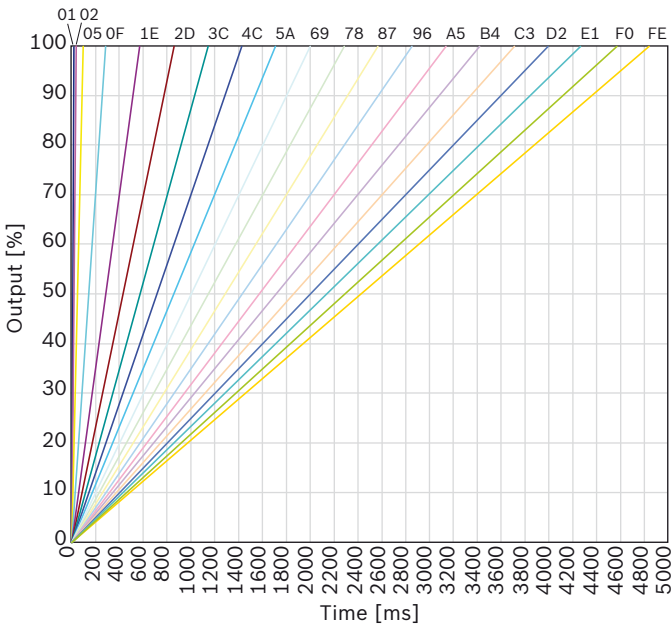
By using time ramps, the valve dynamics can be reduced in a targeted way. Ramp time is the time required to complete the entire stroke (from 0 to 100% or from 100% to 0% lifting or lowering).

255 steps may be programmed for lifting and lowering as well as switching on and off respectively.

00hex, 01hex, 02hex.....FEhex
 0, 16, 32,.....4064 ms

The values for the time ramps are transmitted in the configuration message in CAN mode. In the PWM mode, they are stored in the EEPROM of the valve and can be programmed.

▼ **Time ramps**



Commissioning, installation position

Notice

The valve fulfills no safety function. It may fail. The tractor manufacturer (customer) has to take suitable safety measures if required.

Additional operating and commissioning information for block assembly and installation into the tractor:

- ▶ Do not lose or damage O-rings, support rings or the shuttle valve.
- ▶ Shock-like loads exceeding the specified values may cause invisible damages and are to be avoided at all costs.
- ▶ The valves have to be installed into the machine in such a way that mechanical damage is avoided, e.g. due to stones, etc. which could cause the housing to deform, jamming, damage actuation elements or tear off or damage cables.
- ▶ ESD was tested according to ISO 10605: 2008 tables C1 and C2 for category 1, see "General electric information". This standard also has to be complied with during assembly and painting.
- ▶ If a hydraulic motor is operated with a directional valve in release position, the motor can turn freely. If the hydraulic motor is turned by an external force and stopped abruptly by switching the directional valve into the blocked position, extremely high pressure peaks may be generated due to the moment of inertia of the hydraulic motor which may damage the hydraulic system. This may happen when the machine or the pilot pressure are turned off, for example. The check valves in the directional valve close and the main spool moves to neutral.

Installation position	Admissible rotation around the axis, vertical to the image axis ¹⁾
1	
2	
3	
4	
5	
6	

¹⁾ Please find the admissible installation positions in the applicable quotation drawings.

Related documents

Title	Document number	Document type
Control block SB33-EHS1, EHR33-EHS1	66132-B	Operating instructions
Control block SB33-EHS1, basic document	66133-01-R	Repair instructions
Control block SB33-EHS1, assembly	66133-10-R	Repair instructions
Control valve SB33-EHS1	66136-20-R	Repair instructions
Hitch control valve EHR33-EHS1	66132-30-R	Repair instructions
On-board electronics SB33-EHS1	66133-40-R	Repair instructions
2/2 solenoid valve	18136-16	Data sheet
SB33-EHS1 interface description, hydraulics	Z 206 804 877	Technical information
SB33-EHS1 interface description, electronics	Z 206 E00 444	Technical information
Bleeding directional valves	MH 121	Commissioning information
Supplied installation drawing/hydraulic scheme	Available from your machine or plant manufacturer	Quotation drawing
Mineral oil-based hydraulic fluids	90220	Data sheet

Abbreviations

The following abbreviations are used in this documentation:

Abbreviation	Meaning
AP	Subplate
CAN	Controller Area Network
DBV	Pressure relief valve
DRV	Throttle check valve
EHR	Electrohydraulic hitch control
EHS1	Pilot operated electro-hydraulic actuating unit
EP	End plate
IDW	Individual pressure compensator
LS	Load sensing
MH	Manual auxiliary actuation
OBE	On-board electronics
SB33	Load-sensing control block in sandwich plate design
TKU	Technical documents by the customer

Spare parts

Contacts for accessories and spare parts

Accessories and spare parts are available

- ▶ from the vehicle manufacturer (specialty retailer),
- ▶ from the system manufacturer, and
- ▶ from your Bosch Rexroth specialty retailer.

Valve Modules

Designation	Type	Size	Series	Data sheet	Page
Stabilizing module	RSM2	10	2X	64614	561
Stabilizing module	RSM2	16	2X	64617	567
Stabilizing module	RSM	16	3X	64627	571
Stabilizing module	RSM2	25	2X	64618	579
Slew drive module	MSC	16	1X	64593	583
Traction module (flow divider)	RTM	16, 25	1X	64592	595
Hitch control valves	EHR	5, 23		66125	617
Check-Q-meter	FD	12...32	2X	27551	639
Thermal pressure valve	MHDBDT	6	2X	64309	651
Unlockable check valve for SAE flange connection	MHSVD	19	1X	64545	655
Multi-way directional valves	MH.W.	6, 20, 30	2X	64638	661
Throttle check valve and check valve	MHFS, MHSV	20, 25, 32	1X	64548	669
Safety valves, type-approved (see RE 90010-04, chapter 4)	0 532 VA...			50153	

Stabilising module

Type RSM2

Nominal size 10

Component series 2X

Maximum operating pressure:

- Actuator connections A, B 420 bar
- Accumulator connection X 350 bar

Nominal flow 80 L/min



HAD 7290/04

Overview of contents

Contents

Features	
Ordering details	
Function, circuit	
Parking the vehicle, maintenance and service work	
Regulatory requirements and safety guidelines	
Installation guidelines	
Technical data	
Characteristic curves	
Unit dimensions	

Features

Page	
1	The RSM2 stabilising module reduces pitching movements on wheeled vehicles that effect the vehicle and driver. For this the lifting line is connected to a hydro-pneumatic accumulator, via a switching valve, that absorbs the loads caused by the pitching movements.
2	
2	
3	Applications:
3	– Wheeled loaders
3	– Telescopic handlers
3	The following advantages apply when the RSM2 system is fitted:
4	
5	– Higher transport speeds
	– Higher handling rates
	– Stable steering characteristics
	– Shorter braking distances
	– Higher comfort for the driver
	– Lower mechanical loading of the entire machine
	– Fewer repairs or down times with identical handling rates

Ordering details

RSM2-10 B 2X/ / / / / / / / / / V 01 *

Stabilising module

Nominal size 10 = 10

Design

Block design = B

Component series 20 to 29 (20 to 29: unchanged installation and connection dimensions) = 2X

Accumulator pressure limitation

Without accumulator pressure limitation = A000

Accumulator pressure limitation with EC design test, pressure in bar = A...

Accumulator pressure limitation without EC design test, pressure in bar = B...

Accumulator loading orifice (defined when optimising the machine)

Orifice cross-section → Loading side = 12..

Orifice cross-section → Unloading side = ..04

Further details in clear text

Connections

01 = Pipe thread to ISO 228/1

V = FKM seals

Electrical connections

C4 = Plug, 2-pin, Junior Timer

K41L = Plug, 2-pin, Junior Timer, and diode P6KE30CA (12 V)

K42L = Plug, 2-pin, Junior Timer, and diode P6KE47CA (24 V)

Supply voltage

G12 = 12 V DC

G24 = 24 V DC

Function, circuit

Design

The stabilising module (1) basically comprises of a housing into which are built:

- Valve spool (2)
- 3/2-way directional valve, solenoid operated (3)
- Pressure relief valve (4)
- Emergency drain screw (5)
- Accumulator loading valve (6)

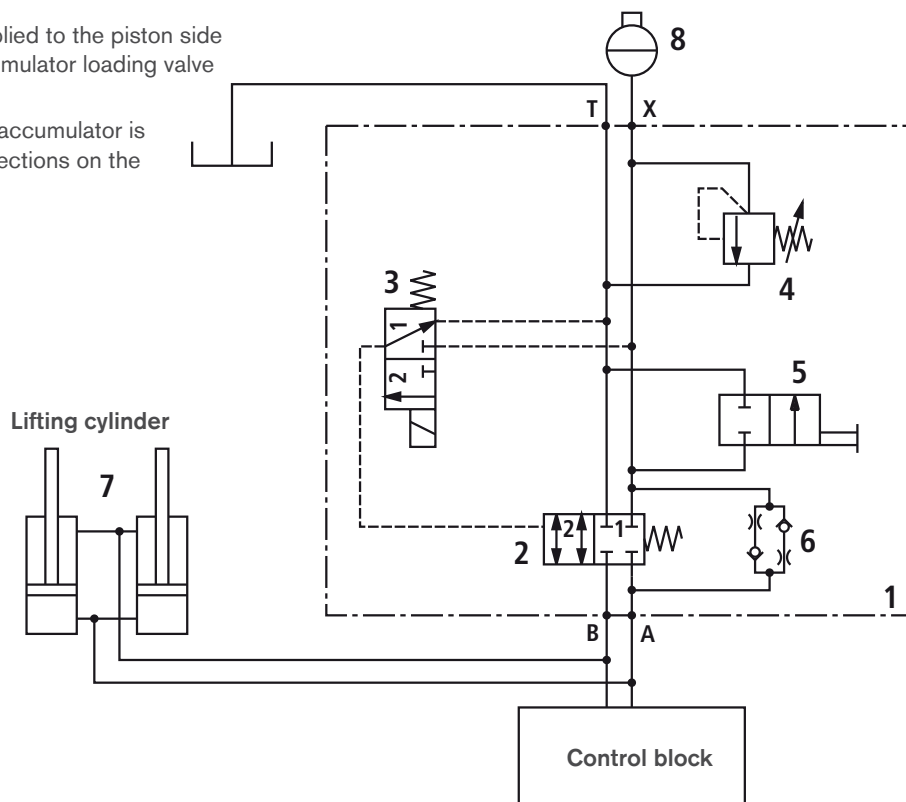
Function

If the lifting cylinder (7) has pressure applied to the piston side then pressure is also applied to the accumulator loading valve (6) as well as the accumulator (8).

The loading and unloading speed of the accumulator is defined via the selectable orifice cross-sections on the accumulator loading valve (6).

The damping valve can be automatically activated via the travel speed. The 3/2-way directional valve (3) is switched into the switched position 2. The valve spool (2) is switched to the switched position 2 and connects the piston side of the lifting cylinder (7) with the accumulator (8) as well as the rod side of the lifting cylinder (7) to tank.

The pressure relief valve (4) prevents unpermissible high pressures in the accumulator. (Set pressure < permissible accumulator pressure).



Parking the vehicle, maintenance and service work

Via the emergency drain screw (5) (shown in the circuit as a mechanically operated 2/2-way directional valve) it is possible to unload the accumulator so that the above mentioned work can be carried out.

The accumulator loading orifice components are subject to

a degree of wear. They should be checked and if necessary replaced after approx. 200.000 load cycles.

⚠ Attention:

The safety technical requirements of the vehicle have to be taken into account! The lifting system must firstly be secured against lowering.

Regularity requirements and safety guidelines

Accumulators are required for the RSM2 stabilisation system. If, due to the operation situation of the machine, the danger exists that the accumulator's permissible pressure limit can be exceeded, then a pressure relief valve has to be fitted. For this system regularity requirements and those from the authorities may have to be complied with.

For this purpose the RSM2 is fitted with a pressure relief valve. This can also be a design tested valve which complies with the pressure component directive 97/23/EC (see ordering details).

If a RSM2 is ordered **without** a pressure relief valve (example: RSM2-10 B2X/A000...), Rexroth assumes that the appropriate pressure safety function has been foreseen by the vehicle manufacturer or that accumulator pressure overloads are prevented in a different manner within the vehicle's design.

In addition for the vehicle other national and international regulations may apply.

The entire responsibility lies with the vehicle manufacturer.

Installation guidelines

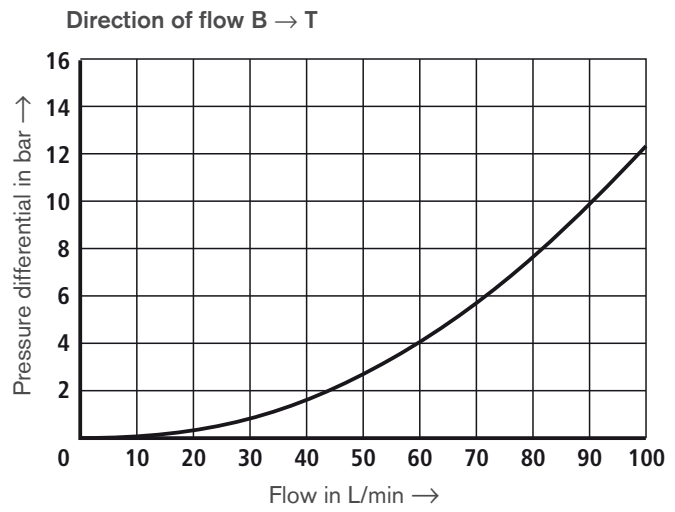
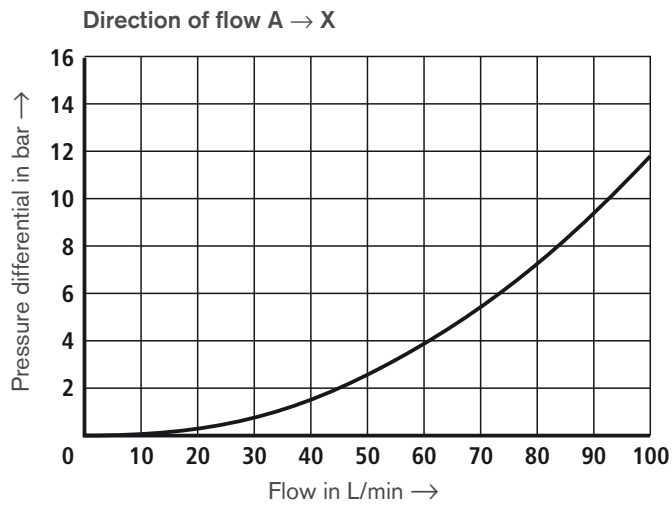
- The number of accumulators is dependent on the lifting cylinder size. Accumulators have to be ordered separately.
- The pressure relief setting (safety valve for the pressure vessel) **must** be lower than the permissible accumulator pressure.

⚠ Attention:

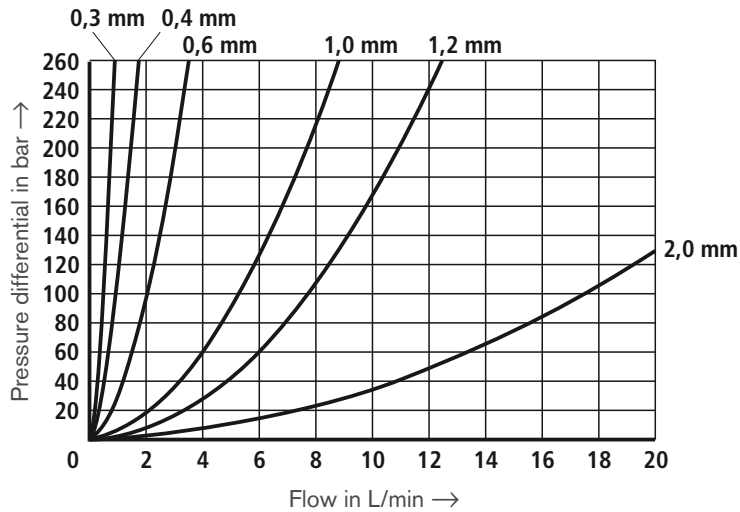
- Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
- For this, unscrew the plug then rotate the valve spindle, located under the plug (3A/F), 2 turns anti-clockwise. The lifting system must firstly be secured against lowering.

Technical data (for applications outside these parameters, please consult us!)

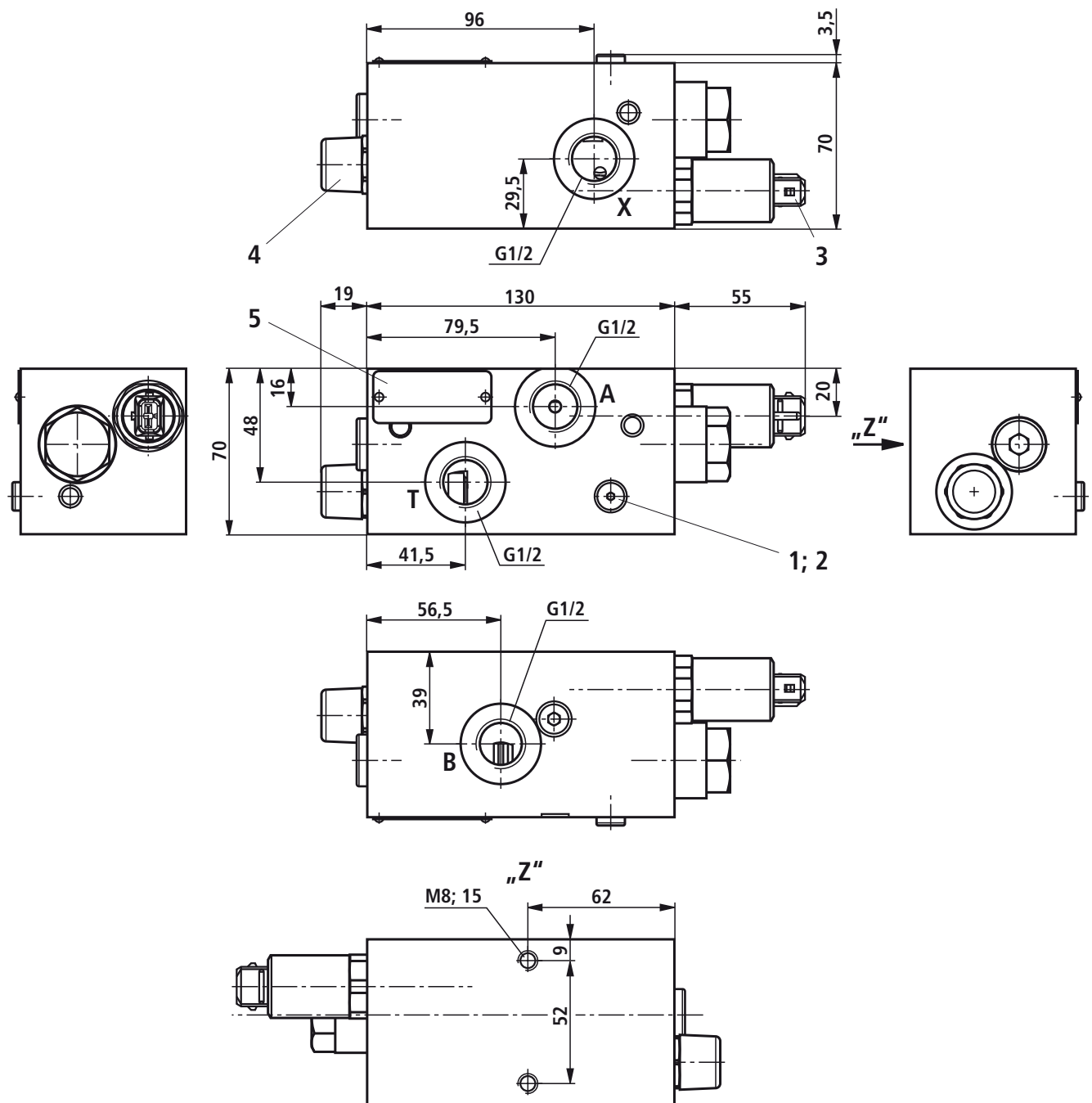
General			
Installation			Optional
Ambient temperature range	°C		– 20 ... + 80
Weight	kg		4.7
Hydraulic			
Operating pressure	Ports A, B	bar	420
	Port X	bar	350
	Port T	bar	30
Max. nominal flow	Ports A, X	L/min	80
Pressure fluid			Mineral oil (HL, HLP) to DIN 51524; Other pressure fluids on request!
Pressure fluid temperature range	°C		– 20 ... + 80
Viscosity range	mm ² /s		10 ... 380
Max. permissible degree of pressure fluid contamination Cleanliness class to ISO 4406 (c)			Class 20/18/15
Electrical			
Control voltage	V		12; 24
Power consumption (solenoid)	W		14.4



Δp - q_v -characteristic curves for selecting the accumulator loading orifice



Unit dimensions (in mm)



1 Emergency lowering screw,
 $M_A = 7 \text{ Nm}$
 (see notes on page 3 regarding
 installation)

2 Valve spindle located under
 Pos.1 3A/F, $M_A = 3.5 \text{ Nm}$

3 Electrical connection
 Plug, 2-pin
 Type Junior Timer (AMP)

4 Pressure relief valve

5 Name plate

Port sizes

A, B, T, X = G 1/2

Stabilising module

Type RSM2

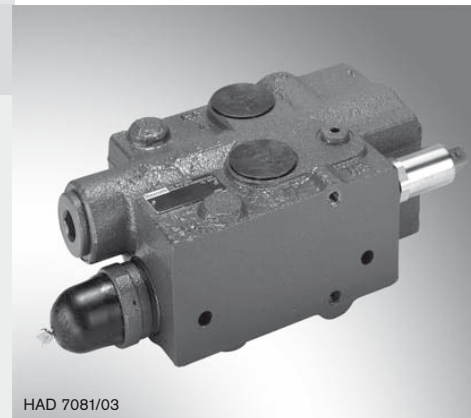
Nominal size 16

Component series 2X

Maximum operating pressure:

- Actuator connections A, B 420 bar
- Accumulator connection X2 350 bar

Nominal flow 150 L/min



HAD 7081/03

Overview of contents

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Features

Page	
1	The RSM2 stabilising module reduces pitching movements on wheeled vehicles that effect the vehicle and driver. For this the lifting line is connected to a hydro-pneumatic accumulator, via a switching valve, that absorbs the loads caused by the pitching movements.
2	
2	
2	
3	Applications:
3	– Wheeled loaders
3	– Telescopic handlers
3	The following advantages apply when the RSM2 system is fitted:
4	– Higher transport speeds
4	– Higher handling rates
	– Stable steering characteristics
	– Shorter braking distances
	– Higher comfort for the driver
	– Lower mechanical loading of the entire machine
	– Fewer repairs or down times with identical handling rates

Ordering details

RSM2-16 B 2X/ / / / / / / / / / / V 01 *

Stabilising module

Nominal size 16 = 16

Design

Block design = B

Component series 20 to 29 = 2X
(20 to 29: unchanged installation and connection dimensions)

Accumulator pressure limitation

Without accumulator pressure limitation = A000

With accumulator pressure limitation, pressure details in bar = A...

Pressure limitation

Pressure limitation 90 bar = B090

Pressure limitation 120 bar = B120

Pressure limitation 160 bar = B160

Further details in clear text

Connections

01 = Pipe thread to ISO 228/1

V = FKM seals

Electrical connections

C4 = Plug, 2-pin, Junior Timer

K41L = Plug, 2-pin, Junior Timer, and diode P6KE30CA (12 V)

K42L = Plug, 2-pin, Junior Timer, and diode P6KE47CA (24 V)

Supply voltage

G12 = 12 V DC

G24 = 24 V DC

Function, circuit

Design

The stabilising module basically comprises of a housing into which are built:

- Valve spool (2)
- 3/2-way directional valve, solenoid operated (3)
- Pressure relief valve (EC design tested) (4)
- Emergency drain screw (5)

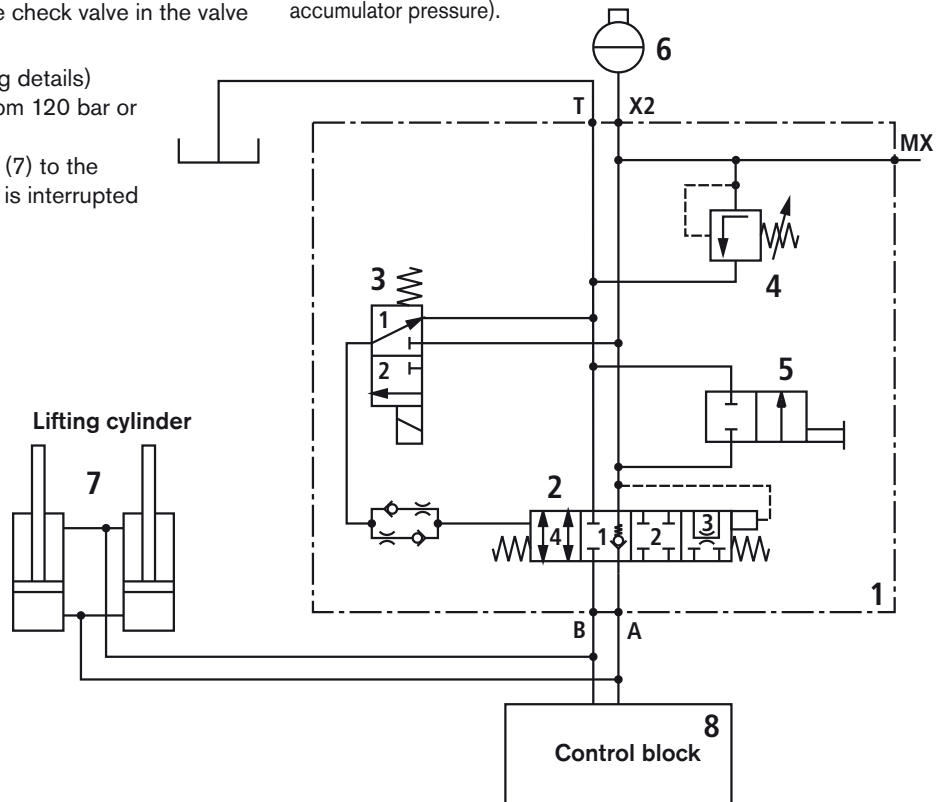
Function

If the lifting cylinder (7) has pressure applied to the piston side, then the pressure is also applied to the check valve in the valve spool (2) and the accumulator (6).

Dependent on the design (see ordering details)
...B090 -> from 90 bar, ...B120 -> from 120 bar or
...B160 -> from 160 bar
the connection from the lifting cylinder (7) to the accumulator (6) via the valve spool (2) is interrupted (switched position 2).

A pressure reducing function for the accumulator (6) is integrated in the valve spool (2) (switched position 3). The opening pressure lies approx. 30 bar higher than the switch off pressure (switched position 2).

The damping valve can be automatically activated via the travel speed. The 3/2-way directional valve (3) is switched into the switched position 2. The valve spool (2) is switched to the switched position 4 and connects the piston side of the lifting cylinder (7) with the accumulator (6) as well as the rod side of the lifting cylinder (7) with the reservoir. The pressure relief valve (4) prevents unpermissible high pressures in the accumulator (opening pressure < permissible accumulator pressure).



Parking the vehicle, maintenance and service work

Via the emergency drain screw (5) (shown in the circuit as a mechanically operated 2/2-way directional valve) it is possible to unload the accumulator so that the above mentioned work can be carried out.

⚠ Attention:

The safety technical requirements of the vehicle have to be taken into account!

The lifting system must firstly be secured against lowering.

Regularity requirements and safety guidelines

Accumulators are required for the RSM2 stabilisation system. If, due to the operation situation of the machine, the danger exists that the accumulator's permissible pressure limit can be exceeded, then a pressure relief valve has to be fitted. For this system regularity requirements and those from the authorities have to be complied with.

The RSM2 is fitted with a design tested pressure relief valve which complies with the pressure component directive 97/23/EC.

If a RSM2 is ordered without a pressure relief valve (example: RSM2-16 B2X/A000...), Rexroth assumes that the appropriate pressure safety function has been foreseen by the vehicle manufacturer or that accumulator pressure overloads are prevented in a different manner within the vehicle's design.

In addition for the vehicle other national and international regulations may apply.

The entire responsibility lies with the vehicle manufacturer.

Installation guidelines

- The number of accumulators is dependent on the lifting cylinder size. Accumulators have to be ordered separately.
- The pressure relief setting (safety valve for the pressure vessel) **must** be lower than the permissible accumulator pressure.

⚠ Attention:

- Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
- For this, unscrew the plug then rotate the valve spindle, located under the plug (3A/F), 2 turns anti-clockwise.
- The lifting system must firstly be secured against lowering.

Technical data (for applications outside these parameters, please consult us!)

General

Installation		Optional
Ambient temperature range	°C	– 20 ... + 80
Weight	kg	15

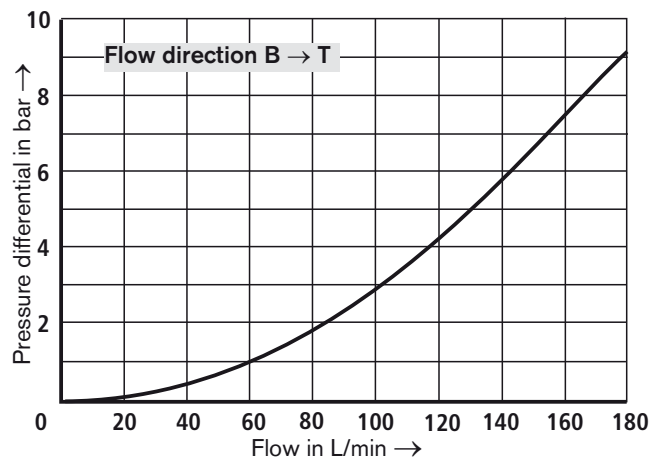
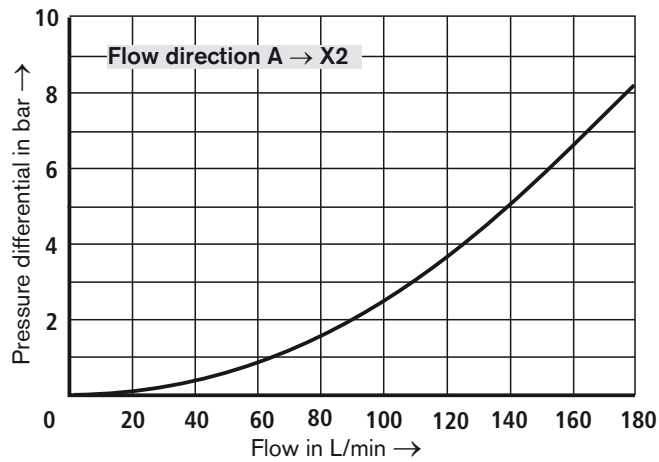
Hydraulic

Operating pressure	Ports A, B	bar	420
	Port X2	bar	350
	Port T	bar	30
Max. nominal flow	Ports A, X2	L/min	150
Pressure fluid			Mineral oil (HL, HLP) to DIN 51 524; Other pressure fluids on request!
Pressure fluid temperature range		°C	– 20 ... + 80
Viscosity range		mm ² /s	10 ... 380
Degree of contamination (max. permissible)			ISO 4406 (c) class 20/18/15

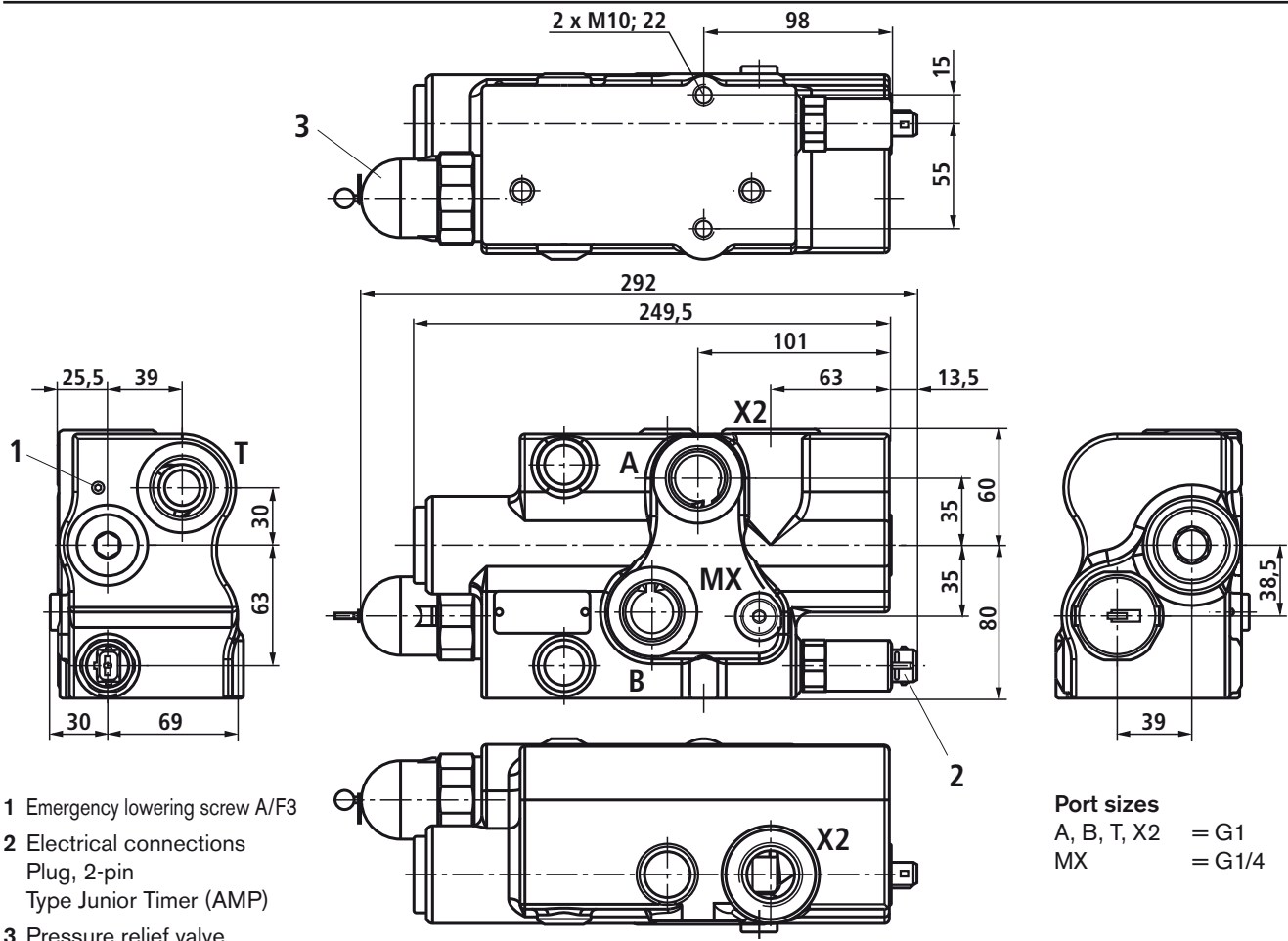
Electrical

Control voltage	V	12; 24
Power consumption (solenoid)	W	14.4

Characteristic curves (measured with HLP68, $\varrho_{oil} = 40\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$)



Unit dimensions (in mm)



- 1 Emergency lowering screw A/F3
- 2 Electrical connections
Plug, 2-pin
Type Junior Timer (AMP)
- 3 Pressure relief valve

Stabilizing module RSM16



- ▶ Size 16
- ▶ Series 3X
- ▶ Max. working pressure
 - Consumer ports **A, B** 420 bar
 - Accumulator port **X2** 350 bar
- ▶ Maximum flow 150 l/min

Features

The RSM stabilizing module reduces pitching movements on wheeled vehicles that effect the drivers and machine. For this the lifting line is connected, via an on/off valve, to a hydro-pneumatic accumulator that absorbs the loads caused by the pitching movements.

Benefits

- ▶ Higher transport speeds
- ▶ Higher handling rates
- ▶ Stable steering characteristics
- ▶ Shorter braking distances
- ▶ Higher comfort for the driver
- ▶ Lower mechanical loading of the entire machine
- ▶ Fewer repairs or standstill periods with identical handling rates

Fields of application

- ▶ Wheeled loaders
- ▶ Telehandlers

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Technical data	3
Type code	4
Characteristic curves	5
Dimensions	6
Parking the vehicle, maintenance and service work	7
Legal requirements and safety instructions	7
Notes regarding installation	7

Functional description

The stabilizing module basically comprises of a housing (1) into which are built:

- ▶ Control spool (2)
- ▶ Accumulator pressure balance spool (3) (optional)
- ▶ 3/2-way directional valve, solenoid operated (4)
- ▶ Emergency drain screw (5)
- ▶ Pressure relief valve (EC type-examination tested) (6)

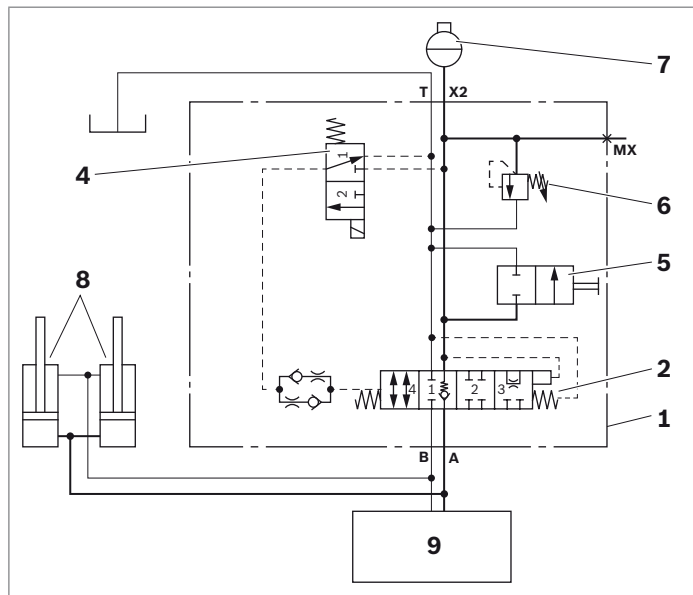
If the stroke cylinder (8) has pressure applied to the piston side, then the pressure is also applied to the check valve in the control spool (2) and the accumulator (7).

Dependent on the design (see type code)

- ▶ B090 → from 90 bar,
- ▶ B120 → from 120 bar or
- ▶ B160 → from 160 bar

the connection from the stroke cylinder (8) to the accumulator (7) via the control spool (2) is interrupted (switching position 2).

▼ Schematic RSM16, without accumulator pressure balance function



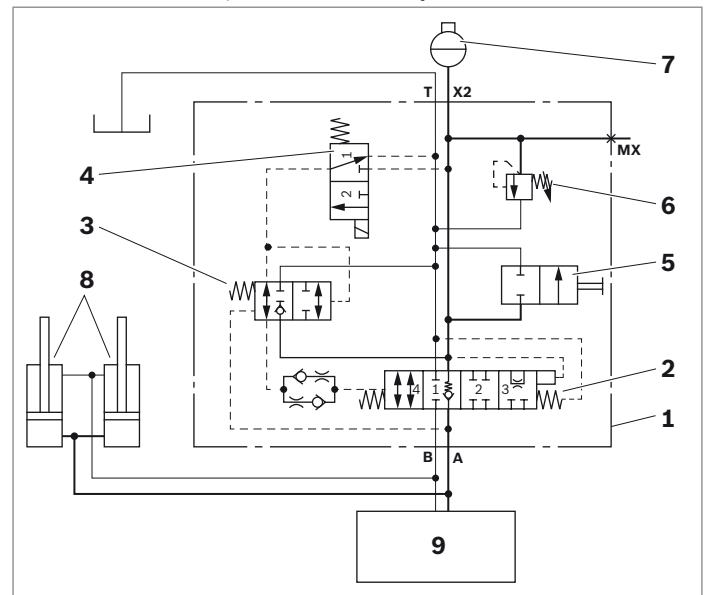
- 1 Housing
- 2 Control spool
- 3 Accumulator pressure balance spool
- 4 3/2-way directional valve, solenoid operated
- 5 Emergency drain screw
- 6 Pressure relief valve
- 7 Accumulator
- 8 Stroke cylinder
- 9 Control block

A pressure limiting function for the accumulator (7) is integrated in the control spool (2) (switching position 3). The cracking pressure lies approx. 30 bar higher than the cut-off pressure (switching position 2).

The damping valve can be automatically activated via the travel speed. The 3/2-way directional valve (4) is switched into the switching position 2. In the version with accumulator pressure balance function (version E) the accumulator pressure in the stroke cylinder is balanced via the accumulator pressure balance spool (3). The control spool (2) is switched to the switching position 4 and connects the piston side of the stroke cylinder (8) with the accumulator (7) as well as the rod side of the stroke cylinder (8) with the reservoir.

The pressure relief valve (6) prevents impermissible high pressures in the accumulator (cracking pressure < permissible accumulator pressure).

▼ Schematic RSM16, with accumulator pressure balance function



Technical data

General				
Weight		kg		19.5
Installation position				see type code on page 4
Consumer connection type				Pipe thread in accordance with ISO 228/1
Ambient temperature range	θ	°C		-20 to +80
Priming (standard)				One-coat paint RAL 5010
Hydraulic				
Maximum working pressure at port	A, B	p_{\max}	bar	420
	X2	p_{\max}	bar	350
	T	p_{\max}	bar	30
Maximum flow at port	A, X2	$q_{V\max}$	l/min	150
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range	θ	°C		-20 to +80
Viscosity range	ν	mm ² /s		10 to 380
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Electric				
Control voltage		V		12; 24
Power consumption (solenoid)		W		14.4

Note

Please contact us if the unit is to be used outside the specified range of values.

Type code

01	02	03	04	05	06	07	08	09	10	11	12	13
RSM	16	B	3X	/						V	01	*

Series

01	Stabilizing module	RSM
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Size

02	Size 16	16
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Design

03	Block installation	B
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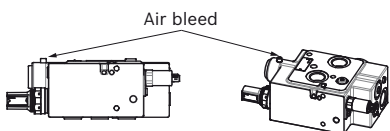
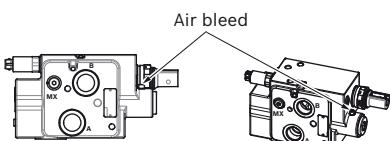
Series

04	30 to 39 (unchanged installation and connection dimensions)	3X
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Accumulator pressure balance function

05	Without accumulator pressure balance spool	Z
	With accumulator pressure balance spool	E

Installation position (the position of the air bleed screw varies depending on the installation position)

06	Standard	1		3
		2		4

Accumulator pressure limitation

07	Without		A000
	Pressure relief valve with EC type-examination test	210 bar	A210
		250 bar	A250
		280 bar	A280
		315 bar	A315

Pressure limitation

08	90 bar	B090
	120 bar	B120
	160 bar	B160

Supply voltage

09	12 V DC	G12
	24 V DC	G24

Electric port

10	Connector, 2-pin, Junior Timer	C4
	Connector, 2-pin, Junior Timer and Diode P6KE30CA (12 V)	K41L
	Connector, 2-pin, Junior Timer and Diode P6KE30CA (24 V)	K42L

Sealing material

11	FKM (fluoroelastomer)	V
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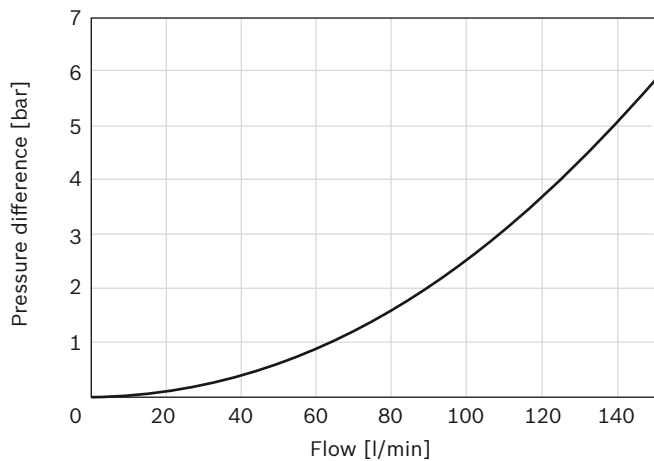
Consumer ports

12	Pipe thread in accordance with ISO 228/1	01
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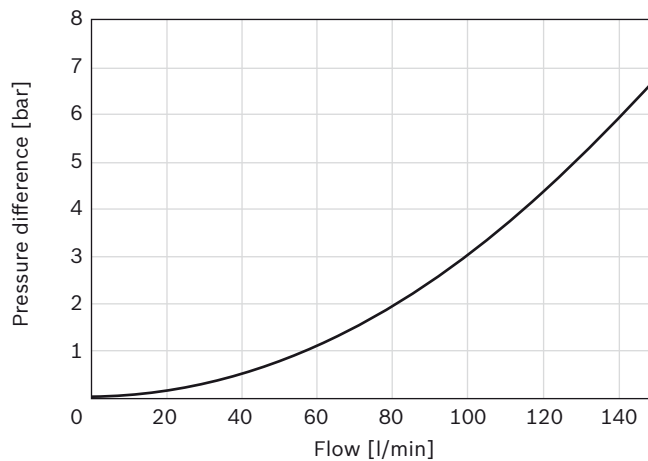
13	Further specifications in plain text	*
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Characteristic curves

▼ **Flow direction A → X2**



▼ **Flow direction B → T**

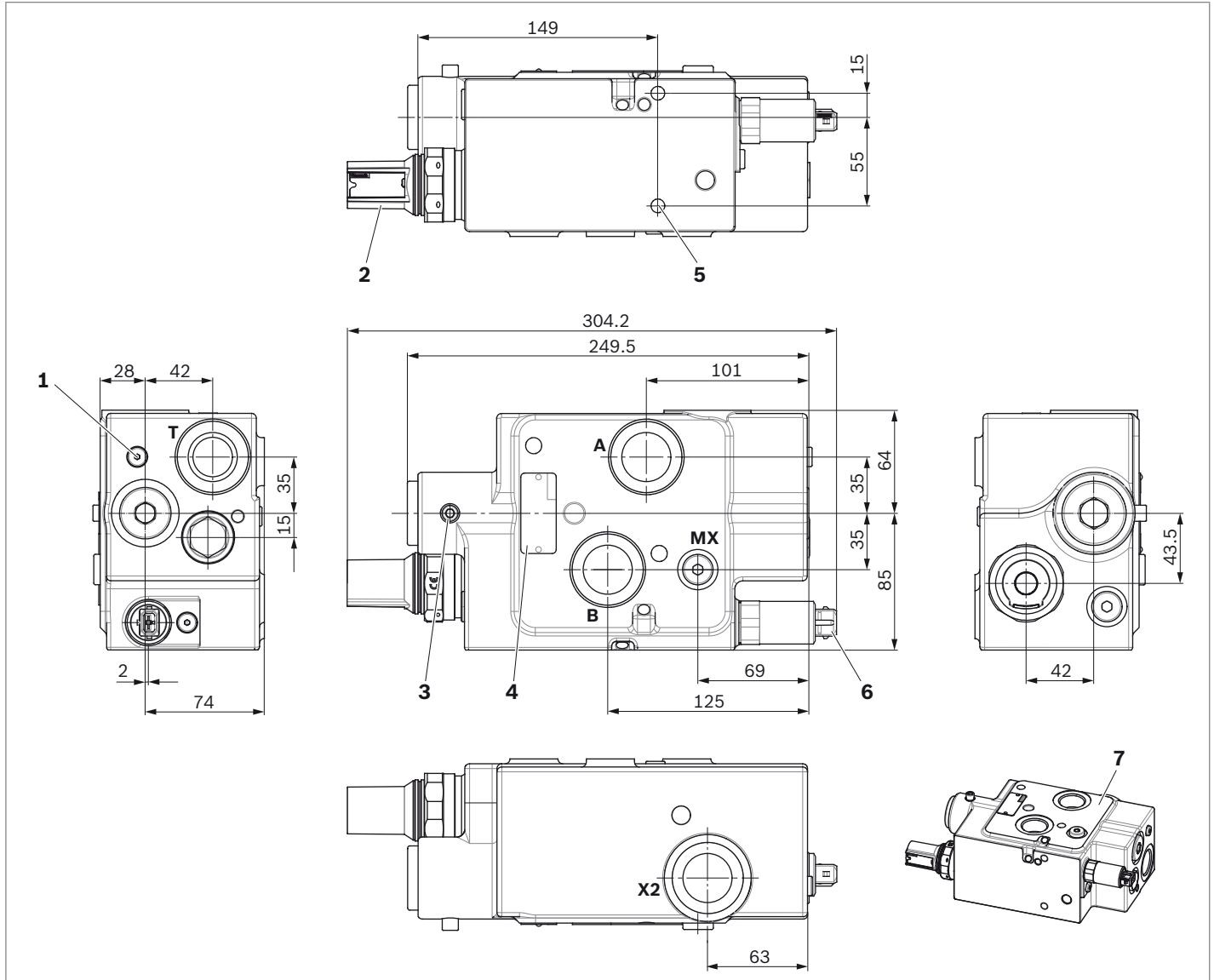


Note

Characteristic curves measured with HLP68, at $\theta = 40 \pm 5$ °C).

Dimensions

▼ RSM16, Standard version



- 1 Emergency drain screw
- 2 Pressure relief valve
- 3 Air bleed screw, tightening torque $M_A = 5^{±0.5}$ Nm.
the position of the air bleed screw varies depending on the installation position (see information regarding installation on page 7).
- 4 Name plate
- 5 Two fastening threads M10, 22 deep
- 6 Electrical connection, 2-pin connector, Junior Timer (AMP)
- 7 Installation position (air bleed screw upwards)

Ports		Size
A, B	Consumer	
T	Reservoir	G 1
X2	Accumulator	
MX	Measuring port	G 1/4

Parking the vehicle, maintenance and service work

Via the emergency drain screw (1) (shown in the schematic as a mechanically operated 2/2-way directional valve) it is possible to unload the accumulator so that the above mentioned work can be carried out.

Note

The safety technical requirements of the machine have to be taken into account! The lifting system must firstly be secured against lowering.

Legal requirements and safety instructions

Pressure accumulators are required for the RSM stabilizing module. If, due to the operation situation of the machine, the danger exists that the accumulator's permissible pressure limit can be exceeded, then a pressure relief valve is to be fitted. For this system regularity requirements and those from the authorities have to be complied with.

The RSM is fitted with a type-examination tested pressure relief valve which complies with the pressure component directive 97/23/EC.

If a RSM is ordered without a pressure relief valve (example: RSM216B2X/A000...), Bosch Rexroth assumes that the appropriate pressure limitation has been foreseen by the machine manufacturer or that accumulator pressure overloads are prevented in a different manner within the machine's design.

In addition other national and international regulations may apply for the machine.

The entire responsibility lies with the machine manufacturer.

Notes regarding installation

- ▶ The number of accumulators is dependent on the stroke cylinder size. Accumulators are not included in the scope of delivery and must be ordered separately.
- ▶ The pressure limitation setting (safety valve for the pressure vessel) must be lower than the permissible accumulator pressure.
- ▶ Vent the RSM before commissioning.
The position of the air bleed screw varies depending on the installation position.

Note

Before carrying out any maintenance work the accumulators must be unloaded (depressurized).

For this, unscrew the emergency drain screw then rotate the valve spindle located below the screw (SW 3), two turns anti-clockwise. The lifting system must first be secured against lowering.

Stabilising module

RE 64618/05.04

1/4

Type RSM2

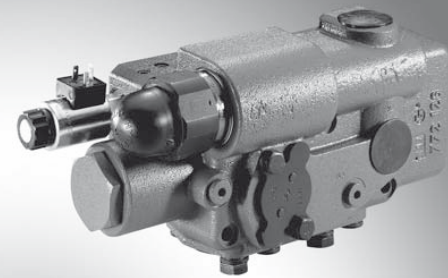
Nominal size 25

Component series 2X

Maximum operating pressure:

- Actuator connections A, B 420 bar
- Accumulator connections X1, X2 350 bar

Nominal flow 300 L/min



HAD 7202/04

Overview of contents

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Unit dimensions	

Features

Page	
1	The RSM2 stabilising module reduces pitching movements on wheeled vehicles that effect the vehicle and driver. For this the lifting line is connected to the hydro-pneumatic accumulator, via a switching valve, that absorbs the loads caused by the pitching movements.
2	
2	
3	Applications:
3	– Wheeled loaders
3	– Telescopic handlers
3	The following advantages apply when the RSM2 system is fitted:
4	
4	– Higher transport speeds
	– Higher handling rates
	– Stable steering characteristics
	– Shorter braking distances
	– Higher comfort for the driver
	– Lower mechanical loading of the entire machine
	– Fewer repairs or down times with identical handling times

Ordering details

RSM2-25 B 2X/ G24 V 11 *

Stabilising module

Nominal size 25 = 25

Design

Block design = B

Component series 20 to 29 = 2X

(20 to 29: unchanged installation and connection dimensions)

Accumulator pressure limitation

Without accumulator pressure limitation = A000

With accumulator pressure limitation,

pressure details in bar = A . . .

Pressure limitation

Pressure limitation 90 bar = B090

Pressure limitation 120 bar = B120

Pressure limitation 160 bar = B160

Further details
in clear text

Connections

11 = SAE flange

V = FKM seals

Electrical connection

C4 = Plug, 2-pin, Junior Timer

K42L = Plug, 2-pin, Junior Timer,
and diode P6KE47CA (24 V)

Supply voltage

G24 = 24 V DC

Function, circuit

Design

The stabilising module basically comprises of a housing into which are built:

- Valve spool (2)
- 3/2-way directional valve, solenoid operated (3)
- Pressure relief valve (EC design tested) (4)
- Emergency drain screw (5)

Function

If the lifting cylinder (7) has pressure applied to the piston side, then the pressure is also applied to the check valve in the valve spool (2) and the accumulator (6).

Dependent on the design (see ordering details)

...B090 -> from 90 bar, ...B120 -> from 120 bar or

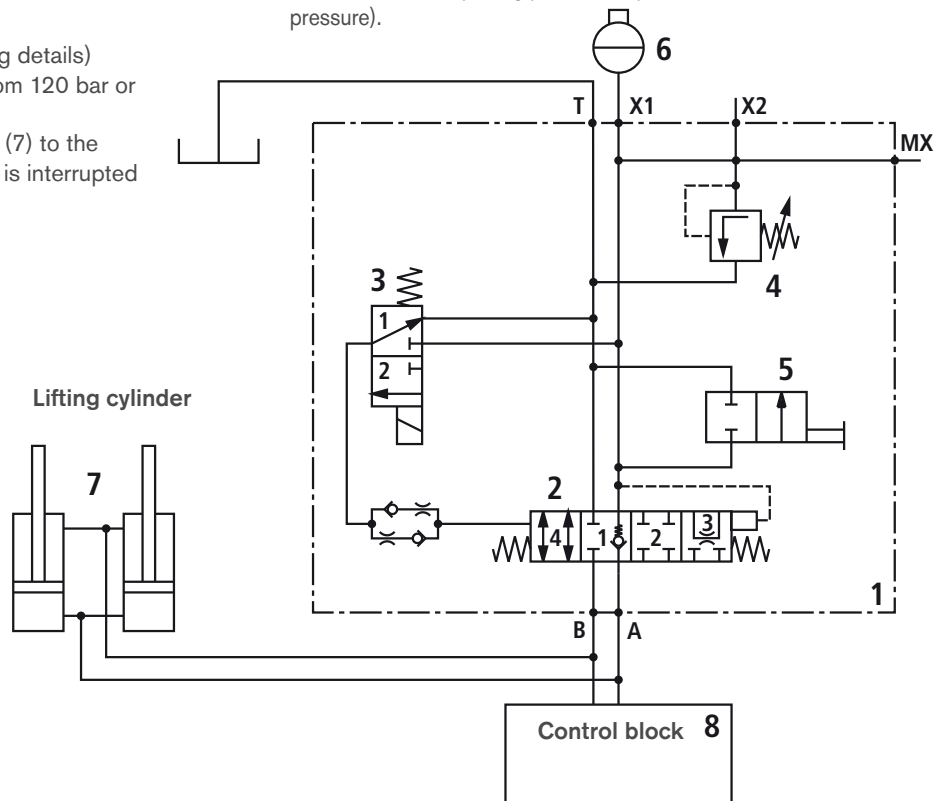
...B160 -> from 160 bar

the connection from the lifting cylinder (7) to the accumulator (6) via the valve spool (2) is interrupted (switched position 2).

A pressure reducing function for the accumulator (6) is integrated in the valve spool (2) (switched position 3). The opening pressure lies approx. 30 bar higher than the switch off pressure (switched position 2).

The damping valve can be automatically activated via the travel speed. The 3/2-way directional valve (3) is switched into the switched position 2. The valve spool (2) is switched to the switched position 4 and connects the piston side of the lifting cylinder (7) with the accumulator (6) as well as the rod side of the lifting cylinder (7) with the reservoir.

The pressure relief valve (4) prevents unpermissible high pressures in the accumulator (opening pressure < permissible accumulator pressure).



Parking the vehicle, maintenance and service work

Via the emergency drain screw (5) (shown in the circuit as a mechanically operated 2/2-way directional valve) it is possible to unload the accumulator so that the above mentioned work can be carried out.

Attention:

The safety technical requirements of the vehicle have to be taken into account!

The lifting system must firstly be secured against lowering.

Regularity requirements and safety guidelines

Accumulators are required for the RSM2 stabilisation system. If, due to the operation situation of the machine, the danger exists that the accumulator's permissible pressure limit can be exceeded, then a pressure relief valve has to be fitted. For this system regularity requirements and those from the authorities have to be complied with.

The RSM2 is fitted with a design tested pressure relief valve which complies with the pressure component directive 97/23/EC.

If a RSM2 is ordered without a pressure relief valve (example: RSM2-25 B2X/A000...), Rexroth assumes that the appropriate pressure safety function has been foreseen by the vehicle manufacturer or that accumulator pressure overloads are prevented in a different manner within the vehicle's design.

In addition for the vehicle other national and international regulations may apply.

The entire responsibility lies with the vehicle manufacturer.

Installation guidelines

- The number of accumulators is dependent on the lifting cylinder size. Accumulators have to be ordered separately.
- The pressure relief setting (safety valve for the pressure vessel) **must** be lower than the permissible accumulator.

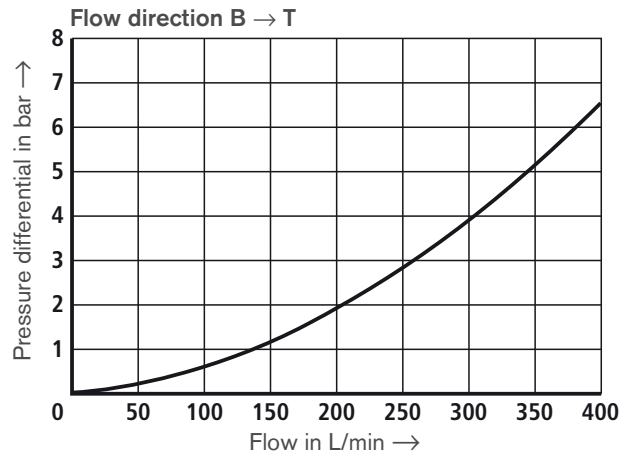
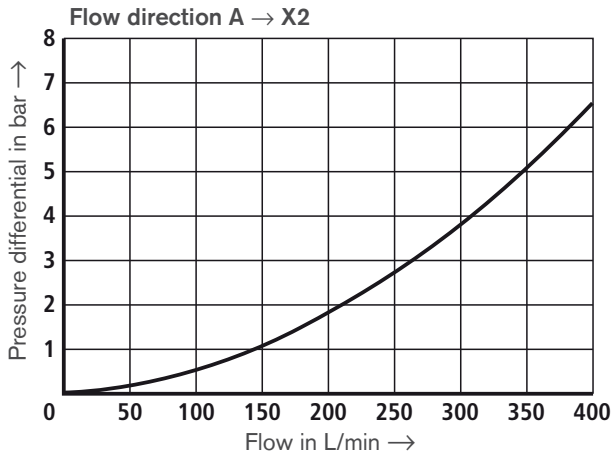
Attention:

- Before carrying out any maintenance work the accumulators must be unloaded (zero pressure).
- For this, unscrew the plug then rotate the valve spindle, located under the plug (3A/F), 2 turns anti-clockwise.
- The lifting system must firstly be secured against lowering.

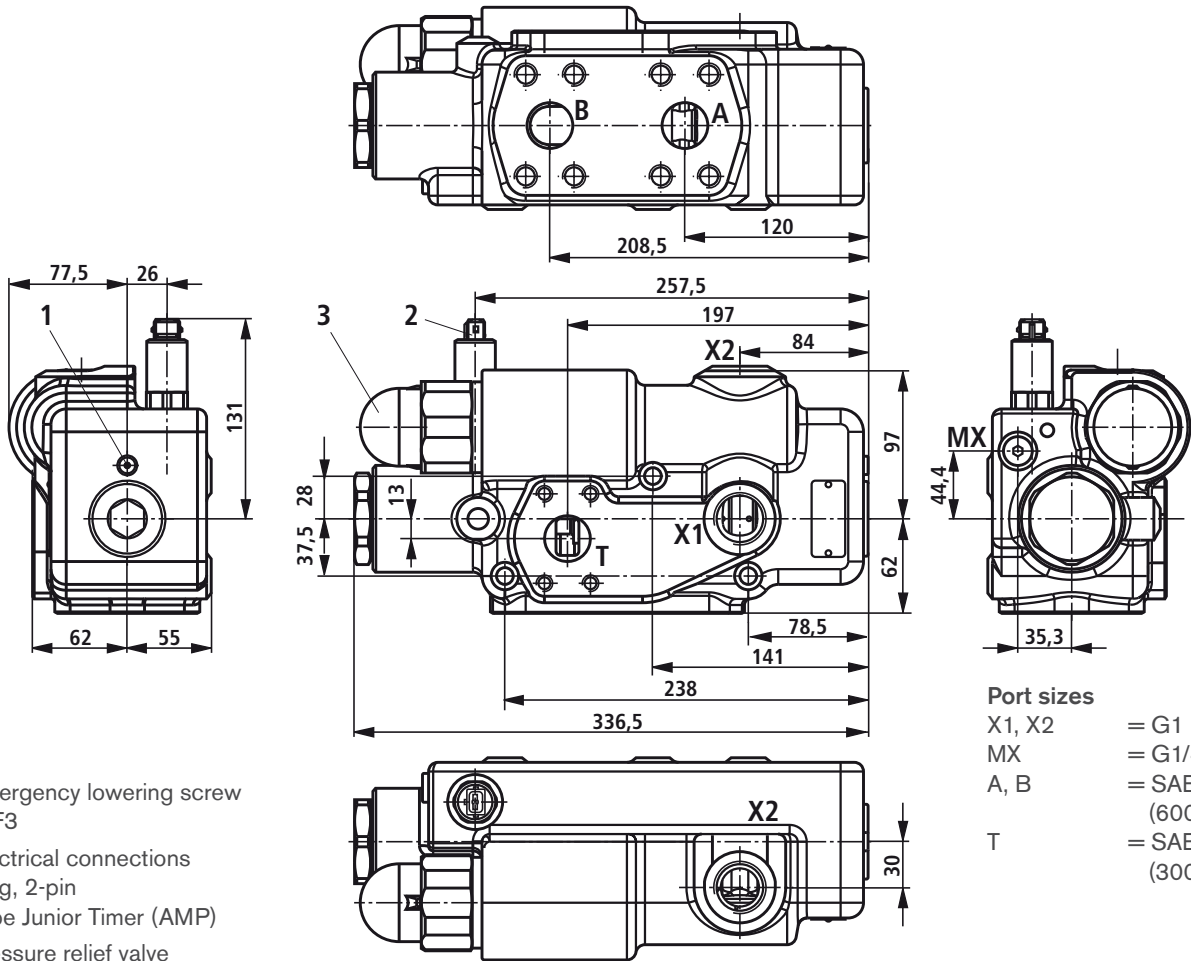
Technical data (for application outside these parameters, please consult us!)

General			
Installation			Optional
Ambient temperature range	°C		– 20 ... + 80
Weight	kg		27.5
Hydraulic			
Operating pressure	Ports A, B	bar	420
	Port X	bar	350
	Port T	bar	30
Max. nominal flow	Ports A, X	L/min	300
Pressure fluid			Mineral oil (HL, HLP) to DIN 51 524; Other pressure fluids on request!
Pressure fluid temperature range		°C	– 20 ... + 80
Viscosity range		mm ² /s	10 ... 380
Degree of contamination (max. permissible)			ISO 4406 (c) class 20/18/15
Electrical			
Control voltage		V	24
Power consumption (solenoid)		W	14.4

Characteristic curves (measured with HLP68, $\nu_{oil} = 40\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$)



Unit dimensions (in mm)

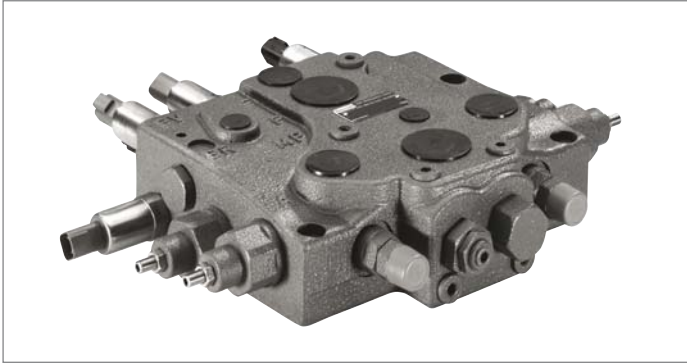


- 1 Emergency lowering screw A/F3
- 2 Electrical connections Plug, 2-pin Type Junior Timer (AMP)
- 3 Pressure relief valve

Port sizes

X1, X2	= G1
MX	= G1/4
A, B	= SAE 1 1/4 (6000 PSI)
T	= SAE 1 1/4 (3000 PSI)

Slew drive module MSC-16



- ▶ Series 1X
- ▶ Size 16
- ▶ Maximum operating pressure 350 bar
- ▶ Maximum flow 160 l/min

Features

- ▶ Independent, separate control of the supply and discharge flow (meter-in (MI) and meter-out (MO))
- ▶ Circulation pressure compensator for load-independent flow control LUDS
- ▶ Operation of a holding brake

Control concepts

- ▶ Open-Vario = Controlled supply
- ▶ Closed-Vario = Controlled supply and discharge
- ▶ Speed-Vario = Controlled discharge
- ▶ Free Swing = Open discharges

Fields of application

Control of slew drives in the open circuit:

- ▶ Cranes
- ▶ Excavators
- ▶ Drilling machines
- ▶ Forestry machinery

Contents

Functional description	2
Technical data	4
Theoretical characteristic curve	5
Ordering code	6
Dimensions	8
Accessories	11

Functional description

The MSC-16 slew drive module contains in a compact form the functions required for actuating slew drives in mobile machines.

Supply and discharge spools are actuated independently.

The pressure compensator is located downstream the supply spool. This allows for the realization of different control concepts. Fluctuating or negative loads (e.g. during braking) can be kept under control by means of these control options.

The pressure drops at the metering orifices depend on the pressures occurring during accelerations or decelerations of the rotary movement. Due to the resolution of the control edges, energetically optimized acceleration and cavitation-free deceleration (by hydraulically claiming the motor) of the rotary movement are possible.

By opening the discharge spools, a floating position can be realized without having to renounce the fine control at the main spool.

Actuation of the supply spool (1) is effected via the pressure reducing valves (2), control of the discharge via the discharge spools (3) and pressure reducing valves (4) with load-independent flow control (7).

Any unwanted rotation of the upper structure against the pump is prevented by the load-holding valve (9).

Apart from that, a primary (5) and a secondary pressure limitation (6) is integrated in the slew drive module.

Optionally, valves for loosening the holding brake (10) can be extended by a valve (13) for actuating a dynamic brake.

The discharge spools can be designed in the position “normally open” or “normally closed”.

Optionally with pilot oil switch-off (12).

Basic actuations:

- ▶ Open-Vario
- ▶ Closed-Vario
- ▶ Speed-Vario
- ▶ Free Swing
- ▶ Special actuations

Thanks to the option of independent supply and discharge spool actuation, the user can program the perfect control concept for the rotary movement, individually for their application

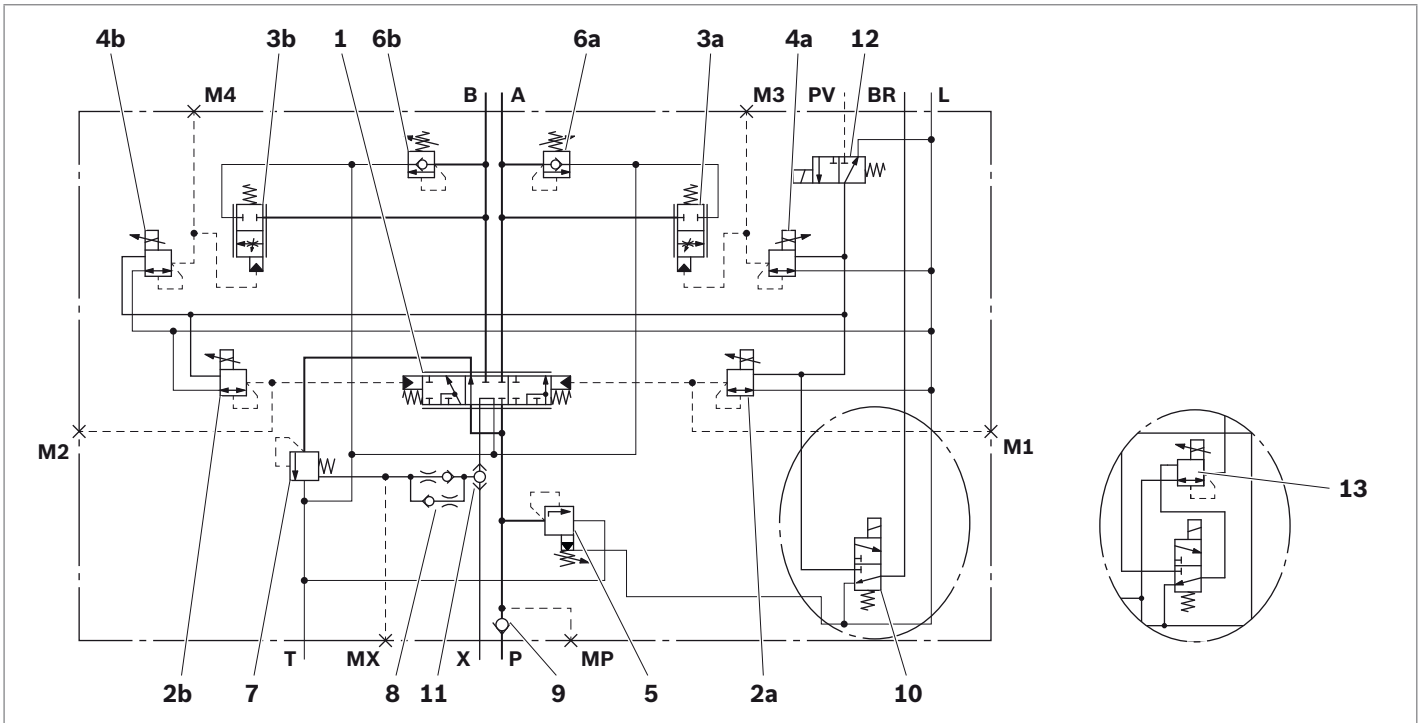
Control concept during rotation

Control concept	Direction of rotation	Supply spool (MI)	Discharge spool A (left) (MO)	Discharge spool B (right) (MO)
Open Vario	Clockwise	Proportional right	Closed	Open
	Counterclockwise	Proportional left	Open	Closed
Closed Vario	Clockwise	Proportional right	Closed	Proportional
	Counterclockwise	Proportional left	Proportional	Closed
Speed Vario	Clockwise	Open right	Closed	Proportional
	Counterclockwise	Open left	Proportional	Closed
Free Swing	–	Closed	Open	Open
Special actuation		Free selection of the supply and discharge spool actuation. Combination of open, closed and speed vario.		

MI = Meter in = Supply control

MO = Meter out = Discharge control

▼ Symbol



Ports	
P	Pump
A, B	Consumer
T	Tank
X	External load indication
L	Leakage oil
PV	Pilot oil
BR	Brake
MX	Measuring port Load indication
MP	Measuring port Pump
M1...M4	Measuring port override (without override function, the ports are closed)

- 1** Supply spool
- 2** Proportional valve (actuation supply spool)
- 3** Discharge spool
- 4** Proportional valve (actuation discharge spool)
- 5** Primary pressure valve supply
- 6** Secondary valve
- 7** Pressure compensator
- 8** Damping valve (optional)
- 9** Load holding valve
- 10** Holding brake valve
- 11** Optional: Shuttle valve external X port
- 12** Optional: Pilot oil switch-off
- 13** Optional: Proportional valve dynamic brake

Technical data

General				
Weight approx.		kg	22	
Installation position	Horizontal (see page 8)			
Line connections of the consumers	SAE flange ports according to ISO 6162			
Ambient temperature range	θ	°C	-40 to +80	
Priming (Standard)	One-coat paint RAL 5010			
Hydraulic				
Maximum operating pressure at the port	P, MP	p	bar	350
	A, B, X, MX	p	bar	350
	PV, BR, M1...M4	p	bar	50
	T	p	bar	20
	L	p	bar	Depressurized to the tank
Maximum flow at the port	P	$q_{v \max}$	l/min	160
Flow resistance, uncontrolled neutral circulation P → A → B → T		Δp	bar	8 (with $q_v = 160$ l/min, $v = 32$ mm ² /s)
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, HEES (Synthetic ester) according to ISO 15380, other hydraulic fluids upon request			
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	10 to 380	
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)	Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$.			
Electrical				
Voltage type	Direct voltage (DC)			
Directional spool valves FTWE 4 K (see data sheet 58008)				
Supply voltages	V	12	24	
Power consumption at 20 °C	W	14.4	14.4	
Coil resistance at 20 °C	Ω	10	40	
Duty cycle	%	100	100	
Proportional pressure reducing valve FTDRE 4 K (see data sheet 58038)				
Supply voltages	V	12	24	
Coil resistance at 20 °C	Ω	2.4	12	
Duty cycle	%	100	100	
Maximum solenoid current	A	1.8	0.8	
Recommended dither frequency (PMW) Chopper frequency (recommended)	Hz	200	200	
Type of mating connector	C4	Junior Timer (AMP)		
	K40	DT04-2P (Deutsch)		
Design according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Mating connector C4	IP65 (with mating connector mounted and locked) ¹⁾ IP67 and IP69K (with Rexroth mating connector material no. R901022127) ¹⁾		
	Mating connector K40	IP67 and IP69K (with mating connector mounted and locked) ¹⁾		
Control electronics, e. g. BODAS	Control unit type RC, see data sheet 95200			

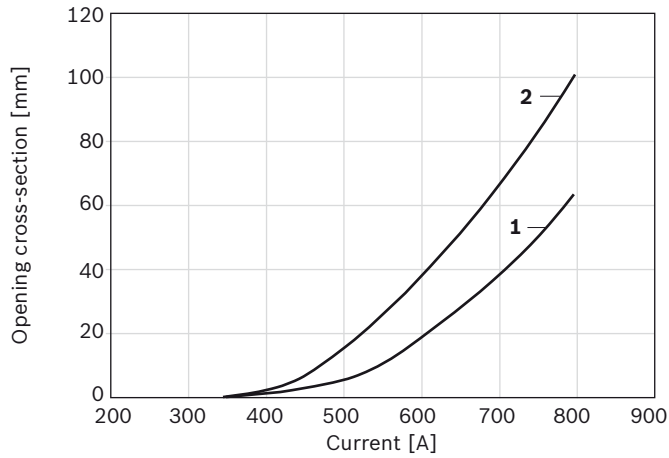
¹⁾ Mating connectors are not included in the scope of supply and must be ordered separately, see page 11.

Note

Please contact us if the unit is to be used outside the specified range of values.

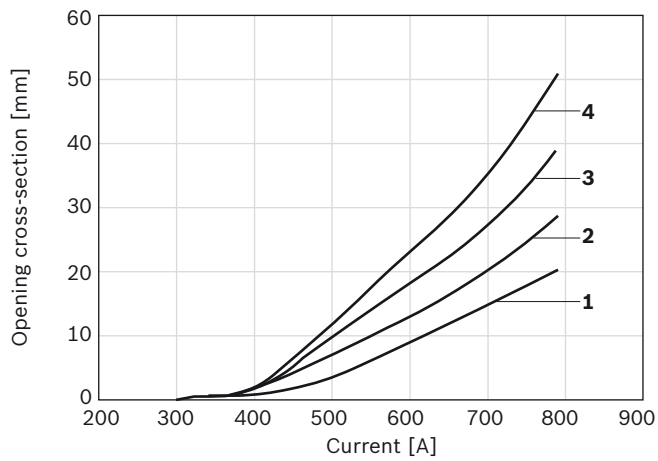
Theoretical characteristic curve

▼ Supply spool linear



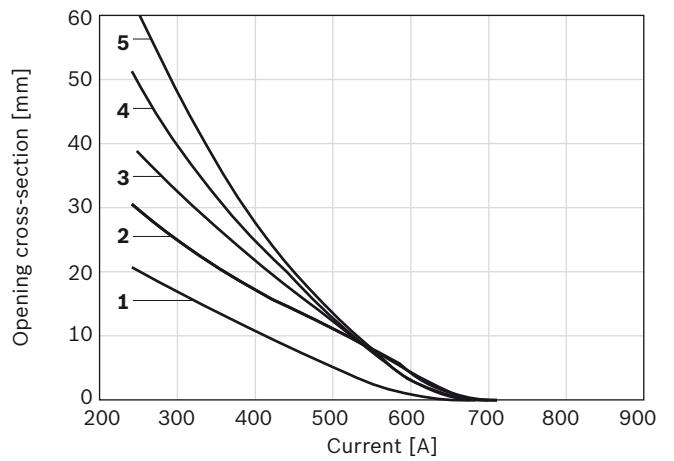
- 1 80 l/min
- 2 160 l/min

▼ Discharge spool linear, normally closed (standard)



- 1 60 l/min
- 2 90 l/min
- 3 120 l/min
- 4 200 l/min

▼ Discharge spool linear, normally open



- 1 60 l/min
- 2 90 l/min
- 3 120 l/min
- 4 160 l/min
- 5 200 l/min

Electrical connection

15	Junior-Timer 2-pin (AMP)	C4
	DT04-2P (Deutsch)	K40

Sealing material

16	FKM (fluoroelastomer)	V
----	-----------------------	----------

Line connections

17	Pipe threads according to ISO 228/1	01
18	Further details in the plain text	*

Information on the name plate

The ordering code serves to specify the technical features and requirements.

The Rexroth distribution organization derives a short type as well as a material number from the ordering code.

Example:

01	02	03	04	05	06	07	08				
MSC	-	1006	-	1	0	/	1	MSC-16	LUDS	G24	-007

01	Component series: Slew drive module MSC
02	4-digit serial number
03	Series 1X (unchanged installation and connection dimensions)
04	Revision status of the series
05	Total number of spool axes
06	Load-independent flow control
07	Direct voltage 24 V
08	Optional: Special designation

Dimensions

Line connections

Port	
P	G 1
A, B	G 3/4
T	G1
X	G1/4
L	G1/2
PV	G1/4
BR	G1/4
MX	G1/4
MP	G1/4
M1...M4	G1/4

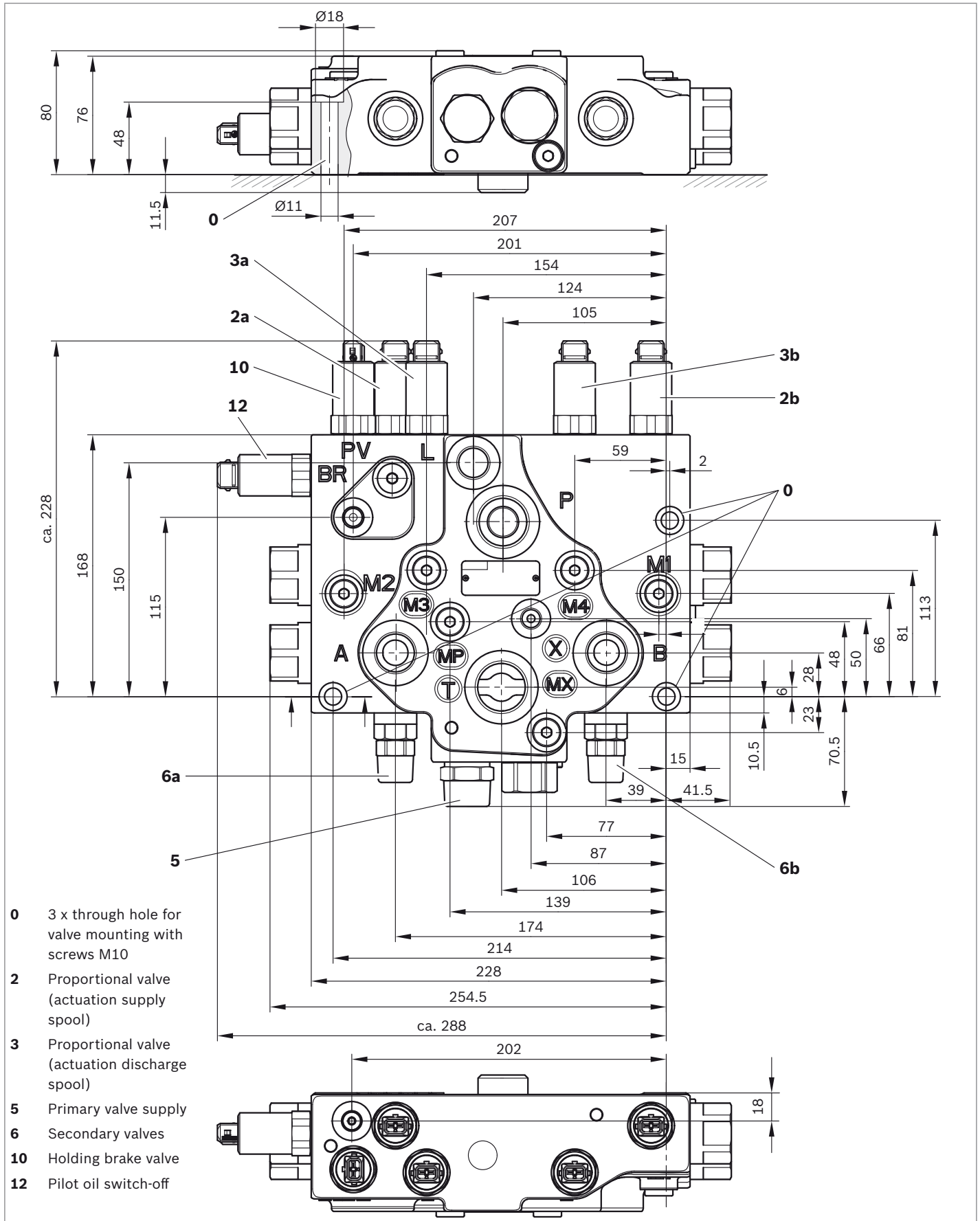
Mounting cavities for pipe fittings with thread according to ISO 228 / DIN 13.

Note

The subsequent unit dimension serve to describe the product. Technical modifications reserved.

Observe the valid, relevant type-specific installation drawing.

▼ MSC-16 with pilot oil switch-off



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Accessories

Mating connectors for FTDRE... and FTWE...

Recommended mating connector for type C4 Junior Timer 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended mating connector for Junior Timer 2-pin (AMP)



Recommended mating connector for type K40 DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

▼ Recommended mating connector for DT04 (DEUTSCH)



Traction module (Flow divider) RTM



- ▶ Series 1X
- ▶ Sizes 16 and 25
- ▶ Nominal pressure 500 bar
- ▶ Maximum flow
 - 160 l/min (size 16)
 - 440 l/min (size 25)

Features

- ▶ Protects hydraulic motors from overspinning in control operation
- ▶ Synchronous operation of parallel consumers in a wide flow range
- ▶ Variable division accuracy can be preselected or adjusted using proportional orifice
- ▶ Double-acting (dividing and summing) flow divider
- ▶ Constant division ratio for summing flow division
- ▶ Division ratio variably selectable for each consumer
- ▶ Suitable for open and closed circuits
- ▶ Optionally with or without free-wheel operation
- ▶ Can be switched in all functions
- ▶ Built-in pressure relief/feed valves for protecting hoses and preventing cavitation
- ▶ Switchable or electro-proportional control of the measurement edge

Fields of application (examples)

- ▶ Road rolling
- ▶ Rollers
- ▶ Special machines

Contents

Type code	2
Type code (old version)	4
Functional description	6
Technical data	10
Symbols	12
Application example	14
Dimensions	15
Accessories	22

Type code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
RTM		S			1X	/								S	S			S		V	4	*

Series

01	Traction module RTM	RTM
----	---------------------	-----

Size

02	Size 16	16
	Size 25	25

Division type

03	Summation division	S
----	--------------------	---

Number of consumers

04	2 consumers	2
	3 consumers	3
	4 consumers	4

Division ratio of consumers [%] (further on request)

05	2-fold			3-fold				4-fold				
	A	B		A	B	C		A	B	C	D	
	50	50	A	33.33	33.33	33.33	A	25	25	25	25	A
			25	50	25	M						

Series

06	10 to 19 (unchanged installation and connection dimensions)	1X
----	---	----

Nominal flow

07	Size 16	80 l/min	080
		160 l/min	160
	Size 25	220 l/min	220
		440 l/min	440

Secondary valves

08	Pressure relief/feed valve (standard)	350 bar	H350
		420 bar	H420
		450 bar	H450
		460 bar	H460
	Threaded plug		QZZZ

Nozzle diameter, fixed orifice

09	4.5 mm	A
	2.8 mm	B
	2.2 mm	C
	1.5 mm	D
	1.4 mm	E
	1.2 mm	F
	1.8 mm	G

Free-wheel function

10	Without free-wheel	1
	With free-wheel	2

Valve for control of division accuracy

		11	12	13	14	
11	Without valve	With threaded plug	Z	Z	Z	Z
	With valve (with proportional nozzle)	4.5 mm – 1.2 mm	A			
		4.5 mm – 1.4 mm	B			
12	Actuation	proportional	9			
		switching	7			
13	Supply voltage	24 V			1	
		12 V			3	
14	Electric port ¹⁾	Device connector DT04-2PA (Deutsch) (K40)				1
		Device connector Junior timer (AMP) (C4)				2

Housing

15	Standard					S
----	----------	--	--	--	--	---

Pressure compensator

		16	17	18	
16	Pressure compensator spool (standard)	S			
17	Pressure compensator spring	Size 16	A		
		Size 25	B		
18	Division deviation (T)	T small			1
		T medium			2
		T large			3

Metering orifice

		19	20
19	Metering orifice (standard)	S	
20	Size 16	T small	1
		T large (standard)	2
	Size 25	T small	3
		T large (standard)	4

Sealing material

21	FKM (fluoroelastomer)			V
----	-----------------------	--	--	---

Line connections (see page 21)

22	Flange according to DIN ISO 6162-2				4
----	------------------------------------	--	--	--	---

23	Further specifications in plain text				*
----	--------------------------------------	--	--	--	---

Note

Not all combinations according to the type code are possible. Design by technical sales.

¹⁾ Plug-in connectors are not included and must be ordered separately, see page 22.

Type code (old version)

Note

Traction modules that were created before 01/01/2016 are encrypted according to the following code.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
RTM		S				1X	/						K40	V	11	*

Series

01	Traction module RTM	RTM
----	---------------------	------------

Size

02	Size 16	16
	Size 25	25

Division type

03	Summation division	S
----	--------------------	----------

Number of consumers

04	2 consumers	2
	3 consumers	3
	4 consumers	4

Division ratio of consumers [%]

05	2-fold			3-fold				4-fold				
	A	B		A	B	C		A	B	C	D	
	50	50	A	33	33	33	A	25	25	25	25	A
	60	40	B	34	32	34	F	33	17	33	17	H
	75	25	C	25	50	25	M	27	23	27	23	K
			30	40	30	T	30	20	30	20	V	

Free-wheel spool

06	Standard	-
	Special spool	Y

Series

07	10 to 19 (unchanged installation and connection dimensions)	1X
----	---	-----------

Nominal flow

08	Size 16	80 l/min	080
		160 l/min	160
	Size 25	220 l/min	220
		440 l/min	440

Δp control

09	Electro-proportional orifice or orifice with electrical change-over orifice (adjustable orifice)	P
	Fixed orifice (without proportional valve)	F

Free-wheel function

10	Without free-wheel	1
	With free-wheel	2

Secondary valves

11	Pressure relief/feed valve	420 bar	H420
	(standard)	460 bar	H460
	Threaded plug		Q

Orifice diameter of fixed orifice or Operation with adjustable orifice

12	Orifice diameter of fixed orifice, e.g. F12 = Ø1.2 mm		F..
	Operation with adjustable orifice, electro-hydraulic proportional		W9
	Operation with adjustable orifice, electro-hydraulic switchable		W7

Supply voltage

13	$U = 24\text{ V}$		1
	$U = 12\text{ V}$		3

Electric port

14	Device connector DT04-2PA (Deutsch), Standard		K40
----	---	--	------------

Sealing material

15	FKM (Fluor-Kautschuk)		V
----	-----------------------	--	----------

Line connections

16	Flange according to DIN ISO 6162-2		11
----	------------------------------------	--	-----------

17	Special configuration		*
----	-----------------------	--	----------

Functional description

The RTM traction module is a flow divider for controlling hydraulic motors ensuring synchronous and free-wheel operation. It can be used for 2-, 3- and 4-wheel drives (multiple drives available upon request). It can be operated in open and closed circuits

Design

The RTM basically comprises of a housing (1) metering orifice (2), the proportional valve (3), free-wheel function (4) and pressure compensator (5).

In the housing (1) the sleeve is radially fixed into position (2.1) with the fixed orifice (3.2) thought it can be moved about its axes. According to the selected division/summation ratio, metering orifices are integrated in the sleeve- these are used to divide the output flows into channels **A, B, C** and **D**. To compensate for differences in load pressure across the different consumer ports, pressure compensators (5.2) have been integrated. The main flow moves the main spool(2.2) against the pre-tensioned springs (2.3). So, depending on the size of the flow, this alters the cross section of the metering orifice and the hydraulic fluid passes through the holes (5.1) to the pressure compensator spool (5.2) and then on to channels **A, B, C** and **D**. When needing to increase the division accuracy, the pressure in the spring chamber (2.4) must be increased by actuating the valve electrically (3.1) so that the pressure compensator spool (5.2) begins controlling earlier, increasing the traction accuracy of the vehicle. The division accuracy can also or alternatively be adjusted by replacing the nozzle (3.2).

To automatically switch from the division to the summation function, the directional valve (5.3) changes from the right to the left stop.

With optional activation (4.2), the differential lock is activated when there is a high pressure (external 3/2 directional valve not included in scope of delivery) at port **X**. Without the activation function, the threaded plug (4.1) is used without port **X**.

Note

The necessary actuation pressure at **X** is the high pressure present in the hydraulic circuit of the RTM. Switching is by means of an external directional valve (order separately).

- ▶ **X** pressure-less → free-wheel, divider deactivated
- ▶ **X** pressurized → synchronism, divider activated
- ▶ A flushing valve is to be provided between the pump and RTM.

(No flushing valve between engines and RTM!)

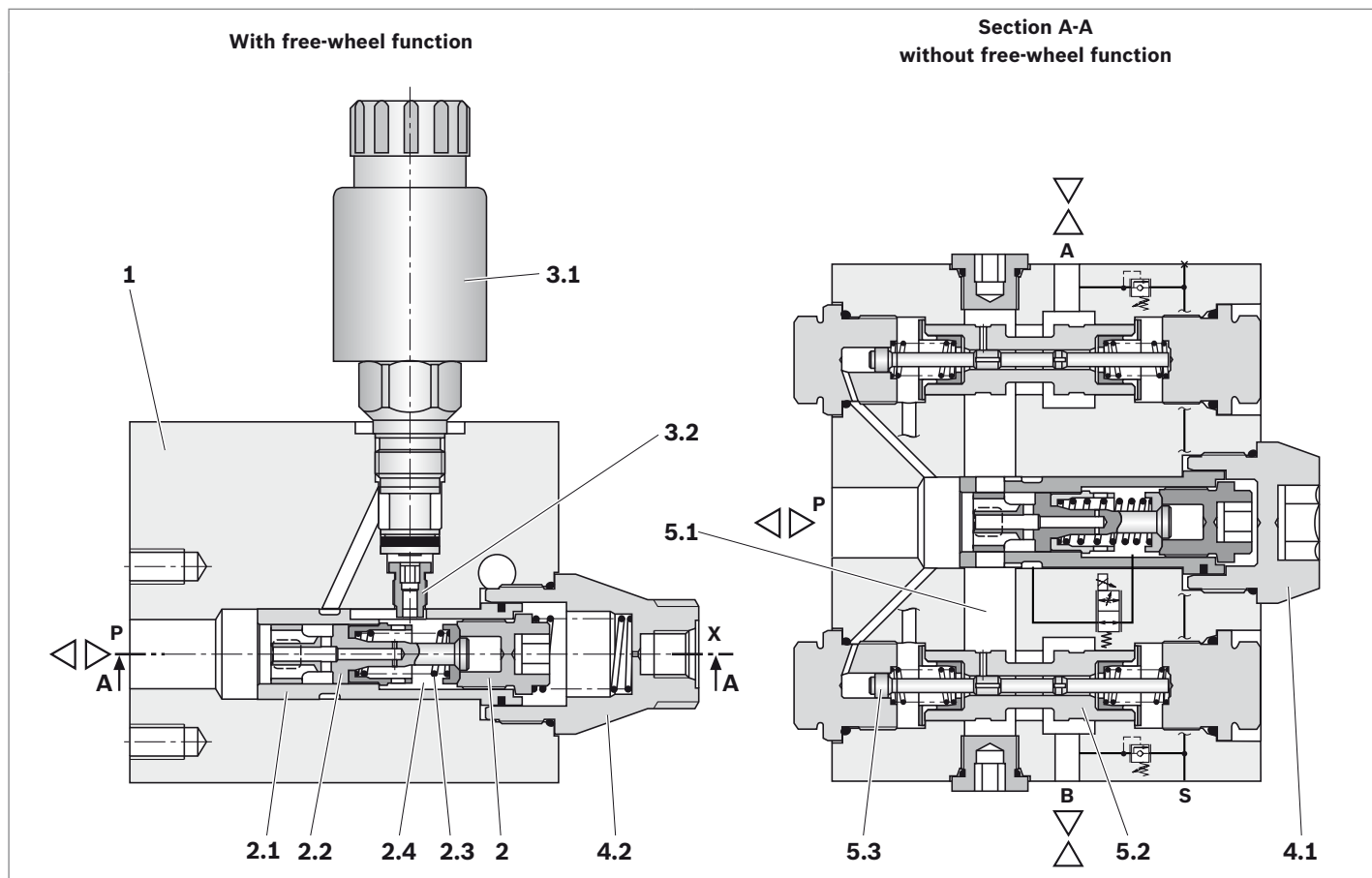
External directional valve: see data sheet 18136-21

flushing valve: see data sheet 95512)

Ports

P	Pump
A, B, C, D	Consumer
S	Boost pressure
X	Free-wheel

▼ Design RTM...S2...

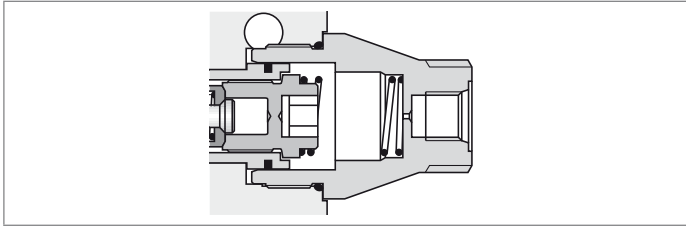


- 1 Housing
- 2 Metering orifice
- 2.1 Sleeve
- 2.2 Main spool
- 2.3 Compression spring
- 2.4 Spring chamber
- 3 Proportional valve
- 3.1 Valve
- 3.2 Fixed orifice

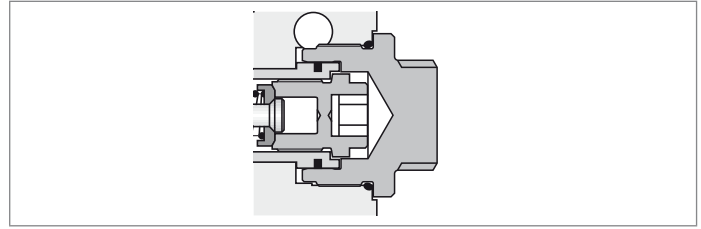
- 4 Free-wheel function
- 4.1 Threaded plug (without free-wheel)
- 4.2 Reducing piece (for free-wheel)
- 5.1 Bore
- 5.2 Pressure compensator spool
- 5.3 Directional valve

Free-wheel function

▼ **With free-wheel**

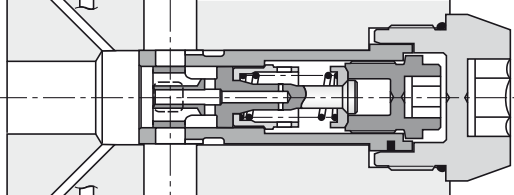
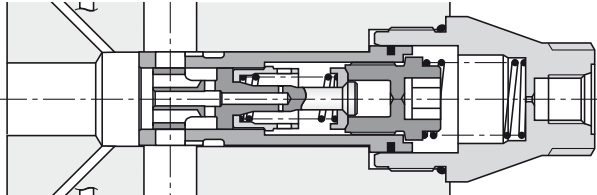
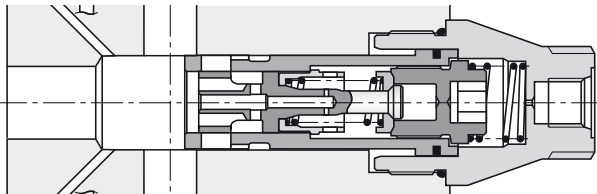


▼ **Without free-wheel**



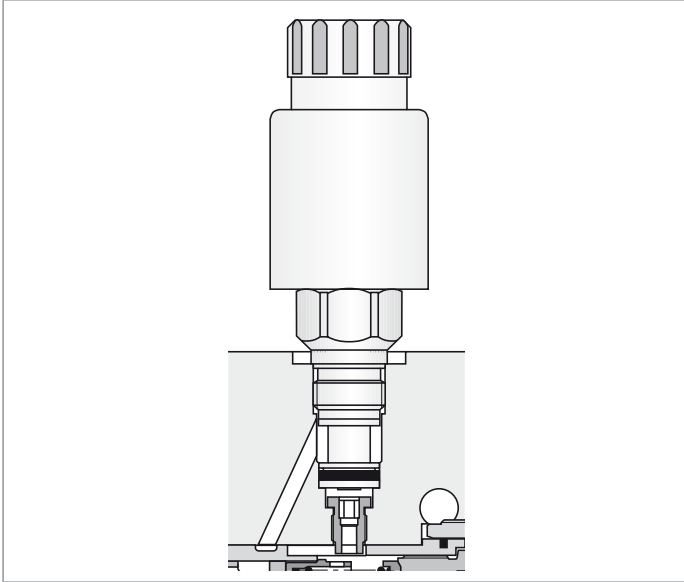
Actuation via external directional valve:

- ▶ **X** pressure-less → free-wheel, divider deactivated
- ▶ **X** pressurized → synchronism, divider activated
(see Notes on page 6)

Free-wheel function		electro-proportional orifice	Electrical switchover orifice	Fixed orifice
Without	RTM active	Proportional solenoid de-energized ($I = 0$)	Switching solenoid de-energized, low division accuracy	Division accuracy defined via fixed orifice
		↓ proportional increase in division accuracy		
		Proportional solenoid energized ($I = I_{max}$)	Switching solenoid energized, high division accuracy	
With	X pressurized RTM active	Proportional solenoid de-energized ($I = 0$)	Switching solenoid de-energized, low division accuracy	Division accuracy defined via fixed orifice
		↓ proportional increase in division accuracy		
		Proportional solenoid energized ($I = I_{max}$)	Switching solenoid energized, high division accuracy	
With	X depressurized RTM inactive	RTM in free-wheel mode; electro-proportional valve has no effect	RTM in free-wheel mode; electrical switchover orifice has no effect	RTM in free-wheel mode; fixed orifice has no effect
				

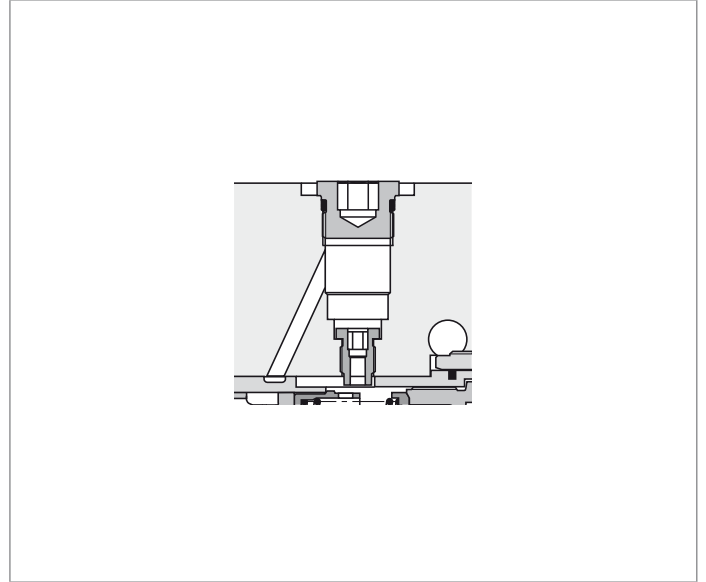
Δp control

▼ With valve

**Actuation**

- ▶ Electrohydraulically proportional, or
- ▶ Electrohydraulically switchable

▼ With fixed orifice



- ▶ With threaded plug

Technical data

General									
Size				16			25		
Weight				Summation division			Summation division		
				S2	S3	S4	S2	S3	S4
	Without free-wheel	kg		14.0	18.2	18.2	29.9	37.4	37.4
	With free-wheel	kg		14.1	18.3	18.3	30.0	37.5	37.5
Installation position	Horizontal (preferred)								
Connection type	SAE flange connection according to ISO 6162-2								
Mounting type	Surface connection								
Ambient temperature range	θ	°C		-25 to +80					
Priming (standard)	RAL 5010								
Hydraulic									
Maximum working pressure at port	P, A, B, C, D	p	bar	500					
	S	p	bar	40					
Max. flow at port	P	q_{Vmax}	l/min	80 or 160			220 or 440		
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids on request								
Hydraulic fluid temperature range	θ	°C		-20 to + 80					
Viscosity range	ν	mm ² /s		10 to 380					
Maximum permissible degree of contamination of the hydraulic fluid Cleanliness level according to ISO 4406 (c)	Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$								

Note

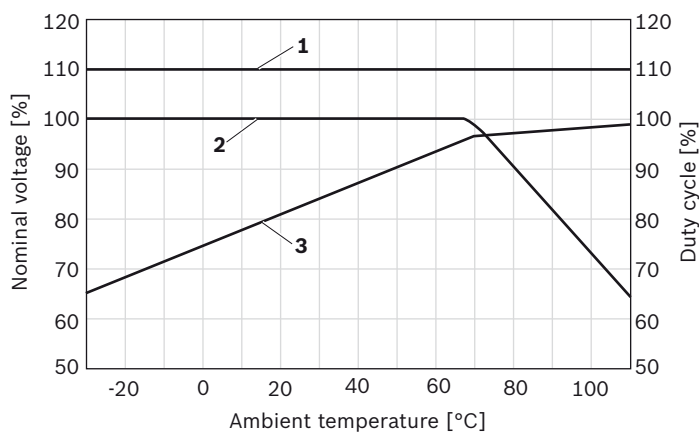
- ▶ Please contact us if the unit is to be used outside the specified range of values.
- ▶ The technical data were determined at a viscosity of 30 mm²/s (HLP46: 50 °C).
- ▶ For the “K40” electrical connection, an protective earth (PE) connection is mandatory based on the specification.

≡

Electrical proportional orifice (proportional control)			
Voltage type		DC voltage	
Supply voltage	V	12	24
Max. control current (nominal current)	A	1.76	1.2
Magnetic coil resistance	Cold value at 20 °C	Ω	2.3
	max. warm value	Ω	3.8
Duty cycle	%	100	
Max. flushing temperature ¹⁾	°C	150	
Type of protection according to VDE 0470-1, DIN 40050-9	Design "K40"	IP67 with installed and locked plug-in connector	
	Design "C4"	IP66 with installed and locked plug-in connector	
		IP69K with Rexroth plug-in connector, Mat-No. R901022127	
Electronic controls		Mobile amplifier VT-MSPA1-100 Plug amplifier VT-SSPA1-1..., see data sheet 30116	

Electrical proportional orifice (switch controlled)			
Voltage type		<i>U</i>	DC voltage
Supply voltage	V	12	24
Voltage tolerance over ambient temperature		See the diagram	
Power consumption	W	22	
Duty cycle		See the diagram	
Switching time according to ISO 6403 (solenoid horizontal)	ON	ms	≤ 80
	OFF	ms	≤ 50
Max. switching frequency	Switches/h	15000	
Max. flushing temperature ¹⁾	°C	150	
Type of protection according to VDE 0470-1, DIN 40050-9	Design "K40"	IP67 with installed and locked plug-in connector	
	Design "C4"	IP66 with installed and locked plug-in connector	
		IP69K with Rexroth plug-in connector, Mat-No. R901022127	
Electronic controls		Mobile amplifier VT-MSPA1-100 Plug amplifier VT-SSPA1-1..., see data sheet 30116	

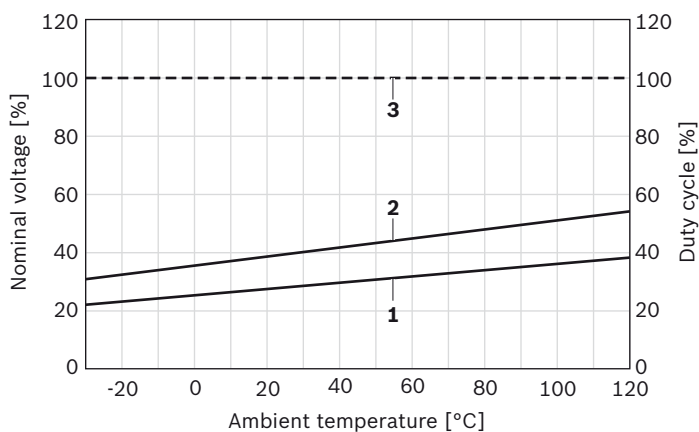
▼ Voltage range and duty cycle depending on the ambient temperature/switching solenoid



- 1 Maximum voltage
- 2 Duty cycle
- 3 Minimum response voltage

1) Surface temperature of coil housing. Due to the arising surface temperature of the solenoid coil, European standards EN 563 and EN 982 must be observed.

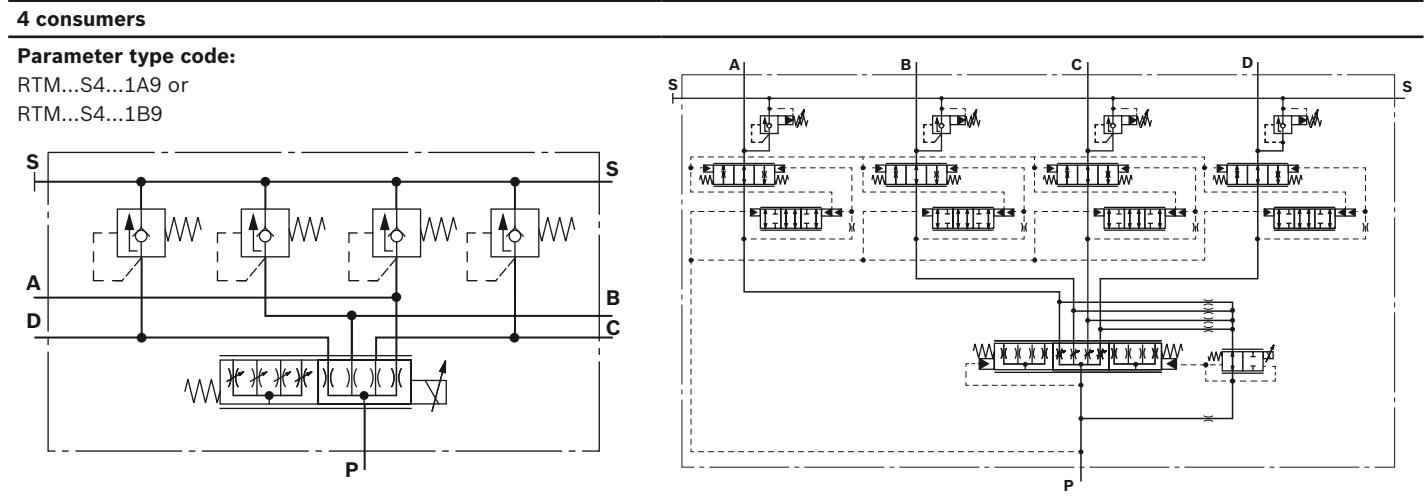
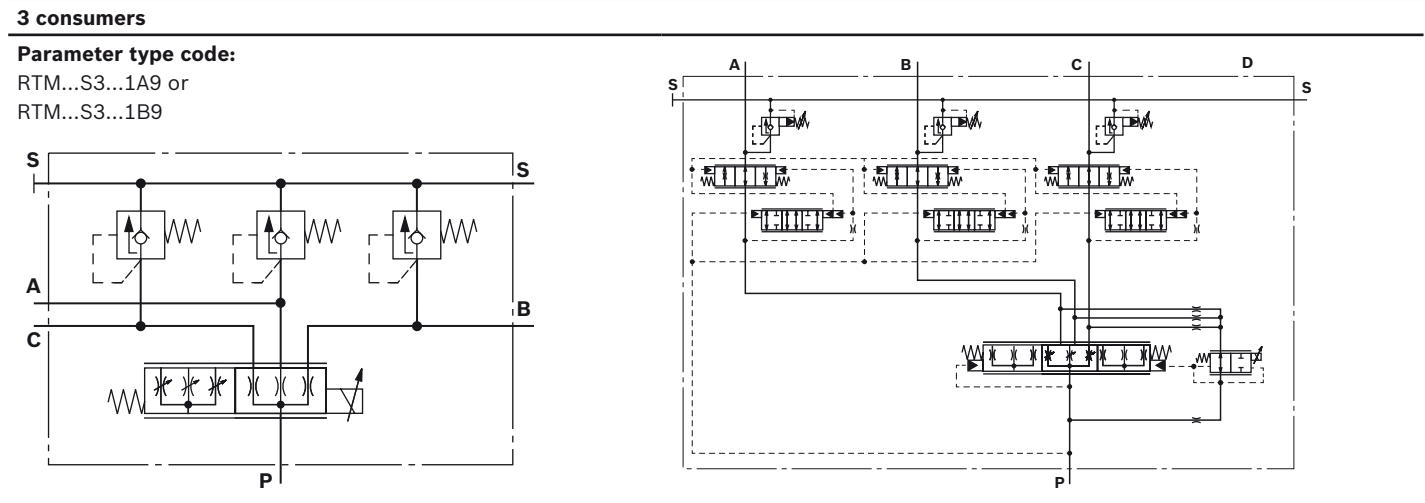
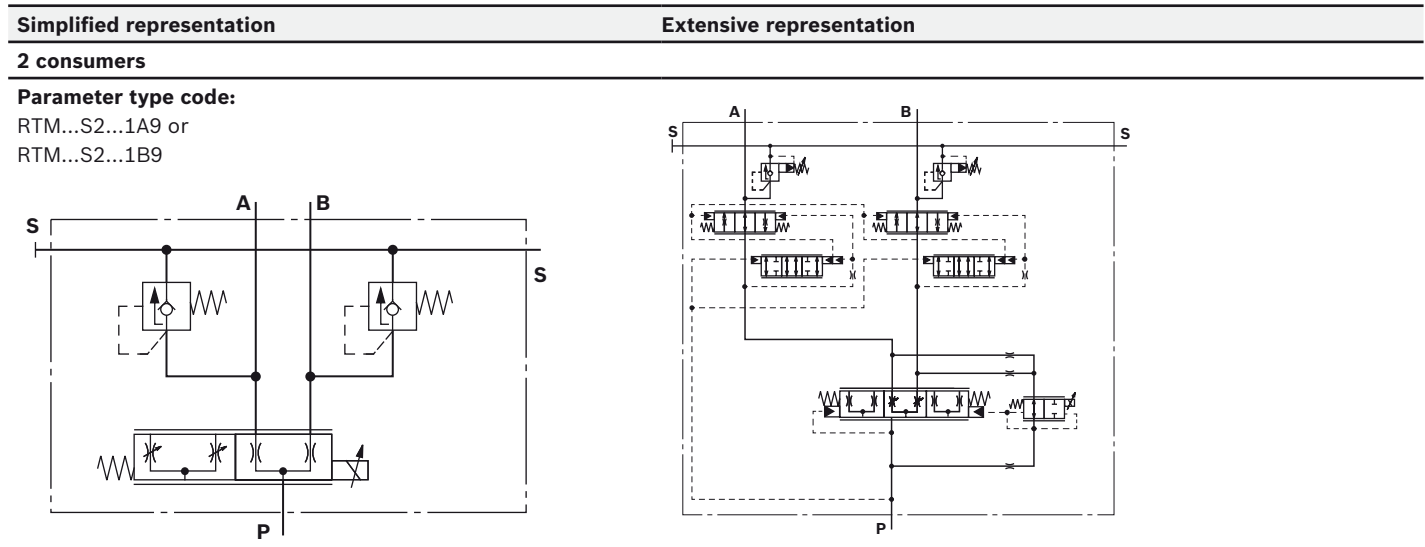
▼ Voltage range and duty cycle depending on the ambient temperature/proportional solenoid



- 1 Voltage supply measured for 1.2 A (24 V)
- 2 Voltage supply measured for 1.76 A (12 V)
- 3 Duty cycle

Symbols

Without free-wheel

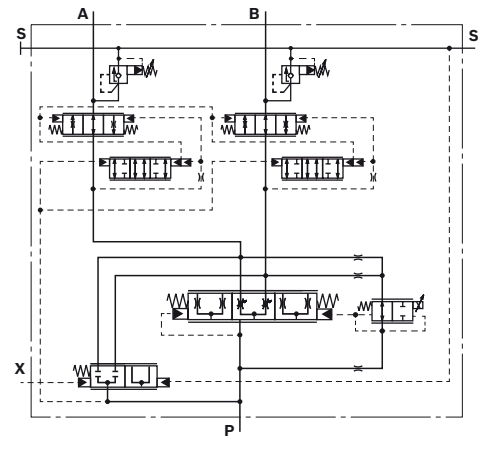
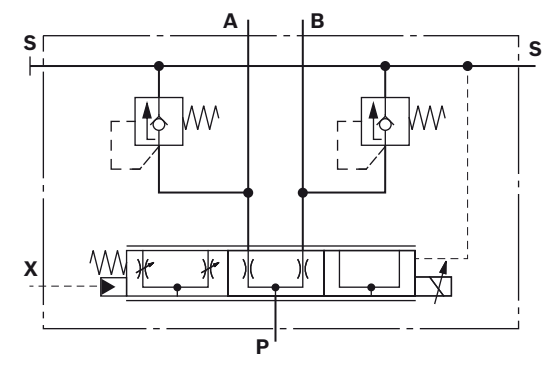


With free-wheel

Simplified representation	Extensive representation
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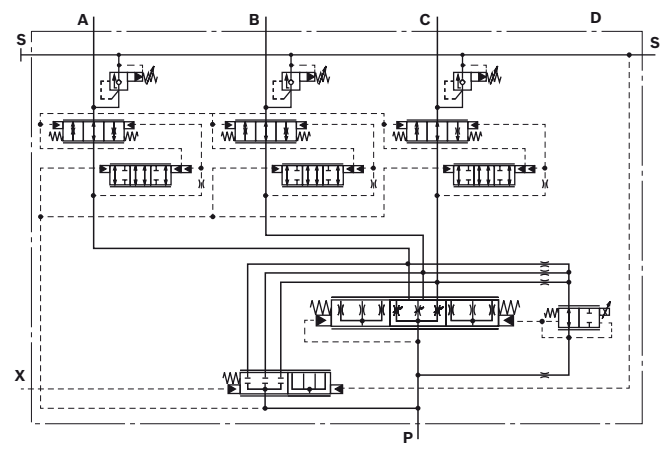
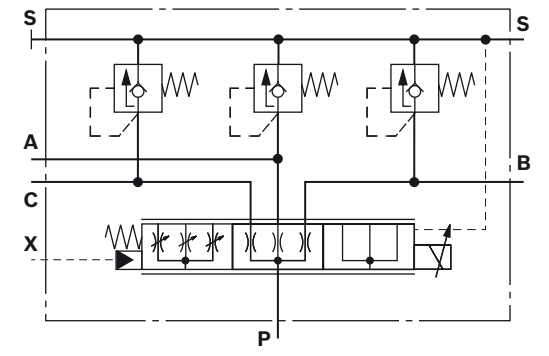
2 consumers

Parameter type code:
RTM...S2...2A9 or
RTM...S2...2B9



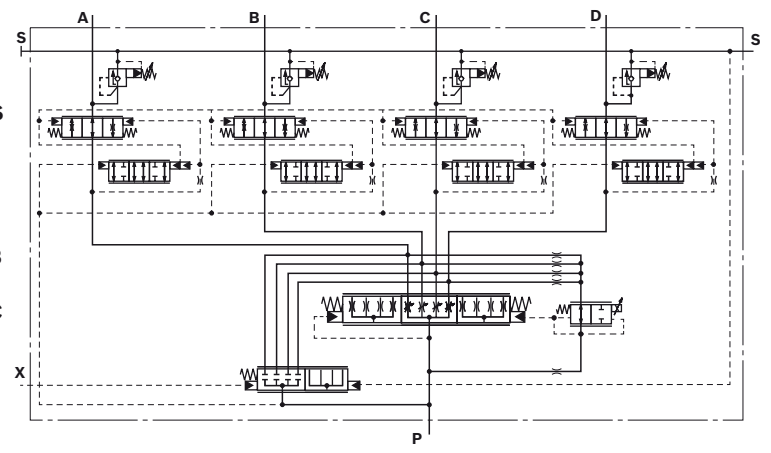
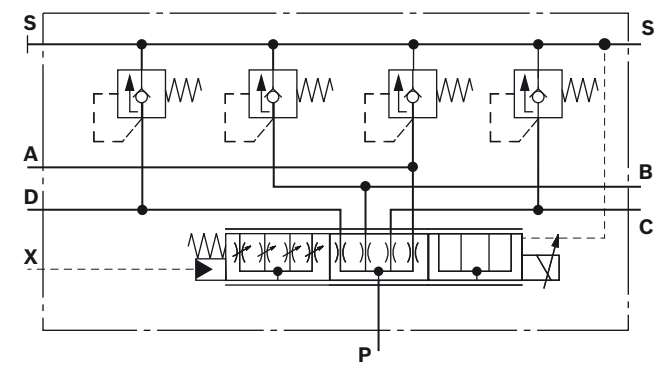
3 consumers

Parameter type code:
RTM...S3...2A9 or
RTM...S3...2B9



4 consumers

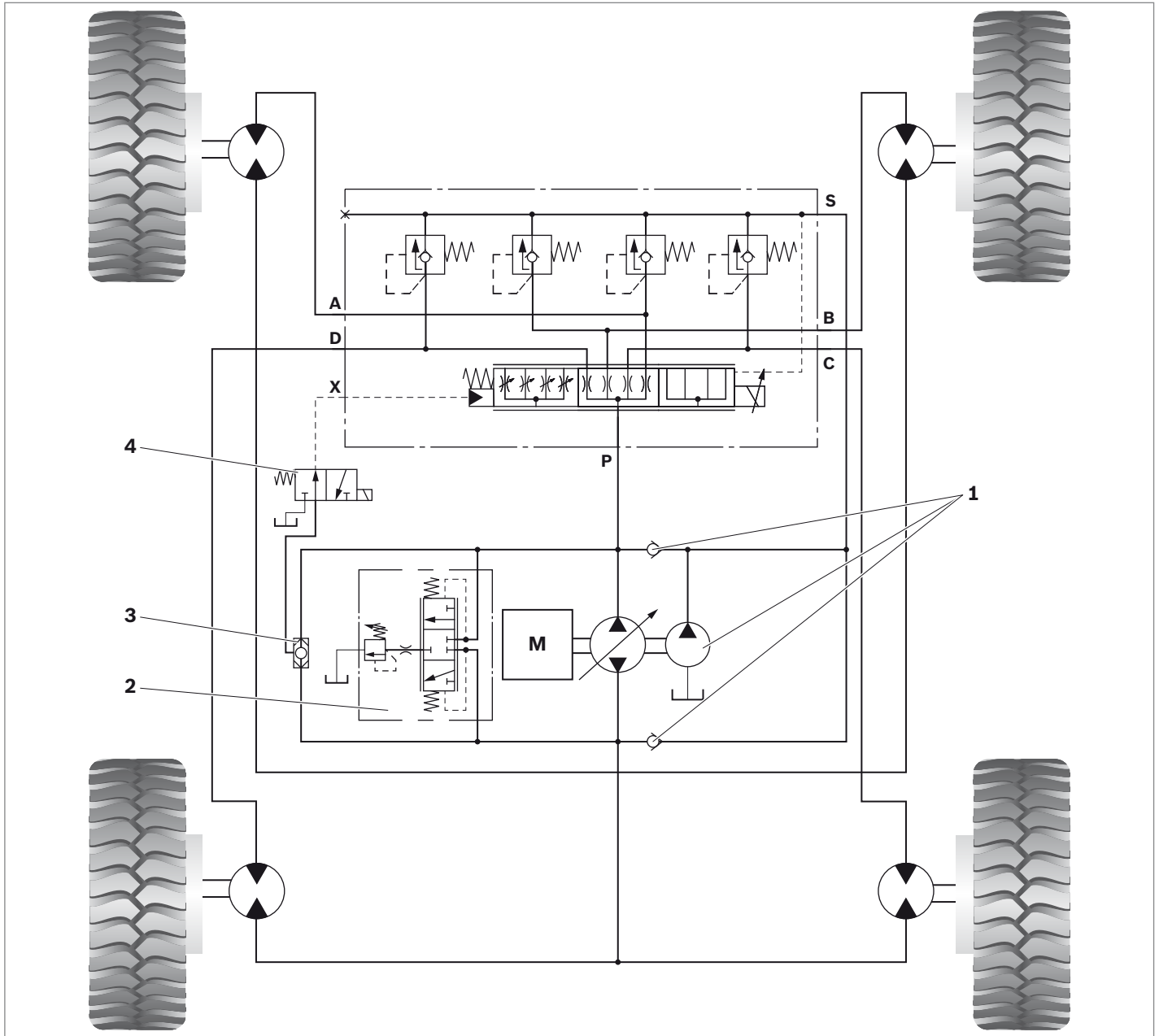
Parameter type code:
RTM...S4...2A9 or
RTM...S4...2B9



3

Application example

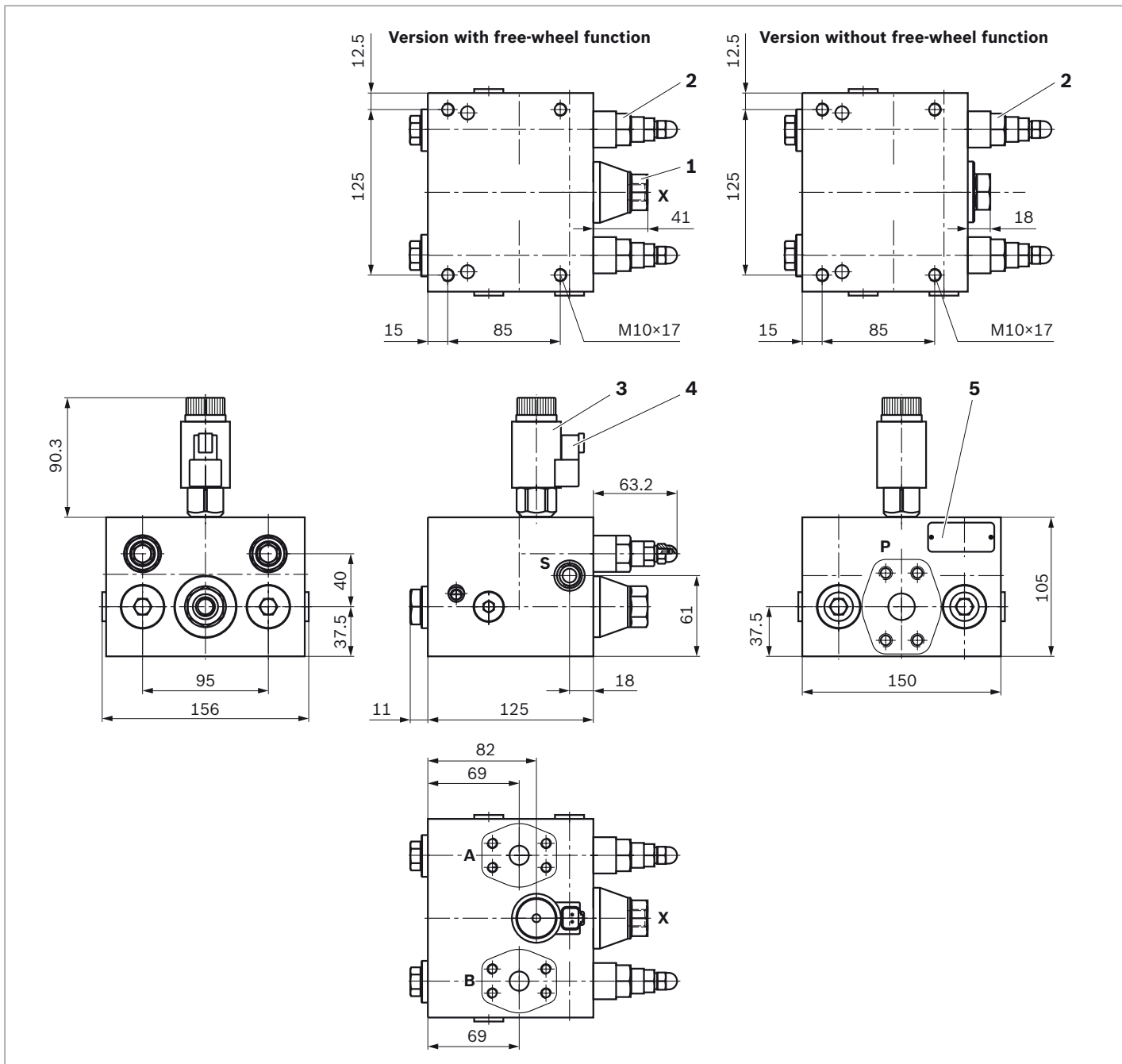
▼ RTM...S4 with free-wheel function (electro-proportional orifice), closed circuit



- 1 Check valves, normally integrated in pump
- 2 Flushing valve, positioning at pump, not at engines
- 3 Shuttle valve, partly integrated in pump (port MH)
- 4 Option: separate valve for free-wheel function high-pressure port (see Pos. 3)

Dimensions

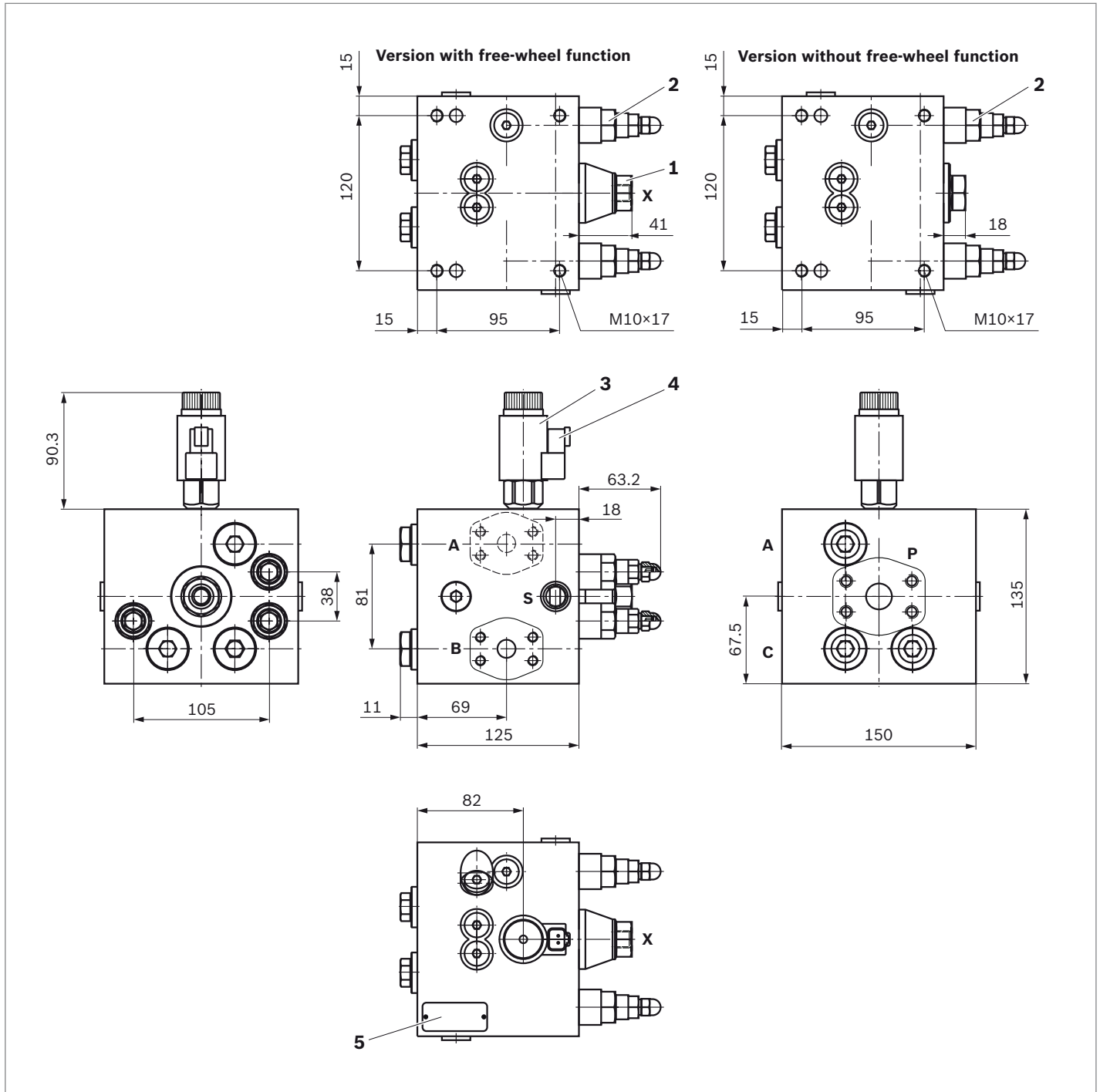
▼ RTM 16 S2



- 1 Port X only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve (preset, this setting must not be changed)
- 3 Proportional valve
- 4 Electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

▼ RTM 16 S3

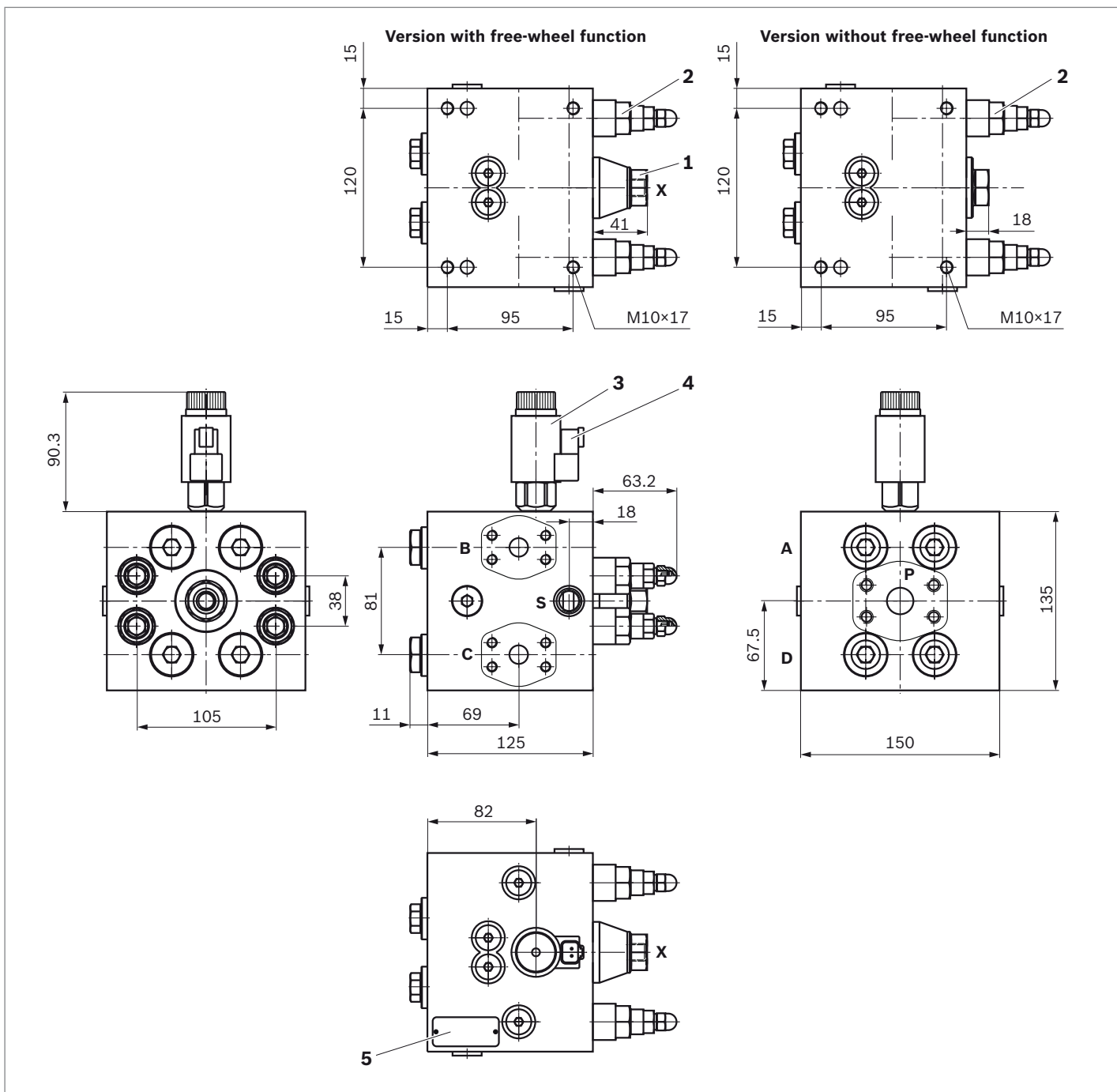


- 1 Port X only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve (preset, this setting must not be changed)
- 3 Proportional valve
- 4 Electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

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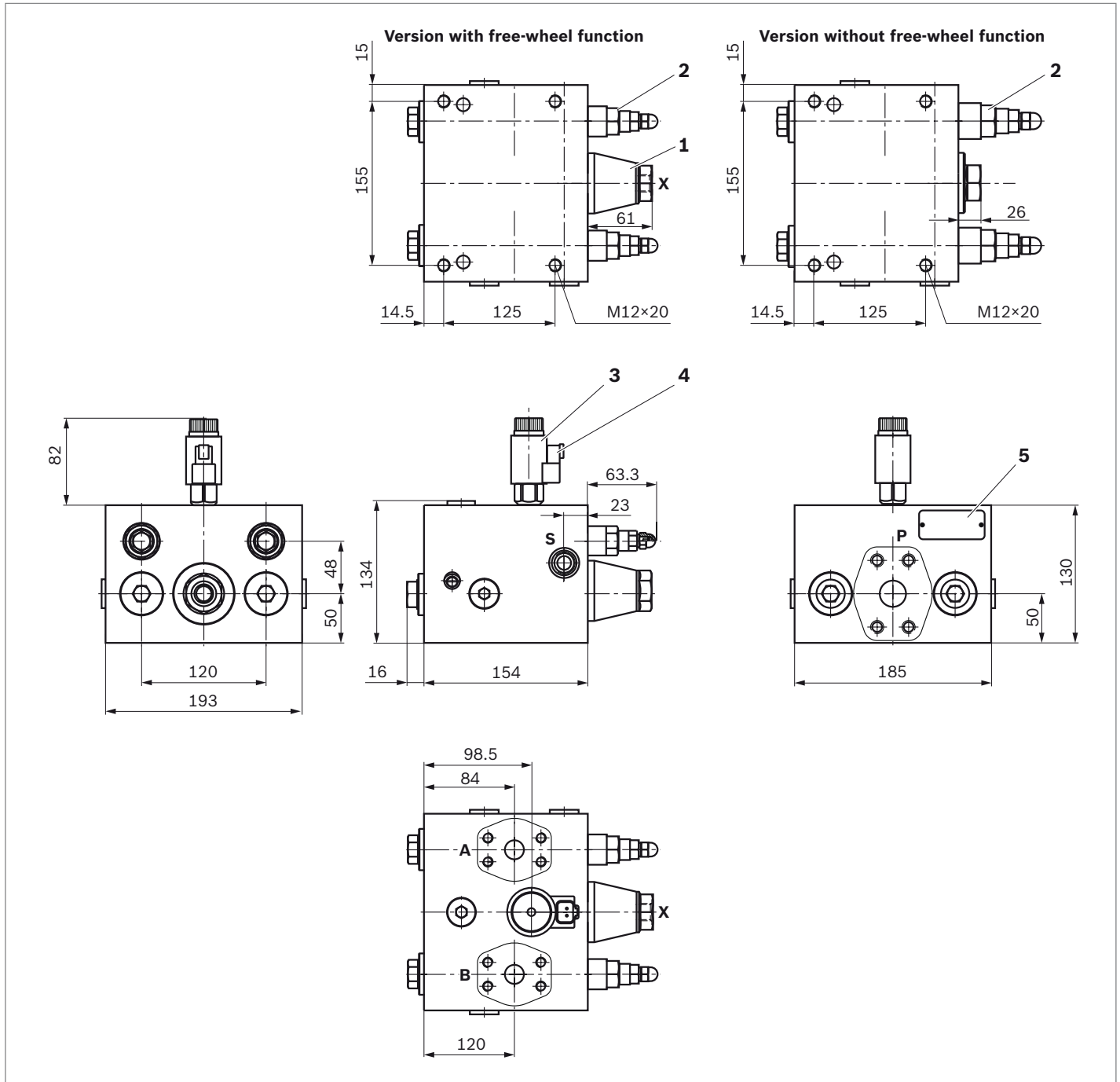
▼ RTM 16 S4



- 1 Port X only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve(preset, this setting must not be changed)
- 3 Proportional valve
- 4 Electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

▼ RTM 25 S2

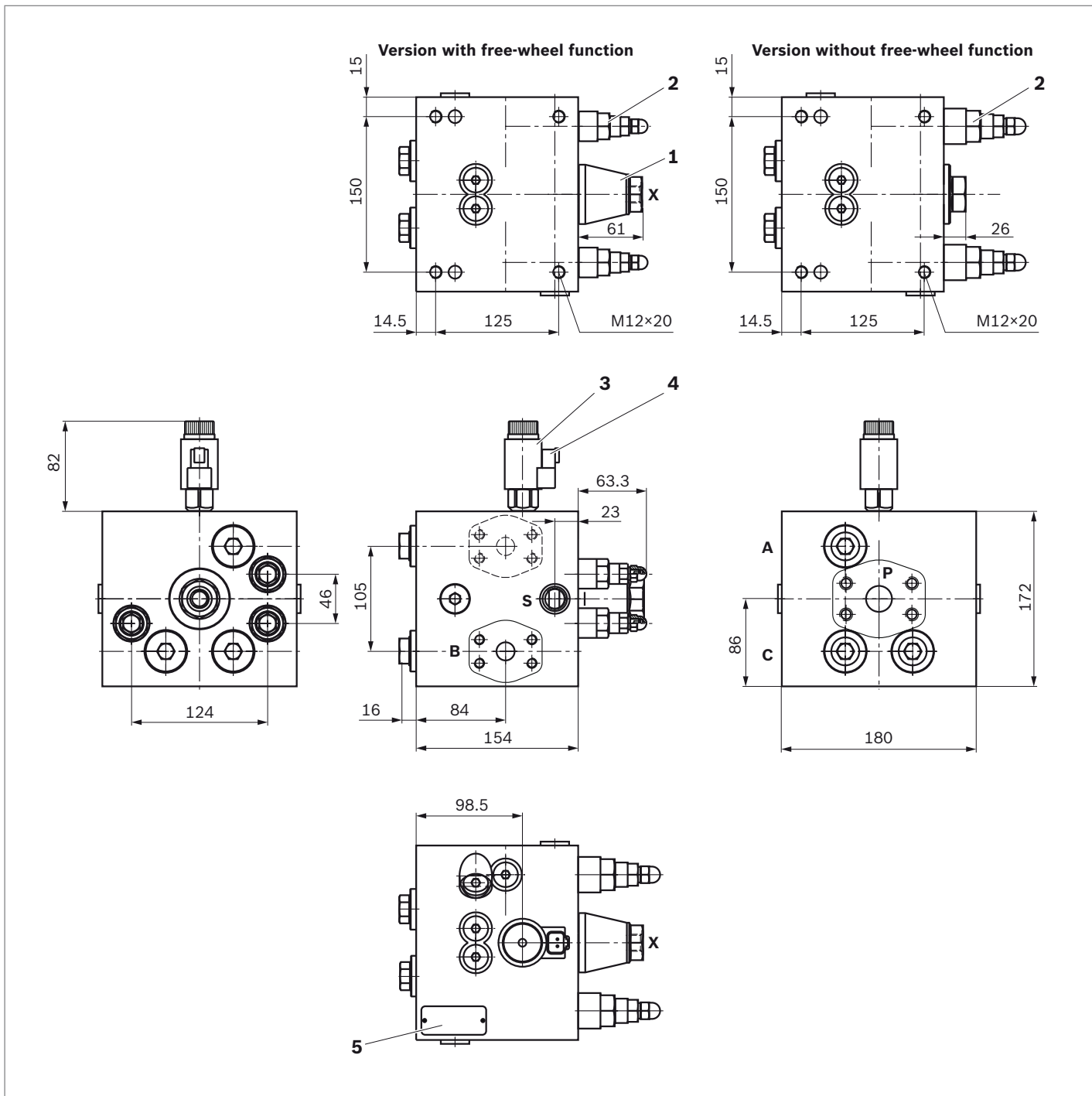


- 1 Port X only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve (preset, this setting must not be changed)
- 3 Proportional valve
- 4 Electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

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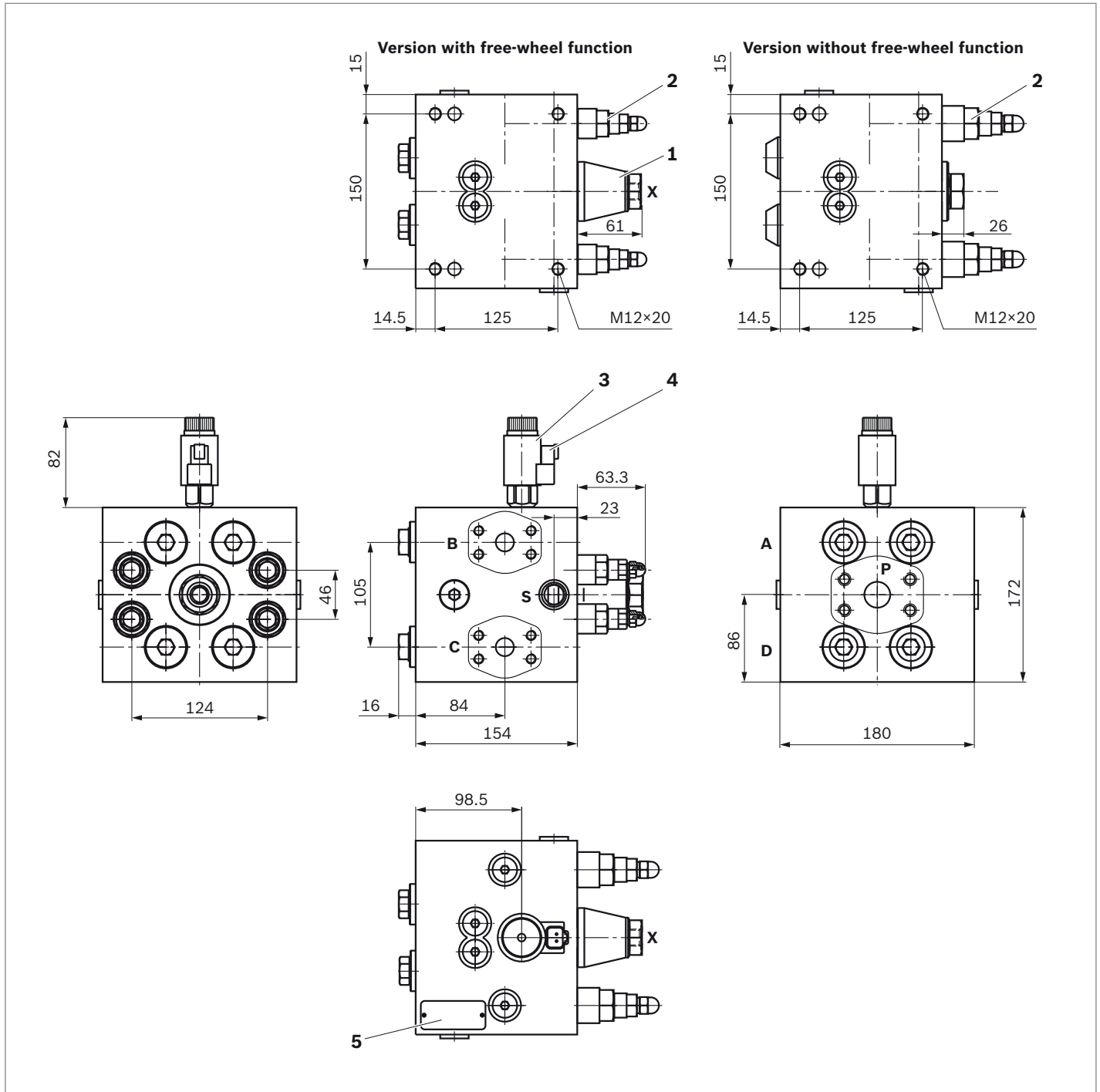
▼ RTM 25 S3



- 1 Port **X** only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve (preset, this setting must not be changed)
- 3 Proportional valve
- 4 electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

▼ RTM 25 S4



- 1 Port X only on versions with proportional orifice and free-wheel function
- 2 Pressure relief/feed valve (preset, this setting must not be changed)
- 3 Proportional valve
- 4 Electrical connection (mating connector is not included in the delivery contents and must be ordered separately)
- 5 Name plate

Line connections see page 21

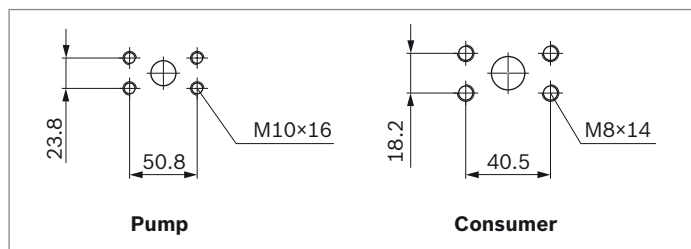
Busch Rexroth AG, F. E. 51 / 02 / 0

Line connections

Size 16

Connection	Dimension	Standard
P	FC1 × 19	ISO 6162-2
A, B, C, D	FC1 × 13	ISO 6162-2
S	M18 × 1,5	ISO 6149-1
X	M14 × 1,5	ISO 6149-1

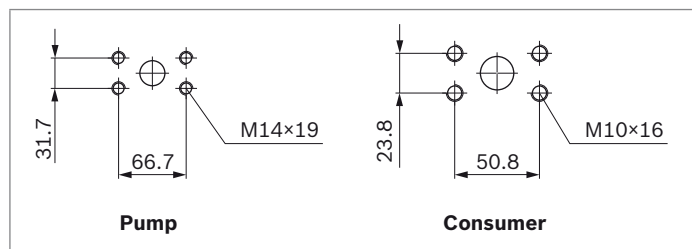
▼ Flange ports, deviation from ISO 6162-2



Size 25

Connection	Dimension	Standard (similar)
P	FC1 × 32	ISO 6162-2
A, B, C, D	FC1 × 19	ISO 6162-2
S	M22 × 1.5	ISO 6149-1
X	M14 × 1.5	ISO 6149-1

▼ Flange ports, deviation from ISO 6162-2



Accessories

Plug-in connector for FTDRE... and FTWE...

Recommended plug-in connector 1 DT04 (DEUTSCH)

- ▶ Material number: R900733451
 - For conductor cross section from 1.3 to 2.08 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm
- ▶ Material number: R901017847
 - For conductor cross section from 0.83 to 1.3 mm² and for an insulation diameter of the individual seals from 1.35 to 3.05 mm

▼ Recommended plug-in connector for DT04 (DEUTSCH)



Recommended plug-in connector 2 Junior Timer, 2-pin (AMP)

- ▶ Material number: R900313533
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 1.2 to 2.1 mm
- ▶ Material number: R901022127
 - For conductor cross section from 0.5 to 1 mm² and for an insulation diameter of the individual seals from 2.2 to 3 mm

▼ Recommended plug-in connector for Junior Timer, 2-pin (AMP)

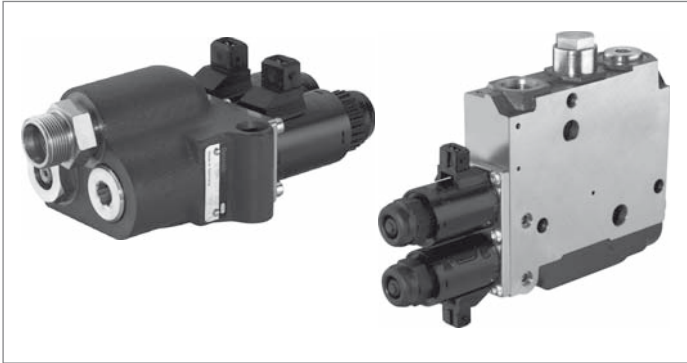


Note

Plug-in connectors are not included and must be ordered separately, see data sheet 08006.

Hitch control valves

EHR5-OC, EHR5-LS, EHR23-EM2



- ▶ Hitch control valves for the electro-hydraulic lifting unit control EHR
- ▶ Maximum flow rate
 - EHR5: 60 l/min
 - EHR23: 100 l/min

Features

- ▶ Proportional valves in flanged design (EHR5)
- ▶ Proportional valves in sandwich plate design (EHR23)
- ▶ EHR23 combinable with directional valves SB23 and SB33 for the work hydraulics

Fields of application

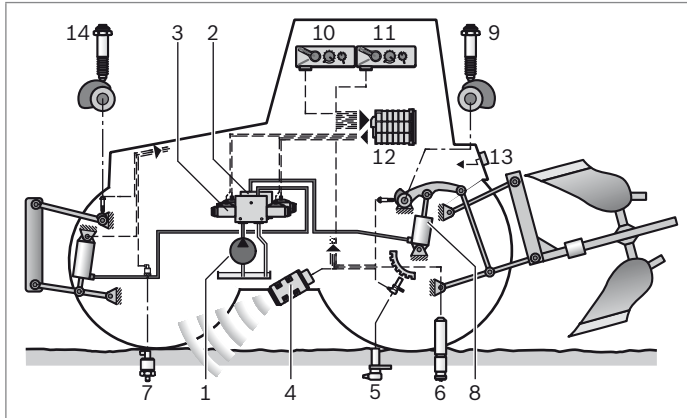
- ▶ Electro-hydraulic lifting unit control (EHR) for tractors and cutting table control for combines
- ▶ Hitch control valves for position, traction force, mix control, pressure and slip control as well as active vibration damping (transport mode)

Contents

Functional description EHR system	2
CAN bus in tractor	3
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EHR5-LS hitch control valves	9
EHR23-EM2 and EHR23-ERV hitch control valves	12
Line connections	20
Installation information	21
Related documents	21
Abbreviations	21
Spare parts	22

Functional description EHR system

System components



- | | |
|-----------------------------|----------------------------|
| 1 Hydraulic pump | 8 Hitch cylinder |
| 2 Hitch control valve rear | 9 Position sensor |
| 3 Hitch control valve front | 10 Operating unit rear |
| 4 Radar speed sensor | 11 Operating unit front |
| 5 Speed sensor | 12 Electronic control unit |
| 6 Force sensor | 13 Rear actuation buttons |
| 7 Pressure sensor | 14 Position sensor |

Mode of operation

The hydraulic pump (1) conveys an oil flow to the hitch control valve (2) which controls the hitch cylinders (8). These have an effect on the lower links so that attachments can be lifted, held or lowered.

The command value is recorded via the operating unit (10), the actual values are recorded via the sensors (9) and (6) and fed to the electronic control unit (12).

The control deviation resulting from the target/actual comparison is processed in the control unit (12) and passed on to the hitch control valve (2). The lifting and lowering valve is adjusted via two proportional solenoids.

The following different operating modes are possible:

Position control

Hereby the controlled quantity is the position of the hitch. The position sensor (9) which is operated by a radial cam on the hitch delivers the actual value.

Traction force control

Hereby the controlled quantity is the force at the lower links. If it is kept constant, an ideal capacity utilization of the tug boat performance will be available, such as with plowing in uneven terrain and with inhomogeneous ground. The actual value is measured by the force sensors (6). Regulation of the traction force is effected by change of the working depth of the attachment (e.g. plow).

Mix control

Hereby the control deviations from position and traction force are mixed in an adjustable ratio at the operating unit and processed as controlled quantity. The mix control can be used to reduce changes of the working depth due to different ground resistances which occur with the pure traction force control.

Vibration damper

In order to reduce the front axle load fluctuations when transporting heavy attachments and thus increase the steerability, the sensors (6) and (9) are used for measuring the controlled quantity. The evaluation is made via the electronic control unit (12) which delivers the corresponding electronic signals to the hitch control valve (2).

Slip control

The slip control offers the following advantages:

- ▶ Expenditure of time and fuel are reduced,
- ▶ The tire wear is reduced,
- ▶ The floor is protected,
- ▶ The driver is relieved,
- ▶ Getting stuck is avoided.

This function is realized by measuring the real driving speed (radar sensor (4)) and the drive speed (speed sensor (5)).

Pressure control

An ideal compression of the farmland with packer rollers can be reached by means of pressure control. The output signals of the pressure sensor (7) are processed in the control unit (12) and passed on to the hitch control valve (2).

Front control

The command values for the front control are determined via the operating unit (11). The actual values are supplied via the sensors (7) and (14) the electronic control unit (12). The volume oil flow of the hitch control valve (3) is proportionally regulated in accordance with the resulting control deviation of the target/actual comparison in the control unit. The front control can be used to realize the functions position and pressure control.

External control

The position sensor at the attachment delivers the electrical signals which are evaluated in the control unit (12) and hitch control valve (2) so that the attachment is controlled in a defined position.

Rear actuation

The hitch can be operated upwards and downwards by means of the rear button (13).

CAN bus in tractor

Every future-oriented and efficient electronics concept puts high requirements on cross-system exchange of information with a high transmission reliability.

The electronics proportion in the tractor has been growing continuously for years. This leads to a higher complexity of the electronics functions in control units the information of which has to be exchanged and/or coordinated for fulfilling the tasks. In this connection the data transmission via the common wiring harness often turns out to be unsuited.

The use of a serial data bus is a good solution which results in reducing the wiring harness and cable plugs. A suited bus system presents the Controller Area Network (CAN) developed by Bosch, because CAN connects equal stations via a serial data bus. Another advantage of CAN with regard to the common cabling is the fact that data errors which occur on an occasional basis due to electromagnetic radiation are recognized and automatically corrected by means of transmission repetition.

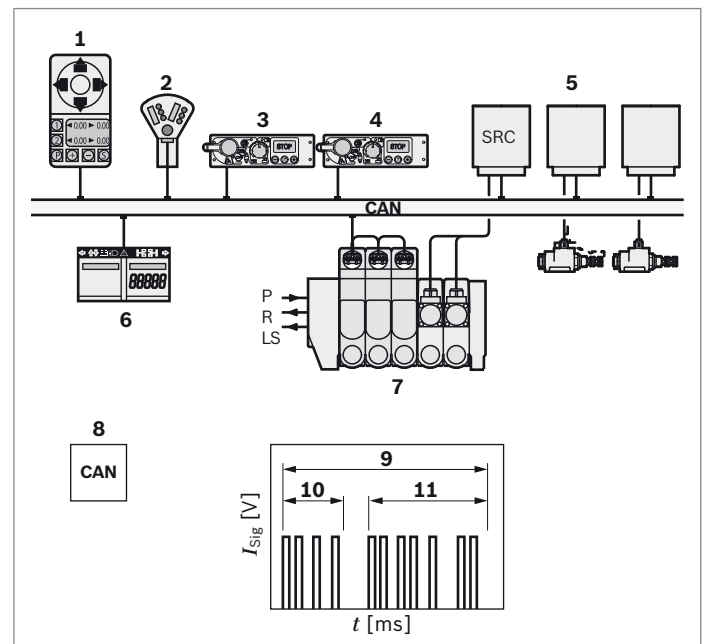
CAN features

- ▶ Definitely more functional safety for all electronic systems.
- ▶ High information and transmission rate.
- ▶ Linking and thus simultaneous communication of several sensors, control units and indicator units possible.
- ▶ Worldwide accepted standard, ISO 11898 and 11519-2 as well as SAEJ 1939.
- ▶ Due to less cabling smaller installation space, less costs and less accident-sensitive.
- ▶ Bigger fault tolerance and high interference resistance of the interface.

Switch-on interlock

The electrical control device has different monitoring installations apart from the control function and the processing of the actual value. A switch-on interlock ensures that no movement is carried out when switching on the hitch. Unlocking is carried out by the operating the excavation switch from stop to transport for the first time. The first movement is carried out with reduced speed. The maximum lift height is additionally monitored. A potentiometer can be used to preselect the limitation. Monitoring the position sensor cable for interruption or short circuit results in switching off the electronic control unit in case of failure so that a movement of the hitch is prevented.

- ▶ Ideal diagnosis capability by means of displaying an error code.
- ▶ Highest possible resolution:

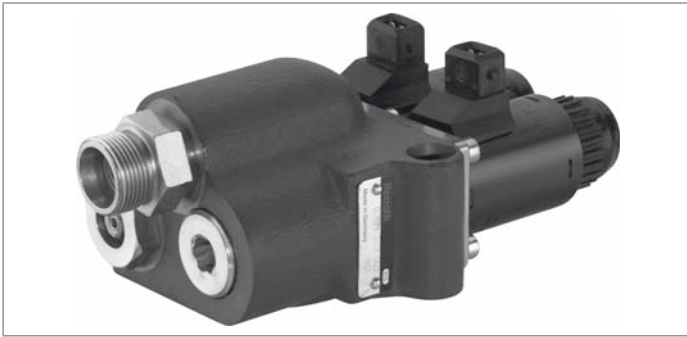


- | | |
|----------------------------|---------------------------------|
| 1 Operating unit | 7 Central modular control block |
| 2 Directional valves | 8 CAN signal |
| 3 EHR front | 9 CAN message |
| 4 EHR rear | 10 ID |
| 5 Electronic control units | 11 Signal |
| 6 Instrument cluster | |

Technical data

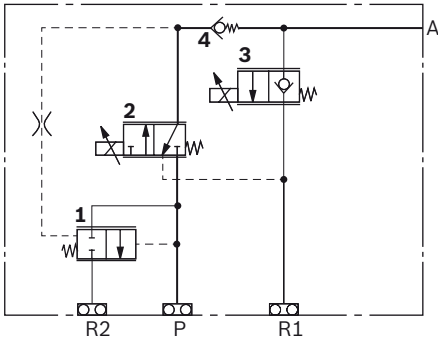
general				EHR5	EHR23
Design				Flange design	Sandwich plate design
Weight	EHR5-OC	kg		3.1	
	EHR5-OC Subplate	kg		1.5	
	EHR5-LS	kg		3.1	
	EHR23	kg			6.5
Installation position				Axis Z-Z, max. 30 ° variation from the horizontal	
Line connections				Screw-in threads see page 21	
Ambient temperature range		θ	°C	-30 to +80	
hydraulic				EHR5	EHR23
Maximum operating pressure at the port	P	p_{\max}	bar	220	250
	A	p_{\max}	bar	220	
	Y	p_{\max}	bar		250
	R	p_{\max}	bar		30
	R1	p_{\max}	bar	5, but smaller than load pressure	
	R2	p_{\max}	bar	10	
Flow rate		q	l/min	See table page 6 and 10	See table page 14 to 19
Maximum load drop off at port A			cm ³ /min	4 (with 125 bar, viscosity 35mm ² /s)	
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524 Additional hydraulic fluids, e.g. environmentally friendly fluids, upon request.	
Hydraulic fluid temperature range	Admissible range		θ	°C	+20 to +90; +100 for a short time
	Admissible range for start		θ	°C	-30
Viscosity range	Admissible range		ν	mm ² /s	10 to 800
	Recommended range		ν	mm ² /s	20 to 100
	Admissible range for start		ν	mm ² /s	Up to 2000
Max. admissible degree of contamination of the hydraulic fluid	Cleanliness class according to ISO 4406 (c)			Class 19/16	For this we recommend using a filter with a minimum retention rate of $\beta_{25} = 75$
	Cleanliness class according to NAS 1638			Class 10	
electric					
Direct shutter actuation by means of proportional solenoids		U	V	12	
		I_{\max}	A	3.35	
Electrical connections				Plug-in connection, 2-pole	
Protection class				IP64A	

EHR5-OC hitch control valves

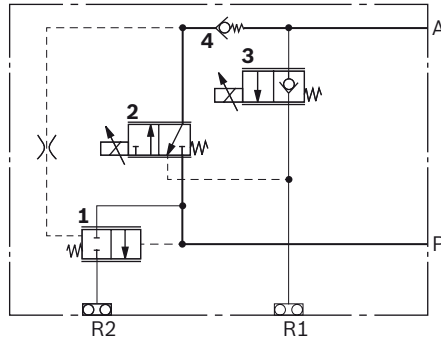


- 1 3-way pressure compensator
- 2 Lifting module
- 3 Lowering module
- 4 Check valve

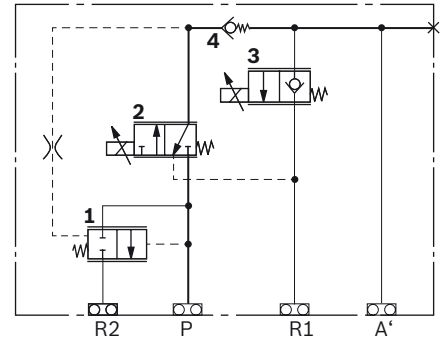
▼ Symbol 1



▼ Symbol 2

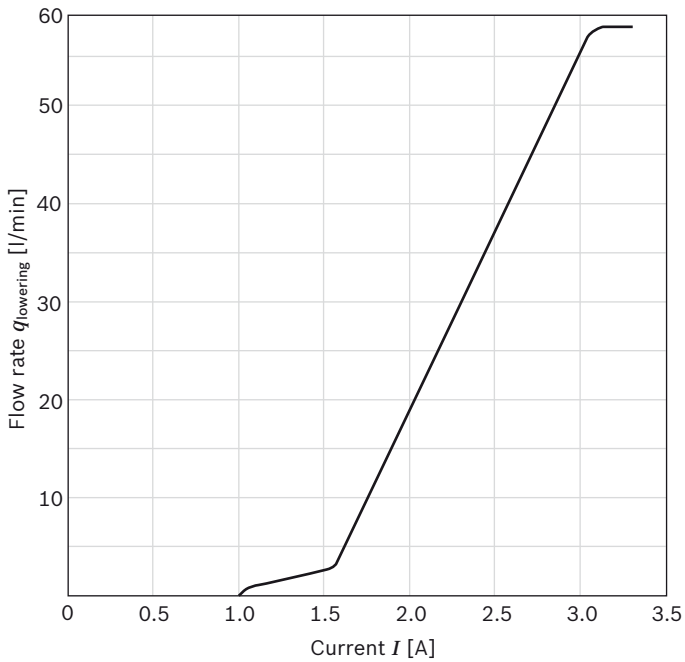


▼ Symbol 3

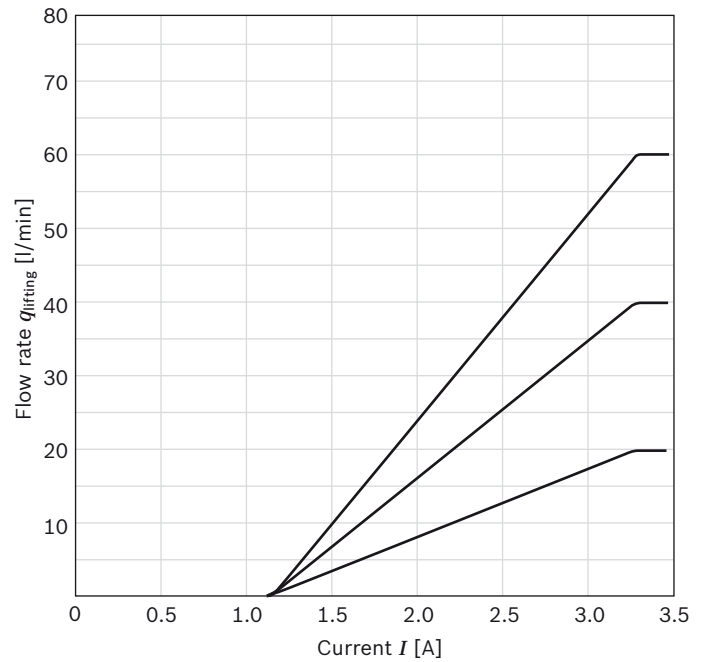


Characteristic curves

▼ Characteristic curve lowering



▼ Characteristic curve lifting



Notice

Measured at $\Delta p A \rightarrow R = 15 \text{ bar}$; $\theta = 50 \text{ }^\circ\text{C}$

Available variants

Material number	Drawing number	Line connections:				Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	Manual override	Position solenoid plug	Symbol see page 5
		A	A' in flange (max. 25 l/min)	P	Threaded version see page 21					
0 521 222 002	RA 501 595 47	M22 x 1.5	–	M22 x 1.5	II	60	40	with	①	2
0 521 222 005	RA 501 561 63	M22 x 1.5	–	M22 x 1.5	II	60	40	without	① + ④	2
0 521 222 009	RA 501 586 30	M22 x 1.5	–	M22 x 1.5	II	60	40	with	②	2
R917007846	A 521 023 253	M22 x 1.5	–	M22 x 1.5	II	60	60	with	①	2
R917000878	RA 501 587 22	M22 x 1.5	–	Flange	I	60	60	without	①	1
R917005088	RA 501 586 29	M22 x 1.5	–	Flange	II	60	60	with	①	1
R917006052	RA 501 595 45	M22 x 1.5	–	Flange	II	20	40	with	①	1
R917006650	RA 501 595 45	M22 x 1.5	x	Flange	II	60	40	with	①	3
R917007147	RA 501 595 45	M22 x 1.5	x	Flange	II	60	60	with	①	3

① = as shown, see page 7

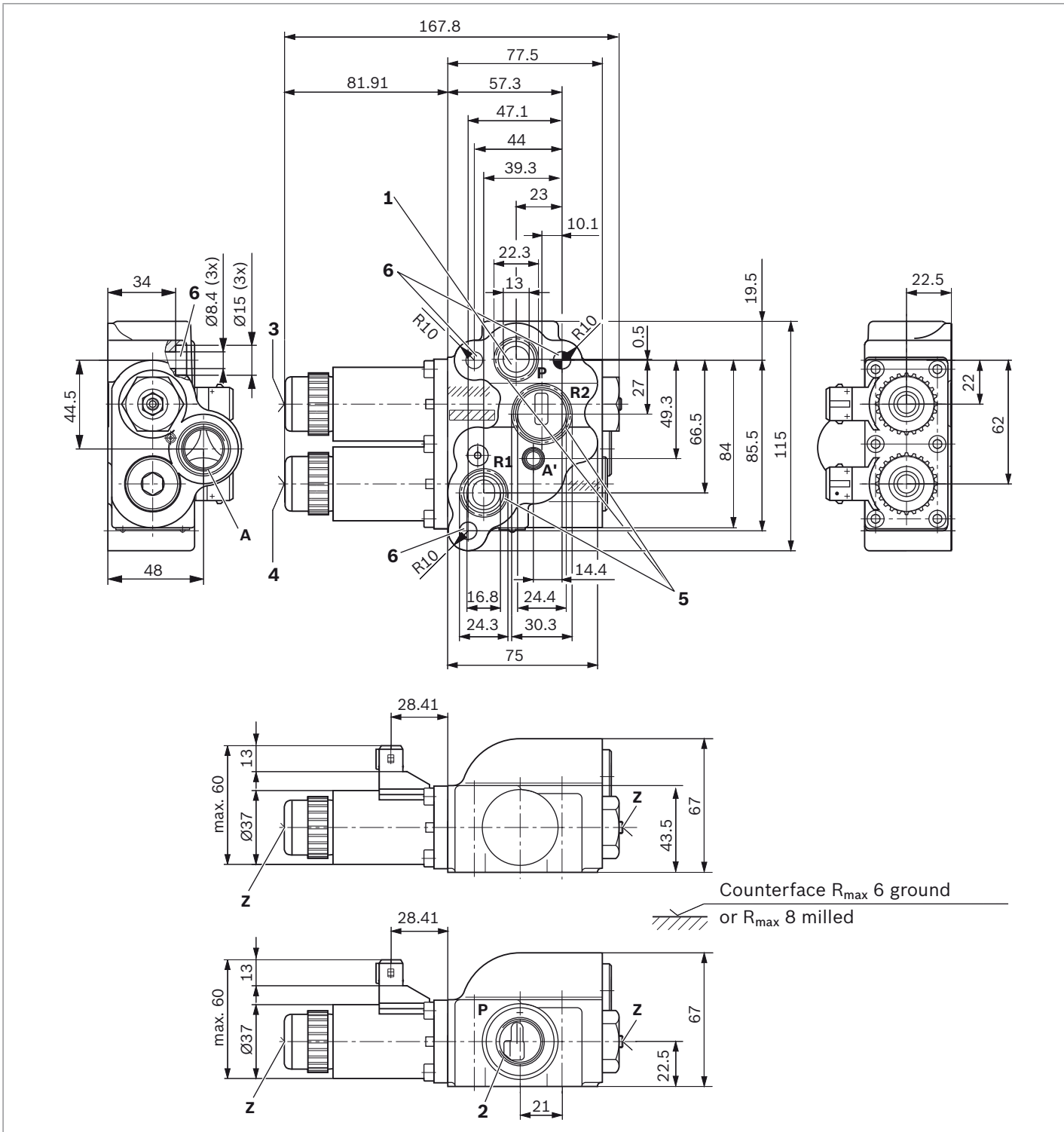
② = Lifting and lowering - solenoid rotated by 90°

④ = Lifting and lowering - solenoid plug with different coding

Ports EHR5-OC	
P	Pump
A, A'	Actuator (cylinder)
R1	Return flow actuator (cylinder)
R2	Return flow

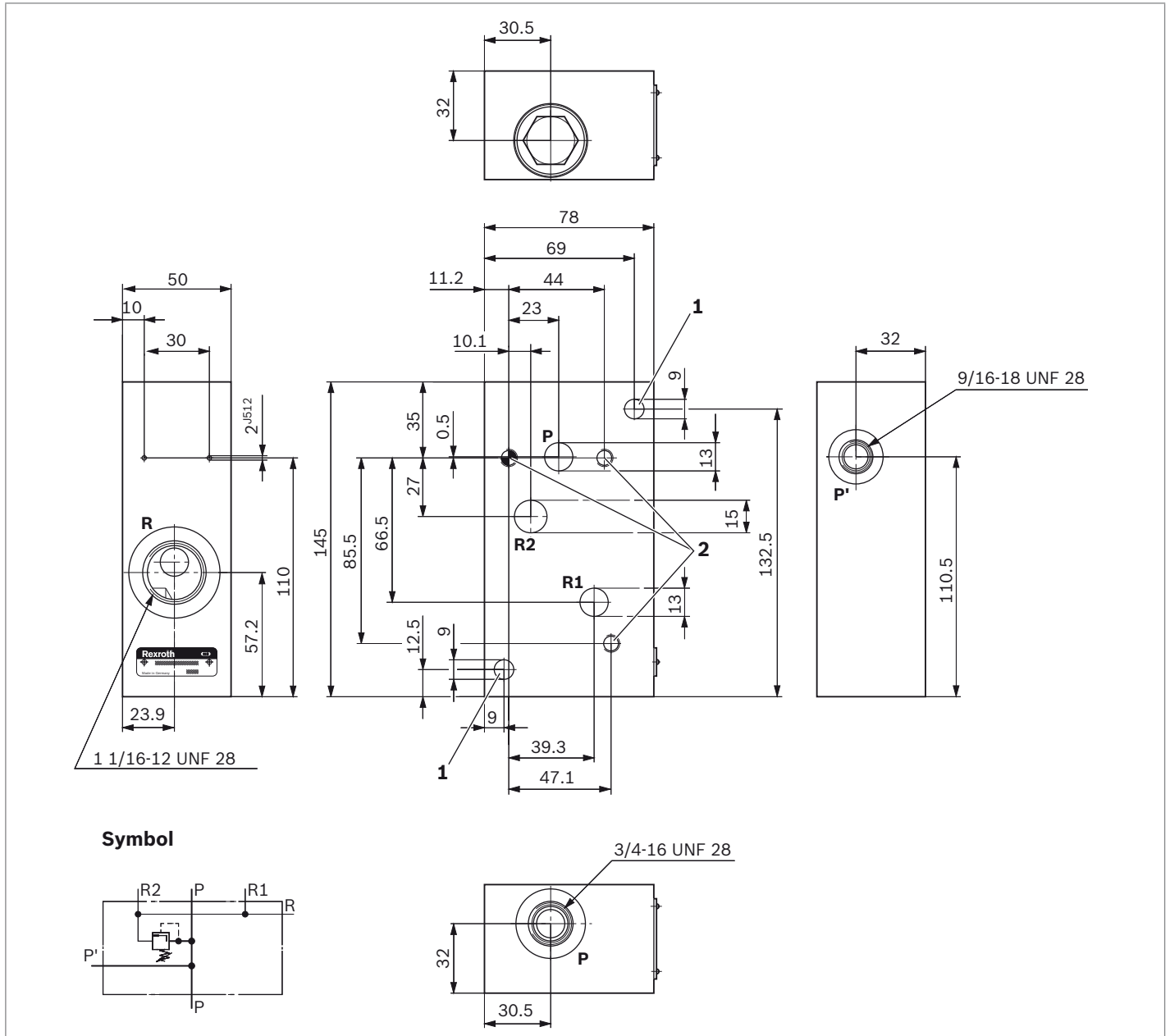
Dimensions

▼ EHR5-OC



- 1 Flange connection P
- 2 Threaded connection P
- 3 Lifting
- 4 Lowering
- 5 O-ring is included in the scope of delivery
- 6 Three mounting bores; $M_A = 25^{+6}$ Nm

▼ Subplate for EHR5-OC



- 1 Two mounting bores
- 2 Three mounting threads

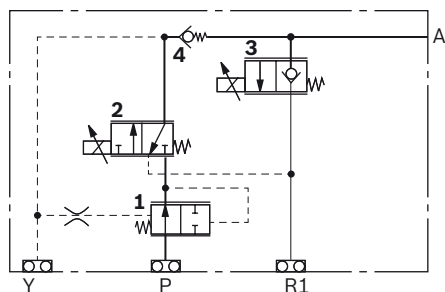
Material number	DBV p [bar]
1 525 503 641	205 ⁺¹⁰

EHR5-LS hitch control valves

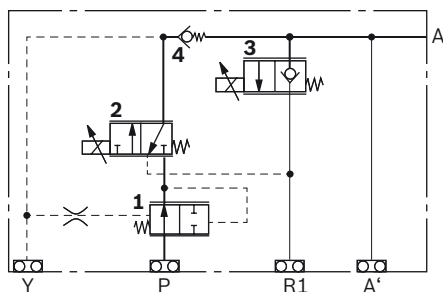


- 1 3-way pressure compensator
- 2 Lifting module
- 3 Lowering module
- 4 Check valve

▼ Symbol 1

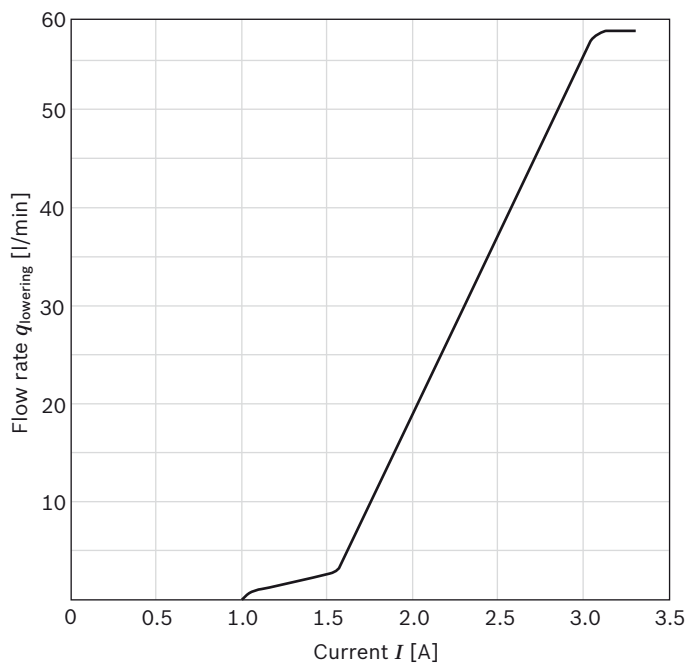


▼ Symbol 2

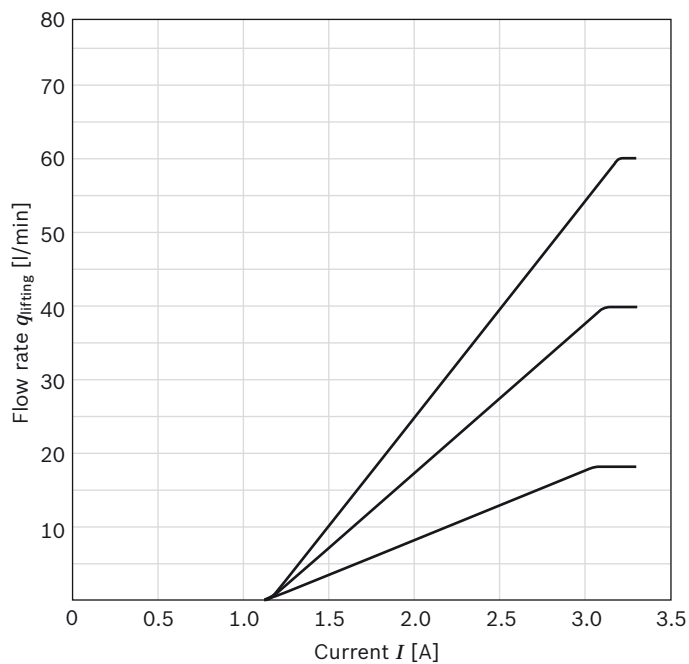


Characteristic curves

▼ Characteristic curve lowering



▼ Characteristic curve lifting



Notice

Characteristic curve lowering measured at $\Delta p_{A \rightarrow R} = 15 \text{ bar}$; $\theta = 50 \text{ }^\circ\text{C}$

Available variants

Material number	Drawing number	Line connections:				Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	Manual override	Position solenoid plug	Symbol see page 9
		A	A' in flange (max. 25 l/min)	P	Threaded version see page 21					
0 521 222 101	RA 501 586 33	M22 x 1.5	x	Flange	II	60	60	with	①	2
R917008251	RA 500 214 45	M22 x 1.5	x	Flange	II	60	60	without	②	2
R917008250	RA 500 082 43	M22 x 1.5	x	Flange	II	60	60	without	①	2
R917006510	RA 501 669 77	M22 x 1.5	x	Flange	II	60	60	with	②	2
0 521 222 100	RA 501 586 33	M22 x 1.5	x	Flange	I	60	60	with	①	2

① = As shown, see page 11

② = Lifting and lowering - solenoid rotated by 90°

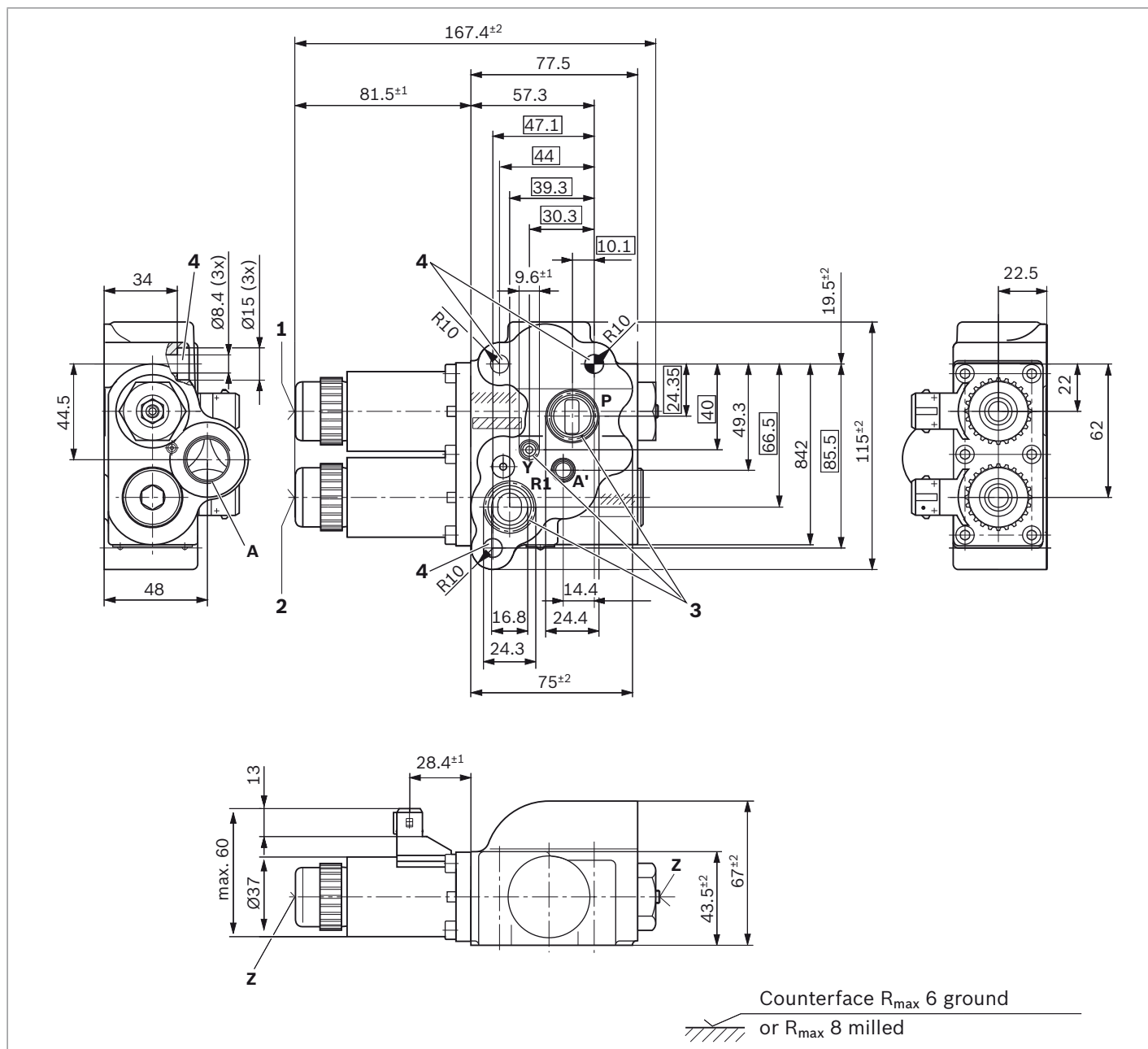
③ = Lifting and lowering - solenoid rotated by 60°

④ = Lifting and lowering - solenoid plug with different coding

Ports EHR5-LS	
P	Pump
A, A'	Actuator (cylinder)
R1	Return flow actuator (cylinder)

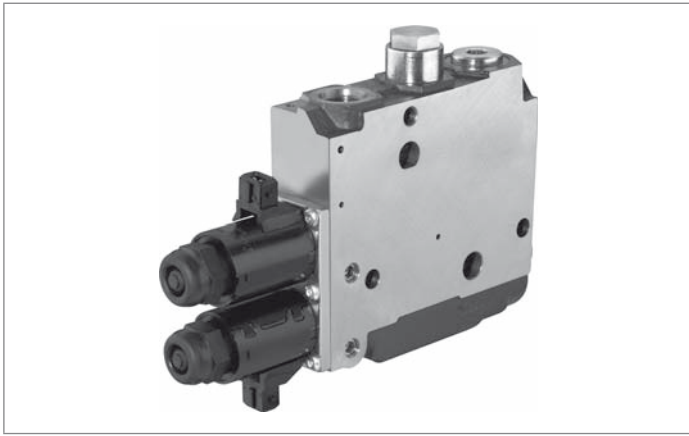
Dimensions

▼ EHR5-LS



- 1 Lifting
- 2 Lowering
- 3 O-ring is included in the scope of delivery
- 4 Three mounting bores; $M_A = 25^{+6}$ Nm

EHR23-EM2 and EHR23-ERV hitch control valves



EM2: Direct electromagnetic operation, proportional

ERV: End hitch control valve

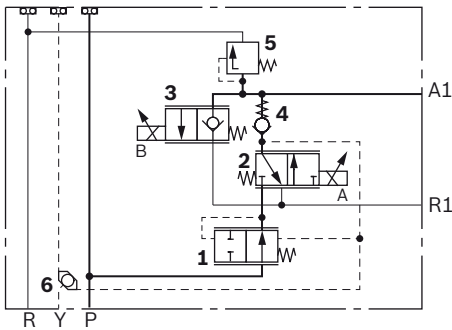
- ▶ With flange surface on the O-ring side (symbol 6)
- ▶ With flange surface on the O-ring counterside (symbol 7)

Notice

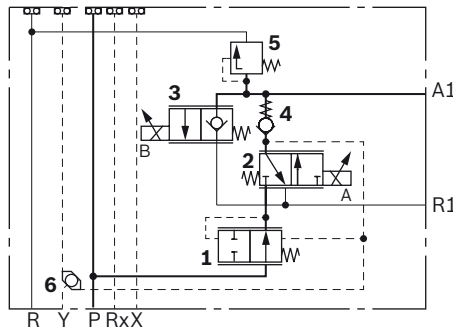
Do not use symbol 6 and 7 as end valve in the control block.

- 1 3-way pressure compensator
- 2 Lifting module
- 3 Lowering module
- 4 Check valve
- 5 Secondary pressure relief valve
- 6 Shuttle valve

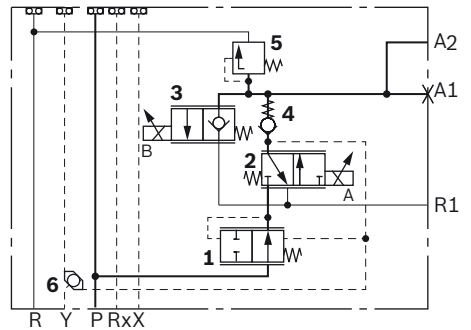
▼ Symbol 1



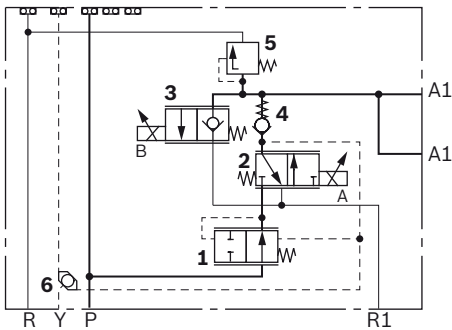
▼ Symbol 2



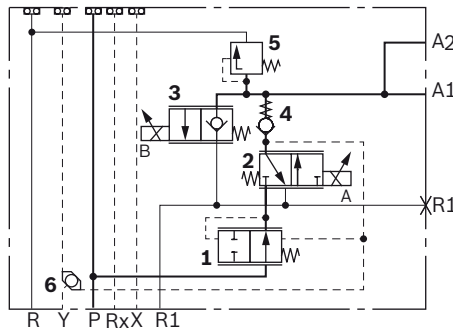
▼ Symbol 3



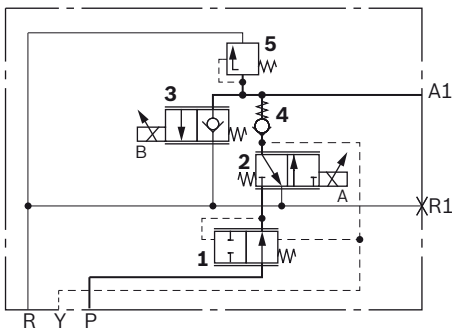
▼ Symbol 4



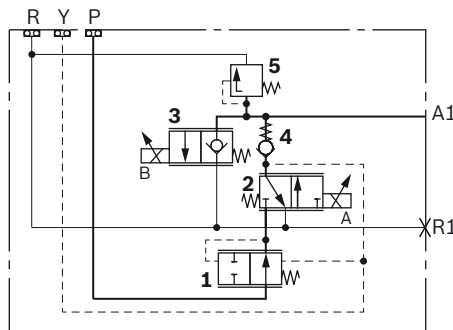
▼ Symbol 5



▼ Symbol 6, ERV

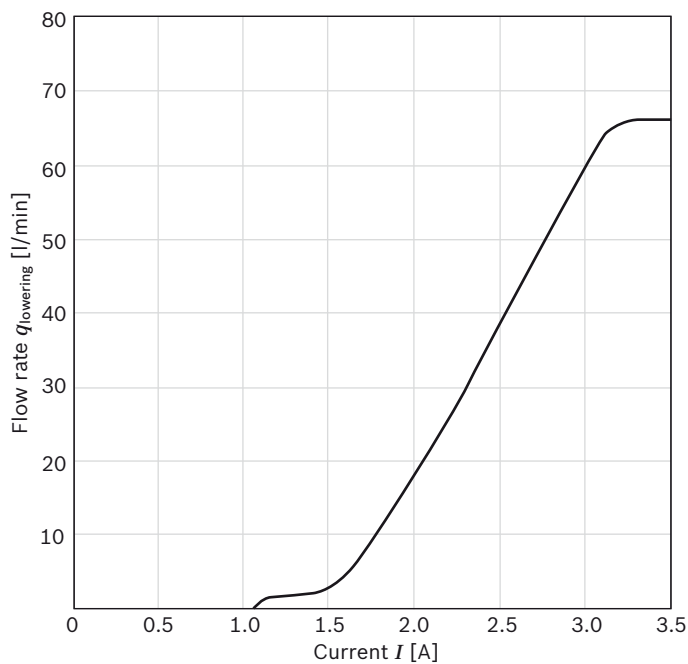


▼ Symbol 7, ERV

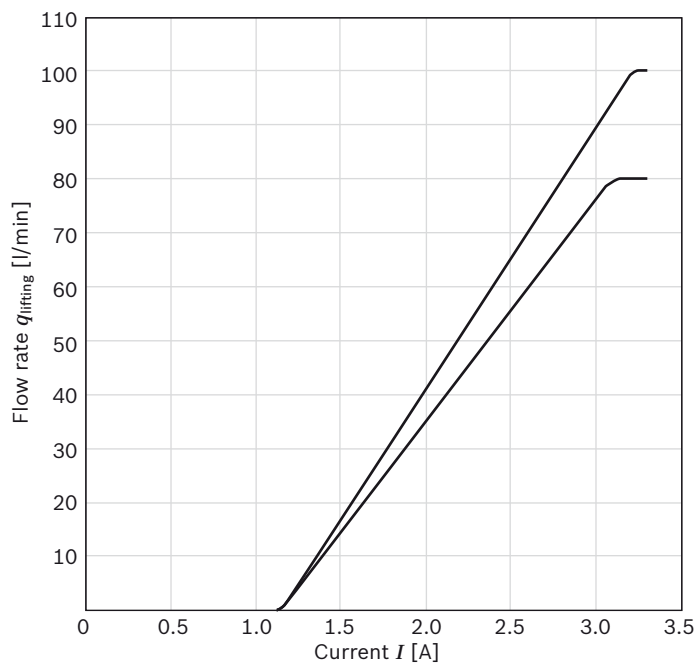


Characteristic curves

▼ **Characteristic curve lowering**



▼ **Characteristic curve lifting**



Notice

Characteristic curve lowering measured at $\Delta p A \rightarrow R = 15 \text{ bar}$; $\theta = 50 \text{ }^\circ\text{C}$

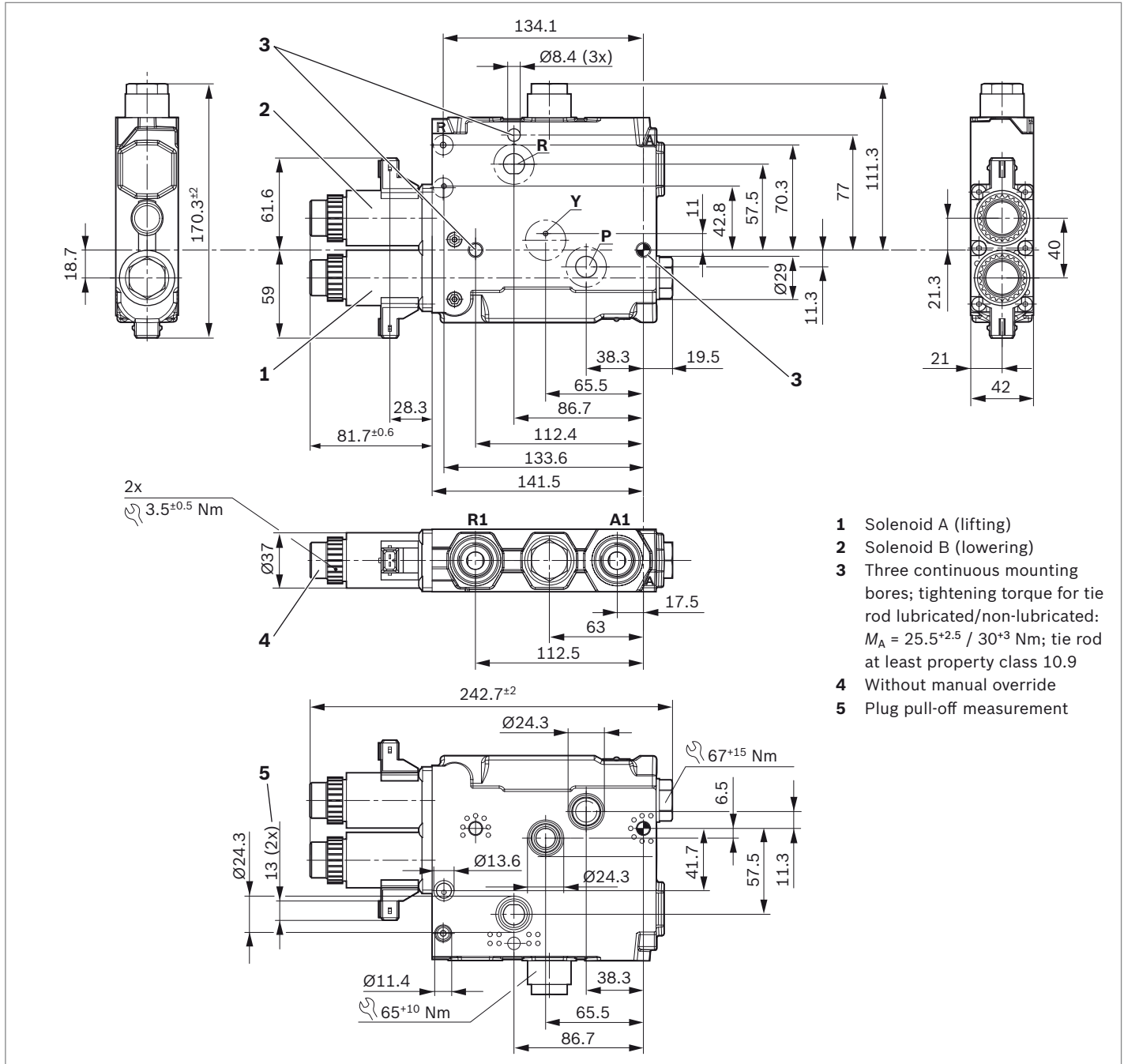
Ports EHR23

P	Pump
A1, A2	Actuator (cylinder) Tightening torque of the fitting $M_A = 125^{+13} \text{ Nm}$
R	Return flow
R1	Return flow, lowering flow rate Tightening torque of the fitting $M_A = 125^{+13} \text{ Nm}$
Y	Controller option for control pumps



Dimensions

▼ **EHR23-EM2, standard with R1- and A1-threaded connection**



- 1 Solenoid A (lifting)
- 2 Solenoid B (lowering)
- 3 Three continuous mounting bores; tightening torque for tie rod lubricated/non-lubricated: $M_A = 25.5^{+2.5} / 30^{+3}$ Nm; tie rod at least property class 10.9
- 4 Without manual override
- 5 Plug pull-off measurement

Material number	Line connections:		Threaded version see page 21	Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	DBV p_{LSV} [bar]	Manual override	Position solenoid plug	EHS bore (X1, RX)	Symbol see page 12
	A1	R1								
R917006918	M22 x 1.5	M22 x 1.5	I	65	80	218 ⁺²²	with	①	without	1
R917005455	M22 x 1.5	M22 x 1.5	I	65	80	218 ⁺²²	with	① + ②	without	1
R917006003	M22 x 1.5	M22 x 1.5	I	65	50	218 ⁺²²	with	② + ③	without	1
R917006449	M22 x 1.5	M22 x 1.5	III	65	80	218 ⁺²²	without	①	with	2
R917005001	M22 x 1.5	M22 x 1.5	III	65	100	218 ⁺²²	with	①	with	2
R917008132	M22 x 1.5	M22 x 1.5	I	65	90	218 ⁺²²	with	①	with	2

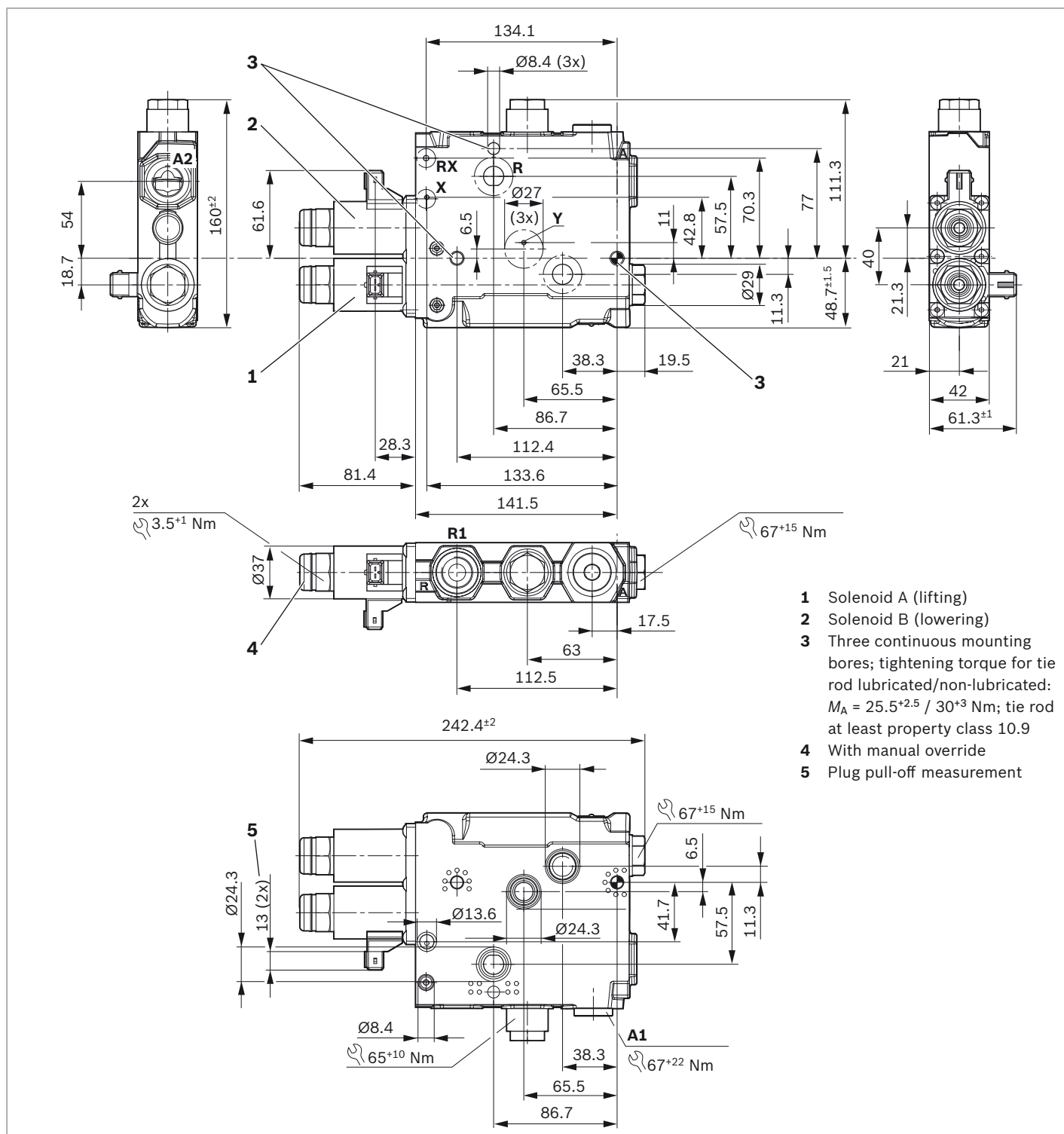
① = As shown

② = Lifting - solenoid plug direction O-ring side

③ = Lowering - solenoid plug direction O-ring side

© 2013 Bosch Rexroth AG, EHR23-EM2/ERV23

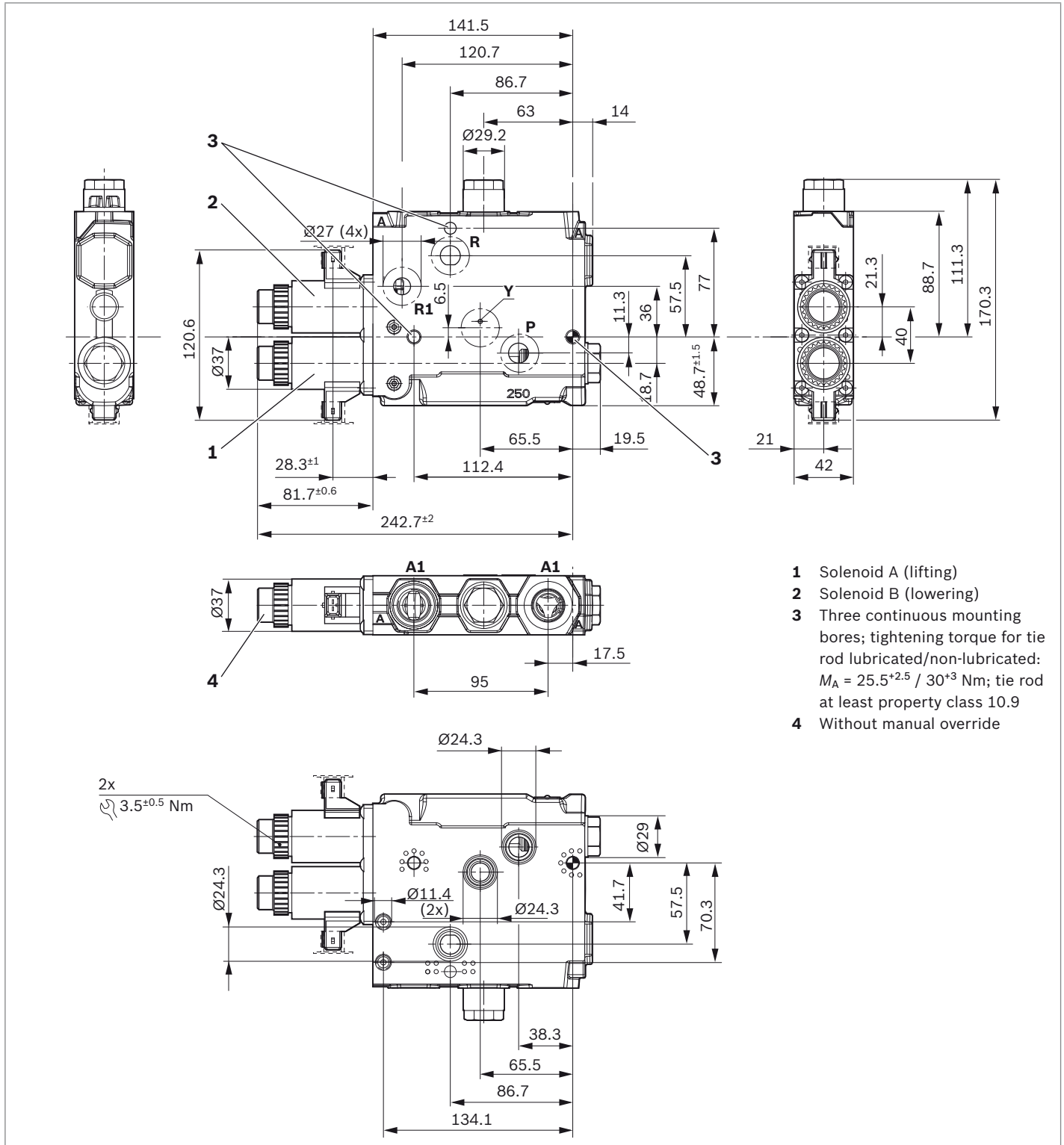
▼ EHR23-EM2, with manual override and lateral A2 threaded connection



- 1 Solenoid A (lifting)
- 2 Solenoid B (lowering)
- 3 Three continuous mounting bores; tightening torque for tie rod lubricated/non-lubricated: $M_A = 25.5^{+2.5} / 30^{+3}$ Nm; tie rod at least property class 10.9
- 4 With manual override
- 5 Plug pull-off measurement

Material number	Line connections:		Threaded version see page 21	Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	DBV p_{LSV} [bar]	Symbol see page 12
	A2	R1					
R917005125	M22 x 1.5	M22 x 1.5	III	65	80	220 ⁺²⁰	3

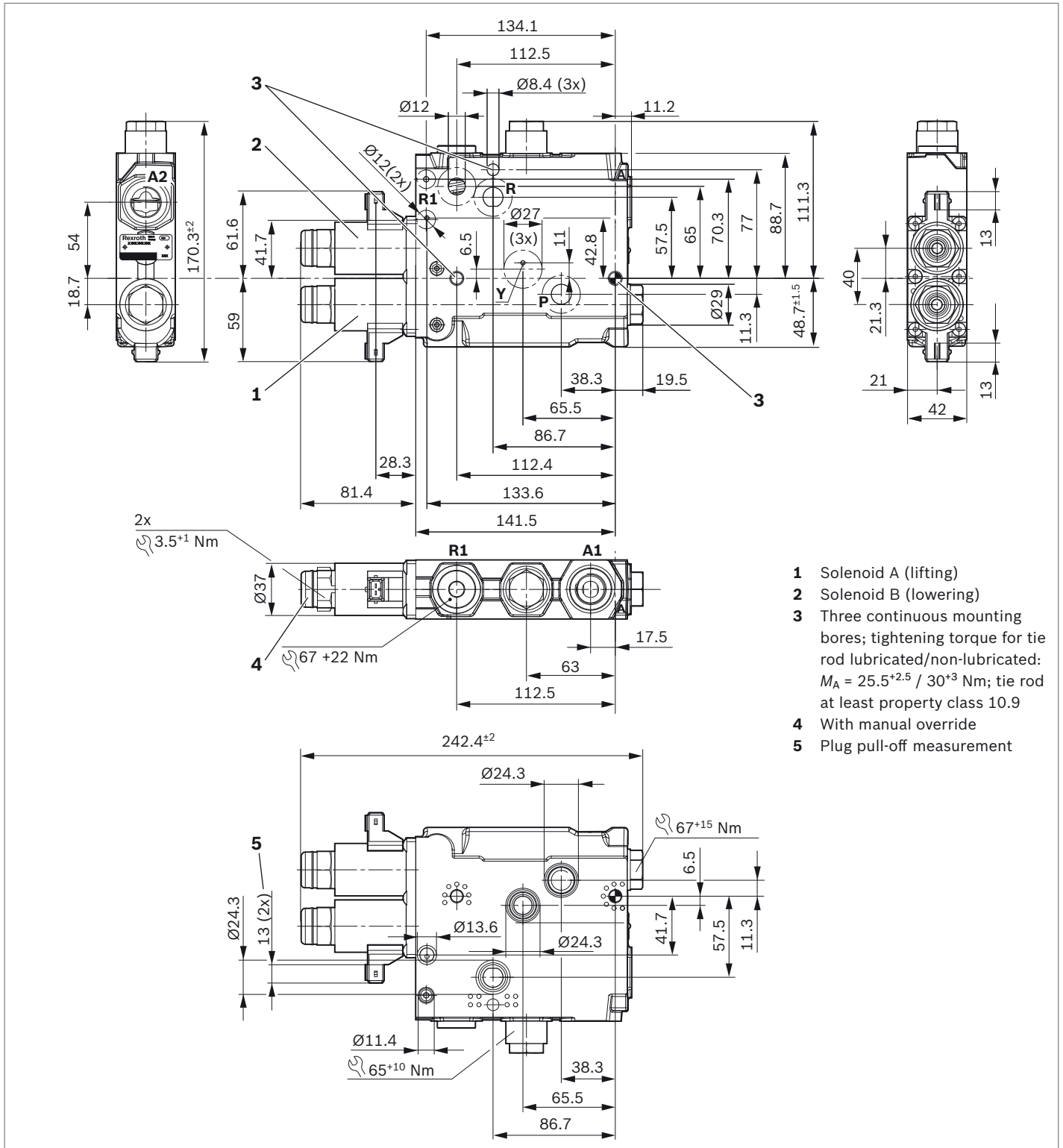
▼ EHR23-EM2 with two A1 threaded connections



- 1 Solenoid A (lifting)
- 2 Solenoid B (lowering)
- 3 Three continuous mounting bores; tightening torque for tie rod lubricated/non-lubricated: $M_A = 25.5^{+2.5} / 30^{+3}$ Nm; tie rod at least property class 10.9
- 4 Without manual override

Material number	Line connections:		Threaded version see page 21	Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	DBV p_{LSV} [bar]	Symbol see page 12
	A1	R1					
R917005120	M22 x 1.5	Flange	III	65	90	218 ⁺²²	4

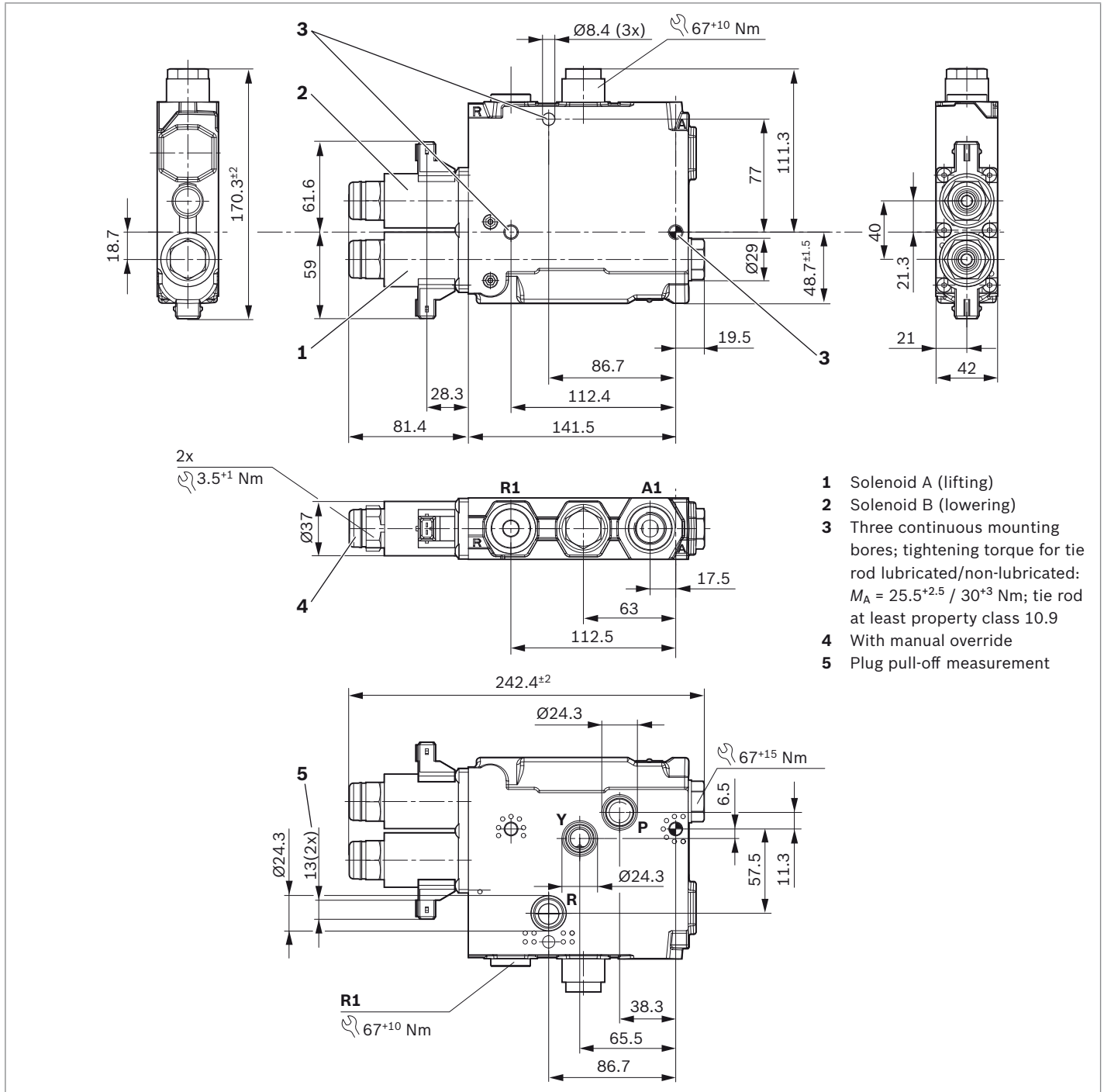
▼ EHR23-EM2, with manual override, lateral A2 threaded connection and R1 flange connection



- 1 Solenoid A (lifting)
- 2 Solenoid B (lowering)
- 3 Three continuous mounting bores; tightening torque for tie rod lubricated/non-lubricated: $M_A = 25.5^{+2.5} / 30^{+3}$ Nm; tie rod at least property class 10.9
- 4 With manual override
- 5 Plug pull-off measurement

Material number	Line connections:		Threaded version see page 21	Lowering	Lifting	DBV	Symbol see page 12
	A2	R1		q_{SN} [l/min]	q_{HN} [l/min]	p_{LSV} [bar]	
R917005129	M22 x 1.5	Flange	III	65	80	220 ⁺²⁰	5

▼ EHR23-ERV, end hitch control valve with flange surface on the O-ring side

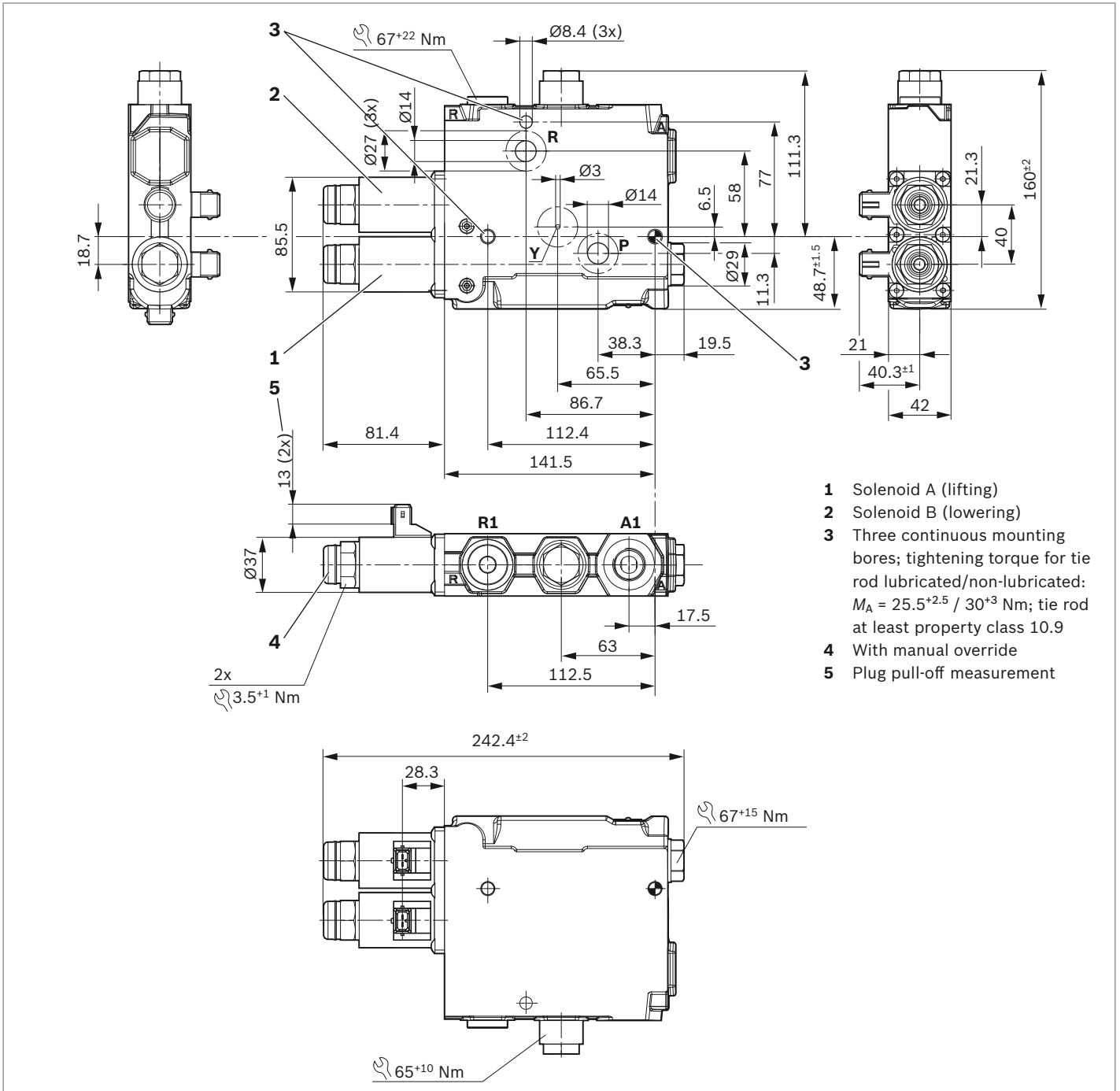


Material number	Line connections:		Threaded version see page 21	Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	DBV p_{LSV} [bar]	Position solenoid plug	Symbol see page 12
	A1	R1						
R917004244	M22 x 1.5	Flange	III	65	80	220 \pm 20	②	6
R917005640	M22 x 1.5	Flange	III	65	100	220 \pm 20	①	6

① = As shown

② = direction of the lifting and lowering solenoid plug with regard to the flange surface

▼ EHR23-ERV, end hitch control valve with flange surface on the O-ring counterside



- 1 Solenoid A (lifting)
- 2 Solenoid B (lowering)
- 3 Three continuous mounting bores; tightening torque for tie rod lubricated/non-lubricated: $M_A = 25.5^{+2.5} / 30^{+3}$ Nm; tie rod at least property class 10.9
- 4 With manual override
- 5 Plug pull-off measurement

Material number	Line connections:		Threaded version see page 21	Lowering q_{SN} [l/min]	Lifting q_{HN} [l/min]	DBV p_{LSV} [bar]	Position solenoid plug	Symbol see page 12
	A1	R1						
R917006959	M22 x 1.5	Flange	I	65	80	220 ⁺²⁰	①	7
R917001441	M22 x 1.5	Flange	III	65	100	220 ⁺²⁰	②	7

① = As shown

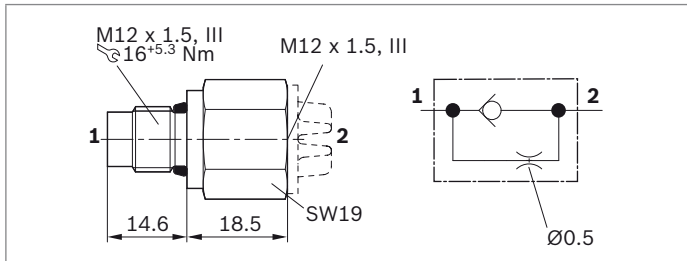
② = Lowering - solenoid plug direction line connection A1

- ▶ **EHR23 Subplate** for variable displacement pump with throttle check valve see data sheet SB23-EHS (66134)

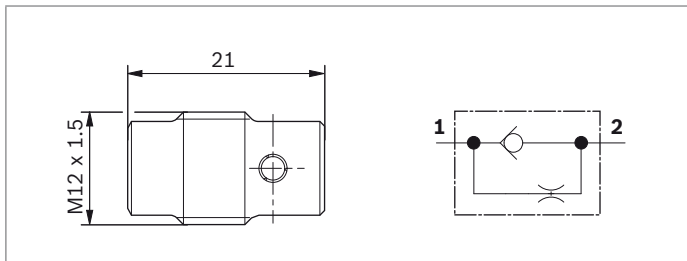
Notice

For control blocks with hitch control valve EHR23-EM2 a throttle check valve in the port Y of the AP is to be provided in systems with variable displacement pump. We recommend the use of material number 1527410106 or 1527410132.

▼ DRV, material number 1527410106



▼ DRV, material number 1527410132



Line connections

Version I

DIN 3852-1

- ▶ For seal ring sealing

Version II

DIN 3852-3

- ▶ For O-ring sealing

Version III

EN ISO 6149-1

- ▶ For O-ring sealing

Installation information

The valves have to be completely filled with pressurizing agent during commissioning and operation.

For practical use the proportion of dispersed air in oil should be little, since it can lead to interferences of the function and damages to the hydraulic components.

According to the state of the art proportions of undissolved air in oil are regarded as risk-free in the area of 0.2 to 0.5 volume percent with normal pressure.

In the case of bigger volume proportions a field test under worst case conditions has to be carried out and documented.

Information on plug-in connection

Guarantee for the reliable function of the connector system only when using the mating connector prescribed by Bosch Rexroth.

Connector system according to customer specification: The customer is responsible for function and reliability.

Bosch Rexroth does not take over any warranty in case of deficiencies.

Further information with regard to the condition of the counterface of the flange and recommendations for the solenoid mating connector, see advice in the quotation drawing.

Related documents

Title	Document number	Document type
Hitch control valves EHR5 and EHR23 for mobile applications	66125-B2	Operating instructions
Hitch control valves EHR 5-OC and EHR5-LS	66125-30-R	Repair instructions
Hitch control valves EHR23-EM2	66130-30-R	Repair instructions
Bleeding directional valves	MH 121	Commissioning information
Supplied installation drawing/hydraulic scheme	Available from your machine or plant manufacturer	Quotation drawing
Hydraulic fluids on mineral oil basis	90220	Data sheet

Abbreviations

The following abbreviations are used in this documentation:

Abbreviation	Meaning
AP	Subplate
DBV	Pressure relief valve
DRV	Throttle check valve
EHR	Electro-hydraulic hitch control
EHS	Pilot operated electro-hydraulic actuating unit

Spare parts

Contacts for accessories and spare parts

Accessories and spare parts are available

- ▶ From the vehicle manufacturer (specialty retailer),
- ▶ From the system manufacturer, and
- ▶ From your Bosch Rexroth specialty retailer.

If you have questions regarding spare parts, please contact your local Rexroth service or the service department of the control block manufacturer.

Check-Q-meter

FD



- ▶ Sizes 12, 16, 25, 32
- ▶ Series 2X
- ▶ Max. operating pressure 350 bar
- ▶ Max. flow 560 l/min

Features

The check-Q-meter is a leakage-free pilot operated check valve. It controls the returning flow q_{V2} in relation to the flow being directed into the opposite side of the actuator q_{V1} . With cylinders the area ratio ($q_{V2} = q_{V1} \times \phi$) has to be taken into account.

- ▶ By-pass valve, free-flow in opposite direction
- ▶ Optional built-on secondary pressure relief valve (only for valve with flange connections)
- ▶ For installation in manifolds (cartridge valve)
- ▶ With SAE flanged ports
- ▶ For sub plate mounting, porting pattern to
 - ISO 5781-06-07-0-00 (size 12, 16)
 - ISO 5781-08-10-0-00 (size 25)
 - ISO 5781-10-13-0-00 (size 32)
- ▶ Use sub plate version when valve panel mounting

Fields of application

- ▶ Construction machinery
- ▶ Cranes
- ▶ Excavators
- ▶ Material handler
- ▶ Drilling rigs
- ▶ Stationary applications

Contents

Functional description	2
Technical data	4
Type code	5
Characteristic curves	6
Circuit examples	7
Dimensions	8

Functional description

Check-Q-meters are used in hydraulic systems to influence the speeds of hydraulic motors and cylinders independent of the load (prevents running away). In addition there is an isolator function for pipe burst safety.

The check-Q-meter comprises basically of the housing (1), main poppet (2), pilot part (3), pilot spool (4), damping spool (5) und pilot damping (6).

Lifting the load

With free-flow from **A** to **B** the main spool (2) is opened. If the load pressure fails (e.g. pipe break between the directional valve and ports **A**) then the main spool (2) immediately closes. This function is achieved by the connection of the load side (7) with spring chamber (8).

Lowering the load (circuit examples)

The direction of flow is from **B** to **A**. Port **A** is connected to tank via the directional valve. The piston rod side of the cylinder has a flow applied which corresponds to the working conditions. The relationship between the control pressure at port **X** and the load pressure at port **B** = 1 : 20. When the control pressure is reached the pre-opening of the main spool takes place. Via the control spool (4) the pilot stage (3) is lifted off its seat and chamber (8) is decompressed via this drilling and port **A** to tank. At the same time the load pressure in port **B** is no longer applied to chamber (8), within the main spool. The main poppet (2) is thereby unloaded. The reverse side of the control spool (4) at the main poppet (2), lies against the collar of the damping spool (5).

The pressure required at port **X** to open **B** to **A** is now only influenced by the spring in chamber (9). The pressure required to begin opening the connection **B** to **A** is 20 bar; to fully open the connection up to 70 bar is required depending on the version.

The opening cross-section for flow control increases progressively. It is created by the successive opening of radial drillings in the bush and the main poppet (2) land.

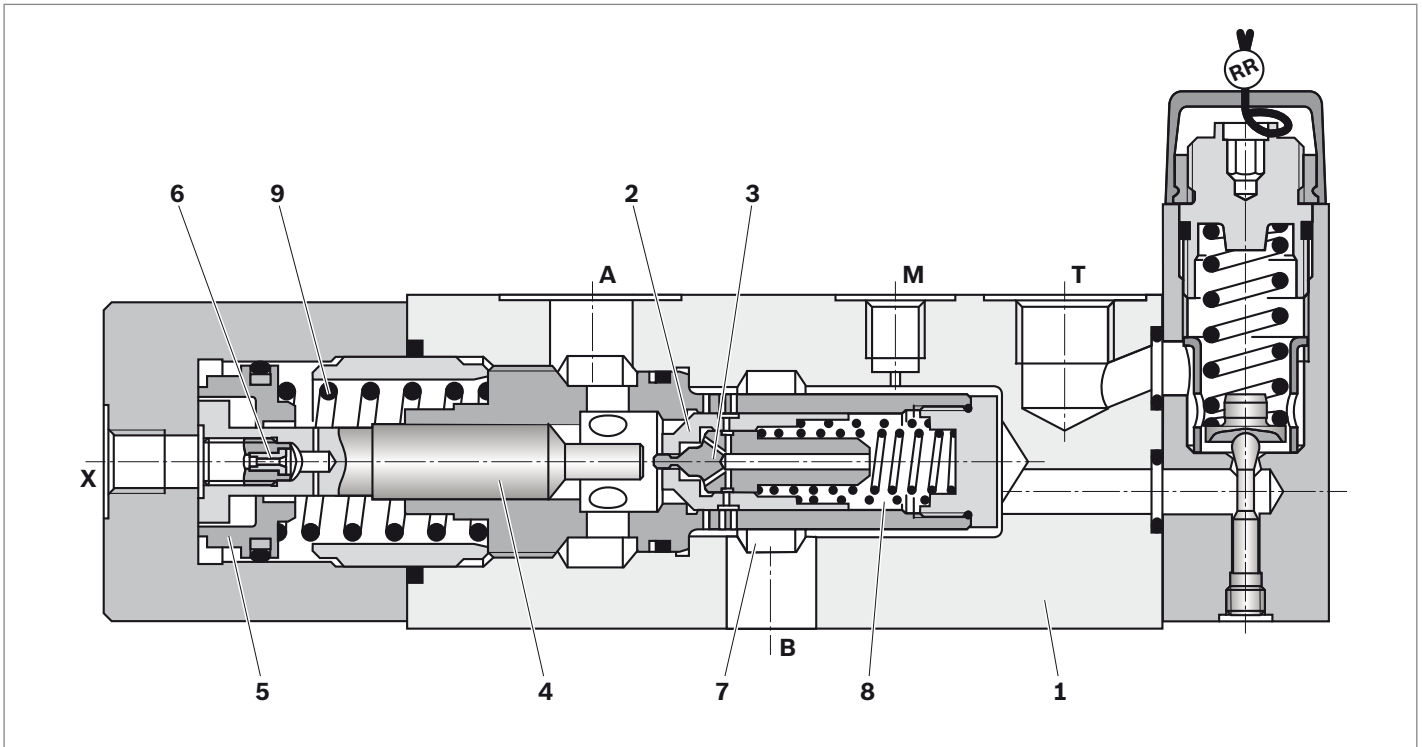
The relationship between the control pressure, cracking pressure and differential pressure determines the flow to the actuator via the connection of **B** to **A**. Thus uncontrolled running away of the actuator is prevented.

The controlled lowering procedure is not affected even if there is a pipe burst between the directional valve and port **A**.

Guidelines for influencing the opening and closing times of the check-Q-meter

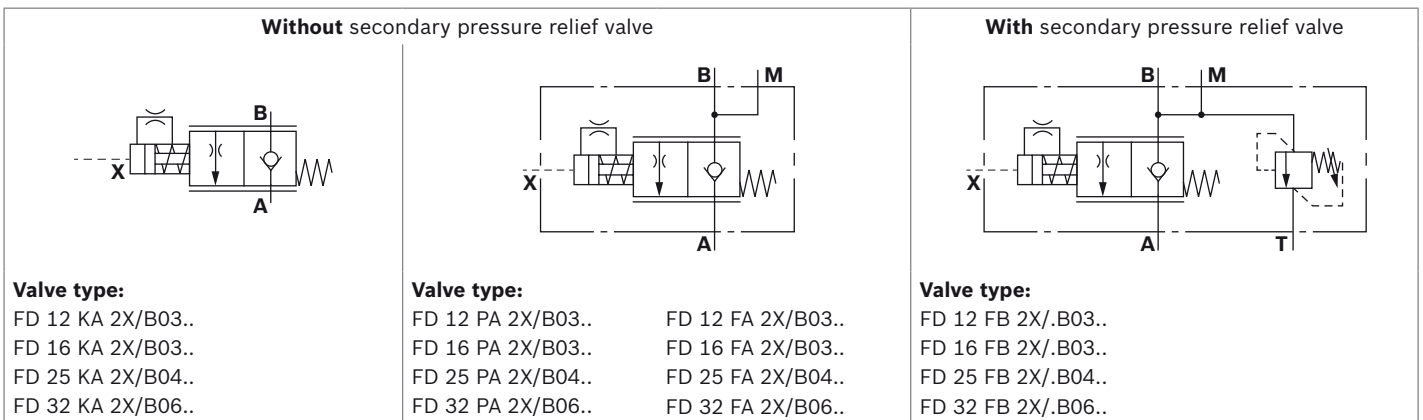
- ▶ Throttling of the opening sequence is via orifice (6) in the control spool (4) and both sides of the damping spool (5). The orifice (6) is protected by sieves.
- ▶ The closing movement of the check-Q-meter is virtually un-throttled.
- ▶ When being used in conjunction with cylinders the control line to port **X** can be fitted with a throttle check valve (meter-out control) to influence the closing sequence.
- ▶ When being used in conjunction with motors a throttle check valve should not be fitted in the control line to port **X**. In this case it is recommended that the control times of the directional valve are influenced.

▼ **Cross section** (example FD...FB2X/...V01)



- | | |
|-----------------|---------------------------|
| 1 Housing | 6 Pilot damping (orifice) |
| 2 Main poppet | 7 Load side |
| 3 Pilot part | 8 Spring chamber |
| 4 Pilot spool | 9 Spring |
| 5 Damping spool | |

▼ **Symbols**



Ports	
A	Control block
B	Consumer
T	Tank
X	Control port
M	Measuring port

Technical data

General							
Weight			kg	See page 8			
Installation position				Preferably upright (port X up)			
Type of connection				See page 8			
Ambient temperature range		θ	°C	-20 to +80			
Priming (Standard)				One-coat paint RAL 5010			
Hydraulic							
Maximum operating pressure at the port	A, X	p_{max}	bar	350			
	B	p_{max}	bar	420			
Control pressure at the port	X	p_{min}	bar	20 to 70 (The cracking pressure depends on the valve type. Further information on request.)			
		p_{max}	bar	350			
Cracking pressure A to B		p	bar	2			
Maximum setting pressure for secondary pressure relief valve		p	bar	420			
Maximum flow at the port	A, B			Size 12	Size 16	Size 25	Size 32
		q_{Vmax}	l/min	80	200	320	560
Area ratio of the pre-opening				$\frac{\text{Control surface}}{\text{Load surface}} = \frac{1}{20}$			
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet 90221, at request			
Hydraulic fluid temperature range		θ	°C	-20 to +80			
Viscosity range		ν	mm ² /s	10 to 800			
Maximum admissible degree of contamination of the hydraulic fluid cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$			

Note

For applications outside these parameters, please consult us!

Type code

01	02	03	04	05	06	07	08
FD			2X	/		V	*

Model

01	Check-Q-meter	FD
----	---------------	-----------

Size

02	Size 12	12
	Size 16	16
	Size 25	25
	Size 32	32

Design

03	Manifold mounting (cartridge valve)	KA
	SAE flange connections without secondary pressure relief valve	FA
	SAE flange connections with secondary pressure relief valve	FB
	Sub-plate mounting without secondary pressure relief valve	PA

Series

04	20 to 29 (unchanged installation and connection dimensions)	2X
----	---	-----------

Pressure range of the secondary pressure relief valve (Valve with SAE flange connections, code only for version **FB**)

05	Pressure setting	up to 200 bar	200
		up to 315 bar	315
		up to 420 bar	420

Orifice diameter

06	Without orifice		B00
	With orifice (other orifice diameters on request)	∅ 0.3 mm sizes 12 and 16	B03
		∅ 0.4 mm size 25	B04
		∅ 0.6 mm size 32	B06

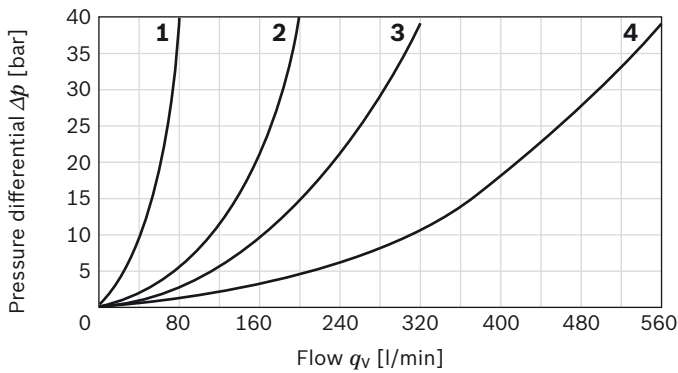
Sealing material

07	FKM (fluoroelastomer)	V
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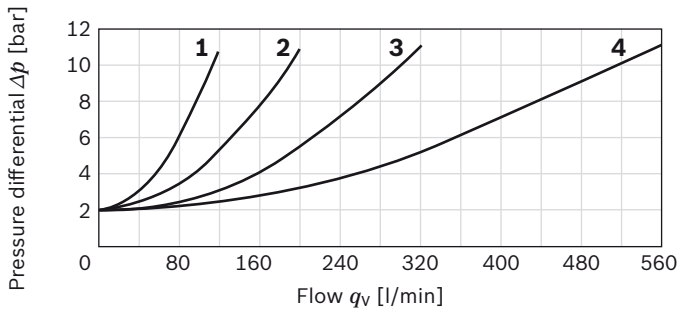
08	Further specifications in plain text	*
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Characteristic curves

- ▼ Pressure differential Δp in relation to flow q_v , measured at throttle position: B \rightarrow A
Throttle fully open ($p_x =$ up to 70 bar)



- ▼ Pressure differential Δp in relation to flow q_v , measured via the check valve: A \rightarrow B



- 1 Size 12
- 2 Size 16
- 3 Size 25
- 4 Size 32

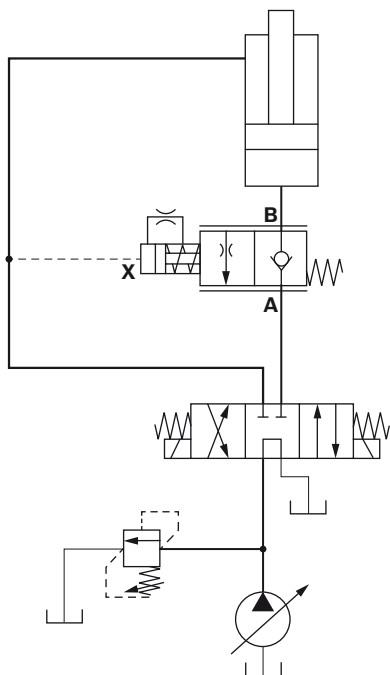
Note

Characteristic curves measured at $v = 41 \text{ mm}^2$ and $\theta = 50^\circ \text{ C}$).

Circuit examples

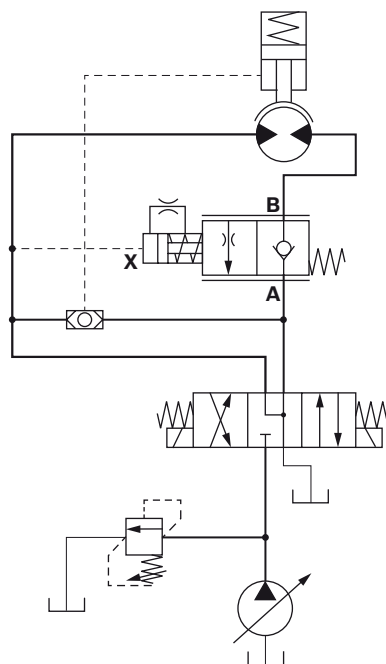
Differential cylinder

For safety reasons, always a closed centre directional valve should be used!



Hydraulic motor

- ▶ Internal control of the holding brake: So that the holding brake can operate both of the direction all valve ports have to be connected to port T in the neutral position.
- ▶ External control of the holding brake: For safety reasons, if the brake is externally unloaded then it is possible to use a closed center directional valve for the neutral position.



Note

Two single check-Q-meters cannot be used to control two cylinders which are forced mechanically to move together, as synchronisation and the same pressure cannot be guaranteed in each cylinder.

Therefore, the cylinders have to be equipped with two pilot operated check valves, type SL from Bosch Rexroth (see data sheet 21460 for size 6 or 21468 for size 10 to 32). The check-Q-meter is fitted in a common line.

In this case, the load pressure must not exceed 200 bar because of the opening ratio of the SL valves!

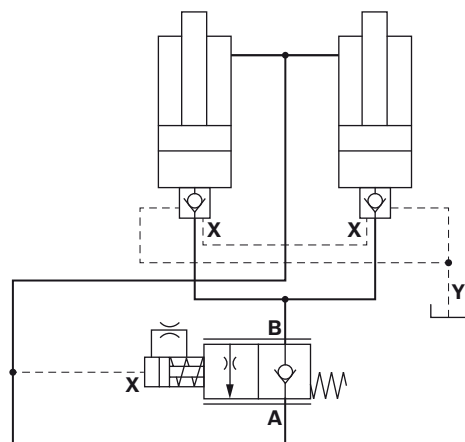
Example:

Load pressure at cylinder: 200 bar

Area ratio SL check valve: $\frac{1}{11}$

Cracking pressure spring FD valve: 20 bar

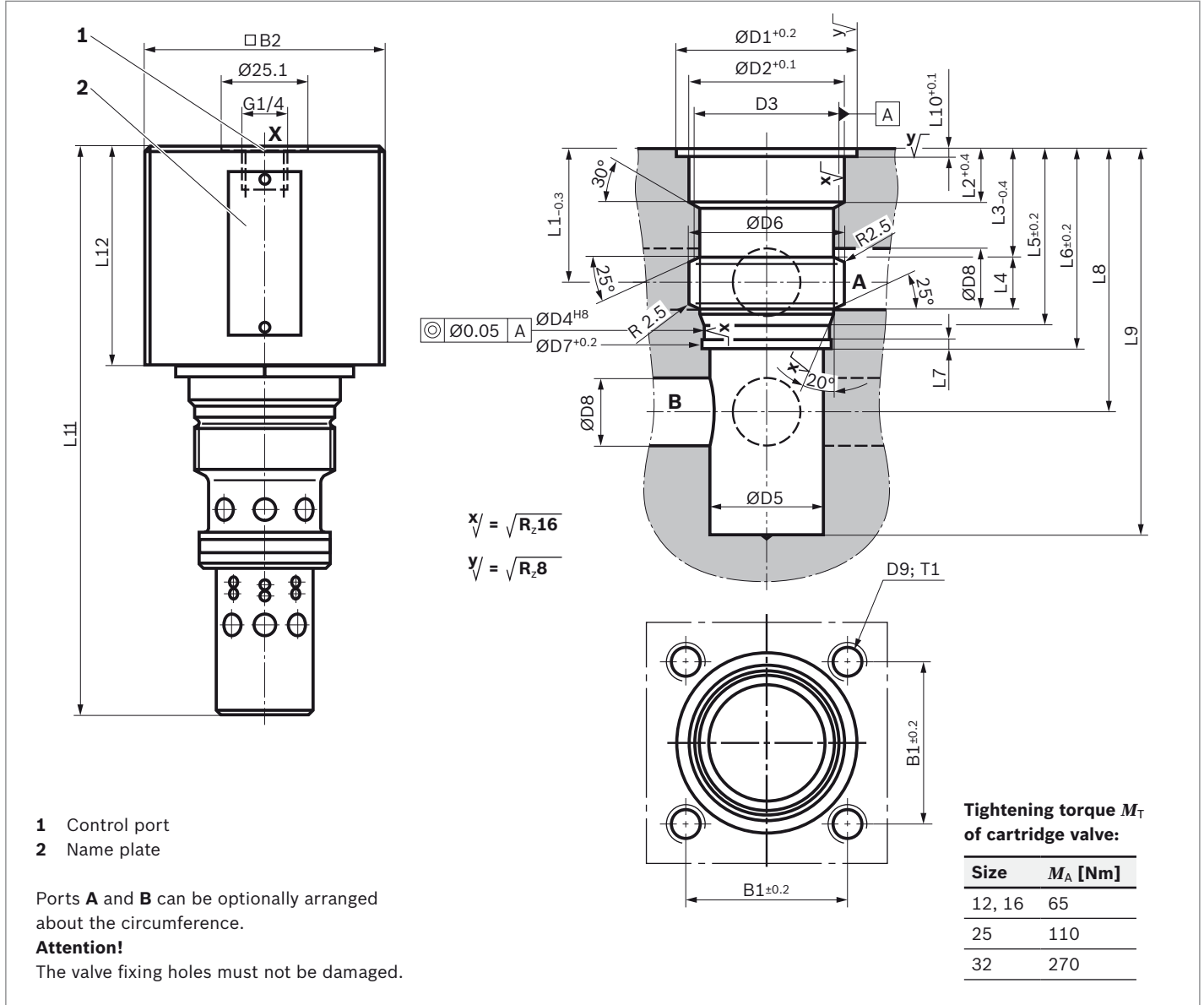
$$\frac{200 \text{ bar}}{11} = 18.2 \text{ bar}$$



18.2 bar < 20 bar
Cracking pressure SL valve Cracking pressure FD valve

Dimensions

▼ FD valve for manifold mounting (version KA)

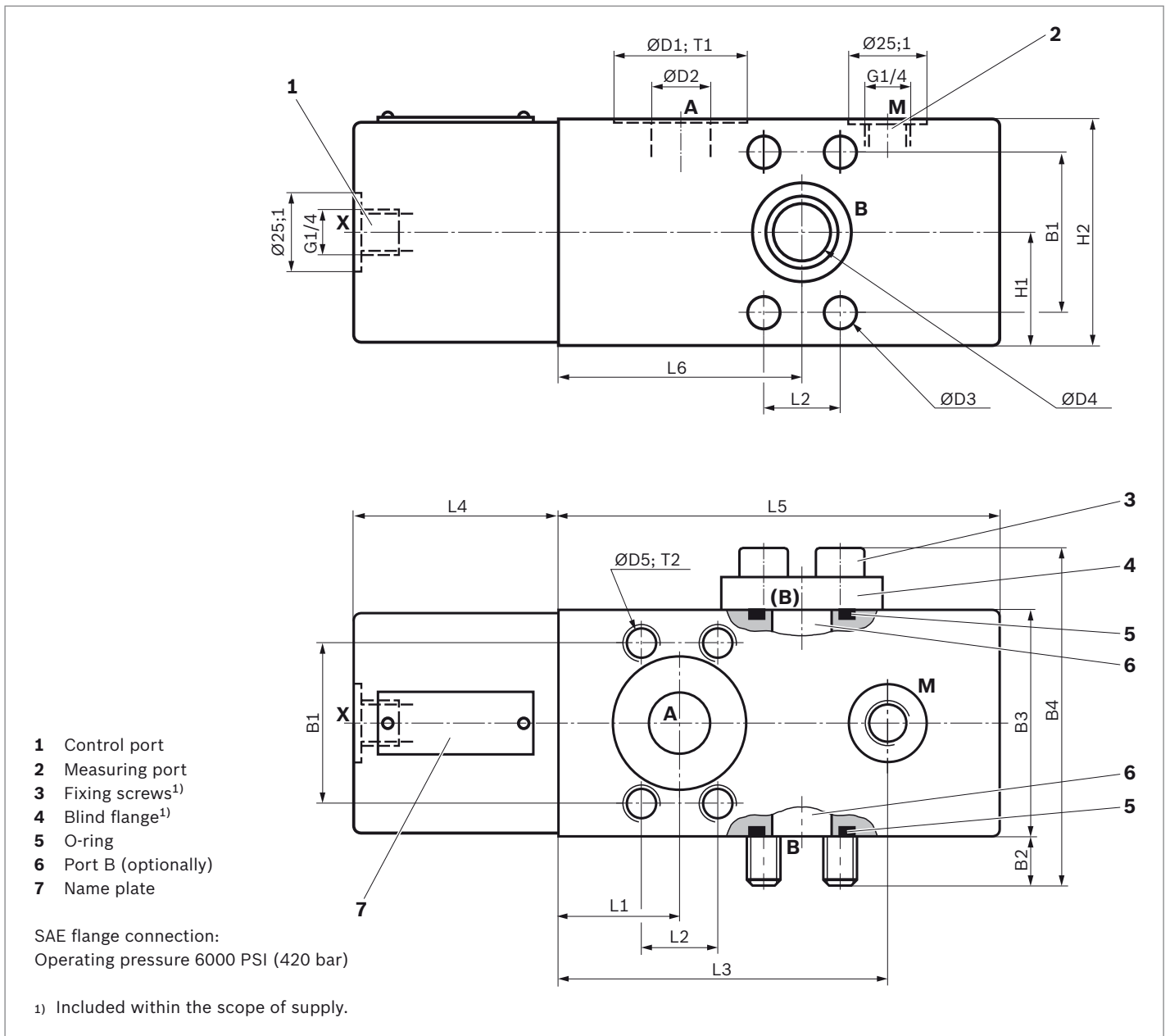


Type	B1	B2	D1	D2	D3	D4	D5	D6	D7	D8	D9	T1	L1	L2	L3	L4	L5	L6
FD 12 KA 2X/...	48	70	54	46	M42 × 2	38	34	46	38.6	16	M10	16	39	16	32	15.5	50.5	60
FD 16 KA 2X/...	48	70	54	46	M42 × 2	38	34	46	38.6	16	M10	16	39	16	32	15.5	50.6	60
FD 25 KA 2X/...	56	80	60	54	M52 × 2	48	40	60	48.6	25	M12	19	50	19	39	22	65	80
FD 32 KA 2X/...	66	95	72	65	M64 × 2	58	52	74	58.6	30	M16	23	52	19	40	25	71	85

Type	L7	L8	L9	L10	L11	L12	Valve fixing screws	Tightening torque M_T [Nm]	Weight [kg]
FD 12 KA 2X/...	3	78	128	2.3	191	65	4 pieces M10 × 70 DIN 912-10.9	69	2.8
FD 16 KA 2X/...	3	78	128	2.3	191	65	4 pieces M10 × 70 DIN 912-10.9	69	2.8
FD 25 KA 2X/...	4	105	182	2.3	253	75	4 pieces M12 × 80 DIN 912-10.9	120	5.6
FD 32 KA 2X/...	4	105	198	2.3	289	94	4 pieces M16 × 100 DIN 912-10.9	295	7.5

Pipe threads **G** according to ISO 228/1

▼ FD valve for SAE flange connections, without secondary pressure relief valve (version FA)

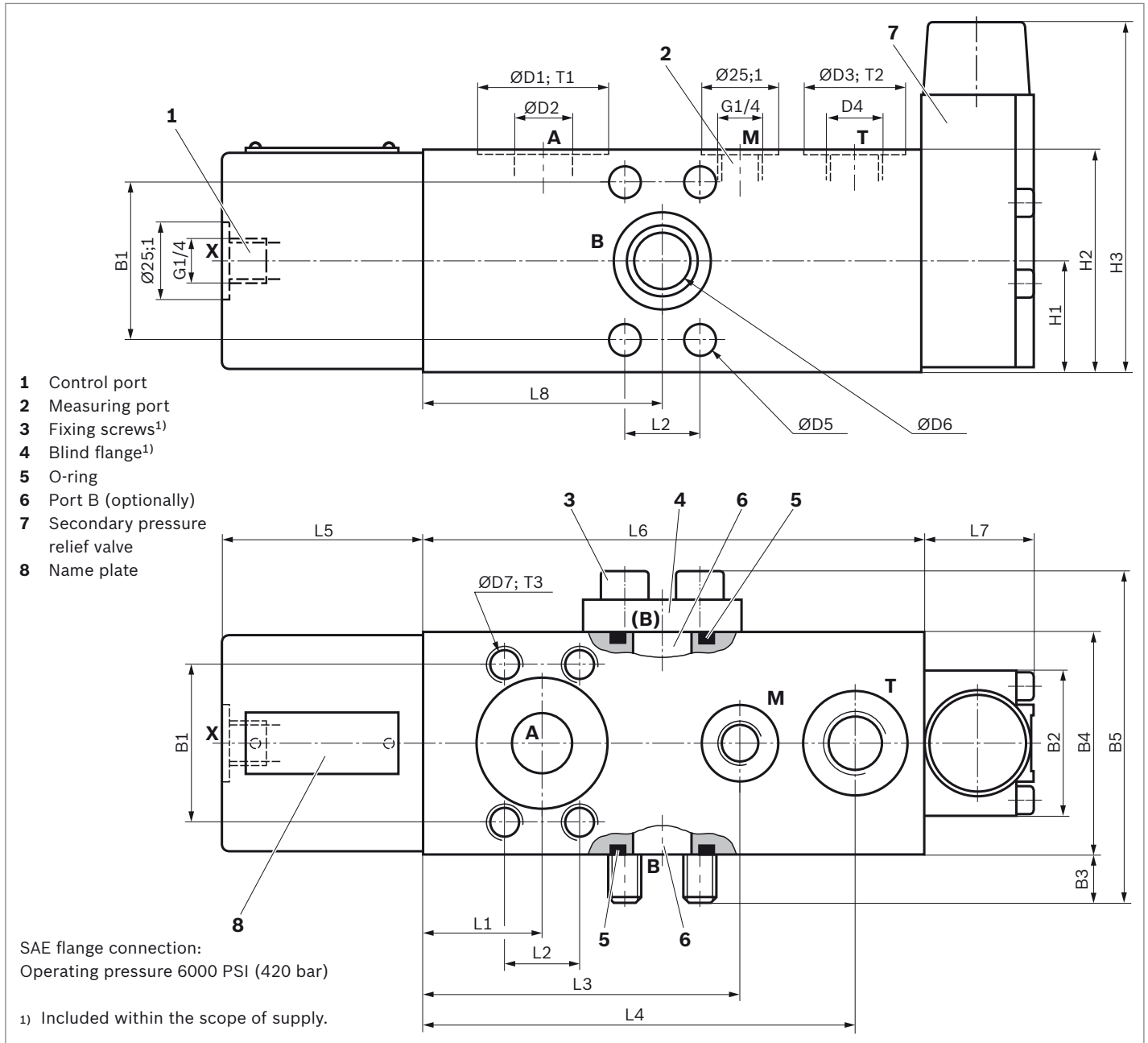


Type	B1	B2	B3	B4	D1	D2	D3	D4	D5	H1	H2
FD 12 FA 2X/...	50.8	16.5	72	110	43	18	10.5	18	M10	36	72
FD 16 FA 2X/...	50.8	16.5	72	110	43	18	10.5	18	M10	36	72
FD 25 FA 2X/...	57.2	14.5	90	132	50	25	13.5	25	M12	45	90
FD 32 FA 2X/...	66.7	20	105	154	56	30	15	30	M14	50	105

Type	L1	L2	L3	L4	L5	L6	T1	T2	Weight [kg]	O-ring (5)
FD 12 FA 2X/...	39	23.8	105	65	140	78	0.1	15	7	25 × 3.5
FD 16 FA 2X/...	39	23.8	105	65	140	78	0.1	15	7	25 × 3.5
FD 25 FA 2X/...	50	27.8	148	75	200	105	0.1	18	16	32.92 × 3.53
FD 32 FA 2X/...	52	31.6	155	94	215	115	0.1	21	21	37.7 × 3.53

Pipe threads **G** according to ISO 228/1

▼ FD valve for SAE flange connections, with secondary pressure relief valve (version FB)



Type	B1	B2	B3	B4	B5	D1	D2	D3	D4	D5	D6	D7	H1	H2
FD 12 FB 2X/...	50.8	47	16.5	72	110	43	18	34	G 1/2	10.5	18	M10	36	72
FD 16 FB 2X/...	50.8	47	16.5	72	110	43	18	34	G 1/2	10.5	18	M10	36	72
FD 25 FB 2X/...	57.2	80	14.5	90	132	50	25	42	G 3/4	13.5	25	M12	45	90
FD 32 FB 2X/...	66.7	80	20	105	154	56	30	42	G 3/4	15	30	M14	50	105

Type	H3	L1	L2	L3	L4	L5	L6	L7	L8	T1	T2	T3	Weight [kg]	O-ring (5)
FD 12 FB 2X/...	118	39	23.8	105	141.5	65	162	38	78	0.1	1	15	9	25 × 3.5
FD 16 FB 2X/...	118	39	23.8	105	141.5	65	162	38	78	0.1	1	15	9	25 × 3.5
FD 25 FB 2X/...	145	50	27.8	148	198	75	225	50	105	0.1	1	18	18	32.92 × 3.53
FD 32 FB 2X/...	145	52	31.6	155	215	94	240	50	115	0.1	1	21	24	37.7 × 3.53

Pipe threads **G** according to ISO 228/1

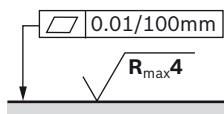
© Bosch Rexroth AG, F.E.N. 5.1.17.2015

▼ FD valve for sub-plate mounting (version PA)

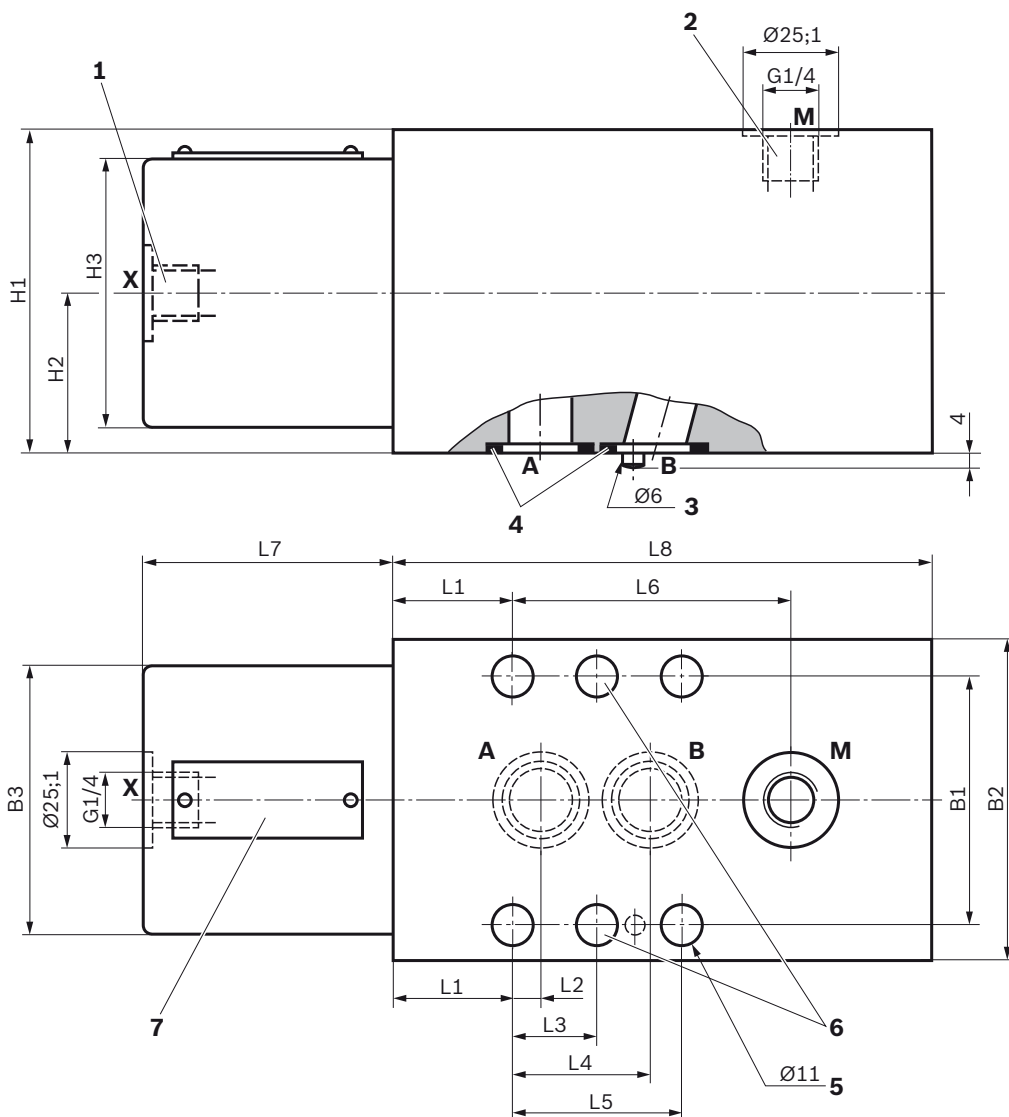
- 1 Control port
 - 2 Measuring port
 - 3 Fixing pin
 - 4 O-ring
- Fixing holes:
 4 pieces for sizes 12, 16, 25
 6 pieces for size 32
- 5 Not for sizes 12, 16, 25
 - 6 Name plate

Porting pattern according to ISO 5781:

Size	Code
12, 16	5781-06-07-0-00
25	5781-08-10-0-00
32	5781-10-13-0-00



Required surface finish of mating plugs



Type	B1	B2	B3	H1	H2	H3	L1	L2	L3	L4	L5	L6	L7	L8
FD 12 PA 2X/...	66.7	85	70	85	42.5	70	31.8	7.2	-	35.8	42.9	73.2	65	140
FD 16 PA 2X/...	66.7	85	70	85	42.5	70	31.8	7.2	-	35.8	42.9	73.2	65	140
FD 25 PA 2X/...	79.4	100	80	100	50	80	38.9	11.1	-	49.2	60.3	109.1	75	200
FD 32 PA 2X/...	96.8	120	95	120	60	95	35.3	16.7	42.1	67.5	84.2	119.7	94	215

Type	Ø A, B	Valve fixing screws	Tightening torque M_T [Nm]	Weight [kg]	O-ring (4)
FD 12 PA 2X/...	16	4 pieces M10 × 100 DIN 912-10.9	75	9	21.3 × 2.4
FD 16 PA 2X/...	16	4 pieces M10 × 100 DIN 912-10.9	75	9	21.3 × 2.4
FD 25 PA 2X/...	22	4 pieces M10 × 120 DIN 912-10.9	75	18	29.82 × 2.62
FD 32 PA 2X/...	30	6 pieces M10 × 140 DIN 912-10.9	75	24	27.69 × 3.53

Pipe threads **G** according to ISO 228/1

Thermal pressure valve

Type MHDBDT 06

Nominal size 6
 Component series 2X
 Maximum operating pressure 280 bar
 Maximum flow 3 l/min



H/A4624/95

Overview of contents

Contents

Features
Ordering details
Function
Symbol
Technical data
Characteristic curves
Unit dimensions

Page

1
2
2
2
2
3
4

Features

- Pressure adjustment, proportional to the temperature via a thermostat
- Low hysteresis
- Very good repeatability accuracy
- Choice of several temperature ranges
- Optional installation orientation
- Low weight
- Saves energy

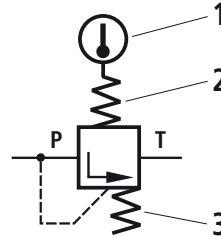
Ordering details

MHDB	DT	06	G	0	2X		M	*
Pressure relief valve								Further details in clear text
Direkt operated via thermostat	= DT							Port threads P and T
Nominal size 6		= 06						06 = Metric 19 = UNF
Valve version								Seal material
Housing			= G					M = NBR seals, suitable for mineral oil (HL, HLP) to DIN 51524
Adjustment								
Not adjustable				= 0				
Component series 20 to 29 (20 to 29: unchanged installation and connection dimensions)					= 2X			
Maximum DB pressure								
210 bar							= 210	
280 bar (for AA10VO control pump)							= 280	
								Nominal temperature at which control starts
								T050 = 50 °C (control range 8 °C)
								T060 = 60 °C (control range 8 °C)
								T075 = 75 °C (control range 10 °C)
								T082 = 82 °C (control range 10 °C)
								T087 = 87 °C (control range 10 °C)

Function, symbol

The thermal pressure valve is a direct operated pressure relief valve of poppet seat design, where the nominal pressure is proportional to temperature within given limits.

The valve basically comprises of a housing, thermoelement (1), valve seat and valve cone. The maximum pressure is dependent on the selected version. The thermal element expands in relation to the temperature and thereby compresses the springs (2) and (3) via a spring plate. If the temperature at the thermoelement (1) is lower than the control range, then the spring decompresses (2) and the re-set spring (3) unloads the pressure chamber P to tank.



Technical data (for applications outside these parameters, please consult us!)

General

Weight	kg	0,8
Installation		Optional

Hydraulic

Max. operating pressure at port P	bar	315
Control pressure at port P	bar	210 or 280 (for AA10VO control pump)
Pressure at port T	bar	Zero pressure, separate line to tank
Max. flow	l/min	3
Pressure fluid		Mineral oil (HL, HLP) to DIN 51524; fast bio-degradable pressure fluids to VDMA 24568 (also see RE 90221); HETG (rape seed oil); HEPG (polyglycols); HEES (synthetic ester); Other pressure fluids on request
Pressure fluid temperature range	°C	-20 to +80
Viscosity range	mm ² /s	2,8 to 300
Degree of contamination		class 20/18/15. We therefore recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$.
Max. hysteresis	°C	4
Repeatability accuracy	%	< ± 2 % of p_{nom}

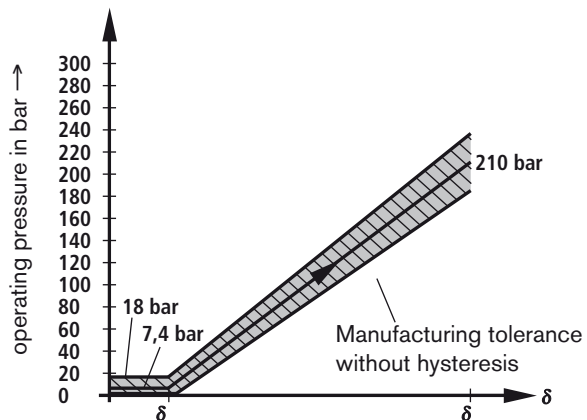
Installation notes:

MHDBDT 06 thermal pressure valves are **only** suitable for fluid circuits. The fluid to be measured should continually flow through the device once it is installed.

Characteristic curves (measured at $q_V = 2 \text{ l/min}$ and $\Delta\delta = 1 \text{ }^\circ\text{C/min}$)

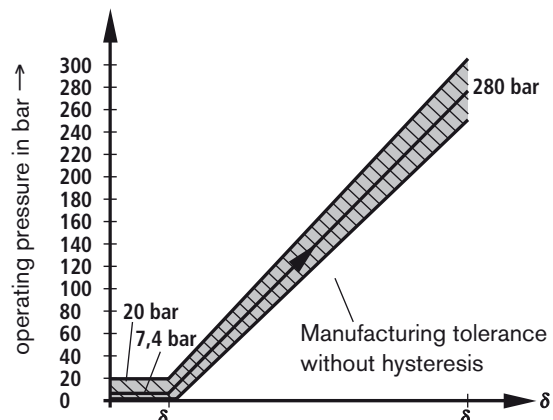
Pressure/temperature characteristic curves

$p_{\text{nom}} = 210 \text{ bar}$

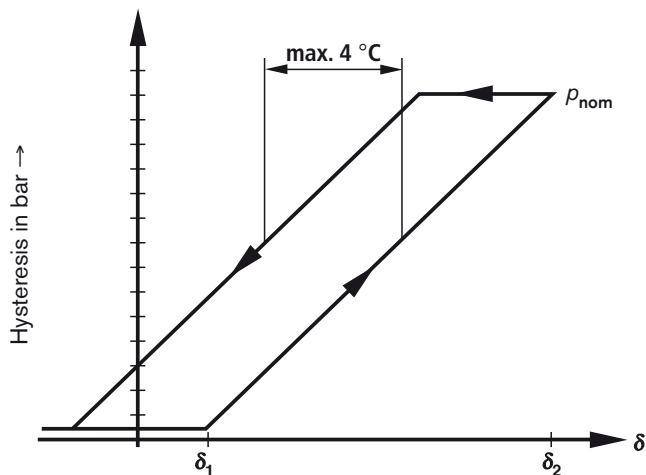


δ_1, δ_2 see table \rightarrow

$p_{\text{nom}} = 280 \text{ bar}$



δ_1, δ_2 see table \rightarrow

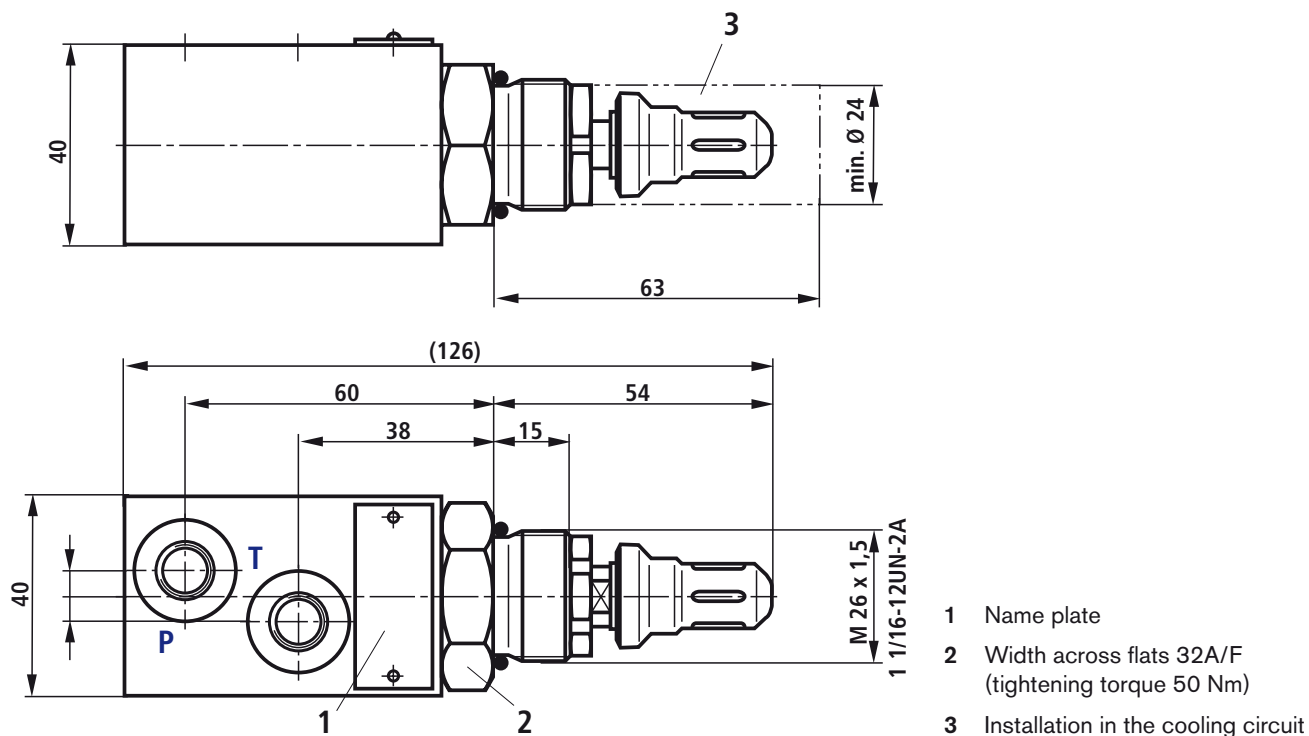


δ_1, δ_2 see table \rightarrow

Temperature range thermostat:

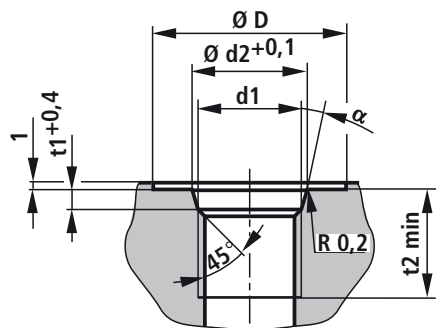
δ_1	-	δ_2
50 °C	-	58 °C
60 °C	-	68 °C
75 °C	-	85 °C
82 °C	-	92 °C
87 °C	-	97 °C

Unit dimensions (dimensions in mm)

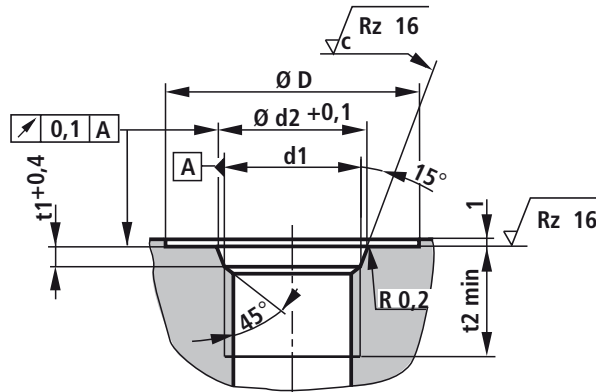


- 1 Name plate
- 2 Width across flats 32A/F (tightening torque 50 Nm)
- 3 Installation in the cooling circuit

Ports P and T



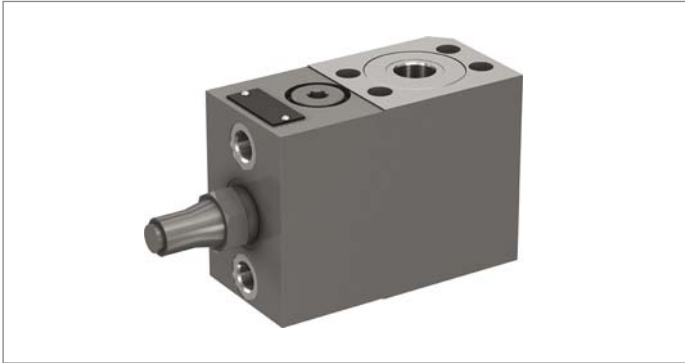
Installation cavity



Ports P and T						
Port thread	d1	$\varnothing d2$	$\varnothing D$	t1	t2	a
06	M12 x 1,5	13,8	22	2,4	11,5	15°
19	7/16-20 UNF-2B	12,4	21	2,4	11,5	12°

Installation cavity for valve						
Port thread	d1	$\varnothing d2$	$\varnothing D$	t1	t2	a
06	M26 x 1,5	29,05	40	3,1	15	
19	1 1/16-12 UNF-2B	29,2	41	3,3	15	

Unlockable check valve (anti-drift valve) for SAE flange connection MHSVD 19



- ▶ Series 1X
- ▶ Size 19
- ▶ Maximum working pressure 420 bar
- ▶ Maximum flow 300 l/min

Features

Unlockable MHSVD check valves are used to keep a hydraulic consumer in a position to minimize leakage oil.

Benefits

- ▶ Compact design
- ▶ Direct installation on the directional valve
- ▶ Minimal throttle losses
- ▶ Automatic check function unlocking
- ▶ Additional measuring port
- ▶ Retrofittable by end customers

Fields of application

- ▶ Excavators
- ▶ Wheeled loaders

Contents

Functional description	2
Technical data	3
Theoretical characteristic curves	3
Type code	4
Dimensions	5
Project planning notes	6
Safety instructions	6

Functional description

In directional valves with spool design, leakages occur in neutral position, which leads to the load lowering. To avoid this, unlockable MHSVD check valves are used.

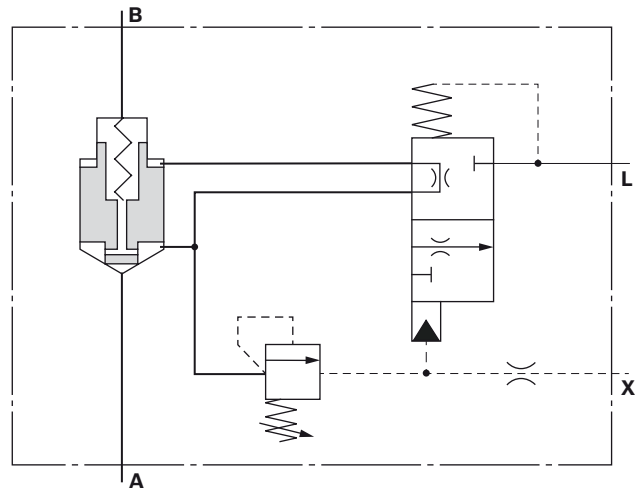
The flow passes via a check valve freely from connection **A** to connection **B**. If there is no pilot pressure present, the consumer is shut off at connection **B** such that leakage oil is kept to a minimum. A hydraulic signal must be applied to open **B** to **A**. A decompression surge can be avoided by opening the unlockable check valve before the main spool. When actuated, a minimum amount flows into the oil drain port.

There is an integrated adjustable pressure-dependent self-unlocking mechanism to protect the consumer against external effects. This is typically set 10 bar lower than the pressure relief valve (secondary pressure limitation) on the consumer port on the control block.

Note

The valve is not intended as or permitted to be used as a pipe burst safety valve.

▼ Symbol MHSVD 19



Ports

A	Control block port
B	Consumer port
X	Pilot port
L (Y)	Drain port

Technical data

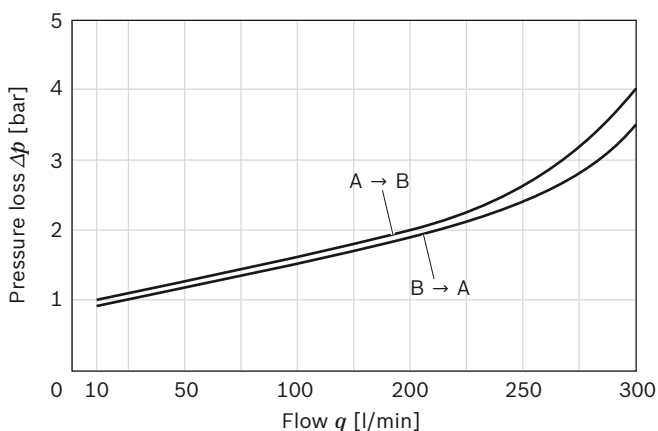
General				
Weight approx.		kg		3.7
Installation position				Any
Consumer connection type				SAE flange connection according to ISO 6162
Ambient temperature range	θ	°C		-25 to +100
Priming (standard)				One-coat paint RAL 5010
Hydraulic				
Maximum working pressure at port	A, B	p	bar	420
	L (Y)	p	bar	1
Maximum pilot pressure at port	X	p	bar	60
Cracking pressure		p	bar	2 to 4.5
Maximum flow at port	A, B	$q_{v \max}$	l/min	300
Maximum flow in unlocked position at port	X	$q_{v \max}$	l/min	1.2 (setting 10 bar below the secondary pressure at $v = 32 \text{ mm}^2/\text{s}$)
	L	$q_{v \max}$	l/min	1 (200 bar at port B at $v = 32 \text{ mm}^2/\text{s}$)
Maximum closing time	B → A	t	ms	500 (with unloading at port X at $v = 32 \text{ mm}^2/\text{s}$)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524
Hydraulic fluid temperature range	θ	°C		-20 to +100
Viscosity range	ν	mm^2/s		10 to 380
Maximum permissible degree of contamination of the hydraulic fluid Cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$

Note

Please contact us if the unit is to be used outside the specified range of values.

Theoretical characteristic curves

Pressure loss Δp at $v = 32 \text{ mm}^2/\text{s}$



Type code

01	02	03	04	05	06	07	08	09
MHSVD	19	-	1X	/	H	/		*

Series

01	Unlockable MHSVD check valve	MHSVD
----	------------------------------	-------

Size

02	Size 19	19
----	---------	----

Series

03	10 to 19 (unchanged installation and connection dimensions)	1X
----	---	----

Type of actuation

04	Hydraulic	H
----	-----------	---

Pressure limitation

05	Without pressure relief valve	P000
	With pressure relief valve, specified pressure in bar, 3-digit	P...

Sealing material

06	FKM (fluoroelastomer) ¹⁾	V
	NBR (nitrile rubber), on request	M

Line connections X, L

07	Pipe thread in accordance with ISO 228/1	01
----	--	----

Option

08	For safety-related applications (only in conjunction with P000) ²⁾	-S
----	---	----

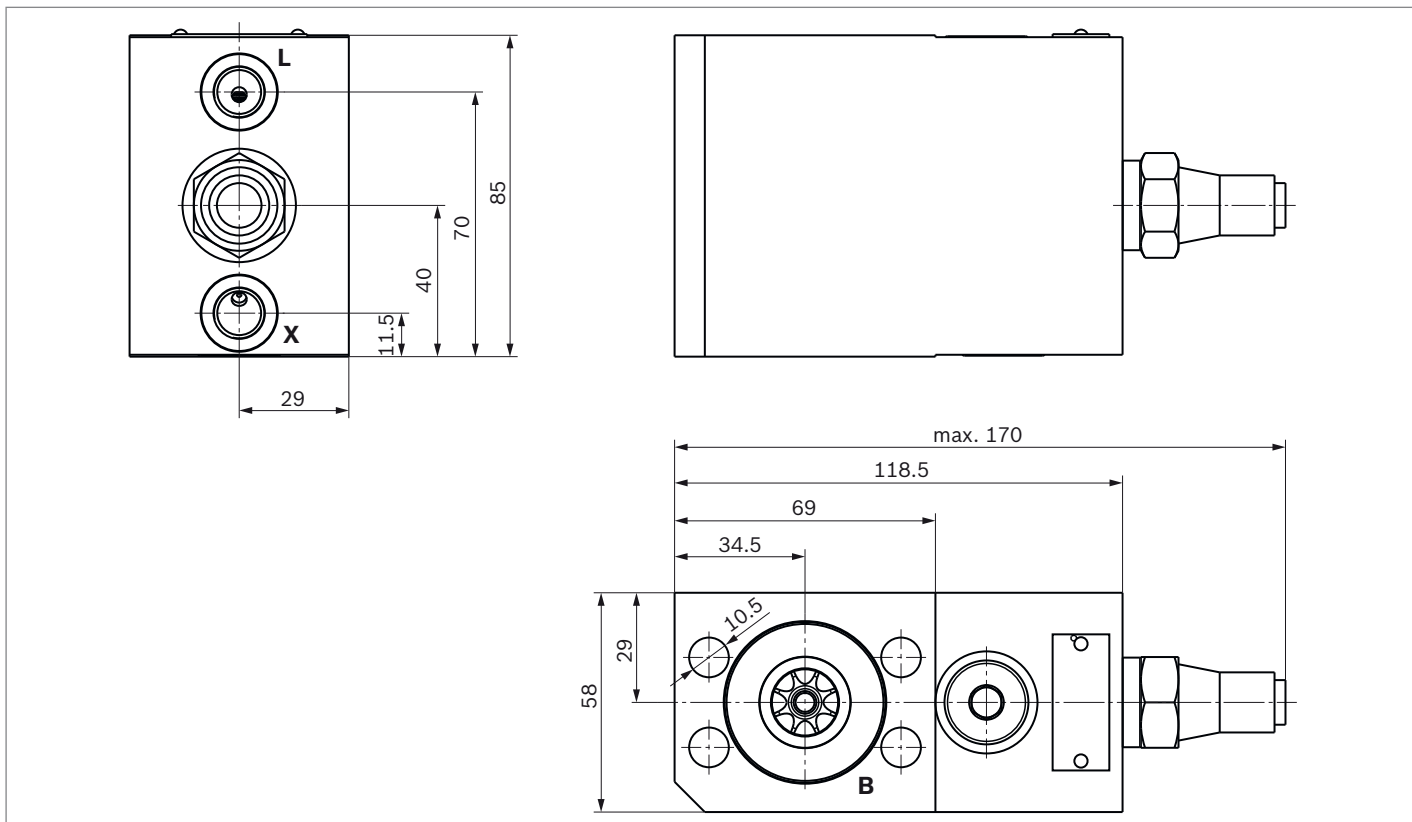
09	Further specifications in plain text	*
----	--------------------------------------	---

1) Exception: Pressure relief valve in NBR

2) Please consult our technical sales department

Dimensions

▼ MHSVD 19



▼ Line connections

Connection	Dimension	Standard
A, B	DN19 (SAE 3/4 in 6000 PSI)	ISO 6162-2
X	G 1/4	ISO 1179-1
L	G 1/4	ISO 1179-1

Project planning notes

- ▶ MHSVD Check valves are intended for use in mobile working machines to keep a hydraulic consumer in a position to minimize leakage oil. Deviating use is only permitted following consultation with Bosch Rexroth.
- ▶ For the project planning and operation of specification MHSVD...P000...-S for safety-related applications you must note the information given in the instruction manual 64545-B compulsory.
- ▶ The project planning, installation and commissioning of the check valve require the involvement of qualified skilled personnel.
- ▶ Before finalizing your design, request a binding installation drawing.
- ▶ Observe the technical data and ambient conditions specified.
- ▶ Depending on the operating conditions of the check valve (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ In unlocked position, the flow at port **X** depends on the pressure difference between the setting pressure of the MHSVD pressure relief valve and setting pressure of the secondary pressure relief valve.

Safety instructions

- ▶ Observe the installation and safety instructions of the machine manufacturer.
- ▶ Ensure that the hydraulic system is depressurized before working on the product. Please follow the machine manufacturer's instructions.
- ▶ The warranty by Bosch Rexroth only applies to the delivered configuration. Conversions and changes of the check valve are not permissible.

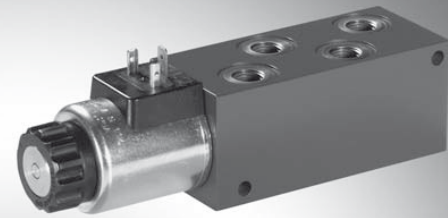
Note

Further information about installation, commissioning and operation can be found in the instruction manual 64545-B.

Multi-way directional valves (hydraulic switches)

Type MH.W...AG

Sizes 6, 20 and 30
Component series 2X
Operating pressure max. 350 bar



H7394-06

Content analysis

Content	Page
Characteristics	1
Function	1
Overview table of available models	2
Operating Curves	2
Unit Dimensions:	
• Size 6	3
• Size 20	4, 5
• Size 30	6, 7

Characteristics

- Direct or pilot operated
- 2 types of actuator (hydraulic and electrical)
- With spring return

Function

The 6/2-way valves are hydraulically or electrically actuated directional spool valves.

They control the starting, stopping and direction of a flow.

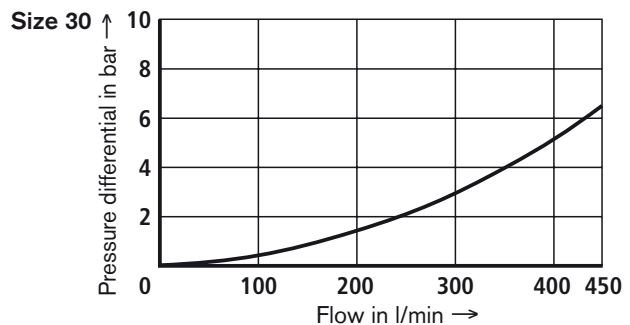
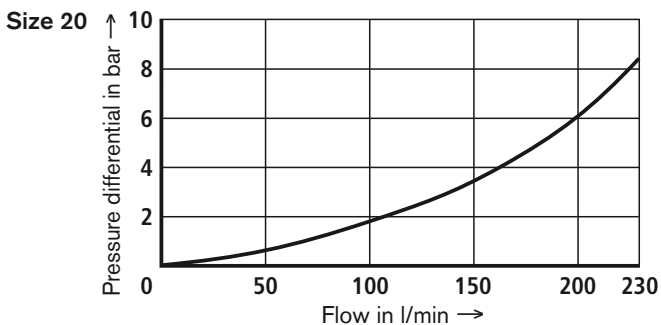
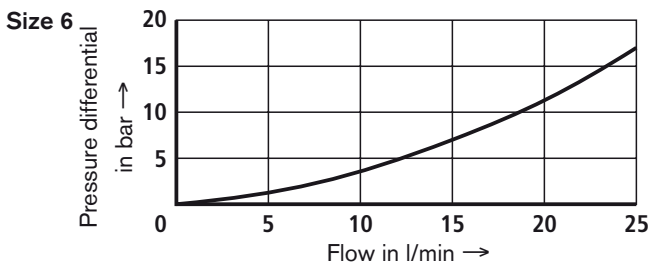
In general, these valves are used as an extension to a mobile control block instead of fitting an extra section. The following overview table shows the models available.

Deviating variants on request.

Overview table of available models

Size	Material No.	Type	Symbol	Actuation/voltage switching pressure $p_{\text{pilot min}}$ pilot pressure $p_{\text{pilot max}}$
6	R901058030	MH7WE 06 AG2X/EG24N9M01		direct actuated, electrical 24 V =
	R901058029	MH7WE 06 AG2X/EG12N9M01		direct actuated, electrical 12 V =
	R901058035	MH6WE 06 AG2X/LEG24N9M01		direct actuated, electrical 24 V =
	R901058036	MH6WE 06 AG2X/LEG12N9M01		direct actuated, electrical 12 V =
20	R901094340	MH6WH 22 AG2X/003V01		hydraulic, with spring return $p_{\text{pilot min}} = 4.5 \text{ bar}$ $p_{\text{pilot max}} = 30 \text{ bar}$
	R901094341	MH6WW 22 AG2X/030L2G24C4V11		pilot operated, electrical 24 V = $p_{\text{pilot min}} = 3.5 \text{ bar}$ $p_{\text{pilot max}} = 30 \text{ bar}$
	R901094342	MH6WW 22 AG2X/030L2G24C4V01		
	R901094343	MH6WW 22 AG2X/030L2G12C4V11		
R901094344	MH6WW 22 AG2X/030L2G12C4V01			
30	R901061669	MH6WH 32 AG2X/003M11		hydraulic, with spring return $p_{\text{pilot min}} = 4.5 \text{ bar}$ $p_{\text{pilot max}} = 30 \text{ bar}$
	R901061670	MH6WW 32 AG2X/L4AG24C4M11		pilot operated, electrical 24 V = $p_{\text{pilot min}} = 3.5 \text{ bar}$ $p_{\text{pilot max}} = 30 \text{ bar}$

Δp - q_V -curves (measured at $v = 41 \text{ mm}^2/\text{s}$ and $\vartheta = 50 \text{ }^\circ\text{C}$)



Unit dimensions: size 6 (Dimensions in mm)

Type MH7WE 06 AG2X/EG..N9M01

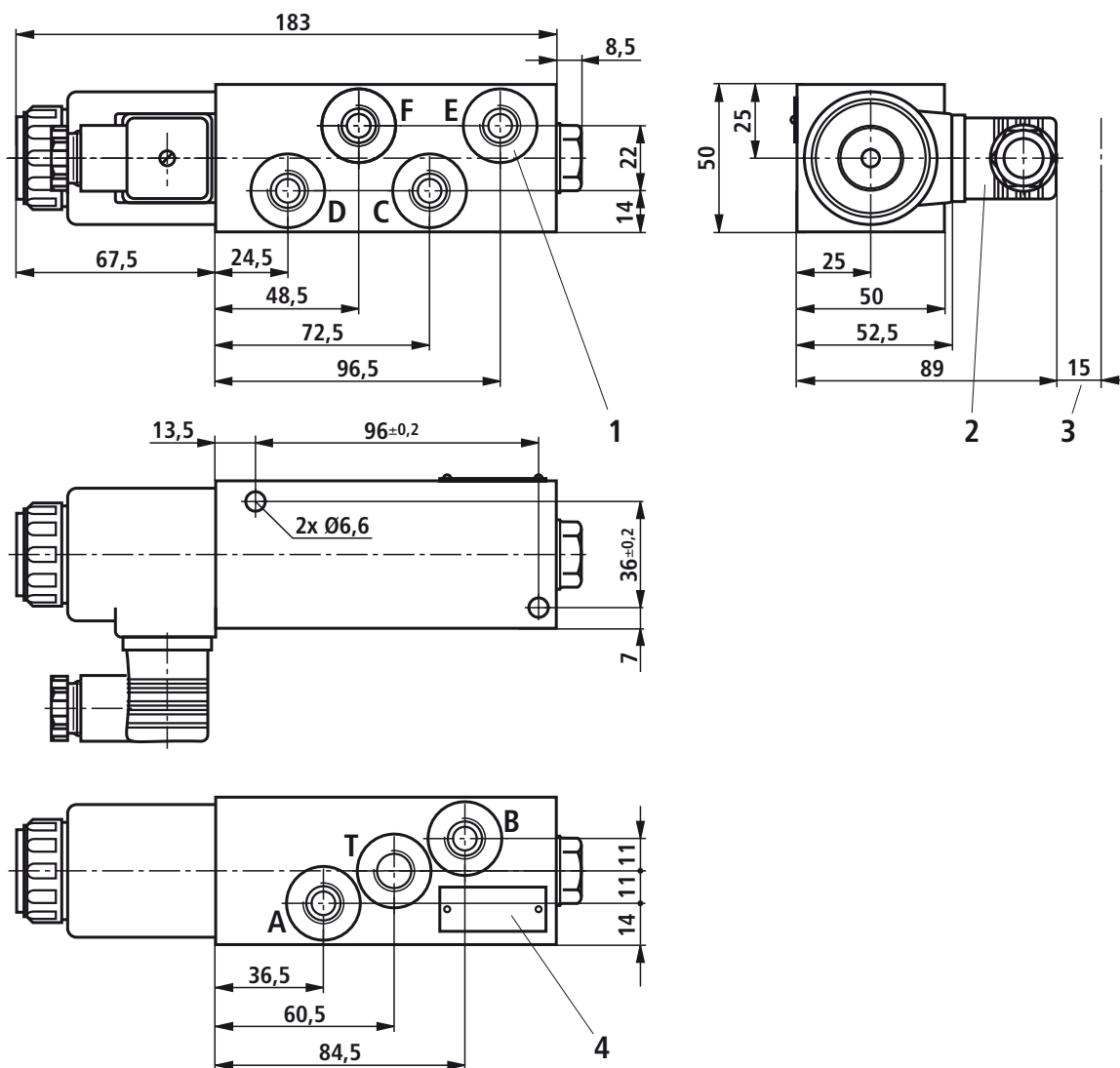
Material-No. R901058030 (24 V ⇒)

R901058029 (12 V ⇒)

Type MH6WE 06 AG2X/LEG..N9M01

Material-No. R901058035 (24 V ⇒)

R901058036 (12 V ⇒)

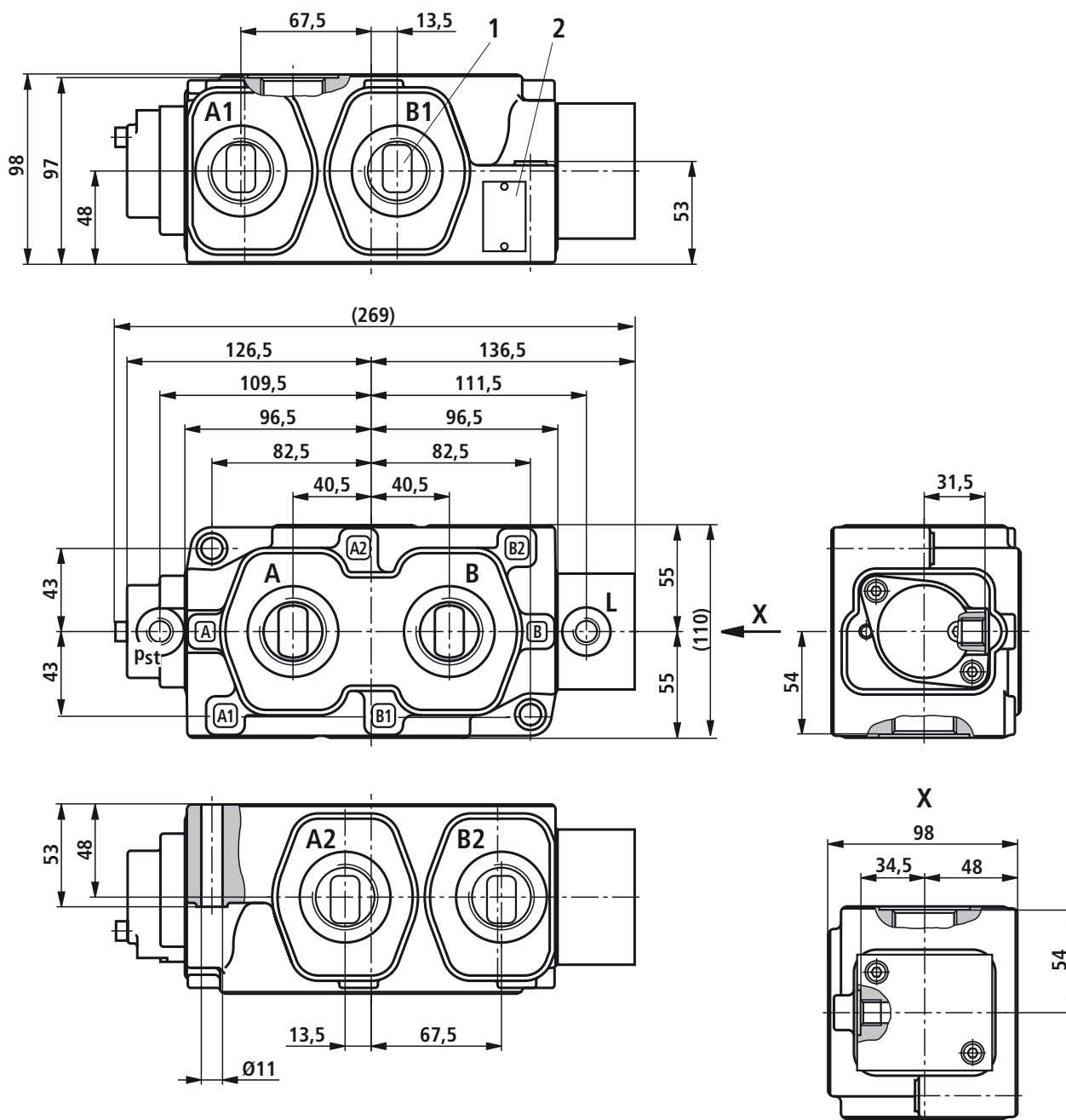


- 1 Ports
A, B, C, D, E, F and T
= G 1/4 to ISO 228/1
- 2 Plug-in connector
- 3 Space required to remove
plug-in connector
- 4 Nameplate

Unit dimensions: size 20 (Dimensions in mm)

Type MH6WH 22 AG2X/003V01

Material-No. R901094340



1 Ports

A, A1, A2, B, B1 and B2
= G 1 to ISO 228/1

p_{pilot} and L = G 1/4 to ISO 228/1

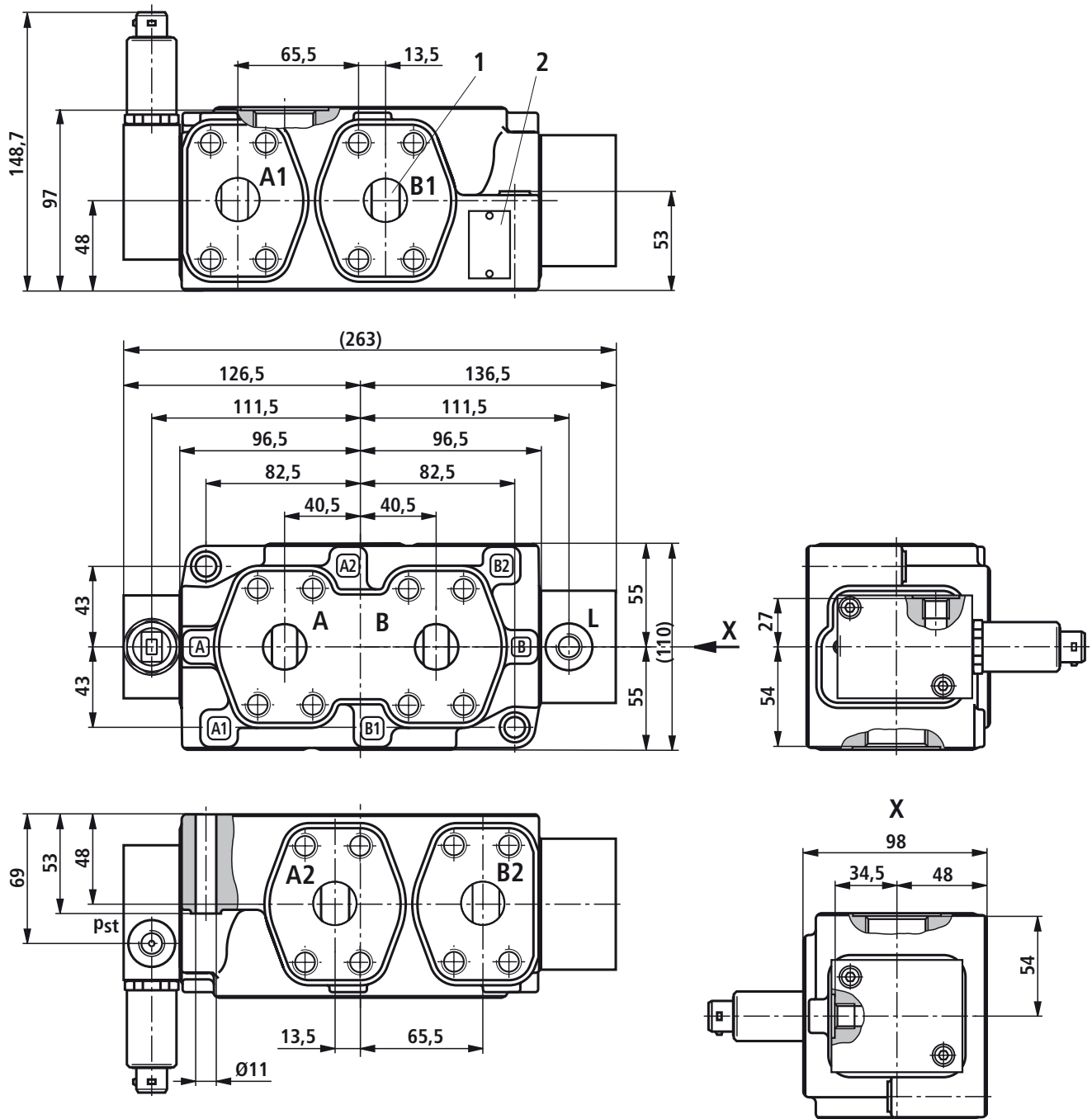
2 Nameplate

Unit dimensions: size 20 (Dimensions in mm)

Typ MH6WW 22 AG2X/030L2G¹²₂₄ C4V11

Material-Nr. R901094341 (24V ⇒)

Material-Nr. R901094343 (12V ⇒)



1 Ports

A, A1, A2, B, B1 und B2

= SAE 1 to J518 (6000 PSI)

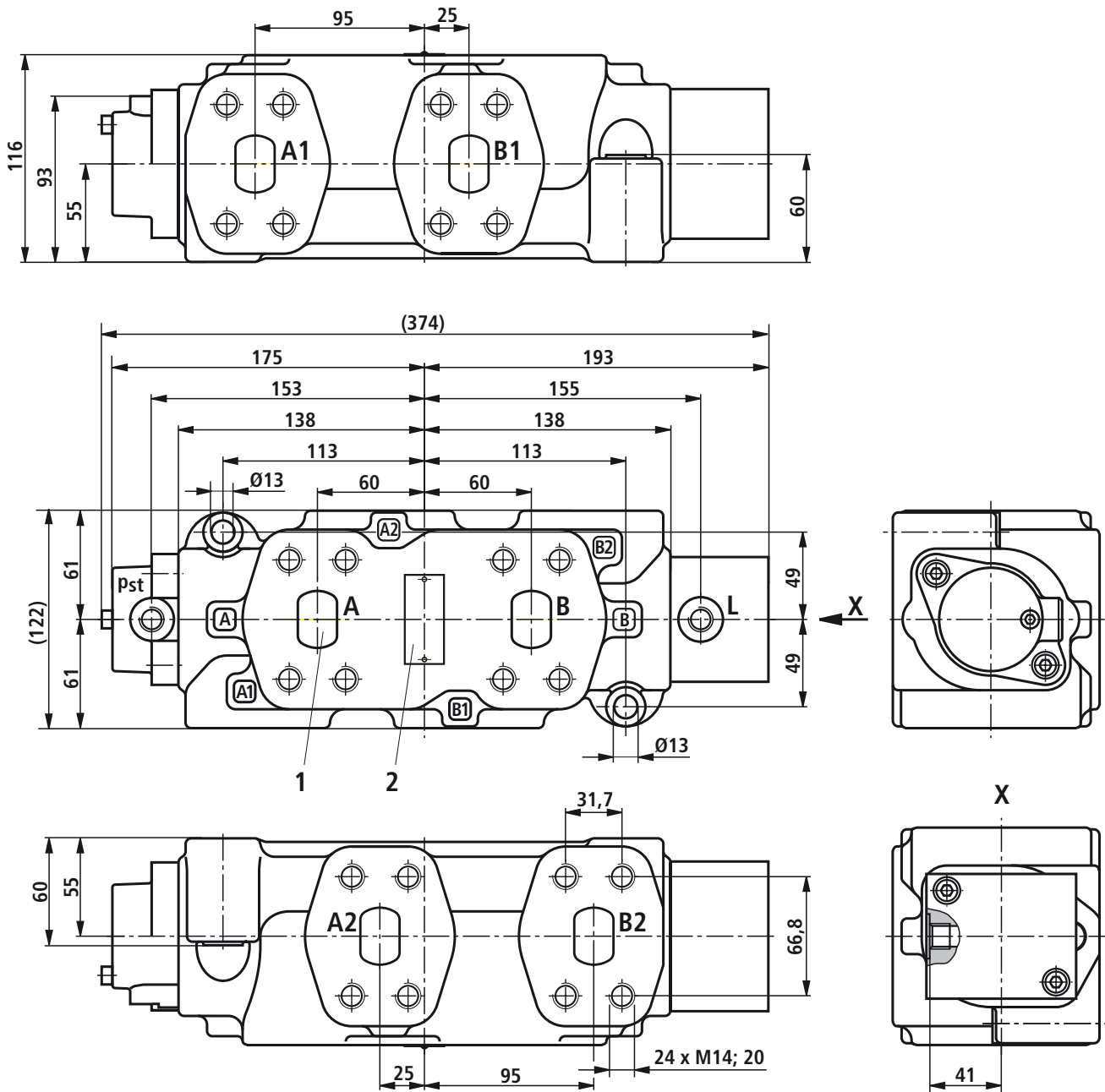
p_{St} and L = G 1/4 to ISO 228/1

2 Nameplate

Unit dimensions: size 30 (Dimensions in mm)

Type MH6WH 32 AG2X/003M11

Material-No. R901061669



1 Ports

A, A1, A2, B, B1 and B2
 = SAE 1 1/4 to J518 (6000 PSI)
 p_{pilot} and L = G 1/4 to ISO 228/1

2 Nameplate

Check Valve and Throttle/Check Valve with SAE Flanged Ports

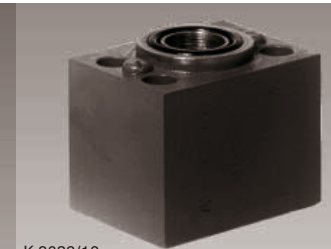
Type MHFS; MHSV

Size 20, 25, 32
Series 1X
Operating pressure max. 420 bar



K 3680/1

Type MHFS ...-1X/...



K 3683/12

Type MHSV...-1X/...

Overview of contents

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Throttle/Check Valve, Type MHFS:	
• Sizes available	2
• Function, Section, Symbol	2
• Technical Data	2
• Operating Curves	3
• Unit Dimensions	3
Check Valve, Type MHSV:	
• Sizes available	4
• Section, Symbol	4
• Technical Data	4
• Unit Dimensions	4
Check Valve, Type MHSV 22 PB2:	
• Size available	5
• Section, Symbol	5
• Technical Data	5
• Unit Dimensions	5

Features

- Operation dependent on pressure and viscosity
- Compact design
- For direct mounting on cylinder or distributor block
- Reduction of possible leakage points
- Additional gauge port

Throttle/Check Valve, Type MHFS

Sizes available:

- Size 20 = 3/4" SAE
Type MHFS 20 E2B1-1X/PBF45B08V11
Ordering code **R900417906**
- Size 25 = 1" SAE
Type MHFS 25 E2B1-1X/PBF10B04V11
Ordering code **R900334465**
- Size 32 = 1 1/4" SAE
Type MHFS 32 E2B1-1X/PBF10B03V11
Ordering code **R900411106**

Function, Section, Symbol

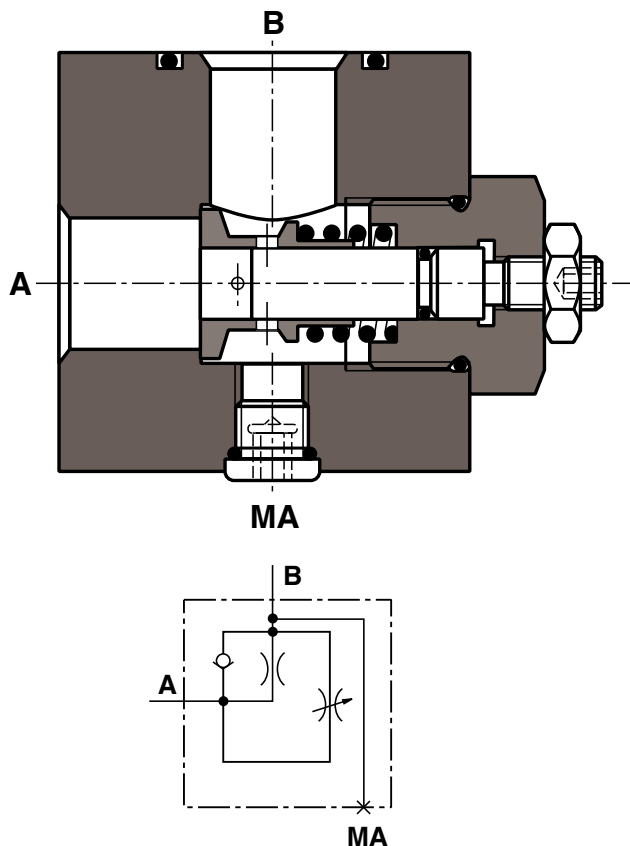
The valves are primarily used for limiting cylinder speeds, in order to reduce shocks when stopping heavy loads.

They consist basically of housing (1), spindle (2), valve poppet (3) and compression spring (4).

Limiting the cylinder speed (flow from B to A) is achieved by means of spindle (2). Depending on the spindle setting, radial holes (5) in valve poppet (3) are plugged to produce the required throttling to flow.

Fixed opening (6) between A and B prevents the throttle opening from being reduced to 0. This opening is 7.6 mm² for size 20, 13.2 mm² for size 25, and 26.4 mm² for size 32.

For the lifting operation (flow from A to B), valve poppet (3), which is guided by spindle (2), is pressed against compression spring (4) to allow the valve to fully open.

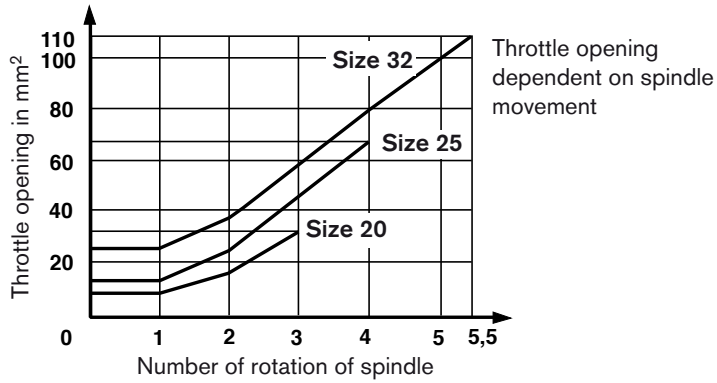


Technical data (For operation outside these parameters, please consult us!)

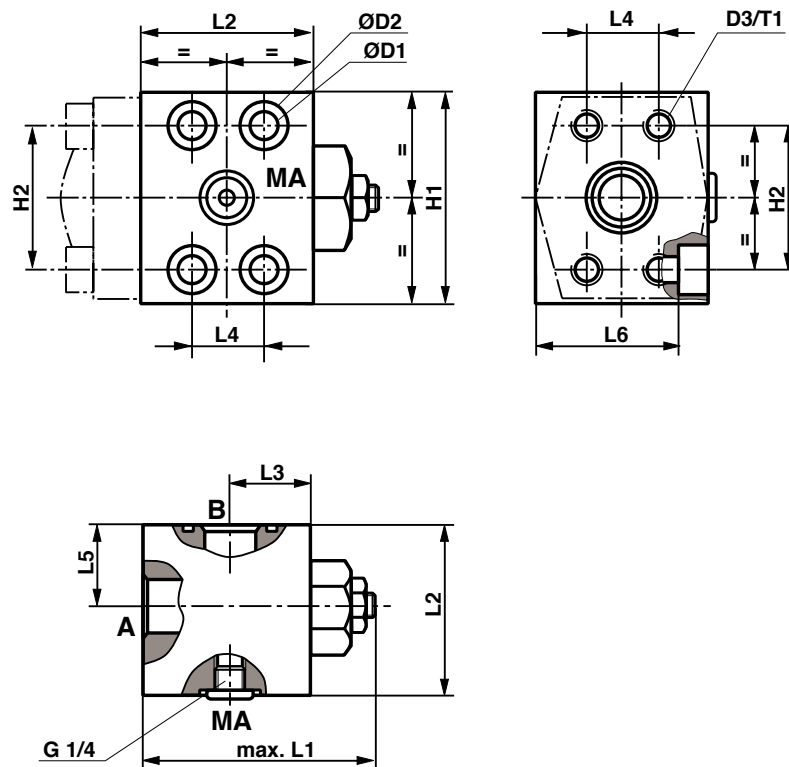
Max. operating pressure	bar	420	
Cracking pressure	bar	0,5	
Fluid		Mineral oil to DIN 51 524 (HL, HLP), phosphate ester (HFD-R)	
Fluid temperature range	°C	- 20 to + 80	
Viscosity range	mm ² /s	2,6 to 380	
Fluid cleanliness (maximum permissible)		ISO 4406 (C) Class 20/18/15	
Weight	Size 20	kg	2,1
	Size 25	kg	3,5
	Size 32	kg	5,1

Throttle/Check Valve, Type MHFS

Operating Curves (measured at $v = 42 \text{ mm}^2/\text{s}$ and $\vartheta = 50 \text{ }^\circ\text{C}$)



Unit dimensions (Dimensions in mm)



Size	Port A, B ¹⁾	L1 max.	L2	L3	L4	L5	L6	H1	H2	ØD1	ØD2	D3	T1
20	SAE 3/4"	85	60	30	23,9	30	49	75	50,8	11	18	M10	14
25	SAE 1"	100	75	37	27,8	40	60	80	57,2	13,5	20	M12	16
32	SAE 1 1/4"	116	85	42,5	31,7	42,5	70	90	66,7	15	24	M14 x 1,5	18

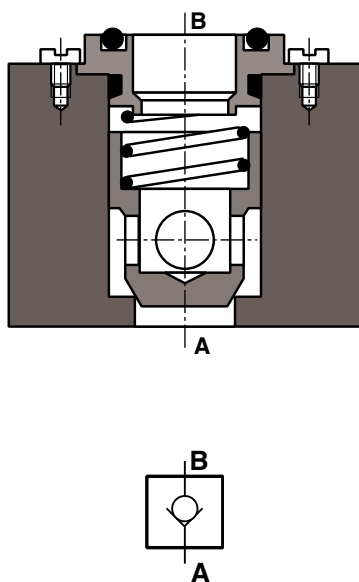
¹⁾ 6000 PSI (420 bar)

Check Valve, Type MHSV

Sizes available:

- Size 20 = 3/4" SAE
Type MHSV 22 ZB1-1X/M11-099
Ordering code **R900493236**
- Size 25 = 1" SAE
Type MHSV 25 FB1-1X/M11
Ordering code **R900358470**
- Size 32 = 1 1/4" SAE
Type MHSV 30 FB1-1X/M11
Ordering code **R900307483**

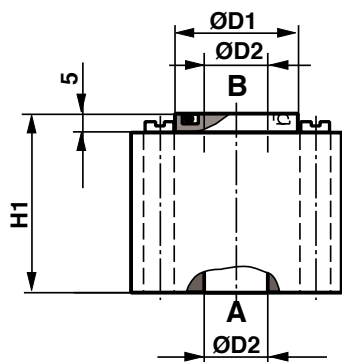
Section, Symbol



Technical data (For operation outside these parameters, please consult us!)

Max. operating pressure	bar	420
Cracking pressure:	Size 20	bar 0,6
	Size 25	bar 0,5
	Size 32	bar 1,5
Fluid	Mineral oil to DIN 51 524 (HL, HLP) Phosphate ester (HFD-R)	
Fluid temperature range	°C	- 20 to + 80
Viscosity range	mm ² /s	2,6 to 380
Fluid cleanliness (maximum permissible)	ISO 4406 (C) Class 20/18/15	
Weight	kg	Approx. 1

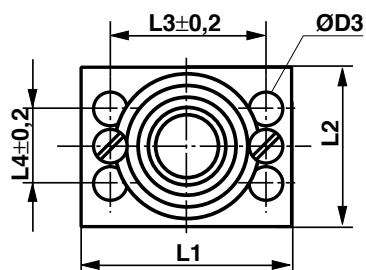
Unit dimensions (Dimensions in mm)



Size	Port A, B ¹⁾	L1	L2	L3±0,2	L4±0,2	H1	ØD1	ØD2	ØD3	Seal kit ordering code
20	SAE 3/4"	70	50	50,8	23,9	57	40	20	11,5	R900312289
25	SAE 1"	80	60	57,2	27,8	70	46	25	13,5	R900312593
32	SAE 1 1/4"	90	72	66,7	31,7	78	52	30	16	R900004330 R900007920 ²⁾

¹⁾ 6000 PSI (420 bar)

²⁾ If necessary, state both ordering codes

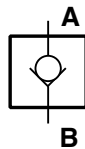
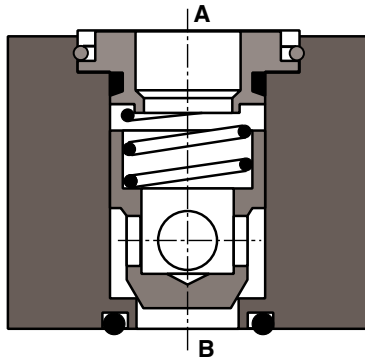


Check Valve, Type MHSV 22 PB2

Size available:

- Size 20 = 3/4" SAE
Type MHSV 22 PB2-1X/M
Ordering code **R900459081**

Section, Symbol



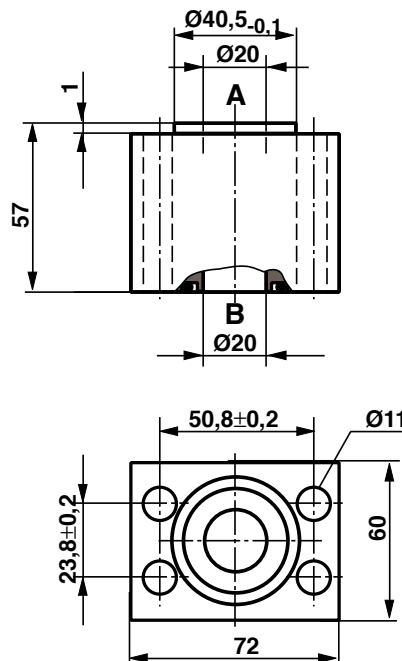
Technical data (For operation outside these parameters, please consult us!)

Max. operating pressure	bar	420
Cracking pressure:	bar	0,6
Fluid		Mineral oil to DIN 51 524 (HL, HLP) Phosphate ester (HFD-R)
Fluid temperature range	°C	- 20 to + 80
Viscosity range	mm ² /s	2,6 to 380
Fluid cleanliness (maximum permissible)		ISO 4406 (C) Class 20/18/15
Weight	kg	Approx. 1

Unit dimensions (Dimensions in mm)

3/4" SAE ports (A, B) 6000 PSI (420 bar)

Seal kit ordering code **R900312289**



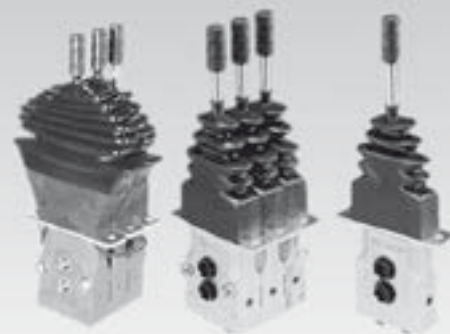
Pilot Control Devices

Designation	Type	Series	Data sheet	Page
Hydraulic pilot control devices				
Hydraulic pilot control device in sandwich plate design	2TH6	1X	64552	677
Hydraulic pilot control device for armrest installation	4TH5, 4TH6, 4TH6N	1X	64555	685
Hydraulic pilot control device unit with end position lock	4THF5, 6THF5	1X	64557	697
Hydraulic pilot control device unit with end position lock	4THF6, 5THF6	2X	64553	709
Hydraulic pilot control device in pedal design	2TH6R	1X	64551	721
Hydraulic pilot control device with 2 pedals and damping system	4TH5NR, 5TH5NR, 6TH5NR	2X	64535	727
Hydraulic pilot control device with 2 pedals and damping system	4TH6NR, 5TH6NR, 6TH6NR	2X	64554	735
Hydraulic pilot control device	TH7	1X	64558	743
Electronic pilot control devices				
Electronic pilot control device	THE5	1X	29881	753
Electronic pilot control device	THE5 CAN	4X	29696	797
Electronic pilot control device	EJ	1X	29896	817

Hydraulic pilot control unit of sandwich plate design for the remote control of directional valves, pumps, motors

Type 2TH6

Series 1X



Contents

Functional description, section	2
Symbol hydraulic	3
Technical data	3
Ordering details	4
Characteristics curves	5
Unit dimensions	6 to 7
Contact location within the plugs	8

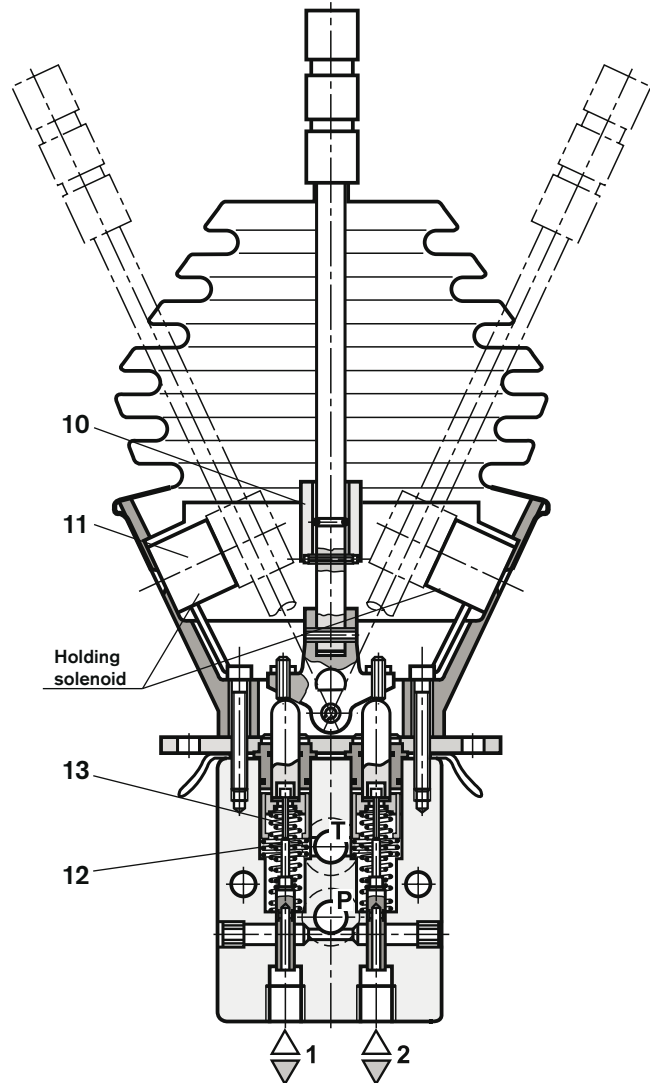
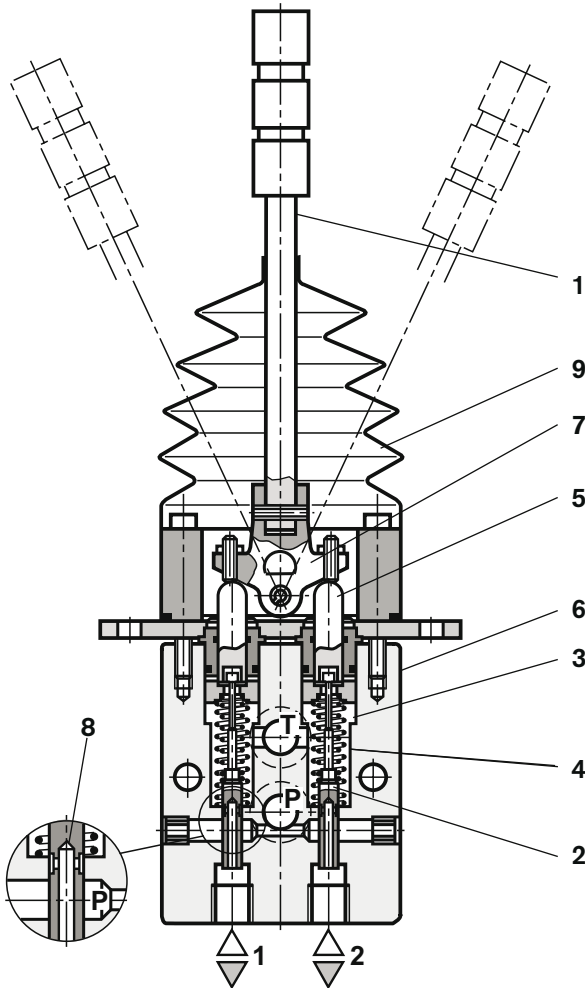
Features

- Progressive, sensitive control
- Precise and play-free control characteristics
- Low actuation force at the lever
- Rust-free plunger

Further remote controls and pilot control units:

- **Hydraulic remote control**
 - Pilot control unit type 2 TH 6 R, pedal version (see RE 64551)
 - Pilot control unit types 4 TH 6, 4 TH 5, 4TH 6 N, for arm rest installation (see RE 64555)
 - Pilot control device type TH 7, for instrument panel installation or in pedal design (see RE 64558)
 - Pilot control device with end position locking type 4/5 THF 6 (see RE 64553) or type 4/6 THF 5 (see RE 64557)
- Electronic pilot control device
 - Electronic remote control device type THE6 for direct controlling of electrical or electro-hydraulic pilot operated actuators (see RE 29771)
 - Electronic pilot control device type THE5 (see RE 29881)
- B2 TH 6 (see picture opposite)
 - Recommended for use with a single 2 TH 6 control axis
 - This pilot control unit cannot be flanged on

Functional description, section



Hydraulic operating principle

Hydraulic pilot control units of the type 2TH6 operate on the basis of direct operated pressure reducing valves.

Pilot control units of the type 2TH6 basically comprise of a control lever (1), two pressure reducing valves and a housing (6).

Each pressure reducing valve consists of a control spool (2), a control spring (3), a return spring (4) and a plunger (5).

In the non-actuated condition, the control lever is held in the neutral position by the return spring (4). The control ports (1,2) are connected to tank port T via a drilling (8).

When the control lever (1) is deflected, the plunger (5) is pressed against the return spring (4) and the control spring (3). The control spring (3) initially moves the control spool (2) downwards and closes the connection between the relevant port and tank port T. At the same time, the relevant port is connected to port P via the drilling (8). The control phase starts as soon as the control spool (2) finds its balance between the force from the control spring (3) and the force resulting from the hydraulic pressure in the relevant ports (ports 1, 2).

As a result of the interaction of the control spool (2) and the control spring (3) the pressure in the relevant ports is proportional to the stroke of the plunger (5) and thus to the

position of the control lever (1).

This pressure control as a function of the control lever (1) position and the characteristics of the control spring (3) enables the proportional hydraulic control of directional valves and high response control valves for hydraulic pumps and motors.

A rubber gaiter (9) protects the mechanical parts in the housing against contamination and ensures that the 2TH6 pilot control units can also be used for the arduous applications.

Electro-magnetic lock

End position locking is only provided for the control connections which require that the control lever is held in the deflected position.

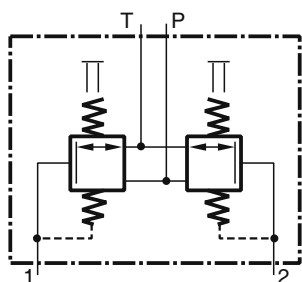
An additional spring (12), which is fitted below an additional plate (13) warns, by means of an increased force, which is required for compressing this spring, that the plunger (5) and the control lever (1) have almost reached the end position.

When this threshold is overcome, a ring (10) contacts the solenoid (11); if the solenoid is energised, then control lever (1) is held in its end position by magnetic force.

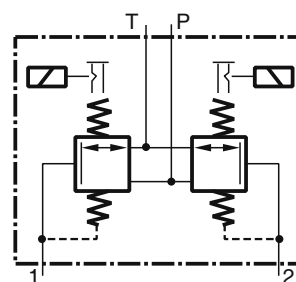
Unlocking can be performed automatically when the solenoid current is switched off.

Symbol, hydraulic

Variants without electrical detent: L, M, P, T, N



Variants with electrical detent: G, H, J



Technical data, mechanical (for applications outside these parameters, please consult us!)

Inlet pressure	bar	up to 50
Back pressure at port T	bar	up to 3
Control fluid flow (P to 1 - 2)	l/min	up to 16
Hysterises	bar	up to 1
Pressure fluid		
¹⁾ suitable for NBR seals		mineral oil (HL, HLP) to DIN 51524 ¹⁾
²⁾ suitable for FKM seals		phosphate ester (HFD-R) ²⁾
Pressure fluid temperature range	°C	- 20 to + 80
Viscosity range	mm ² /s	10 to 380
Degree of pressure fluid contamination		Maximum permissible degree of contamination of the pressure fluid is to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Max. permissible operating torque at lever	Nm	10 in operation
	Nm	80 for an exceptional, one time loading
Weight (dependent on the actuating element)	kg	1.2 to 1.8

Technical data, electrical (for applications outside these parameters, please consult us!)

E-contact technical data for actuator N

• Switching capacity			
	- DC	1 A - 30 V	250 000 cycles
	- AC	0.3 A - 250 V	250 000 cycles
		0.6 A - 125 V	250 000 cycles
• Max. start contact resistance	mW	50	
• Min. isolation resistance at 500 V DC	MW	1 000	
• Dielectric strength		1 000 V eff. 50 Hz min. between outputs	
		1 500 V eff. 50 Hz min. between outputs and mass	
Solenoid supply voltage	V	24 (20 to 27) / DC	
Power consumption of each solenoid		8.5 W at 24 V	

Application guidelines (this list is not intended to be considered as complete)

- Do not direct the jet of a pressure washing unit directly at the unit.
- The electrical cable must be kept free of any mechanical forces.
- During operation protection via the rubber boot must be ensured.

Safety guidelines (this list is not intended to be considered as complete)

- Only one function control must be allocated to an E-contact.
- The circuit functions are to be so designed that uncontrolled machine movements, caused by the application, are prevented and that it is possible to switch from one function to another.
- Take into account all of the application limits, particularly those application limits stated within this catalogue sheet.

Ordering details

Pilot control unit with N flangeable control axis

1st control axis

2nd control axis

3rd control axis

4th control axis

5th control axis

6th control axis

N = number of control axes 1 to 6

Pilot control unit with 1 control axis, not flangeable

Control axis, separate

Example

3-2 TH 6 L06-1X
M70
L06 M01

Example

B 2 TH 6 L06-1X/M01

Example

2 TH 6 L06-1X/M01

Actuator type

- 1 lever without detent = L
- 1 lever with detent in 3 positions = M
- 1 lever held in any position by a friction coupling = P
- 1 lever with detent in 3 positions and held in any position by a friction coupling = T
- 1 lever with E-contact = N
- 1 lever with electrical detent in position 1 = G
- 1 lever with electrical detent in position 2 = H
- 1 lever with electrical detent in both positions = J

Enter the identification number of the control curve that is required (see page 5)

Series 10 à 19 = 1X
(10 to 19 : unchanged installation and connection dimensions))

Further details in clear text

01 = G 1/4 pipe thread to standard ISO 228/1
05 = 9/16 UNF-2 B connections to standard ISO 11926

Seals

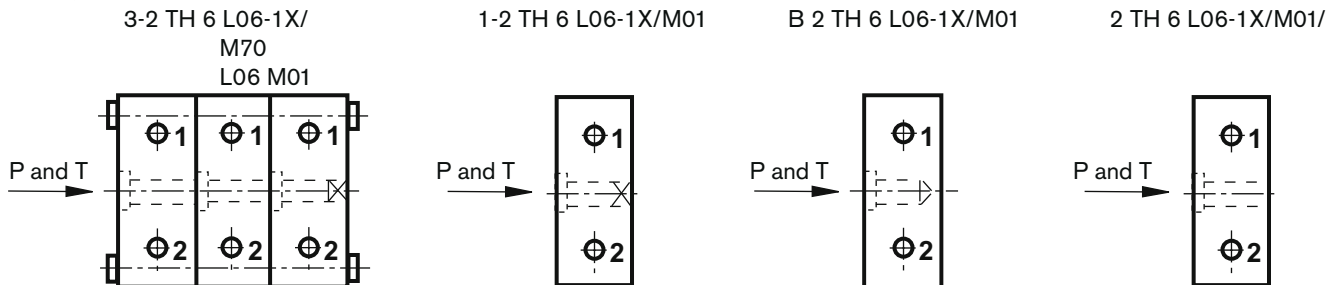
- M = NBR seals
- V = FKM seals

⚠ Attention!
The compatibility of the seals and pressure fluid has to be taken into account

Plug (voir page 8)

- 5 = DEUTSCH sealed plug IP 67 for wiring the solenoid on a 2 TH 6 G/H/J
- 6 = Plug AMP MAT-N-LOK for wiring the solenoid on a 2 TH 6 G/H/J
- 7 = DEUTSCH sealed plug IP 67 for wiring the solenoids on a 2 TH 6 N
- 8 = Plug AMP MAT-N-LOK for wiring the solenoids on a 2 TH 6 N
- No code = Without plug

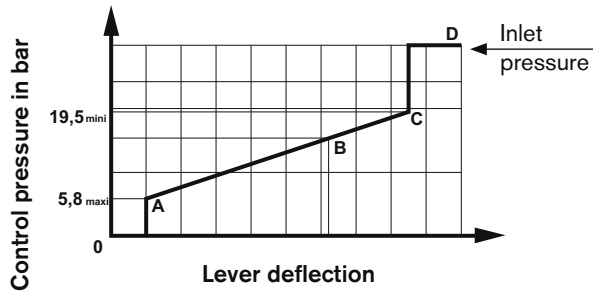
Drillings for connections P and T: connection possibilities (seen from above)



Characteristic curves: control ranges, actuation moments

06 Control curve, identification no. 06

This curve is used for the pilot control of the **SM12, SM18, M1** control blocks

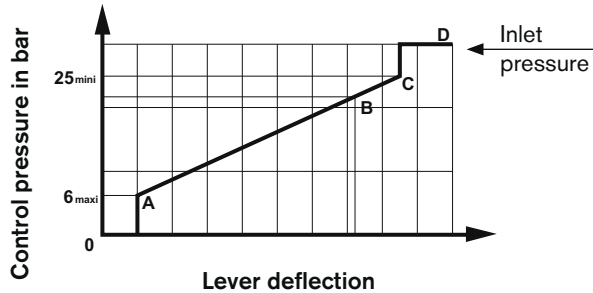


Inter-section point	A	B	C	D
Lever deflection	3°	18°	21°	25°
Actuation moment for actuator L in N.m	0.8	/	2.7	3.8 (p = 35 bar)
Actuation moment for actuators G, H, J in N.m	0.8	1.8	3.2	4.3 (p=35 bar)

B = resistance point before changeover to inlet pressure

70 Control curve, identification no. 70

This curve is used for the pilot control of the **SX14, SX18** control blocks

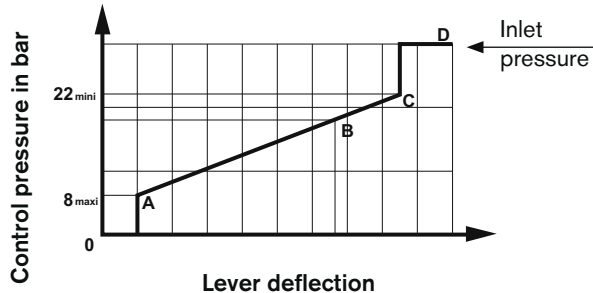


Inter-section point	A	B	C	D
Lever deflection	3°	18°	21°	25°
Actuation moment for actuator L in N.m	0.8	/	2.7	3.8 (p = 35 bar)
Actuation moment for actuators G, H, J in N.m	0.8	3.2	3.6	4.3 (p=35 bar)

B = resistance point before changeover to inlet pressure

20 Control curve, identification no. 20

This curve is used for the pilot control of the **SP12** control blocks

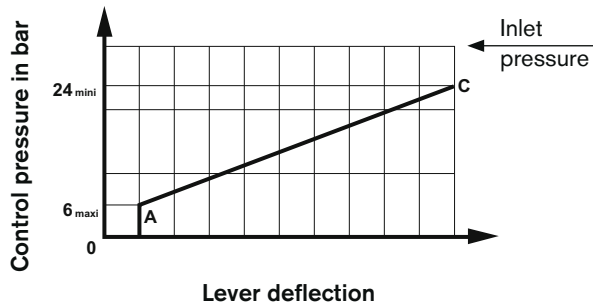


Inter-section point	A	B	C	D
Lever deflection	3°	18°	21°	25°
Actuation moment for actuator L in N.m	1	/	2.9	3.8 (p = 35 bar)
Actuation moment for actuators G, H, J in N.m	1	3.1	3.4	4.3 (p=35 bar)

B = resistance point before changeover to inlet pressure

97 Control curve, identification no. 97 (only for actuators L, M, P, N and T)

This curve is used for the pilot control of the **M7** control blocks



Inter-section point	A	C
Lever deflection	3°	25°
Actuation moment for actuator L in N.m	0.8	3.3

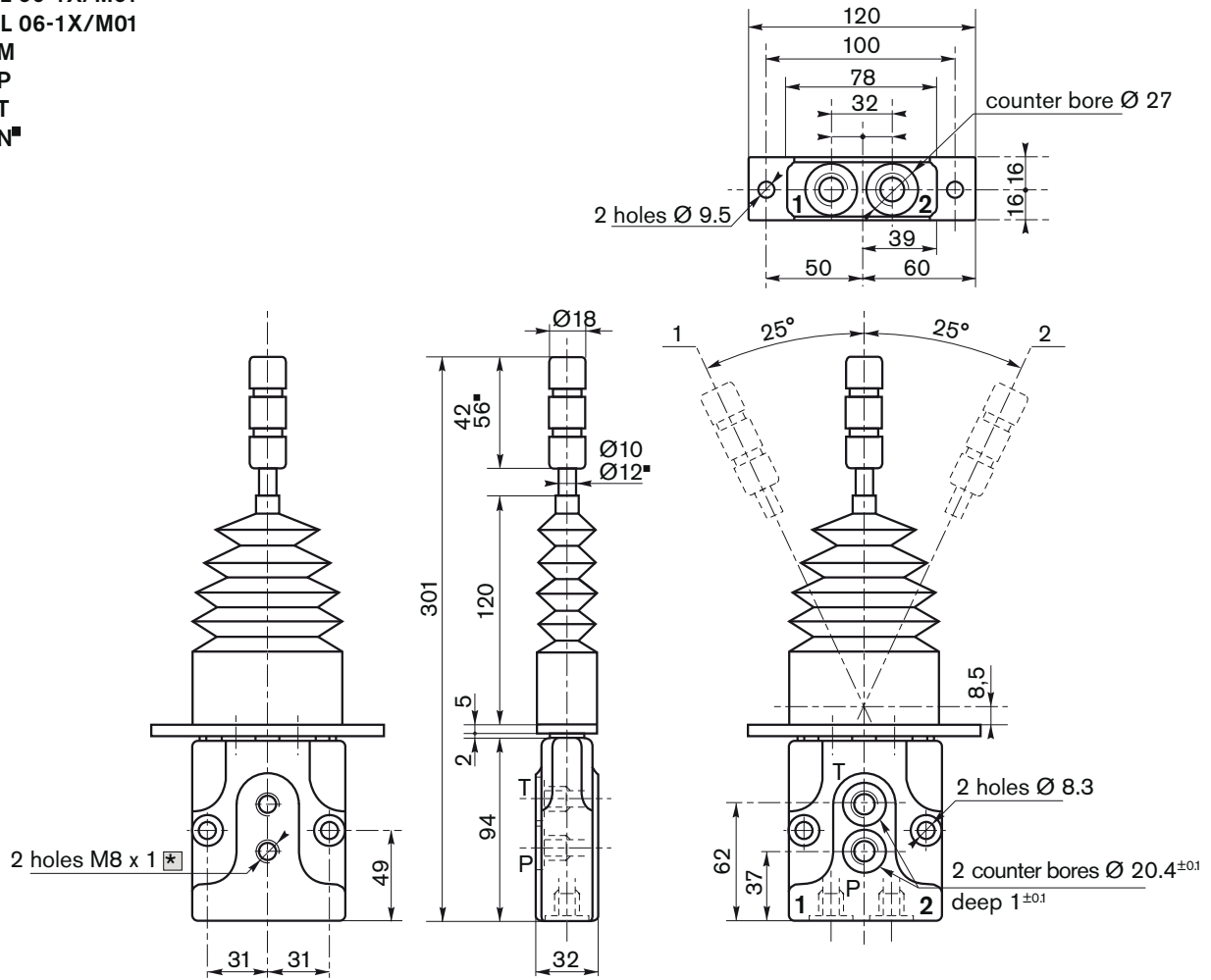
The actuation moments stated are theoretical values which do not take into account the rubber boot resistance.

Unit dimensions (Dimensions in mm)

2 TH6 L 06-1X/M01

1-2 TH6 L 06-1X/M01

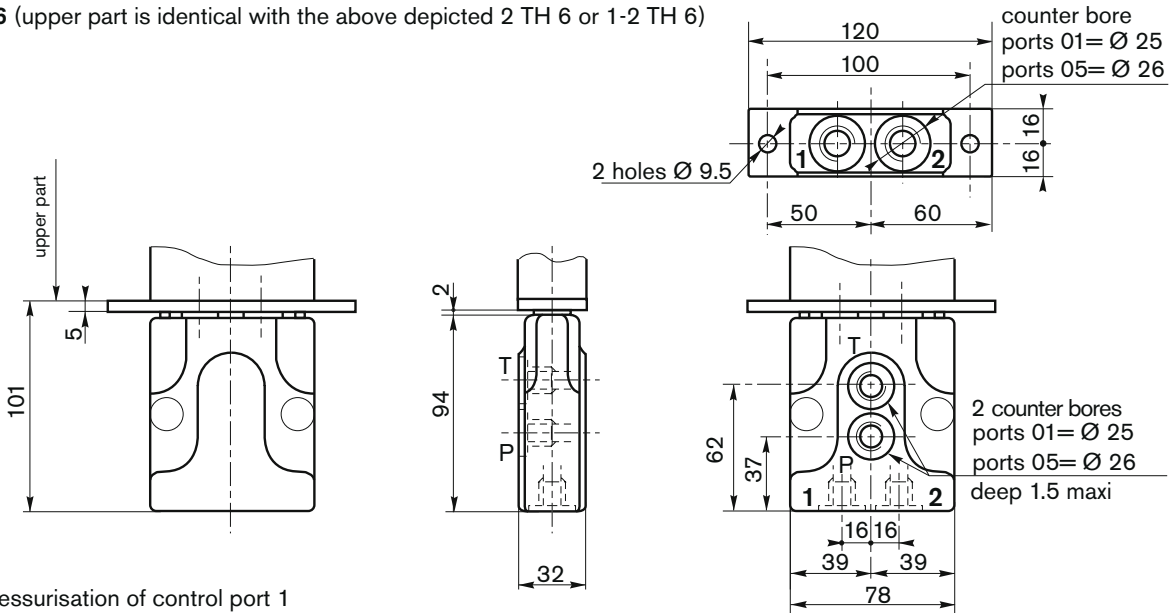
M
P
T
N[■]



☐ for version 2 TH 6 the threads are open
for version 1-2 TH 6 the threads are closed

■ the version 2 TH6 N has other dimensions for the lever and bush

B2 TH6 (upper part is identical with the above depicted 2 TH 6 or 1-2 TH 6)

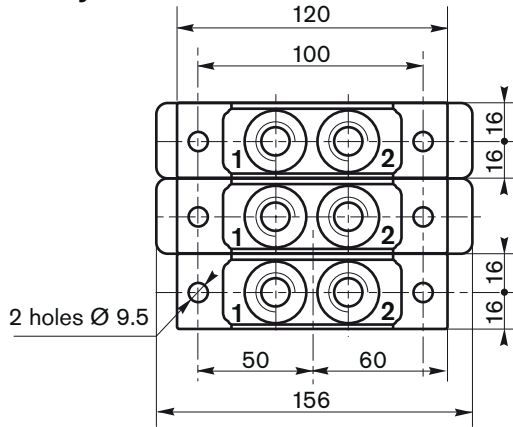


1 pressurisation of control port 1
2 pressurisation of control port 2

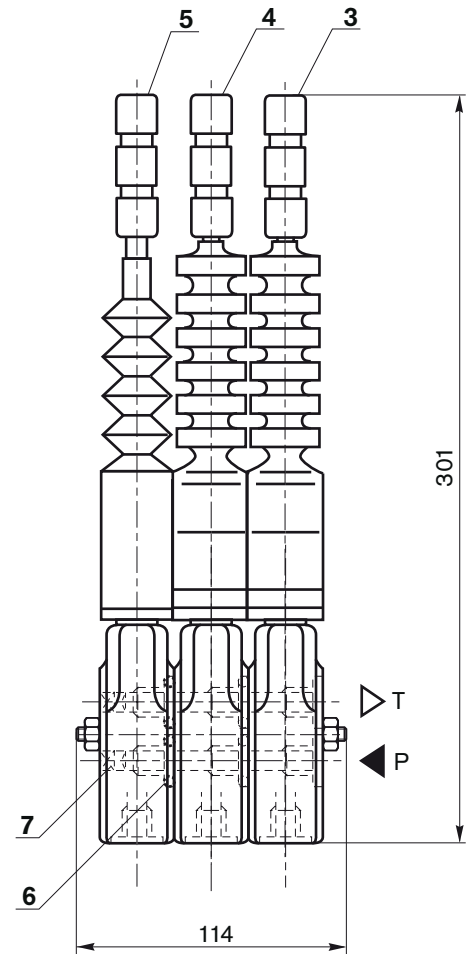
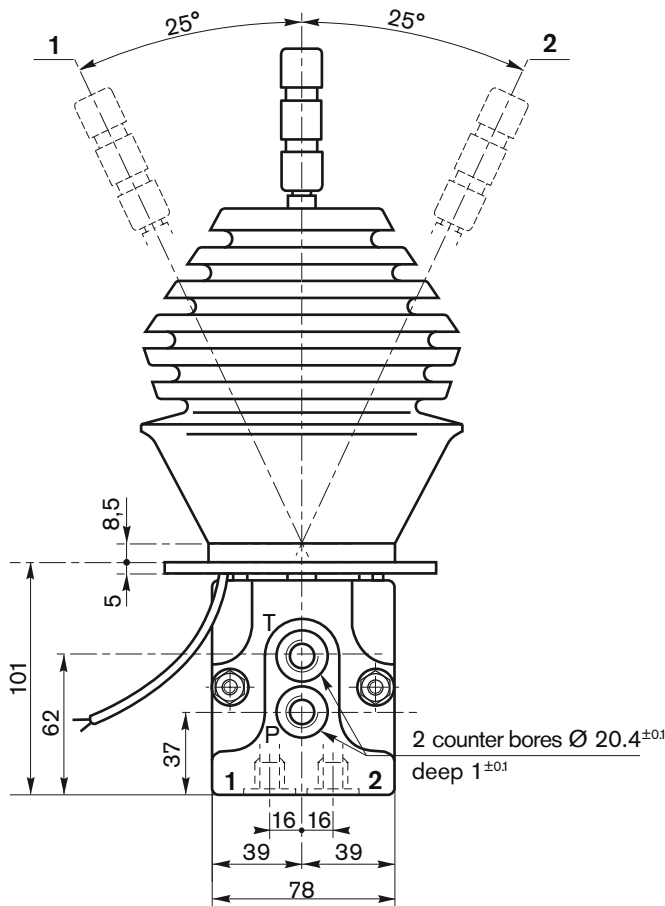
Unit dimensions (Dimensions in mm)

3-2 TH6 H06-1X/H06 L06 M01

G G
J J



- 1 pressurisation of control port 1
- 2 pressurisation of control port 2
- 3 1st control axis (H06)
- 4 2nd control axis (H06)
- 5 3rd control axis (L06)
- 6 O-rings: 17.5 x 1.5 (2 off per contact surface)
- 7 plug factory fitted



Installation guidelines

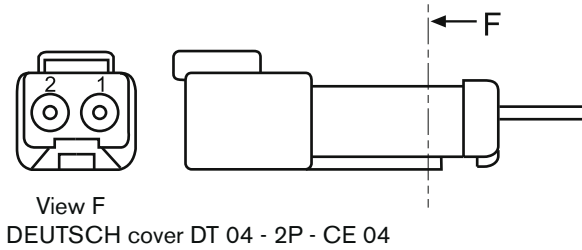
- Mounting flange area: Flatness = 0.5 mm
- Screw head imensions = Ø13 mm
- Tightening torque for the flange fixing screws = Max. 10 Nm
- Tightening torque for the pipe connections = Max. 30 Nm

Electrical contact symbol for version 2 TH 6 N

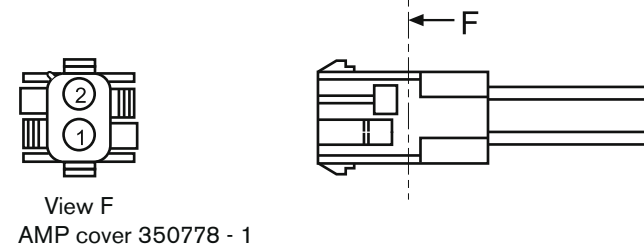


Contact location within the plugs for wiring the 2 TH 6 N

DEUTSCH sealed plug IP 67 (ordering code = 7)

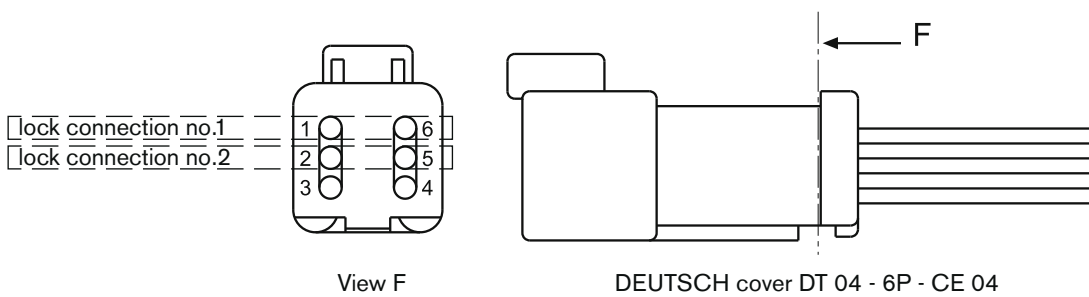


Plug AMP MAT-N-LOK (ordering code = 8)

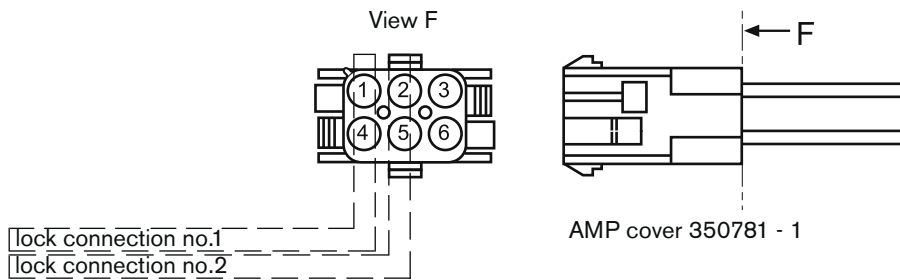


Contact location within the plugs for wiring the solenoids of the electro-magnetic lock 2 TH 6 G / H / J

DEUTSCH sealed plug IP 67 (ordering code = 5)



Plug AMP MAT-N-LOK (ordering code = 6)



Hydraulic pilot control units for armrest installation

Type 4TH5, 4TH6, 4TH6N

Series 1X



Contents

Functional description, section, symbol	2
Technical data	3
Ordering details	4
Unit dimensions	5
Characteristic curves	6 and 7
Variations of ergonomic grip EC2000	8
Contact location within the plugs for wiring grip EC2000	9
Guidelines	10

Special features

- Progressive, sensitive operation.
- Low actuation forces.
- Low force deviations when lever is actuated (4TH5, 4TH6N).
- Several ergonomic grips with various E contacts.
- All connections point downwards.

Functional description, section, symbol

Design

The 4TH6, 4TH6N and 4TH5 pilot control units basically comprise of a control lever (5), four pressure adjustment valves and a housing (10).

Each pressure adjustment valve comprises of a control spool (6), a control spring (7), a return spring (8) and a plunger (9).

General

The design of the 4TH6N and 4TH5 versions differs from that of the 4TH6. Thereby the force's deviations, which are felt when the lever is deflected, are reduced.

As the 4TH5 is smaller and lighter, it is normally used for applications in compact machines.

Function

When not actuated the control lever is held in zero position by the four return springs (8). The control ports (1, 2, 3, 4) are connected to the tank port **T** via the drilling (11).

With deflection of the control lever (5) the plunger (9) pushes against the return spring (8) and the control spring (7). The control spring (7) firstly moves the control spool (6) downwards and closes the connection between the appropriate port and tank port **T**. At the same time the appropriate port is connected to the port **P** via the drilling (11). The control phase begins as soon as the control spool (6) has found its balance between the force of the control spring (7) and the force which results from the hydraulic pressure in the appropriate port (ports 1, 2, 3 or 4).

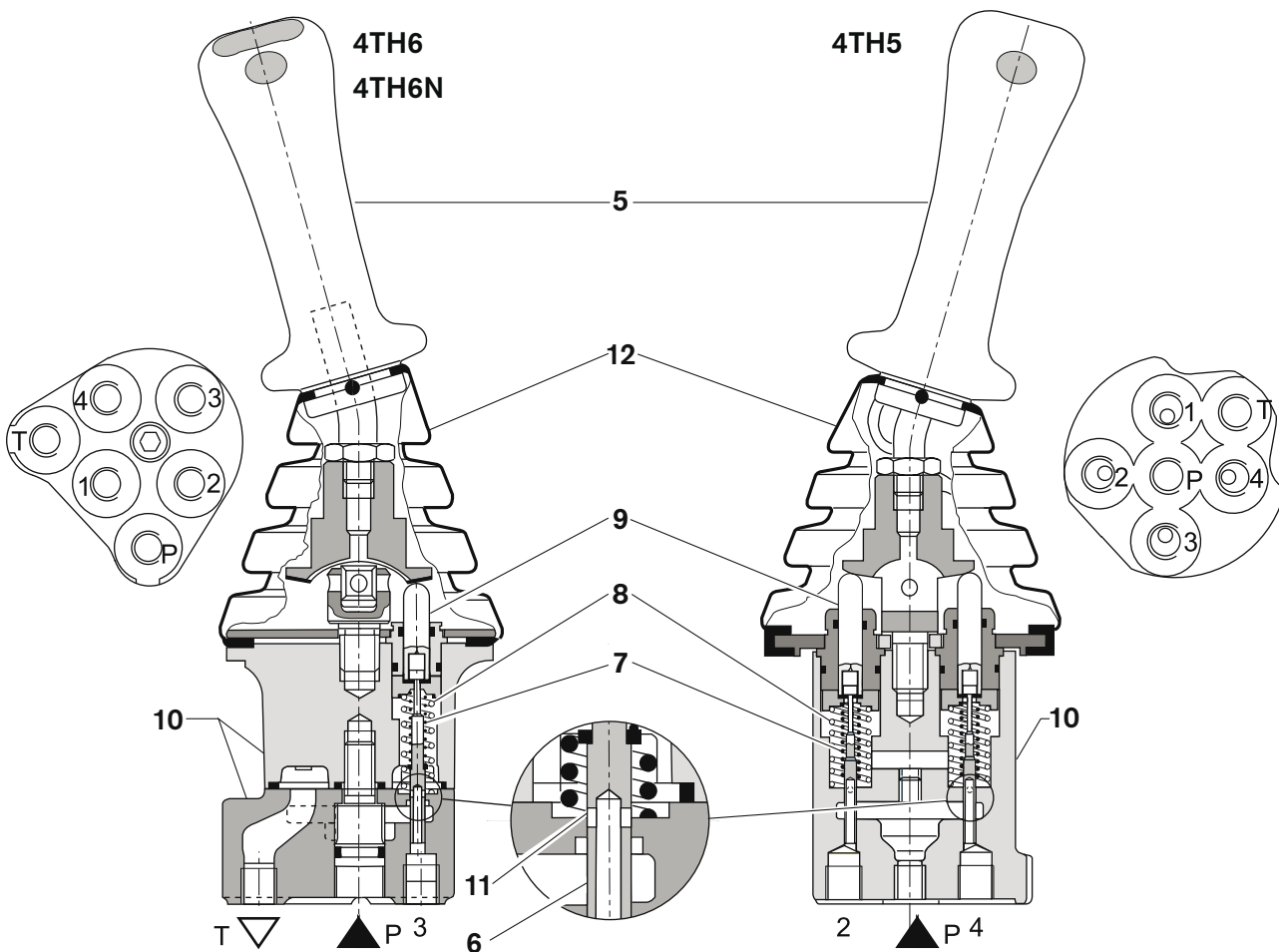
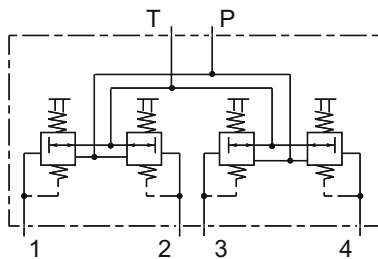
Through the interaction of control spool (6) and control spring (7) the pressure in the appropriate ports is proportional to the stroke of the plunger (9) and thus the position of the control lever (5).

A rubber boot (12) protects the mechanical components of the housing from contamination.

Ports

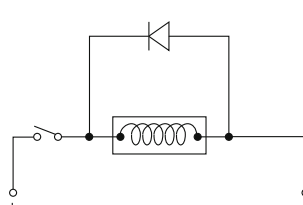
P	Supply
T	Tank
1, 2, 3, 4	Control ports

Hydraulic symbol



Technical data (for applications outside these parameters, please consult us!)

Mechanical		4TH6, 4TH6N	4TH5
Inlet pressure	bar	up to 50	up to 35
Back pressure at port T	bar	up to 3	
Pilot oil flow (P to 1 - 2 - 3 - 4)	l/mn	up to 16	up to 13
Pressure fluid		mineral oil (HL, HLP) to DIN 51524 ¹⁾	
¹⁾ suitable for NBR seals			
²⁾ suitable for FPM seals		phosphate ester (HFD-R) ²⁾	
Pressure fluid temperature range	°C	-20 to +80	
Viscosity range	mm ² /s	10 to 380	
Degree of pressure fluid contamination		to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$	
Max. permissible operating torque at lever	Nm	10 during operation	
	Nm	80 with an exceptional, one time loading	
Weight	kg	approx. 2,6	approx. 1,9

Electrical		Technical data for the grips switch EC2000	
• Switching capacity			
– minimal current	resistive load	100mA at 12VDC or 24VDC	
– maximal current	resistive load	5A at 12VDC or 24VDC	
• Microswitch lifetime			
– resistive load at 12VDC		100 to 500mA	5 millions cycles
		5A	300000 cycles
– resistive load at 24VDC		100 to 500mA	3 millions cycles
		5A	150000 cycles
– inductive load L/R=5ms at 12VDC or 24VDC		1,25A	200000 cycles
• Maximal contact resistance	m Ω	20	
• Switching on/off with low loads			
– minimum voltage	V	12	
– minimum current strength	mA	100	
• E-contact type		high current	
Grip protection		IP65	
Switching guidelines for DC voltages		<p>to ensure the service life of the electrical switch, we recommend the use of free-wheeling diodes that are switched parallel to the inductivity.</p> 	

Ordering details

				4 TH 5	- 1X /					*
Operating force deviations				4 TH 6						
For 4 TH 5 :				no code						
- Reduced										
For 4 TH 6 :				no code						
- Conventional				= N						
- Reduced										
Grip range										
Ergonomic EC2000						= E				
Ergonomic EC4000						= H				
Ergonomic EC2000+						= I				
Ergonomic EC1000						= J ¹⁾				
Customer's				no code						
Without grip						= Z				
Control curve (see pages 6 and 7)				4TH6	4TH6N	4TH5				
Curve 06				•	•	•	06			
Curve 20				•			20			
Curve 70				•	•	•	70			
Curve 97				•	•		97			
Curve 106				•		•	106			
Different control curve: state identification No.				•						
Series 10 to 19 (10 to 19: unchanged installation and connection dimensions)						= 1X				
Type of ergonomic grip										
Grip type E (see page 8)						= TT, ST, VT, YT, YU				
Grip type H, I or J ¹⁾						see datasheet RE 64547				
Without grip						no code				
Grip orientation (see page 5)				4TH6	4TH6N	4TH5				
Lever straight, grip in the direction of control port 3				•	•		03			
Lever curved 15° in the direction of control port 4. Grip in the direction of control port 3				•	•	•	43			
Lever curved 15° in the direction of control port 2. Grip in the direction of control port 3				•	•	•	23			
Plugs (see page 9)				4TH6	4TH6N	4TH5				
DEUTSCH sealed plug IP 67 for wiring the grip				•	•	•	5			
Plug AMP MAT-N-LOK for wiring the grip				•	•		6			
Without plug				no code		•	•	•		
Seals type				4TH6	4TH6N	4TH5				
NBR seals Attention! the compatibility of the seals and				•	•	•	M			
FPM seals pressure fluid has to be taken into account				•	•		V			
Connection threads				4TH6	4TH6N	4TH5				
Pipe thread to standard ISO 228/1				G 1/4	•	•	•	01		
Metric connections to standard ISO 9974				M 14 x 1,5	•			02		
Connections to standard JIS 2351					•		•	04		
UNF connections to standard ISO 11926				9/16 UNF-2B	•	•	•	05		
Further details in clear text										

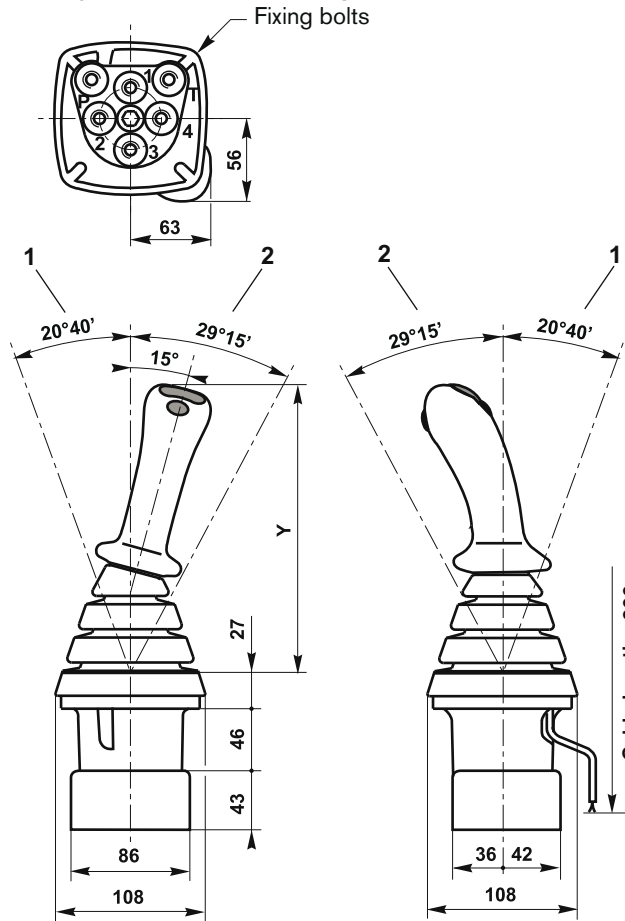
¹⁾ handle EC1000 for 4TH6 and 4TH6N only.

Unit dimensions (dimensions in mm)

Type designation of the pilot control units shown:

4 TH 6 E XX - 1X / - - 43 - - -

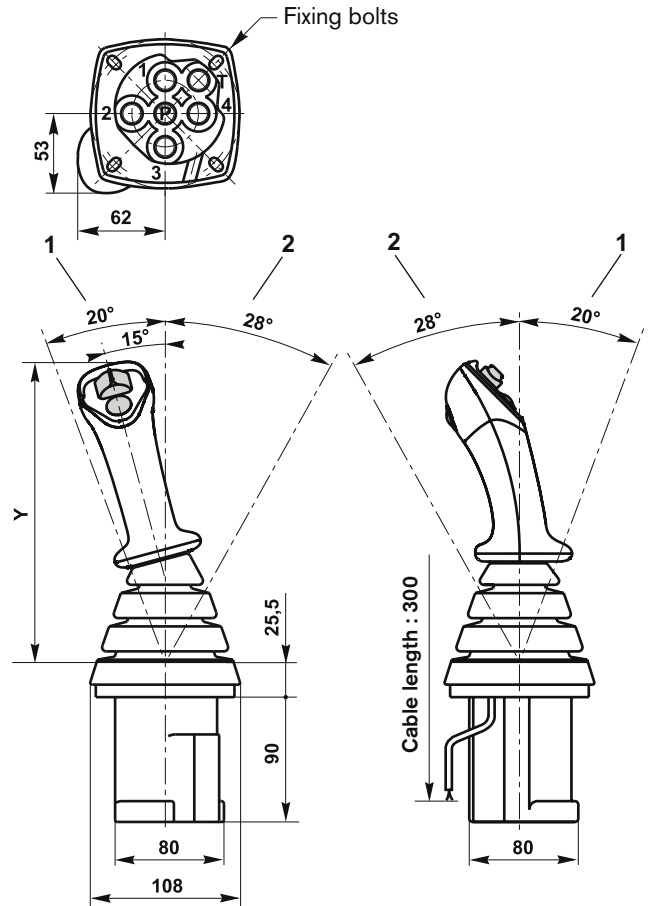
4 TH 6 N E XX - 1X / - - 43 - - -



- 1 Lever deflection when actuating 1 actuator.
- 2 Lever deflection when simultaneously actuating 2 actuators.

Type designation of the pilot control unit shown:

4 TH 5 I XX - 1X / - - 23 - - -



Unit dimension Y in function of the grip type :

type of grip	4TH6, 4TH6N	4TH5
EC1000	236	
EC2000	207	207,5
EC2000+	215	216,5
EC4000	251	248,5

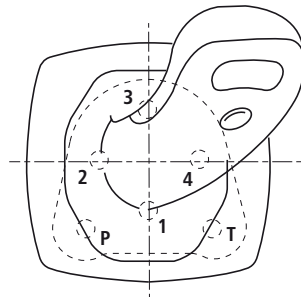
Orientation of the pilot control units at the driver's seat (viewed from above)

Pilot control unit left hand

4 TH 5 E XX - 1X / - - 43 - - -

4 TH 6 E XX - 1X / - - 43 - - -

4 TH 6 N E XX - 1X / - - 43 - - -

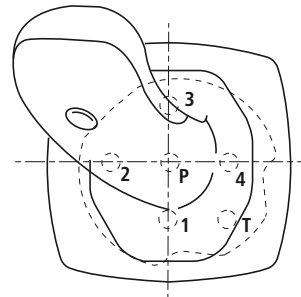


Pilot control unit right hand

4 TH 5 E XX - 1X / - - 23 - - -

4 TH 6 E XX - 1X / - - 23 - - -

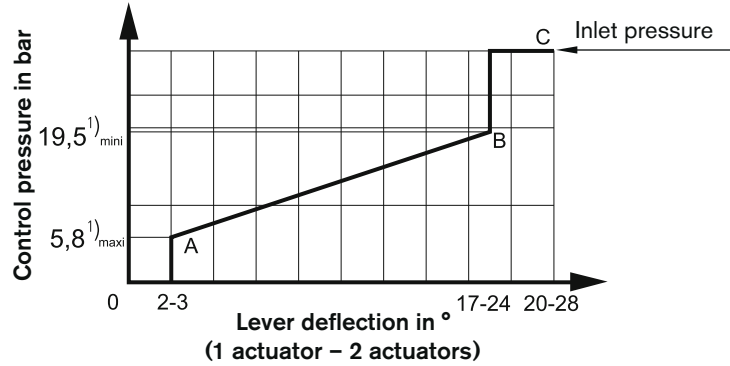
4 TH 6 N E XX - 1X / - - 23 - - -



Characteristic curves : control ranges, actuation moments

06 Control curve, identification No. 06

This curve is used for the pilot control of the SM12, SM18, M1, M6 control blocks

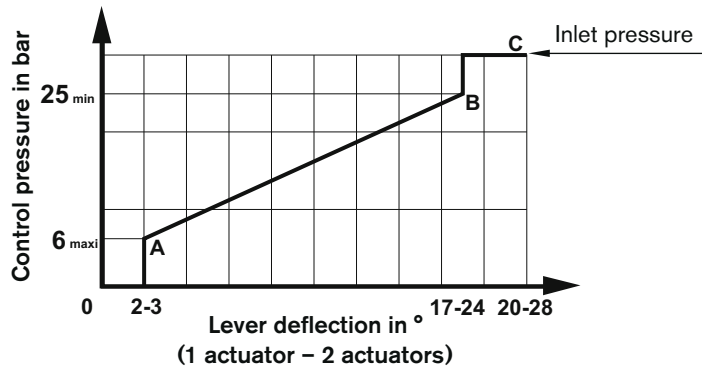


¹⁾ 4TH5 control pressure in bar : 5,9 maxi - 19 mini

	4TH6		4TH6N		4TH5		*p = 35 bar
	1	2	1	2	1	2	
No. of actuated actuators							
Operating torque in Nm	A	0,72	1,43	0,68	1,35	0,68	1,35
	B	1,99	3,99	1,46	2,92	1,45	2,90
	C	2,93*	5,86*	2,10	4,19	2,08	4,16

70 Control curve, identification No. 70

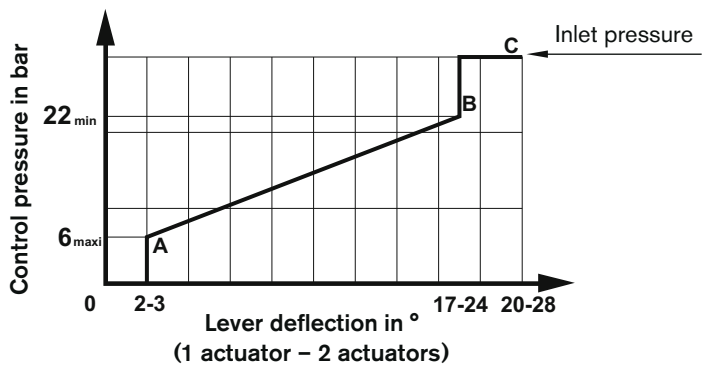
This curve is used for the pilot control of the SX12, SX14, SX18 control blocks



	4TH6		4TH6N		4TH5		*p = 35 bar
	1	2	1	2	1	2	
No. of actuated actuators							
Operating torque in Nm	A	0,73	1,45	0,68	1,37	0,69	1,37
	B	2,33	4,67	1,69	3,39	1,69	3,39
	C	2,93*	5,86*	2,10	4,19	2,08	4,16

106 Control curve, identification No. 106

This curve is used for the pilot control of the SM12 control blocks
(application example : mini excavator)



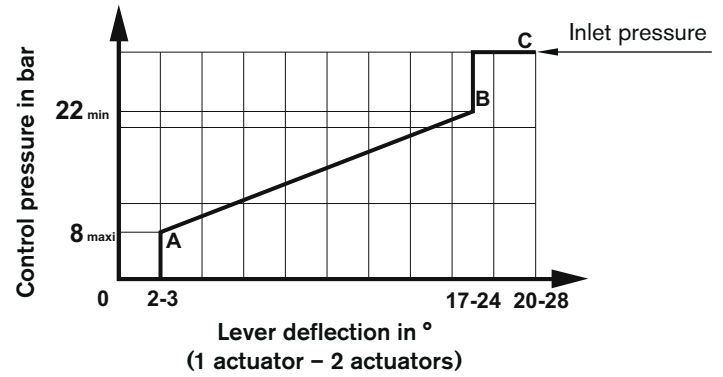
	4TH6		4TH5		*p = 35 bar
	1	2	1	2	
No. of actuated actuators					
Operating torque in Nm	A	0,72	1,44	0,68	1,36
	B	2,17	4,34	1,58	3,15
	C	2,93*	5,86*	2,08	4,16

The operating torques stated are theoretical values which do not take into account the rubber boot resistance.

Characteristic curves : control ranges, actuation moments

20 Control curve, identification No. 20

This curve is used for the pilot control of the SP12 control blocks

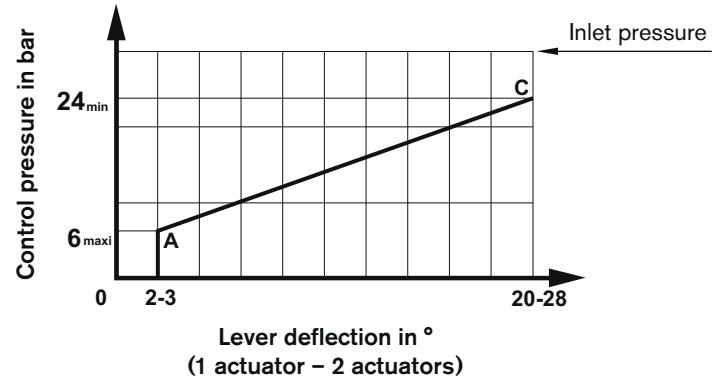


		4TH6	
No. of actuated actuators		1	2
Operating torque in Nm	A	0,83	1,65
	B	2,21	4,42
	C	2,93*	5,86*

*p = 35 bar

97 Control curve, identification No. 97

This curve is used for the pilot control of the M7, M4 control blocks



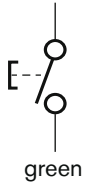


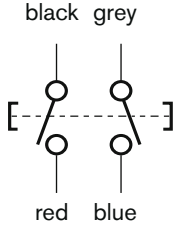


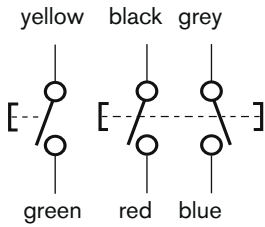


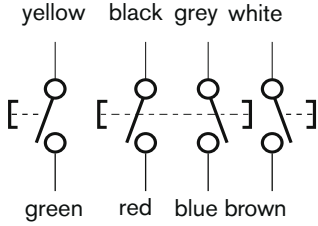



		4TH6		4TH6N	
No. of actuated actuators		1	2	1	2
Operating torque in Nm	A	0,72	1,44	0,68	1,36
	C	2,45*	4,91*	1,77	3,53

*p = 35 bar

The operating torques stated are theoretical values which do not take into account the rubber boot resistance.

Variations of ergonomic grip EC2000

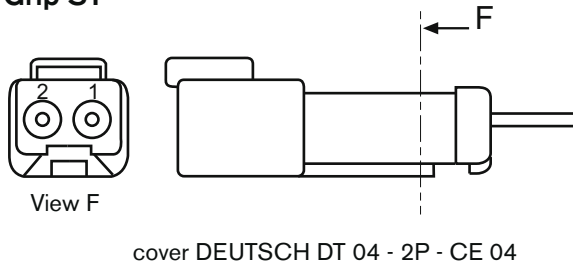
<p>TT</p> 	<p>– without E-contact</p>	
<p>ST</p> 	<p>– single E-contact on top</p>	<p>yellow</p>  <p>green</p> 
<p>VT</p> 	<p>– double E-contact with rocker switch</p>	<p>black grey</p>  <p>red blue</p> 
<p>YT</p> 	<p>– double E-contact with rocker switch</p> <p>– single E-contact on top</p>	<p>yellow black grey</p>  <p>green red blue</p> 
<p>YU</p> 	<p>– double E-contact with rocker switch</p> <p>– single E-contact on top</p> <p>– single E-contact to the front</p>	<p>yellow black grey white</p>  <p>green red blue brown</p> 

Contact location within the plugs for wiring grip EC2000

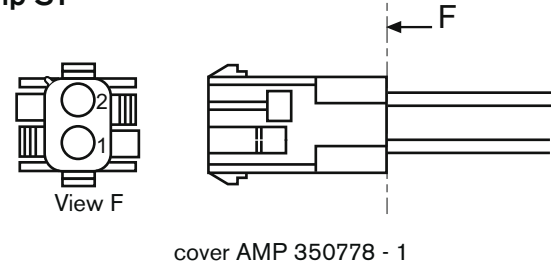
DEUTSCH sealed plug IP 67
(ordering detail = 5)

Plug AMP MAT-N-LOCK
(ordering detail = 6)

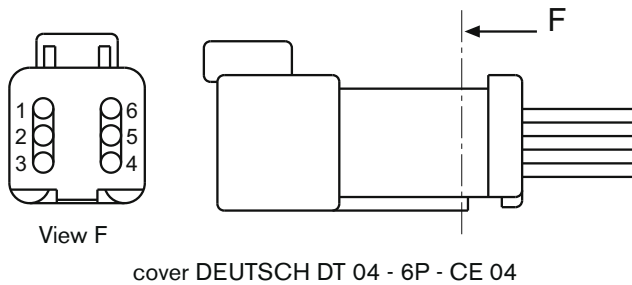
Grip ST



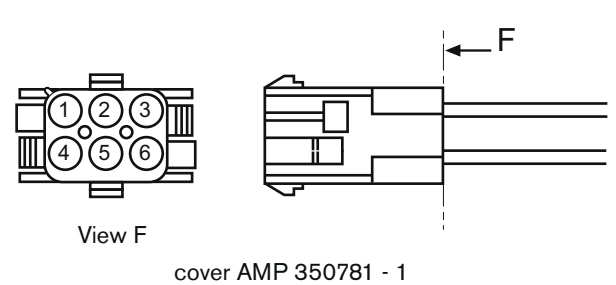
Grip ST



Grip VT or YT



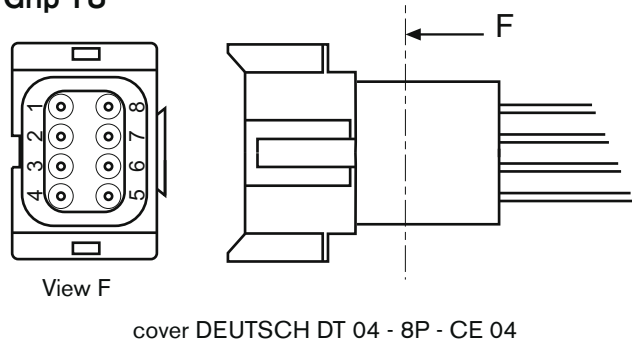
Grip VT or YT



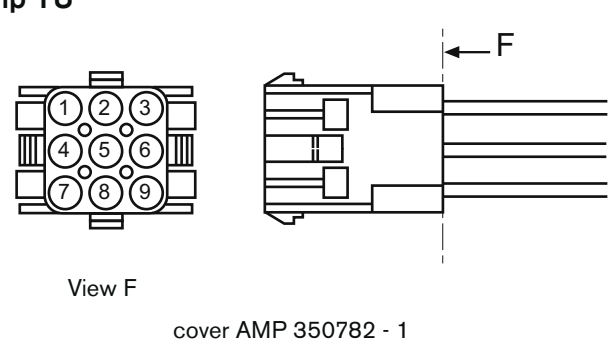
Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	red	X	X
2	black	X	X
3	grey	X	X
4	blue	X	X
5	yellow		X
6	green		X

Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	grey	X	X
2	black	X	X
3	red	X	X
4	blue	X	X
5	yellow		X
6	green		X

Grip YU



Grip YU



Identification in the plug	wire colour	identification in the plug	wire colour
1	red	5	yellow
2	black	6	green
3	grey	7	white
4	blue	8	brown

Identification in the plug	wire colour	identification in the plug	wire colour
1	grey	5	yellow
2	black	6	green
3	red	7	white
4	blue	8	brown

Application guidelines (these guidelines are not intended to be considered as complete)

- Do not direct the jet of a pressure washing unit directly at the unit.
- The electrical cable must be kept free of any mechanical forces.
- During operation protection via the rubber boot must be ensured.
- Only use the unit with its original grip and lever.
- Ensure that the inertia data of the original grip are not exceeded.
- Replace worn push buttons, so that the integrity of the EC2000 grip is ensured.

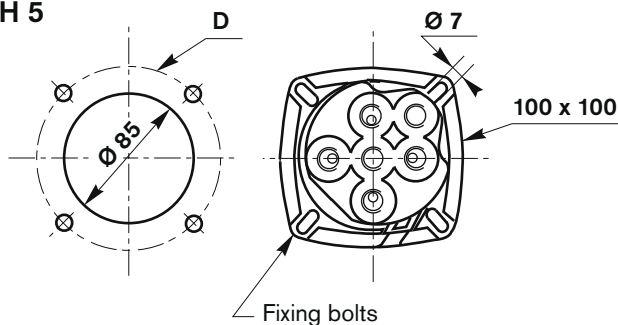
Safety guidelines (these guidelines are not intended to be considered as complete)

- Only one function control must be allocated to an E-contact.
- The circuit functions are to be so designed that uncontrolled machine movements caused by the application are prevented and that it is possible to switch from one function to another.
- Take into account all of the application limits, particularly those application limits stated within this catalogue sheet.
- Preparation for assembly and testing on the machine: The various checks must include all the functions of the pilot control device.

Installation guidelines 4TH6, 4TH6N, 4TH5

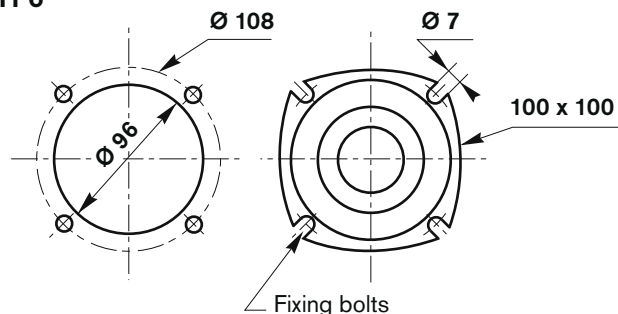
- Mounting flange area: Flatness = 0.5 mm
- Screw head dimensions = \varnothing 10 mm
- Tightening torque for the flange fixing screws = Max. 10 Nm
- Tightening torque for the pipe connections = Max. 30 Nm

Installation hole 4 TH 5



- Nominal diameter / fixing via 4 screws
D = 92 to 100 mm or 100 to 108 mm

Installation hole 4 TH 6



- \varnothing 108 = Nominal diameter / fixing via 4 screws

Notes

Pilot control unit with end position lock for the remote control of directional valves

Type 4THF5 or 6THF5

Series 1X



Contents

Functional description, section, symbol	2
Technical data	3
Ordering details	4
Characteristic curves	5
Unit dimensions	6 and 7
Variations of ergonomic grip EC2000	8
Contact location within the plugs for wiring grip EC2000	9
Contact location within the plugs for wiring the solenoids of the electro-magnetic lock	10
Guidelines	11

Special features

- Progressive, sensitive operation.
- Precise and play-free control.
- Low actuation forces at lever.
- Several ergonomic grips with various E contacts (design patents).
- Electro-magnetic end position lock for holding the control lever in its deflected position.
The electro-magnetic lock may be released by operating a switch on the machine.
- Noticeable resistance point when operating close to the lever end position (summation of progressive force), hence providing a warning just before the changeover occurs to the locked position or float position (prevention of accidental operation).

Functional description, section, symbol

Hydraulic function principle

The pilot control units with end position locks type THF5 operate on the basis of direct actuated pressure reducing valves.

They basically comprise of control lever (1), four to six pressure reducing valves, a housing (6) and locks.

Each pressure reducing valve comprises of a control spool (2), a control spring (3), a return spring (4) and a plunger (5).

At rest, control lever (1) is held in its neutral position by return springs (4). Ports (1, 2, 3, 4) are connected to tank port T via drilling (8).

When the control lever (1) is deflected, plunger (5) is pressed against return spring (4) and control spring (3). Control spring (3) initially moves the control spool (2) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P via drilling (8).

The control phase starts as soon as control spool (2) finds its balance between the force from control spring (3) and the force, which results from the hydraulic pressure in the relevant port (ports 1, 2, 3 or 4).

Due to the interaction between control spool (2) and control spring (3) the pressure in the relevant ports is proportional to the stroke of plunger (5) and hence to the position of control lever (1).

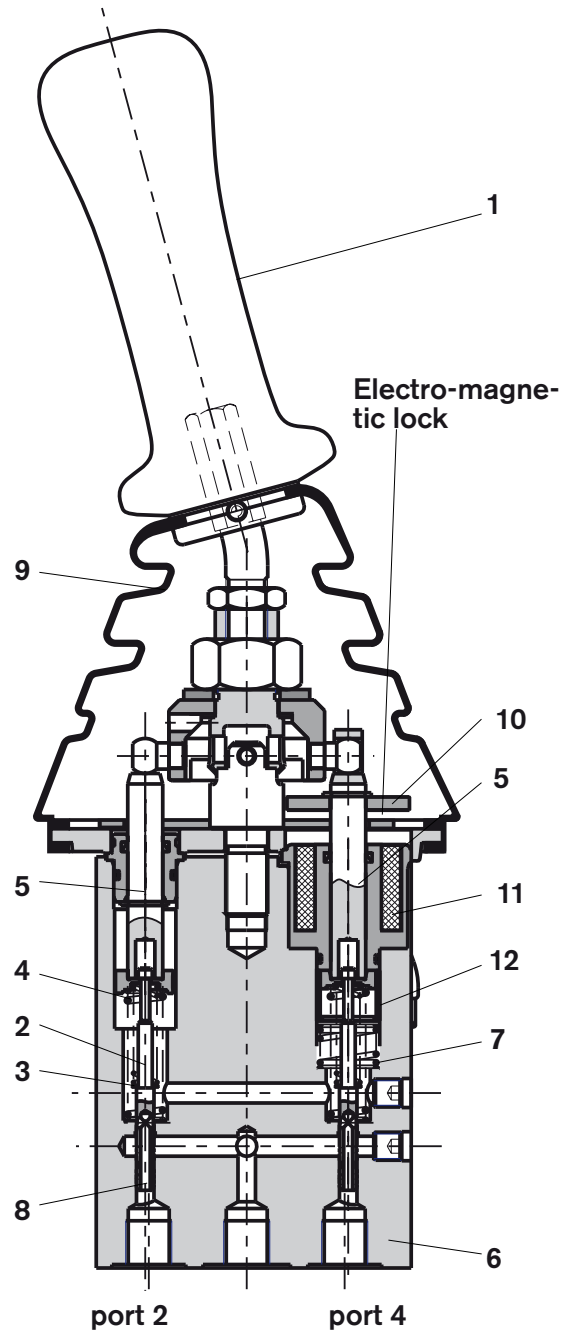
This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of directional valves and high response valves for hydraulic pumps and motors. A rubber boot (9) protects the mechanical components in the housing from contamination, therefore, these pilot control units are suitable for even the most unfavourable operating conditions.

End position lock

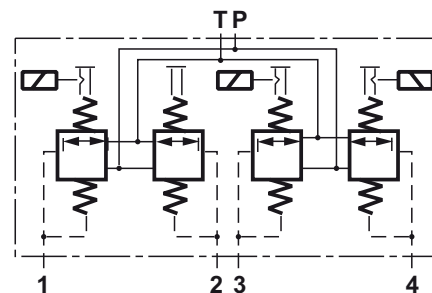
Only those control ports, for which it is necessary to hold the control lever in a deflected position are equipped with end position locks (except control port 2).

Electro-magnetic lock

An additional spring (7), which is fitted below the prefeeling point socket (12) warns, by means of an increased force, which is required for compressing this spring, that the plunger (5) and the control lever (1) have almost reached their end position. When this threshold is overcome, the solenoid armature (10) contacts the solenoid (11); if the solenoid is energised, then control lever (1) is held in its end position by magnetic force. This lock is released automatically when the solenoid is de-energised.

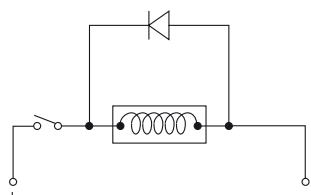


Symbol for the 4 THF 5 with 3 electro-magnetic locks



Technical data (for applications outside these parameters, please consult us!)

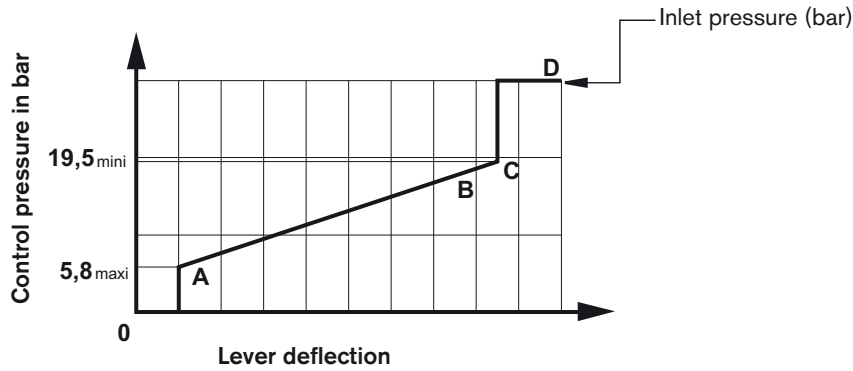
Mechanical		
Back pressure at port T	bar	up to 3
Pilot oil flow (P to 1 - 2 - 3 - 4)	l/mn	up to 13
Pressure fluid <i>¹⁾ suitable for NBR seals</i>		Mineral oil (HL, HLP) to DIN 51524 ¹⁾
Pressure fluid temperature range	°C	-20 to +80
Viscosity range	mm ² /s	10 to 380
Degree of pressure fluid contamination		to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Max. permissible operating torque at lever	Nm	10 during operation
	Nm	80 with an exceptional, one time loading
Weight, version 4 THF 5	kg	approx. 3,5
Weight, version 6 THF 5	kg	approx. 4,9

Electrical		
Technical data for the grips switch EC2000		
• Switching capacity		
– minimal current	resistive load	100mA at 12VDC or 24VDC
– maximal current	resistive load	5A at 12VDC or 24VDC
• Microswitch lifetime		
– resistive load at 12VDC		100 to 500mA 5 millions cycles 5A 300000 cycles
– resistive load at 24VDC		100 to 500mA 3 millions cycles 5A 150000 cycles
– inductive load L/R=5ms at 12VDC or 24VDC		1,25A 200000 cycles
• Maximal contact resistance	m Ω	20
• Switching on/off with low loads		
– minimum voltage	V	12
– minimum current strength	mA	100
• E-contact type		high current
Grip protection		IP65
Switching guidelines for DC voltages		to ensure the service life of the electrical switch, we recommend the use of free-wheeling diodes that are switched parallel to the inductivity. 
• Power supply for the locking solenoids	V	12 V (9 to 15) and 24 V (20 to 27) / DC
• Max. power consumption of each solenoid	W	13,5 at 12 VDC or 24VDC

Characteristic curves : control ranges, actuation moments

06 Control curve, identification No. 06

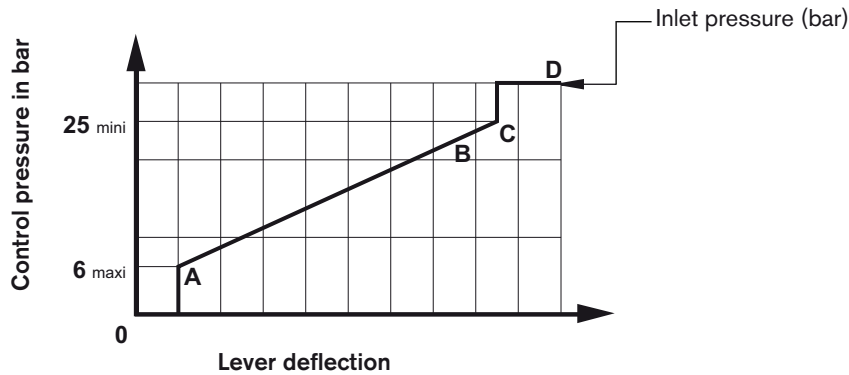
This curve is used for the pilot control of the SM12, M6 control blocks



B = Resistance point before changeover to inlet pressure

70 Control curve, identification No. 70

This curve is used for the pilot control of the SX12, SX14, SX18 control blocks



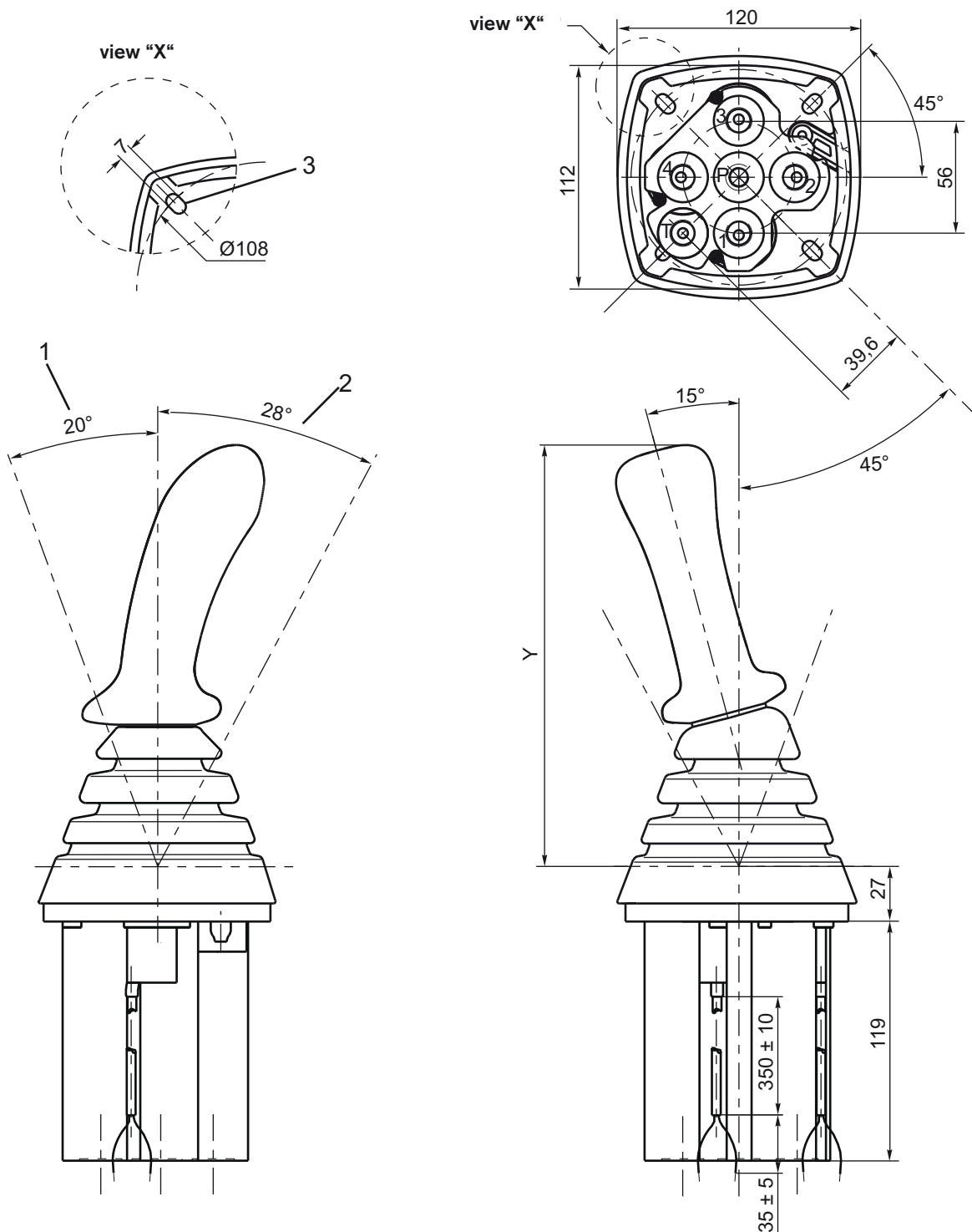
B = Resistance point before changeover to inlet pressure

Actuation moments of 1 actuator				
Inter-section point	A	B	C	D
Lever deflection	2°	16°	18°	20°
Operating torque without detent in N.m	0,8		2,2	3,6 (p = 35 bar)
Operating torque with detent in N.m	0,8	3,4	3,6	5,2 (p = 35 bar)

The operating torques stated are theoretical values which do not take into account the rubber boot resistance.

Unit dimensions (dimensions in mm)

Type designation of the pilot control units shown: **4 THF 5 E...-1X / TT 41**



The 4 THF 5 variants are supplied without fixing screws nor shims

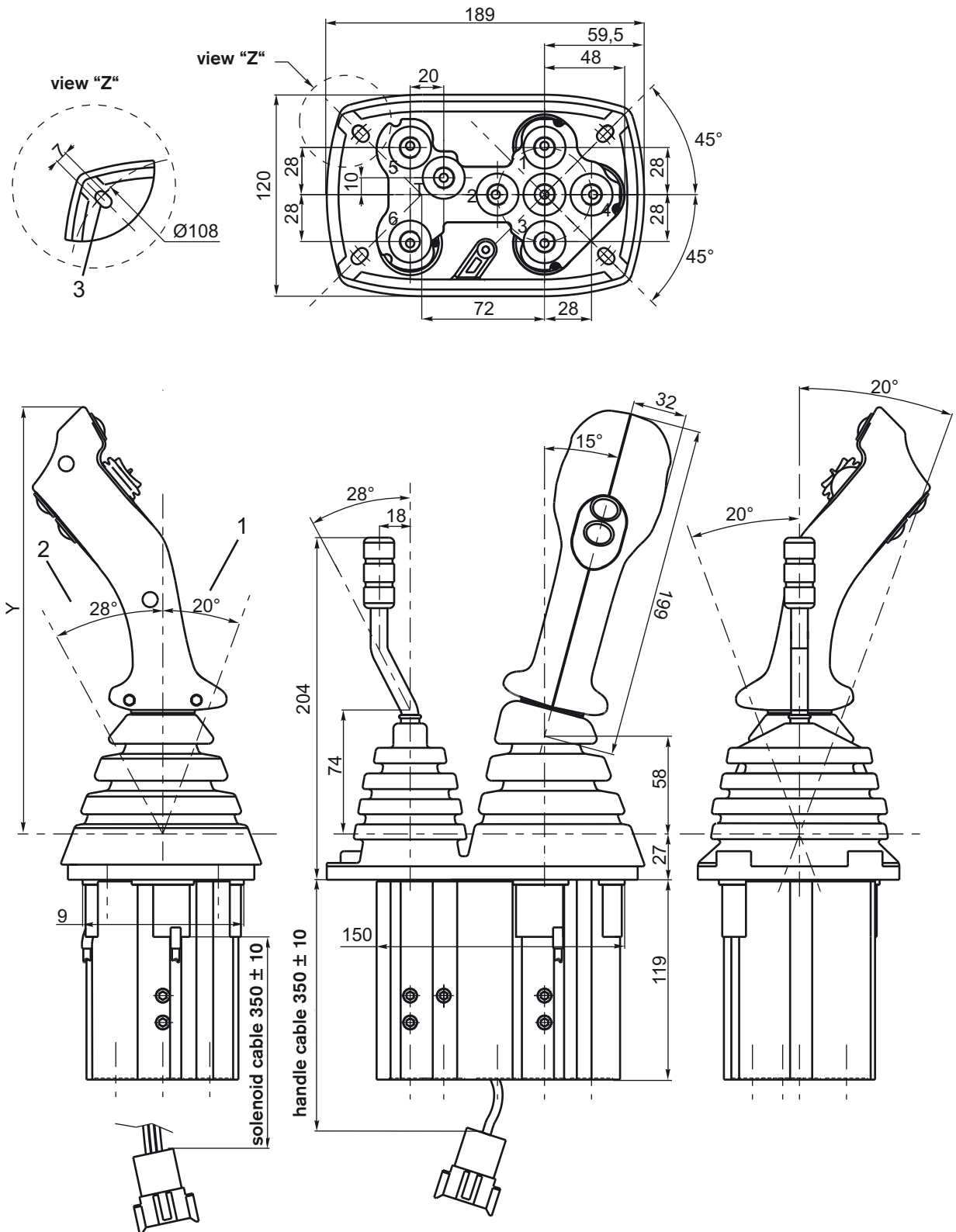
- 1 lever deflection when operating one actuator
- 2 lever deflection when operating two actuators
- 3 four equally space mounting points

Unit dimension in function of the grip type :

type of grip	Y
EC2000	208
EC2000+	220
EC4000	254

Unit dimensions (dimensions in mm)



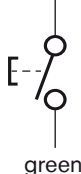


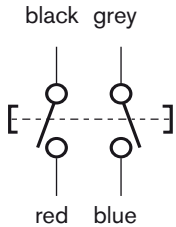


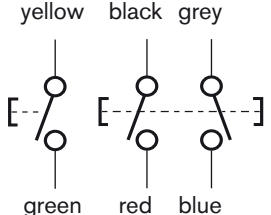


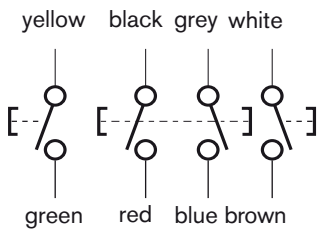

Type designation of the pilot control units shown: **6 THF 5 H...-1X / SL5689 PSA3 RAA2 41**



The 6 THF 5 variants are supplied without fixing screws nor shims

- 1 lever deflection when operating one actuator
- 2 lever deflection when operating two actuators
- 3 four mounting points

Variations of ergonomic grip EC2000

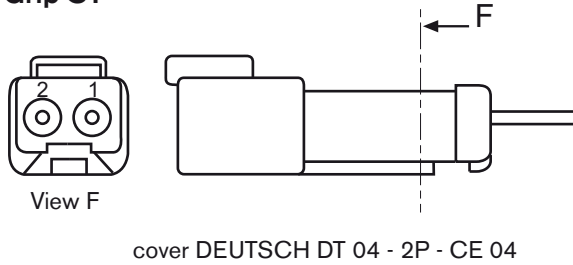
<p>TT</p> 	<p>– without E-contact</p>	
<p>ST</p> 	<p>– single E-contact on top</p>	<p>yellow</p>  <p>green</p> 
<p>VT</p> 	<p>– double E-contact with rocker switch</p>	<p>black grey</p>  <p>red blue</p> 
<p>YT</p> 	<p>– double E-contact with rocker switch – single E-contact on top</p>	<p>yellow black grey</p>  <p>green red blue</p> 
<p>YU</p> 	<p>– double E-contact with rocker switch – single E-contact on top – single E-contact to the front</p>	<p>yellow black grey white</p>  <p>green red blue brown</p> 

Contact location within the plugs for wiring grip EC2000

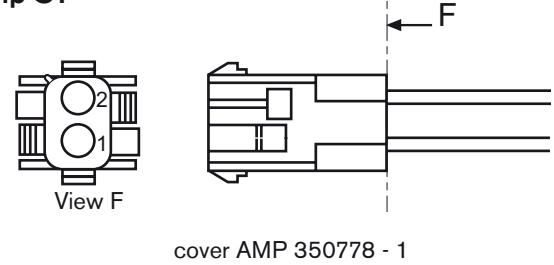
DEUTSCH sealed plug IP 67
(ordering detail = 5)

Plug AMP MAT-N-LOCK
(ordering detail = 6)

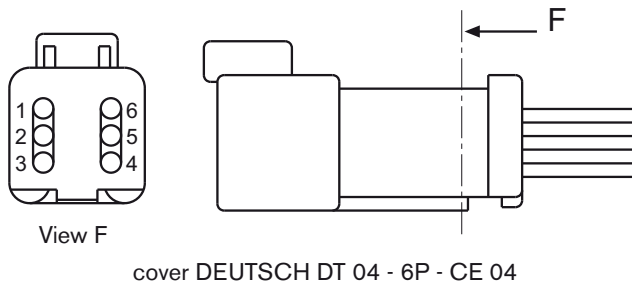
Grip ST



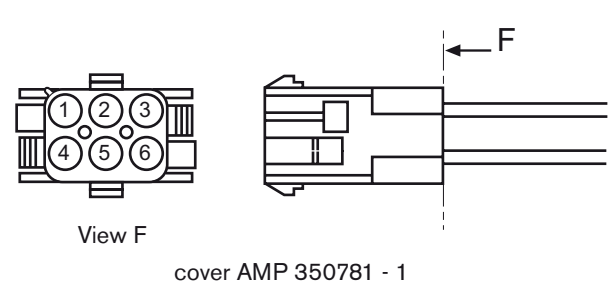
Grip ST



Grip VT or YT



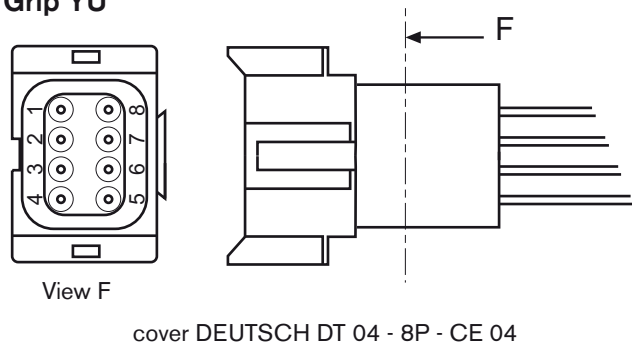
Grip VT or YT



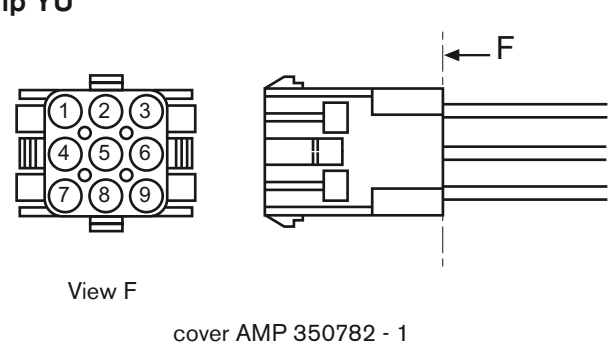
Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	red	X	X
2	black	X	X
3	grey	X	X
4	blue	X	X
5	yellow		X
6	green		X

Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	grey	X	X
2	black	X	X
3	red	X	X
4	blue	X	X
5	yellow		X
6	green		X

Grip YU



Grip YU



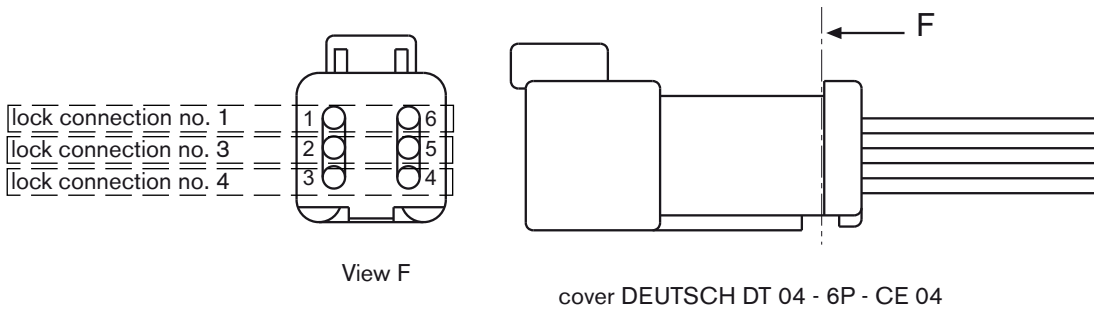
Identification in the plug	wire colour	identification in the plug	wire colour
1	red	5	yellow
2	black	6	green
3	grey	7	white
4	blue	8	brown

Identification in the plug	wire colour	identification in the plug	wire colour
1	grey	5	yellow
2	black	6	green
3	red	7	white
4	blue	8	brown

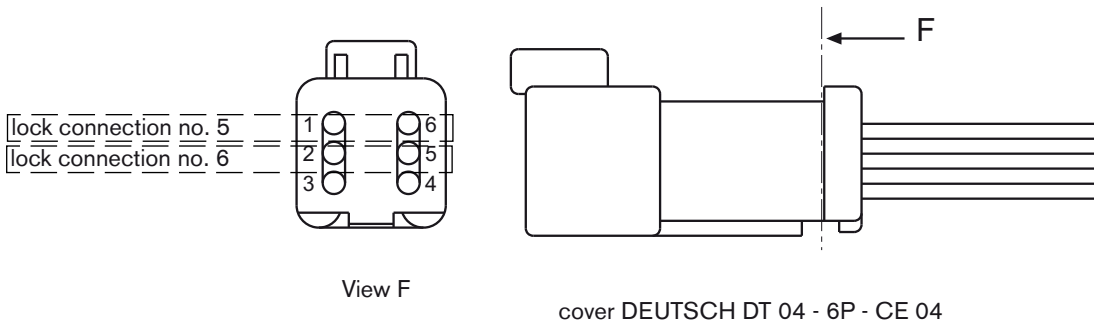
Contact location within the plugs for wiring the solenoids of the electro-magnetic lock

DEUTSCH sealed plug IP 67 (ordering code = 5)

- Plug for wiring the 4/6 THF 5 electro-magnetic lock solenoids (ports 1, 3, 4)

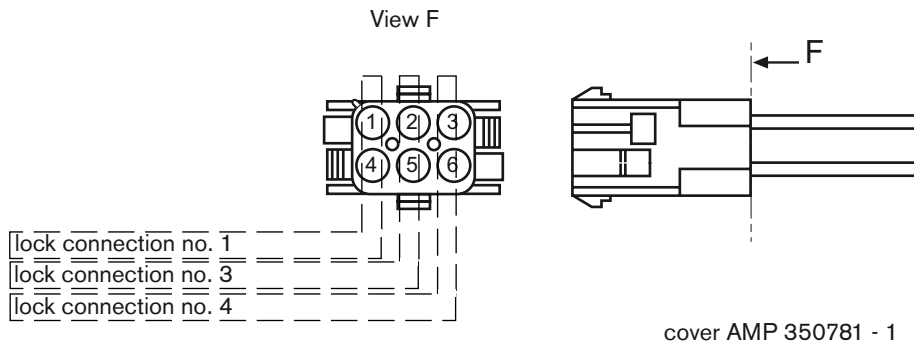


- Plug for wiring the 6 THF 5 electro-magnetic lock solenoids (ports 5, 6)

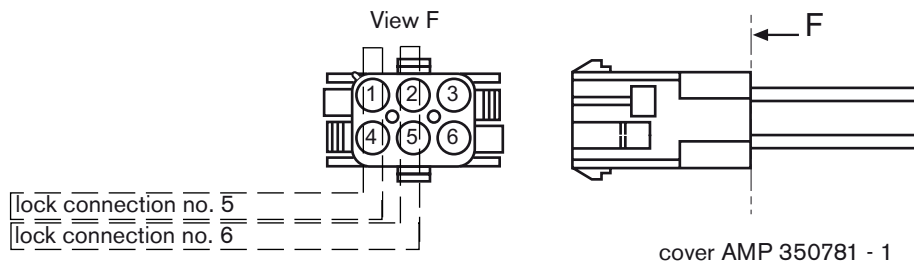


Plug AMP MAT-N-LOK (ordering code = 6)

- Plug for wiring the 4/6 THF 5 electro-magnetic lock solenoids (ports 1, 3, 4)



- Plug for wiring the 6 THF 5 electro-magnetic lock solenoids (ports 5, 6)



Application guidelines (these guidelines are not intended to be considered as complete)

- Limit the control pilot circuit pressure to 35 bars maximum for a good resistance of the electrical detents.
- Do not direct the jet of a pressure washing unit directly at the unit.
- The electrical cable must be kept free of any mechanical forces.
- During operation protection via the rubber boot must be ensured.
- Only use the unit with its original grip and lever.
- Ensure that the inertia data of the original grip are not exceeded.
- Replace worn push buttons, so that the integrity of the EC2000 grip is ensured.

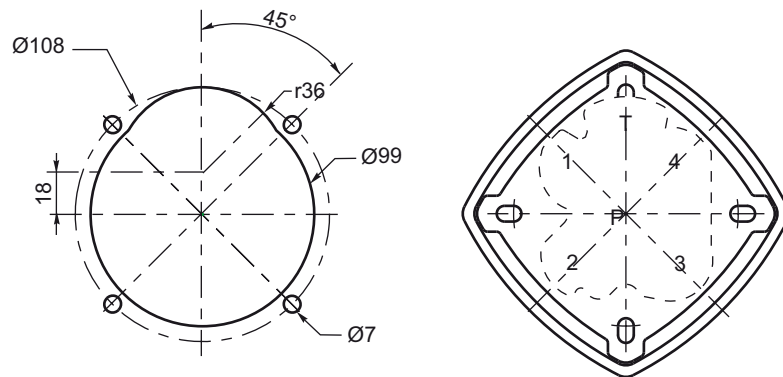
Safety guidelines (these guidelines are not intended to be considered as complete)

- Only one function control must be allocated to an E-contact.
- The circuit functions are to be so designed that uncontrolled machine movements caused by the application are prevented and that it is possible to switch from one function to another.
- Take into account all of the application limits, particularly those application limits stated within this catalogue sheet.
- Preparation for assembly and testing on the machine: The various checks must include all the functions of the pilot control device.

Installation guidelines

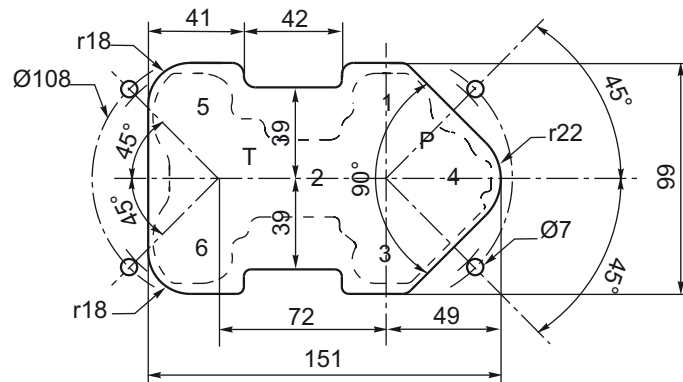
- Mounting flange area: Flatness = 0.5 mm
- Screw head dimensions = \varnothing 10 mm
- Dimensions of shims (large M6) placed underneath the screw heads = \varnothing 18 mm
- Tightening torque for the flange fixing screws = Max. 10 Nm
- Tightening torque for the pipe connections = Max. 30 Nm

Installation hole 4 THF 5



- \varnothing 108 = nominal diameter / fixing via 4 screws and 4 shims

Installation hole 6 THF 5



- 72 mm = between axis
- Fixing via 4 screws and 4 shims

Pilot control unit with end position lock for the remote control of directional valves

Type 4THF6 or 5THF6

Series 2X



Contents

Functional description, section, symbol	2 and 3
Technical data	4
Ordering details	5
Variations of ergonomic grip EC2000	6
Characteristic curve	7
Circuit example	7
Unit dimensions	8 and 9
Contact location within the plugs for wiring grip EC2000	10
Contact location within the plugs for wiring the solenoids of the electro-magnetic lock	11
Guidelines	12

Features

- Progressive, sensitive operation.
- Precise and play-free control.
- Low actuation forces at lever.
- Several ergonomic grips with various E contacts (design patents).
- Electro-magnetic end position lock at each control port (the control lever does not have to be held in its deflected position).
The electro-magnetic lock may be released by operating a switch on the machine.
- Possible 5th hydraulic control port for additional functions (e.g. control of float position).
- One or more type THF6 pilot oil units can be directly flanged on to the 2 TH 6 housing (single axis model, sandwich plate design to RE 64 552) (pipe and space saving combination – optimum for the mounting of auxiliary proportional controls).
- Noticeable resistance point when operating close to the lever end position (summation of progressive force), hence providing a warning just before the changeover occurs to the locked position or float position (prevention of accidental operation).

Functional description, section, symbol

Hydraulic function principle

The pilot control units with end position locks type THF6 operate on the basis of direct actuated pressure reducing valves.

They basically comprise of control lever (1), four pressure reducing valves, a housing (6) and locks.

Each pressure reducing valve comprises of a control spool (2), a control spring (3), a return spring (4) and a plunger (5).

At rest, control lever (1) is held in its neutral position by return springs (4). Ports (1, 2, 3, 4) are connected to tank port T via drilling (8).

When the control lever (1) is deflected, plunger (5) is pressed against return spring (4) and control spring (3). Control spring (3) initially moves the control spool (2) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P via drilling (8). The control phase starts as soon as control spool (2) finds its balance between the force from control spring (3) and the force, which results from the hydraulic pressure in the relevant port (ports 1, 2, 3 or 4).

Due to the interaction between control spool (2) and control spring (3) the pressure in the relevant ports is proportional to the stroke of plunger (5) and hence to the position of control lever (1). This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of directional valves and high response valves for hydraulic pumps and motors.

A rubber boot (9) protects the mechanical components in the housing from contamination, therefore, these pilot control units are suitable for even the most unfavourable operating conditions.

End position lock

Only those control ports, for which it is necessary to hold the control lever in a deflected position are equipped with end position locks.

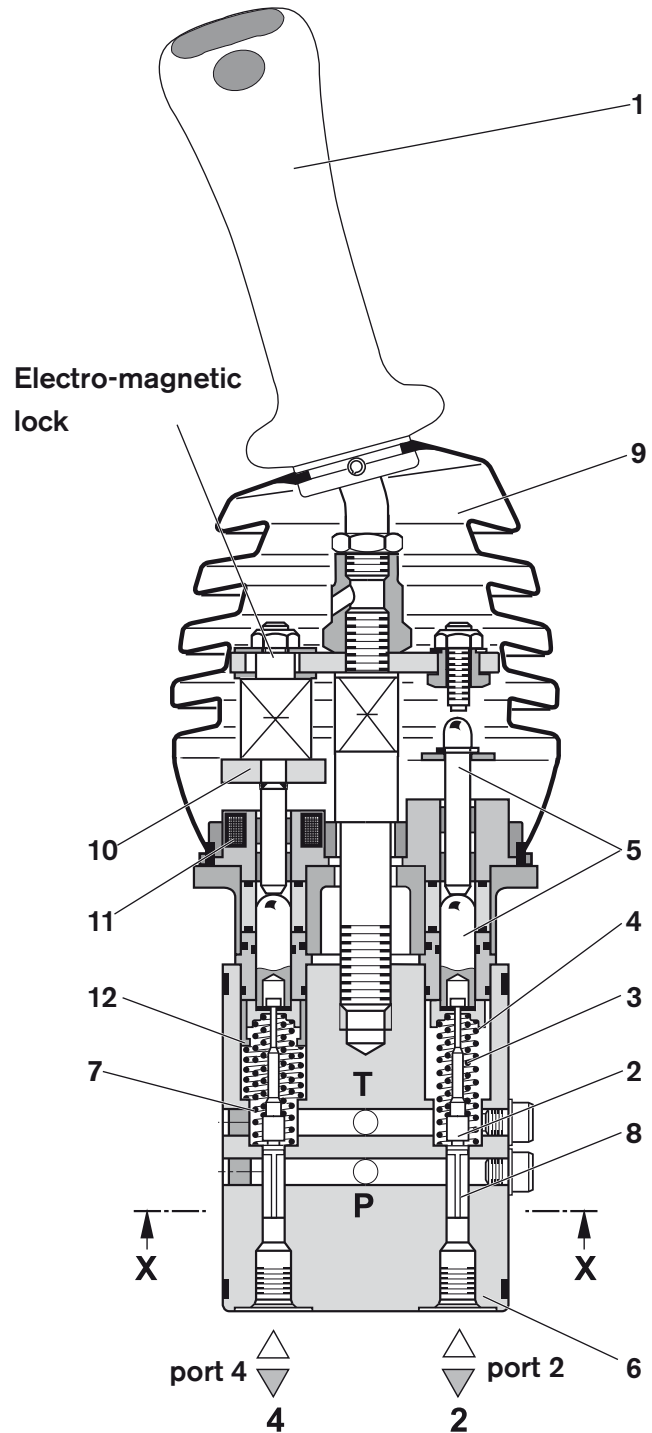
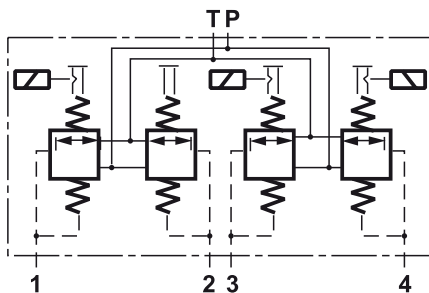
Electro-magnetic lock

An additional spring (7), which is fitted below an additional plate (12) warns, by means of an increased force, which is required for compressing this spring, that the plunger (5) and the control lever (1) have almost reached their end position.

When this threshold is overcome, a ring (10) contacts the solenoid armature (11); if the solenoid is energised, then control lever (1) is held in its end position by magnetic force.

This lock is released automatically when the solenoid is de-energised.

Symbol for the 4 THF 6 with 3 electro-magnetic locks



Functional description, section, symbol

Fifth control port (type 5 THF 6...)

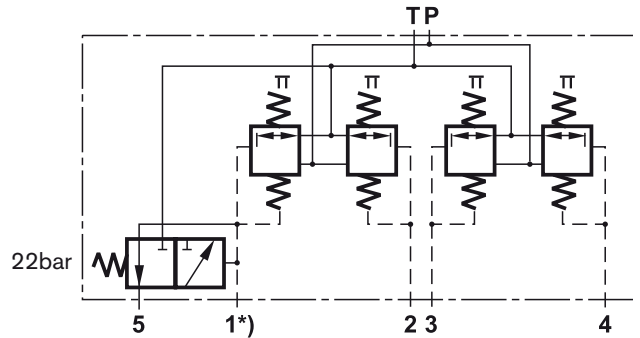
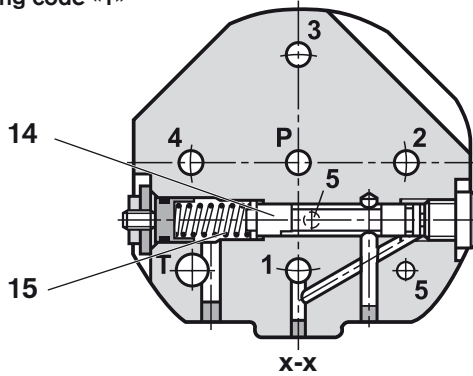
Model 5THF6 is equipped with a fifth control port, which is used to control an auxiliary function. This function may be operated by moving spool (14) against spring (15) under the influence of the pressure acting in port 1.

As soon as this pressure reaches 22 bar, control port 5 is connected with either T, P or control port 1, depending on the circuit required (see symbols).

Ordering code «1»

1 i 5

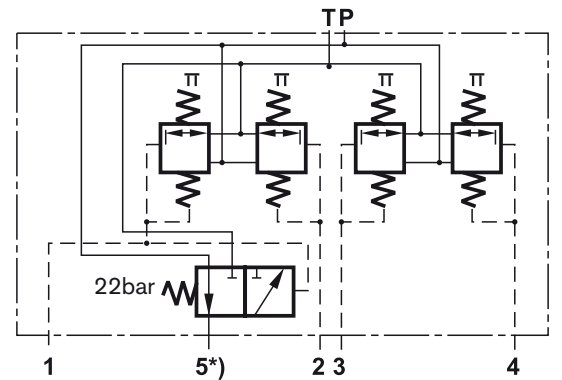
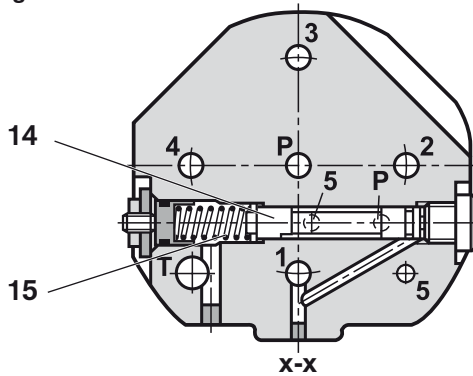
5 i T



Ordering code «2»

P i 5

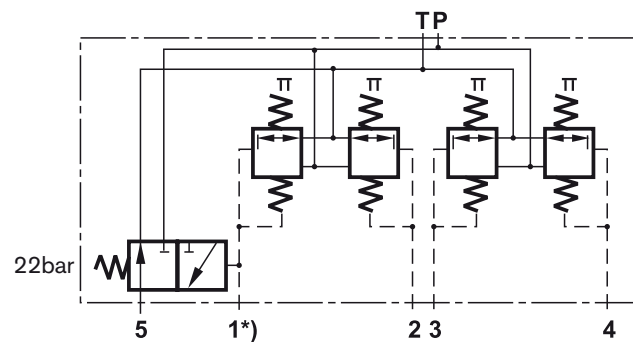
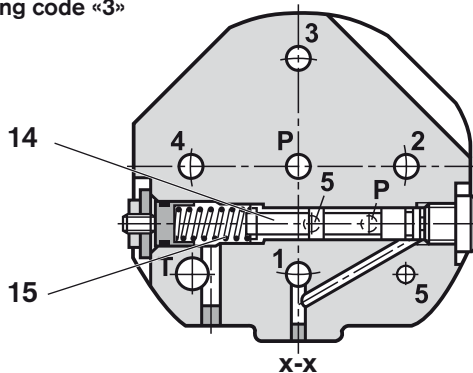
5 i T



Ordering code «3»

5 i T

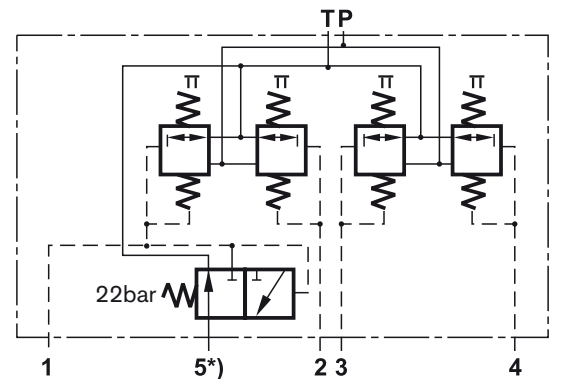
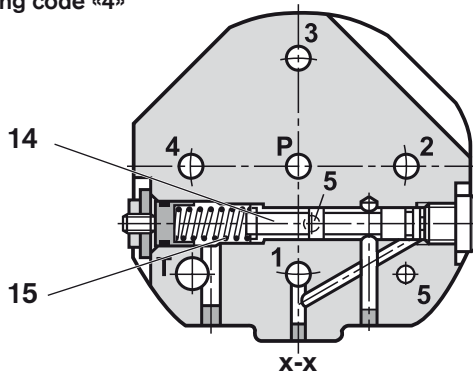
P i 5



Ordering code «4»

5 i T

1 i 5

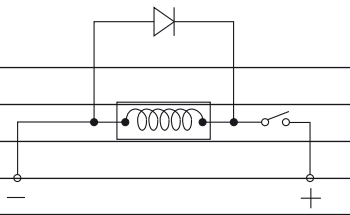


*) float position

Technical data, mechanical (for applications outside these parameters, please consult us!)

Back pressure at port T	bar	Up to 3
Pilot oil flow (P to 1 - 2 - 3 - 4)	l/min	Up to 16
Pressure fluid		Mineral oil (HL, HLP) to DIN 51524 ¹⁾ Phosphate ester (HFD-R) ²⁾
¹⁾ suitable for NBR seals		
²⁾ suitable for FKM seals		
Pressure fluid temperature range	°C	-20 to +80
Viscosity range	mm ² /s	10 to 380
Degree of pressure fluid contamination		To NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Max. permissible operating torque at lever	Nm	10 during operation
	Nm	80 with an exceptional, one time loading
Weight, version 4THF6	kg	Approx. 5.7

Technical data, electrical (for applications outside these parameters, please consult us!)

Technical data for the grip switch EC2000		
• Switching capacity		
–minimal current	resistive load	100mA at 12VDC or 24VDC
–maximal current	resistive load	5A at 12VDC or 24VDC
• Microswitch lifetime		
–resistive load at 12VDC	100 to 500mA 5A	5 millions cycles 300000 cycles
–resistive load at 24VDC	100 to 500mA 5A	3 millions cycles 150000 cycles
–inductive load L/R=5ms at 12VDC or 24VDC	1,25A	200000 cycles
• Maximal contact resistance	mΩ	20
• Switching on/off with low loads		
– minimum voltage	V	12
– minimum current strength	mA	100
• E-contact type		high current
Grip protection		IP65
Switching guidelines for DC voltages		to ensure the service life of the electrical switch, we recommend the use of free-wheeling diodes that are switched parallel to the inductivity.
		
• Power supply for the locking solenoids		12 V (9 to 15) and 24 V (20 to 27) / DC
• Max. power consumption of each solenoid		8 W at 12 VDC or 24VDC

Ordering details

Single pilot control unit 4 / 5 THF 6

THF6	06-2X	/	Y	*
------	-------	---	---	---

Number of control ports
 4 control ports = 4
 5 control ports = 5

Grip range
 Ergonomic EC2000 = E
 Ergonomic EC4000 = H
 Ergonomic EC2000+ = I
 Customer's = no code
 Without grip = Z

Control curve (see page 7) = 06
 Series 20 to 29 = 2X
 (20 to 29: unchanged installation and connection dimensions)

Type of ergonomic grip
 Grip type E (see page 6) = TT, ST, VT, YT, YU
 Grip type H or I see datasheet RE 64547
 Without grip = no code

Grip orientation (see page 9)
 Lever curved 15° towards control port 4 and grip towards control port 1 = 41
 Without grip = no code

End position lock per control port
 Without lock, without resistance point before changeover to inlet pressure = A
 Without lock, with resistance point before changeover to inlet pressure = B
 With electro-magnetic lock 24 V and resistance point before changeover to inlet pressure = C
 With electro-magnet lock 24 V, without resistance point = D
 With electro-magnetic lock 12 V and resistance point before changeover to inlet pressure = E
 With electro-magnetic lock 12 V, without resistance point = F

«control port 1»
«control port 2»
«control port 3»
«control port 4»

Further details in clear text

Connection threads
 01 = G 1/4 pipe thread to standard ISO 228/1
 02 = M 14 x 1,5 metric to standard ISO 9974
 05 = 9/16 UNF-2B to standard ISO 11926

Seals type
 M = NBR seals
 V = FKM seals
 ⚠ Attention!
 the compatibility of the seals and pressure fluid has to be taken into account

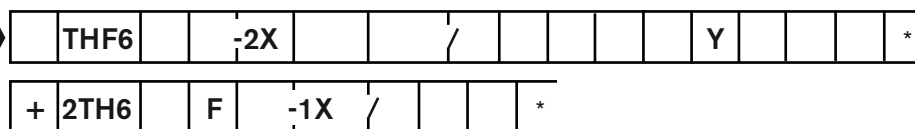
Plug
 5 = DEUTSCH sealed plugs IP67 for the wiring of the grip and solenoids (see pages 10-11)
 6 = AMP MAT-N-LOK plugs for the wiring of the grip and solenoids (see pages 10-11)
 no code without plug

Y = Connection flange, connections plugged, for the optional fitting of a type 2TH 6 unit

Circuit version of the 5th control port
 = 1 5 THF 6 only (enter here the number of the required hydraulic symbol, see page 3)
 = 2
 = 3
 = 4
 No code (relates 4THF6)

Pilot control units 4 / 5 THF 6 + 2 TH 6

For part no. of the single pilot control unit: see above



1 lever curved without detent = LC
 1 lever curved with electrical detent in position 1 = GC
 1 lever curved with electrical detent in position 2 = HC
 1 lever curved with electrical detent in position 1 and 2 = JC



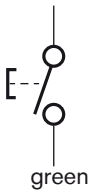


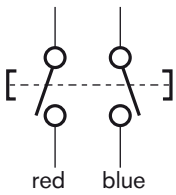


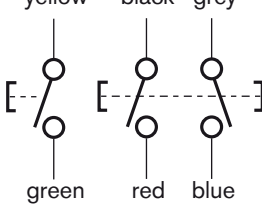


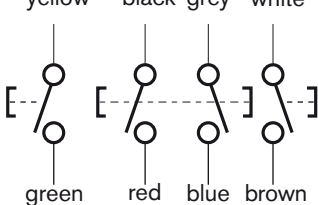

This variant of the 2TH 6 is without fixing holes = F

5 =	DEUTSCH sealed plugs IP67 for the wiring of the grip and solenoids
6 =	AMP MAT-N-LOK plugs for the wiring of the grip and solenoids
No code	without plug

Connection threads
 Seals type
 Plug
 Series
 Control curve

Ordering details: see 2TH6 datasheet RE 64552

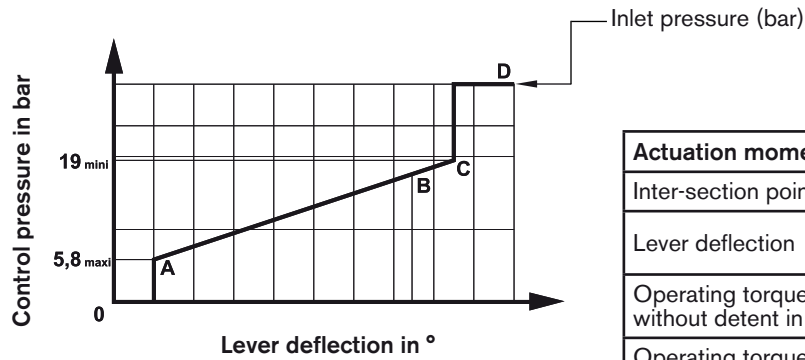
Variations of ergonomic grip EC2000

<p>TT</p> 	<p>– without E-contact</p>	
<p>ST</p> 	<p>– single E-contact on top</p>	<p>yellow</p>  <p>green</p> 
<p>VT</p> 	<p>– double E-contact with rocker switch</p>	<p>black grey</p>  <p>red blue</p> 
<p>YT</p> 	<p>– double E-contact with rocker switch – single E contact on top</p>	<p>yellow black grey</p>  <p>green red blue</p> 
<p>YU</p> 	<p>– double E-contact with rocker switch – single E-contact on top – single E-contact to the front</p>	<p>yellow black grey white</p>  <p>green red blue brown</p> 

Characteristic curve: control ranges, actuation moments

06 Control curve, identification No. 06

This curve is used for the pilot control of the SM12, SM18, M1, M6 control blocks

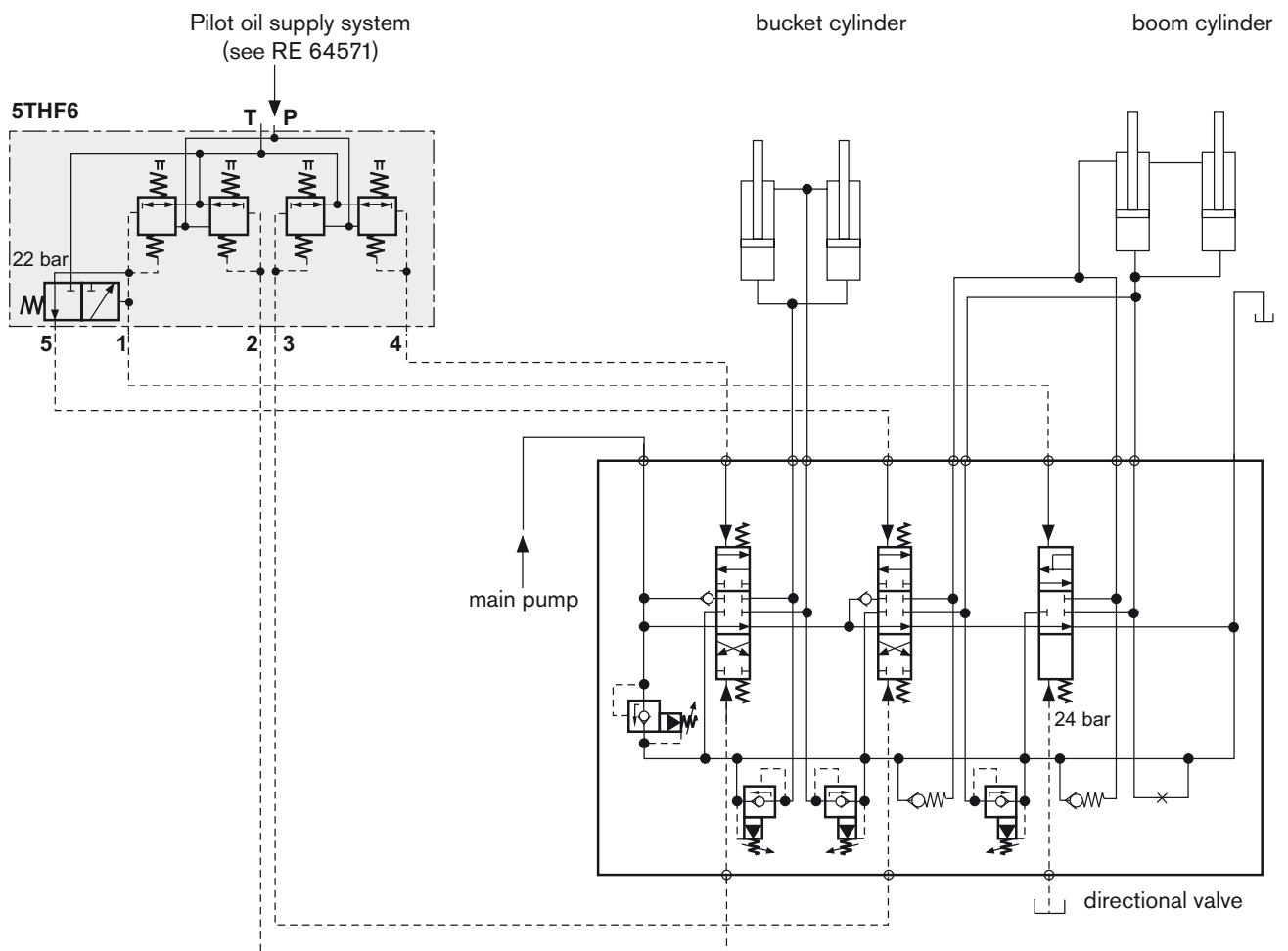


Actuation moments of 1 actuator				
Inter-section point	A	B	C	D
Lever deflection	2°	13°	14°	17°
Operating torque without detent in N.m	0,9		3,2	3,7 (p = 35 bar)
Operating torque with detent in N.m	0,9	4,5	4,8	6 (p = 35 bar)

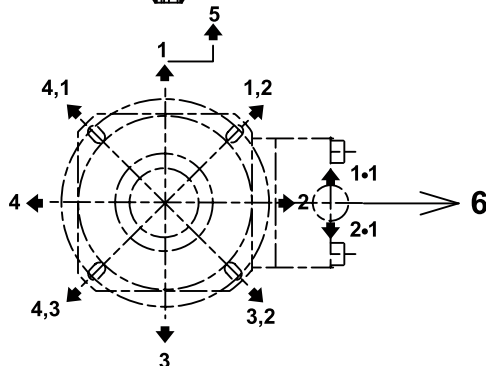
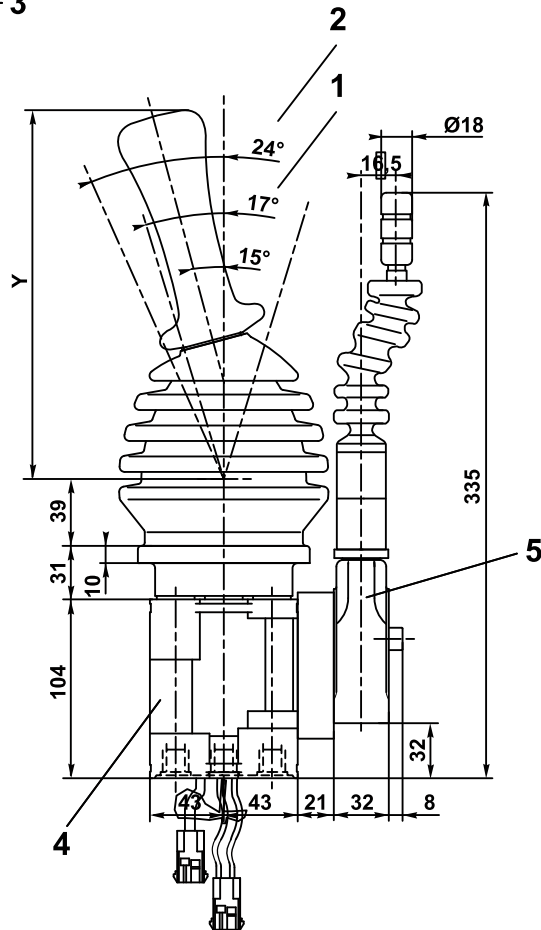
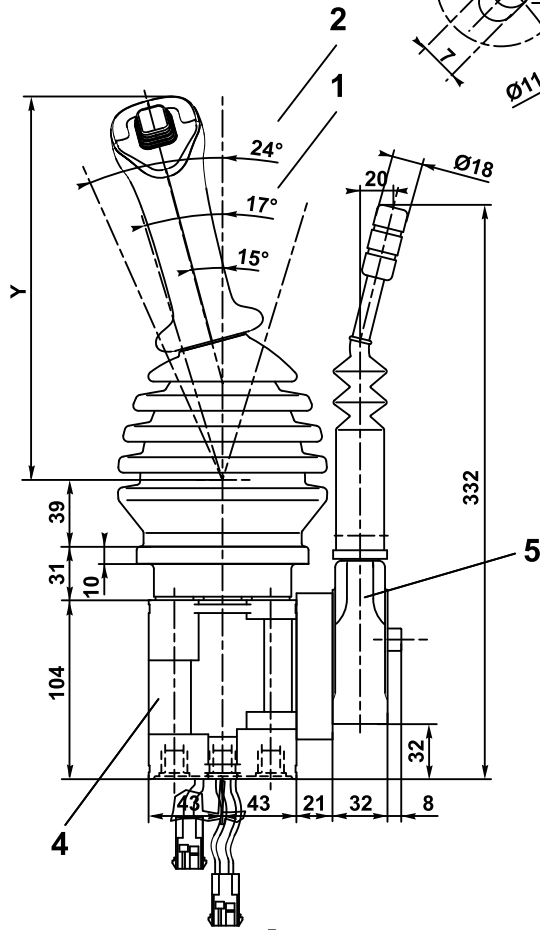
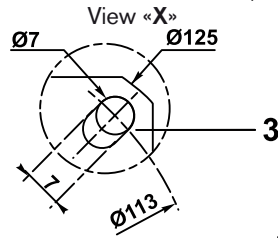
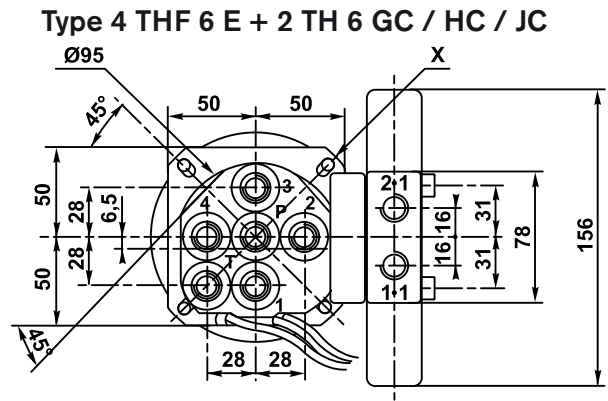
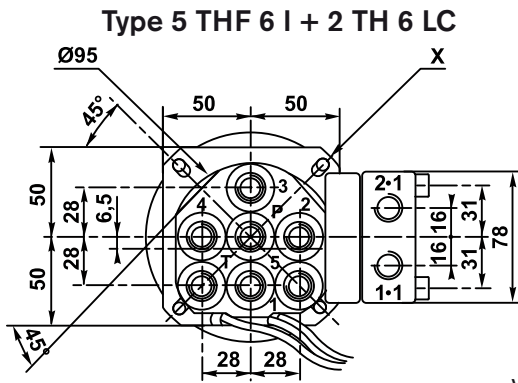
B = Resistance point before changeover to inlet pressure

The operating torques stated are theoretical values which do not take into account the rubber boot resistance.

Circuit example



Unit dimensions (dimensions in mm)



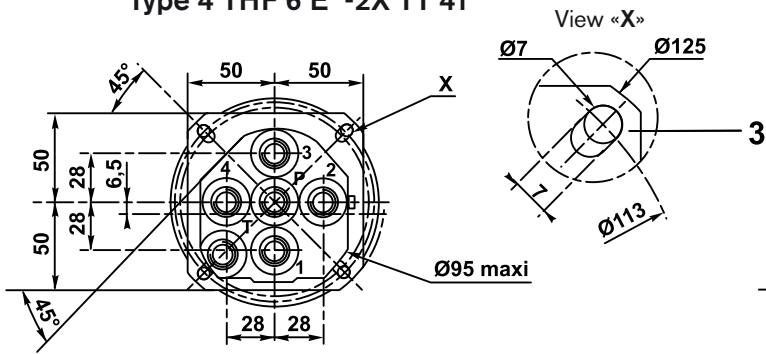
- 1 lever deflection when operating one actuator
- 2 lever deflection when operating two actuators
- 3 four equally space mounting points
- 4 THF 6
- 5 2TH 6
- 6 lever actuation direction and control ports thereby influenced

Unit dimension in function of the grip type:

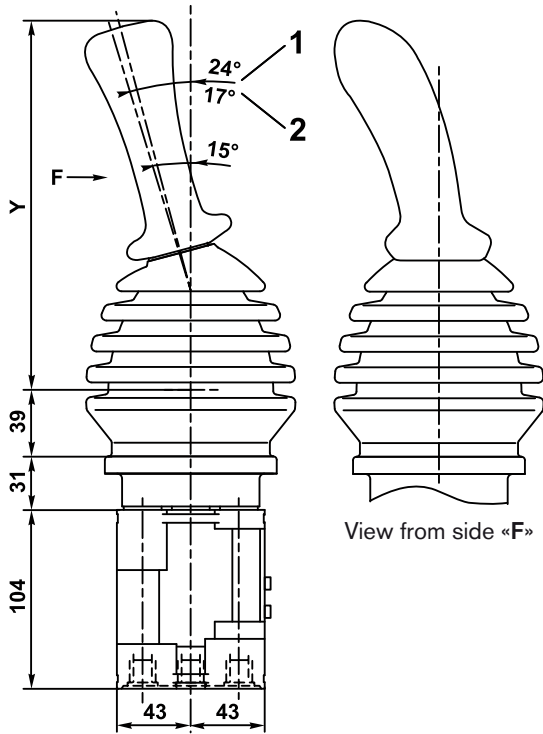
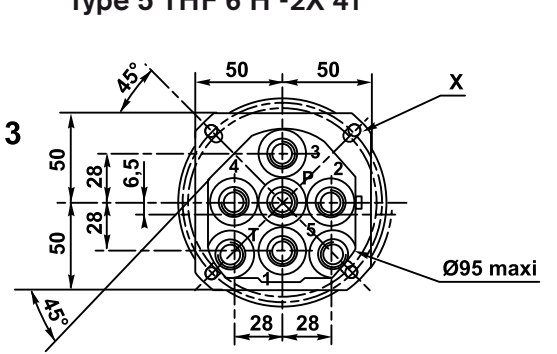
type of grip	Y
EC2000	211
EC2000+	226
EC4000	261

Unit dimensions (dimensions in mm)

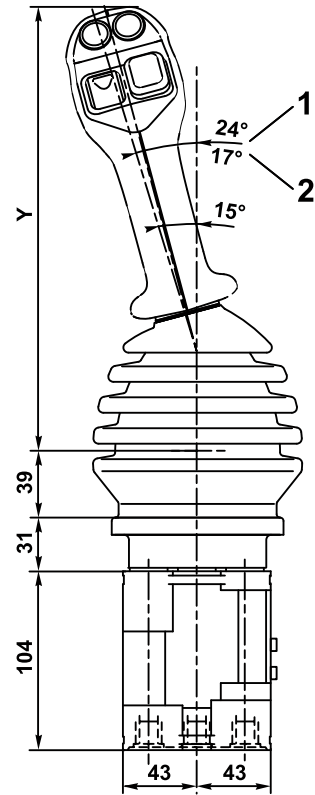
Type 4 THF 6 E -2X TT 41



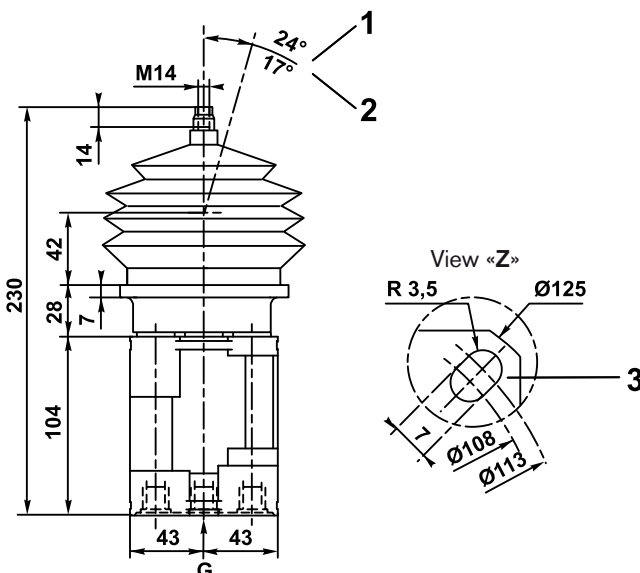
Type 5 THF 6 H -2X 41



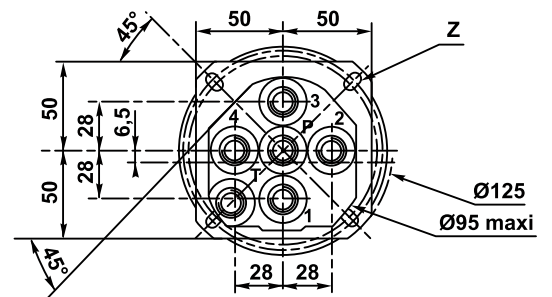
View from side «F»



Type 4 THF 6 Z



Section «G»



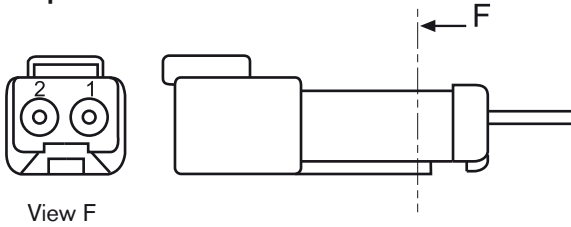
- 1 lever deflection when operating one actuator
- 2 lever deflection when operating two actuators
- 3 four equally spaced mounting points

Contact location within the plugs for wiring grip EC2000

DEUTSCH sealed plug IP 67
(ordering detail = 5)

Plug AMP MAT-N-LOCK
(ordering detail = 6)

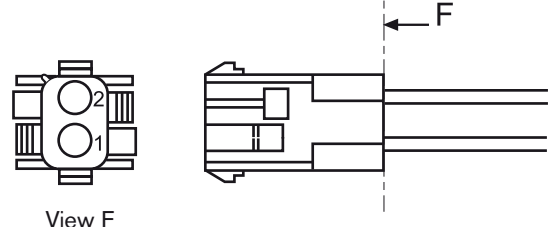
Grip ST



View F

cover DEUTSCH DT 04 - 2P - CE 04

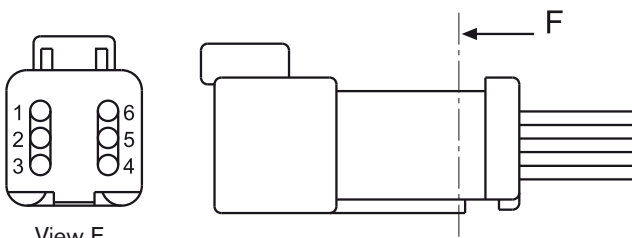
Grip ST



View F

cover AMP 350778 - 1

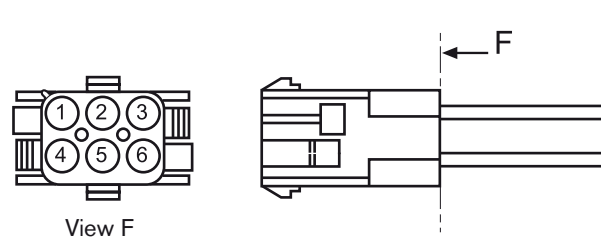
Grip VT or YT



View F

cover DEUTSCH DT 04 - 6P - CE 04

Grip VT or YT



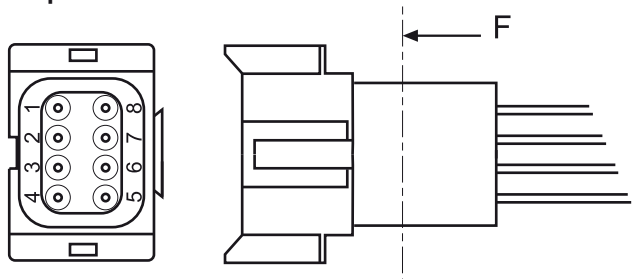
View F

cover AMP 350781 - 1

Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	red	x	x
2	black	x	x
3	grey	x	x
4	blue	x	x
5	yellow		x
6	green		x

Identification in the plug	wire colour	Ergonomic grip type	
		VT	YT
1	grey	x	x
2	black	x	x
3	red	x	x
4	blue	x	x
5	yellow		x
6	green		x

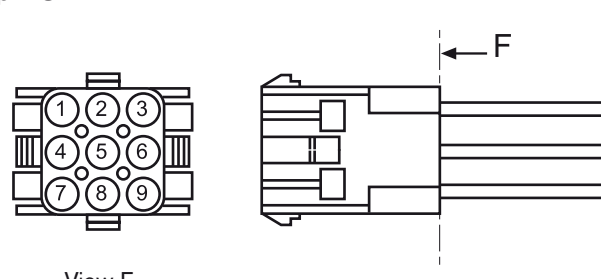
Grip YU



View F

cover DEUTSCH DT 04 - 8P - CE 04

Grip YU



View F

cover AMP 350782 - 1

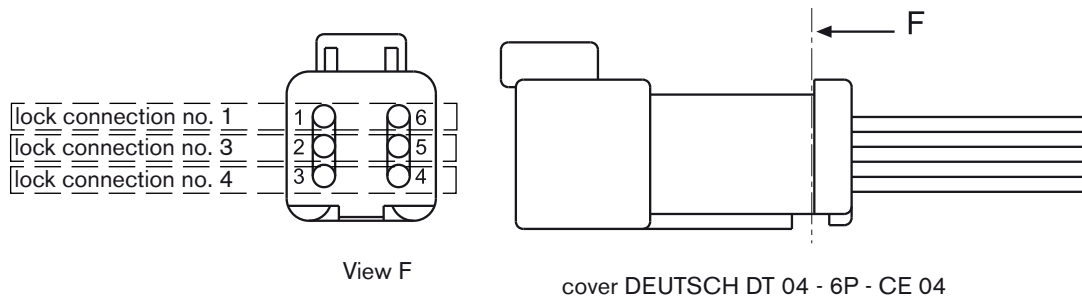
Identification in the plug	wire colour	identification in the plug	wire colour
1	red	5	yellow
2	black	6	green
3	grey	7	white
4	blue	8	brown

Identification in the plug	wire colour	identification in the plug	wire colour
1	grey	5	yellow
2	black	6	green
3	red	7	white
4	blue	8	brown

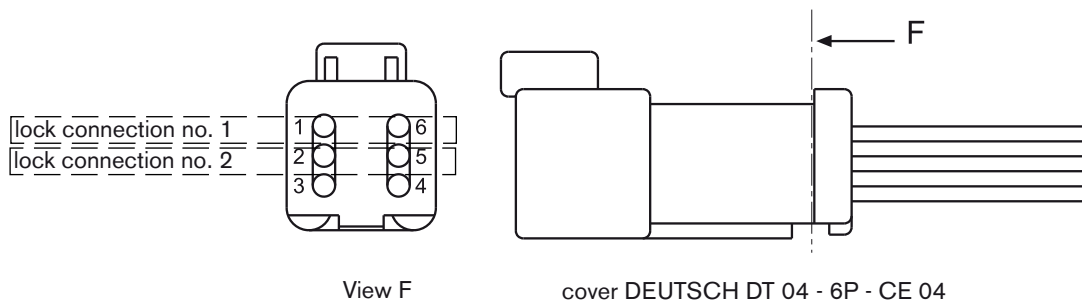
Contact location within the plugs for wiring the solenoids of the electro-magnetic lock

DEUTSCH sealed plug IP 67 (ordering code = 5)

- Plug for wiring the 4/5 THF 6 electro-magnetic lock solenoids

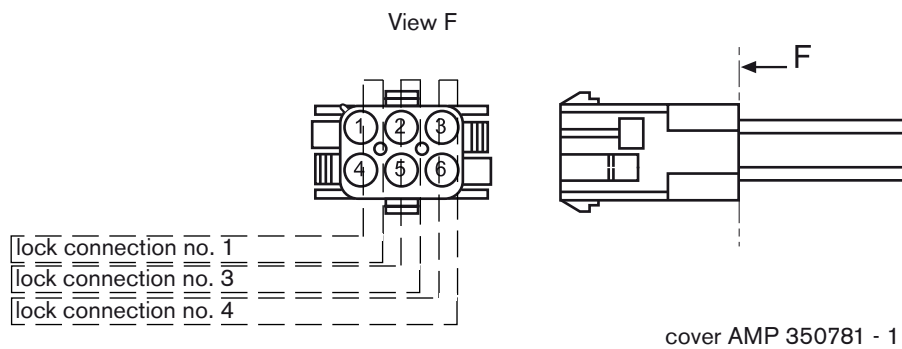


- Plug for wiring the 2 TH 6 GC / HC / JC electro-magnetic lock solenoids

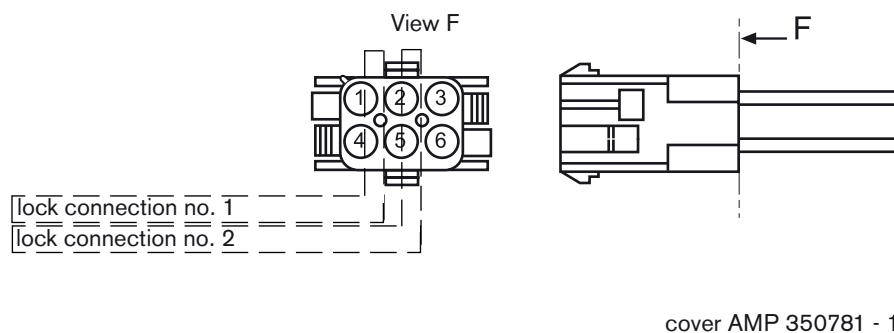


Plug AMP MAT-N-LOK (ordering code = 6)

- Plug for wiring the 4/5 THF 6 electro-magnetic lock solenoids



- Plug for wiring the 2 TH 6 GC / HC / JC electro-magnetic lock solenoids



Application guidelines (these guidelines are not intended to be considered as complete)

- Do not direct the jet of a pressure washing unit directly at the unit.
- The electrical cable must be kept free of any mechanical forces.
- During operation protection via the rubber grommet must be ensured.
- Only use the unit with its original grip and lever.
- Ensure that the inertia data of the original grip are not exceeded.
- Replace worn push buttons, so that the integrity of the grip EC2000 is ensured.

Safety guidelines (these guidelines are not intended to be considered as complete)

- Only one function control must be allocated to an E-contact.
- The circuit functions are to be so designed that uncontrolled machine movements caused by the application are prevented and that it is possible to switch from one function to another.
- Take into account all of the application limits, particularly those application limits stated within this catalogue sheet.
- Preparation for assembly and testing on the machine: The various checks must include all the functions of the pilot control device.

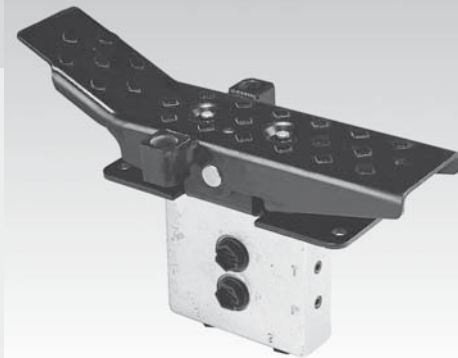
Installation guidelines

- Mounting flange area: Flatness = 0.5 mm
- Screw head imensions = $\varnothing 10$ mm
- Tightening torque for the flange fixing screws = Max. 10 Nm
- Tightening torque for the pipe connections = Max. 30 Nm
- Before fitting the grip to a THF6Z variant use a centralising bush to hold the cardan pin, so that the cardan joint is not damaged. Also see the description in the spare parts list RDEF 64 553-E

Pilot Control Device in Pedal Design for the Remote Control of Directional Valves, Pumps and Motors

Type 2 TH6 R

Series 1X



Contents

Functional description, section	2
Symbol, hydraulic	2
Technical data	3
Application guideline	3
Characteristics	3
Ordering details	4
Unit dimensions	4 to 5
Installation guidelines	6

Features

- Progressive, sensitive operation
- Precise control
- Working ports underneath
- Control elements protected by rubber sleeve
- Plungers made of stainless steel, plunger guides made of brass; this prevents corrosion and seizing

Further remote controls and pilot control units:

- Hydraulic remote control
 - Pilot control device type 2TH6 (see RE 64552) in sandwich plate design
 - Pilot control unit types 4 TH 6, 4 TH 5, 4TH 6 N, for arm rest installation (see RE 64555)
 - Pilot control device type TH 7, for instrument panel installation or in pedal design (see RE 64558)
 - Pilot control device with end position locking type 4/5 THF 6 (see RE 64553) or type 4/6 THF 5 (see RE 64557)
- Electronic pilot control device
 - Electronic remote control device type THE6 for direct controlling of electrical or electro-hydraulic pilot operated actuators (see RE 29771)
 - Electronic pilot control device type THE5 (see RE 29881)

Functional description, section

Hydraulic remote controls of type 2 TH 6 R... operate on the basis of direct operated pressure reducing valves.

They basically consist of foot pedal (1), two pressure reducing valves and housing (6).

Each pressure reducing valve comprises control spool (2), control spring (3), return spring (4) and plunger (5).

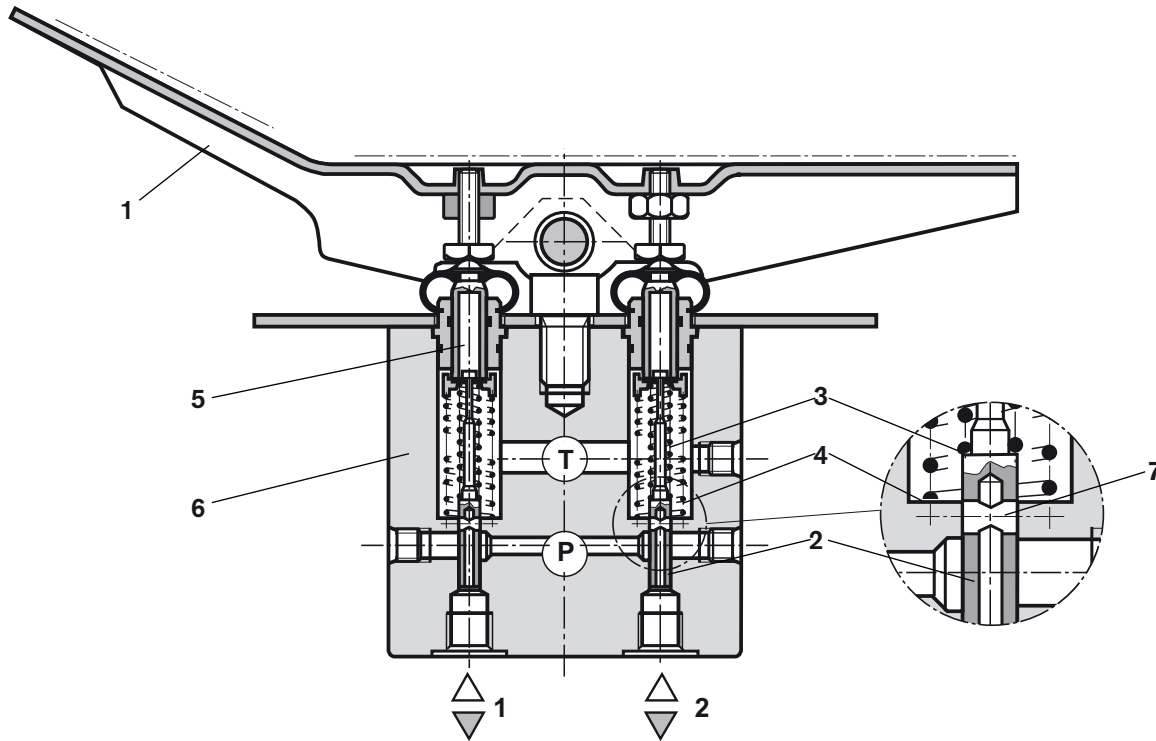
At rest, the pedal is held in the neutral position by return springs (4). Ports (1,2) are connected to the tank port T via bore (7).

When foot pedal (1) is depressed, plunger (5) is pressed against the return spring (4) and control spring (3). Control spring (3) initially moves control spool (2) downwards and closes the connection between the relevant port and tank port T. At the same time, the relevant port is connected to port P

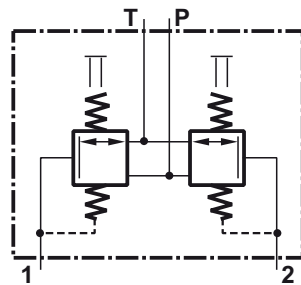
via bore (7). The control phase starts as soon as control spool (2) finds its balance between the force of control spring (3) and the force that results from the hydraulic pressure in the relevant port (port 1 or 2).

Due to the interaction of control spool (2) and control spring (3), the pressure in the relevant ports is proportional to the stroke of plunger (5) and hence to the position of pedal (1).

This closed-loop pressure control in relation to the position of foot pedal (1) and the properties of control spring (3) allows a proportional hydraulic control of directional valves and high-response control valves for hydraulic pumps and motors.



Symbol, hydraulic



Technical data (for applications outside these paramters, please consult us!)

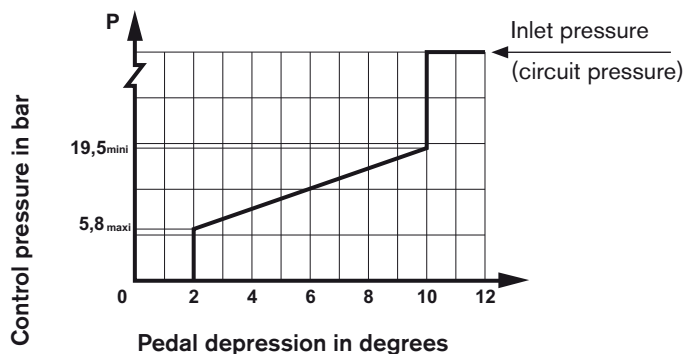
Max. inlet pressure	bar	max. 50
Counterpressure in port T	bar	max. 3
Pilot flow	l/min	max. 16.
Hysteresis	bar	max. 1
Pressure fluid		Mineral oil (HL, HLP) to DIN 51524 ¹⁾ Phosphate ester (HFD-R) ²⁾
¹⁾ suitable for NBR seals		
²⁾ suitable for FKM seals		
Hydraulic fluid temperature range	°C	- 20 to + 80
Viscosity range	mm ² /s	10 to 380
Fluid cleanliness		Max. permissible degree of hydraulic fluid contamination according to NAS 1638 class 9. For this, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$.
Max. permissible operating torque at foot pedal	Nm	200
Weight	kg	approx 3,8

Application guideline (this list is not intended to be considered as complete)

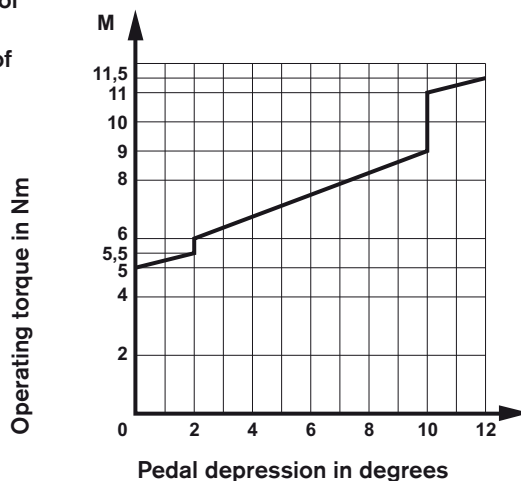
- Do not direct the jet of a pressure washing unit directly at the unit.
- Replace worn bellows to maintain foot pedal tightness..

Characteristic curves : control ranges, operating torque

06 Control curve, identification no. 06



Operating torque for control curve 06, standard return spring and inlet pressure of 50 bar



Ordering details

2	TH6	R			-1X		*
---	-----	---	--	--	-----	--	---

2 control ports	= 2						
Pedal operation		= R					
Pedal version							
Bent pedal			= C				
Flat pedal			= P				
Control curve 06				= 06			
Series 10 à 19 (10 to 19, unchanged installation and connection dimensions)					= 1X		

Further details in plain text

Connecting thread

01 =	G 1/4 pipe thread to standard ISO 228/1
02 =	M14 x 1,5 metric to standard ISO 9974
05 =	9/16 UNF-2B UNF connections to standard ISO 11926

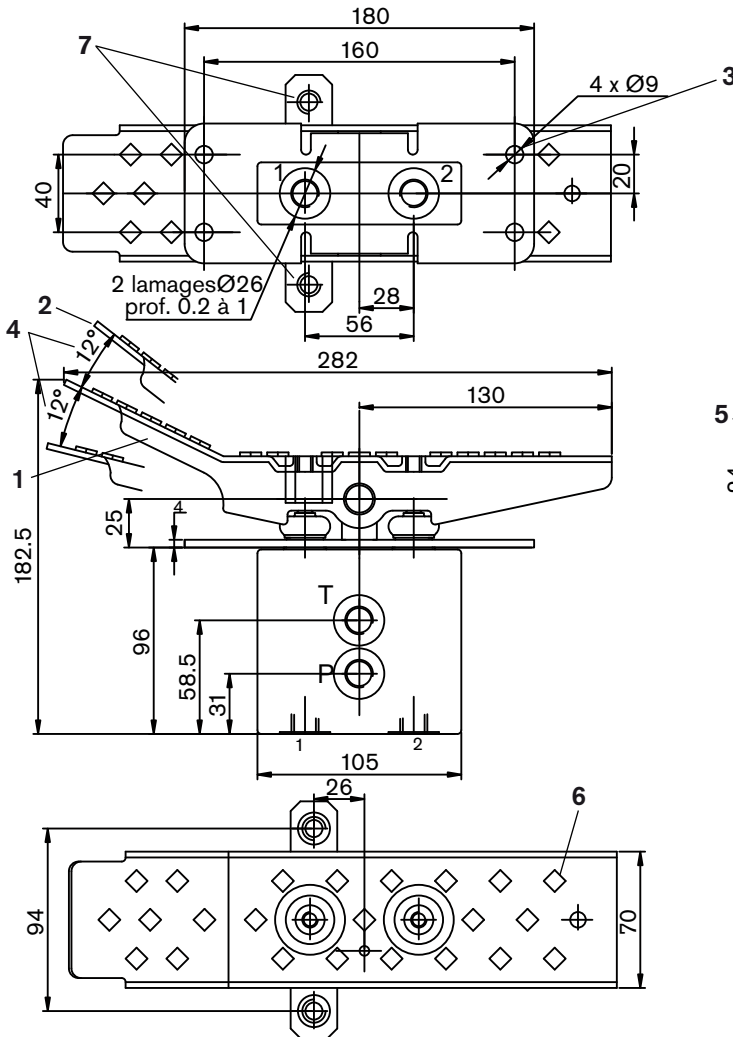
Seals

M =	NBR seals
V =	FKM seals

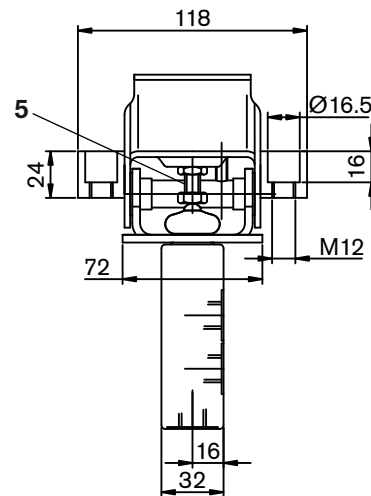
⚠ Attention !

The compatibility of the seals and pressure fluid has to be taken into account

Unit dimensions : flat pedal type "P" (dimensions in mm)



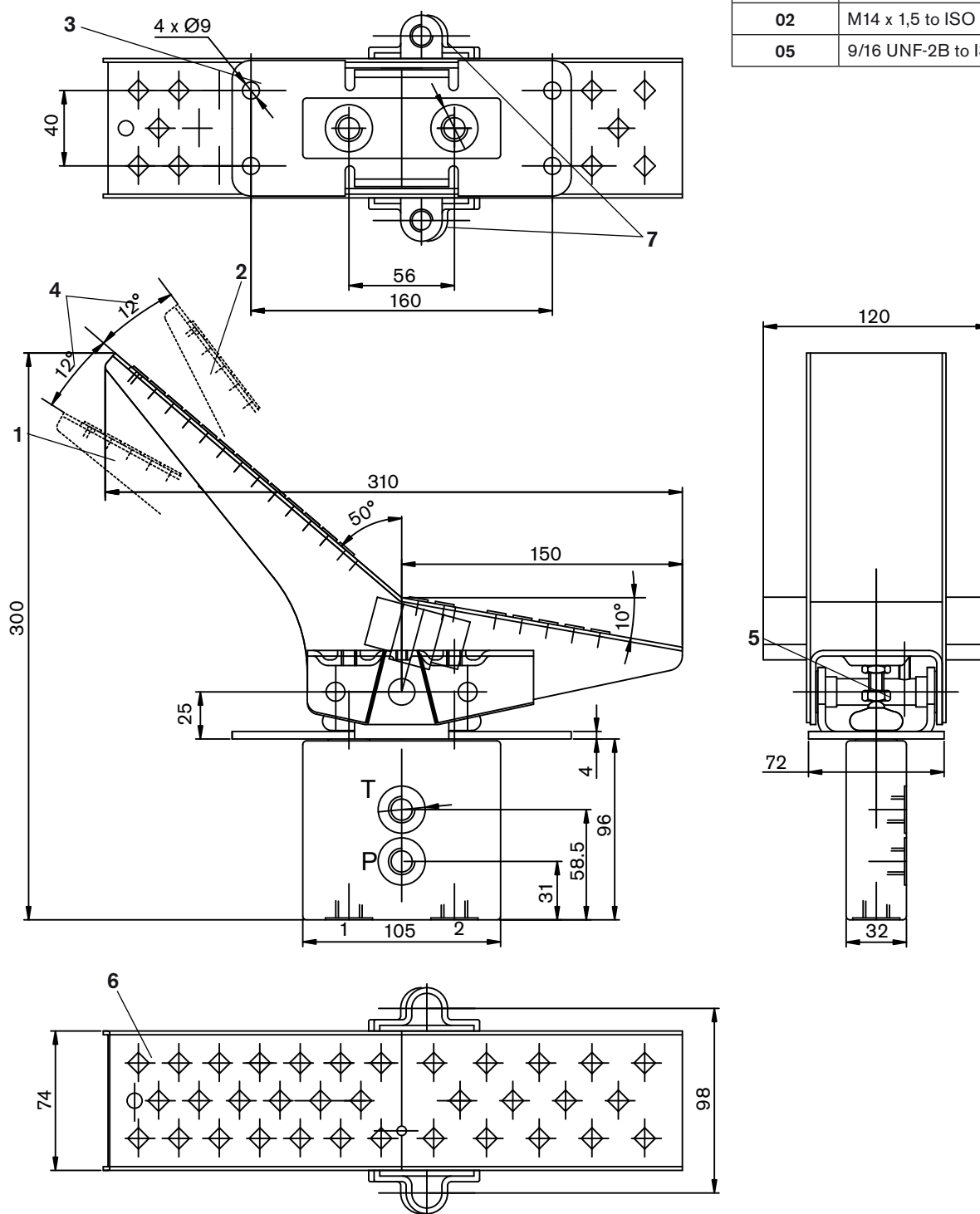
Ordering code	Ports P, T, 1 and 2
01	G 1/4 to ISO 228/1
02	M14 x 1,5 to ISO 9974
05	9/16 UNF-2B to ISO 11926



- 1 Position 1 (port 1 pressurised)
- 2 Position 2 (port 2 pressurised)
- 3 Fixing holes
- 4 Pedal depression
- 5 Adjustment screw
- 6 Anti-slip foot rest
- 7 Fixation of manual operating lever

Unit dimensions : bent pedal type "C" (dimensions in mm)

Ordering code	Ports P, T, 1 and 2
01	G 1/4 to ISO 228/1
02	M14 x 1,5 to ISO 9974
05	9/16 UNF-2B to ISO 11926



- 1 Position 1 (port 1 pressurised)
- 2 Position 2 (port 2 pressurised)
- 3 Fixing holes
- 4 Pedal depression
- 5 Adjustment screw
- 6 Anti-slip foot rest
- 7 Fixation of manual operating lever

Installation guidelines

- Mounting flange area: Flatness = 0,5 mm
- Screw head imensions = \varnothing 13 mm
- Tightening torque for the flange fixing screws = Max. 10 Nm
- Tightening torque for the pipe connections = Max. 30 Nm

Hydraulic pilot control device with 2 pedals and damping system

Type 4 TH5NR, 5 TH5NR, 6 TH5NR

Series 2X

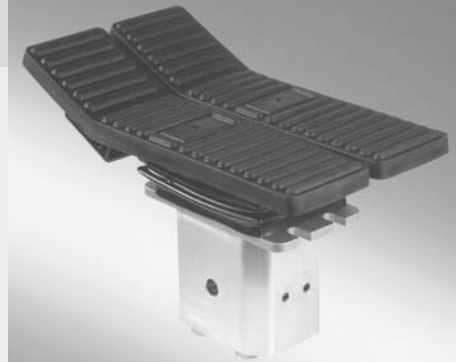


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Unit dimensions	7

Features

Damping

- This damping system provides softer control of the travel function on compact tracked vehicles
- Abrupt manoeuvres are damped and return to neutral is oscillation-free

Compactness

- The monoblock design of the TH5NR integrates a large number of functions and reduces pipe work
- Available with 4, 5 or 6 actuation ports without alteration of the unit dimensions
- The use of a single fixing plate makes fitting on the machine easier
- More compact than 2 independent pedals side by side
- The body in aluminium reduces the weight

Adaptability

- Various types of pedal can be easily fitted by screwing them on the supports (cams)
- Easier fitting/exchange of the bellows protecting the mechanical parts

Application

- Control of compact tracked vehicle translation actuated by foot or hand

About this datasheet

This manual describes functioning, technical data and ordering details of hydraulic pilot control device with pedal TH5NR. This manual is illustrated with hydraulic symbols, sections and unit dimensions drawings.

Related documents

Hydraulic pilot control device with pedal TH5NR is a system component.

- Also follow the instructions for the other system components.
- Also follow the instructions in the following manuals:
 - System documentation from the system manufacturer
 - Spare parts manual RDEF64535-E

Further pilot control devices

Hydraulic pilot control device

- Pilot control device type 2 TH6R, in pedal design (see RE 64551)
- Pilot control device type 4/5/6 TH6NR, with 2 pedals and damping system (see RE 64554)
- Pilot control device type 2 TH6 (see RE 64552), in sandwich plate design
- Pilot control device types 4 TH6, 4 TH5 and 4 TH6N for arm rest installation (see RE 64555)
- Pilot control device type TH7, for instrument panel installation or in pedal design (see RE 64558)

- Pilot control device with end position locking type 4/5 THF6 (see RE 64553) or type 4/6 THF5 (see RE 64557)

Electronic pilot control device

- Electronic remote control device type THE6 for direct controlling of electrical or electrohydraulic pilot operated actuators (see RE 29771)
- Electronic pilot control device type THE5 (see RE 29881)
- Electronic pilot control device type EJ (see RE 29896)

Functional description, cross-section

Hydraulic remote controls of type TH5NR operate on the basis of direct operated pressure reducing valves.

Pilot control devices in double foot pedal design type TH5NR basically consist of an actuation stage composed of a foot holding piece in double design (1), 4 pressure reducing valves (11), 4 damping systems (12), 1 rubber boot (13) and a body (6).

Each pressure reducing valve comprises control spool (2), control spring (3), return spring (4) and plunger (5).

The damping system consists of a plunger (8), a jet (9) and a return spring (10).

At rest, the pedal is held in the neutral position by return springs (4 and 10).

When actuated, the foot pedal pushes the regulation plunger and the damping system plunger in.

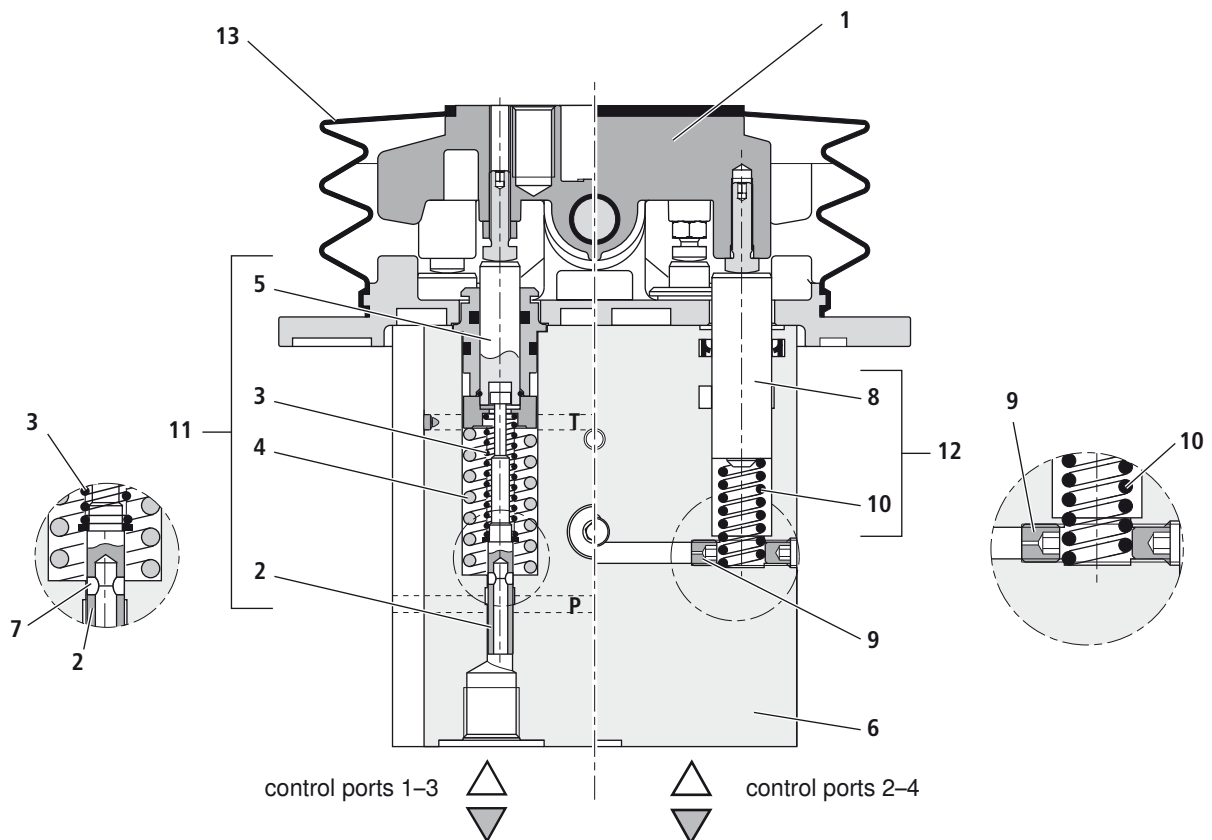
Fluid squeezed inside the damping room gets throttled in the jet, at a pressure depending on the actuation speed. (In the same way, when back to neutral the foot pedal pushed by the return spring will have to drive out the fluid caught in the

chamber. Return speed will be limited by the flow of this fluid through the jet).

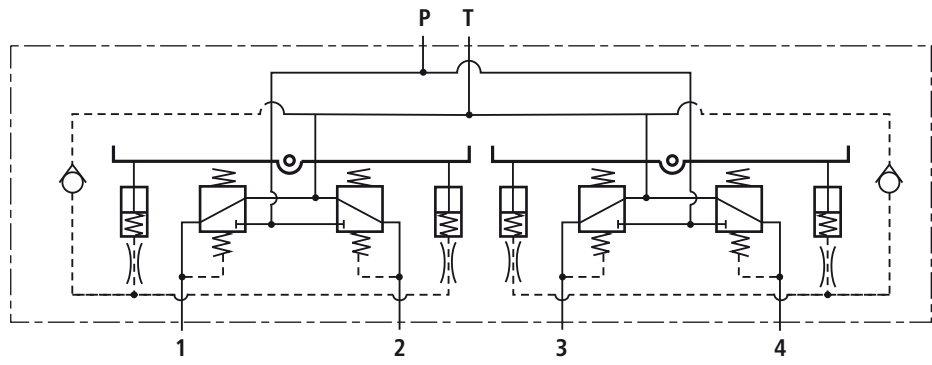
Simultaneously, the plunger (5) is pressed against the return spring (4) and control spring (3). Control spring (3) initially moves control spool (2) downwards and closes the connection between the relevant port and the return line to tank port T.

At the same time, the relevant port is connected to port P via bore (7). The control phase starts as soon as control spool (2) finds its balance between the force of control spring (3) and the force that results from the hydraulic pressure in the relevant port (port 1 or 2).

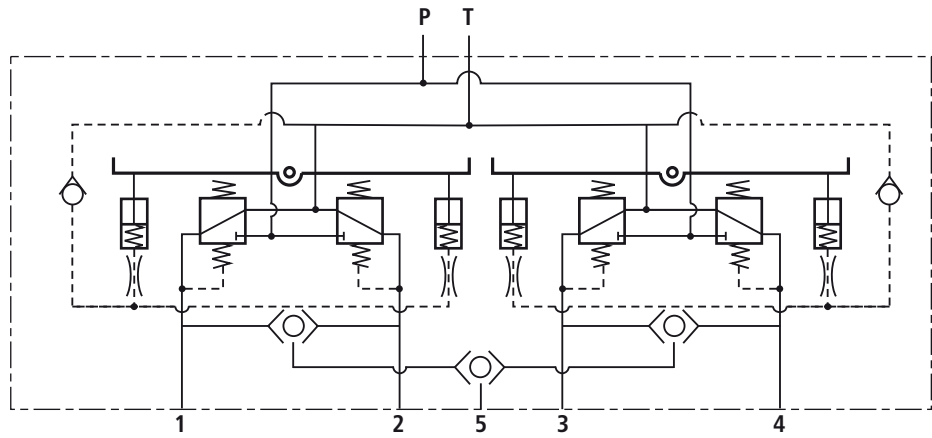
Due to the interaction of control spool (2) and control spring (3), the pressure in the relevant ports is proportional to the stroke of plunger (5) and hence to the position of pedal (1). This closed-loop pressure control in relation to the position of foot pedal (1) and the properties of control spring (3) allows a proportional hydraulic control of directional valves and high-response control valves for hydraulic pumps and motors.



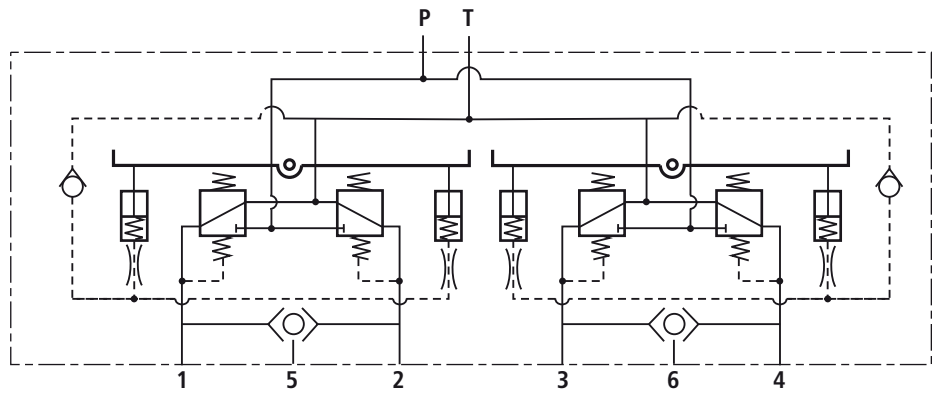
4 TH5NR



5 TH5NR



6 TH5NR



Technical data (for applications outside these parameters, please consult us)

Max. inlet pressure	bar	max. 50
Counter-pressure in port T	bar	min. 2
Pilot flow	l/min	max. 16
Hysteresis	bar	max. 1
Hydraulic fluid		Mineral oil (HL, HLP) according to DIN 51524 (suitable for NBR seals) Phosphate ester (HFD-R) on inquiry
Hydraulic fluid temperature range	°C	-20 to +80
Viscosity range	mm ² /s	10 to 380
Maximum permitted degree of contamination of the hydraulic fluid cleanliness class according to NAS 1638		Class 9, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Max. permissible operating torque at foot pedal	Nm	200
Weight 4TH5NRZ	kg	approx. 2.8
Storage temperature range, ambient	°C	-40 to +60

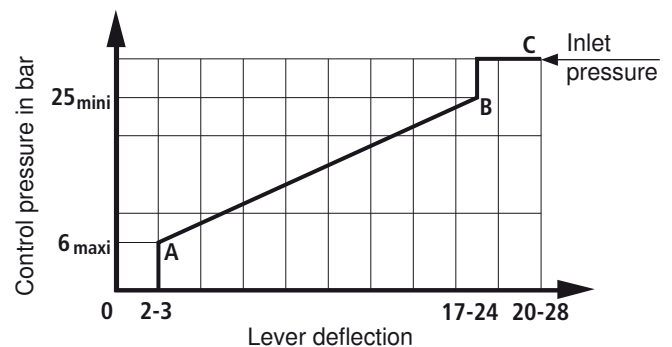
Characteristic curves: control ranges, actuation moments

Control curve identification no. 70

This curve is used for the pilot control of the type SX10, SX12 control blocks.

No. of actuated actuators		1
Operating torque in Nm	A	6.5
	B	9.2
	C	10.3 ¹⁾

¹⁾ p = 35 bar



The actuation moments stated are theoretical values which do not take into account the rubber boot resistance.

Ordering details

		TH5NR		-2X/		*
4 control ports	= 4					
5 control ports	= 5					
6 control ports	= 6					
Hydraulic pilot control with 2 pedals and damping system						
Pedal version						
Bent pedal	= C					
Flat pedal	= P					
Without pedal	= Z					
Control curve	= 70					
Further details in clear text						
Connection thread						
01 =						G 1/4; Pipe thread to ISO 228/1
05 =						9/16 UNF-2B to ISO 11926
Seals						
M=						NBR seals for mineral oil (HL, HLP) to DIN 51524
2X =						Series 20 to 29

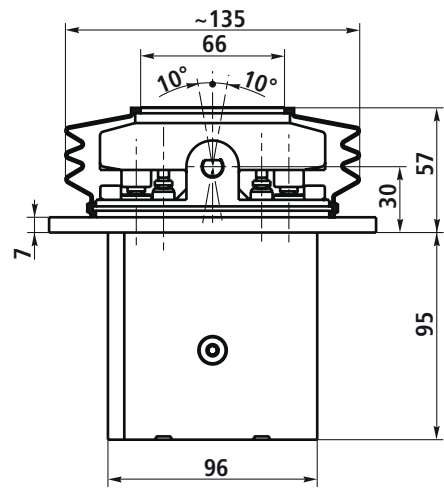
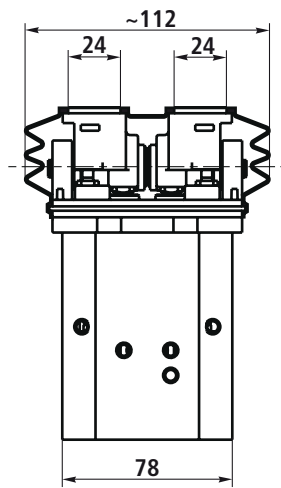
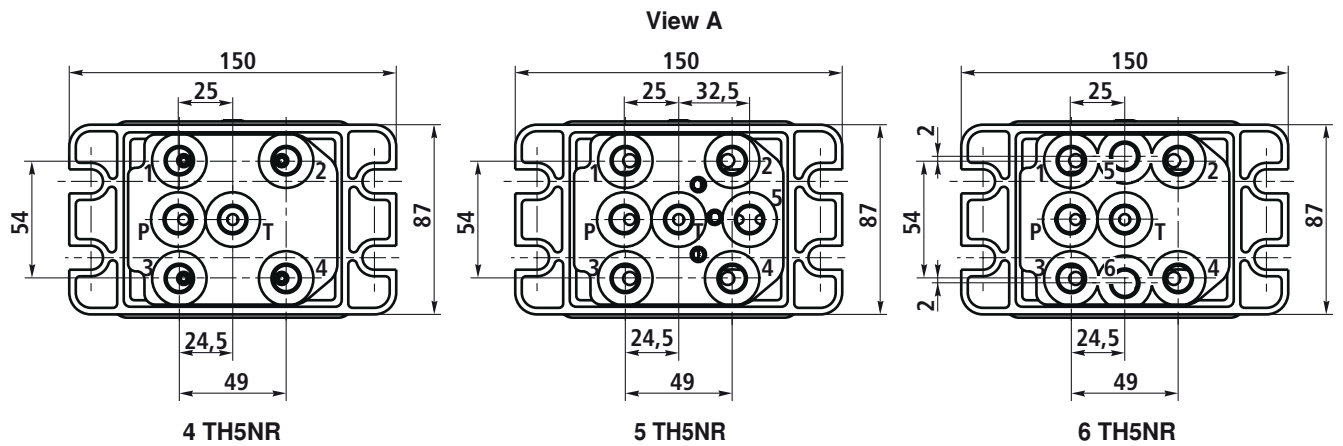
Application guidelines (these guidelines are not intended to be considered as complete)

- Do not use a high-pressure cleaner for cleaning.
- Some back pressure must be maintained at port T (minimum 2 bar) to make sure that damping chambers get filled.
- Back pressure in T helps damping system feeding and contributes to the quick bleeding that takes place once the component has been fitted on the vehicle.
After bleeding completion, the damping system will become fully efficient while being used.
- Do not operate the foot pedal of the component prior to its connection to the hydraulic circuit; otherwise an air intake will make it necessary to bleed the damping circuit.
- Replace worn bellows to maintain foot pedal tightness.

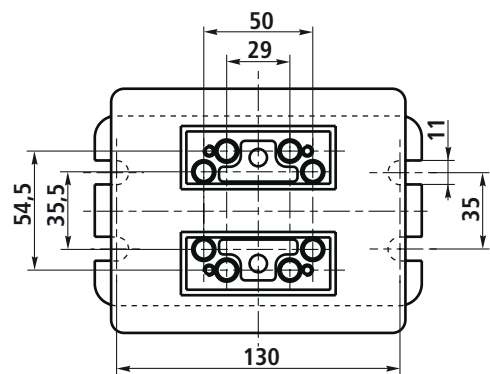
Installation guidelines

- Mounting flange area: Flatness = 0.5 mm
- Screw head dimensions = Ø16 mm
- Tightening torque for the flange fixing screws = max. 40 Nm
- Tightening torque for the pipe connections = max. 30 Nm
- Pedals fixation: screw M10 and penetration of screw in the switchplate thread: max. 15 mm
- Tightening torque for the pedal fixing screws = 30 Nm ±10%
- Installation hole: see page 6

Unit dimensions (dimensions in mm)



View from side A



Ordering detail	Ports P, T, control ports 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Hydraulic pilot control device with 2 pedals and damping system

Type 4 TH6NR, 5 TH6NR, 6 TH6NR

Series 2X



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Unit dimensions	7

Features

Damping

- This damping system provides softer control of the travel function on compact tracked vehicles
- Abrupt manoeuvres are damped and return to neutral is oscillation-free

Compactness

- The monoblock design of the TH6NR integrates a large number of functions and reduces pipe work
- Available with 4, 5 or 6 actuation ports without alteration of the unit dimensions
- The use of a single fixing plate makes fitting on the machine easier
- More compact than 2 independent pedals side by side

Adaptability

- Various types of pedal can be easily fitted by screwing them on the supports (cams)
- Easier fitting/exchange of the bellows protecting the mechanical parts

Application

- Control of compact tracked vehicle translation actuated by foot or hand

About this datasheet

This manual describes functioning, technical data and ordering details of hydraulic pilot control device with pedal TH6NR. This manual is illustrated with hydraulic symbols, sections and unit dimensions drawings.

Related documents

Hydraulic pilot control device with pedal TH56NR is a system component.

- Also follow the instructions for the other system components.
- Also follow the instructions in the following manuals:
 - System documentation from the system manufacturer
 - Spare parts manual RDEF64554-E

Further pilot control devices

Hydraulic pilot control device

- Pilot control device type 2 TH6R, in pedal design (see RE 64551)
- Pilot control device type 2 TH6 (see RE 64552), in sandwich plate design
- Pilot control device types 4 TH6, 4 TH5 and 4 TH6N for arm rest installation (see RE 64555)
- Pilot control device type TH 7, for instrument panel installation or in pedal design (see RE 64558)

- Pilot control device with end position locking type 4/5 THF6 (see RE 64553) or type 4/6 THF5 (see RE 64557)

Electronic pilot control device

- Electronic remote control device type THE6 for direct controlling of electrical or electrohydraulic pilot operated actuators (see RE 29771)
- Electronic pilot control device type THE5 (see RE 29881)
- Electronic pilot control device type EJ (see RE 29896)

Functional description, cross-section

Hydraulic remote controls of type TH6NR operate on the basis of direct operated pressure reducing valves. Pilot control devices in double foot pedal design type TH6NR basically consist of an actuation stage composed of a foot holding piece in double design (1), 4 pressure reducing valves (11), 4 damping systems (12), 2 rubber boot (13) and a body (6).

Each pressure reducing valve comprises control spool (2), control spring (3), return spring (4) and plunger (5).

The damping system consists of a plunger (8), a jet (9) and a return spring (10).

At rest, the pedal is held in the neutral position by return springs (10).

When actuated, the foot pedal pushes the regulation plunger and the damping system plunger in.

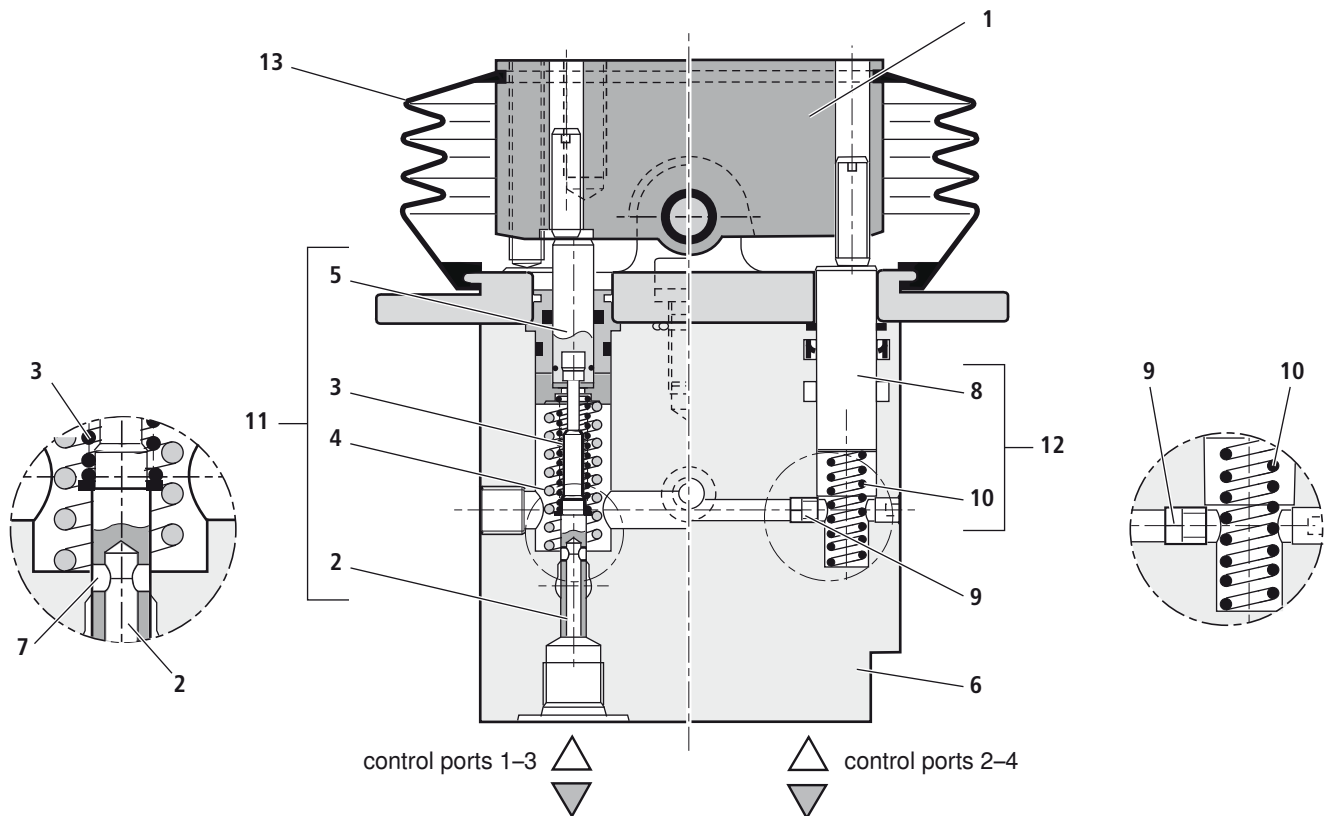
Fluid squeezed inside the damping room gets throttled in the jet, at a pressure depending on the actuation speed. (In the same way, when back to neutral the foot pedal pushed by the return spring will have to drive out the fluid caught in the

chamber. Return speed will be limited by the flow of this fluid through the jet).

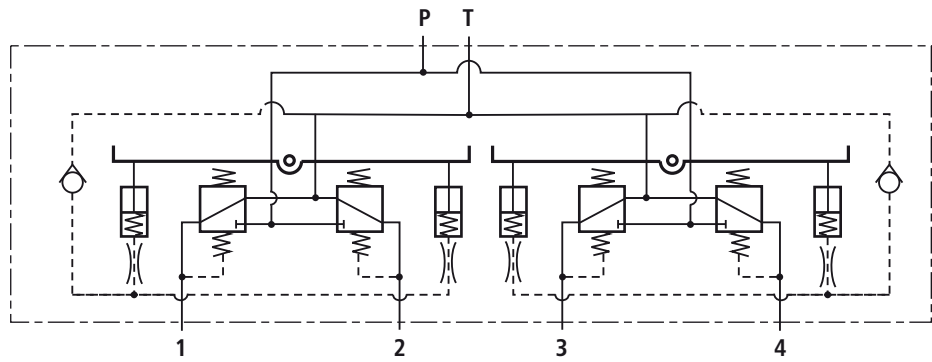
Simultaneously, the plunger (5) is pressed against the return spring (4) and control spring (3). Control spring (3) initially moves control spool (2) downwards and closes the connection between the relevant port and the return line to tank port T.

At the same time, the relevant port is connected to port P via bore (7). The control phase starts as soon as control spool (2) finds its balance between the force of control spring (3) and the force that results from the hydraulic pressure in the relevant port (port 1 or 2).

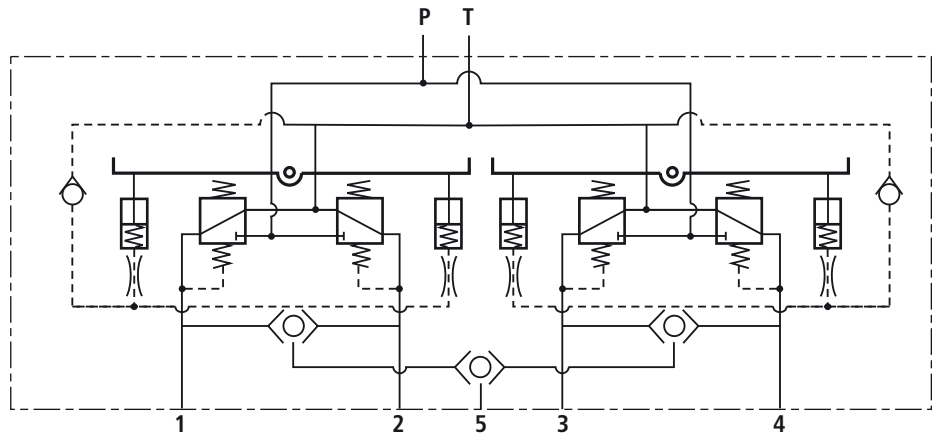
Due to the interaction of control spool (2) and control spring (3), the pressure in the relevant ports is proportional to the stroke of plunger (5) and hence to the position of pedal (1). This closed-loop pressure control in relation to the position of foot pedal (1) and the properties of control spring (3) allows a proportional hydraulic control of directional valves and high-response control valves for hydraulic pumps and motors.



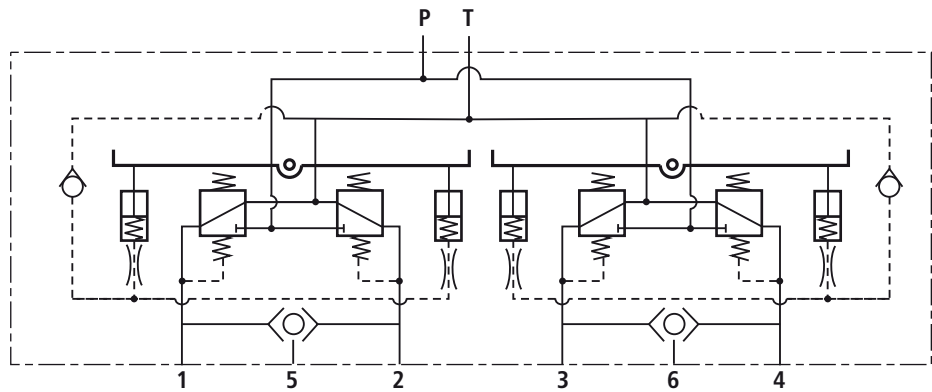
4 TH6NR



5 TH6NR



6 TH6NR



Technical data (for applications outside these parameters, please consult us)

Max. inlet pressure	bar	max. 50
Counter-pressure in port T	bar	min. 2
Pilot flow	l/min	max. 16
Hysteresis	bar	max. 1
Hydraulic fluid		Mineral oil (HL, HLP) according to DIN 51524 (suitable for NBR seals) Phosphate ester (HFD-R) on inquiry
Hydraulic fluid temperature range	°C	-20 to +80
Viscosity range	mm ² /s	10 to 380
Maximum permitted degree of contamination of the hydraulic fluid cleanliness class according to NAS 1638		Class 9, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Max. permissible operating torque at foot pedal	Nm	200
Weight 4TH6NRZ	kg	approx. 7.8
Storage temperature range, ambient	°C	-40 to +60

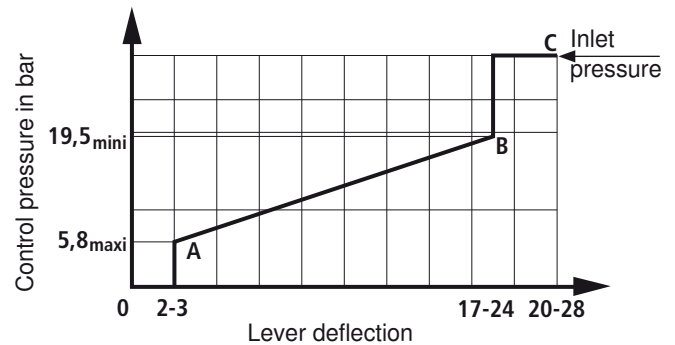
Characteristic curves: control ranges, actuation moments

Control curve identification no. 06

This curve is used for the pilot control of the type SM12, M1 control blocks.

No. of actuated actuators		1
Operating torque in Nm	A	6.7
	B	10.5
	C	12.2 ¹⁾

¹⁾ p = 35 bar

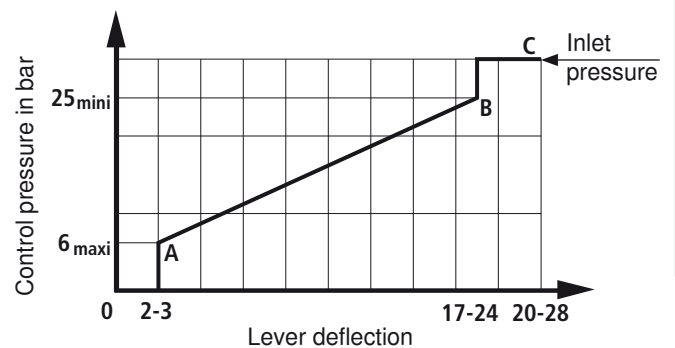


Control curve identification no. 70

This curve is used for the pilot control of the type SX14 control blocks.

No. of actuated actuators		1
Operating torque in Nm	A	7.1
	B	11.0
	C	12.2 ¹⁾

¹⁾ p = 35 bar



The actuation moments stated are theoretical values which do not take into account the rubber boot resistance.

Ordering details

		TH6NR		-2X/		*
4 control ports	= 4					Further details in clear text
5 control ports	= 5					
6 control ports	= 6					
Hydraulic pilot control with 2 pedals and damping system						
Pedal version						
Bent pedal			= C			Connection thread
Flat pedal			= P			
Without pedal			= Z			01 = G 1/4; Pipe thread to ISO 228/1 05 = 9/16 UNF-2B to ISO 11926
Seals						
Control curve 06			= 06			M= NBR seals for mineral oil (HL, HLP) to DIN 51524 2X = Series 20 to 29
Control curve 70			= 70			

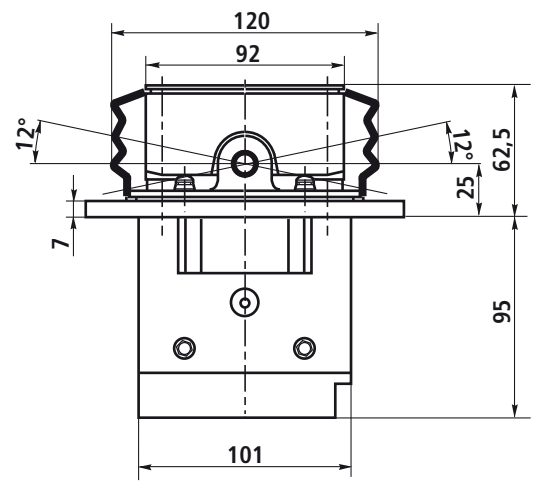
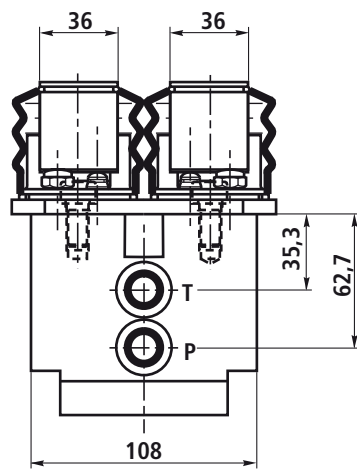
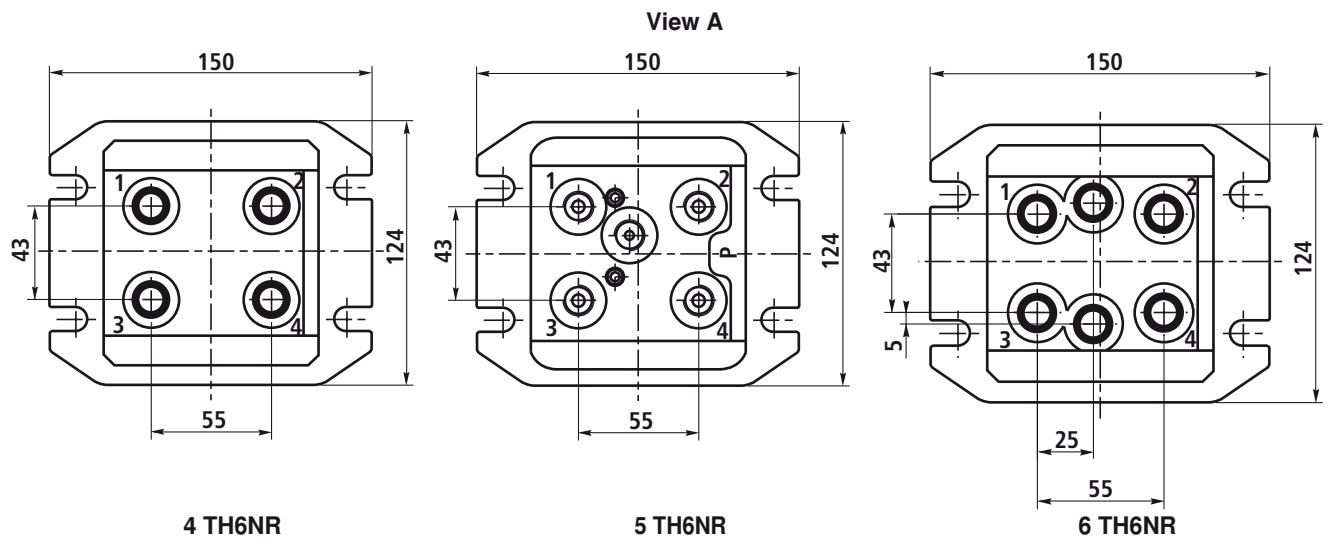
Application guidelines (these guidelines are not intended to be considered as complete)

- Do not use a high-pressure cleaner for cleaning.
- Some back pressure must be maintained at port T (minimum 2 bar) to make sure that damping chambers get filled.
- Back pressure in T helps damping system feeding and contributes to the quick bleeding that takes place once the component has been fitted on the vehicle.
After bleeding completion, the damping system will become fully efficient while being used.
- Do not operate the foot pedal of the component prior to its connection to the hydraulic circuit; otherwise an air intake will make it necessary to bleed the damping circuit.

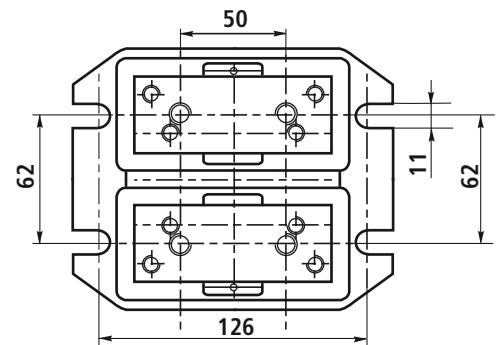
Installation guidelines

- Mounting flange area: Flatness = 0.5 mm
- Screw head dimensions = Ø16 mm
- Tightening torque for the flange fixing screws = max. 40 Nm
- Tightening torque for the pipe connections = max. 30 Nm
- Pedals fixation: screw M10 and penetration of screw in the switchplate thread: max. 15 mm
- Tightening torque for the pedal fixing screws = 30 Nm ±10%
- Installation hole: see page 6

Unit dimensions (dimensions in mm)



↑
View from side A



Ordering detail	Ports P, T, control ports 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Hydraulic pilot control devices

Type TH7



Type 1TH7Z



Type 1TH7QL



Type 2TH7Q

Series 1X



Type 2TH7N



Type 4TH7G

Contents

Functional description, symbol	2
Technical data	2
Ordering details	3
Unit dimensions	4 - 7
Characteristics curves	8 - 9

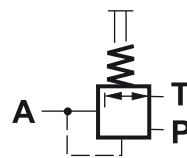
Features

- Progressive, sensitive operation
- Precise and play-free control

Functional description, symbol

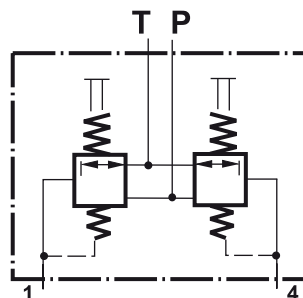
1TH7QL: Single acting hydraulic remote control, operation via one long pedal

1TH7Z: Single acting hydraulic remote control without operator

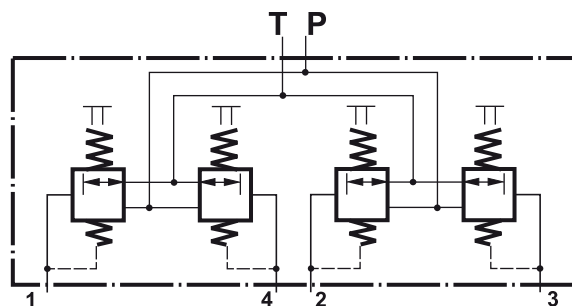


2TH7Q: Single acting hydraulic remote control, operation via two independent pedals

2TH7L, M, N, P: Double acting hydraulic remote control, operation via one side lever




4TH7G, H, J, K: Double acting hydraulic remote control, operation via two side levers



Technical data, mechanical (for applications outside these parameters, please consult us!)

Inlet pressure	bar	50
Back pressure at port T	bar	3
Pilot oil flow	l/min	up to 20
Hysteresis	bar	up to 1
Pressure fluid		
¹⁾ suitable for NBR seals		Mineral oil (HL, HLP) to DIN 51524 ¹⁾
²⁾ consult us		Phosphate ester (HFD-R) ²⁾
Pressure fluid temperature range	°C	- 20 to + 80
Viscosity range	mm ² /s	10 to 380
Degree of pressure fluid contamination		Max. permissible degree of contamination of the pressure fluid is to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $B_{10} \geq 75$.
Max. permissible operating torque at the pedals	Nm	20
Max. permissible actuation force at the plunger	N	88
Max. permissible operating torque at the levers	Nm	8
Weight	kg	3,2 (1TH7QL, 2TH7L, M, N, P)
	kg	1,2 (1TH7Z)
	kg	6,2 (2TH7Q)
	kg	3,5 (4TH7G, H, J, K)

Codification

		- 1X /			
1 control port:					<p>SO.008 = Sea water resistant (only 2TH7L, 2TH7M, 4TH7G, 4TH7H) SO.198 = Plunger grommet (only 1TH7Z)</p> <p>Threaded ports 01 = G1/4 Pipe thread to standard ISO 228/1 05 = 9/16 UNF-2B UNF connection to ISO 11926</p> <p>Seals M = NBR seals  Attention! The compatibility of the seals and pressure fluid has to be taken into account</p> <p>1X = Series 10 to 19 Unchanged installation and connection dimensions (10 to 19)</p>
• long pedal	= 1TH7QL				
• Without operator	= 1TH7Z				
2 control ports:					
• 2 independent pedals	= 1TH7QL				
• 1 side lever, with spring return	= 2TH7L				
• 1 side lever, with spring return and detents in 3 positions	= 2TH7M				
• 1 side lever, with spring return, lockable in any position and release	= 2TH7N				
• 1 side lever, with spring return and can be fixed in any position by a friction clutch	= 2TH7P				
4 control ports:					
• 2 side levers, with spring return	= 4TH7G				
• 2 side levers, with spring return and detents in 3 positions	= 4TH7H				
• 2 side levers, with spring return, lockable in any position and release	= 4TH7J				
• 2 side levers, with spring return and can be fixed in any position by a friction clutch	= 4TH7K				
		05, 06, 73, 91, 93 =			Control curve

Application guidelines (these guidelines are not intended to be considered as complete)

- Do not direct the jet of a pressure washing unit directly at the unit.
- Replace worn rubber grommets.

Safety guidelines (these guidelines are not intended to be considered as complete)

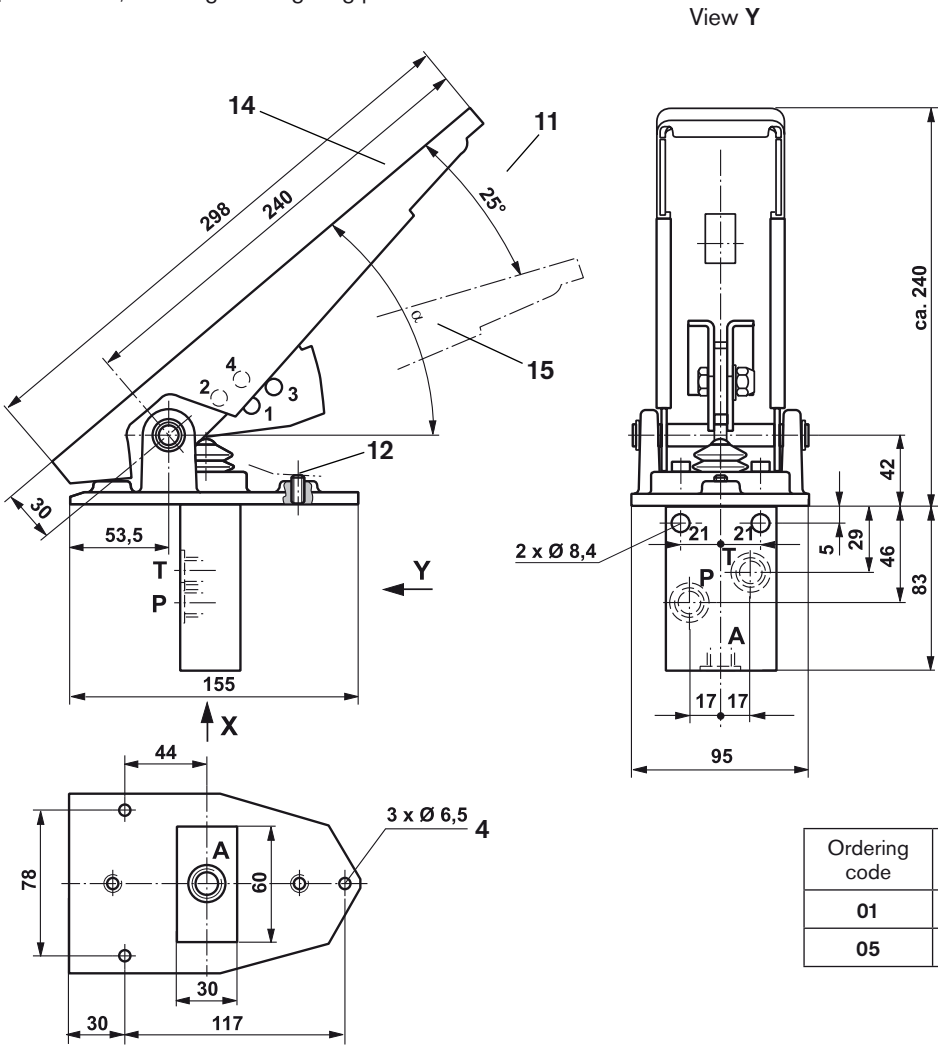
- Take into account all of the application limits, particularly those application limits stated within this catalogue sheet!

Installation guidelines

- Mounting flange area: flatness = 0.5 mm
- Screw head dimensions = Ø10 mm
- Tightening torque for the flange fixing screws = 10 Nm max.
- Tightening torque for the pipe connections = 30 Nm max.

Unit dimensions (dimensions in mm)

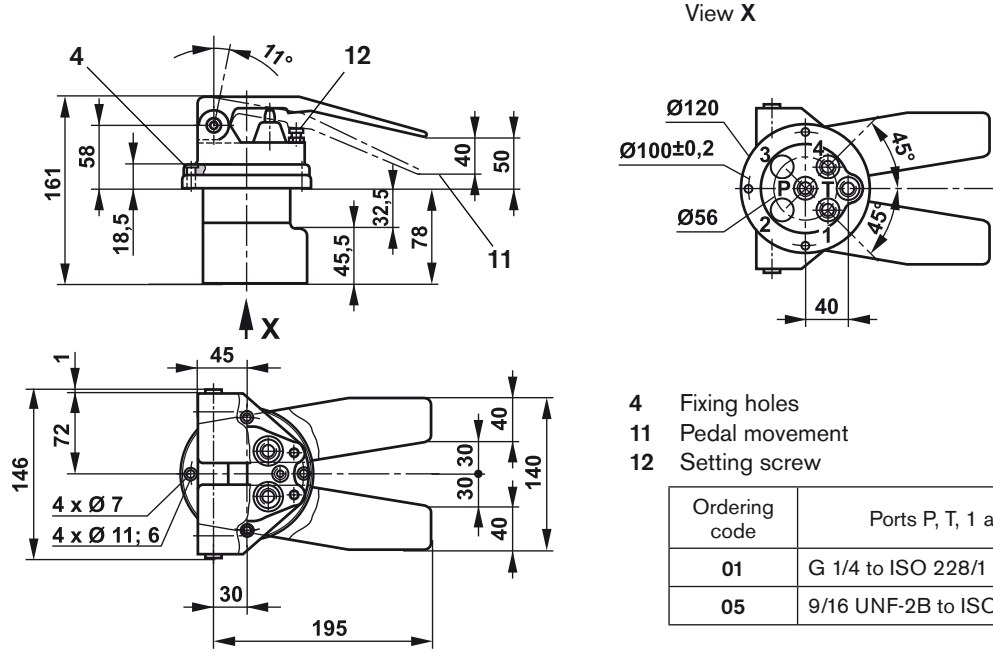
Type 1TH7QL, one single acting long pedal



- 4 Fixing holes
 - 11 Pedal movement
 - 12 Setting screw
 - 14 Anti-slip pedal surface
 - 15 Adjustable angle approx. every 5°:
- | Hole | α |
|------|----------|
| 1 | 25° |
| 2 | 30° |
| 3 | 35° |
| 4 | 40° |

Ordering code	Ports P, T, A
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type 2TH7Q, 2 independent single acting pedals

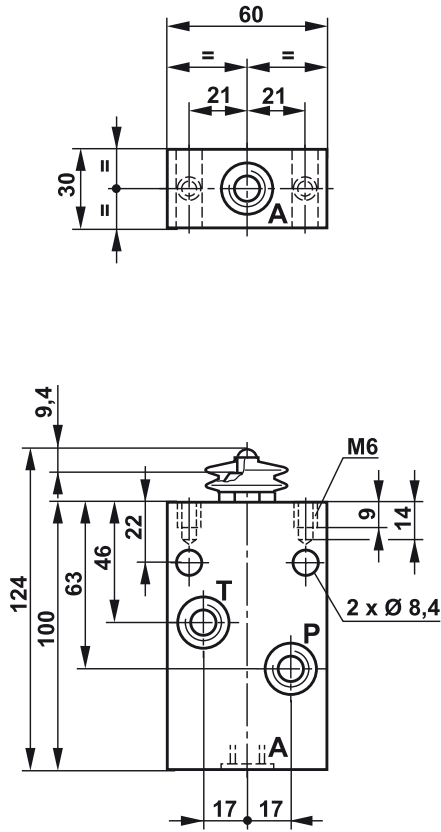


- 4 Fixing holes
- 11 Pedal movement
- 12 Setting screw

Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Unit dimensions (dimensions in mm)

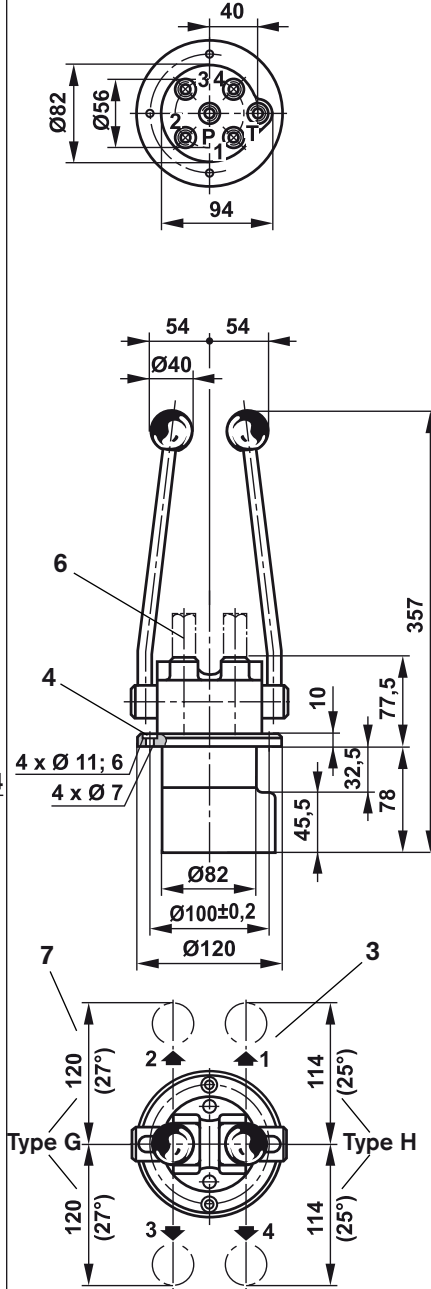
Type 1TH7Z Without operator element
(grommet = SO.198)



Ordering code	Ports P, T, A
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

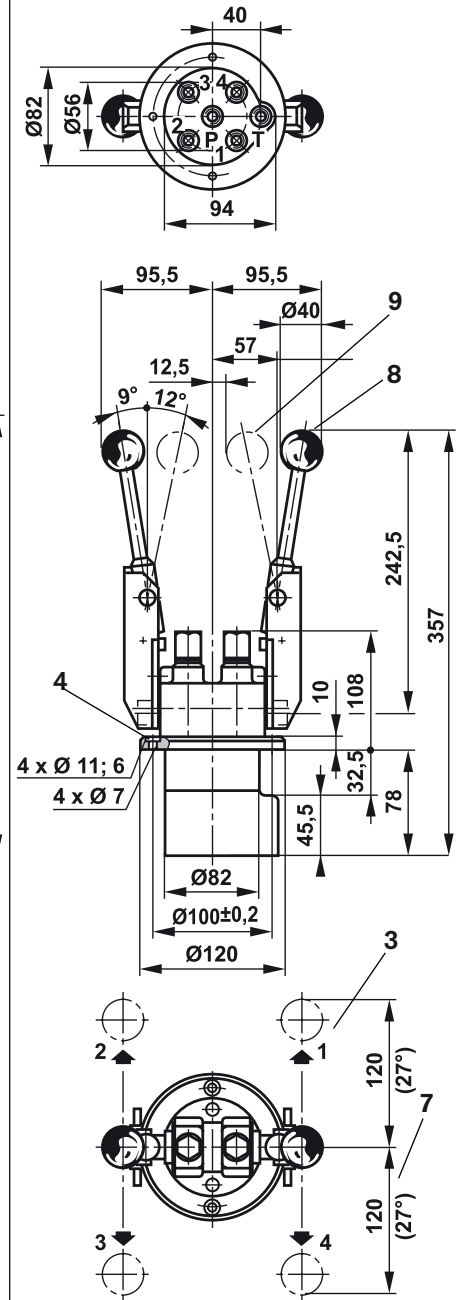
Type G 2 side levers, with spring return

Type H 2 side levers, with spring return and detents in 3 positions



Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type J 2 side levers, spring return, with lock and release in any position



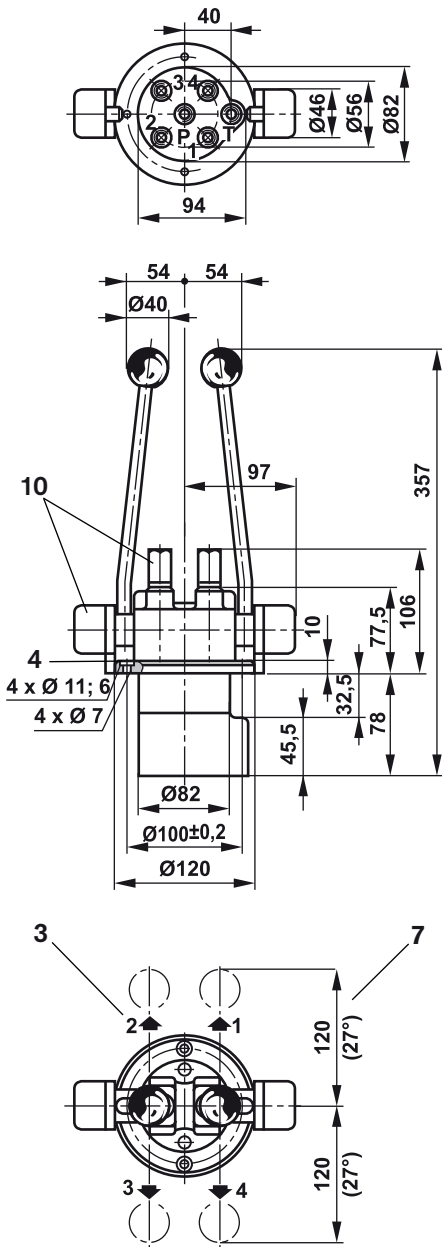
Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

- 3 Lever operation direction and control ports thereby influenced
- 4 Fixing holes
- 6 Detents in 3 positions (type H)

- 7 Lever deflection
- 8 Lever position locked
- 9 Lever position released

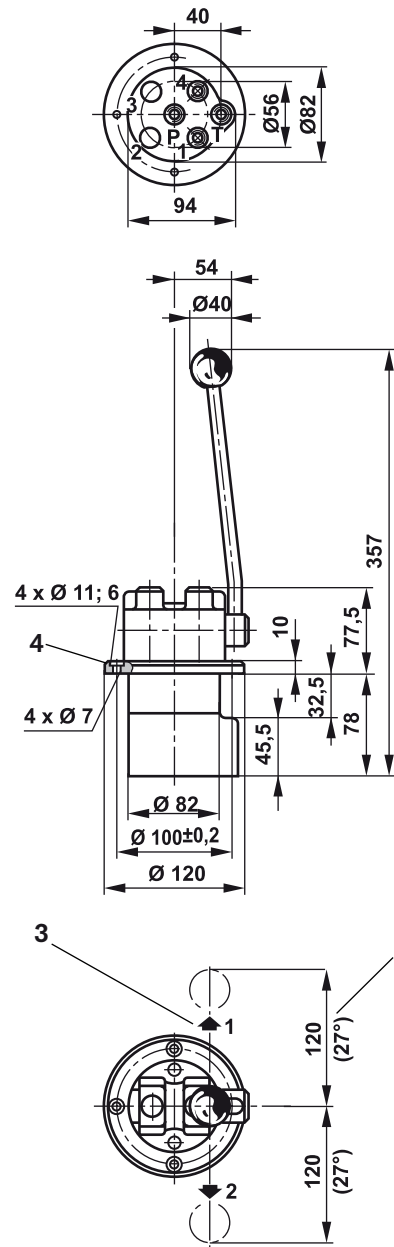
Unit dimensions (dimensions in mm)

Type K 2 side levers, spring return, can be fixed in any position by friction clutch



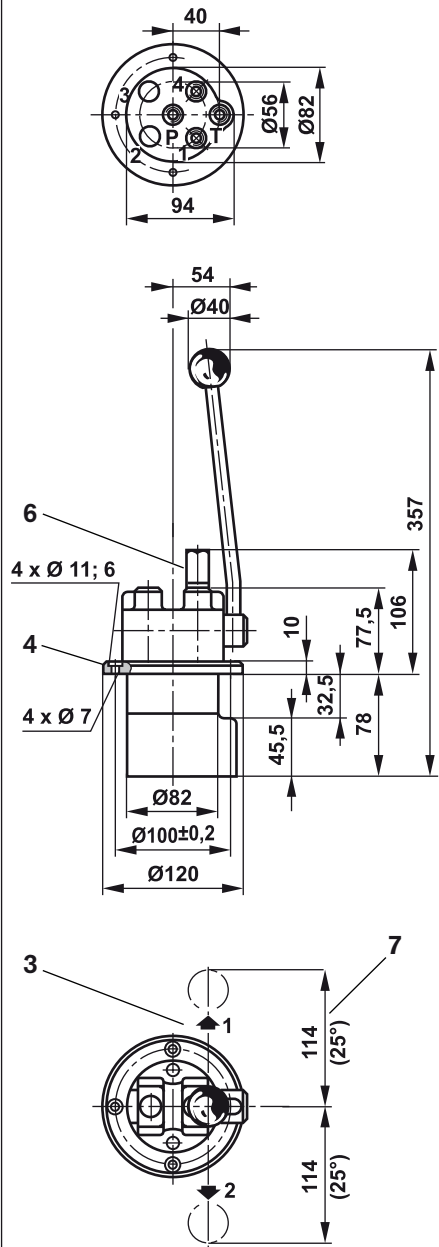
Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type L 1 side lever, spring return



Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type M 1 side lever, spring return, detents in 3 positions



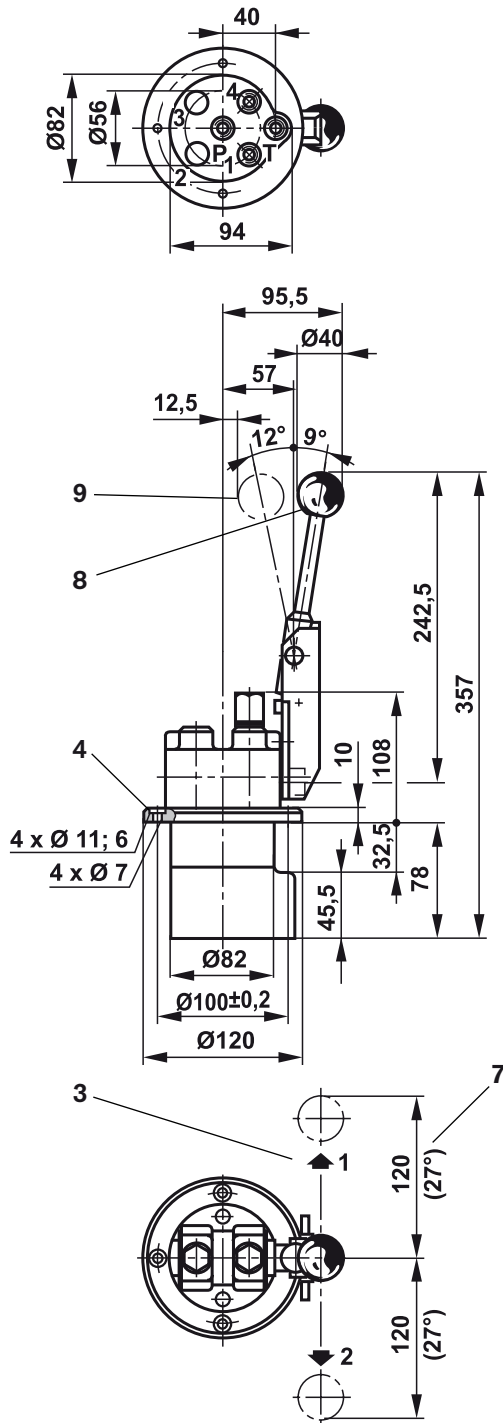
Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

- 3 Lever operation direction and control ports thereby influenced
- 4 Fixing holes
- 6 Detents in 3 positions (type M)

- 7 Lever deflection
- 10 Fixed in any position by friction clutch

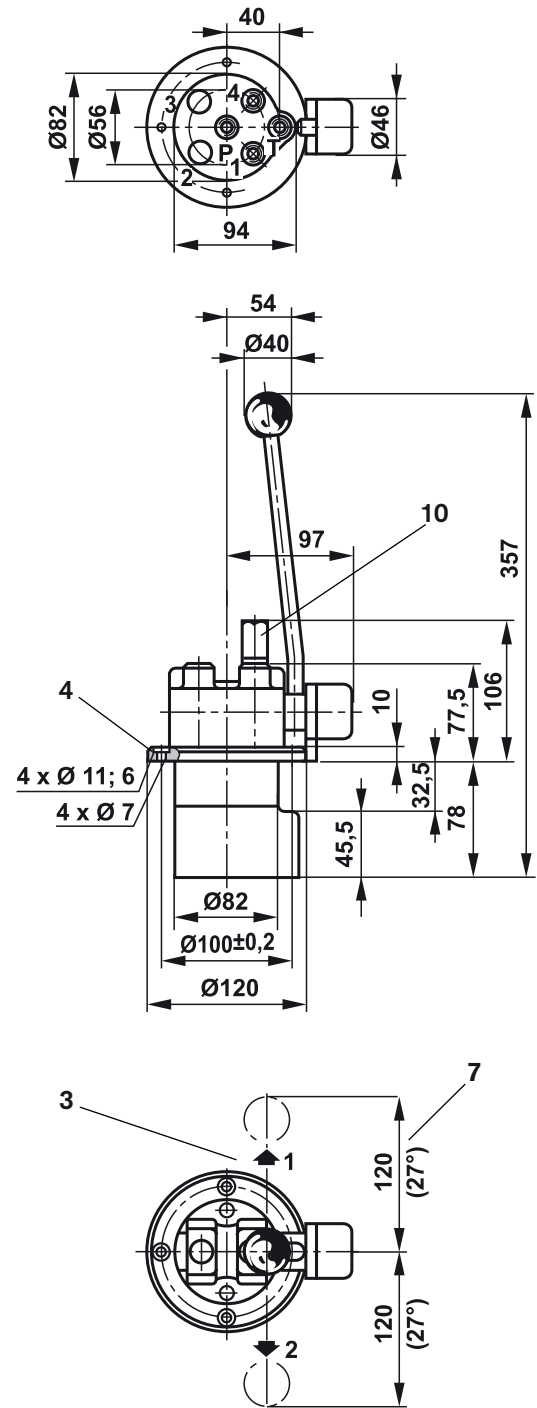
Unit dimensions (dimensions in mm)

Type N 1 side lever, spring return, with lock and release in any position



Ordering code	Ports P, T, 1 and 4
01	G 1/4 selon ISO 228/1
05	9/16 UNF-2B selon ISO 11926

Type P 1 side lever, spring return, can be fixed in any position by friction clutch



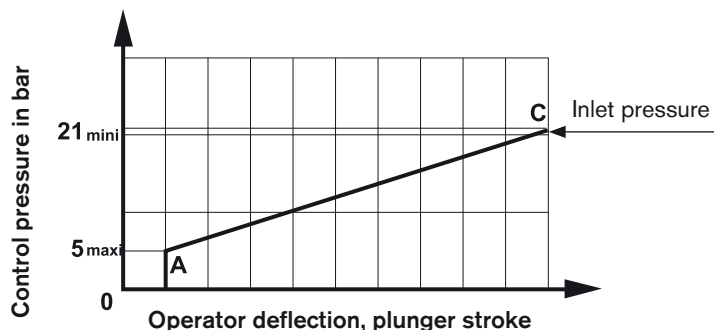
Ordering code	Ports P, T, 1 and 4
01	G 1/4 selon ISO 228/1
05	9/16 UNF-2B selon ISO 11926

- 3 Lever operation direction and control ports thereby influenced
- 4 Fixing holes
- 7 Lever deflection

- 7 Lever position locked
- 9 Lever position released
- 10 Fixed in any position by friction clutch

Characteristic curves: control ranges, actuation moments

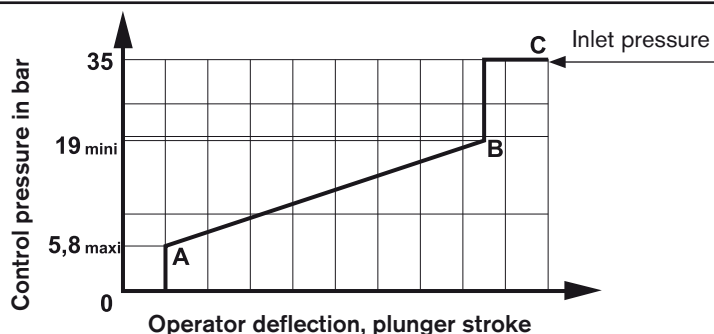
05 Control curve, identification no. 05



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A		C	A		C	A		C	A		C	A		C
Operator deflection (°)	4°55'		26°10'				1°50'		10°40'	4°40'		27°30'	4°40'		27°30'
Plunger stroke (mm)				1,6		9,2									
Actuation moment (Nm)	0,82		2,38				2,33		6,72	1,95		3,57			
Actuation force (N)				5,49		13,57									

06 Control curve, identification no. 06

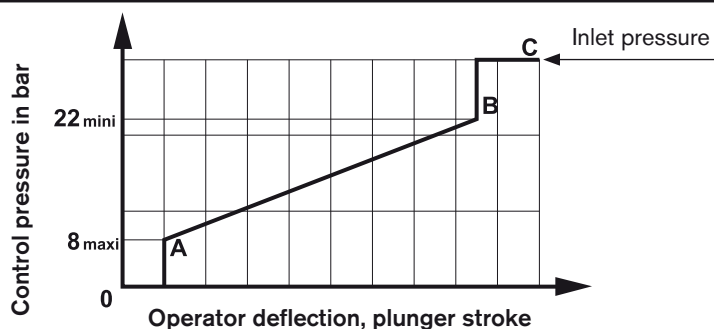
This curve is used for the pilot control of the SM12, SM18, M1 control blocks



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,86	2,29	2,66				2,42	6,48	7,53	1,17	3,33	3,63			
Actuation force (N)				6,57	12,80	18,96									

73 Control curve, identification no. 73

This curve is used for the pilot control of the SP12 control blocks

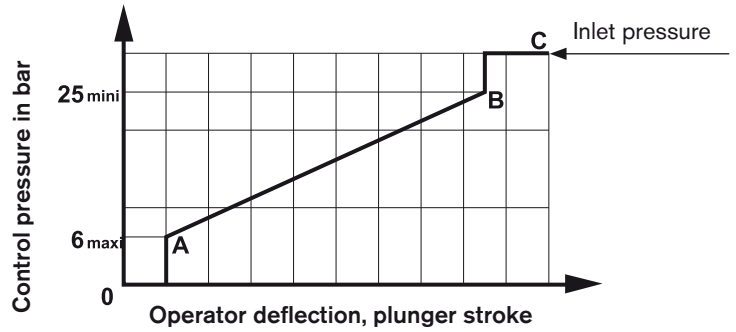


	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,94	2,29	2,66				2,67	6,48	7,53	1,29	3,13	3,63			
Actuation force (N)				8,57	13,96	18,96									

Characteristic curves: control ranges, actuation moments

91 Control curve, identification no. 91

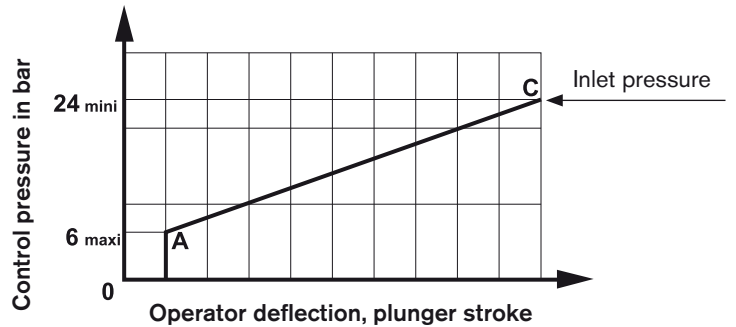
This curve is used for the pilot control of the SX12, SX14, SX18 control blocks



Intersection point	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,86	2,29	2,66				2,44	6,48	7,53	1,18	3,13	3,63			
Actuation force (N)				7,79	15,11	18,96									

93 Control curve, identification no. 93

This curve is used for the pilot control of the M7, M4 control blocks



Intersection point	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
	A		C	A		C	A		C	A		C	A		C
Operator deflection (°)	4°55'		26°10'				1°50'		10°40'	4°40'		27°30'	4°40'		27°30'
Plunger stroke (mm)				1,6		9,2									
Actuation moment (Nm)	2,44		6,72				1,18		3,25	0,86		2,74			
Actuation force (N)				7,79		14,73									

Electronic remote control for mobile application

Type THE5



Type 4THE5 H ¹⁾



Type 2THE5 RC ¹⁾

Series 2X

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Software parameters	7
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PWM Signal characteristics	
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CAN Bus characteristics	
• Electrical.....	27 to 29
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Features

- Specially designed for mobile machines
- Types available: Voltage signal, PWM signal, CAN, Power
- High mechanical robustness of hydraulic remote control components
- Large selection of ergonomic grips with various E-contacts on/off rockers or proportional control
- Several types of pedals
- Actuator ergonomics comparable with hydraulic remote controls
- The design ensures an excellent protection of electronics
- Hall effect contactless sensors

¹⁾ Noncontractual pictures

Functional description, cross-section

Design

Remote controls type THE5 are mainly composed of an operating element (lever or pedal) (1), a fixation body or plate (2) and a box (3) containing the contactless sensors and electronic cards.

General

All types of THE5 remote controls have similar mechanics and ergonomics to the hydraulic remote controls. This design provides a high robustness level to the THE5. Main differences come from the integrated electronic functions and the type of output signals.

The remote control Voltage Signal needs external regulated power supply for its sensors. It generates an analog voltage command value (V).

The remote controls PWM Signal, CAN and Power integrate a power supply regulation and can therefore be supplied by the vehicle battery directly.

The remote control CAN periodically generates a frame on CAN bus which allows the communication with other systems.

The remote controls Voltage Signal, PWM Signal and CAN only generate low power signals. The actuation of an electrohydraulic axis requires a further external electronic power interface.

The remote control Power gives pulse-width-modulated currents for the direct operation of electrohydraulic proportional pressure reducing valves.

Remote controls fitted with microcontrollers (PWM Signal, CAN and Power) communicate with the PC via ISOK interfaces.

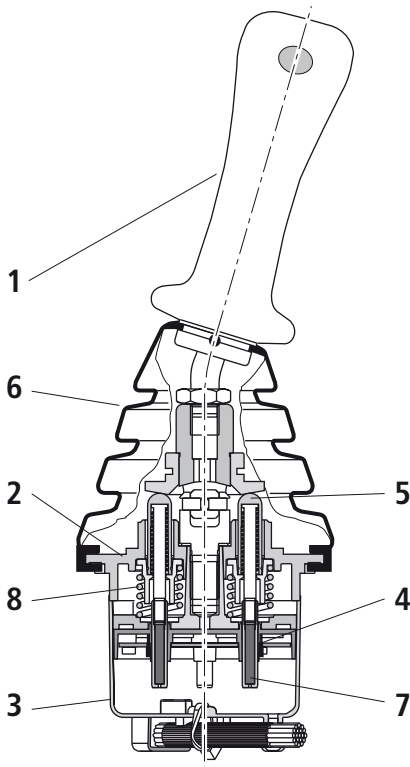
Function principle

When not actuated the operating element is held in neutral position by the return springs (8).

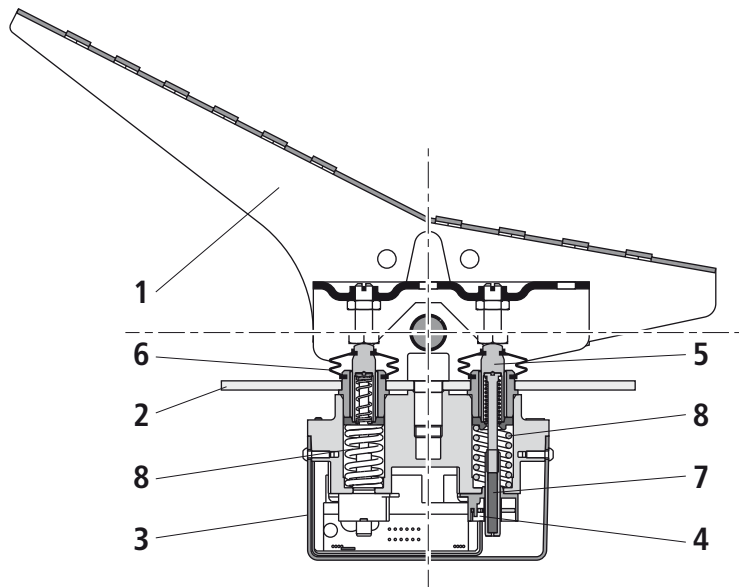
With deflection of the operating element (pedal or lever) (1), plunger (5) pushes against return spring (8). The magnet (7) mechanically linked to the plunger (5) moves upward or downward while following the operating element actuation direction. The command value generated by the sensor (4) is proportional to the deflection of the pedal or lever.

A rubber boot (6) protects the mechanical components of the housing from external contamination.

4THE5 section



2THE5R section



4THE5, 6THE5, 8THE5

Features

- The 4THE5 is available in version Voltage Signal, CAN, PWM Signal or Power.
- Electromagnetic compatibility (ECM) according to the standards ISO 7637, 11452.
- Ergonomics similar to hydraulic remote controls type 4TH6 and 4TH5.
- Life expectancy: up to 5 millions cycles.
- Up to 4 integrated proportional axis.

Wiring: block diagram

See pages 5 (Voltage Signal), 7 (PWM Signal), 9 (CAN), or 11 (Power).

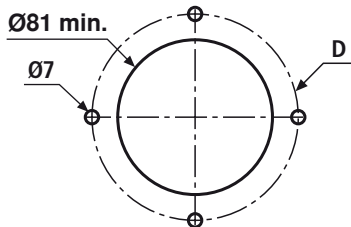
Outputs characteristic curves

See pages 5 (Voltage Signal), 7 (PWM Signal), 9 (CAN), or 11 (Power).

Installation guidelines

- Mounting flange area: flatness = 0.5 mm.
- Screw head dimensions = \varnothing 10 mm.
- Tightening torque for the flange fixing screws = Max. 10 Nm.

Installation hole



- Nominal diameter / fixing via 4 screws
D = \varnothing 100 to \varnothing 113 mm.



4THE5 H ¹⁾

Application

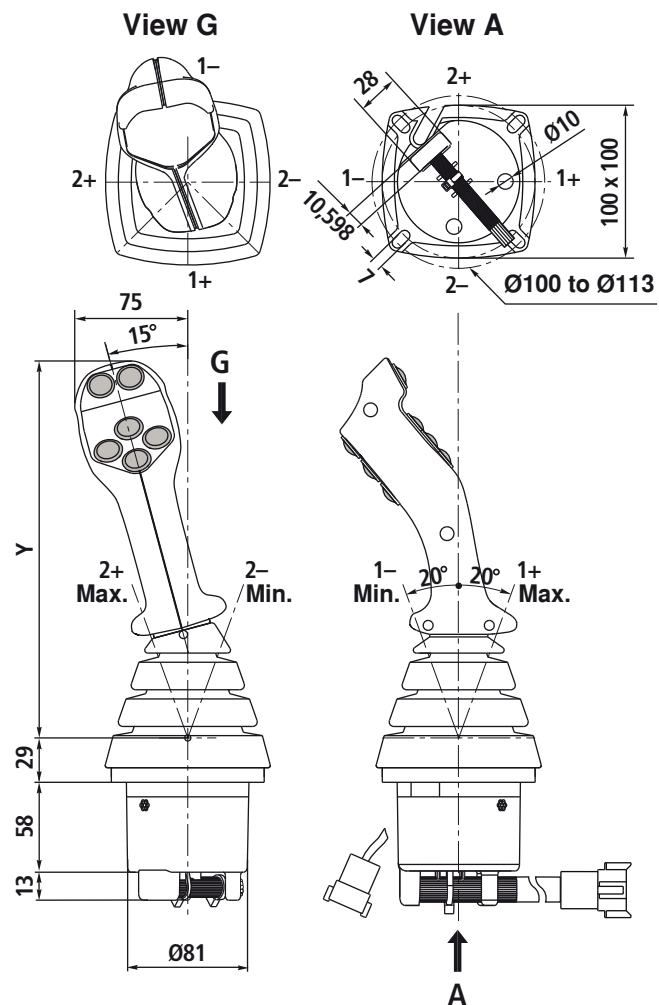
The pilot control unit type 4THE5 is for armrest installation and for the remote control of mobile machines equipment. The electronics integrated in the joystick enables the remote control of up to 4 proportional axis if it is connected to the proportional sensors inside the grip.

¹⁾ Noncontractual picture

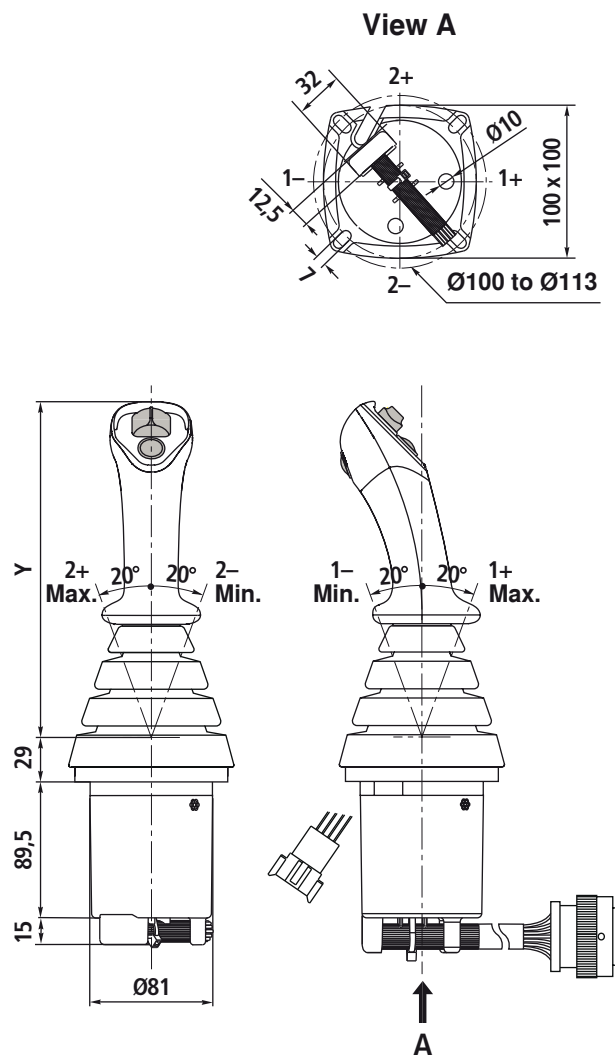
4THE5, 6THE5, 8THE5

Unit dimensions (in mm)

Signal and CAN joystick: THES5, THESW5, THEC5



Power joystick THE5



Unit dimension in function of the grip type

Type of grip	Y (with bent lever)	Z (with straight lever)
EC2000	207	211.5
EC2000+	215.5	220.5
EC4000	250.5	257

2THE5R

Features

- The 2THE5R is available in version Voltage Signal, CAN, PWM Signal or Power.
- Electromagnetic compatibility (ECM) according to the standards ISO 7637, 11452.
- Ergonomics similar to hydraulic remote controls type 2TH6R or electronic remote controls type 2THE6R.
- Life expectancy: up to 1 million cycles.
- Up to 2 integrated proportional axis.

Wiring: block diagram

See pages 5 (Voltage Signal), 7 (PWM Signal), 9 (CAN), or 11 (Power ²⁾).

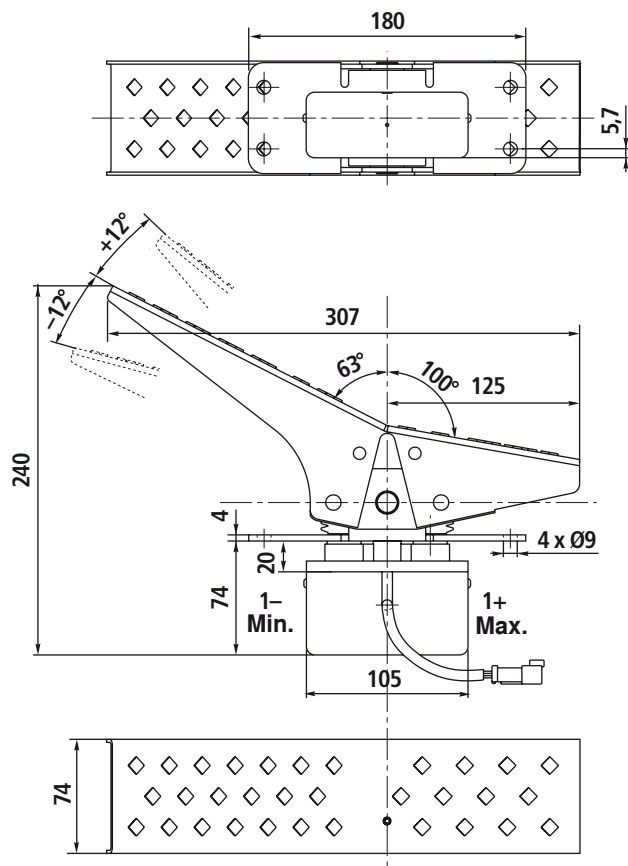
Outputs characteristic curves

See pages 5 (Voltage Signal), 7 (PWM Signal), 9 (CAN), or 11 (Power ²⁾).

Application

The pilot control device type 2THE5R is for the remote control via a pedal of various functions.

Unit dimensions (in mm)



¹⁾ Noncontractual picture

²⁾ Power version under development

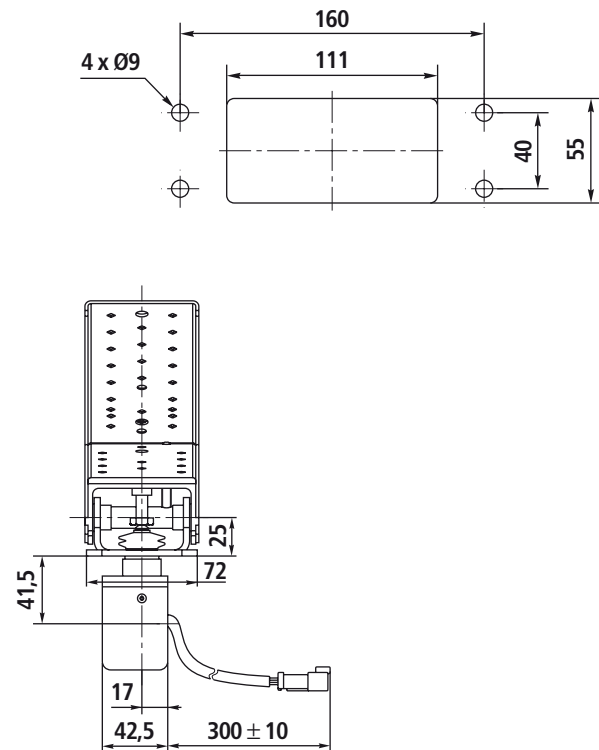


2THE5 RC ¹⁾

Installation guidelines

- Mounting flange area: flatness = 0.5 mm.
- Screw head dimensions = Ø 13 mm.
- Tightening torque for the flange fixing screws = Max. 10 Nm.

Installation hole



Ordering details

	THE		5	-2X/			*	
--	-----	--	---	------	--	--	---	--

Number of axis

1 axis	= 2
2 axis	= 4
3 axis ¹⁾	= 6
4 axis ²⁾	= 8

Type of output

Voltage Signal ³⁾	= S
Signal PWM	= SW
CAN	= C
Power	= no code

Type of controller

Grip EC2000	= E
Grip EC4000	= H
Grip EC2000+	= I
Grip EC3000+	= G
Single flat pedal	= RP
Single bent pedal	= RC
Double pedal simple effect	= Q
Without lever	= Z
Other grip	= no code

Further details in clear text

Plug

5 =	Deutsch sealed plugs IP67 for the wiring of the grip
no code =	no plug

Grip orientation / Machine ⁴⁾

03 =	Lever straight and grip towards 1-
43 =	Lever bent towards 2- and grip towards 1- (left hand joystick)
23 =	Lever bent towards 2+ and grip towards 1- (right hand joystick)
no code =	Without grip

Grip type

TT, ST, VT, YT, YU =	Grip type E
	Grip type H, I, G see datasheet: RE 64547
no code =	Other grip

Series

2X =	Default
3X =	(DT6 + DT12) connection ⁵⁾

¹⁾ 6THE5 with grip EC2000+ or EC4000 or EC3000+

²⁾ 8THE5 with grip EC4000

³⁾ Designate the Signal remote control with 2 axis maximum because the additional axis provided by grips EC3000 and EC4000 are not controlled by the remote control electronic

⁴⁾ 4THE5, 6THE5 and 8THE5

⁵⁾ Only for CAN signal

Mechanical characteristics (for applications outside these parameters, please consult us !)

Type of THE5		Joysticks	Pedals
Lifetime		5 millions actuation cycles ¹⁾	1 million actuation cycles ¹⁾
Temperature range			
	Storage, ambient °C	-40 to +85	
	Operation °C	-20 to +60	
Resistance to vibrations and shocks		frequency 11 to 2,000 Hz const. accel. 5 g. Consult us	
Electronic protection degree		IP 67	
Actuation Torque	Nm		
	Stroke start	0.6	3
	Full stroke position	1.5	7
	Maximum permissible at the operating element with an exceptional, one-time loading	100	200
Actuation angle	in degree		
	On longitudinal axis	20°	12°
	On lateral axis	20°	/
Weight	Kg	1	2.3

Software parameters

Parameters properties

For PWM signal, print pages 15 to 16.

For Power signal, print pages 24 to 26.

For CAN signal, print pages 35 to 37.

You will have to fill the parameters values following these rules:

Parameter	Value	Available Range	Default
(give the names of parameter list)	(enter your choice here)	(give information about possible values)	(give the default value if no choice has been done)
PARAMETER_NAME		[X-Y] This means that you can select a value between X and Y, the resolution is done with the unit.	Default Value and Unit
		[X;Y] This means that you can select only X or Y.	
		- Function 1 - Function 2 ... This means that you can select only 1 Function in the function list 1,2...	
		YES / NO Select YES to have the function active or NO to have the function inactive	

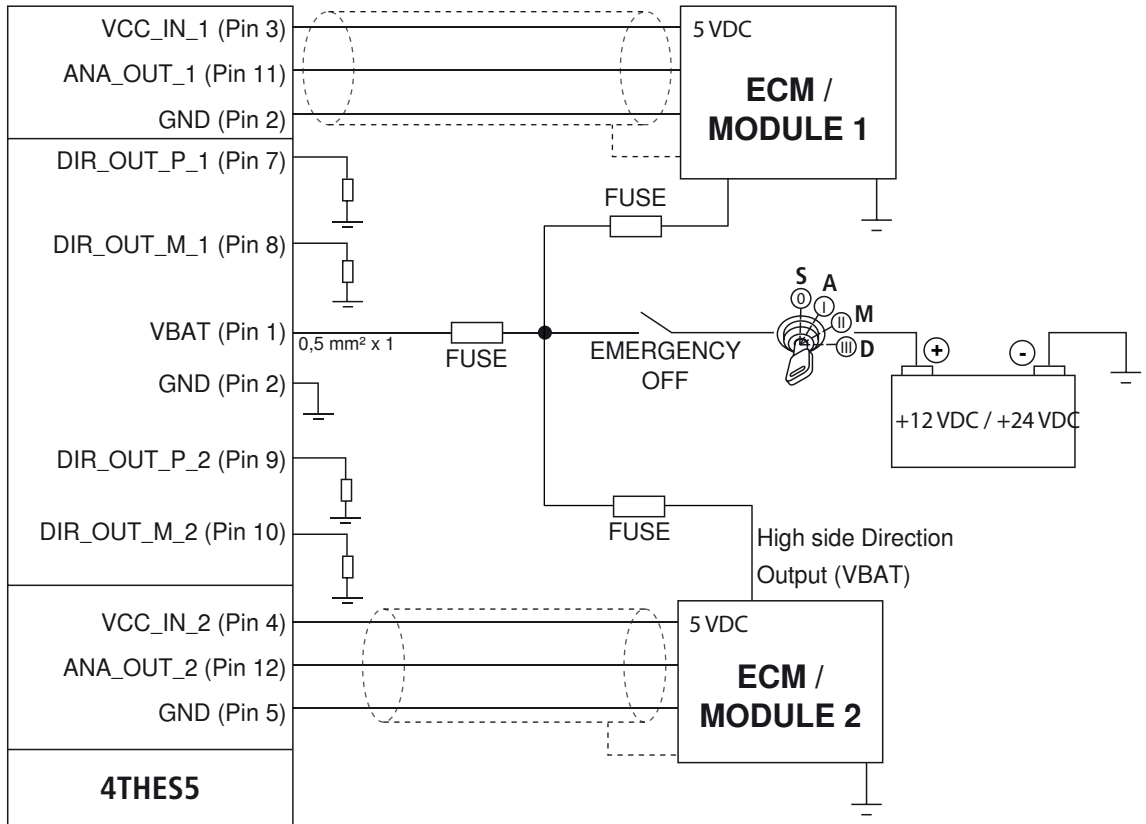
¹⁾ Life test realized with the operating torques (i.e. at full stroke position).

Electrical characteristics Voltage Signal (for applications outside these parameters, please consult us !)

Power supply	V	Regulated 5 V (supply the digital outputs separately with the battery voltage)
Maximum current consumption	mA	34
Proportional Signal		
Voltage	V	(with power supply 5 VDC)
Full stroke towards 1+ or 2+		4.3 V \pm 200 mV ¹⁾ (under 5 VDC)
Neutral		2.5 V \pm 150 mV ¹⁾ (under 5 VDC)
Full stroke towards 1- or 2-		0.7 V \pm 200 mV ¹⁾ (under 5 VDC)
Maximum sourcing current	mA	1
Recommended load capacity	nF	10
Digital Output (DIR_OUT)		
Voltage	V	
Neutral		0
Off Neutral		Battery voltage
Rising edge trigger level (L _{RE})		2.75 V / 2.25 V \pm 40 mV
Falling edge trigger level (L _{FE})		(L _{RE} - 50mV) \pm 40 mV
Hysteresis	mV	50
Maximum sourcing current	mA	200 (with resistive load)
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	0.5
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2	V/m	100
Current injection according to ISO 11452 part 4	mA	200
Direct electrostatic discharge	kV	\pm 6
Electrostatic discharge in the air	kV	\pm 8
Further data		Consult us

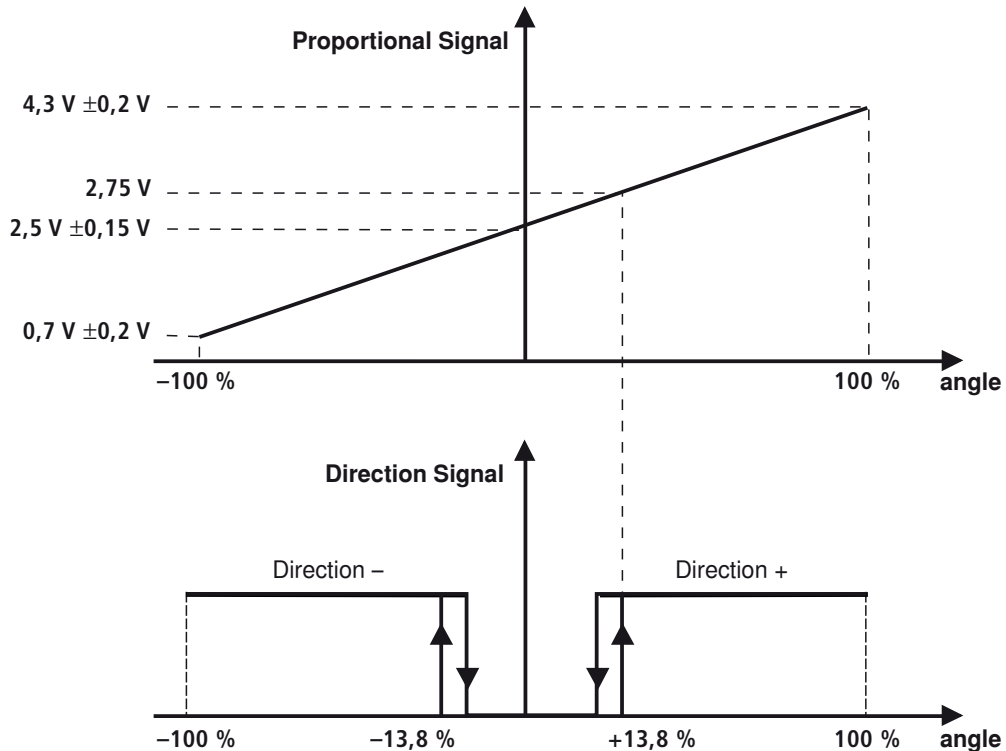
¹⁾ The tolerance is function of the full scale range and takes into account thermal drift and lifetime.

Wiring: block diagram



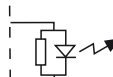
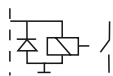
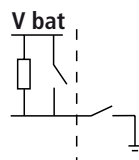
Pin assignment: see page 43

Output characteristic



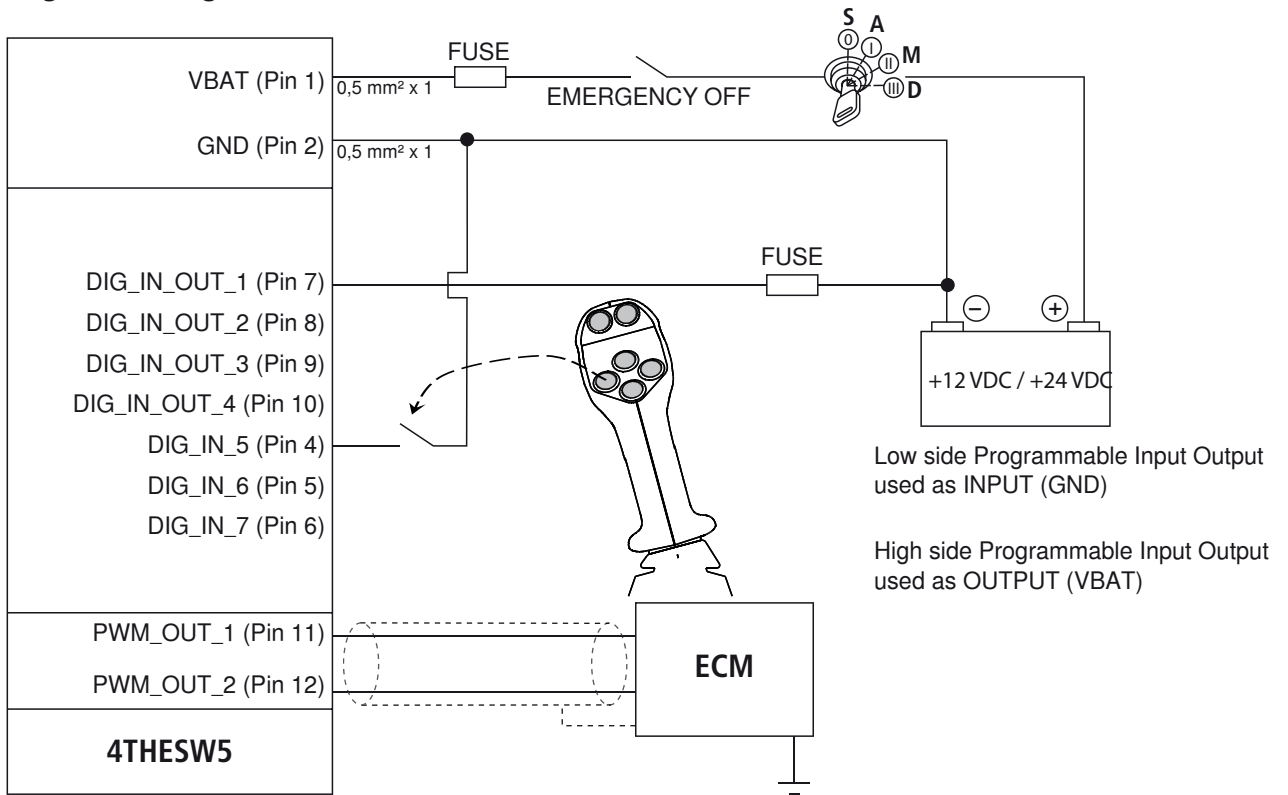
Electrical characteristics PWM Signal (for applications outside these parameters, please consult us !)

Power supply	V	9 to 32 VDC
Maximum current consumption	mA	300
Proportional Signal		
Proportional signal duty cycle	%	
Full stroke towards 1+ or 2+		90 % ± 2.5 % ¹⁾
Neutral		50 % ± 2.5 % ¹⁾
Full stroke towards 1- or 2-		10 % ± 2.5 % ¹⁾ (i.e. 7.5 % at 12.5 %)
PWM Signal frequency	Hz	196
High voltage signal	V	4 to 5
Low voltage signal	V	0 to 1
Maximum sourcing current	mA	20
Digital Input / Output (DIG_IN_OUT)		
Characteristic		Adjustable by programming
Input function connected to a switch		To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance of 8.2 K Ω . The switch must be fitted to a 5 mA current.
Output function		When the output is inactive, take into account the pull up 8.2 K Ω resistance to set the output voltage
Output function connected with a relay		The relay must have a minimal current of activation of 10mA
Output function connected with a LED		The LED must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Output function connected to a logical input		The logical input must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Maximum sourcing current	mA	200 (with resistive load)
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	2
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2 V/m		100
Current injection according to ISO 11452 part 4 mA		200
Direct electrostatic discharge	kV	± 6
Electrostatic discharge in the air	kV	± 8
Further data		Consult us



¹⁾ The tolerance is function of the full scale range and takes into account thermal drift and lifetime.

Wiring: block diagram

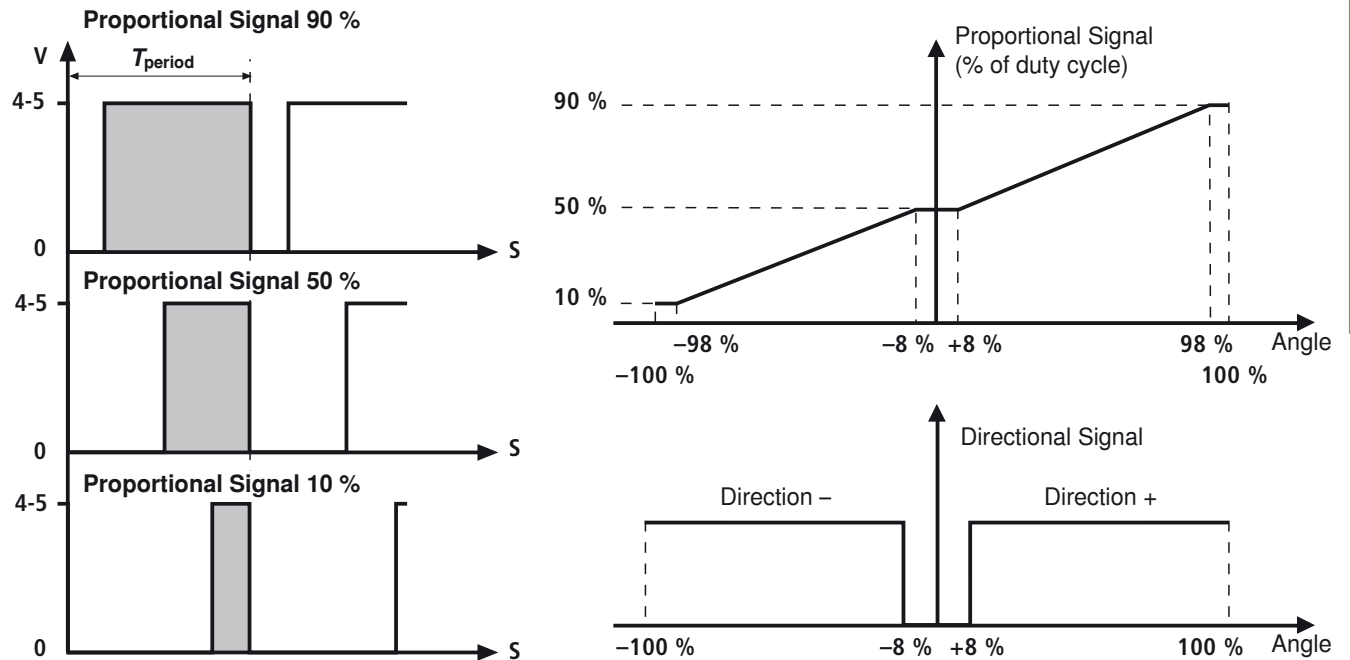


Programming tool: see page 42

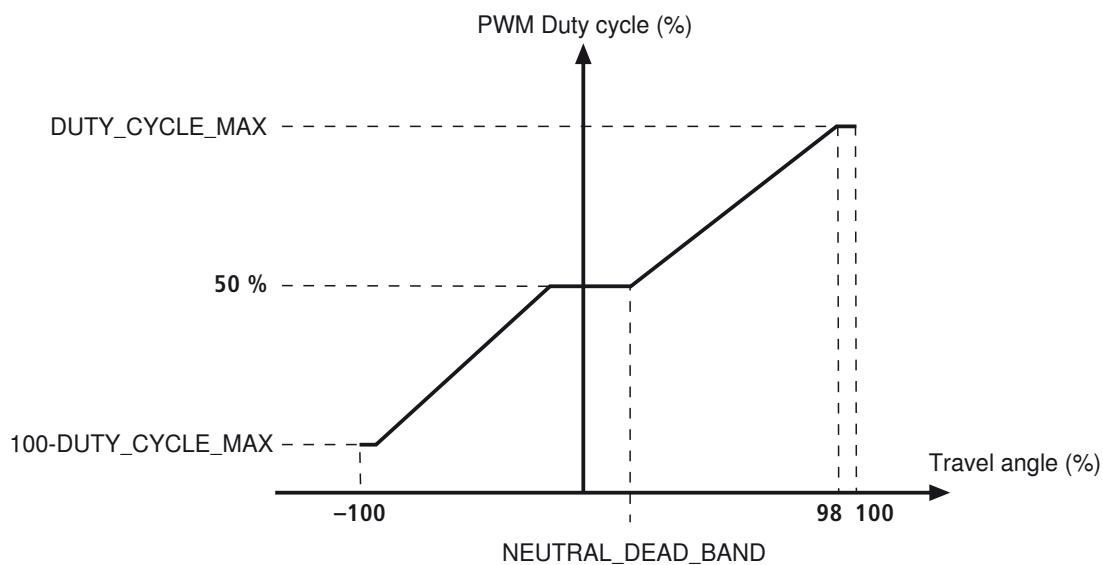
Pin assignment: see page 44

Output characteristics

The proportional signal (%) is the ratio between the time at high side and the time at low side



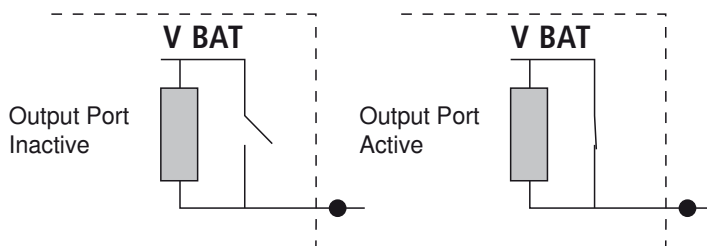
PWM Signal Outputs



⇒ Please refer to board #1 ¹⁾

Digital Input / Output Port

SIGNAL PWM integrate 4 Digital Configurable Input Output ports and 3 Digital Not Configurable Input ports. Inputs are active when they are connected to ground by external circuitry and inactive when disconnected from ground, pull up is done internally. Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation:



⇒ Please refer to board #2 ¹⁾

¹⁾ boards are at the end of this section.

Functions parameters

1. Direction and Out of Neutral Outputs

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Consider the internal pull up 8.2k Ohm resistors when Output is inactive for external load and voltage level calculation. Direction is active when the sensor's position leaves the neutral dead band defined in percent of the full travel range (NEUTRAL_DEAD_BAND).

There are 6 modes:

- Direction Plus on Axis 1 (D1P): The Output Port is activated when the axis 1 goes in direction 1 Plus
- Direction Minus on Axis 1 (D1M): The Output Port is activated when the axis 1 goes in direction 1 Minus
- Direction Plus on Axis 2 (D2P): The Output Port is activated when the axis 1 goes in direction 2 Plus
- Direction Minus on Axis 2 (D2M): The Output Port is activated when the axis 1 goes in direction 2 Minus
- Out Of Neutral Axis 1 (OU1): The Output Port is activated in both directions Plus and Minus on Axis 1
- Out Of Neutral Axis 2 (OU2): The Output Port is activated in both directions Plus and Minus on Axis 2

2. Status Indicator Output

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Connect a LED to the relevant output considering the internal pull up 8.2 kOhm resistors when Output is inactive.

There are 2 modes:

- Error Status Indicator (FLT): This mode will lead LED indicator to light on in case of fault.
- Ready to Work Indicator (RTW): This mode will light on the LED if there is no fault detected.

⇒ Please refer to board #3 ¹⁾

3. Dead Man Input

This function works using an Input port.

This function is activated when port is connected to ground.

Dead Man function allows freezing the joystick signals in neutral if the assigned input is not activated and whatever the position sensors are. Transition will be done without ramp time.

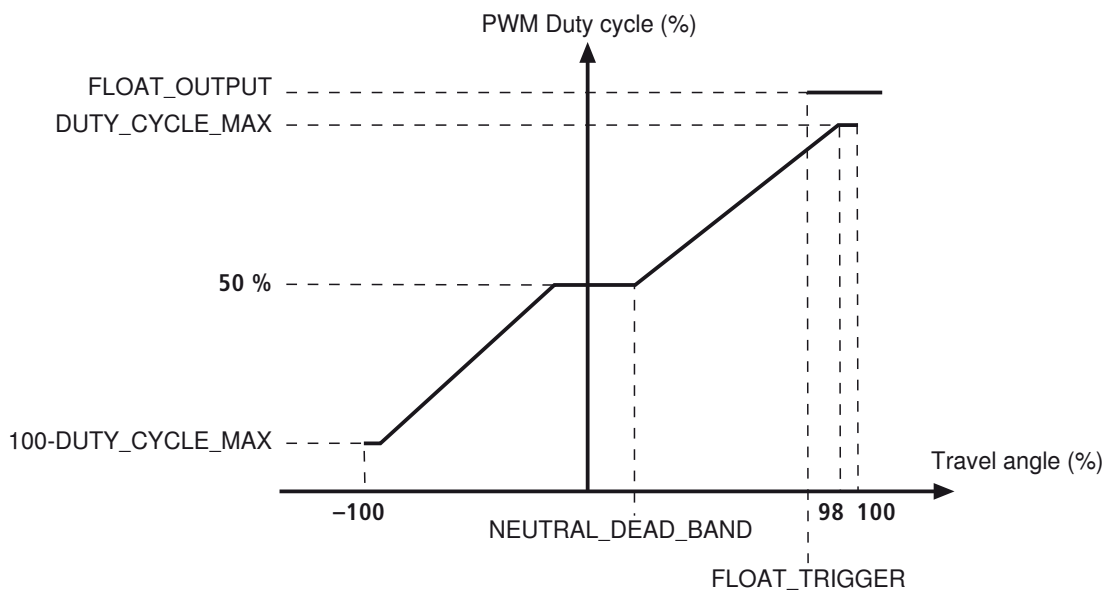
There are 2 modes to enable the outputs signals:

- Permanent: The output signals are enabled while the input stays connected to the ground.
- WatchDog: The output signals are enabled while the input changes periodically from connected to disconnected.

⇒ Please refer to board #4 ¹⁾

¹⁾ boards are at the end of this section.

4. Floating



Floating allows shifting the assigned spool in fourth position. The floating function works using an Input port and is activated when port is connected to ground (the input doesn't need to stay active after) and if the output activation is in the range [80 %-90 %]. The float will then stay active until the axis goes out of neutral in the direction where the float has been assigned.

PWM duty cycle for the Floating Instruction, PWM duty cycle for triggering, axi(s) and direction(s) assigned to the float can be selected in the following board.

⇒ Please refer to board #5 ¹⁾

¹⁾ boards are at the end of this section.

PWM Signal Boards

Board #1:

Parameter	Value	Available Range (Unit)	Default
PWM_FREQUENCY		[120;124;...;500] (Hz)	196
DUTY_CYCLE_MAX		[80;90] (%)	90
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	8
NEUTRAL_DEAD_BAND_AXIS_2		[8-15] (%)	8
PWM_VOLTAGE_OUTPUT	5V	[5V]	5V

Note 1: PWM Dduty cycle is always 50 % in neutral.

Note 2: Maxi Duty Cycle is reached at 98 % of the stroke (exemple: 19.6° for a 20° joystick), this value is not adjustable.

Note 3: PWM Voltage Output is 5 V for high level, 0VDC for low level (not adjustable).

Board #2:

Parameter	Value	Available Range	Default
FUNCTION_DIO_1		INPUT FUNCTIONS – No Function (NOF) – Floating (FLO) – DeadMan (DMA) OUTPUT FUNCTIONS – Axis 1+ Direction (D1P) – Axis 1- Direction (D1M) – Axis 1 Out of Neutral (OU1) – Axis 2+ Direction (D2P) – Axis 2- Direction (D2M) – Axis 2 Out of Neutral (OU2) – Status Indicator (STA)	NOF
FUNCTION_DIO_2			NOF
FUNCTION_DIO_3			NOF
FUNCTION_DIO_4			NOF
FUNCTION_DI_5		INPUT FUNCTIONS – No Function (NOF) – Floating (FLO) – DeadMan (DMA)	NOF
FUNCTION_DI_6			NOF
FUNCTION_DI_7			NOF

Note 1: Floating, DeadMan and Status Indicator functions require additionnals parameters, refer to section "Functions parameters" for furthers details.

Note 2: Floating and DeadMan functions can be assigned to one input maximum.

PWM Signal Boards

Board #3:

Parameter	Value	Available Range	Default
STATUS_MODE		- Fault Indicator (FLT) - Ready to work Indicator (RTW)	FLT

Board #4:

Parameter	Value	Available Range	Default
DEAD_MAN_MODE		- Permanent (PER) - WatchDog (WDG)	PER
DEAD_MAN_TEMPO (if WatchDog mode selected)		[0-60] (s)	60

Board #5:

Parameter	Value	Available Range	Default
FLOAT_TRIGGER		[80-90] (%)	80
FLOAT_OUTPUT		[95;95.5...;98] (%)	96.5
FLOAT_AXIS_1_PLUS		YES / NO	NO
FLOAT_AXIS_1_MINUS		YES / NO	NO
FLOAT_AXIS_2_PLUS		YES / NO	NO
FLOAT_AXIS_2_MINUS		YES / NO	NO

Electrical characteristics Power (for applications outside these parameters, please consult us !)

Power supply	V	9 to 32 VDC ¹⁾
Maximum current consumption	A	< 10
Proportional Current		
% of maximum solenoid current		
Neutral		0 % (with dead band ²⁾ of ± 8 %)
Stroke start		Minimum current programmed
Full stroke position		Maximum current programmed
PWM frequency	Hz	83, 100, 133, 166, 200, 233, 266
Maximum sourcing current	A	2 (per proportional output)
Programming curves		In 5 points
Programming ramps		0 to 10 s
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against power outputs short circuits at ground ³⁾		Yes
Fuse	A	3 (2THE5) 5 (4THE5) 7.5 (6THE5) 10 (8THE5)
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2 V/m		100
Current injection according to ISO 11452 part 4 mA		200
Direct electrostatic discharge	kV	± 6
Electrostatic discharge in the air	kV	± 8
Further data		Consult us

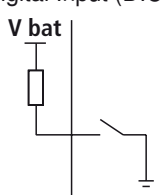
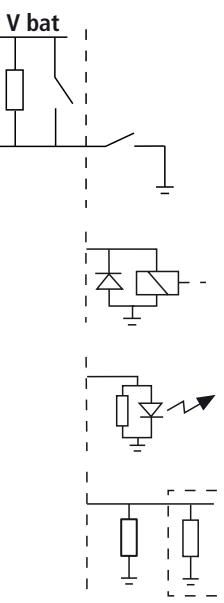
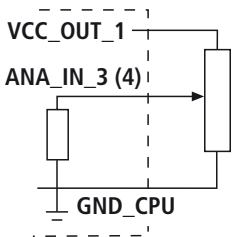
¹⁾ Under certain conditions, battery voltage lower than 12 V and temperature greater than 85 °C, maximum current cannot be reached.

²⁾ We recommend a dead band of ± 8 %. The dead band is set at the transmitter only (Power joystick). The dead band on neutral / full stroke positions depends upon the angular stroke (± 8 % for a stroke of $\pm 20^\circ = \pm 1.6^\circ$).

³⁾ The current inputs are not protected against short circuits at battery voltage.

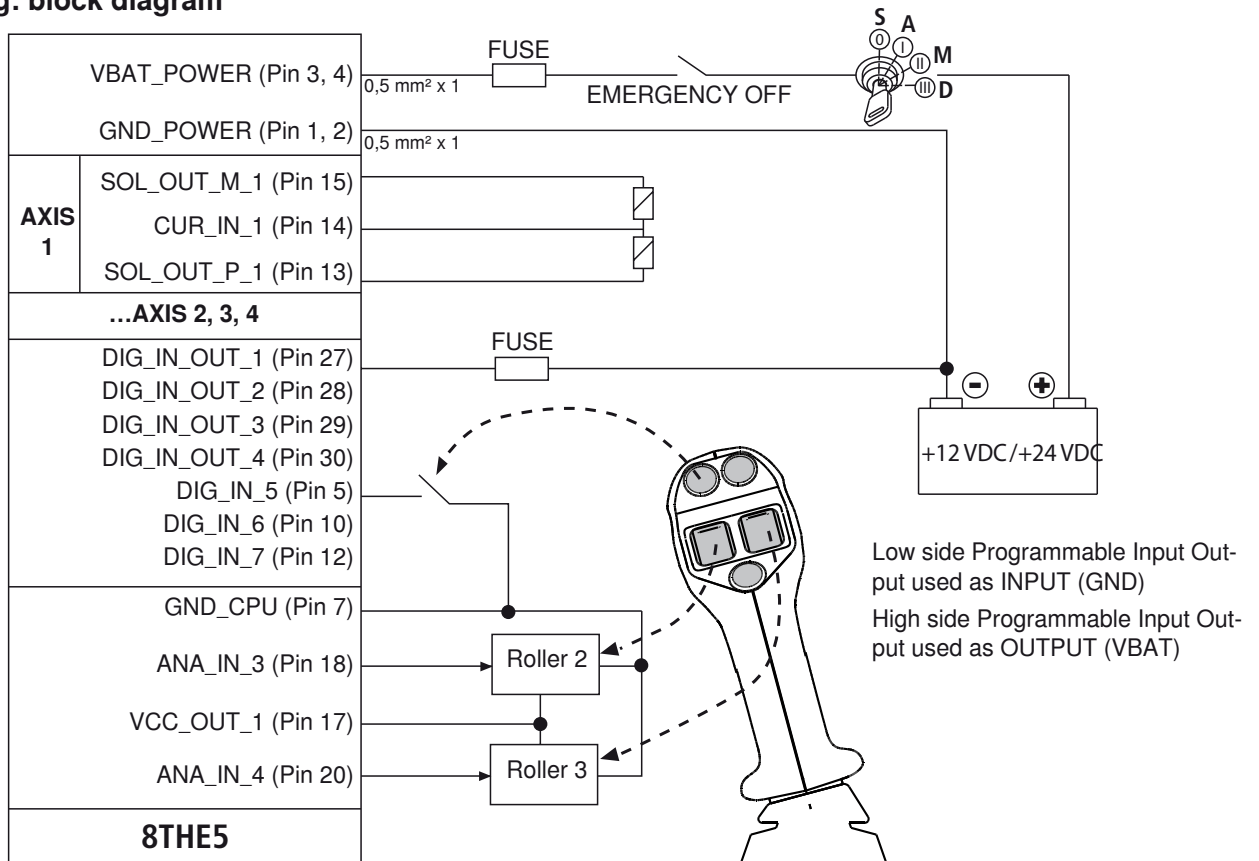
Electrical characteristics Power (for applications outside these parameters, please consult us !)

Input / Output Electrical characteristics

Digital Input (DIG_IN)		
	Characteristic	Adjustable by programming
	Input function	To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance
Digital Input / Output (DIG_IN_OUT)		
	Characteristic	Adjustable by programming
	Input function connected to a switch	To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance of 8.2 K Ω . The switch must be fitted to a 5 mA current.
	Output function	When the output is inactive, take into account the pull up 8.2 K Ω resistance to set the output voltage
	Output function connected with a relay	The relay must have a minimal current of activation of 10 mA
	Output function connected with a LED	The LED must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Output function connected to a logical input	The logical input must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle	
Maximum sourcing current	mA	200 (with resistive load)
Analog Inputs for axis 3 and 4		
	VCC_OUT_1 maximum sourcing current mA	75
	Pull down resistor on ANA_IN_3 (4) kOhms	10

Electrical characteristics Power (for applications outside these parameters, please consult us !)

Wiring: block diagram

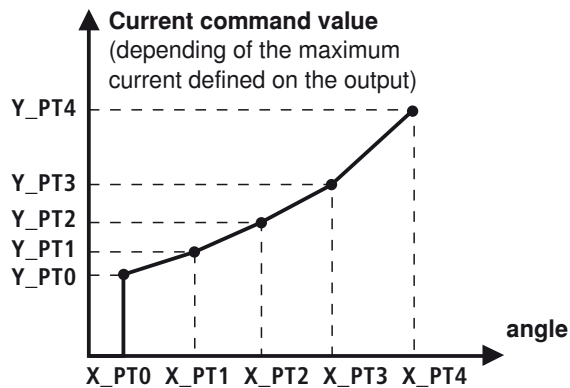


Programming tool: see page 42

Pin assignment: see page 46

Output characteristics

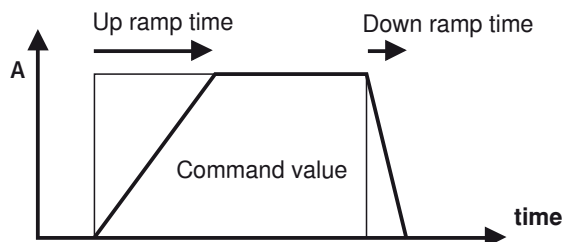
Control curves



For each proportional output, a control curve can be adapted to the customer system (solenoid).

The control curve programming of each output can be determined through 5 points.

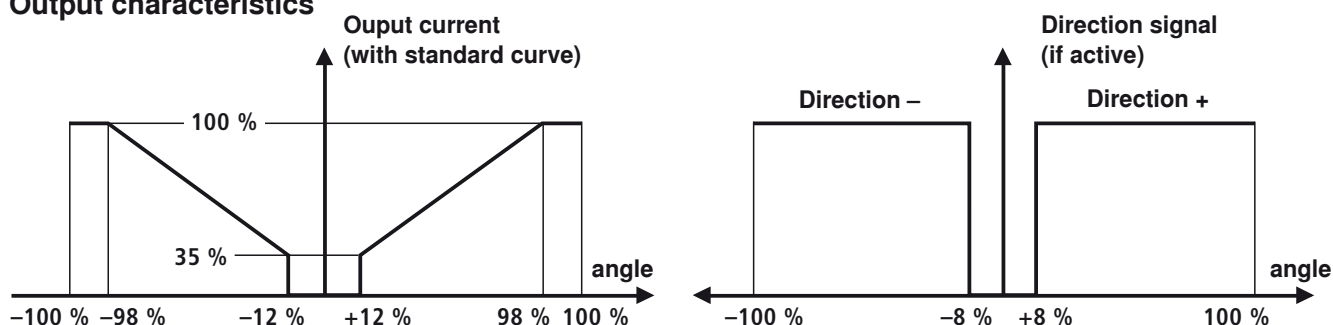
Ramps



Each control curve has a ramp "Up" and a ramp "Down".

The programming allows the adaptation of the ramp times to the operated function.

Output characteristics



Power Software parameters

Power Outputs

1. Pressure reducer characteristics

THE5 joystick and pedal are able to drive pressure reducers as long as the current is within [0.25 ; 2.4] Amp It is also able to control Black and White solenoid (flip Flop). For better performances, all connected pressure reducers should be the same type (Resistance, Voltage).

a) Standard pressure reducers

⇒ Please refer to board #6 ¹⁾

	12 Volts			
	FTDRE2 18 BAR	MHDRE2 18 BAR	MHDRE2 24 BAR	MHDRE2 30 BAR
RESISTANCE (Ω)	2.4	3.5	2.4	3.5
PWM_FREQUENCY (Hz)	150	150	150	150
MIN_CURRENT (A)	0.80	0.60	0.60	0.60
MAX_CURRENT (A)	1.80	1.70	1.70	1.70

	24 Volts			
	FTDRE2 18 BAR	MHDRE2 18 BAR	MHDRE2 24 BAR	MHDRE2 30 BAR
RESISTANCE (Ω)	12	10.9	12	10.9
PWM_FREQUENCY (Hz)	150	150	150	150
MIN_CURRENT (A)	0.36	0.34	0.26	0.34
MAX_CURRENT (A)	0.80	1.95	0.75	0.95

¹⁾ boards are at the end of this section.

Power Software parameters

b) Non Standard pressure reducers

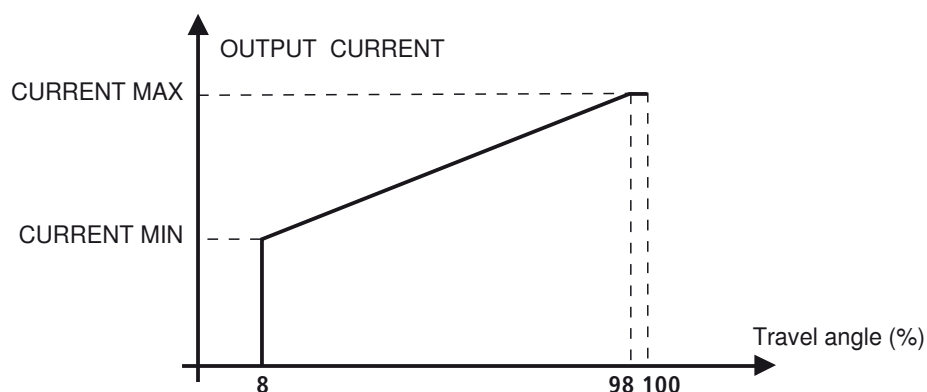
For non standard solenoids the following information are required, note that all load are supposed to be identical.

⇒ Please refer to board #7 ¹⁾

2. Curves shape

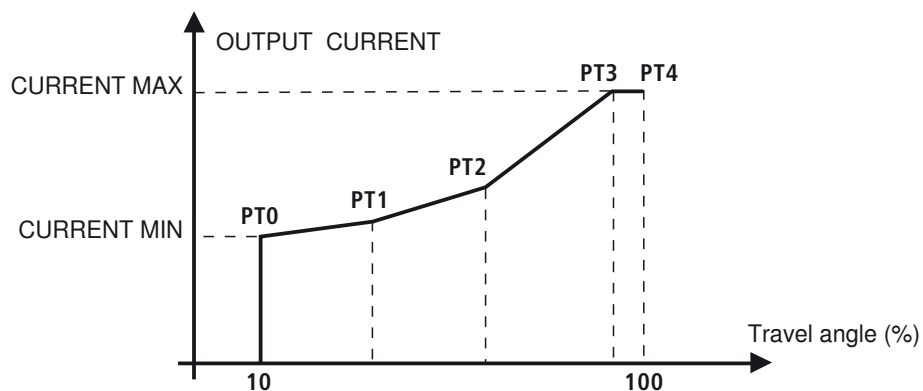
a) Standard curves shape

Standard curve shape is linear between CURRENT_MIN and CURRENT_MAX adjusted to selected pressure reducer and valve (if specified).



b) Non standard curves shape

Define special curves allows having a non linear response on the joystick; this feature is useful to optimize the control of the pressure reducers. The shape of the curve is defined in percent of the maximum currents applied on the output.



⇒ Please refer to board #8 ¹⁾

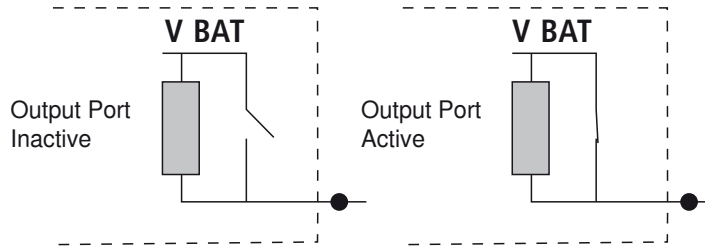
If the application requires a special curve, you can specify it. You can define 7 special curves maximum.

⇒ Please refer to board #9 ¹⁾

¹⁾ boards are at the end of this section.

Digital Input / Output Port

POWER THE5 integrates 4 Digital Configurable Input Output ports and 3 Digital Not Configurable Input ports. Inputs are active when they are connected to ground by external circuitry and inactive when disconnected from ground, pull up is done internally. Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation:



⇒ Please refer to board #10 ¹⁾

Functions parameters

1. Direction and Out of Neutral Outputs

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation. Direction is active when the sensor's position leaves the neutral dead band defined in percent of the full travel range (NEUTRAL_DEAD_BAND).

There are 6 modes:

- Direction Plus on Axis 1 (D1P): The Output Port is activated when the axis 1 goes in direction 1 Plus
- Direction Minus on Axis 1 (D1M): The Output Port is activated when the axis 1 goes in direction 1 Minus
- Direction Plus on Axis 2 (D2P): The Output Port is activated when the axis 1 goes in direction 2 Plus
- Direction Minus on Axis 2 (D2M): The Output Port is activated when the axis 1 goes in direction 2 Minus
- Out Of Neutral Axis 1 (OU1): The Output Port is activated in both directions Plus and Minus on Axis 1
- Out Of Neutral Axis 2 (OU2): The Output Port is activated in both directions Plus and Minus on Axis 2

2. Status Indicator Output

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Connect a LED to the relevant output considering the internal pull up 8.2 kOhm resistors when Output is inactive.

There are 2 modes:

- Error Status Indicator (FLT): This mode will lead LED indicator to light on in case of fault.
- Ready to Work Indicator (RTW): This mode will light on the LED if there is no fault detected.

⇒ Please refer to board #11 ¹⁾

¹⁾ boards are at the end of this section.

3. Dead Man Input

This function works using an Input port.

This function is activated when port is connected to ground.

Dead Man function allows freezing the joystick signals in neutral if the assigned input is not activated and whatever the position sensors are. Transition will be done without ramp time.

There are 2 modes to enable the outputs signals:

- Permanent: The output signals are enabled while the input stays connected to the ground.
- WatchDog: The output signals are enabled while the input changes periodically from connected to disconnected.

⇒Please refer to board #12 ¹⁾

4. Fine Control

This function works using an Input port.

This function stays activated while the port stays connected to ground.

When the function is active, the Fine Control Curve set is active.

When the function is inactive, the Normal Control Curve set is active.

Various set configurations may be defined from one axis alone up to all axis in the same set. Changing of Fine Control Curve set can occur whatever the operating element position.

Secondary Outputs

For compatibility with 4THE6 joystick, secondary outputs can be activated.

Secondary Output allows to drive 2 axis using the same operating element sensor:

- Axis 1 sensor is used to drive axis 3 outputs
- Axis 2 sensor is used to drive axis 4 outputs

Obviously, axis 3 and 4 sensors are not requested for such application.

⇒Please refer to board #13 ¹⁾

¹⁾ boards are at the end of this section.

Power Boards

Board #6:

Parameter	Value	Available Range	Default
PRESSURE_REDUCER		<ul style="list-style-type: none"> - FTDRE2 18 bars 12Volts (FT-18-12) - MHDRE2 18 bars 12Volts (MH-18-12) - MHDRE2 24 bars 12Volts (MH-24-12) - MHDRE2 30 bars 12Volts (MH-30-12) - FTDRE2 18 bars 24Volts (FT-18-24) - MHDRE2 18 bars 24Volts (MH-18-24) - MHDRE2 24 bars 24Volts (MH-24-24) - MHDRE2 30 bars 24Volts (MH-30-24) 	MH-30-12
VALVE		<ul style="list-style-type: none"> - SX14NGE - SX14S - SX12 	SX14NGE

Note 1: Specify the valve allows making a fine adjustment of the joystick in order to optimize the proportional control range.

Board #7:

Parameter	Value	Available Range	Default
NETWORK_VOLTAGE		[12;24] (Volt)	12
RESISTANCE		[2;20] (Ohm)	3.5
PWM_FREQUENCY		[83;100;125;150;167;200;250](Hz)	200
MAX_CURRENT_AXIS_1_PLUS		[0.25-2.4] (Amp)	1.7
MAX_CURRENT_AXIS_1_MINUS			
MAX_CURRENT_AXIS_2_PLUS			
MAX_CURRENT_AXIS_2_MINUS			
MAX_CURRENT_AXIS_3_PLUS			
MAX_CURRENT_AXIS_3_MINUS			
MAX_CURRENT_AXIS_4_PLUS			
MAX_CURRENT_AXIS_4_MINUS			

Power Boards

Board #8:

Parameter	Value	Available Range	Default
X_PT0		[8-30] (%)	8
X_PT1	33	33 (%)	33
X_PT2	66	66 (%)	66
X_PT3		[66-X_PT4] (%)	85
X_PT4		[X_PT3-100] (%)	100

Board #9:

Parameter	1	2	3	4	5	6	7	Available Range
TARGET_AXIS								[1;2;3;4]
TARGET_DIRECTION								- PLUS - MINUS
CURVE_TYPE								- NORMAL - FINE CONTROL
Y_PT0								[0-Y_PT1] (%)
Y_PT1								[Y_PT0-Y_PT2] (%)
Y_PT2								[Y_PT1-Y_PT3] (%)
Y_PT3								[Y_PT2-Y_PT4] (%)
Y_PT4								[Y_PT3-1000] (%)
RAMP_UP								[0-2.56] (s)
RAMP_DOWN								[0-2.56] (s)

Note 1: TARGET_AXIS and TARGET_DIRECTION define the output where you want to have the special curve.

Note 2: CURVE_TYPE define if the curve is activated when the FINE CONTROL is ON or OFF.

Note 3: If the output is defined with a maximum current of 1.7 Amps, you will define Y_PT(%) between 0 and 100 % of 1.7 Amps. Typically, the Y_PT0 will be set to 40 % to output a current of 680 mA at the starting point X_PT0.

Note 4: The parameter RAMP define the time the output will take to go from 0 to 100 % with a linear curve. If the Y_PT0 is for example 50 %, the ramp time will be divided by a factor 2. Ramp resolution is 25.6 ms.

Power Boards

Board #10:

Parameter	Value	Available Range	Default
FUNCTION_DIO_1		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA) – Fine Control Axis 1 (FC1) – Fine Control Axis 2 (FC2) – Fine Control all Axis (FCA) OUTPUT FUNCTIONS – Axis 1+ Direction (D1P) – Axis 1- Direction (D1M) – Axis 1 Out of Neutral (OU1) – Axis 2+ Direction (D2P) – Axis 2- Direction (D2M) – Axis 2 Out of Neutral (OU2) – Status Indicator (STA)	NOF
FUNCTION_DIO_2			NOF
FUNCTION_DIO_3			NOF
FUNCTION_DIO_4			NOF
FUNCTION_DI_5		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA) – Fine Control Axis 1 (FC1) – Fine Control Axis 2 (FC2) – Fine Control all Axis (FCA)	NOF
FUNCTION_DI_6			NOF
FUNCTION_DI_7			NOF

Note 1: Floating, DeadMan and Status Indicator functions require additional parameters, refer to section "Functions parameters" for further details.

Note 2: Floating and DeadMan functions can be assigned to one input maximum.

Board #11:

Parameter	Value	Available Range	Default
STATUS_MODE		– Fault Indicator (FLT) – Ready to work Indicator (RTW)	FLT

Board #12:

Parameter	Value	Available Range	Default
DEAD_MAN_MODE		– Permanent (PER) – WatchDog (WDG)	PER
DEAD_MAN_TEMPO (if WatchDog mode selected)		[0-60] (s)	60

Board #13:

Parameter	Value	Available Range	Default
SECONDARY_OUTPUTS		YES / NO	NO

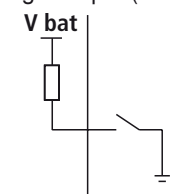
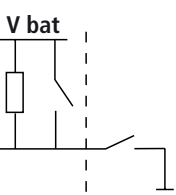
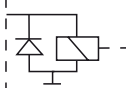
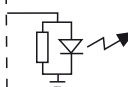
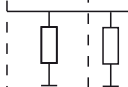
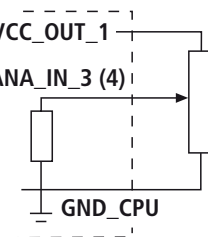
Electrical characteristics CAN Bus (for applications outside these parameters, please consult us!)

Power supply	V	9 to 32 VDC
Maximum current consumption	mA	300
Output Signal		
	% of ± 250	(1 byte encoding)
Neutral		0 % ¹⁾
Full stroke		± 100 % ¹⁾
Bus frequency	kHz	100, 125, 250, 500
Protocol (see page 29)		2.0 A or 2.0 B
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	2
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2 V/m		100
Current injection according to ISO 11452 part 4mA		200
Direct electrostatic discharge	kV	± 6
Electrostatic discharge in the air	kV	± 8
Further data		Consult us

¹⁾ We recommend a dead band of ± 8 %. The dead band can be set at the transmitter (CAN joystick) or at the receiver. By default, there is no dead band on the transmitter.

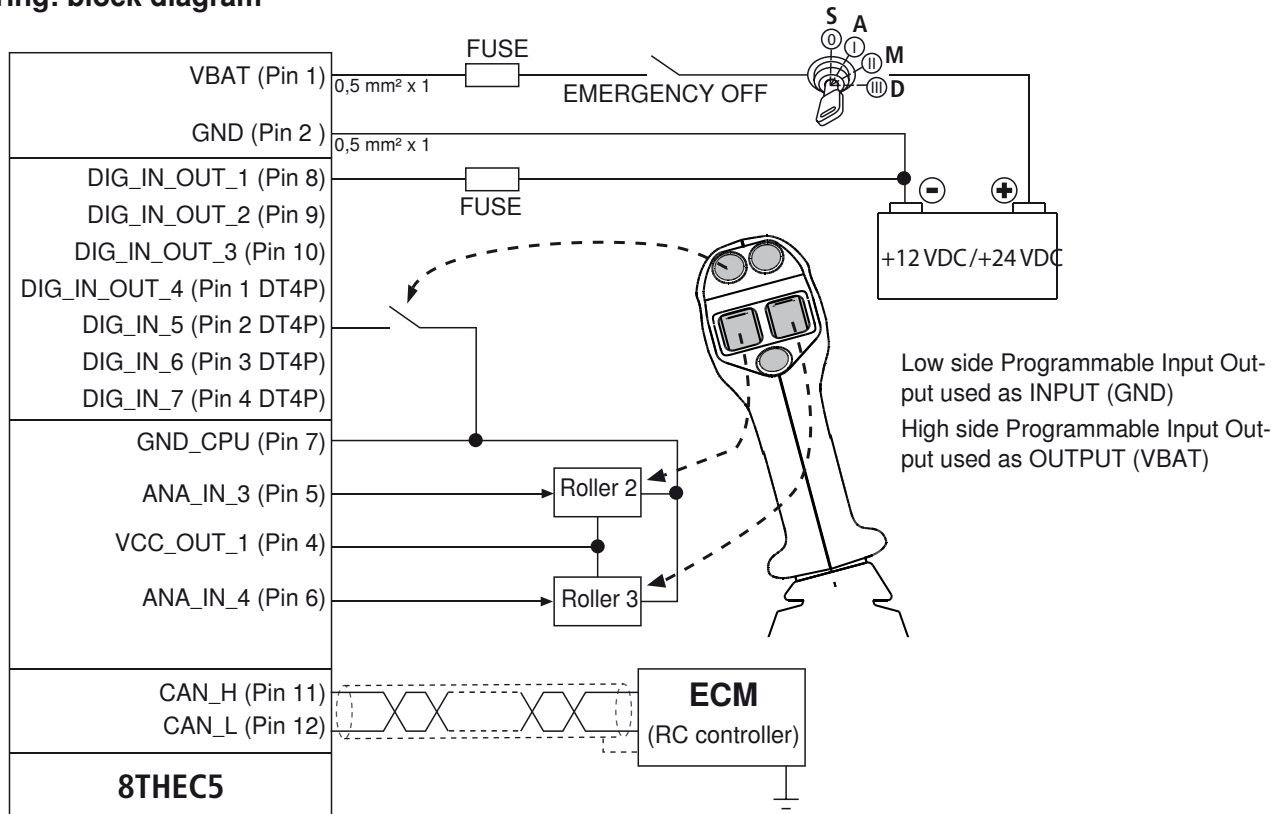
Electrical characteristics CAN Bus (for applications outside these parameters, please consult us!)

Input / Output Electrical characteristics

Digital Input (DIG_IN)		
	Characteristic	Adjustable by programming
	Input function	To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance
Digital Input/Output (DIG_IN_OUT)		
	Characteristic	Adjustable by programming
	Input function connected to a switch	To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance of 8.2 KΩ. The switch must be fitted to a 5 mA current.
	Output function	When the output is inactive, take into account the pull up 8.2 KΩ resistance to set the output voltage
	Output function connected with a relay	The relay must have a minimal current of activation of 10 mA
	Output function connected with a LED	The LED must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
	Output function connected to a logical input	The logical input must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
	Maximum sourcing current	200 (with resistive load)
		mA
Analog Inputs for axis 3 and 4		
	VCC_OUT_1 maximum sourcing current	75
	Pull down resistor on ANA_IN_3 (4)	10
	kOhms	

Electrical characteristics CAN Bus (for applications outside these parameters, please consult us!)

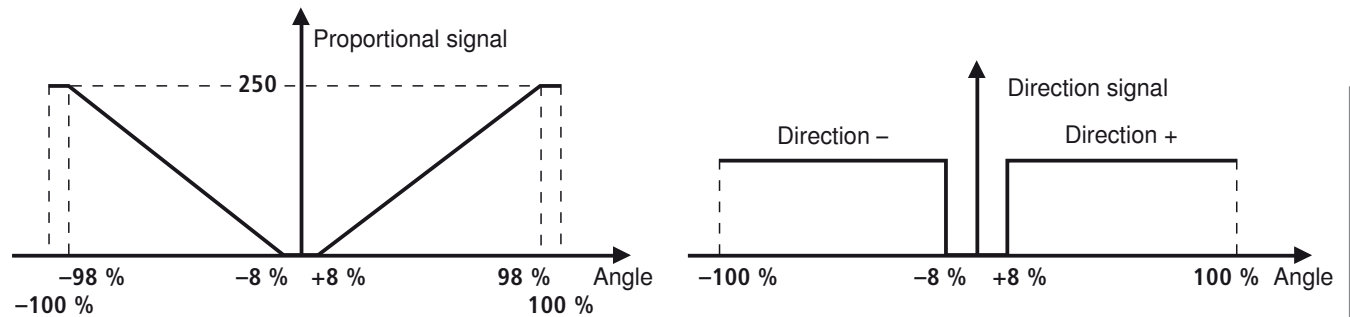
Wiring: block diagram



Programming tool: see page 42

Pin assignment: see page 45

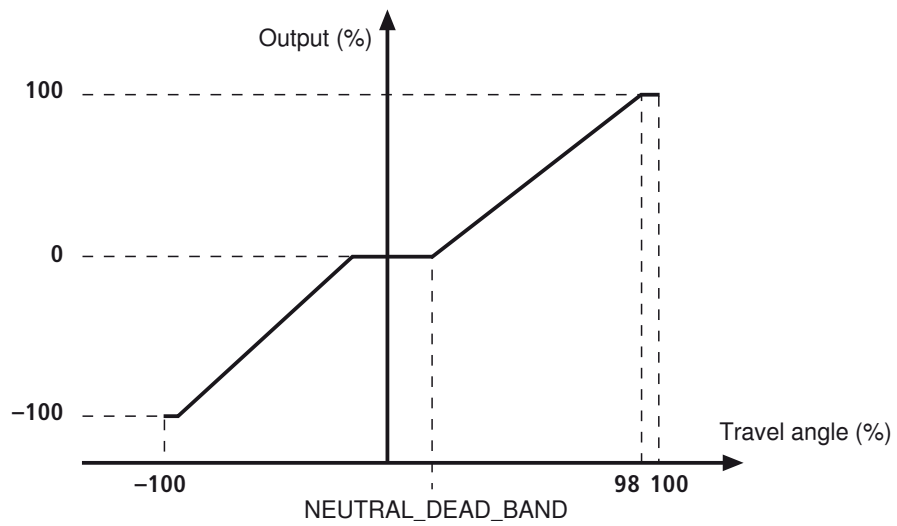
Output characteristics



BRM Standard Protocol

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Position Axis 1 0->250	Position Axis 2 0->250	Position Axis 3 0->250	Position Axis 4 0->250	Bit 0: Axis1-	Bit 0: DIG_IN_OUT_1	zero	Bit 0: 0
				Bit 1: Axis1+	Bit 1: DIG_IN_OUT_2		Bit 1: 0
				Bit 2: Axis2+	Bit 2: DIG_IN_OUT_3		Bit 2: 0
				Bit 3: Axis2-	Bit 3: DIG_IN_OUT_4		Bit 3: 0
				Bit 4: Axis3+	Bit 4: DIG_IN_5		Bit 4-7: counter 0->16
				Bit 5: Axis3-	Bit 5: DIG_IN_6		
				Bit 6: Axis4+	Bit 6: DIG_IN_7		
				Bit 7: Axis4-	Bit 7: 0		

CAN Signal Outputs



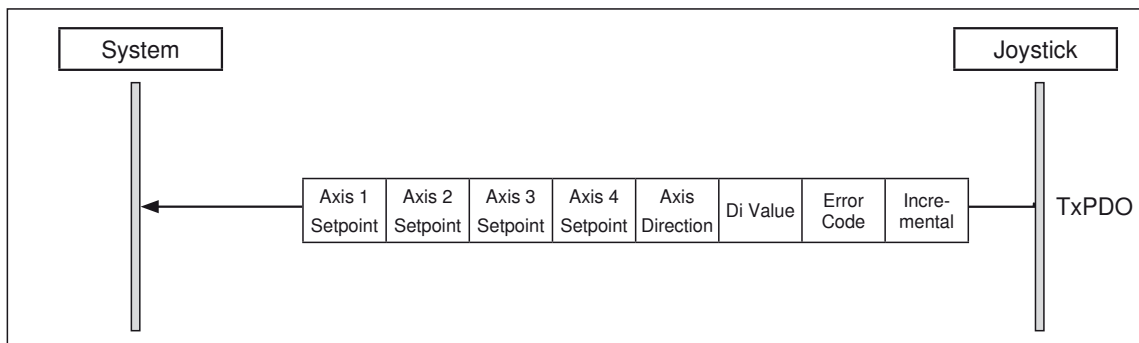
⇒ Please refer to board #14 ¹⁾

Protocol

⇒ Please refer to board #15 ¹⁾

¹⁾ boards are at the end of this section.

TxPDO BRM



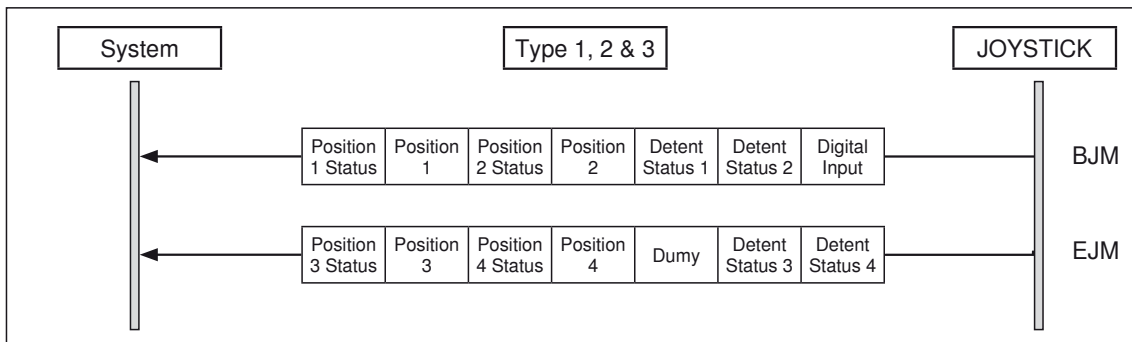
⇒ Please refer to board #16 ¹⁾

Message content:

Byte	bit	Parameter Name
1	1-8	Joystick Axis 1 Position
2	1-8	Joystick Axis 2 Position
3	1-8	HandGrip Axis 3 Position
4	1-8	HandGrip Axis 4 Position
5	1	Axis 1 Direction – [Forward]
	2	Axis 1 Direction + [Backward]
	3	Axis 2 Direction + [Left]
	4	Axis 2 Direction – [Right]
	5	Axis 3 Direction + [Up]
	6	Axis 3 Direction – [Down]
	7	Axis 4 Direction + [Up]
	8	Axis 4 Direction – [Down]
6	1	DIO_1 (1 = connected to ground)
	2	DIO_2
	3	DI_3
	4	DI_4
	5	DI_5
	6	DI_6
	7	DI_7
7	1-8	ZERO (Error Code)
8	1-4	ZERO
	5-8	Incremental counter

¹⁾ boards are at the end of this section.

TxPDO J1939



⇒ Please refer to board #17 ¹⁾

BJM Message content:

Byte	bit	Parameter Name
1	1-2	Joystick Axis 2 NEUTRAL Direction Status
	3-4	Joystick Axis 2 Direction + status
	5-6	Joystick Axis 2 Direction – status
	7-8	Joystick Axis 2 Position
2	1	Joystick Axis 2 Position
3	1-2	Joystick Axis 1 NEUTRAL Direction Status
	3-4	Joystick Axis 1 Direction + status
	5-6	Joystick Axis 1 Direction – status
	7-8	Joystick Axis 1 Position
4	1	Joystick Axis 1 Position
5	1-4	Not defined
	5-6	Joystick 1-Axis Detent Position Status
	7-8	Joystick 2-Axis Detent Position Status
6	1-2	Joystick Button 4 pressed status
	3-4	Joystick Button 3 pressed status
	5-6	Joystick Button 2 pressed status
	7-8	Joystick Button 1 pressed status
7	1-2	Joystick Button 8 pressed status
	3-4	Joystick Button 7 pressed status
	5-6	Joystick Button 6 pressed status
	7-8	Joystick Button 5 pressed status

¹⁾ boards are at the end of this section.

CAN Signal Software parameters

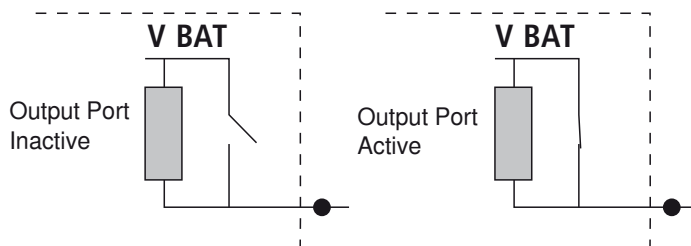
EJM Message content:

Byte	bit	Parameter Name
1	1-2	Joystick Axis 3 NEUTRAL Direction Status
	3-4	Joystick Axis 3 Direction + status
	5-6	Joystick Axis 3 Direction – status
	7-8	Joystick Axis 3 Position
2	1	Joystick Axis 3 Position
3	1-2	Joystick Axis 4 NEUTRAL Direction Status
	3-4	Joystick Axis 4 Direction + status
	5-6	Joystick Axis 4 Direction – status
	7-8	Joystick Axis 4 Position
4	1	Joystick Axis 4 Position
5	1-8	Not defined
		Not defined
		Not defined
		Not defined
6	1-8	Not defined
7	1-2	Not defined
	3-4	Not defined
	5-6	Not defined
	7-8	Not defined
6	1-8	Not defined

Digital Input / Output Port

CAN BUS THE5 integrates 2 Digital Configurable Input Output ports and 3 Digital Not Configurable Input ports. Inputs are active when they are connected to ground by external circuitry and inactive when disconnected from ground, pull up is done internally.

Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation:



⇒ Please refer to board #18 ¹⁾

Functions parameters

1. Direction and Out of Neutral Outputs

This function works using an Output Port. The activation switches the Output Port to battery voltage (200 mA max). Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation. Direction is active when the sensor's position leaves the neutral dead band defined in percent of the full travel range (NEUTRAL_DEAD_BAND).

There are 6 modes:

- Direction Plus on Axis 1 (D1P): The Output Port is activated when the axis 1 goes in direction 1 Plus
- Direction Minus on Axis 1 (D1M): The Output Port is activated when the axis 1 goes in direction 1 Minus
- Direction Plus on Axis 2 (D2P): The Output Port is activated when the axis 1 goes in direction 2 Plus
- Direction Minus on Axis 2 (D2M): The Output Port is activated when the axis 1 goes in direction 2 Minus
- Out Of Neutral Axis 1 (OU1): The Output Port is activated in both directions Plus and Minus on Axis 1
- Out Of Neutral Axis 2 (OU2): The Output Port is activated in both directions Plus and Minus on Axis 2

2. Status Indicator Output

This function works using an Output Port. The activation switches the Output Port to battery voltage (200 mA max). Connect a LED to the relevant output considering the internal pull up 8.2 kOhm resistors when Output is inactive.

There are 2 modes:

- Error Status Indicator (FLT): This mode will lead LED indicator to light on in case of fault.
- Ready to Work Indicator (RTW): This mode will light on the LED if there is no fault detected.

⇒ Please refer to board #19 ¹⁾

3. Dead Man Input

This function works using an Input port. This function is activated when port is connected to ground. Dead Man function allows freezing the joystick signals in neutral if the assigned input is not activated and whatever the position sensors are. Transition will be done without ramp time.

There are 2 modes to enable the outputs signals:

- Permanent: The output signals are enabled while the input stays connected to the ground.
- WatchDog: The output signals are enabled while the input changes periodically from connected to disconnected.

⇒ Please refer to board #20 ¹⁾

¹⁾ boards are at the end of this document.

CAN Signal Boards

Board #14:

Parameter	Value	Available Range (Unit)	Default
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	8
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	8
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	12
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	12

Note 1: Maxi Output % is reached at 98 % of the stroke (exemple: 19.6° for a 20° joystick), this value is not adjustable.

Board #15:

Parameter	Value	Available Range (Unit)	Default
PROTOCOL		[BRM;J1939]	BRM
BUS FREQUENCY		[125;250;500] (kHz)	250
EMISSION PERIOD		[20-50] (ms)	20
EMISSION PERIOD IN NEUTRAL		[20-50] (ms)	20

BRM protocol is an eleven bit identifier protocol (2.0A)

J1939 protocol is a 29 bits identifier protocol (2.0B), remote control integrates 4 identifiers:

©BJM1 Basic Joystick Message 1 for axis 1 & 2

©BJM1R Basic Joystick Message 1 redundant

©EJM1 Extended Joystick Message 1 for axis 3 & 4 if any

©EJM1R Extended Joystick Message 1 redundant

CAN Signal Boards

Board #16:

Parameter	Value	Available Range (Unit)	Default
BJM1_PRIORITY (3 MSB ID 11 bits)		[0x2;0x3]	0x2
PDU_SA (8 LSB ID 11 bits)		[0x00-0xFF]	0xFE (Right) 0xFF (Left)

Note 1: With Default values, identifier is 0x2FE.

Note 2: BRM protocol use same parameters name that J1939 protocol (BJM1, PDU_SA)

Board #17:

Parameter	Value	Available Range	Default												
STD_PGN_ID		– Type 1 – Type 2 – Type 3 <table border="1"> <thead> <tr> <th></th> <th>Type 1</th> <th>Type 2</th> <th>Type 3</th> </tr> </thead> <tbody> <tr> <td>BJM</td> <td>0xFDD6</td> <td>0xFDD8</td> <td>0xFDDA</td> </tr> <tr> <td>EJM</td> <td>0xFDD7</td> <td>0xFDD9</td> <td>0xFDDB</td> </tr> </tbody> </table>		Type 1	Type 2	Type 3	BJM	0xFDD6	0xFDD8	0xFDDA	EJM	0xFDD7	0xFDD9	0xFDDB	1
	Type 1	Type 2	Type 3												
BJM	0xFDD6	0xFDD8	0xFDDA												
EJM	0xFDD7	0xFDD9	0xFDDB												
SPE_BJM_PGN_ID (For non standard)															
SPE_EJM_PGN_ID (For non standard)															

CAN Signal Boards

Board #18:

Parameter	Value	Available Range	Default
FUNCTION_DIO_1		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA) OUTPUT FUNCTIONS – Axis 1+ Direction (D1P) – Axis 1- Direction (D1M) – Axis 1 Out of Neutral (OU1) – Axis 2+ Direction (D2P) – Axis 2- Direction (D2M) – Axis 2 Out of Neutral (OU2) – Status Indicator (STA)	NOF
FUNCTION_DIO_2			NOF
FUNCTION_DI_3		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA)	NOF
FUNCTION_DI_4			NOF
FUNCTION_DI_5			NOF
FUNCTION_DI_6			NOF
FUNCTION_DI_7			NOF

Note 1: DeadMan function require additionnals settings, refer to section "Functions parameters" for furthers details.

Note 2: DIO and DI status will be transmitted on the bus in all conditions and even if no function is selected.

Note 3: Floating and DeadMan functions can be assigned to one input maximum.

Board #19:

Parameter	Value	Available Range	Default
STATUS_MODE		– Fault Indicator (FLT) – Ready to work Indicator (RTW)	FLT

Board #20:

Parameter	Value	Available Range	Default
DEAD_MAN_MODE		– Permanent (PER) – WatchDog (WDG)	PER
DEAD_MAN_TEMPO (if WatchDog mode selected)		[0-60] (s)	60

Safety guidelines for the application of the THE5

The system using the signals delivered by the remote controls must check the consistency of the signals (Amplitude, Frequency) and implement the relevant corrective actions in case of failure.

When a fault is detected, the power outputs are automatically switched off. The electrohydraulic system must be designed in such a manner that safe behaviour is guaranteed when the command value gets equal to zero (case of translation drives).

Warning

- An emergency stop switch is to be provided to disconnect the power supply to the electronics. This switch must be easily accessible to the operator. Safe braking must be provided for in case of emergency stop (case of translation drives).
- Screen the electric cables connected to position sensors (regulated power supply and proportional output). A low impedance line should connect the screen with the vehicle's ground.
- Signal cables and power cables must be rooted separately and away from each other.
- In case of electric welding operations on the machine, unplug the power supply battery as well as all plugs connecting the electronics.
- Place the electronics away from possible radio equipments, to limit the magnetic field effect on remote control.
- Hall sensors are sensitive to external magnetic fields.
- Do not use the remote controls close to a magnetic field source of frequency lower than 50 Hz and of amplitude greater than 2 mT.
- Do not use in hazardous environment.
- Do not direct the jet of a pressure washing unit directly at the unit.
- Solenoids must be fitted with free-wheeling diode to avoid disturbances.
- Remote controls must be switched off when starting the engine of a mobile machine or vehicle.

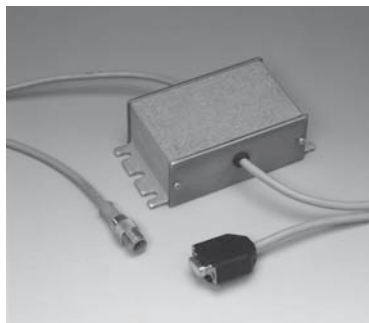
Additional application guidelines for THE5 Power PWM

- Select the same supply voltage for the remote control THE5 and the solenoids which are to be connected. I. e. 12 V solenoids for a 12 V application and 24 V solenoids for a 24 V application.
- After correcting a fault, reset the remote control by switching the power supply off.
- An emergency cut-off for the remote control power supply must be provided for. Warning: when the remote control power supply is switched off, the output currents are switched off without a ramp.
- Do not fit free-wheel diodes in the power lines that directly connect the solenoids with the THE5 Power as they are integrated in the remote control. If the lines are interrupted (e.g. by relays), then suitable protective circuitry has to be provided.

Programming tool for PWM Signal, CAN and Power joysticks

Display and adjustment possibilities

All adjustment processes and display of functions, faults and system-specific values are performed by means of a PC with software EMToolBox ¹⁾ via the serial control panel (DSI part number: R908250400 or R908250401).

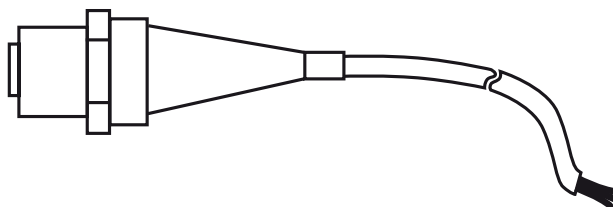


Control panel connection

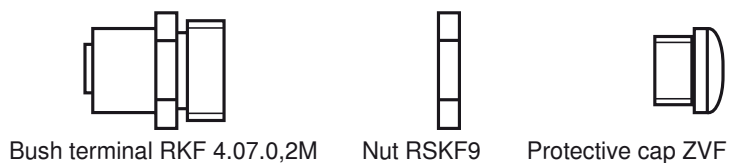
The control panel is equipped with a connector Lumberg type RST 4.07.02M.

The machine must be equipped with one of the following connector Lumberg:

– Connector Lumberg type RKT 4.07.2M with prolongation cable; DSI part number: R907213052.



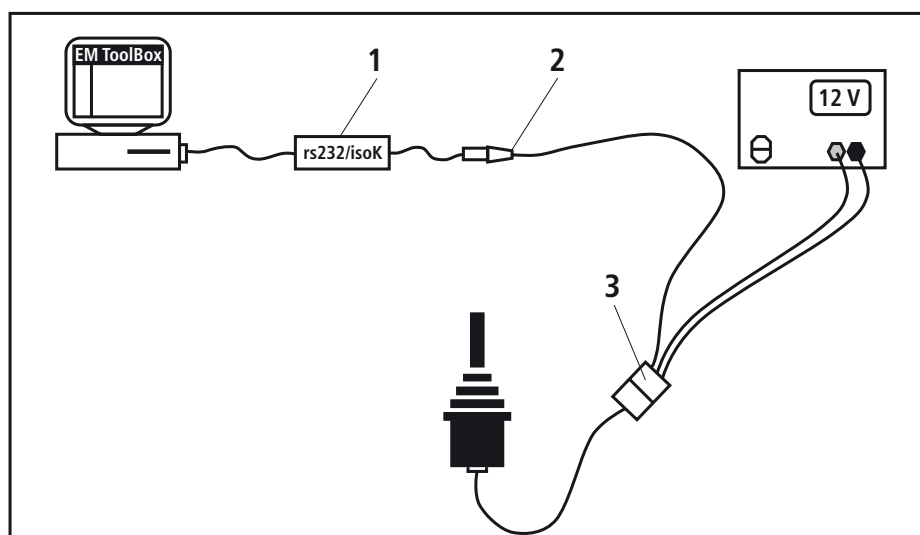
– Connector Lumberg to fix on a dashboard; DSI part number: R907213053.



Example of equipment to order

Diagnostic and adjustment of a joystick equipped with a Deutsch plug 12 pins:

- EMToolBox software and serial control panel: DSI part number: R908250400 (1)
- Connector Lumberg type RKT 4.07.2M with prolongation cable; DSI part number: R907213052 (2)
- Machine plug: DT06-12SA-CE01; DSI part number: R908250513 (3)



¹⁾ EMToolBox software and updates are freeware.

Pin assignment – Voltage Signal

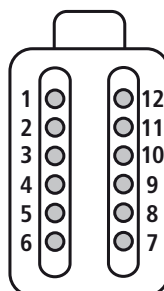
4THES5 2THES5R

Output connection on Deutsch plug 12 pins

Remote control plug designation: DT04-12PA-CE01; 12 pins.

Machine plug designation: DT06-12SA-CE01; DSI part number: R908250513.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VBAT
	2	GND
	3	VCC_IN_1
	4	VCC_IN_2
	5	GND
	6	NO_CONNECTED
	7	DIR_OUT_P_1
	8	DIR_OUT_M_1
	9	DIR_OUT_P_2
	10	DIR_OUT_M_2
	11	ANA_OUT_1
	12	ANA_OUT_2



Symbol:

VBAT = +V battery

GND = Ground

VCC_IN_1 = 5 VDC Power supply for axis 1

VCC_IN_2 = 5 VDC Power supply for axis 2

DIR_OUT = Direction Output

Pin assignment – PWM Signal

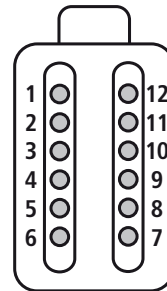
4THESW5

Output connection on Deutsch plug 12 pins

Remote control plug designation: DT04-12PA-CE01; 12 pins.

Machine plug designation: DT06-12SA-CE01; DSI part number: R908250513.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	DIG_IN_5
	5	DIG_IN_6
	6	DIG_IN_7
	7	DIG_IN_OUT_1
	8	DIG_IN_OUT_2
	9	DIG_IN_OUT_3
	10	DIG_IN_OUT_4
	11	PWM_OUT_1
	12	PWM_OUT_2



2THESW5R

Output connection on Deutsch plug 4 pins

Remote control plug designation: DT04-04PA-CE01; 4 pins.

Machine plug designation: DT06-04SA-CE01; DSI part number: R908250695.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 04PA-CE01	1	VBAT
	2	GND
	3	PWM_OUT_1
	4	ISOK

Symbol:

VBAT = +V batterie

GND = Ground

DIG_IN = Digital Input

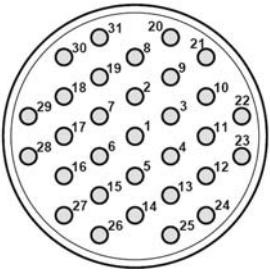
DIG_IN_OUT = Digital Input / Output

PWM_OUT = PWM Output

Pin assignment – Power

Output connection on Deutsch plug 31 pins HDP 31

Machine plug designation: HDP24_24_31_SE_L017; DSI part number: R908250514.

Pin assignment plug		Compatible with THE5 Potentiometric ¹⁾
Customer plug		4-6-8THE5 (2-3-4 axis)
Type	Pin	Name
 <p>DEUTSCH HDP26_24_31_PE_L017</p>	1	GND_POWER
	2	GND_POWER
	3	VBAT_POWER
	4	VBAT_POWER
	5	DIG_IN_5
	6	SOL_OUT_P_4
	7	GND_CPU
	8	SOL_OUT_M_4
	9	CUR_IN_4
	10	DIG_IN_6
	11	CUR_IN_2
	12	DIG_IN_7
	13	SOL_OUT_M_1
	14	CUR_IN_1
	15	SOL_OUT_P_1
	16	CUR_IN_3
	17	VCC_OUT_1
	18	ANA_IN_3
	19	ISOK
	20	ANA_IN_4
	21	SOL_OUT_M_2
	22	SOL_OUT_P_2
	23	SOL_OUT_P_3
	24	SOL_OUT_M_3
	25	NO_CONNECTED
	26	NO_CONNECTED
	27	DIG_IN_OUT_1
	28	DIG_IN_OUT_2
	29	DIG_IN_OUT_3
	30	DIG_IN_OUT_4
	31	NO_CONNECTED

Symbol:

VBAT = +V battery

GND = Ground

POWER = Power electronic board

CPU = Signal electronic board

DIG_IN = Digital Input

DIG_IN_OUT = Digital Input / Output

VCC_OUT_1 = 5 VDC Power supply regulated
for external sensors (grip)

ANA_IN = Voltage Input for external sensor (grip)

CUR_IN_2 = Return for current measurement on axis 2

SOL_OUT = Power Output for solenoid

¹⁾ Compatibility with 4THE5 Serie 1X and 4THE6: consult us.

Pin assignment – CAN

4/6/8 THEC5

Output connection on Deutsch plugs 12 pins and 4 pins.

Remote control plug designation: DT04–12PA–CE01: 12 pins.

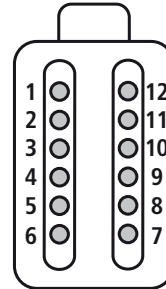
DT04–04PA–CE01: 4 pins.

Machine plug designation:

DT06–12SA–CE01; DSI part number: R908250513

DT06–04SA–CE01; DSI part number: R908250695.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	VCC_OUT_1
	5	ANA_IN_3
	6	ANA_IN_4
	7	GND
	8	DIG_IN_OUT_1
	9	DIG_IN_OUT_2
	10	DIG_IN_OUT_3
	11	CAN_H
	12	CAN_L
DEUTSCH DT04 04PA-CE01	1	DIG_IN_OUT_4
	2	DIG_IN_5
	3	DIG_IN_6
	4	DIG_IN_7



Symbol:

VBAT = +V battery

GND = Ground

DIG_IN = Digital Input

DIG_IN_OUT = Digital Input/Output

VCC_OUT_1 = 5VDC Power supply regulated for external sensors (grip)

ANA_IN = Voltage Input for external sensor (grip)

2THEC5R

Output connection on Deutsch plug 8 pins.

Remote control plug designation: DT04–08PA–CE01: 8 pins.

Machine plug designation:

DT06–08SA–CE01; DSI part number: R908250593.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 08PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	DIG_IN_OUT_1
	5	DIG_IN_OUT_2
	6	DIG_IN_OUT_3
	7	CAN_H
	8	CAN_L

Pin assignment – CAN (Series 3X)

4/6/8 THEC5

Output connection on Deutsch plugs 12 pins and 6 pins.

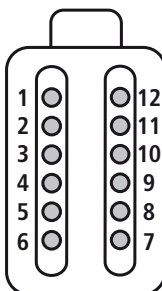
Remote control plug designation: DT04–12PA–CE01: 12 pins.

DT04–06PA–CE01: 6 pins.

Machine plug designation: DT06–12SA–CE01; DSI part number: R908250513

DT06–06SA–CE01; DSI part number: R908250598.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VCC_OUT_1
	2	DIG_IN_OUT_1
	3	DIG_IN_OUT_2
	4	DIG_IN_3
	5	GND
	6	ANA_IN_3
	7	ANA_IN_4
	8	
	9	DIG_IN_4
	10	DIG_IN_5
	11	DIG_IN_6
	12	DIG_IN_7
DEUTSCH DT04 06PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	
	5	CAN_H
	6	CAN_L



Symbol:

VBAT = +V battery

GND = Ground

DIG_IN = Digital Input

DIG_IN_OUT = Digital Input/Output

VCC_OUT_1 = 5VDC Power supply regulated
for external sensors (grip)

ANA_IN = Voltage Input for external sensor (grip)

Electronic joystick for mobile application THE5 CAN



► Série 4X

Features

- Specially designed for the equipment of mobile machines
- Reliable and robust mechanism similar to the one of the hydraulic joysticks
- Large selection of ergonomic grips with various E-contacts on/off rockers or proportional control
- Actuator ergonomics comparable with hydraulic joysticks
- Excellent protection of the electronic part
- Configurable Electronics
- Optimized design for obtaining high security level of utilization (performance level PLc & PLd according to ISO13849 standard)
- Outputs on 1 to 2 CAN channels to increase the reliability level of the systems or reduce the load of the bus.

Contents

4THE5 features	4
Unit dimensions	4
Ordering details.....	5
Informations related to standard ISO13849.....	6
Mechanical characteristics of the CAN electronic joysticks THEC5 or THED5	7
Variants of operation curves.....	7
Electrical characteristics of the CAN electronic joysticks THEC5 or THED5	8
Electrical functions of the CAN electronic joysticks THEC5 or THED5	9
CAN frame according to the protocol in the CAN electronic joysticks THEC5 or THED5	12
Guidelines for the electronic joystick CAN THEC5 or THED5	18

About this datasheet

This manual describes functioning, technical data and ordering details of electronic joystick THE5. This manual is illustrated with hydraulic symbols, sections and unit dimensions drawings.

Related documents

Electronic joystick THE5 is a system component.

- ▶ Also follow the instructions for the other system components.
- ▶ Also follow manufacturer instruction manual.

Functional description, Section

Design

Joysticks type THE5 CAN are mainly composed of an operating element (1), a fixation plate (2) and a box (3) containing the contactless sensors and electronic cards.

General

THE5 have similar mechanics and ergonomics to the hydraulic joysticks.

This design provides a high robustness level to the THE5. The ergonomics of THE5 pushes the refinement to reproduce the sensations perceived by the operation of hydraulic joysticks.

The THE5 CAN periodically generates a frame on CAN bus which allows the communication with other systems. These electronic joysticks equipped with micro-processors can be configured using a PC.

The THE5 reliable architecture increases the safety of use of electronic joysticks to the high level of performance required by the machine directive.

This THE5 CAN is able to generate frames on two separate

channels in order to further increase the expected reliability level of electro-hydraulic system which they are connected to.

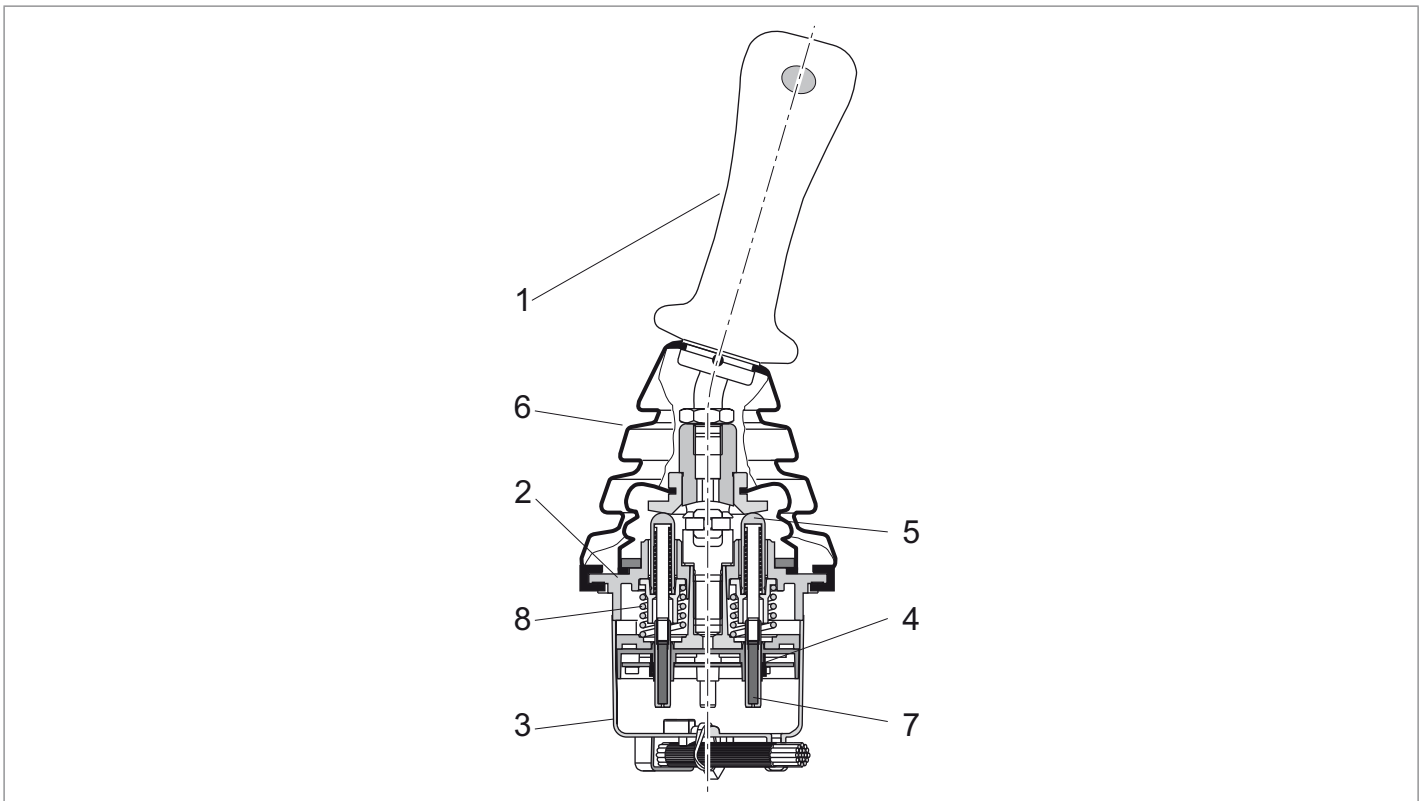
Apart from the possible presence of one or more power rollers in the handgrip, the control of an electro-hydraulic axis with the THE5 CAN requires adding an external electronic power interface.

Function principle

When not actuated the operating element is held in neutral position by the return springs (8). With deflection of the lever (1), the plunger (5) compresses the return spring (8). The magnet (7) mechanically linked to the plunger (5) moves upward or downward while following the lever actuation direction. The command value generated by the sensor (4) is proportional to the deflection of the lever.

A rubber boot (6) protects the mechanical components of the housing from external contamination. The internal mini boot (9) is an additional protective barrier of the cardan and plungers.

▼ 4THE5 section



4THE5 features

Special features

- ▶ Electromagnetic compatibility (CEM) according to the standards ISO 7637, 11452, 16750.
- ▶ Life expectancy up to 5 millions cycles.

Supported by the electronic base :

- ▶ Up to 7 proportional axis
- ▶ Up to 16 On/Off or analogic push buttons without redundancy.
- ▶ Up to 8 analogic push buttons with redundancy.
- ▶ Up to 6 On Off or signal PWM outputs (LED driver).
- ▶ Up to 2 CAN channels

Wiring: block diagram

See page 8

Outputs characteristic curves

See page 11

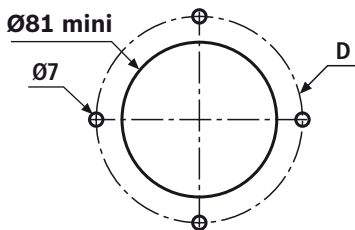
Installation guidelines

- ▶ Mounting flange area: flatness = 0,5 mm.
- ▶ Screw head dimensions = Ø 10 mm.
- ▶ Tightening torque for the flange fixing screws = 10 Nm maxi.

Application

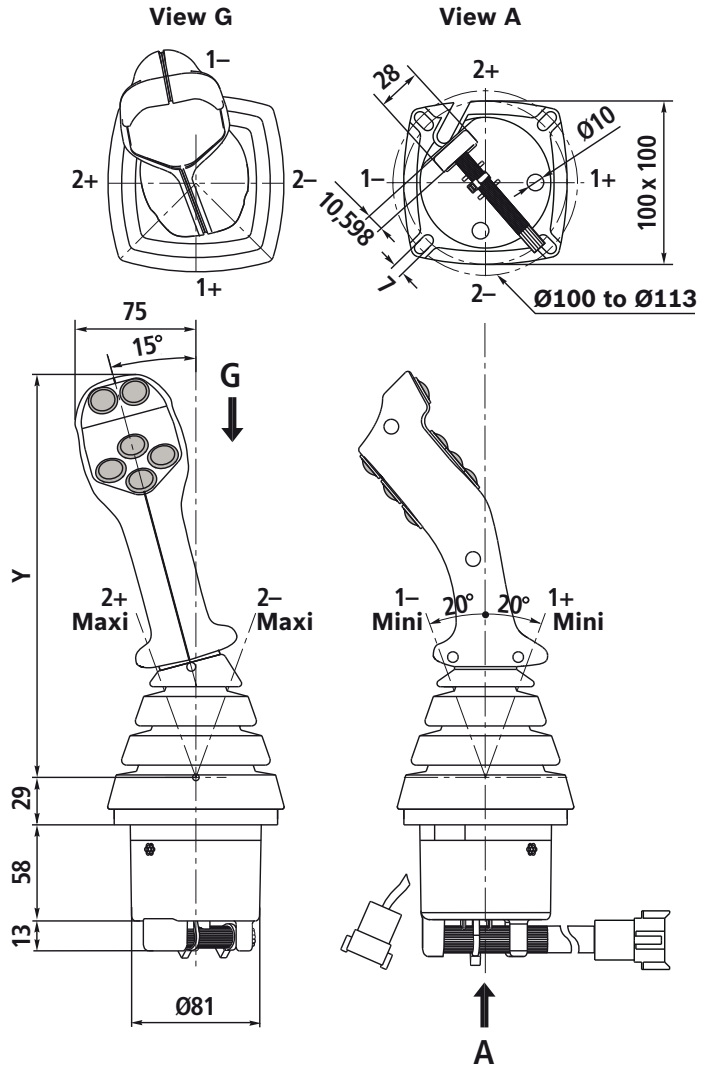
The pilot control unit type 4THE5 is for armrest installation and for the remote control of mobile machines equipment. The electronics integrated in the joystick enables the remote control of up to 4 proportional axis if it is connected to the proportional sensors inside the grip.

Implantation



- ▶ Nominal diameter / fixing via 4 screws
D = Ø100 to Ø113 mm.

Unit dimensions



Vertical dimension Y by type of handgrip

Type of handgrip	With bent lever	With straight lever
EC2000	207	211.5
EC2000+	215.5	220.5
EC3000+	234	238
EC3500+	240	244
EC4000	250.5	257

Ordering details

Ordering details of a joystick THE5

01	02	03	04	05	06	07	08	09	10	11
4	THE		5		4X	/			5	*

Ordering details: meaning

Axis number

01	2 axis (joystick)	4
----	-------------------	---

Product

02	Electronic joystick	THE
----	---------------------	-----

Type of output

03	CAN 1 network (performance level PLc)	CS
	CAN 1 network (performance level PLd)	DS
	CAN 2 networks (performance level PLc)	CF
	CAN 2 networks (performance level PLd)	DF

Product

04	THE5 joystick	5
----	---------------	---

Type of control element

05	Handgrip EC2000	E
	Handgrip EC4000	H
	Handgrip EC2000+	I
	Handgrip EC3000+	K
	Handgrip EC3500+	M/N
	Without lever	Z
	Other handgrip	

Series

06	Series 40 to 49 : unchanged installation and connection dimensions	4X
----	--	----

Handgrip description

07	Handgrip type E	TT
		ST
		VT
		YT
		YU
	Handgrip type H, I, K : see datasheet RE 64547	*
	Other handgrip	

Handgrip orientation / machine

08	Straight lever and handgrip towards 1-	03
	Bent lever towards 2- and handgrip towards 1- (left hand joystick)	43
	Bent lever towards 2+ and handgrip towards 1- (right hand joystick)	23
	Without handgrip	

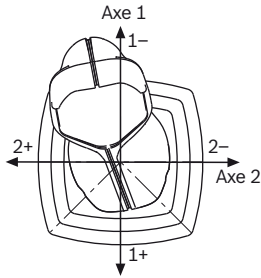
Curve operating force

09	Standard	A
	PFI curve	B
	PFD curve	C

Connectors

10	Deutsch sealed plugs IP67 for the wiring of the grip	5
11	Further details	*

Axis positions and handgrip orientation



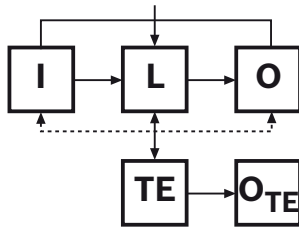
Informations related to standard ISO13849

For further informations about standard ISO13849 applied to electronic joysticks, refer to RE90293

4THED5

4THED5 with or without redundant rollers or push buttons (XS, ZL) managed by the electronic joystick

- ▶ Meets the Tier 2 requirements of the standard ISO 13849 (redundant axis)
- ▶ PFHd < 10⁻⁶



4THEC5

4THEC5 with or without non redundant rollers or push buttons managed by the electronic joystick

- ▶ Meets the Tier 1 requirements of the standard ISO 13849 (non redundant axis)
- ▶ PFHd < 3 x 10⁻⁶



Mechanical characteristics of the CAN electronic joysticks THEC5 or THED5

(for applications outside these parameters, please consult us)

Life time		5 millions actuation cycles
Temperature range		
Storage, ambient	°C	-40 to +85
Operation	°C	-20 to +65
Resistance to vibrations and shocks		
Vibration (ISO 16750-3 and CEI 60068-2-64)	Hz	20 to 2000 Hz (11,2g RMS)
Shocks (CEI 60068-2-27)	g	50g during 11ms
Protection level (CEI 60529)		IP 67
Actuation torque	Nm	See curve
Maximum permissible at the operating element with an exceptional, one-time loading	Nm	80
Actuation angle	°	± 20
Weight (depends of equipment)	Kg	1

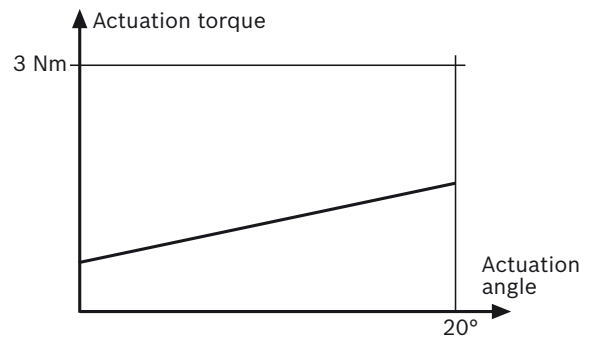
Variants of operation curves

The design of the THE5 joysticks can reproduce similar sensations to the maneuver of hydraulic joysticks.

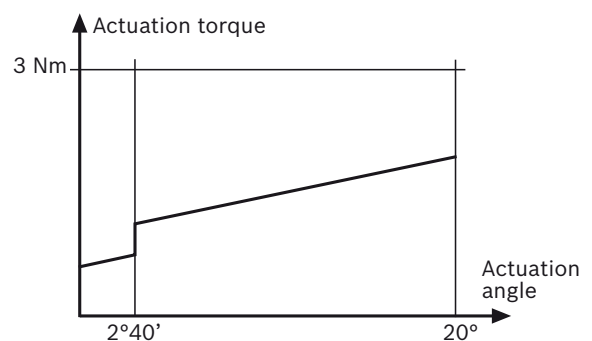
Echelons can be added to the standard operation curve for feeling the out of neutral or the activation of a specific functionality (float position...)

- ▶ Standard operation curve
- ▶ Operation curve with feeling of the out of neutral : PFI
- ▶ Operation curve with prefeeling of the activation of a specific functionality: PFD

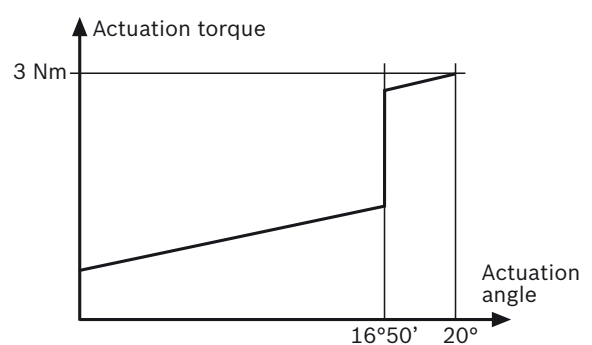
Standard curve



PFI curve



PFD curve

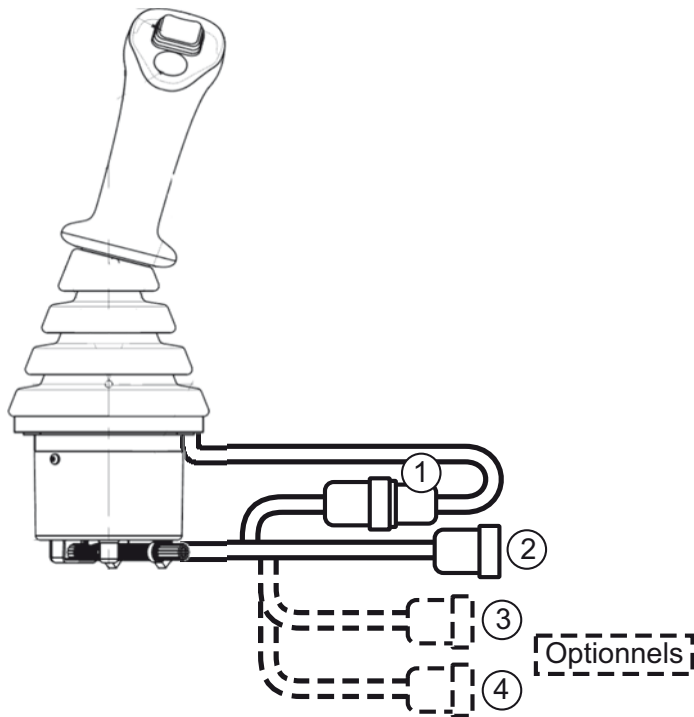


Electrical characteristics of the CAN electronic joysticks THEC5 or THED5

(for applications outside these parameters, please consult us)

Power supply	V	6.5 to 36
Maximum current consumption	mA	300
Protections		
Protection against reverse polarity		Yes on supply side
Protection against short circuit		Connections towards machine protected from 0 to 36V
Electromagnetic compatibility (CEM)		
Current injection (ISO 1152-4)		[50 kHz ; 400 Mhz] ; [100 mA - 300 mA]
Radiated emission (CISPR 25 - 2002)		[30 MHz ; 1 GHz] ; <50 dBµV/m
Radiated field (ISO 1152-2)		[200 MHz ; 2 GHz] ; -150 V/m
Direct electrostatic discharge (ISO 10605)	kV	± 8
Electrostatic discharge in the air (ISO 10605)	kV	± 15
Others		Consult us

Electrical connection to the machine and connectors

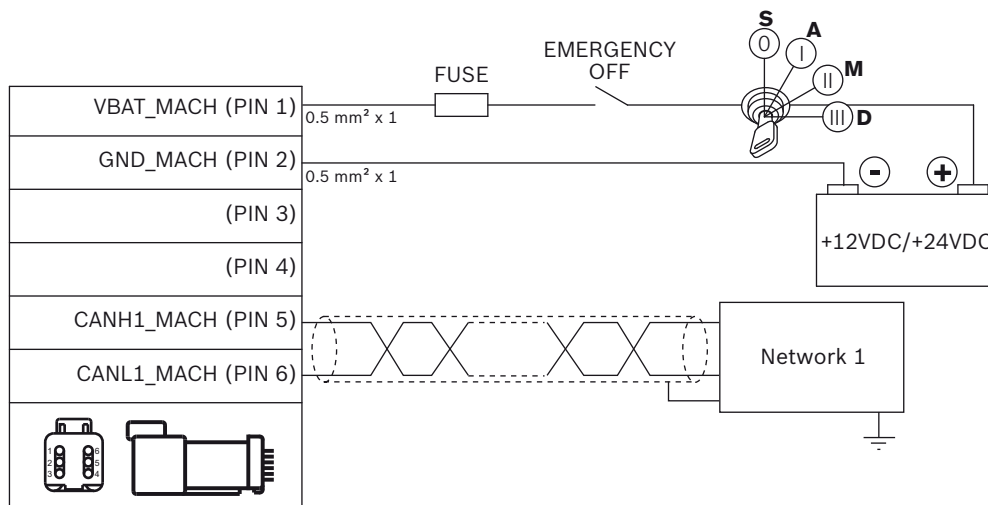


- 1 Handgrip connector 12P
- 2 Supply and CAN connector 6P
- 3 Connector for analogical options 8P
 - Supply 5V for external functions
 - Voltage input from potentiometer or push button
- 4 Connector for On/Off options 8P
 - Inputs outputs at V bat.

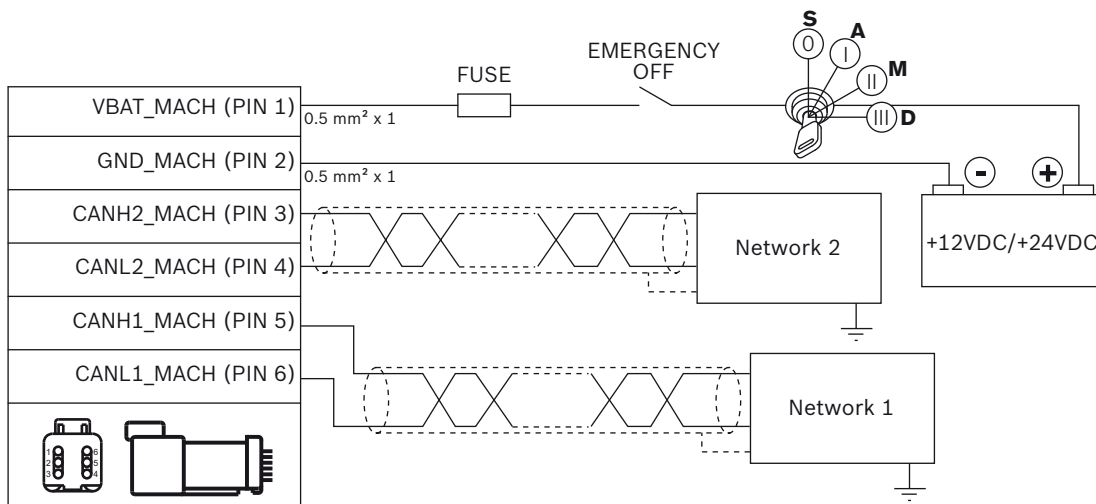
Electrical functions of the CAN electronic joysticks THEC5 or THED5

(for applications outside these parameters, please consult us)

Electrical connection to a CAN network (connector 2, power supply and CAN)



Electrical connection to a double CAN network (connector 2, power supply and CAN)



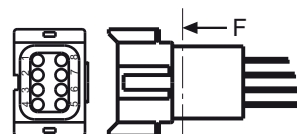
Characteristics of the 5V power supply

The CAN electronic joystick deliver stabilized 5V on one output for the supply of external components.

Power supply 5V	Cable identification	Characteristics			
		Voltage (V)	Current (mA)	Protection	Remarks
For sensors and main functions of the machine wiring	VCCAUX_PPAL_36V	0 - 5	150	Short circuit : - 0V - 36V	

Electrical connection (connector 3)

See next page, Pos. 8 on connector 3 for analog options.



Characteristics of the digital outputs (on-off / PWM)

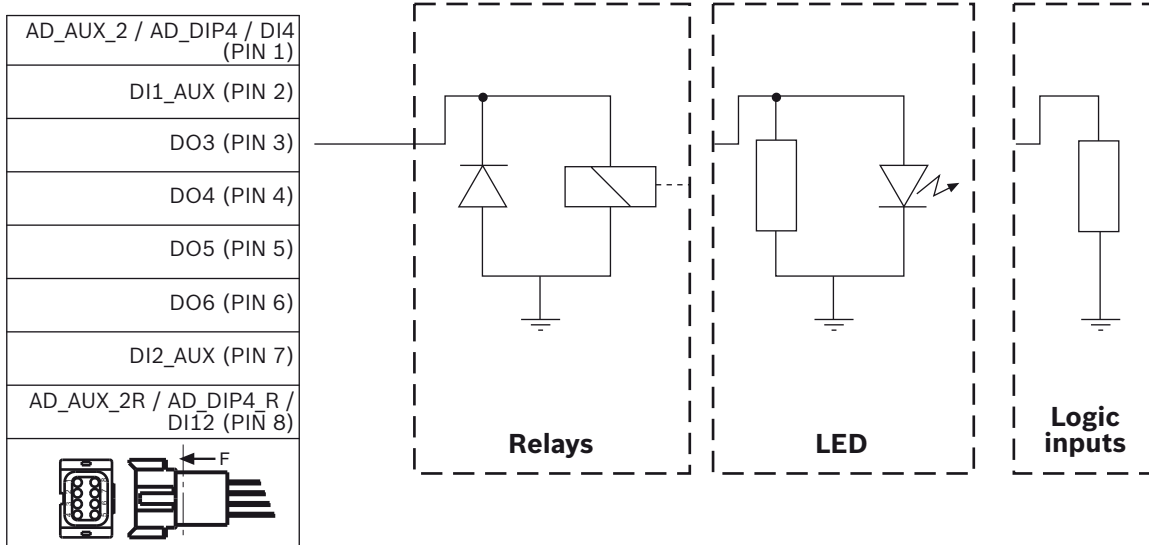
The CAN joysticks integrate 6 digital outputs.

These voltage outputs can supply relays, lamps but also control the brightness of LED by PWM modulation of the voltage signal (contact us for the configuration of the PWM signal).

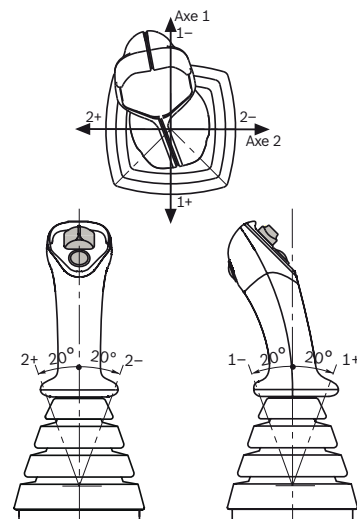
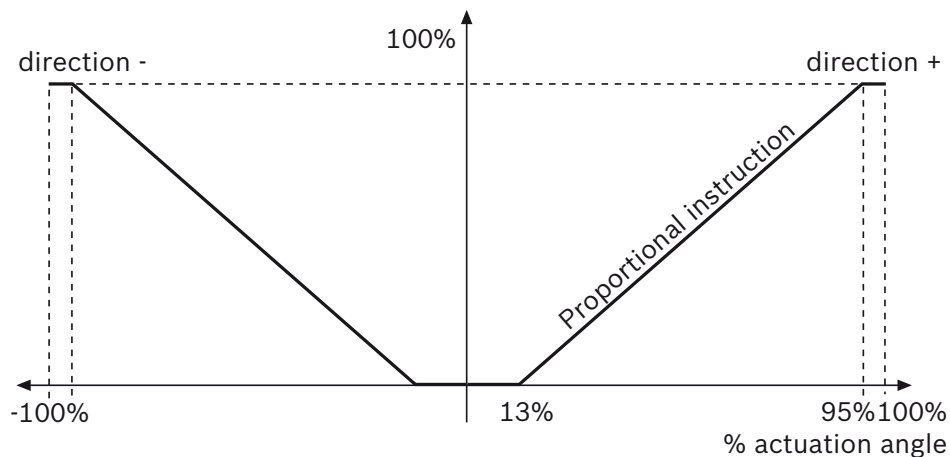
List of the digital outputs

Digital output	Cable identification	Characteristics				
		Voltage (V)	Current (mA)	Protection	Polarization mode	Remarks
DO1	DO1_36V	0 - 36	30 per output	Short circuit : - 0V - 36V	On/Off output «pull up» at Vbat.	Switchable common upstream protection stage against short circuits.
DO2	DO2_36V					
DO3	DO3_36V					
DO4	DO4_36V					
DO5	DO5_36V					
DO6	DO6_36V					

Electrical connection of the digital outputs (connector 4 for On/Off options)



Outputs of the CAN signal



Révisé le 25/06/11. Révisé le 01/01/12. B. Sc. Révisé le 01/01/12

CAN frame according to the protocol in the CAN electronic joysticks THEC5 or THED5

Protocol Bosch Rexroth standard

Predefined protocol with periodic transmission of frames. The identifier of the frame is configurable.

Telegram 1									
ID :	Configurable on 11 bits								
Transmission rate :	Every 20 ms								
DLC :	8 Bytes								
Mapping									
	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
Axis 1	0..250								Byte 1
Axis 2	0..250								Byte 2
Axis 3	0..250								Byte 3
Axis 4	0..250								Byte 4
Direction (Dir)	4-	4+	3-	3+	2-	2+	1-	1+	Byte 5
Digital input (DI)	DI8	DI7	DI6	DI5	DI4	DI3	DI2	DI1	Byte 6
Error (Err)	Error codes are available on request								Byte 7
Incremental counter (Inc)	Cyclic counter 0..255								Byte 8

Additional information :

- ▶ Physical layer : Standard 2.0A
- ▶ Identifier 11 Bits
- ▶ BUS speed : 125, 250, 500, 1000 kbps

Object dictionary

The CANopen protocol is based on the use of the object dictionary that contains a list of objects accessible via the configuration tools.

CANopen and eds file (electronic data sheet) are available on request.

Service Data Object (SDO)

Allows access to objects defined in the object dictionary (Read / Write).

Fully compatible with the tool «vector CANsetter» (software for configuring a CANopen component).

The «multi packet» (transmit objects larger than 4 bytes) is not managed by the electronic joystick.

Network management

According to DS300 standard, CANopen defines four operating status:

- ▶ Initialization: component initialization on the network
- ▶ Pre-operational: component configuration on the network.
- ▶ Operational: normal function of the component on the network

- ▶ Stop: Suspension of the frame transmissions to the network (to temporarily reduce the bus load). The operating status are accessible via NMT frame (Network Management)

A special option offered to customers can boot directly into the operational status (without using NMT frame to move from the pre-operational to operational status).

TxPDO

The TxPDOs frames convey the status of internal axis information, rollers, rockers and pushbuttons. They may also contain frame counters, error codes and other objects of the dictionary.

The electronic joystick sends the TxPDO1 frames TxPDO2, TxPDO3 and TxPDO4 whose identifiers respect the DS300 standard.

The electronic joystick proposes following frames transmission modes :

- ▶ Synch 0: Transmission on reception of synchronization frames when internal status changes
- ▶ Synch X (1 – 10): Transmission after reception of X synchronization frames.

- ▶ Asynchronous :
 - Periodic transmission (configurable periodicity with a resolution of 10 ms).
 - Periodic transmission (configurable periodicity) or on status change.

The content of TxPDOs frames is fully configurable during production or when using on machine.

RxPDO

RxPDO frames are used for piloting On/Off outputs (ex: relays, LED,...) or PWM (ex: back light on push button).
 The electronic joystick receives the RxPDO1 frame which identifier comply with the DS300 standard.
 The use or not of this frame depends of the customer need.

EMCY

The EMCY frame (emergency) is emitted by the electronic joystick as soon as it detects a default.
 EMCY identifier comply with the DS300 standard.

The list of error codes is available on request.

General	
Node ID	Configurable
SDO	Multipacket transfert no supported (Object dictionary available on request)
NMT	Compliant with DS301 (Configurable initial state : Pre-operationnal or Operationnal)
Emergency frame (EMCY)	Compliant with DS301 (error code are available on datasheet)
Error Control Services	Configurable: Node guarding, heartbeat
Device profile	DS401 (Object dictionary and eds file available on request)

Frame1 TxPDO	
COD ID	0x180 + node ID
Transmission rate :	Every XX ms; On Synch Y; Every XXX ms or on change (not exceed 10m)
DLC	8 Bytes

Mapping								
bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
								Byte 1
								Byte 2
								Byte 3
								Byte 4
								Byte 5
								Byte 6
								Byte 7
								Byte 8

*Area to be filled with the items contained in the object dictionary available on request.
 See section describing the specifics of the CANopen standard.*

Frame 2 (TxPDO)								
COD ID			0x280 + node ID					
Transmission rate :			Every XX ms; On Synch Y; Every XXX ms or on change (not exceed 10m)					
DLC			8 Bytes					
Mapping								
bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
								Byte 1
								Byte 2
								Byte 3
								Byte 4
								Byte 5
								Byte 6
								Byte 7
								Byte 8

Area to be filled with the items contained in the object dictionary available on request. See section describing the specifics of the CANopen standard.

Frame RxPDO1								
COD ID			0x200 + node ID					
Transmission rate :			Every XX ms; On Synch Y; Every XXX ms or on change (not exceed 10m)					
DLC			8 Bytes					
Mapping								
bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	
								Byte 1
								Byte 2
								Byte 3
								Byte 4
								Byte 5
								Byte 6
								Byte 7
								Byte 8

Area to be filled with the items contained in the object dictionary available on request. See section describing the specifics of the CANopen standard.

J1939 protocol

Physical layer: Standard CAN 2.0A

Identifier 29 Bits

BUS speed : 125, 250, 500, 800, 1000kBd (kBps)

Source Adresse

The source address is the identifier of the electronic joystick on the CAN J1939 network. It is configurable from 2-253 based on the needs expressed by the customer.

Address claiming process (SAE J1939-81 JUN2011)

The electronic joystick can be configured in « master configurable mode », or in « self configurable mode ».

▶ Master configurable mode :

In case of conflict and priority loss during the claiming process, the electronic joystick stops any frame transmission until the master node allocate a new address.

▶ Self configurable mode :

In case of conflict and priority loss during the claiming process, the electronic joystick automatically choose a new address and start again the claiming process.

The frames

▶ BJM (basic joystick message) and EJM (extended joystick message)

The electronic joystick manages BJM and EJM frames. The frame transmission occurs when status changes or periodically each 100ms. The periodicity in case of sta-

tus change can be configured (10ms or 20ms)

The electronic joystick proposes two frames contents. The first content complies with the SAE J1939-71 standard and the second is a customization integrating counters and redundancy checks.

▶ DM1 (diagnostic message 1) according to SAE J1939-73 JUL 2013

The DM1 frame is an information issued by the electronic joystick when an internal default is detected. It is reissued every second until the fault disappears. The DM1 frame contains the code of the detected error, which list is available on request.

▶ DM13 (diagnostic message 13) according to (SAE J1939-73 JUL 2013)

The DM13 frame allows the control of the BUS load by validating or stopping the frame transmission on the CAN bus.

▶ DM14 to DM16 (diagnostic message 14 to 16) according to (SAE J1939-73 JUL 2013)

The DM14 to DM16 frames allow the configuration of the electronic joystick by using the J1939 protocol.

The list of objects (or parameters) accessible by means of the DM14 DM16 frames is available on request. The exchange mechanism includes the expression of a request by using the frame DM14, the acquittal of the request using the DM15 frame and the transmission of the required data by the DM16 frame.

Protocole J1939

General	
Source Adress (SA)	Configurable
Name	To be defined by the customer
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 JUN2011
Diagnosis Message 1 (DM1)	Compliant with SAEJ1939-73 JUL2013
Diagnosis Message 13 (DM13)	Compliant with SAEJ1939-73 JUL2013
Diagnosis Message 14-16 (DM14-16)	Compliant with SAE J1939-73 JUL2013 (detail available on datasheet or on request)

Telegram 1																																																																																		
Type	Basic Joystick Message 1 (BJM1)																																																																																	
Parameter group number (PGN)	0x00FDD6																																																																																	
Transmission rate	Every 100 ms or on change (not exceed 20ms)																																																																																	
DLC	8 Bytes																																																																																	
Mapping																																																																																		
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SPN = Suspected Parameter Number

Evolved J1939 protocol

General	
Source Adress (SA)	Configurable
Name	To be defined by the customer
Address claiming process	[Self Configurable; Master configurable] compliant with SAE J1939-81 JUN2011
Diagnosis Message 1 (DM1)	Compatible with SAEJ1939-73 JUL2013
Diagnosis Message 13 (DM13)	Compatible with SAEJ1939-73 JUL2013
Diagnosis Message 14-16 (DM14-16)	Compatible with SAE J1939-73 JUL2013 (detail available on datasheet or on request)

Telegram 1																																																																																										
Type	Basic Joystick Message 1 (BJM1)																																																																																									
Parameter group number (PGN)	0x00FDD6																																																																																									
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SPN = Suspected Parameter Number

Guidelines for the electronic joystick CAN THEC5 or THED5

Operating precautions

Safety measures

- ▶ Provide a fully accessible device to the operator for disabling the electronic joystick signal.
- ▶ Provide at the receiver (Machine Controller), a «time out» device compatible with the controlled functions.
- ▶ Signal cables and power cables must be rooted separately and away from each other.
- ▶ In case of electric welding operations on the machine, unplug the power supply battery as well as all plugs connecting the electronics.
- ▶ Ensure adequate distance between electronics and any radio installations in order to limit the magnetic field seen by the electronic joystick.
- ▶ Do not use electronic joysticks close to a magnetic field source of frequency lower than 50 Hz and amplitude greater than 2 mT.
- ▶ Do not use in explodable environment.
- ▶ Do not direct the jet of a pressure washing unit directly at the unit.
- ▶ Equip other inductances of the machine with freewheel diodes to avoid the generation of parasites.

Wiring recommendations

The wiring diagram on the machine is described on page 9. The fuse used on the power supply is 1.4A at 12V or 1A at 24V.

Recommendations for the definition of CAN frames

We recommend to incorporate an incremental frames counter into the set frames sent by the electronic joystick. When processing CAN messages, the machine controller must verify the correct increment of the counter of the joystick frame and implement a message detection that will stop the movements controlled by the joystick in case of no message detected.

Startup recommendations (CAN setter...)

Maintenance test: A self test sequence has been defined in order to check the availability of the SIL2 safety functions. To reduce the startup time we can program a “light” self-test. The «light» self test does not exclude the periodic execution of the complete test.

- ▶ Starting with the CANopen protocol: If no adjustment is scheduled on machine, we recommend using the boot option in operational mode.
If you want to configure the electronic joystick at each start, the .eds file (compatible with DSP306 standard) can be provided on request.
- ▶ Starting with the J1939 protocol: When starting in J1939 protocol, the electronic joystick will wait to have a valid address before transmitting the instructions frames.

Maintenance recommendations

Self test:

The self test must be started automatically at each start or on demand every 10 000 hours of use. The self test sequence takes about 500ms.

Error code:

If the electronic joystick is in default, an error code is emitted. The message containing the error code depends on the protocol used.

- ▶ In BRM Std: The error code is included in the 7th bytes of the frame 1.
- ▶ In CANopen: The error code is included in the 3rd and 4th bytes of the EMCY frame.
- ▶ In J1939: The error code is included in the 3rd and 4th bytes of the DM1 frame.

The description of the error codes is available on request.

Reset in case of error:

The error codes are classified into 4 categories.

- ▶ Information Error Code
This type of defect does not influence the functioning it disappears when the fault is no longer present.

- ▶ Minor error code
This type of defect notify a malfunction of an electronic joystick functionality.
It issues a neutral position signal on the faulty axis regardless of its position. It indicates an inactive status of some component regardless of its status. The operation returns to normal as soon as the axis or component returns to neutral and the fault is no longer detected.
- ▶ A major error code
This type of defect notify a major malfunction of the electronic joystick.
It issues neutral position signals on all axes in default whatever their positions.
It indicates an inactive status of all connected components whatever their status. Resetting requires a reboot.
- ▶ Critical error code
Identical description to the “major error code” unless the fault remains present even after reset. To disable this type of defect, a specific CAN message must be sent to the electronic joystick.
Contact Bosch Rexroth for the reset procedure.

Electronic remote control for mobile application

Type EJ

Series 1X



Type 8EJ H ¹⁾

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Features

- Specially designed for mobile machines forklift truck or tractor type.
- Types available: PWM Signal or CAN.
- Up to 4 proportional axis integrated.
- Large selection of ergonomic grips with various E-contacts on / off rockers or proportional control.
- The design ensures an excellent protection of electronics.
- Hall effect contactless sensors.

¹⁾ Noncontractual picture

Functional description, section

Design

Remote controls type EJ are mainly composed of a handle (1), a fixation body or plate (2) and a cover (3) containing the contactless sensors and electronic cards.

General

The main differences between types of EJ are the integrated electronic functions and the type of output signals.

The remote controls PWM Signal and CAN integrate a power supply regulation and can therefore be supplied by the vehicle battery directly.

The remote control CAN periodically generates a frame on CAN bus which allows the communication with other systems.

The remote controls PWM Signal and CAN only generate low power signals. The actuation of an electrohydraulic axis requires a further external electronic power interface.

Remote controls fitted with microcontrollers communicate with the PC through ISOK interfaces.

Function principle

When not actuated the operating element is held in neutral position by the return springs (8).

With deflection of the handle (1), plunger (5) pushes against return spring (8). The magnet (7) mechanically linked to the lever (9) of the handle (1) moves upward or downward while following the operating element actuation direction. The command value generated by the sensor (4) is proportional to the deflection of the lever.

A rubber boot (6) protects the mechanical components of the housing from external contamination.

Application

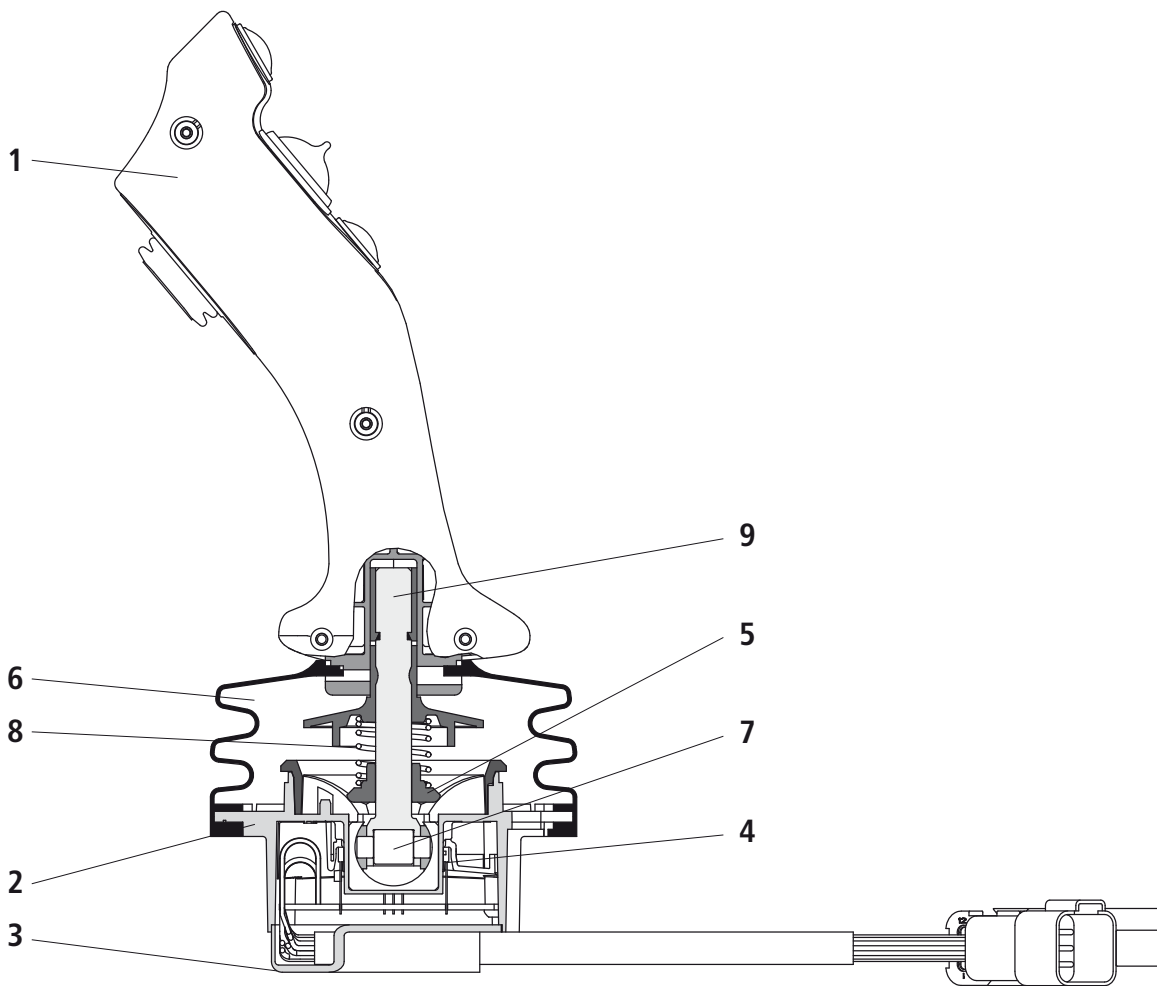
Remote controls type EJ is for armrest installation and for the remote control of mobile machines equipment (forklift truck, tractor). The electronics integrated in the joystick enables the remote control of up to 4 proportional axis if it is connected to the proportional sensors inside the grip.

In the PWM version, additional functionality dedicated to agricultural application, such as floating function, can be configured. Please consult us for more details.

Standard joystick BODAS EJ

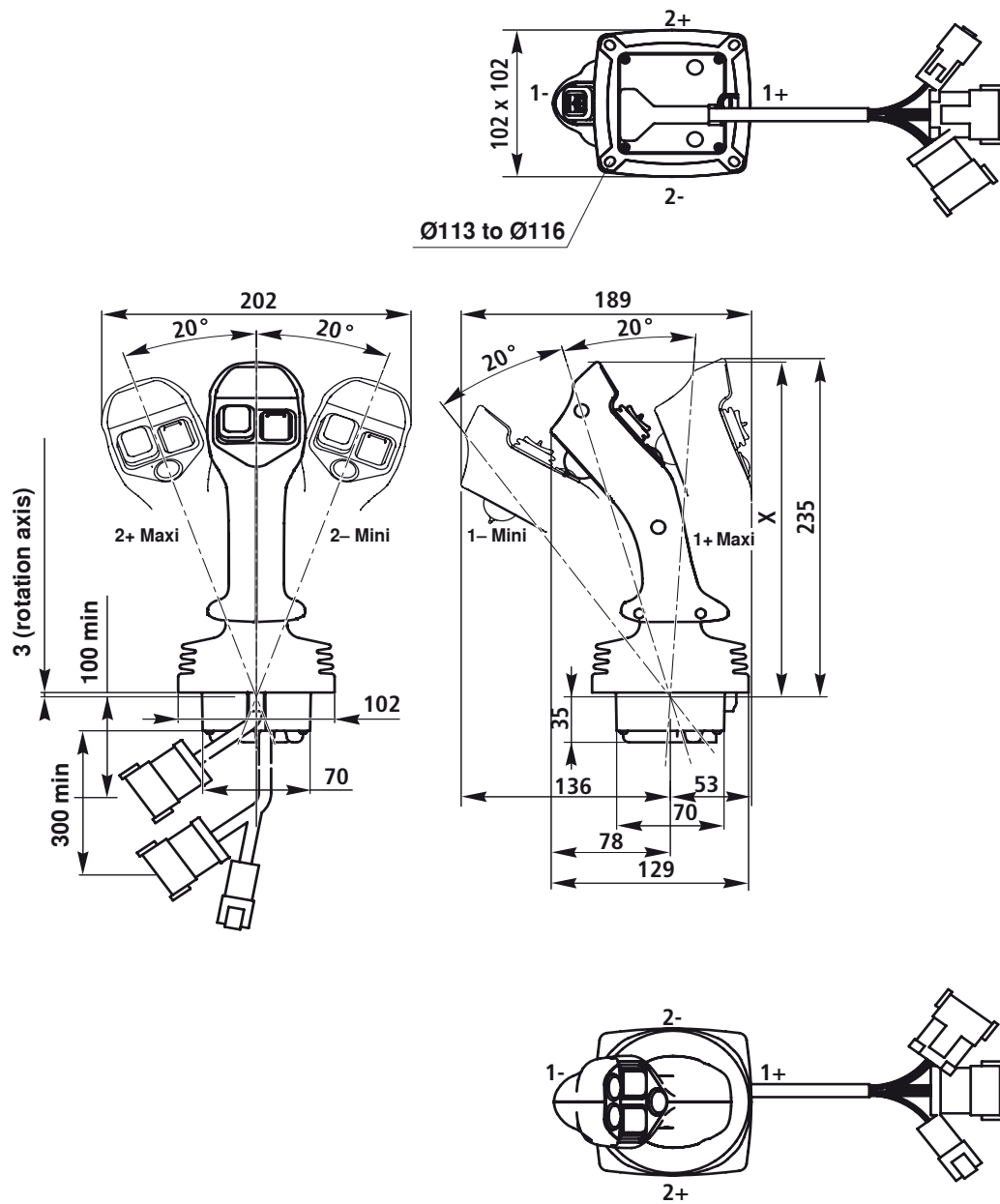
Pre-configured EJ standard configurations fitting to the Rexroth BODAS Mobile Electronics System can also be ordered directly from Mobile Electronics. See ordering details page 4 for more details.

EJ section



Unit dimensions (in mm)

Joystick EJ



Unit dimension in function of the grip type

Type of grip	X (with straight lever)
EC2000	188
EC2000+	197
EC4000	233

Ordering details

	EJ		-1X/	03		*
--	-----------	--	-------------	-----------	--	----------

Number of axis

2 axis	= 4
3 axis ¹⁾	= 6
4 axis ²⁾	= 8

Type of output

Signal PWM	= SW
CAN	= C

Type of controller

Grip EC2000 ³⁾	= E
Grip EC4000	= H
Grip EC2000+	= I
Grip EC3000+	= G
Without lever	= Z
Other grip	= no code

Further details in clear text

Plug

5 =	Deutsch sealed plugs IP67 for the wiring of the grip and solenoid
no code =	no plug

Grip orientation / Machine

03 =	Lever straight and grip towards 1-
no code =	Without grip

Grip type

TT, ST, VT, YT, YU =	Grip type E
	Grip type H, I, G see datasheet: RE 64547
no code =	Other grip

Standard BODAS EJ Configurations (default software parameters)

- 4 EJ C E -1X / TT 03 5:** 2 axes, CAN interface, handle EC2000 without push buttons
- 4 EJ C E -1X / VT 03 5:** 2 axes, CAN interface, handle EC2000 with 2 push buttons
- 4 EJ C E -1X / YU 03 5:** 2 axes, CAN interface, handle EC2000 with 4 push buttons

These part numbers are to be ordered from Rexroth Mobile Electronics Elchingen.

Note:

Standard BODAS EJ equipped with VT or YU handles feature an inverted connector on the handle that allows to directly plug the handle connector into one of the joystick base connectors.

¹⁾ 6EJ with grip EC2000+ or EC4000 or EC3000+

²⁾ 8EJ with grip EC4000

³⁾ 4EJ only

Mechanical technical data (for applications outside these parameters, please consult us)

Lifetime		3 millions actuation cycles ¹⁾	
Temperature range	Storage, ambient	°C	-40 to +80
	Operation	°C	-20 to +60
Resistance to vibrations and shocks		According to CDC 381002. Consult us	
Electronic protection degree		IP 67	
Actuation Torque		Nm	
	Stroke start		0.6
	Full stroke position		1.5
	Maximum permissible at the operating element with an exceptional, one-time loading		100
Actuation angle		in degree	
	On all axis		20°
Weight		Kg	0.9

Software Guidelines

Parameters properties

For PWM signal, print and fill pages 11 to 12.

For CAN signal, print and fill pages 21 to 23.

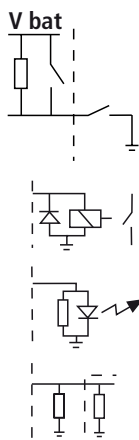
You will have to fill the parameters values following these rules:

Parameter	Value	Available Range	Default
(give the names of parameter list)	(enter your choice here)	(give information about possible values)	(give the default value if no choice has been done)
PARAMETER_NAME		[X-Y] This means that you can select a value between X and Y, the resolution is done with the unit.	Default Value and Unit
		[X;Y] This means that you can select only X or Y.	
		- Function 1 - Function 2 ... This means that you can select only 1 Function in the function list 1,2...	
		YES / NO Select YES to have the function active or NO to have the function inactive	

¹⁾ Life test realized with the operating torques (i.e. at full stroke position).

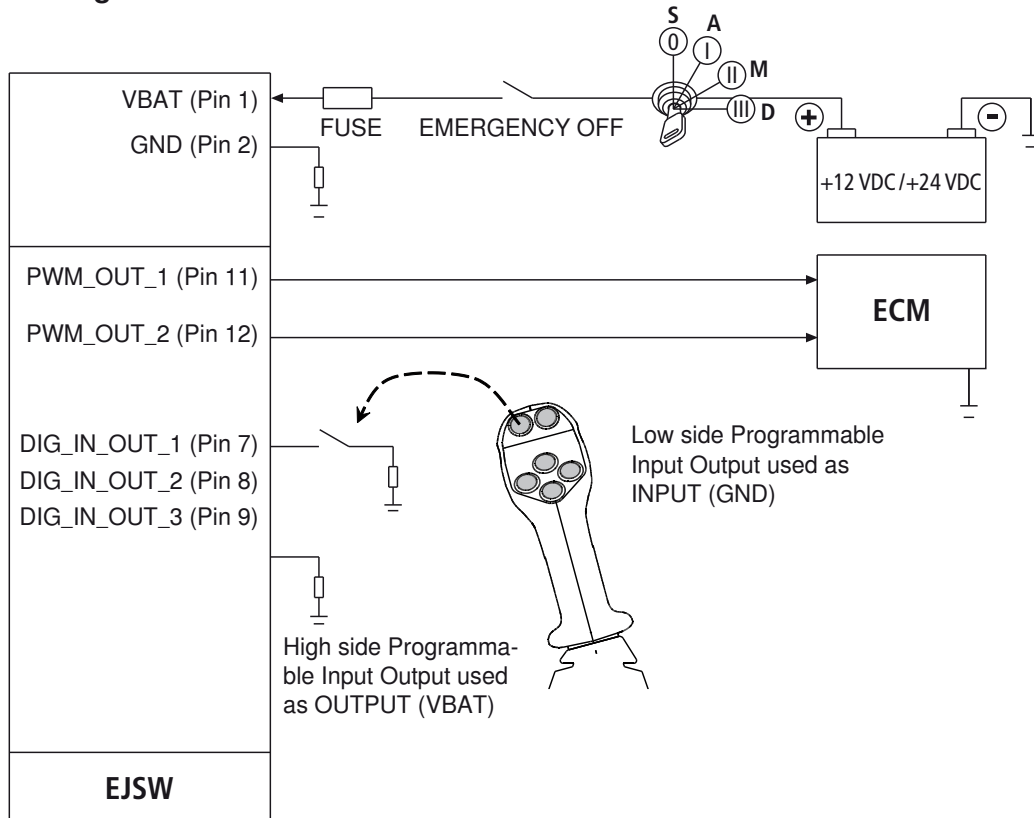
Electrical technical data PWM Signal (for applications outside these parameters, please consult us)

Power supply	V	9 to 32 VDC
Maximum current consumption	mA	300
Proportional Signal		
Proportional signal duty cycle	%	
Full stroke towards 1+ or 2+		90 % \pm 2.5 % ¹⁾
Neutral		50 % \pm 2.5 % ¹⁾
Full stroke towards 1- or 2-		10 % \pm 2.5 % ¹⁾ (i.e. 7.5 % to 12.5 %)
PWM Signal frequency	Hz	196
High voltage signal	V	4 to 5
Low voltage signal	V	0 to 1
Maximum sourcing current	mA	20
Digital Input / Output (DIG_IN_OUT)		
Characteristic		Adjustable by programming
Input function connected to a switch		To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance of 8.2 K Ω . The switch must be fitted to a 5 mA current.
Output function		When the output is inactive, take into account the pull up 8.2 K Ω resistance to set the output voltage
Output function connected with a relay		The relay must have a minimal current of activation of 10 mA
Output function connected with a LED		The LED must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Output function connected to a logical input		The logical input must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Maximum sourcing current	mA	200 (with resistive load)
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	2
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2 V/m		100
Current injection according to ISO 11452 part 4 mA		200
Direct electrostatic discharge	kV	\pm 6
Electrostatic discharge in the air	kV	\pm 8
Further data		Consult us



¹⁾ The tolerance is function of the full scale range and takes into account thermal drift and lifetime.

Wiring: block diagram

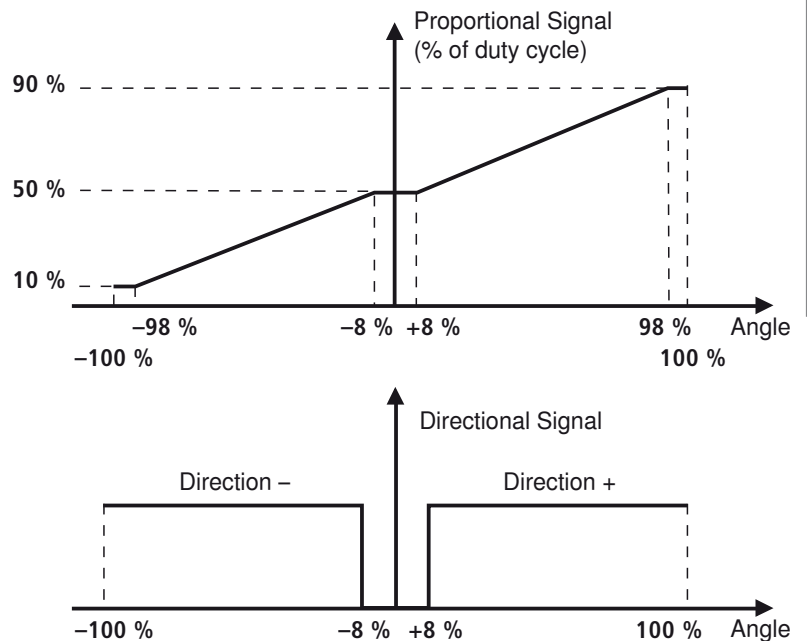
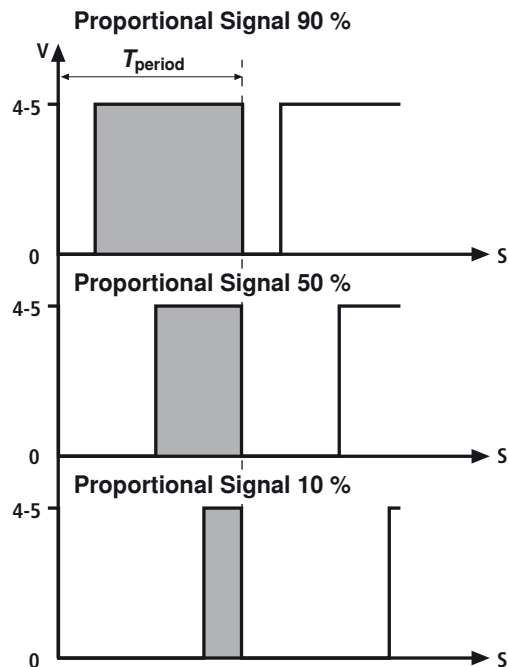


Programming tool: see page 25

Pin assignment: see page 26

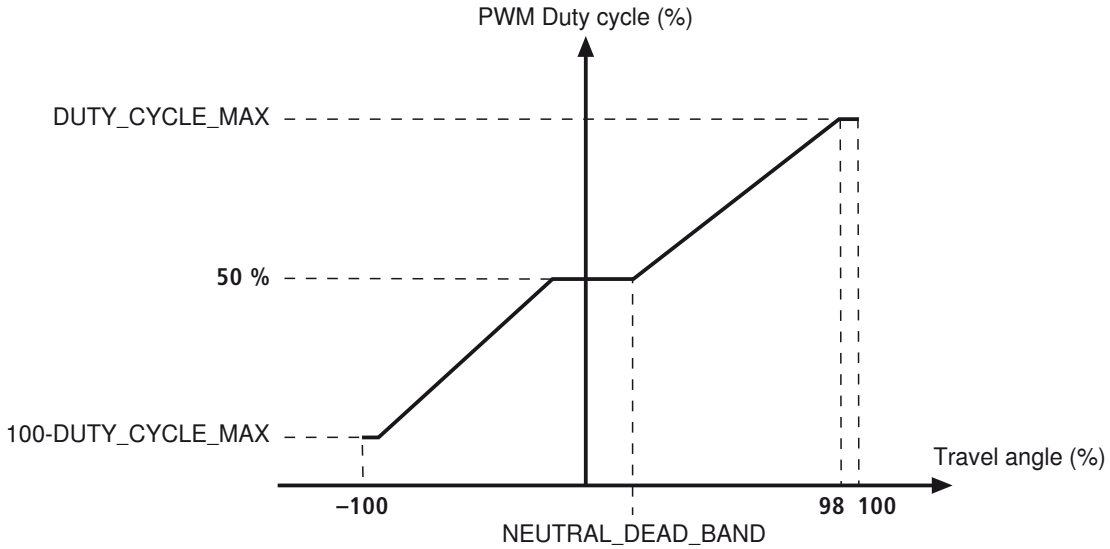
Output characteristic

The proportional signal (%) is the ratio between the time at high side and the time at low side



PWM Signal Software parameters

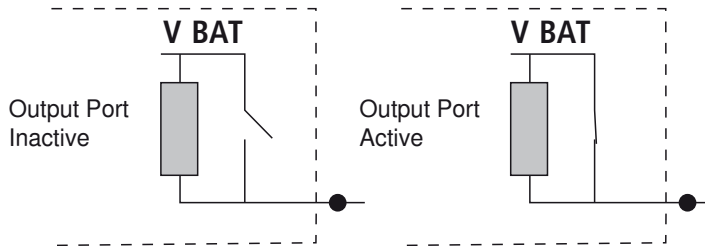
PWM Signal Outputs



⇒ Please refer to board #1 ¹⁾

Digital Input / Output Port

SIGNAL PWM integrate 4 Digital Configurable Input Output ports and 3 Digital Not Configurable Input ports. Inputs are active when they are connected to ground by external circuitry and inactive when disconnected from ground, pull up is done internally. Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation:



⇒ Please refer to board #2 ¹⁾

¹⁾ boards are at the end of this section.

Functions parameters

1. Direction and Out of Neutral Outputs

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation. Direction is active when the sensor's position leaves the neutral dead band defined in percent of the full travel range (NEUTRAL_DEAD_BAND).

There are 6 modes:

- Direction Plus on Axis 1 (D1P): The Output Port is activated when the axis 1 goes in direction 1 Plus
- Direction Minus on Axis 1 (D1M): The Output Port is activated when the axis 1 goes in direction 1 Minus
- Direction Plus on Axis 2 (D2P): The Output Port is activated when the axis 1 goes in direction 2 Plus
- Direction Minus on Axis 2 (D2M): The Output Port is activated when the axis 1 goes in direction 2 Minus
- Out Of Neutral Axis 1 (OU1): The Output Port is activated in both directions Plus and Minus on Axis 1
- Out Of Neutral Axis 2 (OU2): The Output Port is activated in both directions Plus and Minus on Axis 2

2. Status Indicator Output

This function works using an Output Port.

The activation switches the Output Port to battery voltage (200 mA max).

Connect a LED to the relevant output considering the internal pull up 8.2 kOhm resistors when Output is inactive.

There are 2 modes:

- Error Status Indicator (FLT): This mode will lead LED indicator to light on in case of fault.
- Ready to Work Indicator (RTW): This mode will light on the LED if there is no fault detected.

⇒ Please refer to board #3 ¹⁾

3. Dead Man Input

This function works using an Input port.

This function is activated when port is connected to ground.

Dead Man function allows freezing the joystick signals in neutral if the assigned input is not activated and whatever the position sensors are. Transition will be done without ramp time.

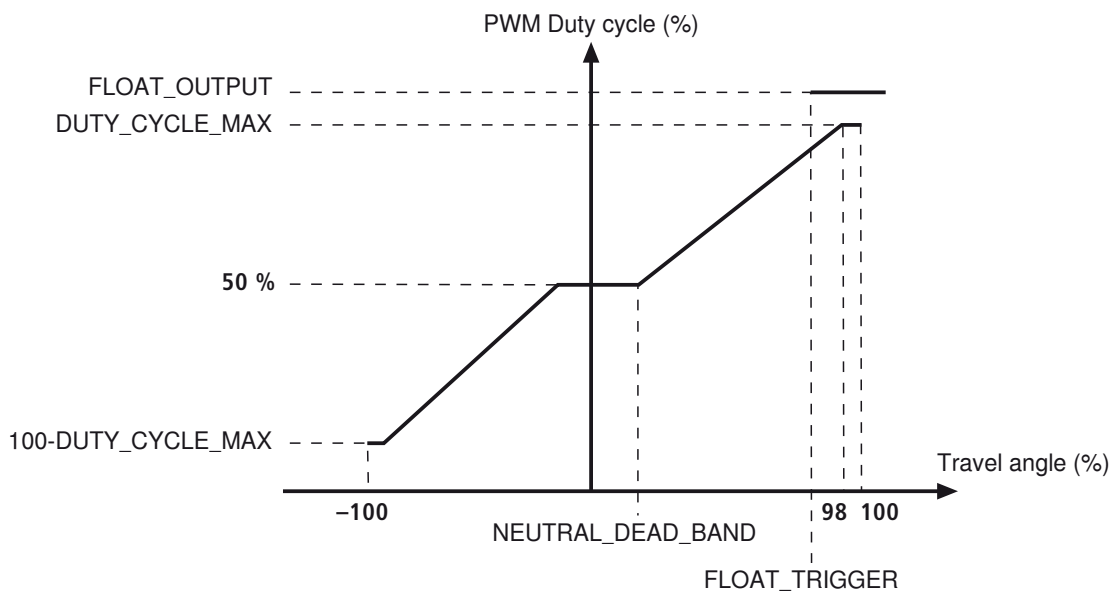
There are 2 modes to enable the outputs signals:

- Permanent: The output signals are enabled while the input stays connected to the ground.
- WatchDog: The output signals are enabled while the input changes periodically from connected to disconnected.

⇒ Please refer to board #4 ¹⁾

¹⁾ boards are at the end of this section.

4. Floating



Floating allows shifting the assigned spool in fourth position. The floating function works using an Input port and is activated when port is connected to ground (the input doesn't need to stay active after) and if the output activation is in the range [80 %-90 %]. The float will then stay active until the axis goes out of neutral in the direction where the float has been assigned.

PWM duty cycle for the Floating Instruction, PWM duty cycle for triggering, axi(s) and direction(s) assigned to the float can be selected in the following board.

⇒ Please refer to board #5 ¹⁾

¹⁾ boards are at the end of this section.

PWM Signal Boards

Board #1:

Parameter	Value	Available Range (Unit)	Default
PWM_FREQUENCY		[120;124;...;500] (Hz)	196
DUTY_CYCLE_MAX		[80;90] (%)	90
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	10
NEUTRAL_DEAD_BAND_AXIS_2		[8-15] (%)	10
PWM_VOLTAGE_OUTPUT		[5 V;VBAT]	5 V

Note 1: PWM Dduty cycle is always 50 % in neutral.

Note 2: Maxi Duty Cycle is reached at 98 % of the stroke (exemple: 19.6° for a 20° joystick), this value is not adjustable.

Note 3: PWM Voltage Output is either 5 V or VBAT for high level, 0 VDC for low level.

Board #2:

Parameter	Value	Available Range	Default
FUNCTION_DIO_1		INPUT FUNCTIONS – No Function (NOF) – Floating (FLO) – DeadMan (DMA)	NOF
FUNCTION_DIO_2			NOF
FUNCTION_DIO_3			NOF
FUNCTION_DIO_4			NOF
FUNCTION_DI_5		OUTPUT FUNCTIONS – Axis 1+ Direction (D1P) – Axis 1- Direction (D1M) – Axis 1 Out of Neutral (OU1) – Axis 2+ Direction (D2P) – Axis 2- Direction (D2M) – Axis 2 Out of Neutral (OU2) – Status Indicator (STA)	NOF
FUNCTION_DI_6			NOF
FUNCTION_DI_7			NOF

Note 1: Floating, DeadMan and Status Indicator functions require additionnals parameters, refer to section "Functions parameters" for furthers details.

Note 2: Floating and DeadMan functions can be assigned to one input maximum.

PWM Signal Boards

Board #3:

Parameter	Value	Available Range	Default
STATUS_MODE		- Fault Indicator (FLT) - Ready to work Indicator (RTW)	FLT

Board #4:

Parameter	Value	Available Range	Default
DEAD_MAN_MODE		- Permanent (PER) - WatchDog (WDG)	PER
DEAD_MAN_TEMPO (if WatchDog mode selected)		[0-60] (s)	60

Board #5:

Parameter	Value	Available Range	Default
FLOAT_TRIGGER		[80-90] (%)	80
FLOAT_OUTPUT		[95;95.5...;98] (%)	96.5
FLOAT_AXIS_1_PLUS		YES / NO	NO
FLOAT_AXIS_1_MINUS		YES / NO	NO
FLOAT_AXIS_2_PLUS		YES / NO	NO
FLOAT_AXIS_2_MINUS		YES / NO	NO

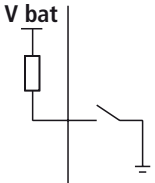
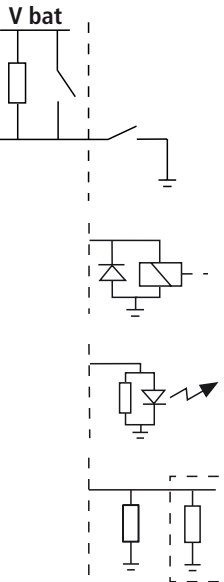
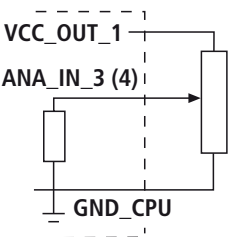
Electrical technical data CAN Signal (for applications outside these parameters, please consult us)

Power supply	V	9 to 32 VDC
Maximum current consumption	mA	300
Output Signal		
	% of ± 250	(1 byte encoding)
Neutral		0 %
Full stroke		± 100 %
Bus frequency	kHz	100, 125, 250, 500
Protocol (see page 15)		2.0 A or 2.0 B
Protections		
Protection against polarity reversal		Outputs protected between 0 and 32 V
Protection against short circuits		Yes
Fuse	A	2
Electromagnetic compatibility (EMC)		
Magnetic field according to ISO 11452 part 2	V/m	100
Current injection according to ISO 11452 part 4	mA	200
Direct electrostatic discharge	kV	± 6
Electrostatic discharge in the air	kV	± 8
Further data		Consult us

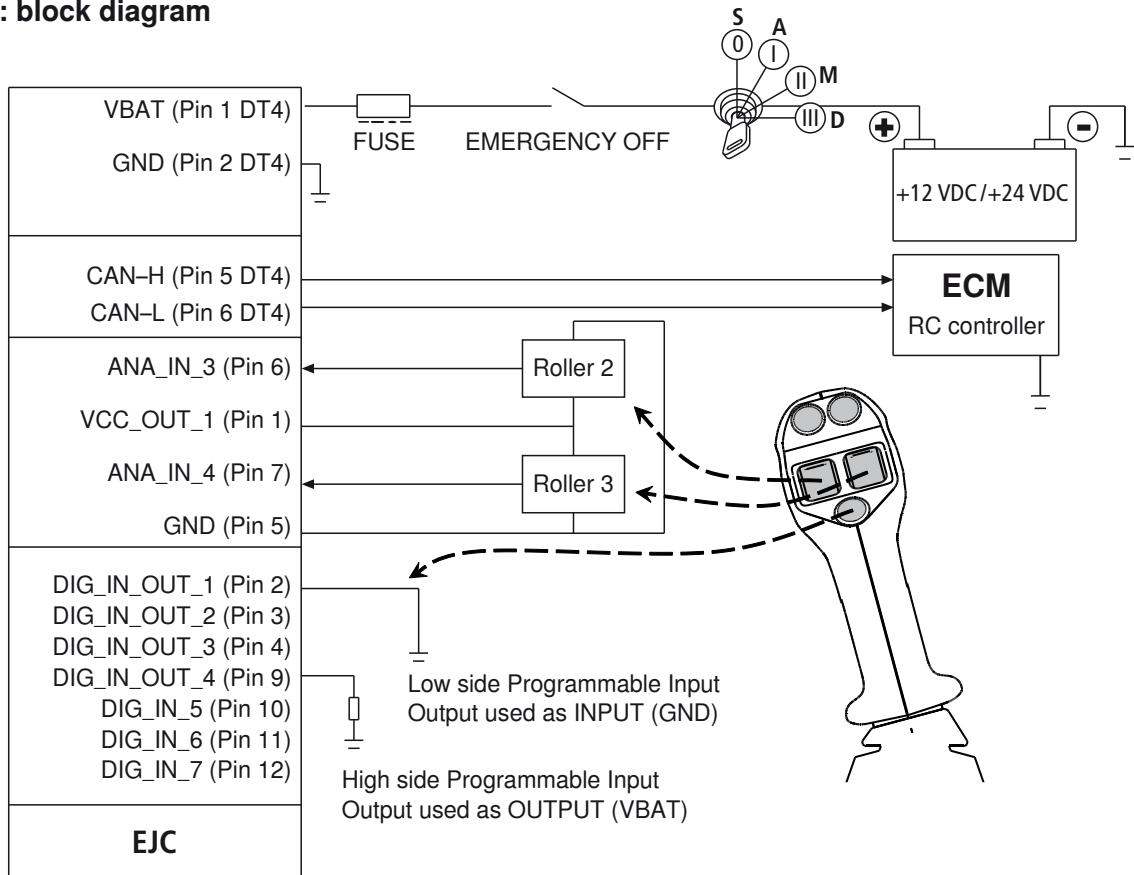
¹⁾ We recommend a dead band of ± 8 %. The dead band can be set at the transmitter (CAN joystick) or at the receiver. By default, there is no dead band on the transmitter.

Electrical characteristics CAN Bus (for applications outside these parameters, please consult us !)

Input / Output Electrical characteristics

Digital Input (DIG_IN)			
	Characteristic		Adjustable by programming
	Input function		To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance
Digital Input / Output (DIG_IN_OUT)			
	Characteristic		Adjustable by programming
	Input function connected to a switch		To ensure a minimum current when switching off the connected switch, each inlet is fitted with an internal pull up resistance of 8.2 K Ω . The switch must be fitted to a 5 mA current.
	Output function		When the output is inactive, take into account the pull up 8.2 K Ω resistance to set the output voltage
	Output function connected with a relay		The relay must have a minimal current of activation of 10 mA
	Output function connected with a LED		The LED must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
	Output function connected to a logical input		The logical input must have a 500 Ω resistance in parallel to reduce its alimentation voltage under 2 V when output is idle
Maximum sourcing current	mA		200 (with resistive load)
Analog Inputs for axis 3 and 4			
	VCC_OUT_1 maximum sourcing current	mA	75
	Pull down resistor on ANA_IN_3 (4)	kOhms		10

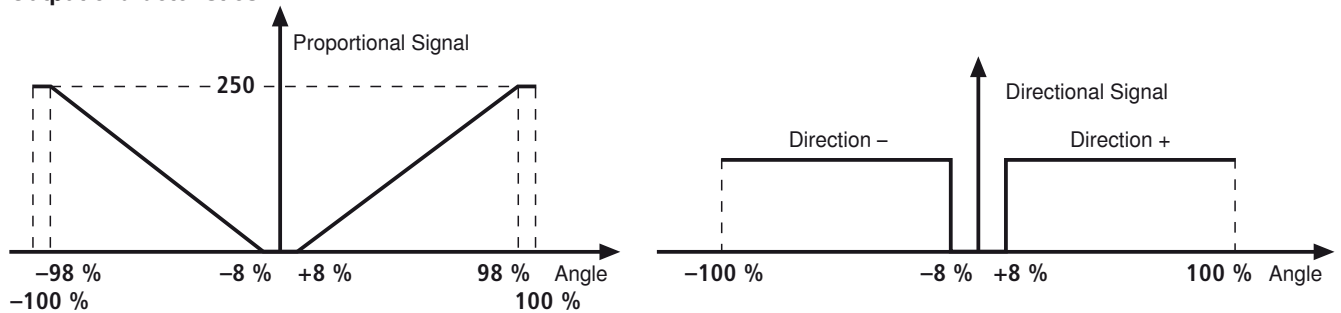
Wiring: block diagram



Programming tool: see page 25

Pin assignment: see page 26

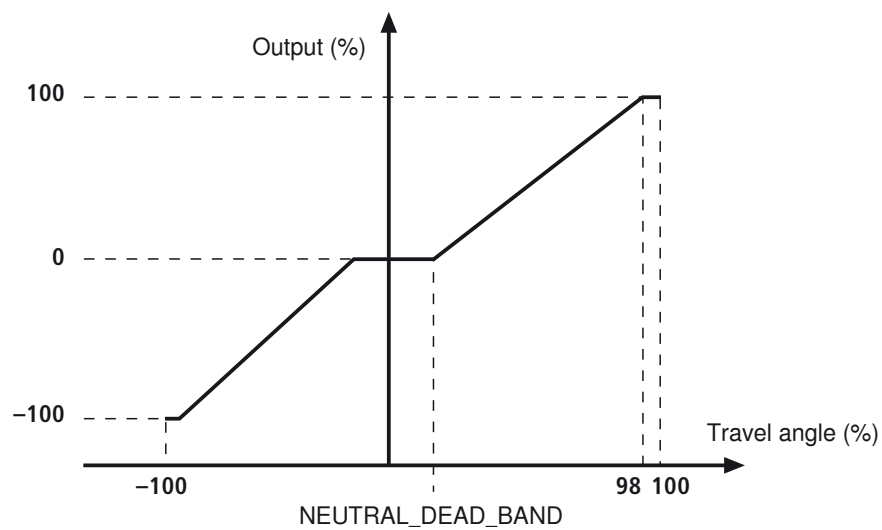
Output characteristics



Standard Protocol

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Position Axis 1 0->250	Position Axis 2 0->250	Position Axis 3 0->250	Position Axis 4 0->250	Bit 0: Axis1-	Bit 0: DIG_IN_OUT_1	zero or default code	Bit 0: 0
				Bit 1: Axis1+	Bit 1: DIG_IN_OUT_2		Bit 1: 0
				Bit 2: Axis2+	Bit 2: DIG_IN_OUT_3		Bit 2: 0
				Bit 3: Axis2-	Bit 3: DIG_IN_OUT_4		Bit 3: 0
				Bit 4: Axis3+	Bit 4: DIG_IN_5		Bit 4-7: counter 0->16
				Bit 5: Axis3-	Bit 5: DIG_IN_6		
				Bit 6: Axis4+	Bit 6: DIG_IN_7		
				Bit 7: Axis4-	Bit 7: 0		

CAN Signal Outputs



⇒ Please refer to board #14 ¹⁾

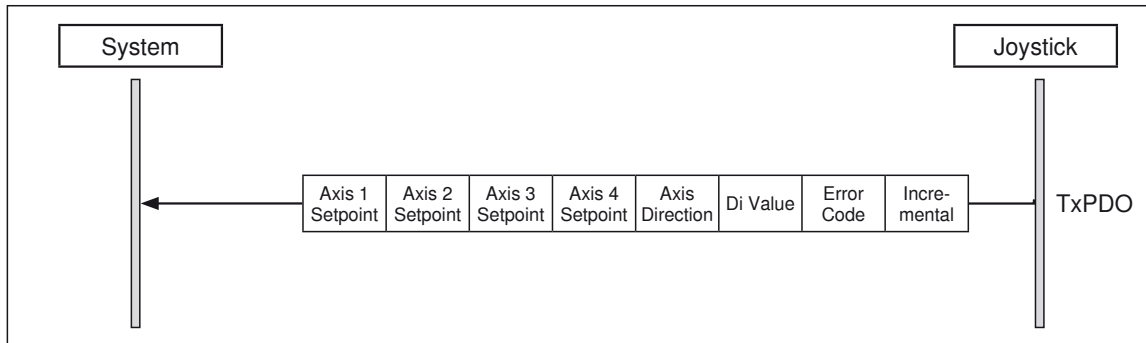
Protocol

⇒ Please refer to board #15 ¹⁾

¹⁾ boards are at the end of this section.

CAN Signal Software parameters

TxPDO BRM



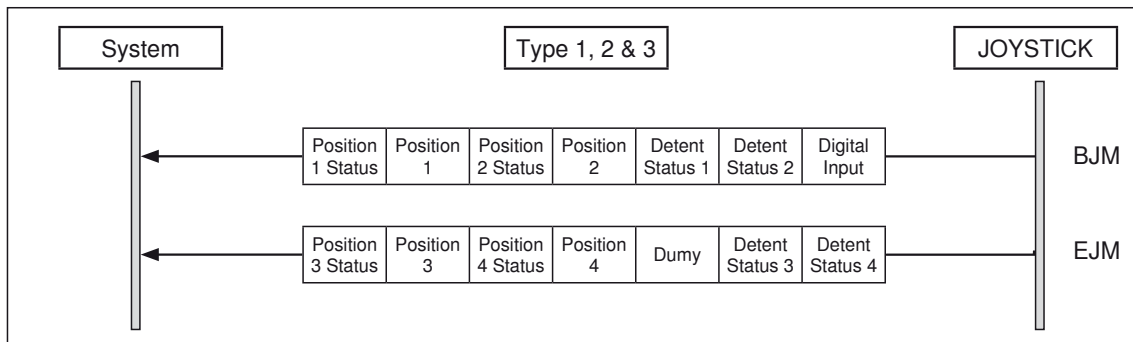
⇒ Please refer to board #16 ¹⁾

Message content:

Byte	bit	Parameter Name
1	1-8	Joystick Axis 1 Position
2	1-8	Joystick Axis 2 Position
3	1-8	HandGrip Axis 3 Position
4	1-8	HandGrip Axis 4 Position
5	1	Axis 1 Direction – [Forward]
	2	Axis 1 Direction + [Backward]
	3	Axis 2 Direction + [Left]
	4	Axis 2 Direction – [Right]
	5	Axis 3 Direction + [Up]
	6	Axis 3 Direction – [Down]
	7	Axis 4 Direction + [Up]
	8	Axis 4 Direction – [Down]
6	1	DIO_1 (1 = connected to ground)
	2	DIO_2
	3	DI_3
	4	DI_4
	5	DI_5
	6	DI_6
	7	DI_7
7	1-8	ZERO (Error Code)
8	1-4	ZERO
	5-8	Incremental counter

¹⁾ boards are at the end of this section.

TxPDO J1939



⇒ Please refer to board #17 ¹⁾

BJM Message content:

Byte	bit	Parameter Name
1	1-2	Joystick Axis 2 NEUTRAL Direction Status
	3-4	Joystick Axis 2 Direction + status
	5-6	Joystick Axis 2 Direction – status
	7-8	Joystick Axis 2 Position
2	1	Joystick Axis 2 Position
3	1-2	Joystick Axis 1 NEUTRAL Direction Status
	3-4	Joystick Axis 1 Direction + status
	5-6	Joystick Axis 1 Direction – status
	7-8	Joystick Axis 1 Position
4	1	Joystick Axis 1 Position
5	1-4	Not defined
	5-6	Joystick 1-Axis Detent Position Status
	7-8	Joystick 2-Axis Detent Position Status
6	1-2	Joystick Button 4 pressed status
	3-4	Joystick Button 3 pressed status
	5-6	Joystick Button 2 pressed status
	7-8	Joystick Button 1 pressed status
7	1-2	Joystick Button 8 pressed status
	3-4	Joystick Button 7 pressed status
	5-6	Joystick Button 6 pressed status
	7-8	Joystick Button 5 pressed status

¹⁾ boards are at the end of this section.

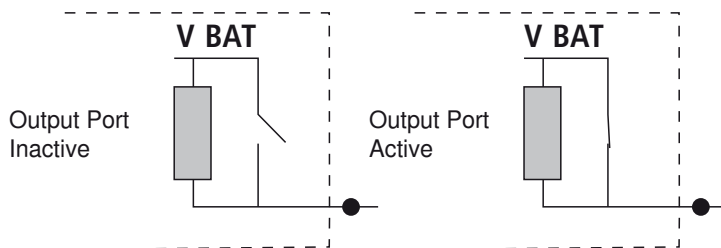
CAN Signal Software parameters

EJM Message content:

Byte	bit	Parameter Name
1	1-2	Joystick Axis 3 NEUTRAL Direction Status
	3-4	Joystick Axis 3 Direction + status
	5-6	Joystick Axis 3 Direction – status
	7-8	Joystick Axis 3 Position
2	1	Joystick Axis 3 Position
3	1-2	Joystick Axis 4 NEUTRAL Direction Status
	3-4	Joystick Axis 4 Direction + status
	5-6	Joystick Axis 4 Direction – status
	7-8	Joystick Axis 4 Position
4	1	Joystick Axis 4 Position
5	1-8	Not defined
		Not defined
		Not defined
		Not defined
6	1-8	Not defined
7	1-2	Not defined
	3-4	Not defined
	5-6	Not defined
	7-8	Not defined
6	1-8	Not defined

Digital Input / Output Port

CAN BUS EJ integrates 2 Digital Configurable Input Output ports and 3 Digital Not Configurable Input ports. Inputs are active when they are connected to ground by external circuitry and inactive when disconnected from ground, pull up is done internally. Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation:



⇒ Please refer to board #18 ¹⁾

Functions parameters

1. Direction and Out of Neutral Outputs

This function works using an Output Port. The activation switches the Output Port to battery voltage (200 mA max). Consider the internal pull up 8.2 kOhm resistors when Output is inactive for external load and voltage level calculation. Direction is active when the sensor's position leaves the neutral dead band defined in percent of the full travel range (NEUTRAL_DEAD_BAND).

There are 6 modes:

- Direction Plus on Axis 1 (D1P): The Output Port is activated when the axis 1 goes in direction 1 Plus
- Direction Minus on Axis 1 (D1M): The Output Port is activated when the axis 1 goes in direction 1 Minus
- Direction Plus on Axis 2 (D2P): The Output Port is activated when the axis 1 goes in direction 2 Plus
- Direction Minus on Axis 2 (D2M): The Output Port is activated when the axis 1 goes in direction 2 Minus
- Out Of Neutral Axis 1 (OU1): The Output Port is activated in both directions Plus and Minus on Axis 1
- Out Of Neutral Axis 2 (OU2): The Output Port is activated in both directions Plus and Minus on Axis 2

2. Status Indicator Output

This function works using an Output Port. The activation switches the Output Port to battery voltage (200 mA max). Connect a LED to the relevant output considering the internal pull up 8.2 kOhm resistors when Output is inactive.

There are 2 modes:

- Error Status Indicator (FLT): This mode will lead LED indicator to light on in case of fault.
- Ready to Work Indicator (RTW): This mode will light on the LED if there is no fault detected.

⇒ Please refer to board #19 ¹⁾

3. Dead Man Input

This function works using an Input port. This function is activated when port is connected to ground. Dead Man function allows freezing the joystick signals in neutral if the assigned input is not activated and whatever the position sensors are. Transition will be done without ramp time.

There are 2 modes to enable the outputs signals:

- Permanent: The output signals are enabled while the input stays connected to the ground.
- WatchDog: The output signals are enabled while the input changes periodically from connected to disconnected.

⇒ Please refer to board #20 ¹⁾

¹⁾ boards are at the end of this document.

CAN Signal Boards

Board #14:

Parameter	Value	Available Range (Unit)	Default
NEUTRAL_DEAD_BAND_AXIS_1		[8-15] (%)	10
NEUTRAL_DEAD_BAND_AXIS_2		[8-15] (%)	10
NEUTRAL_DEAD_BAND_AXIS_3		[8-15] (%)	14
NEUTRAL_DEAD_BAND_AXIS_4		[8-15] (%)	14

Note 1: Maxi Output % is reached at 98 % of the stroke (exemple: 19,6° for a 20° joystick), this value is not adjustable.

Board #15:

Parameter	Value	Available Range (Unit)	Default
PROTOCOL		[BRM;J1939]	BRM
BUS FREQUENCY		[125;250;500] (kHz)	250
EMISSION PERIOD		[20-50] (ms)	20
EMISSION PERIOD IN NEUTRAL		[20-50] (ms)	50

BRM protocol is an eleven bit identifier protocol (2.0A)

J1939 protocol is a 29 bits identifier protocol (2.0B), remote control integrates 4 identifiers:

©BJM1 Basic Joystick Message 1 for axis 1 & 2

©BJM1R Basic Joystick Message 1 redundant

©EJM1 Extended Joystick Message 1 for axis 3 & 4 if any

©EJM1R Extended Joystick Message 1 redundant

CAN Signal Boards

Board #16:

Parameter	Value	Available Range (Unit)	Default
BJM1_PRIORITY (3 MSB ID 11 bits)		[0x2;0x3]	0x2
PDU_SA (8 LSB ID 11 bits)		[0x00-0xFF]	0xFE (Right) 0xFF (Left)

Note 1: With Default values, identifier is 0x2FE.

Note 2: BRM protocol use same parameters name that J1939 protocol (BJM1, PDU_SA)

Board #17:

Parameter	Value	Available Range	Default												
STD_PGN_ID		<ul style="list-style-type: none"> - Type 1 - Type 2 - Type 3 <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Type 1</th> <th>Type 2</th> <th>Type 3</th> </tr> </thead> <tbody> <tr> <td>BJM</td> <td>0xFDD6</td> <td>0xFDD8</td> <td>0xFDDA</td> </tr> <tr> <td>EJM</td> <td>0xFDD7</td> <td>0xFDD9</td> <td>0xFDDB</td> </tr> </tbody> </table>		Type 1	Type 2	Type 3	BJM	0xFDD6	0xFDD8	0xFDDA	EJM	0xFDD7	0xFDD9	0xFDDB	1
	Type 1	Type 2	Type 3												
BJM	0xFDD6	0xFDD8	0xFDDA												
EJM	0xFDD7	0xFDD9	0xFDDB												
SPE_BJM_PGN_ID (For non standard)															
SPE_EJM_PGN_ID (For non standard)															

CAN Signal Boards

Board #18:

Parameter	Value	Available Range	Default
FUNCTION_DIO_1		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA) OUTPUT FUNCTIONS – Axis 1+ Direction (D1P) – Axis 1– Direction (D1M) – Axis 1 Out of Neutral (OU1) – Axis 2+ Direction (D2P) – Axis 2– Direction (D2M) – Axis 2 Out of Neutral (OU2) – Status Indicator (STA)	NOF
FUNCTION_DIO_2			NOF
FUNCTION_DI_3		INPUT FUNCTIONS – No Function (NOF) – DeadMan (DMA)	NOF
FUNCTION_DI_4			NOF
FUNCTION_DI_5			NOF
FUNCTION_DI_6			NOF
FUNCTION_DI_7			NOF

Note 1: DeadMan function require additionnals settings, refer to section "Functions parameters" for furthers details.

Note 2: DIO and DI status will be transmitted on the bus in all conditions and even if no function is selected.

Note 3: Floating and DeadMan functions can be assigned to one input maximum.

Board #19:

Parameter	Value	Available Range	Default
STATUS_MODE		– Fault Indicator (FLT) – Ready to work Indicator (RTW)	FLT

Board #20:

Parameter	Value	Available Range	Default
DEAD_MAN_MODE		– Permanent (PER) – WatchDog (WDG)	PER
DEAD_MAN_TEMPO (if WatchDog mode selected)		[0-60] (s)	60

Safety features and guidelines of the EJ

Safety features of the EJ

PWM Signal and CAN joysticks

These remote controls usually integrate one sensor per axis (main sensor). A second sensor may be added to provide redundancy.

The internal 5 VDC power supply is controlled to avoid any signal drift.

Optional on CAN joysticks

A hardware version can integrate the CAN joystick into SIL 2 level customer systems ¹⁾ (IEC 61508).

Safety guidelines for the application of the EJ

PWM Signal and CAN joysticks

The system using the signals delivered by the remote controls must check the consistency of the signals (Amplitude, Frequency) and implement the relevant corrective actions in case of failure.

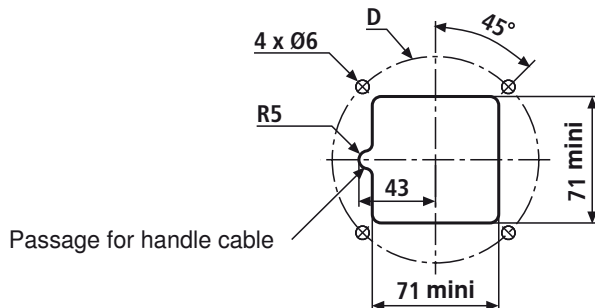
Warning

- An emergency stop switch is to be provided to disconnect the power supply to the electronics. This switch must be easily accessible to the operator. Safe braking must be provided for in case of emergency stop (case of translation drives).
- Shield the electric cables connected to position sensors (regulated power supply and proportional output). A low impedance line should connect the screen with the vehicle's ground.
- Signal cables and power cables must be routed separately and away from each other.
- In case of electric welding operations on the machine, unplug the power supply battery as well as all plugs connecting the electronics.
- Place the electronics away from possible radio equipments, to limit the magnetic field effect on remote control.
- Hall sensors are sensitive to external magnetic fields.
- Do not use the remote controls close to a magnetic field source of frequency lower than 50 Hz and of amplitude greater than 2 mT.
- Do not use in hazardous environment.
- Do not direct the jet of a pressure washing unit directly at the unit.
- Solenoids must be fitted with free-wheeling diode to avoid disturbances.
- Remote controls must be switched off when starting the engine of a mobile machine or vehicle.

Installation guidelines

- Mounting flange area: Flatness = 0.5 mm
- Screw head dimensions = \varnothing 10 mm
- Tightening torque for the flange fixing screws = Max. 10 Nm

Installation hole



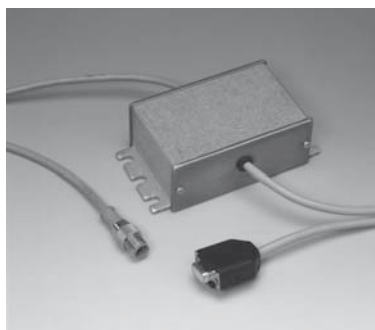
- Nominal diameter / fixing via 4 screws
D = \varnothing 113 to \varnothing 116 mm

¹⁾ Certification pending

Programming tool for PWM Signal and CAN joysticks

Display and adjustment possibilities

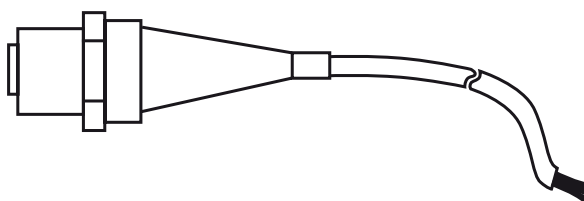
All adjustment processes and display of functions, faults and system-specific values are performed by means of a PC with software EMToolBox ¹⁾ via the serial control panel (DSI part number: 08250400 or 08250401).



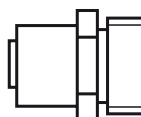
Control panel connection

The control panel is equipped with a connector Lumberg type RST 4.07.02M.
The machine must be equipped with one of the following connector Lumberg:

- Connector Lumberg type RKT 4.07.2M with prolongation cable; DSI part number: 07213052.



- Connector Lumberg to fix on a dashboard; DSI part number: 07213053.



Bush terminal RKF 4.07.0,2M

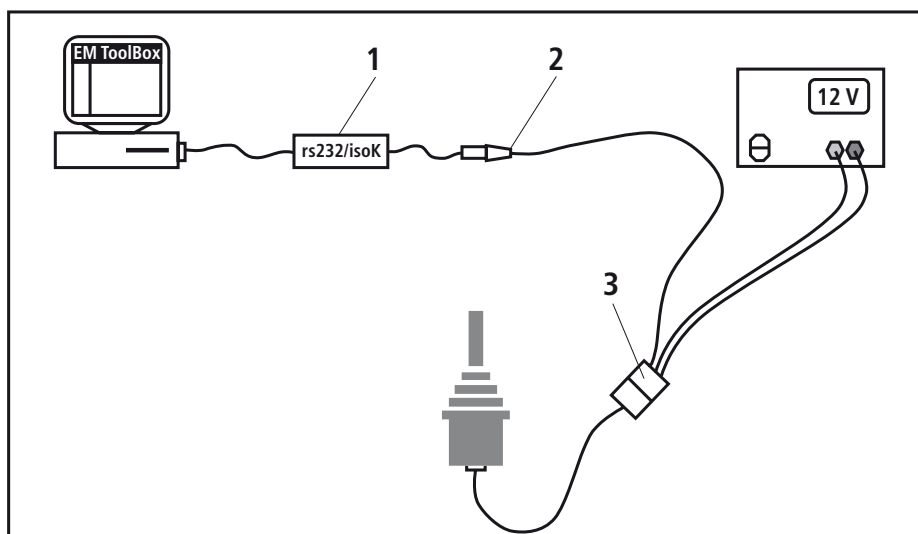
Nut RSKF9

Protective cap ZVF

Example of equipment to order

Diagnostic and adjustment of a joystick equipped with a Deutsch plug 12 pins:

- EMToolBox software and serial control panel: DSI part number: 08250400 (1)
- Connector Lumberg type RKT 4.07.2M with prolongation cable; DSI part number: 07213052 (2)
- Machine plug: DT06-12SA-CE01; DSI part number: 08250513 (3)



¹⁾ EMToolBox software and updates are freeware.

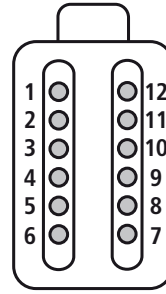
Pin assignment – PWM Signal

Output connection on Deutsch plug 12 pins

Remote control plug designation: DT04–12PA–CE01; 12 pins.

Machine plug designation: DT06–12SA–CE01; DSI part number: 08250513.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	DIG_IN_5
	5	DIG_IN_6
	6	DIG_IN_7
	7	DIG_IN_OUT_1
	8	DIG_IN_OUT_2
	9	DIG_IN_OUT_3
	10	DIG_IN_OUT_4
	11	PWM_OUT_1
	12	PWM_OUT_2



Symbol:

VBAT = +V batterie
 GND = Ground
 DIG_IN = Digital Input
 DIG_IN_OUT = Digital Input / Output
 PWM_OUT = PWM Output

Pin assignment – CAN

Output connection on Deutsch plugs 12 pins and 6 pins.

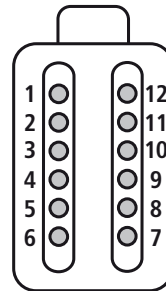
Remote control plug designation: DT04–12PA–CE01; 12 pins.

DT04–06PA–CE01; 6 pins.

Machine plug designation: DT06–12SA–CE01; DSI part number: 08250513

DT06–06SA–CE01; DSI part number: 08250598.

Customer plug		
Type	Pin	Name
DEUTSCH DT04 12PA-CE01	1	VCC_OUT_1
	2	DIG_IN_OUT_1
	3	DIG_IN_OUT_2
	4	DIG_IN_OUT_3
	5	GND
	6	ANA_IN_3
	7	ANA_IN_4
	8	
	9	DIG_IN_OUT_4
	10	DIG_IN_5
	11	DIG_IN_6
	12	DIG_IN_7
DEUTSCH DT04 06PA-CE01	1	VBAT
	2	GND
	3	ISOK
	4	
	5	CAN_H
	6	CAN_L



Symbol:

VBAT = +V battery
 GND = Ground
 DIG_IN = Digital Input
 DIG_IN_OUT = Digital Input / Output
 VCC_OUT = 5VDC Power supply regulated for external sensors (grip)
 ANA_IN = Voltage Input for external sensor (grip)

Power Brake Valves

Designation	Type	Series	Data sheet	Page
Single-Circuit remotely powered brake valve	LT 05	3X	66143	847
Accumulator charging valve	LT 06	3X	66191	855
Dual-Circuit remotely powered brake valve	LT 07	2X	66146	861
Hand brake valve	LT 08	2X	66148	873
Relay valve	LT 09	2X	66153	879
Single-circuit power brake valve of compact design	LT 12	3X	66218	885
Dual-circuit power brake valve of compact design	LT 13	3X	66221	901
Dual-circuit power brake valve of compact design	LT 17	4X	66228	921
Hydraulic inch power brake valve	LT 31	1X	66227	933

Single-circuit power brake valve

LT 05

RE 66143

Edition: 09.2013

Replaces: 08.2004



- ▶ Series 3X
- ▶ Service brake pressure 40, 60, 80, 100 and 125 bar

Features

- ▶ Small installation dimensions
- ▶ Integrated maximum pressure limitation of the brake circuit
- ▶ Brake pressure proportional to actuation force
- ▶ Ergonomic adaption of the pedal blade angle possible
- ▶ All pedal variations with slip resistant, removable rubber plates

Fields of application

- ▶ Construction equipment
- ▶ Material handling vehicles
- ▶ Forestry and agricultural machines
- ▶ Municipal vehicles
- ▶ Special vehicles

Contents

Functional description	2
Technical data	3
Characteristic curve	3
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Brake pedal variations	7
Related documents	8

Functional description

The single-circuit powered brake valve LT 05 is a directly operated pressure reducing valve in three-way design with stepless mechanical operation.

It has a maximum pressure relief of secondary circuit and infinitely adjustable pressure which is in proportion to the travel of the operating element (5) or to the actuation travel angle of the pedal. The actuation force is also proportional to the travel of the actuator.

The single-circuit power brake valve consists mainly of the housing (1) and control spool (2), main compression springs (3), operating element (5) and the return spring (4). The valve is operated via the operating element (5). This pushes the main compression spring (3) against the control spool (2). Firstly the control edges close at channel T, afterwards the flow from P to A is released in the braking circuit.

The pressure building up in the brake line pushes simultaneously via the brake pressure return behind the control spool against the main compression spring (3) so that the brake pressure (secondary pressure) rises in proportion to the deflection of the operating element (5). With the deflection of the operating element (5) kept constant, the control spool (2) moves into the control position and holds the defined pressure constant.

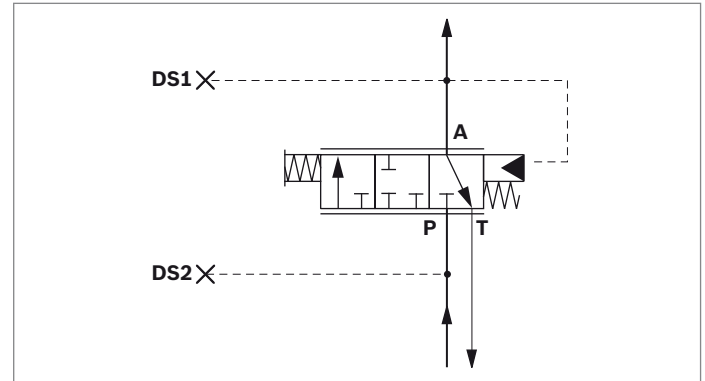
When the main compression spring (3) is unloaded, the return spring (4) move the control spool (2) back to initial position. The control edges close from P to A and open A towards T. Thus closes the secondary circuit (braking circuit).

Line connections

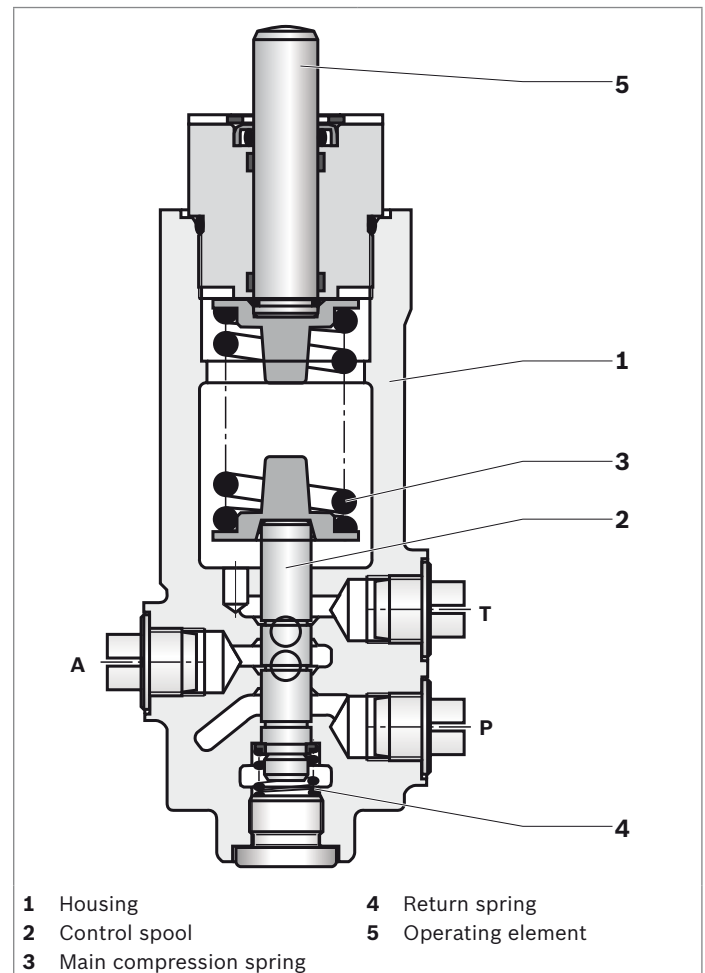
The valve must be connected as shown in the circuit diagram. Port T is to be connected to a drain line (the pressure of the drain line acts on the brakes → max. 0.5 bar).

Ports	
A	Service brake
P	Supply service brake
T	Tank
DS1	Pressure switch (brake light)
DS2	Pressure switch (accumulator pressure)

▼ Symbol LT 05



▼ Section LT 05



Technical data

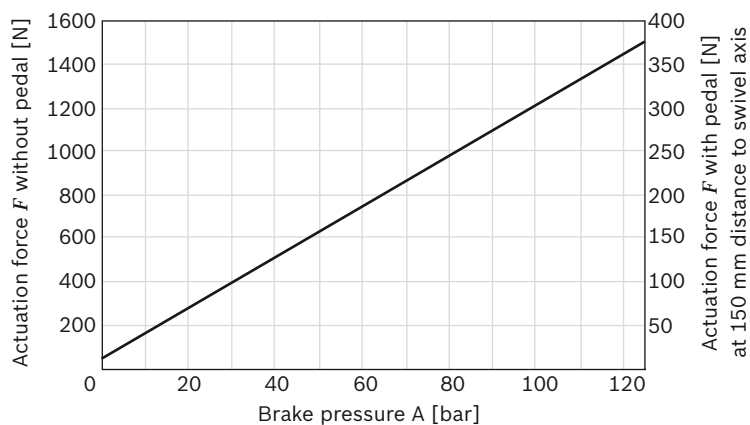
General				
Weight	Without pedal		kg	2.7
Installation position				Upright preferred
Type of connection				Metric threats according to DIN 3852-1
Ambient temperature range		θ	°C	-25 to +80
Priming				Single-layer coating RAL 5010
Hydraulic				
Maximum service brake pressure at port	A	p	bar	125
Maximum inlet pressure at port	P	p	bar	200
Maximum tank pressure at port	T	p	bar	0.5 (Tank pressure must not exceed the pressure being applied by the brake.)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568 as well as hydraulic fluids as specified in the data sheet 90221, on inquiry.
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum permitted degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$

Note

For applications outside these parameters, please consult us!

Characteristic curve

▼ Actuation force without and with pedal according to braking pressure



Ordering code

01	02	03	04	05	06	07	08	
LT 05	MKA	-	3X	/	/	02	M	*

Model code

01	Single-circuit power brake valve LT 05	LT 05
----	--	-------

Type of actuation

02	Mechanical	MKA
----	------------	-----

Series

03	30 to 39 (unchanged installation and connection dimensions)	3X
----	---	----

Service brake pressure

04	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	125 bar	125

Line connections

05	Metric threads according to DIN 3852-1 (see table on page 5)	02
----	--	----

Seal material

06	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
----	--	---

Accessories (optional)

07	Fitted with a standard brake pedal LT 19	12
----	--	----

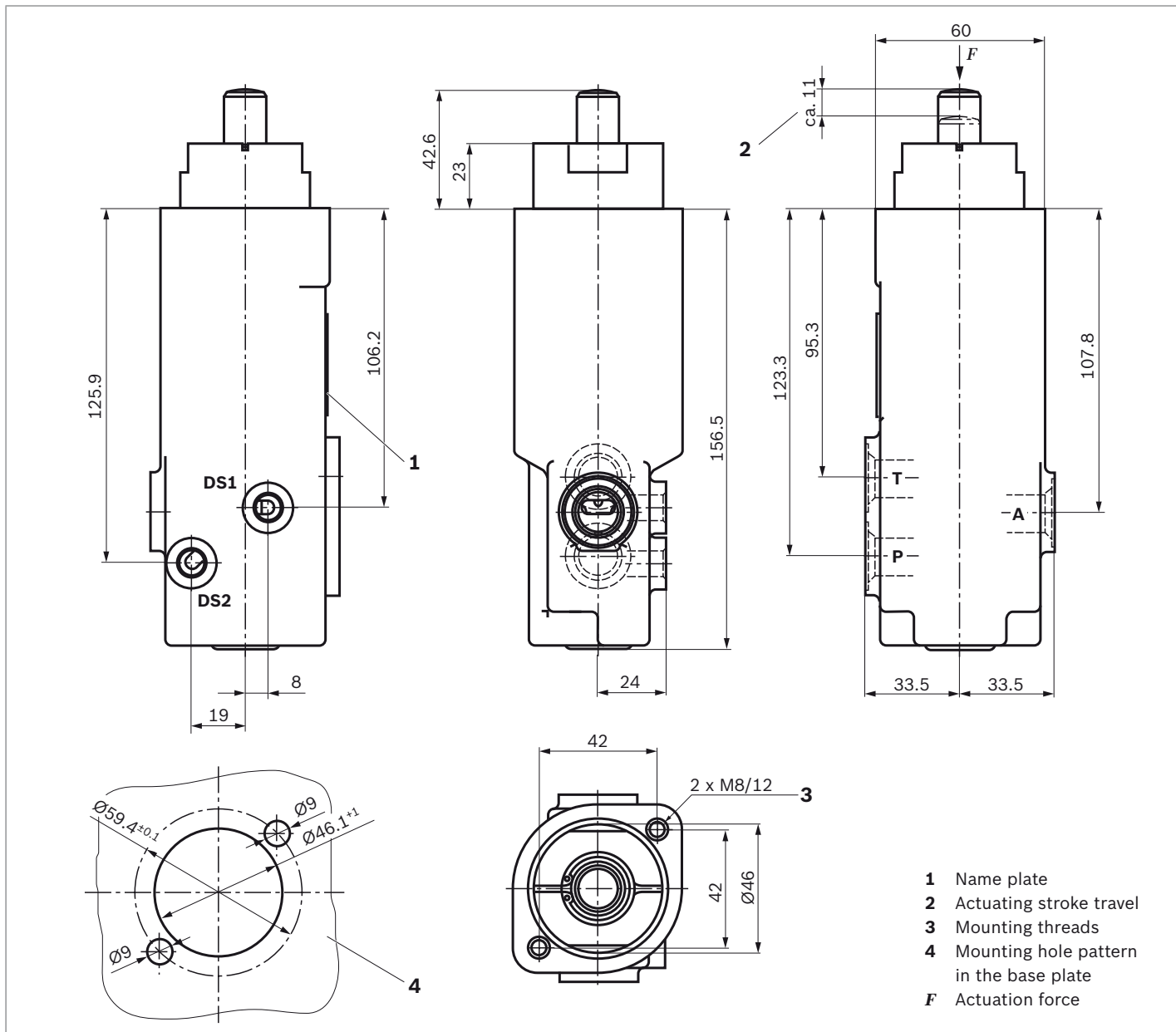
08	Further details in clear text	*
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Preferred standard types

Pressure stage [bar]	LT 05 without pedal Part no.	LT 05 with fitted standard pedal Part no.
040	R901002822	R901026424
060	R900960193	R900776990
080	R900960195	R900776991
100	R900960196	R900776992
125	R900960199	R900776993

Dimensions

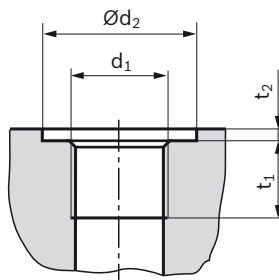
Without pedal



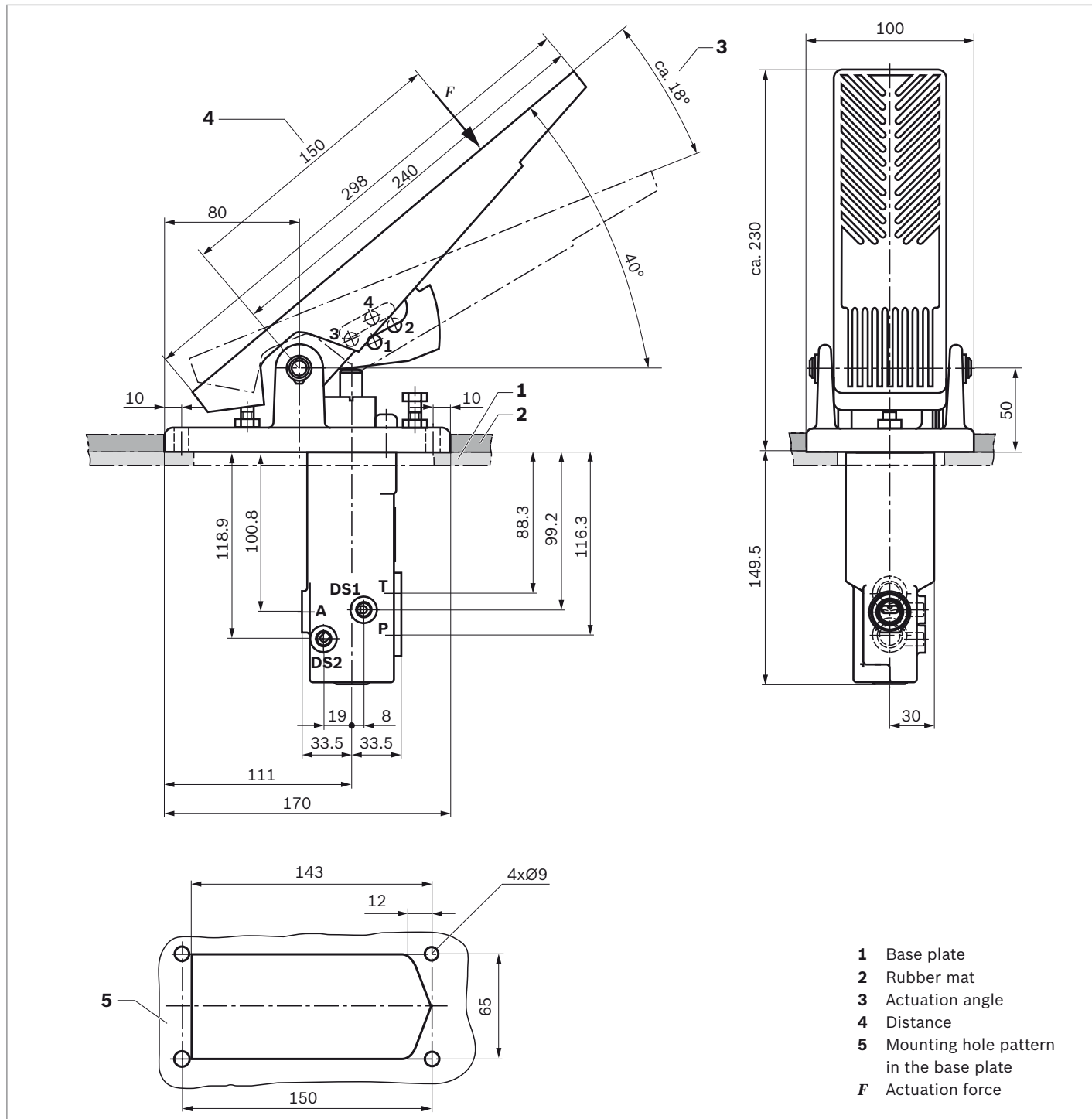
Ports according to DIN 3852-1

Port	d_1	$\varnothing d_2^{+0.1}$	t_1	t_2
A	M16 x 1.5	23	13	1
P	M16 x 1.5	23	13	1
T	M16 x 1.5	23	13	1
DS1, DS2	M10 x 1	16	9	-

Ports **DS1** and **DS2** plugged by default.



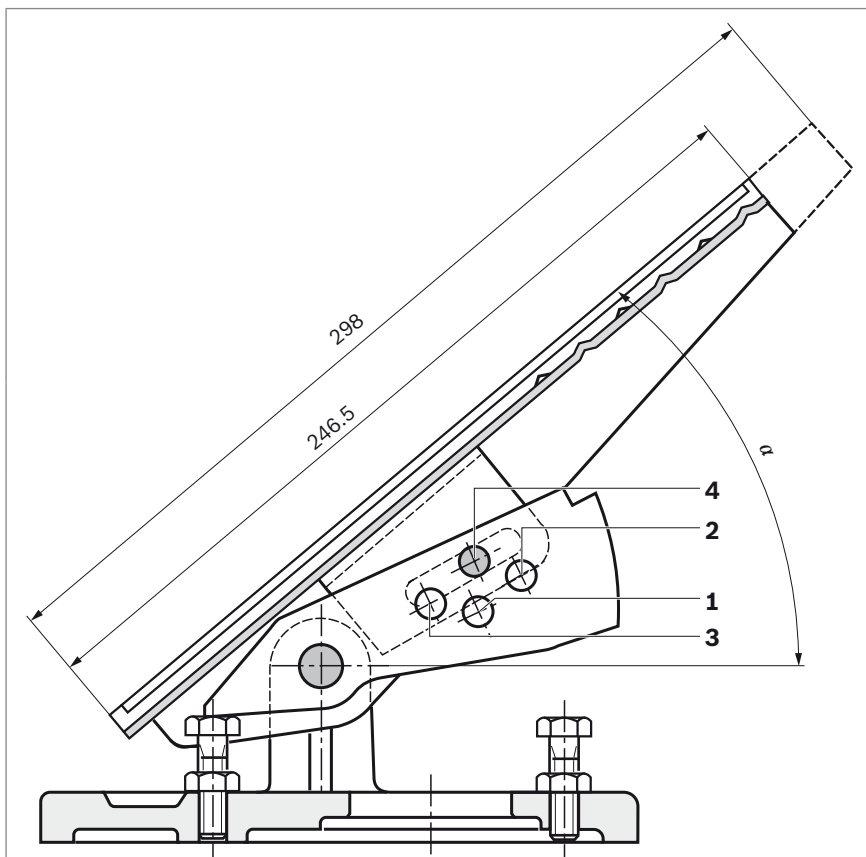
With fitted standard pedal LT 19



Brake pedal variations

The power brake valve LT 05 is optionally provided with or without pedal. The pedals LT 19 and LT 20 are available (Further variants on request).

▼ Standard type LT 19 / Type LT 19 with shortened pedal plate



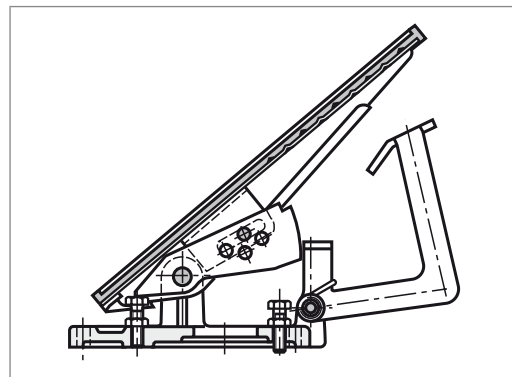
Pedal angle α adjustable in 5° increments:

- 1 Hole 1 = 25°
- 2 Hole 2 = 30°
- 3 Hole 3 = 35°
- 4 Hole 4 = 40° (Standard)

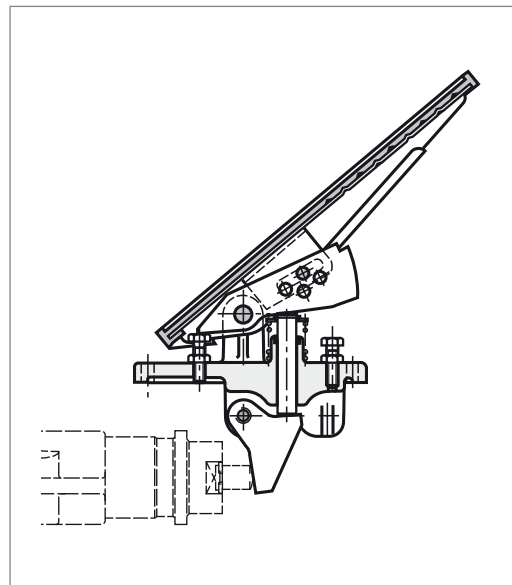
Note

All pedal variations are fitted with a slip resistant, removable rubber plate by default.

▼ Type LT 19 with detent



▼ Type LT 20 for horizontal fitted brake valves



Related documents

The power brake valves LT 05 are hydraulic components to be used in power brake systems in mobile machines. Also observe the instructions for the other system components. Do not commission the product until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

Accumulator charging valve

Type LT 06



- ▶ Component series 3X
- ▶ Maximum system pressure 200 bar
- ▶ Approx. 4 bar Δp with a flow of 70 l/min

Features

- ▶ Simple and quick installation
- ▶ Reduced piping effort
- ▶ Small installation dimensions
- ▶ Integration into existing hydraulic systems is possible
- ▶ Quickly ready-for-operation
- ▶ Flexible connection possibilities of accumulators
- ▶ Connection possibilities for downstream consumers

Contents

Ordering code	2
Technical data	3
Function	4
Symbol, cross-section	4
General notes	5
Intended use	5
Characteristic curve	5
Dimensions	6
Spare parts	6

Ordering code

01	02	03	04	05	06	07	08	09	10		
LT	06	-	A	06	-	3X	/	/	02	M	*

01 to 04	This information is used only for internal purposes and is always identical.	
----------	--	--

Component series

05	30 to 39 (unchanged installation and connection dimensions)	3X
----	---	----

Pressure stage of the accumulator circuit

06	100 bar	100
	150 bar	150
	185 bar	185
	200 bar	200

Accumulator charging flow

07	ca. 6 l/min	B18
	ca. 17 l/min (Standard)	B40

Line connections

08	Metric threads according to DIN 3852-1 (see table on page 6)	02
----	--	----

Seal material

09	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M ¹⁾
----	--	-----------------

10	Further details in clear text	
----	-------------------------------	--

Preferred standard types

Pressure stage [bar]	LT 06 B18 Part no.	LT 06 B40 Part no.
100	R900549834	R900427588
150	R900455464	R900427591
200	R900586937	R900427595

1) Observe sealing compatibility of the hydraulic fluid used!

Technical data

(For applications outside these parameters, please consult us!)

General			
Weight		kg	Approx. 3
Installation position			Upright preferred, pressure adjustment element face upwards
Type of connection			Metric threads according to DIN 3852-1
Ambient temperature range	θ	°C	-25 to +80
Priming			Single coat RAL 5010
Hydraulic			
Maximum system pressure in the accumulator circuit		bar	200
Maximum inlet pressure at port	- P	bar	200
Maximum tank pressure at port	- T	bar	Zero pressure to tank
Maximum flow (at ca. 4 bar Δp)	- Accumulator charging flow P → S	l/min	ca. 17 (Standard = B40)
	- Pump flow P → N	l/min	70
Hydraulic fluid			Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568 as well as hydraulic fluids as specified in the data sheet 90221, on inquiry.
Hydraulic fluid temperature range	θ	°C	-20 to +80
Viscosity range	ν	mm ² /s	2.8 to 380
Maximum permitted degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)			Class 20/18/15, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$

Function

Accumulator charging valves or pressure shut-off valves assume the function of keeping a pressure level in an accumulator circuit within certain limit values (cut-in pressure, cut-out pressure). The switching pressure differential is approx. 18 % of the cut-off pressure.

Caution!

If downstream consumers (**N**) generate a higher pressure than the cut-off pressure of the accumulator charging valve, the pressure of the accumulator circuit is raised to this level. The pressure of the downstream consumers (**N**) must be 30 % lower than the accumulator pressure ($N < \text{Accumulator pressure} - 30\%$).

The valve basically consists of a pilot control with pressure adjustment element (**1**), pressure compensator (**2**) and check valve(**3**).

Changing the pump flow over from accumulator charging to neutral circulation

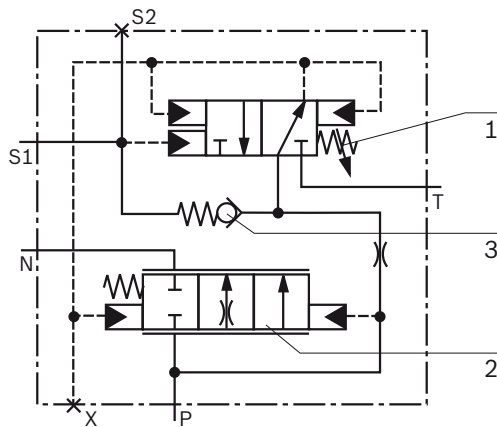
During the charging process, the pump feeds oil via the check valve (**3**) into the accumulator circuit. To this end, the pressure is directed via the pilot line and pilot control to the load signal side of the pressure compensator (**2**). This pressure compensator throttles the pump flow until the pressure that builds up in the accumulator circuit overcomes the spring force of the pressure adjustment element (**1**).

The pilot control element reconnects the load signal line of the pressure compensator (**2**) from **S1** to **T**. The pressure compensator (**2**) then re-directs the pump flow from **P** to **N** and the check valve (**3**) closes. The charging process is completed and the pump flow flows with a low Δp through the charging valve.

Changing the pump flow over from neutral circulation to accumulator charging

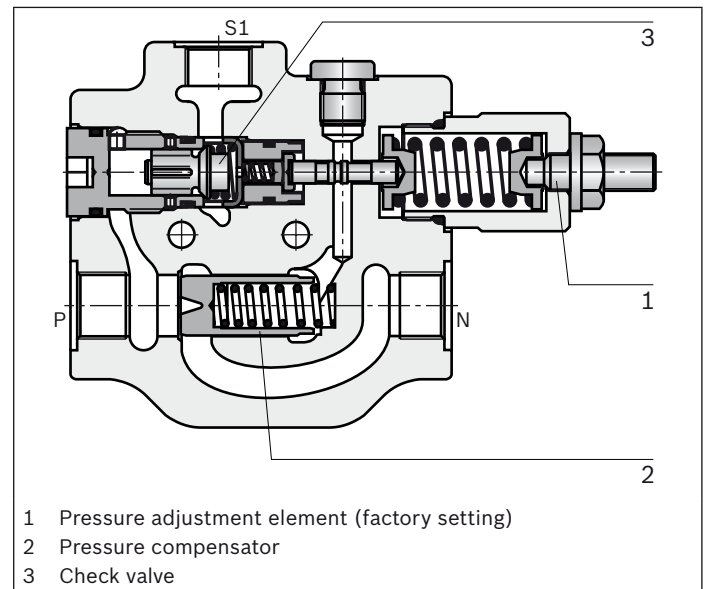
When the pressure in the accumulator circuit falls below the lower switching point (cut-in point), **P** is connected to the load signal chamber of the pressure compensator (**2**) and the pump flow is directed again into the accumulator circuit.

Symbol, cross-section



Legend

P	Pump
T	Tank
S1	Accumulator circuit 1
S2	Accumulator circuit 2
X	Load Sensing (LS)
N	Downstream consumers



- 1 Pressure adjustment element (factory setting)
- 2 Pressure compensator
- 3 Check valve

General notes

Installation notes

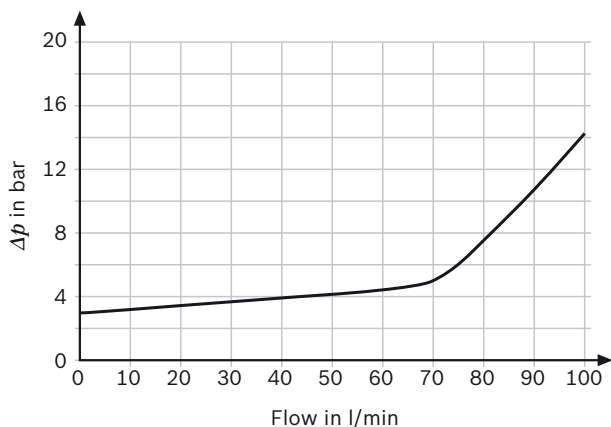
- ▶ Observe the minimum distance of 30 cm to the valve while cleaning with a high-pressure cleaner.
- ▶ The cross-sections of hydraulic transmission elements (pipes, hoses) must be selected so that at low operating temperatures the pressure drop between hydraulic accumulator and brake cylinder remains low.
- ▶ Port **T** must be connected separately at zero pressure to tank.
- ▶ Ensure that the brake system is always vented.
- ▶ Protect the pressure compensator from falling down while removing the plug from port **P**.

Intended use

Accumulator charging valves LT 06 are hydraulic components and are therefore either covered by the cope of the completely or the partly completed machinery in the sense of the EC machinery directive 2006/42/EC. The component is exclusively intended to be assembled together with other components to form partly completed or complete machinery. The component may only be commissioned if it has been integrated in the machine for which it is designed.

Characteristic curve

Pressure loss Δp from P → N



Notes for the repair

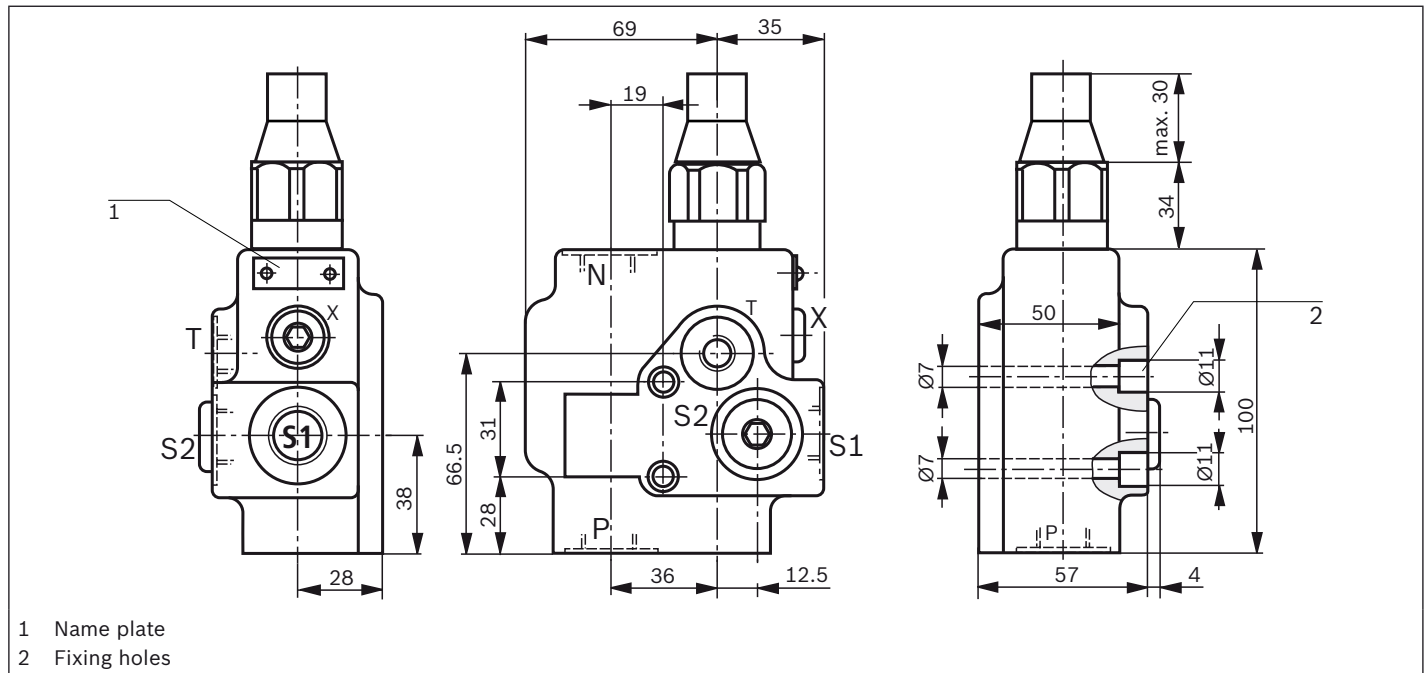
- ▶ Damaged valves must be repaired, even if their function is not impaired.

You may use the product as follows:

- ▶ Accumulator charging valves LT 06 have been developed for the application in mobile working machinery.
- ▶ Comply with the technical data.
- ▶ The product is only intended for professional use and not for private use.

Dimensions

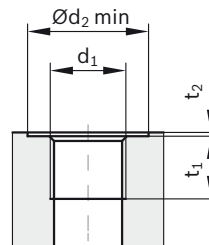
Dimensions in mm



Ports according to DIN 3852-1

Port	d_1	$\varnothing d_2$	t_1	t_2
P, N	M18 x 1.5	32	12	1
S1, S2	M18 x 1.5	32	12	1
T, X	M12 x 1.5	19	12	1

Ports **S2** and **X** plugged by default.



Spare parts

Spare part	Part no.
Protective cap (Color code orange) for pressure adjustment element	R900025379

Dual-circuit power brake valve LT 07



- ▶ Series 2X
- ▶ Service brake pressure 40, 60, 80, 100, 120 and 140 bar
- ▶ Maximum inlet pressure 250 bar
- ▶ For modular designs

Features

- ▶ A direct-operated pressure reducing valve in 3-way design with continuous mechanical actuation
- ▶ Optimum piping possible through freely rotating mounting flange
- ▶ Brake pressure proportional to the actuating force
- ▶ Synchronization thanks to low hysteresis
- ▶ Integrated maximum pressure limitation of the brake circuits
- ▶ All consumer ports on one side
- ▶ Ergonomic adjustment of the pedal work angle possible
- ▶ All pedal models with detachable, slip resistant pedal rubber
- ▶ Compact mounting dimensions

Fields of application

- ▶ Construction machines
- ▶ Material handling vehicles
- ▶ Forestry and agricultural machinery
- ▶ Specialized vehicles

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Functional description	2
Technical data	4
Theoretical curves	5
Ordering code	6
Dimensions	7
Brake pedal models	11
Related documents	12

Functional description

The dual-circuit power brake valve LT 07 is a direct-operated pressure reducing valve in 3-way design with continuous mechanical actuation.

It has a maximum pressure limitation of the secondary circuits and continuous dosing of the pressure in the secondary circuits (brake circuits) proportional to the path of the actuation element **(4)** or to the pedal opening angle **(8)**. In case of failure of one brake circuit, the second brake circuit remains functional by means of mechanical contact of the two control spools **(2)**. The actuating force of the pedal remains unchanged.

The dual-circuit power brake valve consists essentially of a housing **(1)** and control spool **(2)**, the main regulator springs **(3)**, actuation element **(4)** and the return springs **(5)** and **(6)**. The valve is operated via the actuation element **(4)**. This presses both of the main regulator springs **(3)** against both control spools **(2)**. First, the control edges at channel **T** close, then the control edges of **SP** to **BR** open, creating pressure build-up in both brake circuits. The pressure then builds up in the brake lines, acting simultaneously on the brake pressure returns **(7)** located behind the control spools pushing against the main regulator springs **(3)**, so that the brake pressure (secondary pressure) in both brake circuits rises in proportion to the deflection of the actuating element **(4)**. In keeping the deflection of the actuation elements constant, the control spools **(2)** move into the control position and keep the pressure introduced in the channels **BR1** and **BR2** constant, whereby the pressure in **BR1** is only about 2 bar higher than in **BR2**. The actuation force of the actuation element is proportional to its deflection.

If the main regulator springs **(3)** are released, the return springs move the control spools back into the starting position. The control edges close from **SP** to **BR** and open from **BR** to **T**. The secondary circuits (braking circuits) are thereby released.

Combined mechanical/hydraulic actuation

The brake valve can be controlled mechanically by a pedal and/or hydraulically via the **Pst** port.

Version with rotary angle sensor (inching)

When the driver presses the brake pedal gently, only the hydrostatic drive brakes via the inch function. The rotary angle sensor converts the pedal angle into an electrical output signal.

When the pedal is pressed with more force, this causes the hydrostatics and the service brake to brake simultaneously.

Thus, the braking process is composed of two parts: an electric and a hydraulic output signal.

The control of the pump is connected to the electrical angle sensor of the service brake via the on-board electronics.

In the first part of the overall braking action, only the electrical signal is sent, which then lets the drive pump swing back via the electronic system (inching). In the second part, the hydraulic braking pressure is built up (hydraulic braking).

Note

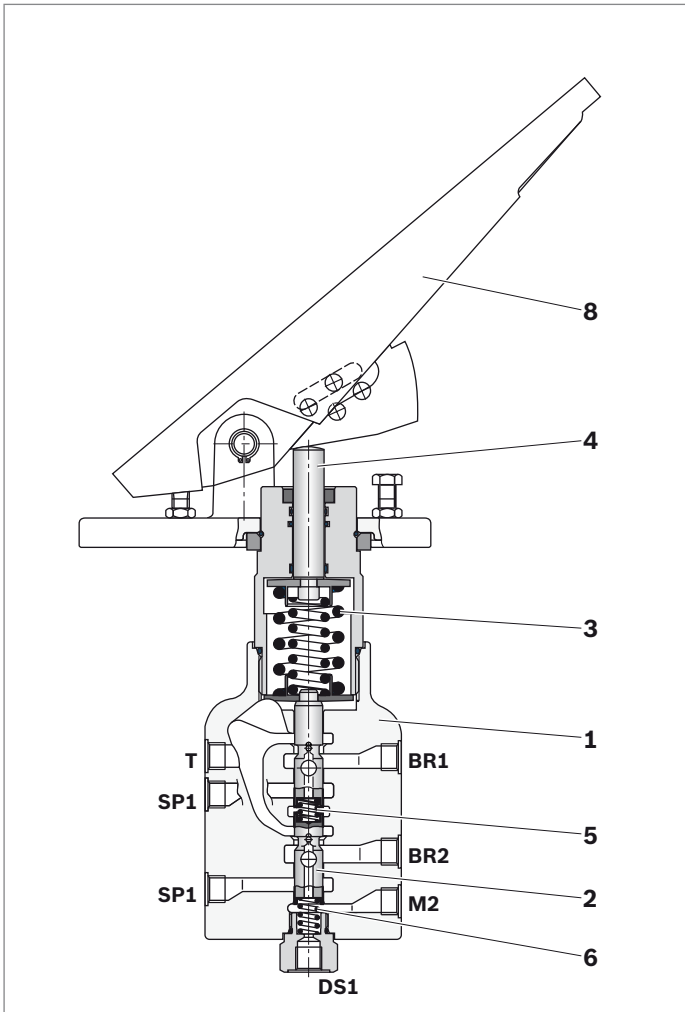
For versions with rotary angle sensor is cabin fitting for sensor assembly prescribed.

Ports

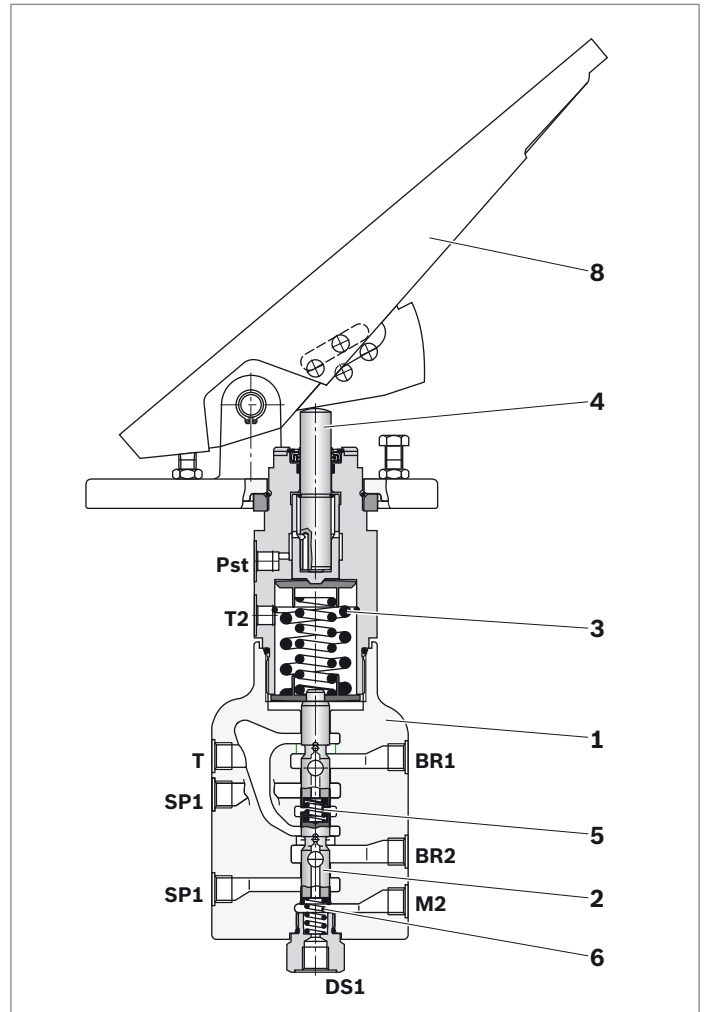
SP1	Supply to service brake circuit 1
SP2	Supply to service brake circuit 2
T	Tank
BR1	Service brake circuit 1
BR2	Service brake circuit 2
M1	Brake pressure return (service brake circuit 1) ¹⁾
M2	Brake pressure return (service brake circuit 2) ¹⁾
DS1	Pressure switch (brake lights)
Pst	Control pressure

¹⁾ Pressure switch optional (brake lights)

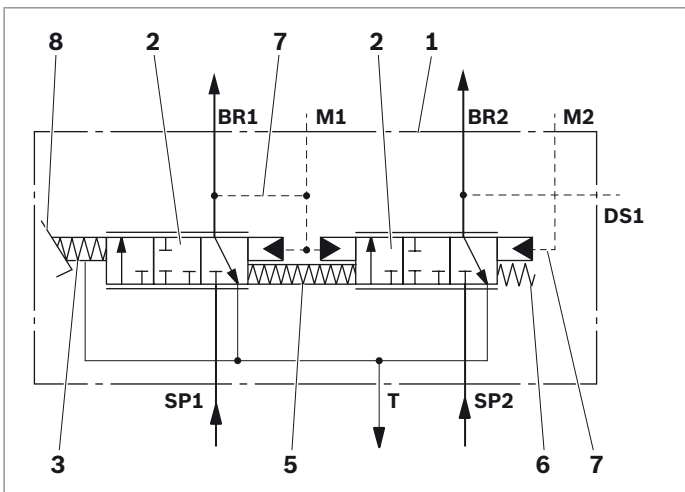
▼ Cross section LT 07 MKA



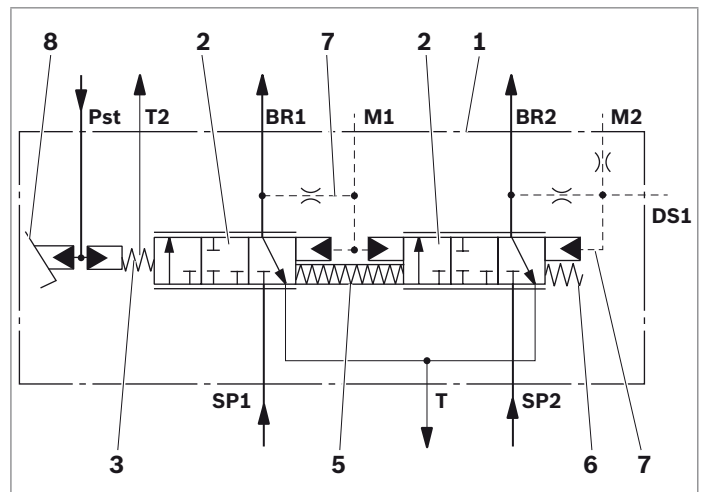
▼ Cross section LT 07 MKA



▼ Symbol LT 07 MKA



▼ Symbol LT 07 MKA



- | | |
|--------------------------|-------------------------|
| 1 Housing | 5 Return spring |
| 2 Control spool | 6 Return spring |
| 3 Main regulator springs | 7 Brake pressure return |
| 4 Actuation element | 8 Standard brake pedal |

Technical data

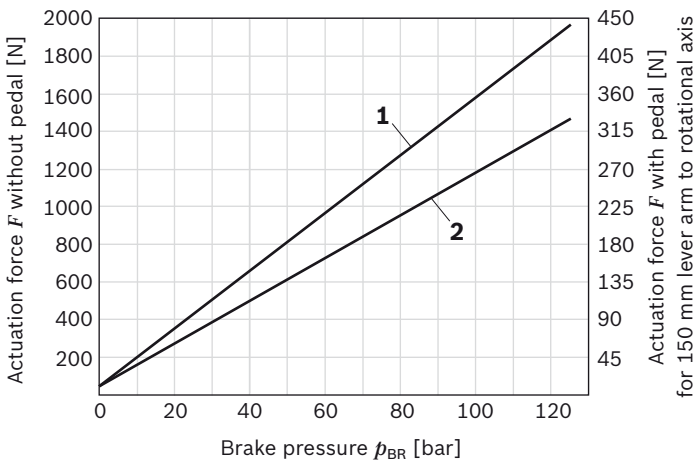
General				
Weight	Excluding pedal	kg	4.7	
	With standard pedal	kg	6.4	
Installation position	Preferably standing			
Connection type	See page 10			
Ambient temperature range	θ	°C	-25 to +80	
Priming	One-coat paint RAL 5010			
Hydraulic				
Maximum operating brake pressure at port	BR1, BR2	p_{BR}	bar	140
Maximum intake pressure at port	SP1, SP2	p	bar	250
	Pst	p_{St}	bar	30
Maximum tank pressure at port	T	p	bar	0.5 (The tank pressure must not exceed the contact pressure of the brake. Tank pressure peaks due to flow operations are permitted.)
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request			
Hydraulic fluid temperature range	θ	°C	-20 to +80	
Viscosity range	ν	mm ² /s	2.8 to 380	
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Electric				
Voltage type				DC voltage
Supply voltage	V	10 to 30		
Output signal	V	0.5 to 4.5		
Type of protection according to VDE 0470-1 (DIN EN 60529), DIN 40050-9				IP67 with installed and locked plug socket

Note

Please contact us if the unit is to be used outside the specified range of values.

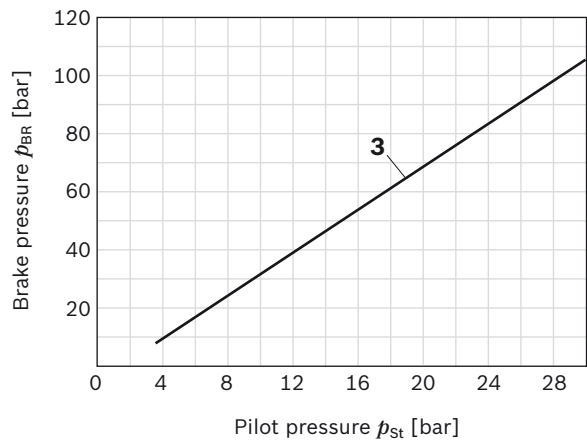
Theoretical curves

▼ Actuation force with and without pedal depending on the braking pressure



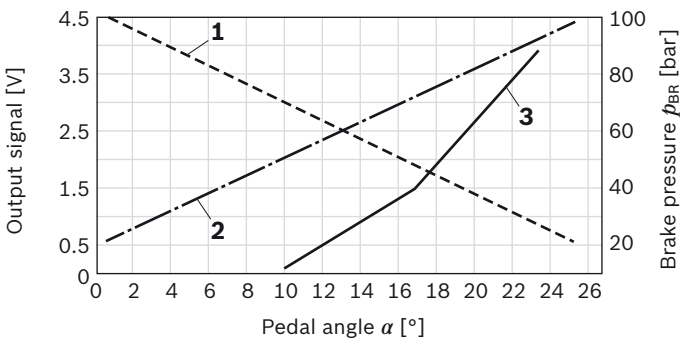
- 1 Version MKA
- 2 Version MRA

▼ Brake pressure depending on the control pressure



- 3 Version MHA

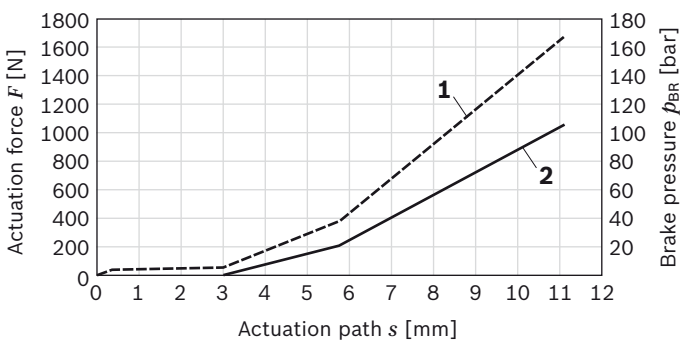
▼ Brake pressure and rotary angle sensor voltage signal depending on the pedal angle



- 1 Signal 1
- 2 Signal 2
- 3 Brake pressure

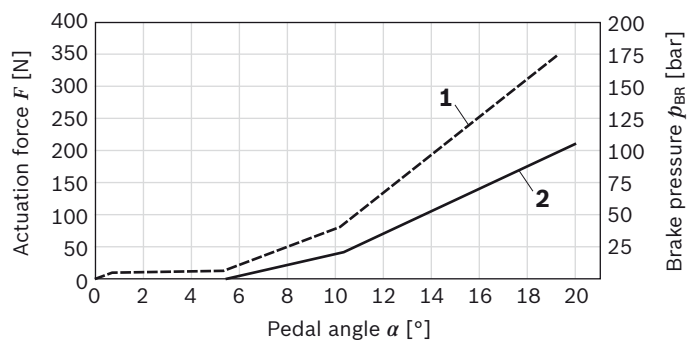
▼ Actuation force and brake pressure depending on the actuation path or angle (example: version MKA, 100 bar)

Excluding pedal



- 1 Force F
- 2 Brake pressure p_{BR}

Including pedal



- 1 Force F
- 2 Brake pressure p_{BR}

Ordering code

01	02	03	04	05	06	07	08	09	10	11
LT 07		-	2X	/	/	02	M			*

Series

01	Dual-circuit power brake valve LT 07	LT 07
----	--------------------------------------	-------

Type of actuation

02	Mechanical	MKA
	Mechanical, reduced actuation force	MRA
	Combined mechanical/hydraulic	MHA

Series

03	30 to 39 (unchanged installation and connection dimensions)	2X
----	---	----

Service brake pressure		Preferred type MKA without pedal	Preferred type MKA with standard pedal				
				MKA	MRA	MHA	
04	40 bar			●	-	●	040
	60 bar	R900900612	R900900334	●	-	●	060
	80 bar	R900907143	R900904638	●	-	●	080
	100 bar	R900905251	R900904622	●	●	●	100
	120 bar	R900907144	R900907145	●	●	●	120
	140 bar			-	●	●	140

Line connections (see page 10)

05	Metric thread according to DIN 3852-1	02
	UNF thread according to ISO 11926	19
	Thread according to ISO 6149-1 (with O-ring seal)	50

Sealing material

06	NBR (nitrile rubber)	M
----	----------------------	---

Pedal (optional)

07	Standard pedal LT 19	12
----	----------------------	----

Electrical rotary angle sensor (optional)

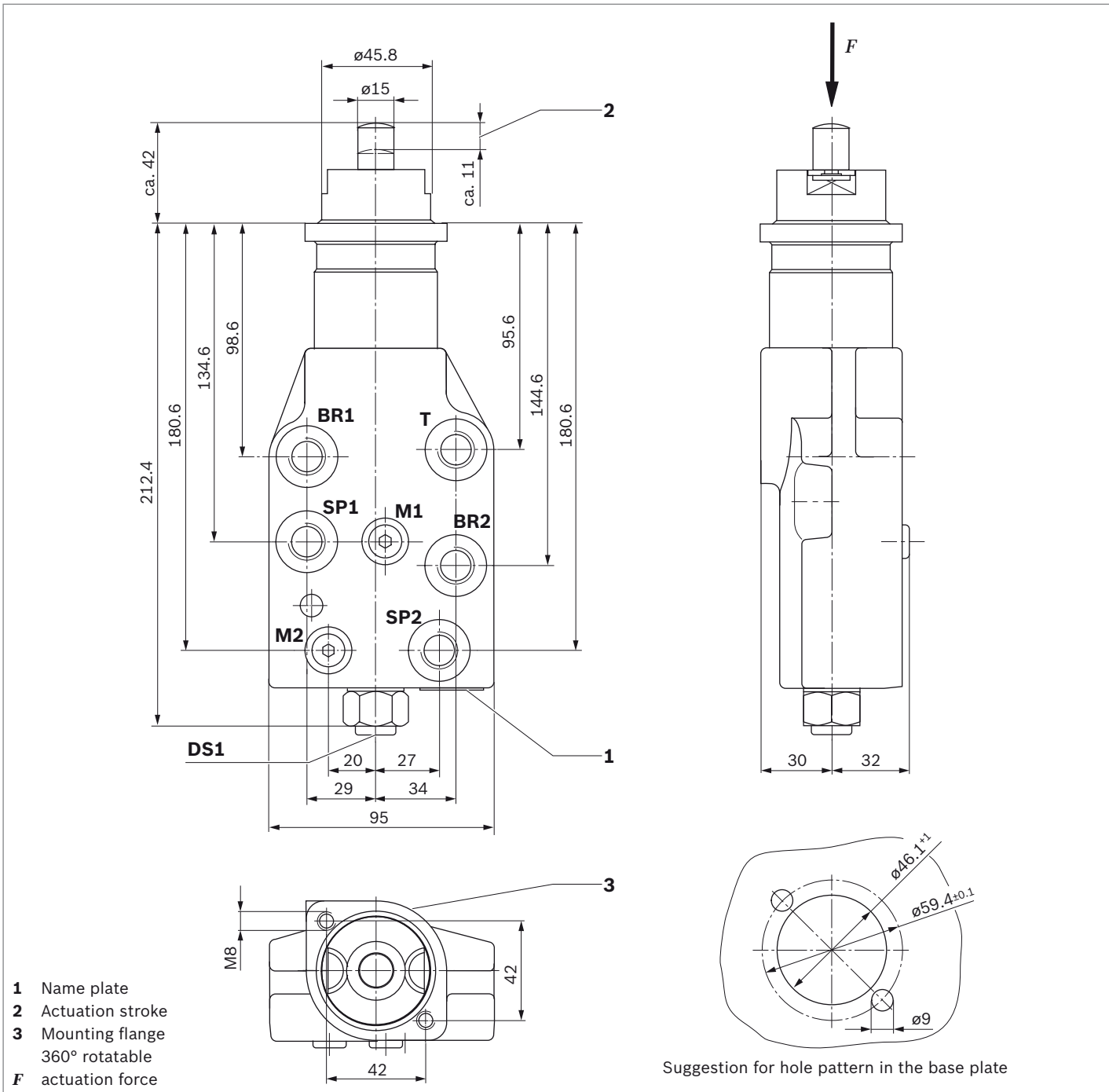
08	Sensor, in the direction of travel left	S
09	Connector type DT04-2P (Deutsch)	K40
10	Output signal Volt	F

11	Further specifications in plain text	*
----	--------------------------------------	---

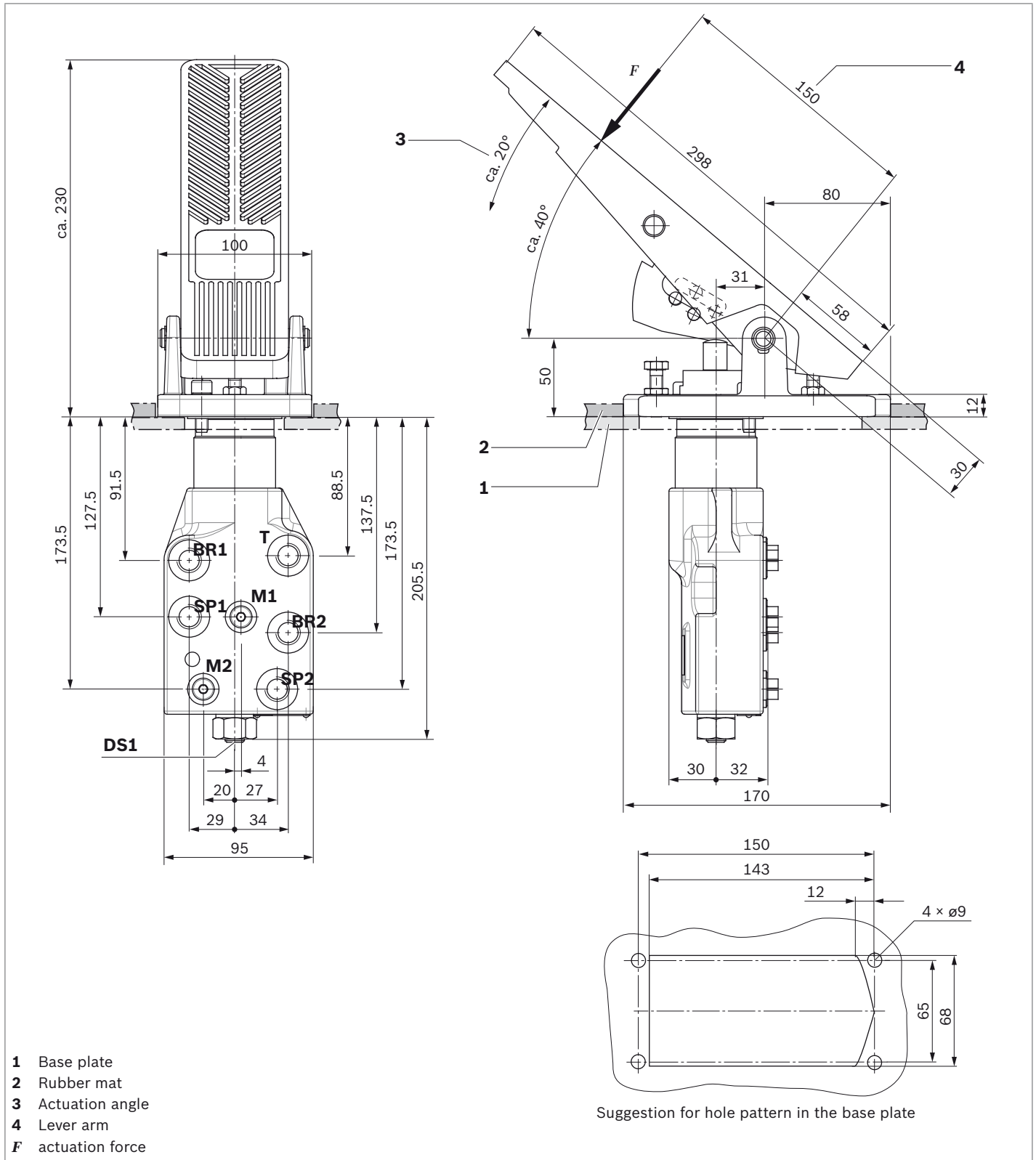
● = Available - = Not available

Dimensions

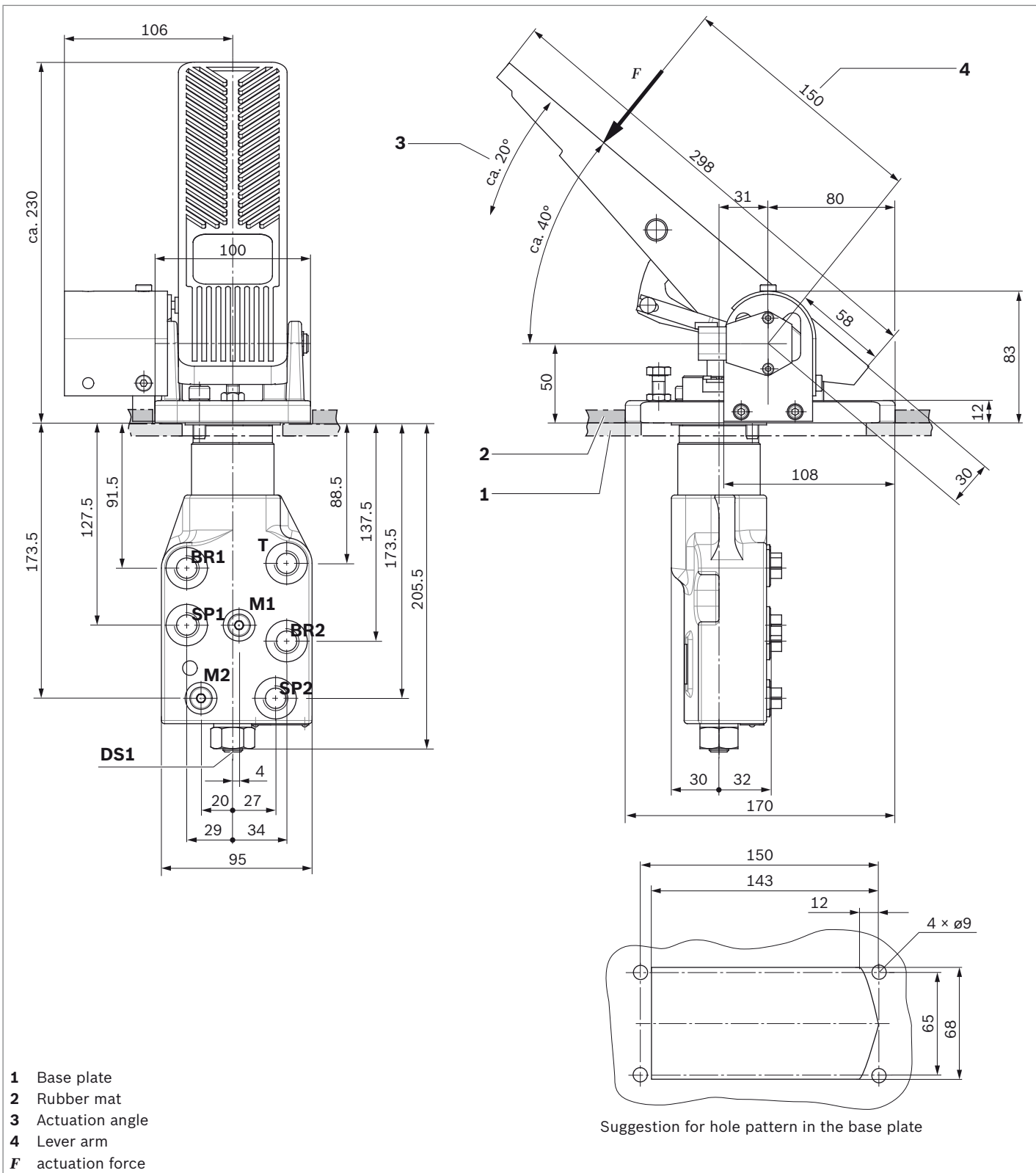
▼ LT 07 excluding pedal



▼ LT 07 with mounted standard pedal LT 19

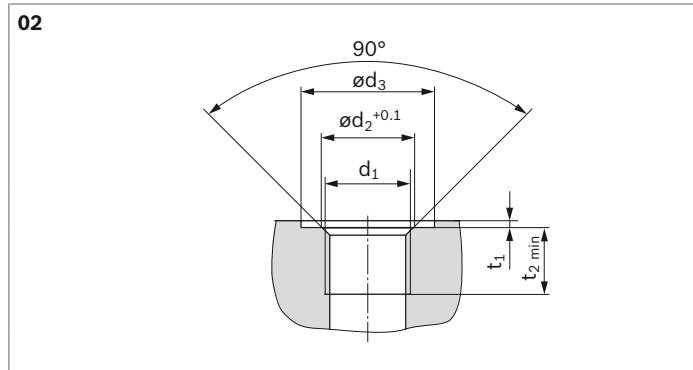


▼ LT 07 with mounted standard pedal LT 19 and rotary angle sensor S



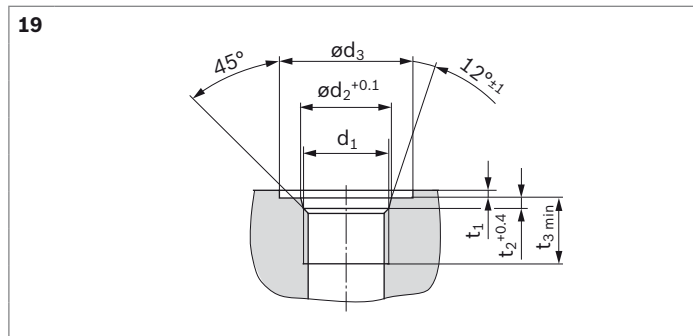
Line connections

▼ Metric thread according to DIN 3852-1



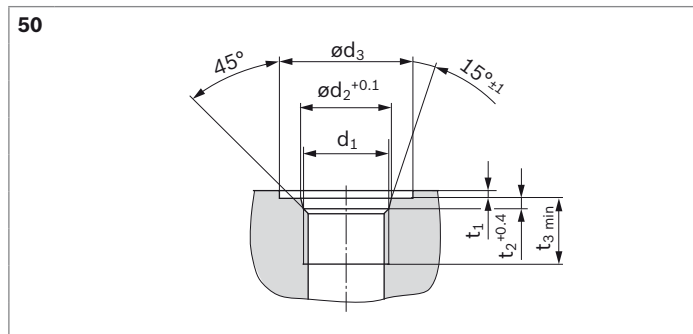
Port	d_1	$\varnothing d_2$	$\varnothing d_3$	t_1	t_2
BR1; BR2	M16 × 1.5	16.4	26	1.5	12
SP1; SP2	M16 × 1.5	16.4	26	1.5	12
T	M16 × 1.5	16.4	26	1.5	12
DS1	M12 × 1.5	-	20	0.9	11
M1	M10 × 1	-	20	1	8
M2	M10 × 1	-	20	1.5	8
Pst	M10 × 1	-	20	1	8
T2	M10 × 1	-	20	1	8

▼ UNF thread according to ISO 11926



Port	d_1	$\varnothing d_2$	$\varnothing d_3$	t_1	t_2	t_3
BR1; BR2	9/16-18	15.6	25	1.5	2.5	13
SP1; SP2	9/16-18	15.6	25	1.5	2.5	13
T	9/16-18	15.6	25	1.5	2.5	13
DS1	7/16-20	12.4	21	0.9	2.4	12
M1, M2	7/16-20	12.4	21	1.5	2.4	11.5
Pst	M10 × 1	-	20	1	-	8
T2	M10 × 1	-	20	1	-	8

▼ Thread according to ISO 6149-1



Port	d_1	$\varnothing d_2$	$\varnothing d_3$	t_1	t_2	t_3
BR1; BR2	M16 × 1.5	17.8	27	1.5	2.4	13
SP1; SP2	M16 × 1.5	17.8	27	1.5	2.4	13
T	M16 × 1.5	17.8	27	1.5	2.4	13
DS1	M12 × 1.5	12.4	20	0.9	-	11
M1, M2	M10 × 1	-	27	1.5	-	9
Pst	M10 × 1	-	20	1	-	8
T2	M10 × 1	-	20	1	-	8

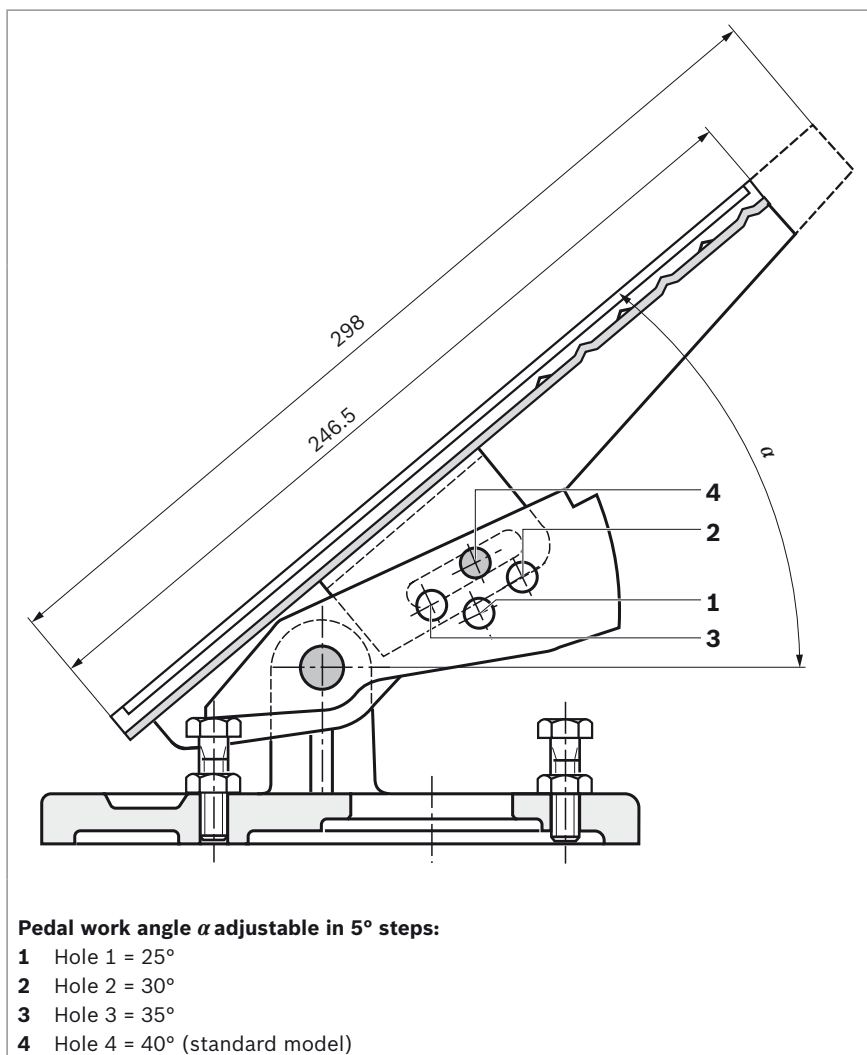
Note

- Ports **DS1**, **M1** and **M2** are usually closed.

Brake pedal models

The power brake valve LT 07 is supplied with or without pedal. Pedals LT 19 and LT 20 are available (other models on request).

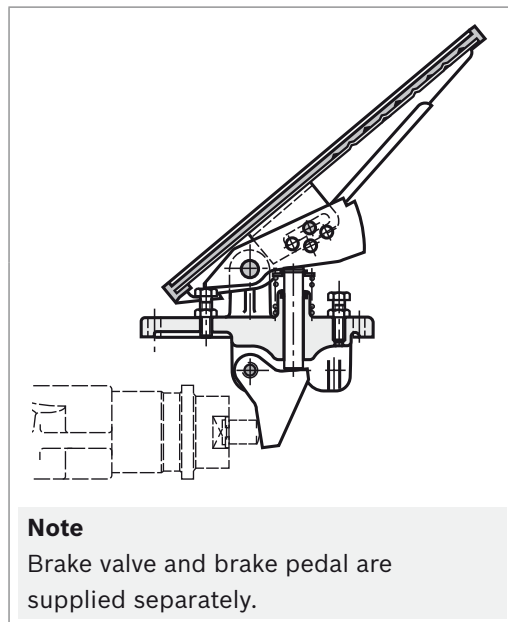
▼ Standard model LT 19 / Model LT 19 with shortened pedal plate



Note

- ▶ All pedal models come equipped with a slip-resistant, removable rubber mat.
- ▶ The inching function is only possible at a 40° angle.

▼ Model LT 20 for horizontally-installed brake valve



Related documents

Further information on installation, commissioning, and operation can be found in the instruction manual 66200-B: „Hydraulic power brake valves for mobile applications“.

Dual-circuit power brake valve LT 08



HAD 6881

- ▶ Series 2X
- ▶ Parking brake pressure 25, 40, 60, 80, 100 and 125 bar
- ▶ Maximum inlet pressure 200 bar
- ▶ For modular designs

Features

- ▶ A direct-operated pressure reducing valve in 3-way design with hand lever actuation
- ▶ For use in spring loaded brake systems
- ▶ Integrated maximum pressure limitation of the parking brake pressure
- ▶ Good fine control

Fields of application

- ▶ Construction machines
- ▶ Material handling vehicles
- ▶ Forestry and agricultural machinery
- ▶ Specialized vehicles

Contents

Function	2
Technical data	3
Ordering code	4
Dimensions	5
Related documents	6

Technical data

General				
Weight		kg		3.2
Installation position				Preferably standing
Connection type				Metric threads according to DIN 3852-1
Ambient temperature range		θ	°C	-25 to +80
Priming				One-coat paint RAL 5010
Hydraulic				
Maximum parking brake pressure at port	B	p	bar	125
Maximum inlet pressure at port	S	p	bar	200
Maximum tank pressure at port	T	p	bar	0.5 (The tank pressure must not exceed the contact pressure of the brake. Tank pressure peaks due to flow operations are permitted.)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$

Note

Please contact us if the unit is to be used outside the specified range of values.

Ordering code

01	02		03	04	05	06	11
LT 08	MM	A	-	2X	/	/	02 M *

Series

01	Hand brake valve LT 08	LT 08
----	------------------------	--------------

Type of actuation

02	Mechanical with hand lever	MM
----	----------------------------	-----------

Series

03	20 to 29 (unchanged installation and connection dimensions)	2X
----	---	-----------

Parking brake pressure

04	25 bar	025
	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	125 bar	125

Line connections

05	Metric threads according to DIN 3852-1 (see table on page 5)	02
----	--	-----------

Sealing material

06	NBR (nitrile rubber)	M
----	----------------------	----------

07	Further specifications in plain text	*
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Related documents

The hand brake valves LT 08 are hydraulic components in the power brake systems of mobile machines. Observe the instructions for the other system components. Only commission the product if the following documentation is available to you and you have understood and observed it.

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Instruction manual
System documentation from the machine manufacturer		Instruction manual

Relay valve

LT 09



- ▶ Series 2X
- ▶ Maximum service brake pressure 200 bar
- ▶ Maximum control pressure 140 bar
- ▶ For modular designs

Features

- ▶ Direct operated pressure reducing valve in 3-way version with hydraulic actuation
- ▶ Brake pressure proportional to the control pressure
- ▶ Installation preferably directly at the axis to be decelerated

Fields of application

- ▶ For mobile machines with very long brake lines or very large brake cylinder volumes

Contents

Functional description	2
Technical data	3
Characteristic curve	3
Ordering code	4
Dimensions	4
Project planning information	6
Related documents	6

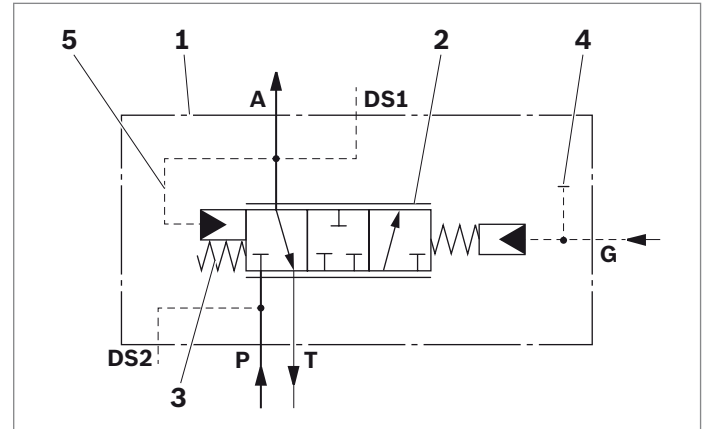
Functional description

The hydraulic relay valve is a directly operated proportional pressure reducing valve of 3-way design with hydraulic pilot.

The relay valve consists mainly of the housing (1), control spool (2), return spring (3) and bleed screw (4). The valve is controlled via a hydraulic control pressure in port **G**. This control pressure directly effects the control spool (2). Firstly the control edge closes at port **T**, afterwards the flow from **P** to **A** is released.

The pressure which builds up in the brake line **A** simultaneously pushes via the pilot oil drilling (5) behind the control spool (2) against the control pressure so that the brake pressure rises in proportion to the control pressure. With the control pressure being held constant, the control spool (2) moves into the control position and holds the value set in channel **A** constant. When the control pressure decreases, the return spring closes via the control spool (2) from **P** to **A** and opens **A** to **T**, so that the braking circuit is unloaded.

▼ Symbol LT 09



- 1 Housing
- 2 Control spool
- 3 Return spring
- 4 Bleed screw
- 5 Pilot oil drilling

Ports	
P	Pump port
T	Tank port
A	Service brake
G	Pilot control port
DS1	Pressure switch (brake light)
DS2	Pressure switch (accumulator pressure)

Technical data

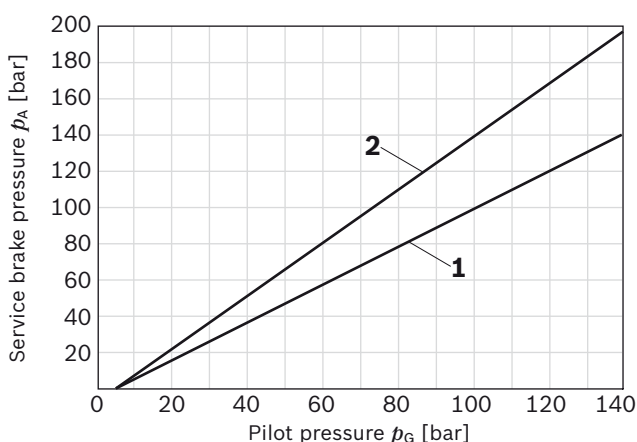
General				
Weight		kg		3
Installation position				Upright, bleed screw at the top (see page 6)
Connection type				See page 4
Ambient temperature range	θ	°C		-25 to +80
Priming				One-coat paint RAL 5010
Hydraulic				
Maximum service brake pressure at port	A	p_A	bar	200
Maximum inlet pressure at port	P	p	bar	250
Maximum pilot pressure at port	G	p_G	bar	140
Maximum tank pressure at port	T	p	bar	0.5 (The tank pressure must not exceed the contact pressure of the brake. Tank pressure peaks due to flow operations are permitted.)
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, e.g. HEES (Synthetic ester) according to VDMA 24568 and hydraulic fluids as specified in data sheet 90221, on request
Hydraulic fluid temperature range	θ	°C		-20 to +80
Viscosity range	ν	mm ² /s		2.8 to 380
Maximum admissible degree of contamination of the hydraulic fluid, Cleanliness level according to ISO 4406 (c)				Class 20/18/15, we recommend a filter with a minimum retention rate $\beta_{10} \geq 75$

Note

Please contact us if the unit is to be used outside the specified range of values.

Characteristic curve

▼ Service brake pressure depending on the pilot pressure



- 1 Ratio $p_G: p_A = 1:1$ (Standard)
- 2 Ratio $p_G: p_A = 1:1.4$

Note

Further ratios on request.

Ordering code

01	02	03	04	05	06	07	08
LT 09	HA	-	2X	/	/	M	*

Series

01	Relay valve LT 09	LT 09
----	-------------------	-------

Type of actuation

02	Hydraulic	HA
----	-----------	----

Series

03	20 to 29 (unchanged installation and connection dimensions)	2X
----	---	----

Service brake pressure

04	Details given in bar, 3-digit (max. 200 bar) e.g. 150	...
----	---	-----

Line connections (see page 4)

05	Metric thread according to DIN 3852-1	02
	Thread according to ISO 6149-1 (with O-ring seal)	50

Sealing material

06	NBR (nitrile rubber)	M
----	----------------------	---

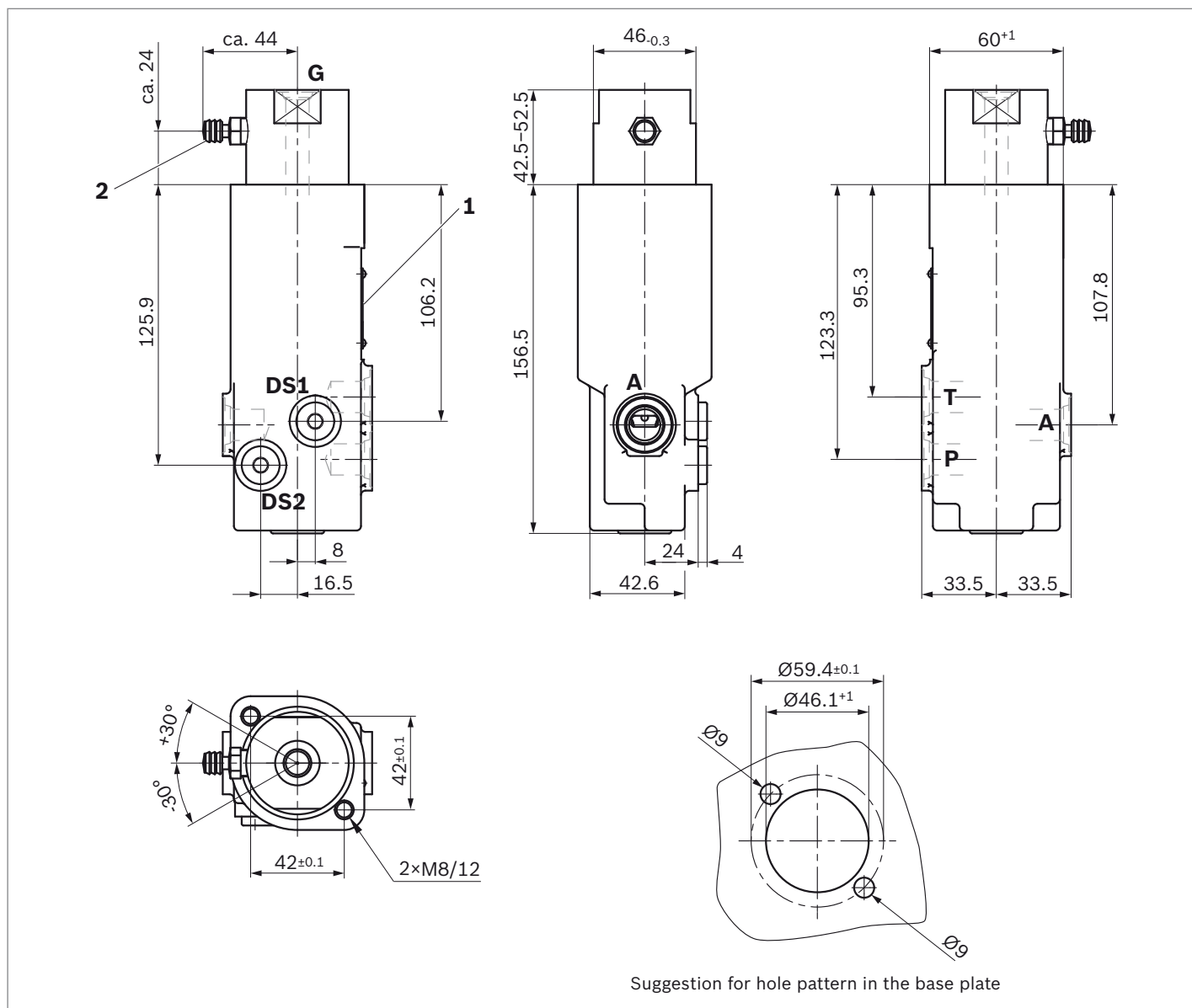
Ratio (further on request)

07	Pilot pressure p_G : Service brake pressure p_A	1:1 (Standard, no code)	
		1:1.4	1/1.4

08	Further specifications in plain text	*
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Dimensions

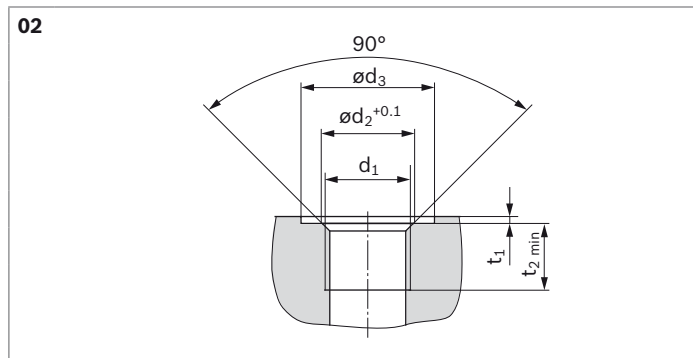
▼ LT 09



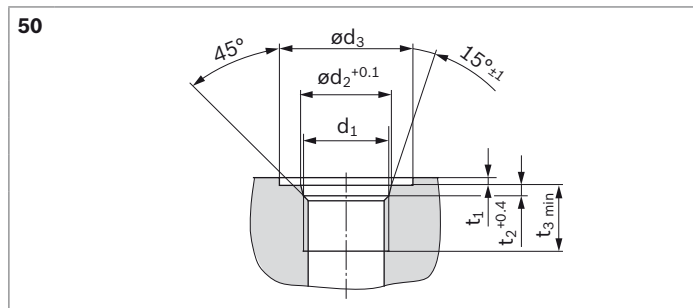
- 1 Name plate
- 2 Bleed screw, alignment varies within $\pm 30^\circ$ relatively to the housing; Tightening torque $M_A = 15 \text{ Nm}$, SW12

Line connections

▼ Metric thread according to DIN 3852-1



▼ Thread according to ISO 6149-1



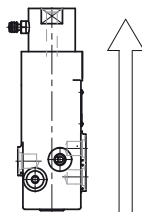
Project planning information

Installation notes

- ▶ Preferably the accumulators should be installed near the relay valve.
- ▶ The tank pressure must not exceed the brake application pressure.
- ▶ The tank must be mounted above the relay valve LT 09.

Installation position

Upright, bleed screw at the top.



Port	d_1	$\varnothing d_2$	$\varnothing d_3$	t_1	t_2
P	M16 × 1.5	16.4	23	1	13
T	M16 × 1.5	16.4	23	1	13
A	M16 × 1.5	16.4	23	1	13
G	M12 × 1.5	12.4	20	1	12
DS1	M10 × 1	10.4	16	–	9
DS2	M10 × 1	–	16	–	9

Note

Ports **DS1**, **DS2** are usually closed.

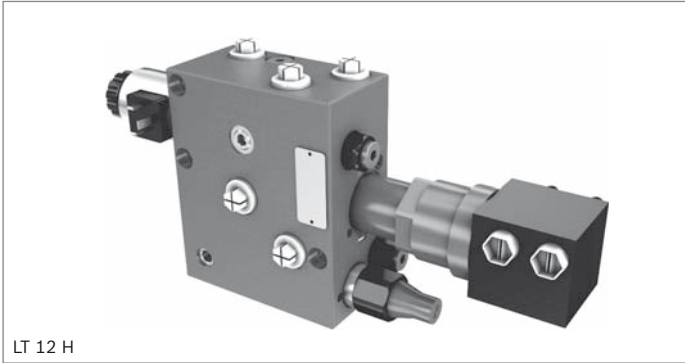
Port	d_1	$\varnothing d_2$	$\varnothing d_3$	t_1	t_2	t_3
P	M16 × 1.5	17.8	24	1.5	2.4	13
T	M16 × 1.5	17.8	24	1.5	2.4	13
A	M16 × 1.5	17.8	24	1.5	2.4	13
G	M12 × 1.5	13.8	19	1.5	2.4	11.5

Related documents

Further information on installation, commissioning, and operation can be found in the instruction manual 66200-B: “Hydraulic power brake valves for mobile applications”.

Single-circuit power brake valve with compact design

LT 12



LT 12 H

- ▶ Series 3X
- ▶ Service brake pressure 40, 60, 80, 100 and 125 bar

Features

- ▶ Single-circuit power brake valve, accumulator charging valve and shuttle valve in one housing
- ▶ Electric or mechanical parking brake valve (optional)
- ▶ Brake pressure proportional to actuating force and path
- ▶ Fast and simple assembly
- ▶ Minimized piping
- ▶ Little space required
- ▶ Integration into existing hydraulic systems possible
- ▶ Fast readiness for operation
- ▶ Sensitive dosing
- ▶ Minimum number of components
- ▶ Flexible installation

Fields of application

- ▶ Construction machines
- ▶ Conveyor vehicles
- ▶ Forestry and agricultural machinery
- ▶ Municipal vehicles
- ▶ Special vehicles

Contents

Functional description	2
Technical data	4
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Characteristic curves	6
Symbols	7
Overall set-up	9
Dimensions	12
Line connections	14
Brake pedal variants	15
Accessories	16
Related documents	16

Functional description

The LT 12 is a single-circuit power brake valve in compact design combining all required functions in one valve.

Accumulator charging valve

The accumulator charging valve **(1)** primarily charges the accumulator. If the accumulator pressure falls below the switch-on pressure of the charging valve, the accumulators will be charged until the cut-off pressure is reached. The switching pressure differential is approx. 18 % of the cut-off pressure. The accumulators are charged with a charging flow of e.g. 17 l/min (version B40). If the pump delivers more than e.g. 17 l/min, the downstream actuator **(N)** will be supplied with the difference.

NOTICE

If downstream actuators **(N)** generate a pressure higher than the cut-off pressure of the accumulator charging valve, the accumulator circuit will be raised to this pressure level. The pressure of the downstream actuators **(N)** must be 30 % lower than the set accumulator pressure ($N < \text{accumulator pressure} - 30\%$).

Accumulator circuit separation

The valve supplies the two brake circuits service brake system (BBA) and parking brake system (FBA). The accumulators S1 (BBA) and S2 (FBA) are separated by the inverted shuttle valve **(2)**. If the BBA fails, the FBA still remains functional and can - with mechanical operation of the FBA - be used as "auxiliary brake".

Single-circuit braking valve

The single-circuit power brake valve LT 12 is a direct operated pressure reducing valve in 3-way version with stepless mechanical operation.

The LT 12 offers stepless dosing of the brake pressure in the BBA **(BR1)** proportional to the path of the actuation element and to the actuating force. The maximum BBA brake pressure must be set at the brake pedal (e.g. LT 20), see page 9.

Mechanically operated service brake

For the mechanical operation of LT 12 M, an LT 20 foot pedal is most suitable. If the recommended overall set-up is observed, actuating force and path are adjusted to each other.

Hydraulically operated service brake

In case of hydraulic operation, the tandem master cylinder is operated by means of a suitable pedal. The hydraulic fluid supplied from the storage tank is piped to the LT 12 H pickup head proportional to the pedal path. Both, the tandem master cylinder and the LT 12 H pickup head have two separate chambers.

The pickup spools steer in line proportional to the supplied hydraulic fluid and charge the main brake spool via the brake pressure control springs.

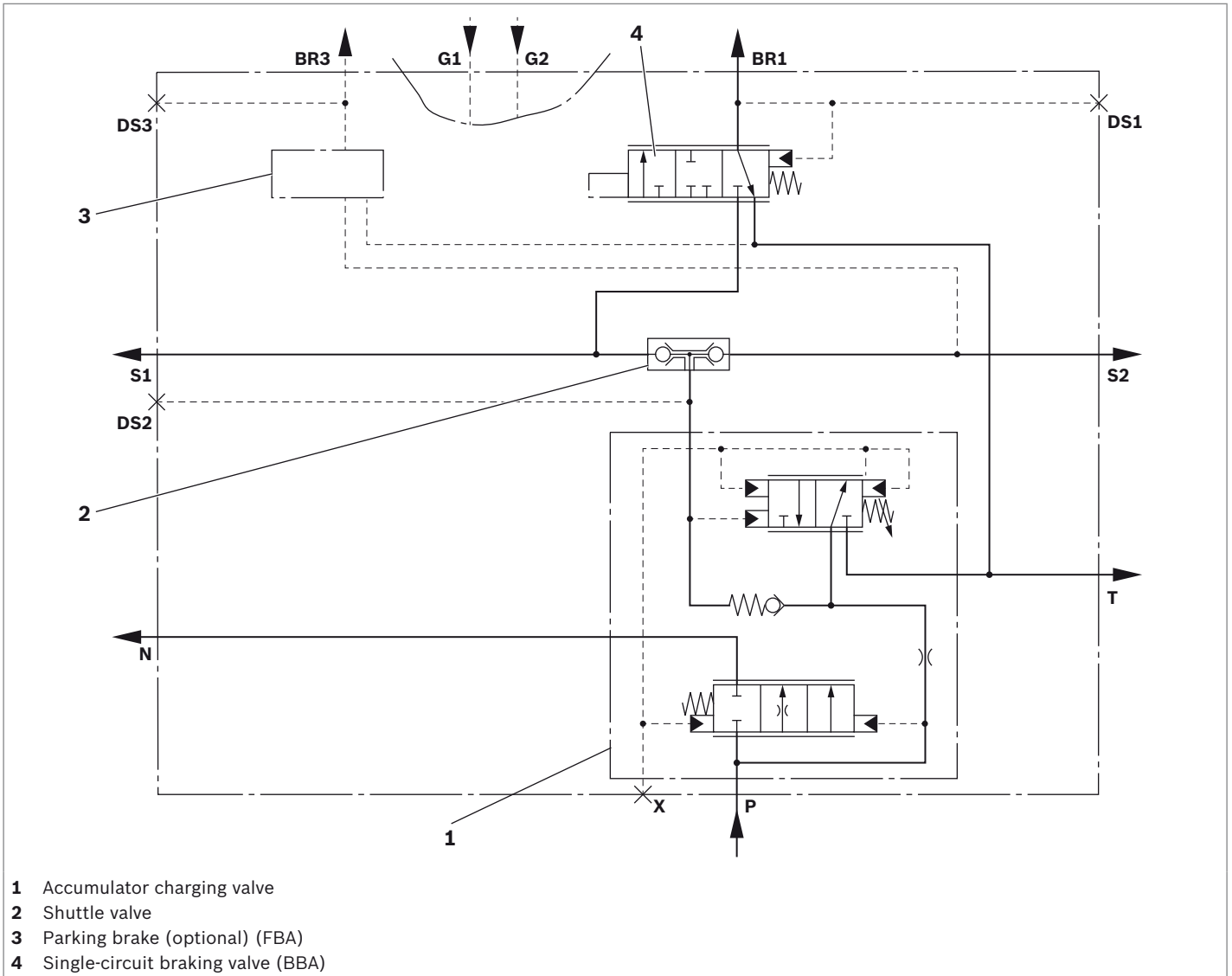
Mechanically operated parking brake/auxiliary brake (3)

The parking brake valve is a direct operated 3-way pressure reducing valve. If the valve is operated, the pressure decreases proportional to the operation. The valve controls the pressure in a controllable manner. So the "auxiliary brake" function can also be satisfied.

Electrically switched parking brake (3)

The electrically switched parking brake valve **(3)** is a 3/2 directional valve. If the valve is switched with an electric signal, port **BR3** is connected to port **S2**. The applied accumulator pressure **S2** supplies the parking brake via **BR3**. If the electric signal is switched off or fails, the parking brake valve **BR3** is connected to **T** and the pressure pending in the parking brake can be reduced. The auxiliary brake function cannot be shown.

▼ Symbol LT 12



Connections	
BR1	Service brake
BR3	Parking brake
DS1	Pressure switch, braking light
DS2	Pressure switch, accumulator pressure
DS3	Pressure switch, parking brake
S1	Service brake supply
S2	Parking brake supply
G	Hydraulic control of the service brake (alternative)
P	Pump
T	Tank
N	Return flow or downstream actuators
X	Load-sensing (LS)

Technical data

general				
Weight		kg		Approx. 10 (depending on the version)
Installation position				Preferably horizontal
Type of connection				Metric thread
Ambient temperature range	θ	°C		-25 to +80
Priming				Single-layer coating RAL 5010
hydraulic				
Maximum service brake pressure at port	BR1	p_{Br}	bar	125
Maximum parking brake pressure at port BR3	Version M	p	bar	120 (proportional)
	Version E	p	bar	Corresponds to the accumulator charging pressure/depending on the setting at the accumulator charging valve
Maximum inlet pressure at port	P	p	bar	210
Maximum accumulator pressure at port	S1, S2	p	bar	200
Maximum accumulator charging pressure	Cut-off pressure	p	bar	200
	Switch-on pressure	p	bar	Approx. 18 % below cut-off pressure
Maximum tank pressure at port	T	p	bar	0.5 (The tank pressure must not exceed the application pressure of the brake.)
Maximum pressure at port	N	p	bar	30 % less than the set accumulator pressure
Maximum encoder pressure with version H at port	G1, G2	p_G	bar	30
Maximum flow	P → S		l/min	Approx. 6 (B18) Approx. 17 (standard, B40)
	P → N		l/min	70
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet RE 90221, upon request
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$
electric				
Voltage type				Direct voltage
Supply voltage		V		12; 24
Protection class according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Version K4			IP65 with mating connector mounted and locked ¹⁾
	Version C4			IP65 with mating connector mounted and locked ¹⁾
	Version K40			IP69K with Rexroth mating connector (material number R901022127) ¹⁾
	Version K40			IP65K with mating connector mounted and locked ¹⁾

NOTICE

For applications outside these parameters, please consult us!

¹⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006.

Ordering code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
LT 12		3X	/							/		M		*

Series

01	Single-circuit power brake valve with compact design LT 12	LT 12
----	--	-------

Type of actuation (BBA)

02	Mechanical	M
	Hydraulic	H

Series

03	30 to 39 (unchanged installation and connection dimensions)	3X
----	---	----

Characteristic curve

04	Linear characteristic curve	L
	Progressive characteristic curve	P

Service brake pressure (BBA)

05	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	125 bar	125

Type of actuation parking brake system (FBA)

06	Without FBA	-
	Mechanically operated	M
	Electrically switched	E ¹⁾

Parking brake pressure (FBA)

07	¹⁾	XXX
	Without FBA	000
	20 bar	020
	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	120 bar	120

Accumulator charging pressure

08	100 bar	A
	120 bar	B
	150 bar (standard)	C
	165 bar	D
	185 bar	E
	200 bar	F

¹⁾ With electrically switched FBA, the parking brake pressure of the FBA corresponds to the accumulator charging pressure. Observe the switching hysteresis!

Accumulator charging current

09	Approx. 17 l/min (standard)	B40
	Approx. 6 l/min	B18

Voltage at the switching solenoid

10	12 Volt	AG12
	24 Volt	AG24

Connector type (standard with manual override)²⁾

11	Cubic connector	NK4
	Deutsch plug	NK40
	Junior timer, 2-pole (AMP)	NC4

Line connections

12	Metric thread	02
	UNF thread	19

Seal material

13	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
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Additional equipment

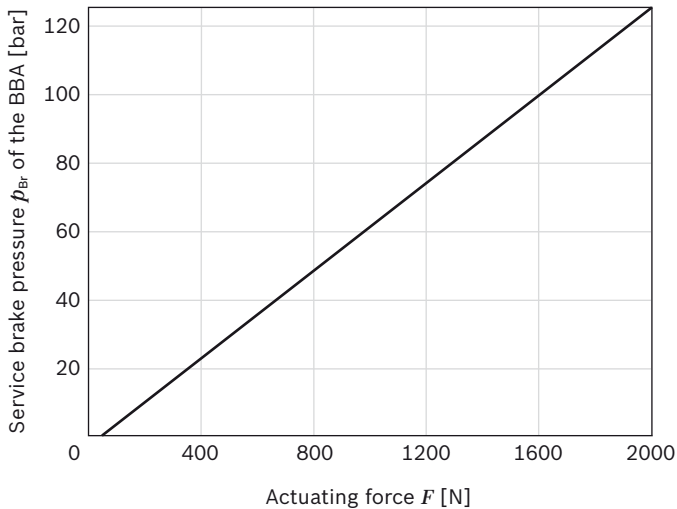
14	With actuation rod	16
	With actuation rod and pressure switch	17

15	Further details in the plain text	*
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Characteristic curves

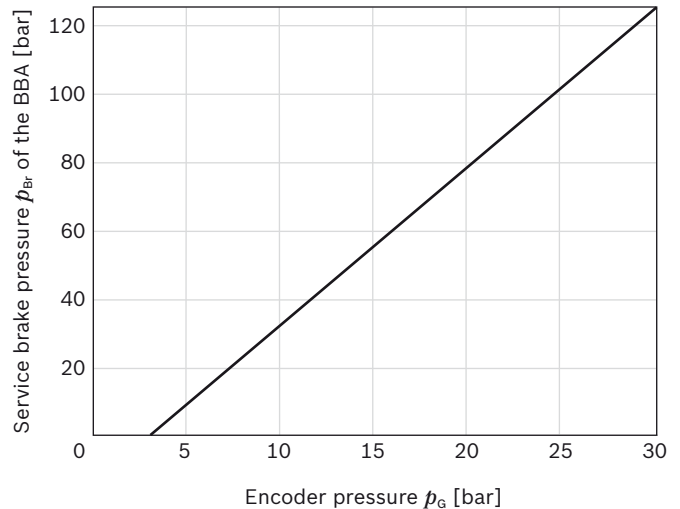
Version M

▼ **Service brake pressure dependent on the actuating force (directly operated, without pedal)**



Version H

▼ **Service brake pressure depending on the encoder pressure**



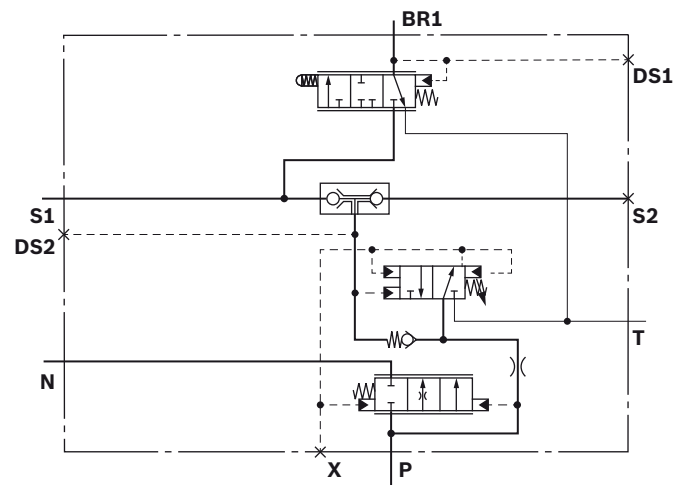
²⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006.

Symbols

Mechanical actuation BBA, without FBA

Ordering code:

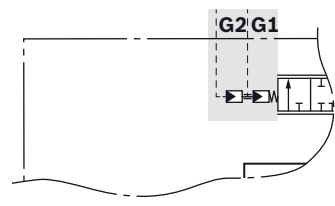
LT 12	M	3X	/	...	-	...
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Hydraulic actuation BBA, without FBA

Ordering code:

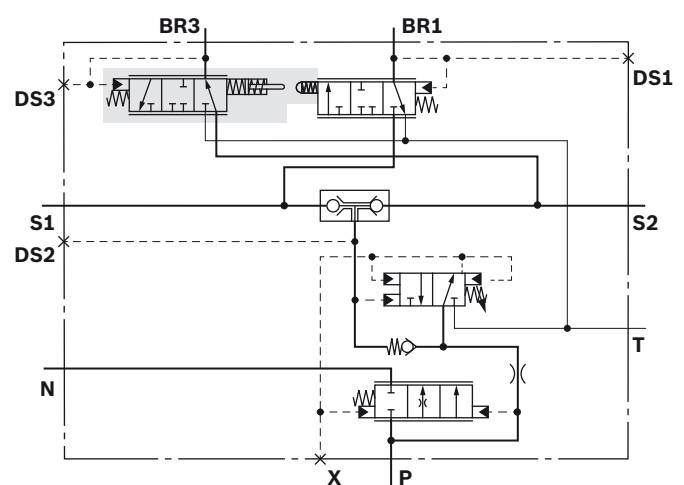
LT 12	H	3X	/	...	-	...
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Mechanical actuation BBA, mechanical FBA

Ordering code:

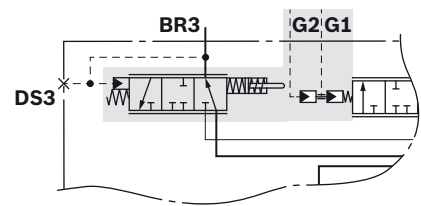
LT 12	M	3X	/	...	M	...
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Hydraulic actuation BBA, mechanical FBA

Ordering code:

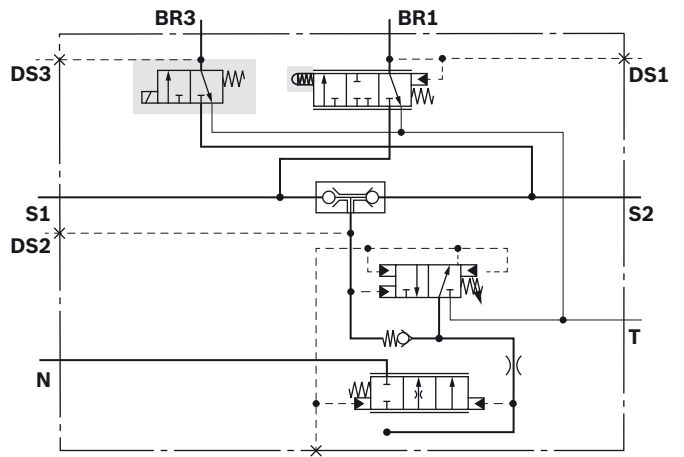
LT 12	H	3X	/	...	M	...
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Mechanical actuation BBA, electric FBA

Ordering code:

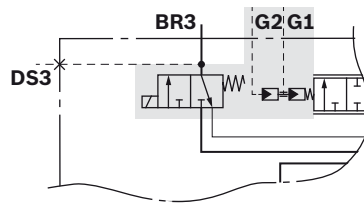
LT 12	M	3X	/	...	E	...
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Hydraulic actuation BBA, electric FBA

Ordering code:

LT 12	H	3X	/	...	E	...
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Overall set-up

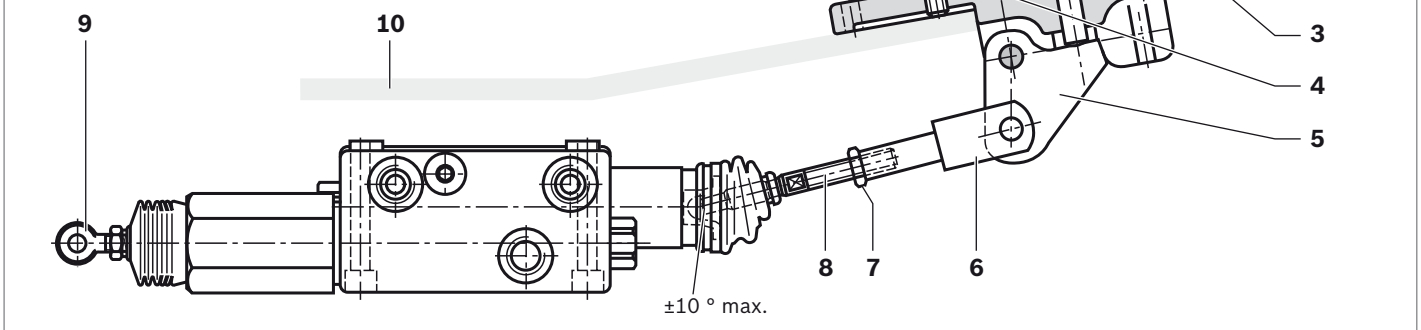
LT 12 with mechanical actuation

- 1 Brake pedal LT 20, see page 15
- 2 Detent locking (optional)
- 3 Setscrew
- 4 Pedal adjustment screw
- 5 Diversion plate
- 6 Fork clevis according to DIN 71752¹⁾
- 7 Lock nut ¹⁾
- 8 Actuation rod (optional)
- 9 Ring bolt for the mechanical actuation of the parking brake
- 10 Base plate (e.g. cabin)¹⁾

¹⁾ Not included in the scope of delivery

NOTICE

Valve and pedal with rod have to be mounted in an aligned manner!



Assembly

Low-friction operation requires good orientation of the valve to the pedal. In the top view, valve axis, actuation rod (8) and pedal (1) must be aligned! In the side view, the actuation rod may press against the valve actuation with an incline of max. 10°. Incline and height of the pedal influence the actuation angle and the force.

If due to the space required, the control is designed with a longer actuation unit, it has to be resistant to buckling (see actuating force).

Setting the pedal

Lock nut (7) and fork clevis (6) are screwed onto the actuation rod (8); after assembly of the valve and the pedal, the fork clevis (6) will be connected at the diversion plate (5) with the axis bolt.

Pedal (1) not operated

The actuation rod (8) is adjusted until the play between ball head and valve actuation is reduced to the minimum.

NOTICE

The valve actuation must not be preloaded. The operation rod must allow for minimum movement. This setting is secured by means of the lock nut (7).

Pedal (1) operated

The maximum brake pressure is set by means of the set-screw (3) as required and secured by means of the lock nut. When the pedal is released, only the tank pressure may be available.

Option – Pedal with detent locking (2)

Lock nut (7) and fork clevis (6) are screwed onto the actuation rod (8), the fork clevis is connected at the diversion plate (5) with the axis bolt. Bring the pedal in the detented position. Set the actuation rod (8) so that the valve achieves the desired maximum pressure. Secure the pressure adjustment by locking the nut (7).

Releasing the detent locking

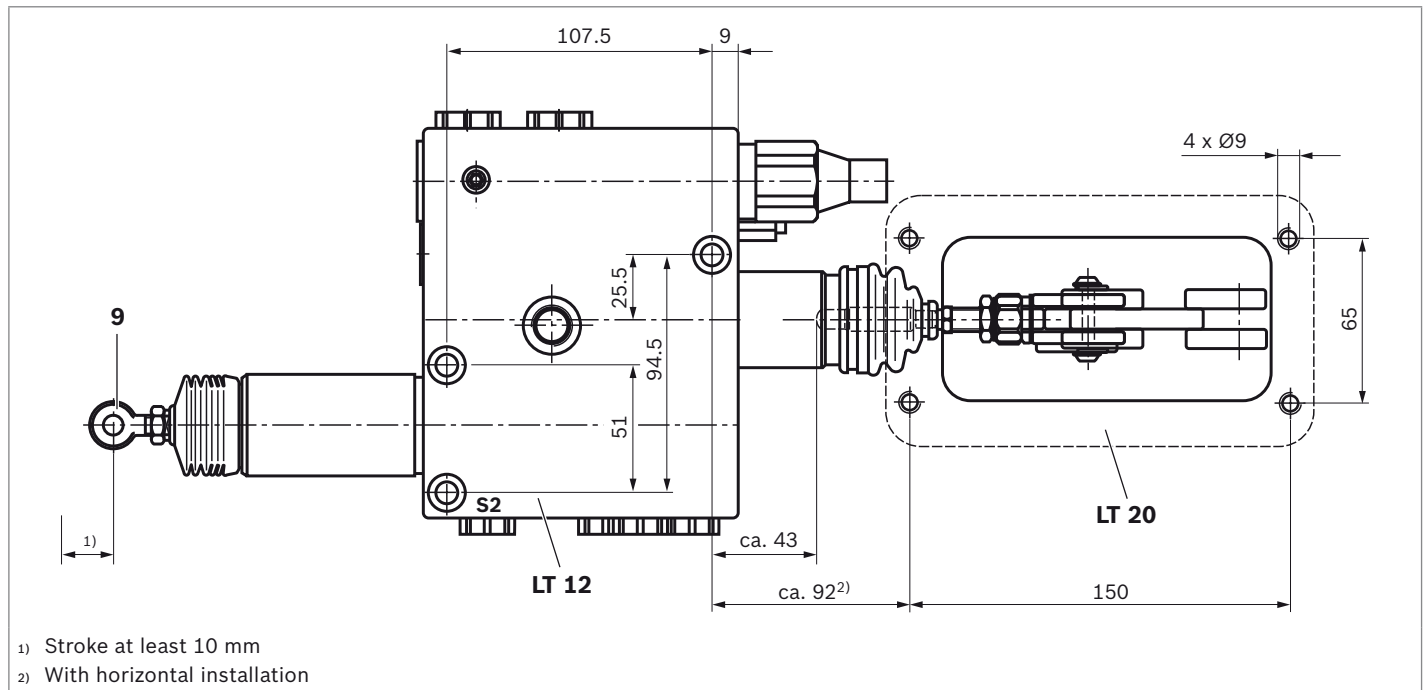
When the pedal (1) is not operated, rotate the pedal adjustment screw (4) until the smallest play possible is achieved.

Parking brake version M

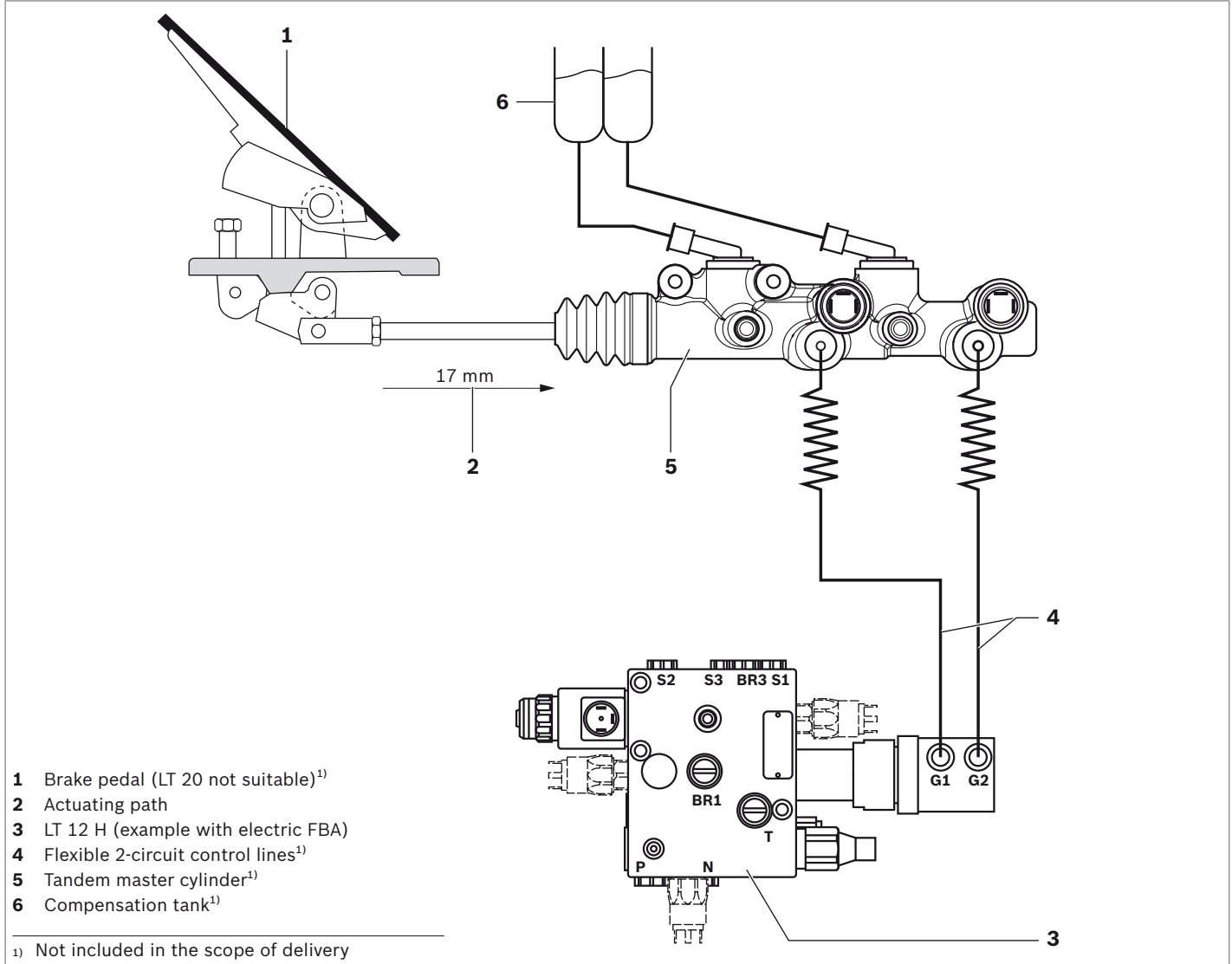
The parking brake has been set to the desired pressure at the factory. If the parking brake is not activated, the parking brake pressure corresponds to the pressure set at the factory. The bowden cable must be set so that in the non-operated state, no traction force acts on the ring bolt (9). With increasing operation (pulling) of the parking brake, the brake pressure decreases to the tank pressure. Then, the entire force of the spring-loaded accumulator cylinder acts on the wheel brake. To this end, the bowden cable must allow for a stroke of at least 10 mm. The holding force corresponds to the connection force and is max. 1100 N. The bowden cable is to be laid so that low-friction operation is possible.

Parking brake version E

The electric FBA cannot be set. With voltage applied to the solenoid (12 or 24 Volt), the accumulator pressure is switched to the parking brake. The minimum parking brake pressure corresponds to the switch-on pressure of the charging valve. If there is no voltage applied to the solenoid, the output pressure corresponds to the tank pressure.



LT 12 with hydraulic actuation

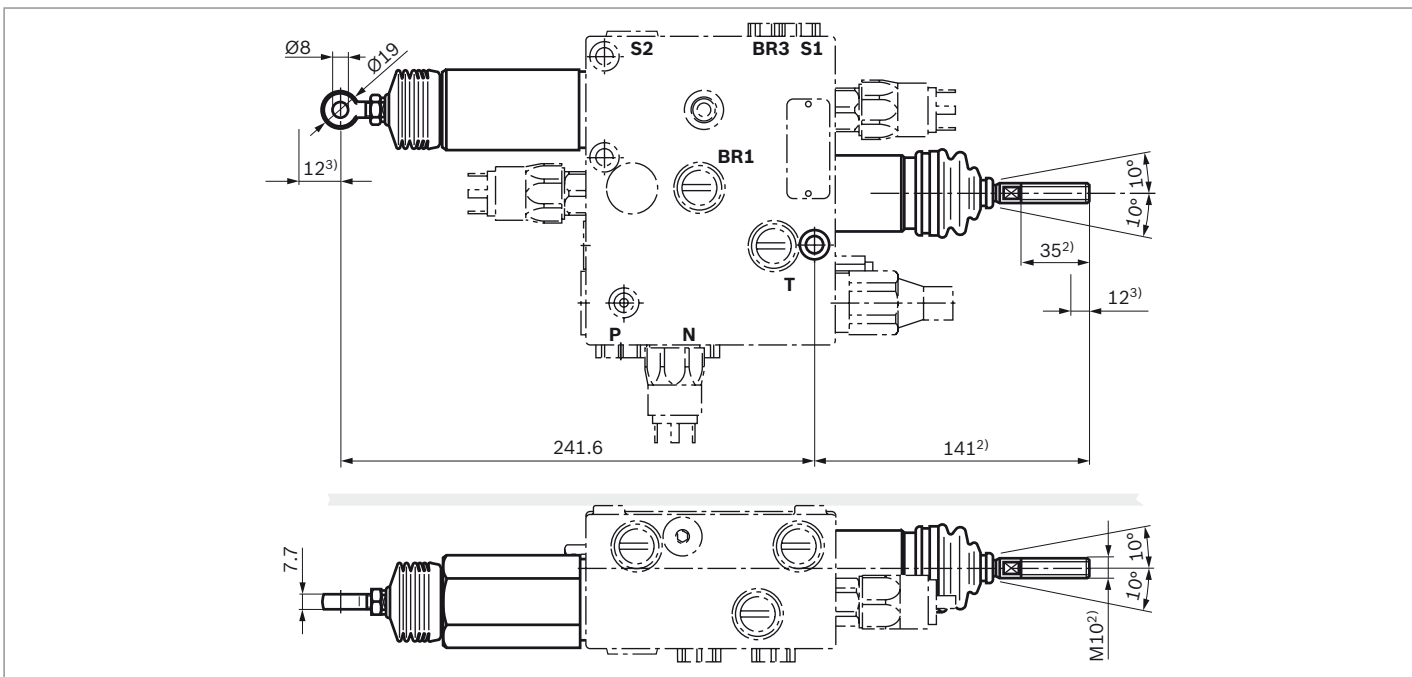


For the control, we recommend the tandem master cylinder MH17861.2.1 by FTE Automotive (Ebern). Stroke volume of encoder cylinder and displacement of the LT 12 H pickup head are adjusted to each other.

NOTICE
If one control line (4) fails, the tandem master cylinder requires twice the actuating path to achieve the brake pressure.

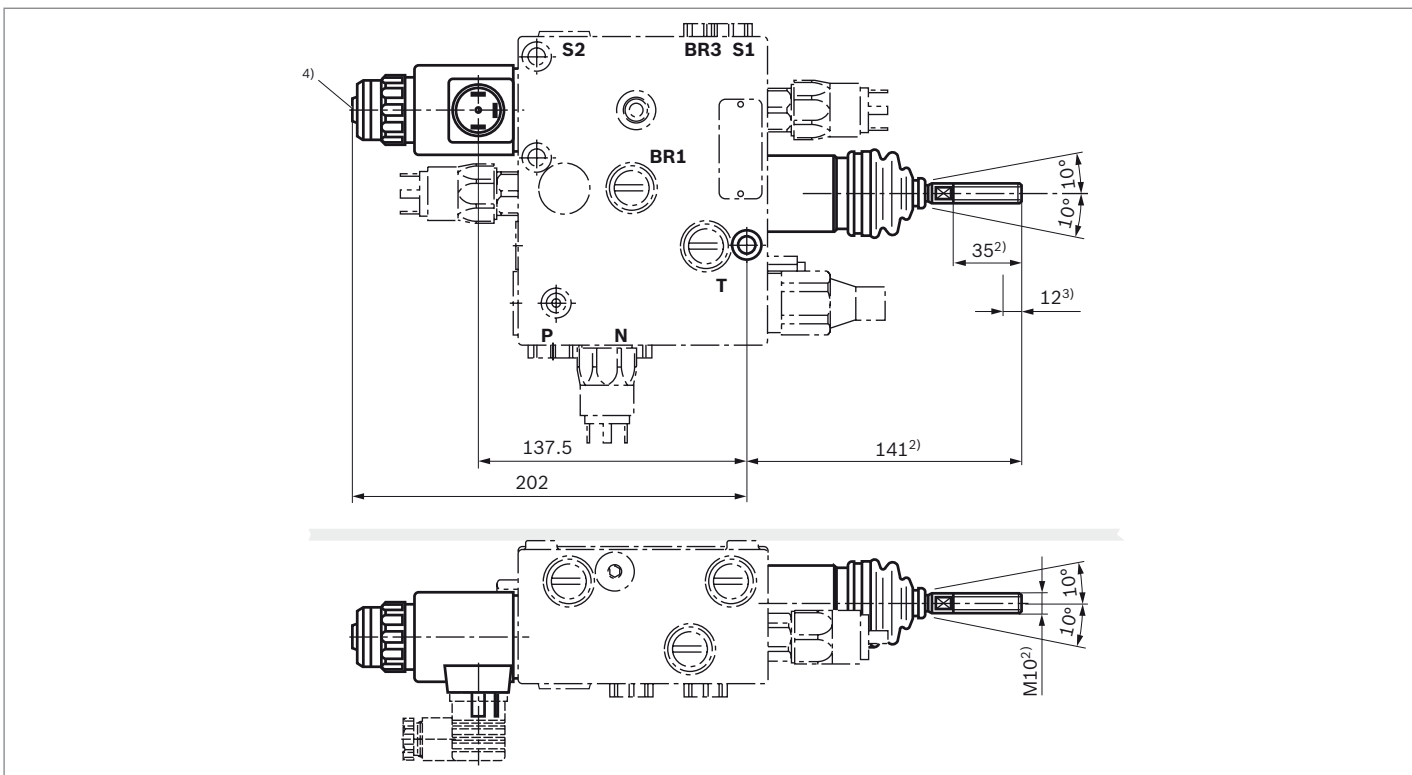
▼ Mechanical actuation BBA, mechanical FBA

Version	LT 12	M	3X	...	M	...
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▼ Mechanical actuation BBA, electric FBA

Version	LT 12	M	3X	...	E	...
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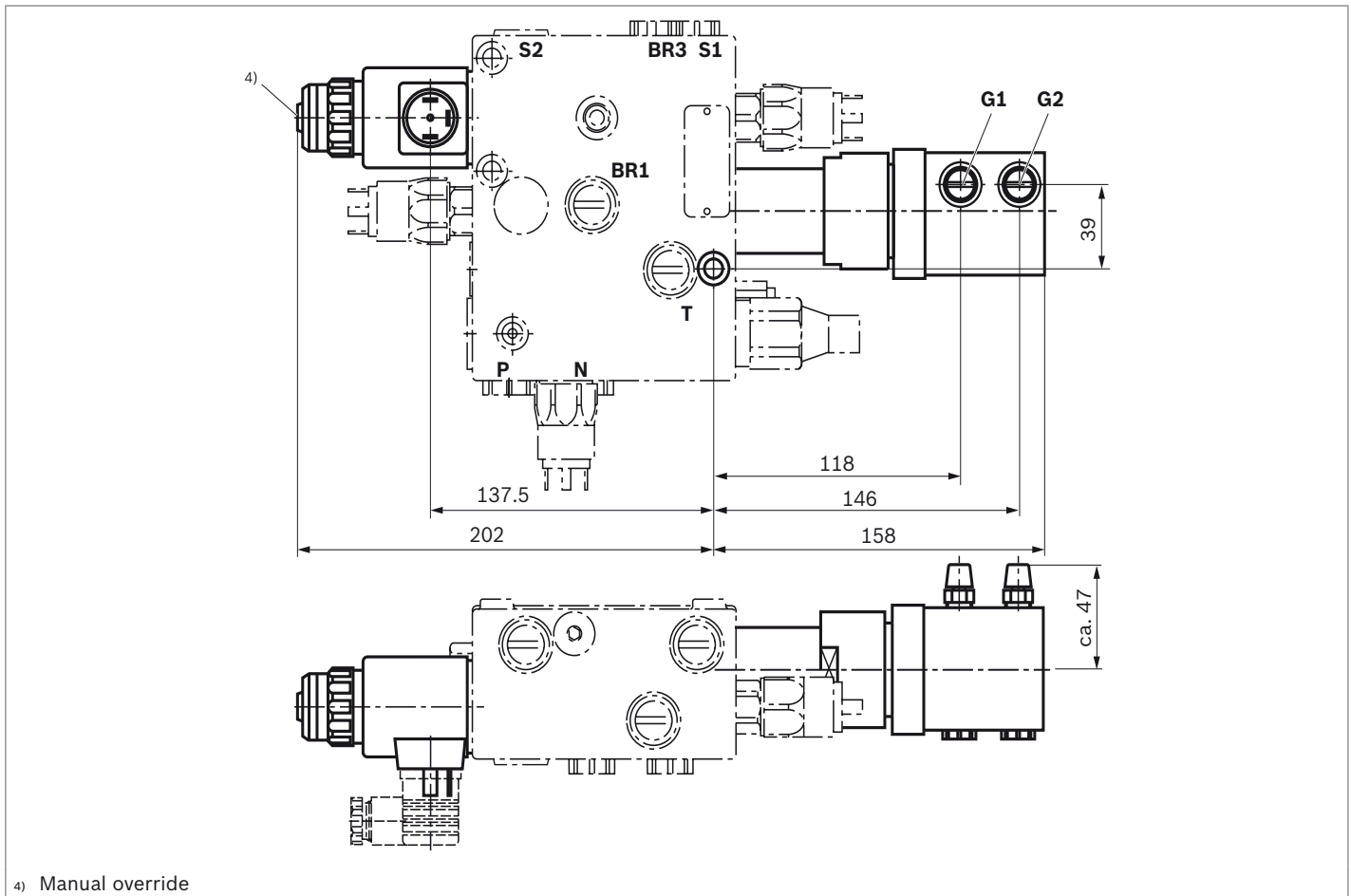


- 2) Version with actuation lever
- 3) Maximum stroke
- 4) Manual override

▼ Hydraulic actuation BBA, electric FBA

Version

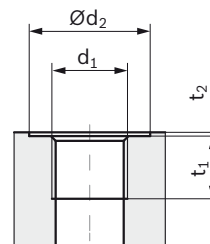
LT 12	H	3X	...	E	...
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Line connections

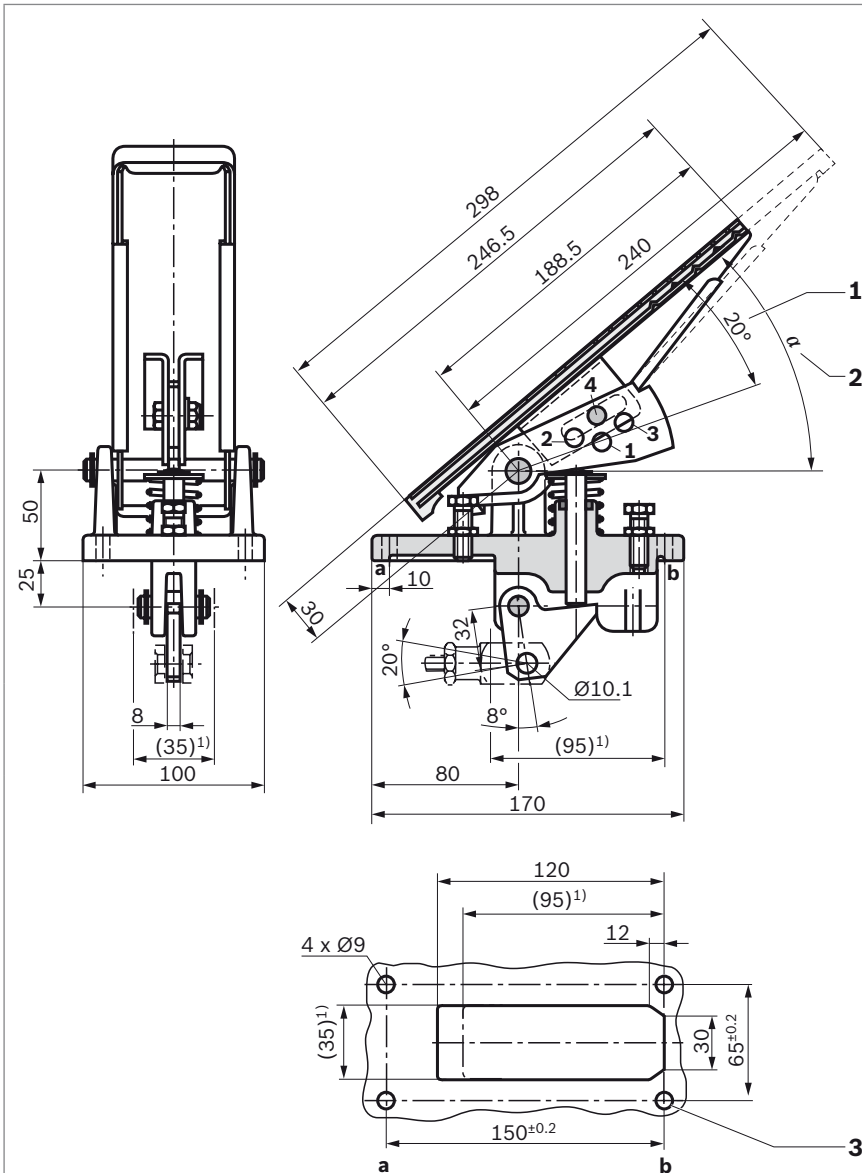
Thread design 02

Connection	d_1	$\varnothing d_2$	t_1	t_2
BR1, BR3	M16 x 1.5	26	12	1
DS1, DS3	M12 x 1.5	18	12	0.5
DS2	M10 x 1	–	6	–
S1, S2	M16 x 1.5	26	12	1
G1, G2	M12 x 1.5	20	12	1
X	M12 x 1.5	18	12	1
P, N	M18 x 1.5	28	12	1.5
T	M16 x 1.5	26	12	1



Brake pedal variants

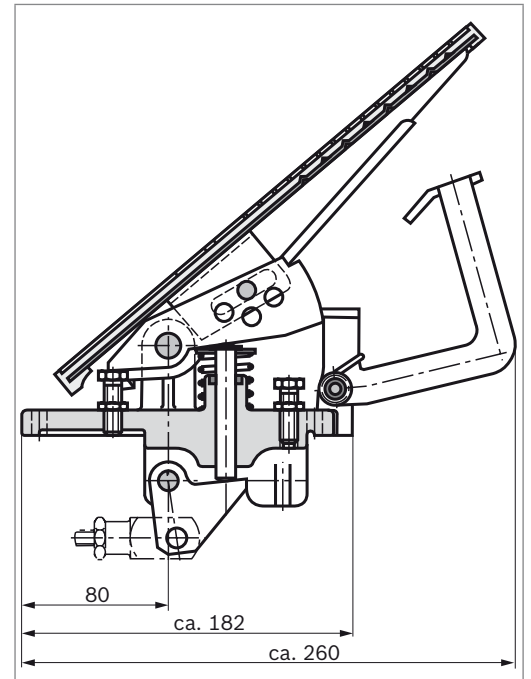
▼ **Standard version LT 20 (R900412420)/
version LT 20 with shortened pedal plate (R901056192)**



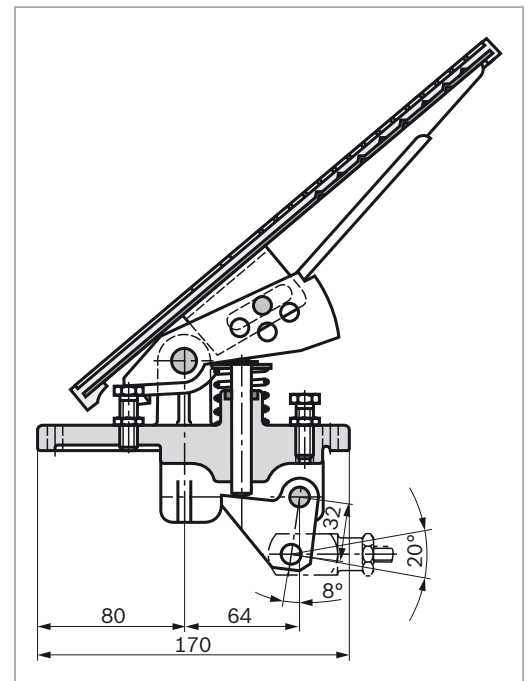
- 1 Actuation angle
- 2 **Pedal angle of attack α can be adjusted in 5° steps:**
 Hole 1 = 25°
 Hole 2 = 30°
 Hole 3 = 35°
 Hole 4 = 40° (standard version)
- 3 Assembly hole pattern in the base plate (proposal)

¹⁾ Minimum dimensions of the base plate for the pedal installation

▼ **Version LT 20 with locking hook (R900328536)**



▼ **Version LT 20 with actuation rod to the front (R900412421)**



NOTICE

All pedal variants are, by default, equipped with anti-slid pedal rubber that can be disassembled.

Accessories

Pressure switches

Connection	Function	Switching pressure	Order number
DS1	Braking light	5 bar	R901355130
DS2	Accumulator pressure	50 bar	R900015507
	Accumulator pressure	100 bar	R900014525
	Accumulator pressure	115 bar	R900026566
DS3	Parking brake	25 bar	R901355138

NOTICE

Bosch Rexroth uses pressure switches by SUCO / Bietigheim-Bissingen.

Brake pedals

Type	Description	Order number
LT 20 MKA-1X/000H/00-	Standard version	R900412420
LT 20 MKA-1X/000H/00-SO1	Version with locking hook	R900328536
LT 20 MKA-1X/000H/00-SO2	Version with actuation rod to the front	R900412421
LT 20 MKA-1X/000H/00-SO9	Version with shortened pedal plate	R901056192

Other components (recommendation, not sold by Bosch Rexroth)

Description	Type
Stepped tandem cylinder	MH17861.2.1 by FTE Automotive, Ebern
Bowden cable (remote operation FBA)	MFB GmbH, Mühlheim a. d. Ruhr
Fork clevis	FBA axis connection, fork clevis according to DIN 71752 G8 x 16/32
	BBA axis connection, fork clevis according to DIN 71752 G10 x 20/40
Accumulator	NOTICE: Use ECO diaphragms for brake accumulators (for extended temperature range!)

Related documents

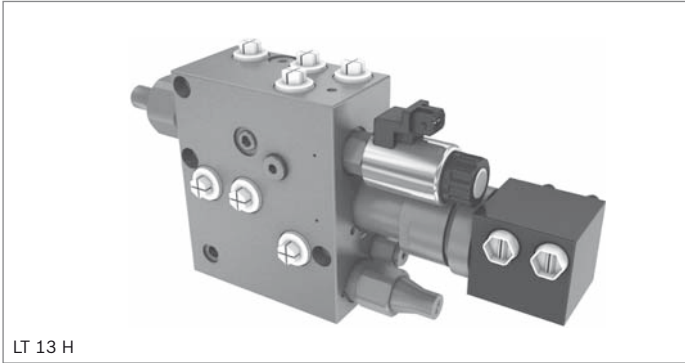
The power brake valves LT 12 are hydraulic components in power brake systems in mobile machines.

Also observe the instructions for the other system components. Do not commission the product until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

Dual-circuit power brake valve with compact design

LT 13



- ▶ Series 3X
- ▶ Service brake pressure 40, 60, 80, 100 and 125 bar

Features

- ▶ Dual-circuit power brake valve, accumulator charging valve and shuttle valve in one housing
- ▶ Electric or mechanical parking brake valve (optional)
- ▶ Brake pressure proportional to actuating force and path
- ▶ Fast and simple assembly
- ▶ Minimized piping
- ▶ Little space required
- ▶ Integration into existing hydraulic systems possible
- ▶ Fast readiness for operation
- ▶ Sensitive dosing
- ▶ Minimum number of components
- ▶ Flexible installation

Fields of application

- ▶ Construction machines
- ▶ Conveyor vehicles
- ▶ Forestry and agricultural machinery
- ▶ Municipal vehicles
- ▶ Special vehicles

Contents

Functional description	2
Technical data	4
Ordering code	5
Characteristic curves	7
Symbols	8
Overall set-up	11
Dimensions	14
Line connections	18
Brake pedal variants	19
Accessories	20
Related documents	20

Functional description

The LT 13 is a dual-circuit power brake valve in compact design combining all required functions in one valve.

Accumulator charging valve

The accumulator charging valve **(1)** primarily charges the accumulator. If the accumulator pressure falls below the switch-on pressure of the charging valve, the accumulators will be charged until the cut-off pressure is reached. The switching pressure differential is approx. 18 % of the cut-off pressure. The accumulators are charged with a charging flow of e.g. 17 l/min (version B40). If the pump delivers more than e.g. 17 l/min, the downstream actuator **(N)** will be supplied with the difference.

NOTICE

If downstream actuators **(N)** generate a pressure higher than the cut-off pressure of the accumulator charging valve, the accumulator circuit will be raised to this pressure level. The pressure of the downstream actuators **(N)** must be 30 % lower than the set accumulator pressure ($N < \text{accumulator pressure} - 30\%$).

Circuit separation

The valve supplies two separate brake circuits. They are separated by means of an inverted shuttle valve **(2)**.

Dual-circuit braking valve

The dual-circuit power brake valve LT 13 is a direct operated pressure reducing valve in 3-way version with stepless mechanical operation.

The LT 13 basically comprises of two 3-way pressure reducing valves arranged in tandem design. The pressure in both brake circuits increases proportional to actuating force and actuating path. When the deflection is kept constant, the set pressure in channels **BR1** and **BR2** is kept constant. The valve of the first brake circuit **(4.1)** is direct operated. The pressure of the second brake circuit **(4.2)** is controlled by the first braking valve. If the hydraulic supply of the first brake circuit fails, the second brake circuit will be direct operated.

Mechanically operated service brake

For the mechanical operation of LT 13 M, an LT 20 foot pedal is suitable (variants see page 19). If the recommended overall set-up is observed, actuating force and path are adjusted to each other.

Hydraulically operated service brake

In case of hydraulic operation, the tandem master cylinder is operated by means of a suitable pedal. The hydraulic fluid supplied from the storage tank is piped to the LT 13 H pickup head proportional to the pedal path. Both, the tandem master cylinder and the LT 13 H pickup head have two separate chambers.

The pickup spools steer in line proportional to the supplied hydraulic fluid and charge the main brake spools via the brake pressure control springs.

Mechanically operated parking brake/auxiliary brake (3)

The parking brake valve is a direct operated 3-way pressure reducing valve. If the valve is operated, the pressure decreases proportional to the operation. The valve controls the pressure in a controllable manner. So the "auxiliary brake" function can also be satisfied.

Electrically switched parking brake (3)

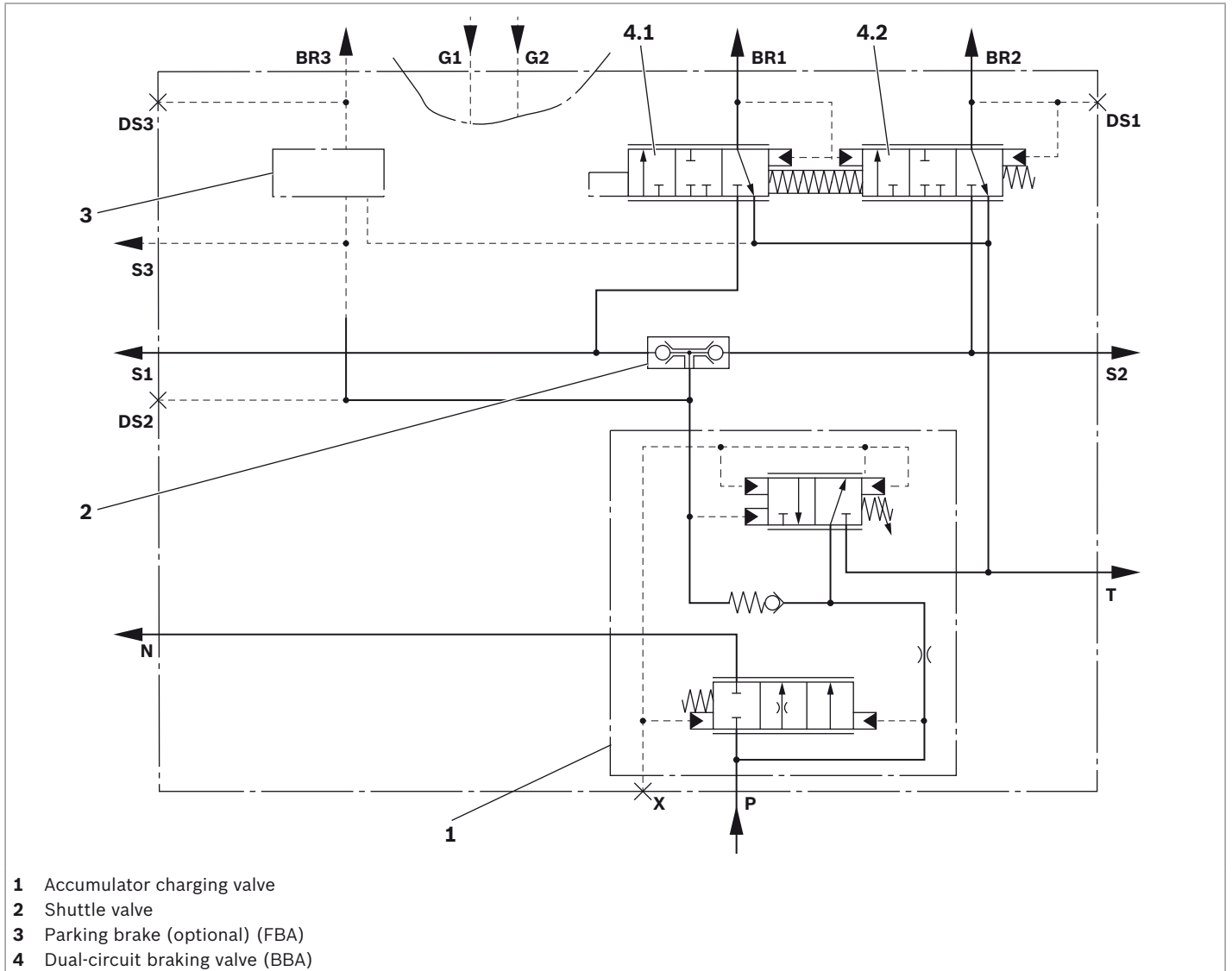
The electrically switched parking brake valve **(3)** is a 3/2 directional valve. If the valve is switched with an electric signal, port **BR3** is connected to port **S3**. The applied accumulator pressure **S3** supplies the parking brake via **BR3**. If the electric signal is switched off or fails, the parking brake valve **BR3** is connected to **T** and the pressure pending in the parking brake can be reduced. The auxiliary brake function cannot be shown.

Combined mechanically/hydraulically operated service brake

For the mechanical operation of LT 13 K, an LT 20 foot pedal is suitable (variants see page 19). If the recommended overall set-up is observed, actuating force and path are adjusted to each other.

In addition, the LT 13 K can be controlled hydraulically via port **G**. This unit is controlled either via the internal parking brake valve **(3)** or by an external pressure supply (switched or proportional).

▼ Symbol LT 13

**Connections**

BR1	Service brake (1st brake circuit)
BR2	Service brake (2nd brake circuit)
BR3	Parking brake
DS1	Pressure switch, braking light
DS2	Pressure switch, accumulator pressure
DS3	Pressure switch, parking brake
S1	Service brake supply (1st brake circuit)
S2	Service brake supply (2nd brake circuit)
S3	Parking brake supply
G	Hydraulic control of the service brake (alternative)
P	Pump
T	Tank
N	Return flow or downstream actuators
X	Load-sensing (LS)

Technical data

general				
Weight		kg		Approx. 11 (depending on the version)
Installation position				Preferably horizontal
Type of connection				Metric thread
Ambient temperature range	θ	°C		-25 to +80
Priming				Single-layer coating RAL 5010
hydraulic				
Maximum service brake pressure at port	BR1, BR2	p_{Br}	bar	125
Maximum parking brake pressure at port BR3	Version M	p	bar	120 (proportional)
	Version E	p	bar	Corresponds to the accumulator charging pressure/depending on the setting at the accumulator charging valve
	Version R	p	bar	120
	Version P	p	bar	210 (\neq max. pressure S3 of the external pressure supply)
Maximum inlet pressure at the port	P	p	bar	210
Maximum accumulator pressure at port	S1, S2	p	bar	200
	S3	p	bar	210
Maximum accumulator charging pressure	Cut-off pressure	p	bar	200
	Switch-on pressure	p	bar	Approx. 18 % below cut-off pressure
Maximum tank pressure at port	T	p	bar	0.5 (The tank pressure must not exceed the application pressure of the brake.)
Maximum pressure at port	N	p	bar	30 % less than the set accumulator pressure
Maximum encoder pressure at port	G1, G2	p_G	bar	40 (with version H)
	G	p_G	bar	180 (with version K)
Maximum flow	P → S		l/min	Approx. 6 (B18) Approx. 17 (standard, B40)
	P → N		l/min	70
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet RE 90221, upon request
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$
electric				
Voltage type				Direct voltage
Supply voltage			V	12; 24
Protection class according to VDE 0470-1 (DIN EN 60529), DIN 40050-9	Version K4			IP65 with mating connector mounted and locked ¹⁾
	Version C4			IP65 with mating connector mounted and locked ¹⁾
				IP69K with Rexroth mating connector (material number R901022127) ¹⁾
	Version K40			IP65K with mating connector mounted and locked ¹⁾

NOTICE

For applications outside these parameters, please consult us!

¹⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006.

Ordering code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
LT 13		3X	/							/		M		*

Series

01	Dual-circuit power brake valve with compact design LT 13	LT 13
----	--	-------

Type of actuation service brake (BBA)

02	Mechanical	M
	Hydraulic	H
	Mechanical/hydraulic combined	K

Series

03	30 to 39 (unchanged installation and connection dimensions)	3X
----	---	----

Characteristic curve

04	Linear characteristic curve	L
	Progressive characteristic curve	P

Service brake pressure (BBA)

05	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	125 bar	125

Type of actuation parking brake (FBA)

06	Without FBA	-
	Mechanically operated	M
	Electrically switched ¹⁾	E
	Electrically switched, reduced	R
	Electrically switched with external pressure supply ²⁾	P

Parking brake pressure (FBA)

07	^{1); 2)}	XXX
	Without FBA	000
	20 bar	020
	40 bar	040
	60 bar	060
	80 bar	080
	100 bar	100
	120 bar	120

Accumulator charging pressure

08	100 bar	A
	120 bar	B
	150 bar (standard)	C
	165 bar	D
	185 bar	E
	200 bar	F

¹⁾ With electrically switched FBA, the parking brake pressure of the FBA corresponds to the accumulator charging pressure. Observe the switching hysteresis!

²⁾ With external FBA pressure supply, the parking brake pressure of the FBA corresponds to the supplied pressure.

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
LT 13		3X	/								/		M	*

Accumulator charging flow

09	Approx. 17 l/min (standard)	B40
	Approx. 6 l/min	B18

Voltage at the switching solenoid

10	12 Volt	AG12
	24 Volt	AG24

Connector type (standard with manual override)³⁾

11	Cubic connector	NK4
	Deutsch plug	NK40
	Junior timer, 2-pole (AMP)	NC4

Line connections

12	Metric thread	02
	UNF thread	19

Seal material

13	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
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Additional equipment

14	With actuation rod	16
	With actuation rod and pressure switch	17

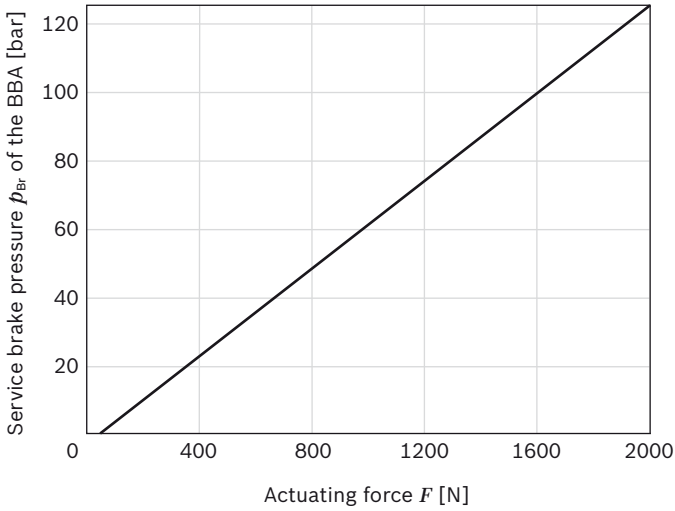
15	Further details in the plain text	*
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³⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006.

Characteristic curves

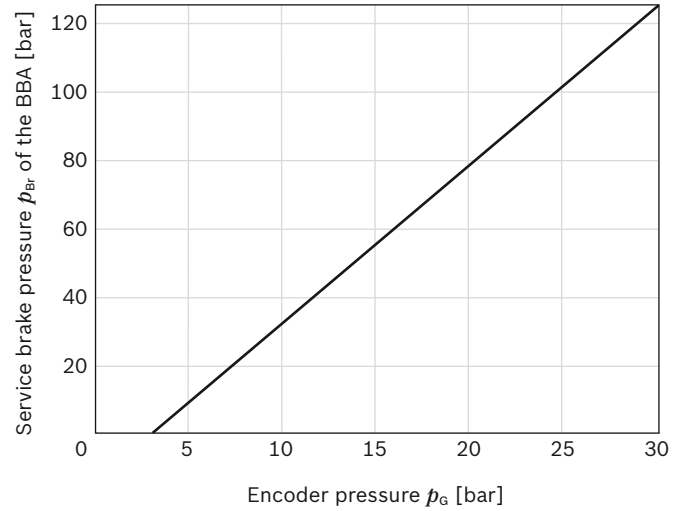
Version M

- ▼ Service brake pressure dependent on the actuating force (directly operated, without pedal)



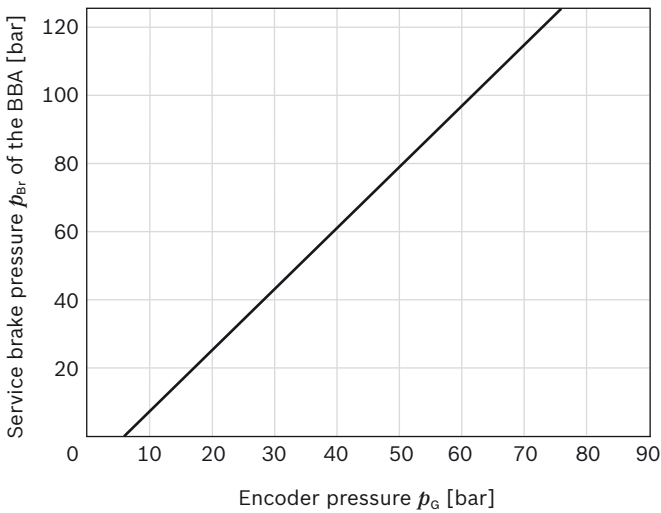
Version H

- ▼ Service brake pressure depending on the encoder pressure



Version K

- ▼ Service brake pressure depending on the encoder pressure



NOTICE

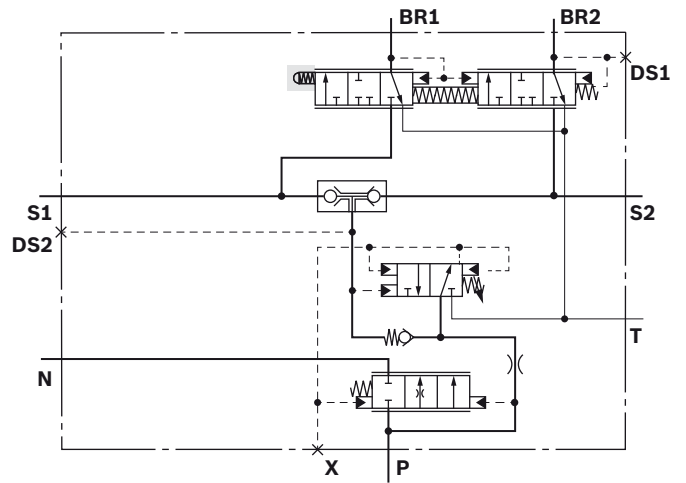
The adjusted service brake pressure can not be exceeded with a higher encoder pressure.

Symbols

Mechanical actuation BBA, without FBA

Ordering code:

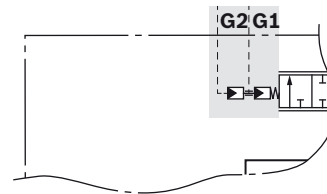
LT 13	M	3X	/	...	-	...
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Hydraulic actuation BBA, without FBA

Ordering code:

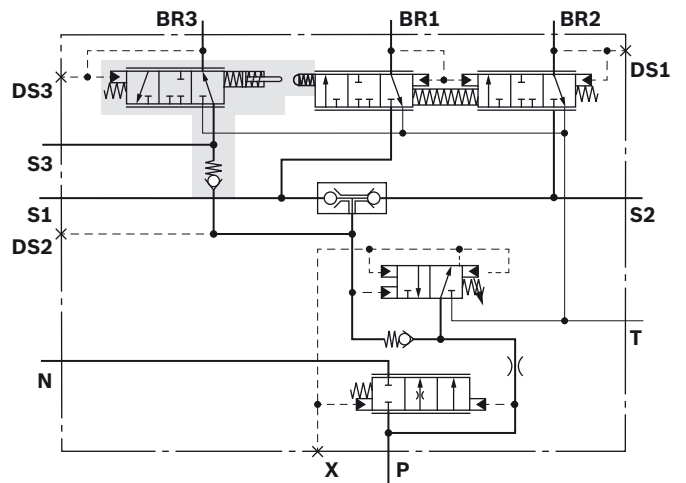
LT 13	H	3X	/	...	-	...
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Mechanical actuation BBA, mechanical FBA

Ordering code:

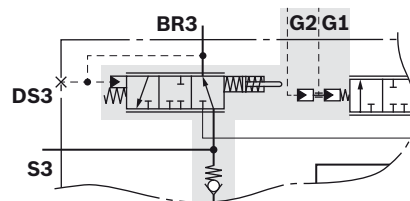
LT 13	M	3X	/	...	M	...
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Hydraulic actuation BBA, mechanical FBA

Ordering code:

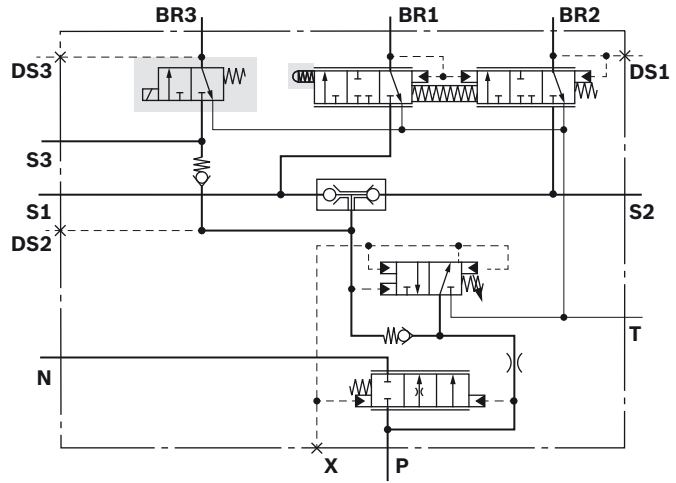
LT 13	H	3X	/	...	M	...
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Mechanical actuation BBA, electric FBA

Ordering code:

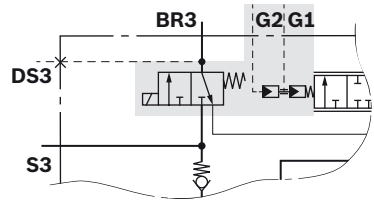
LT 13	M	3X	/	...	E	...
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Hydraulic actuation BBA, electric FBA

Ordering code:

LT 13	H	3X	/	...	E	...
-------	---	----	---	-----	---	-----

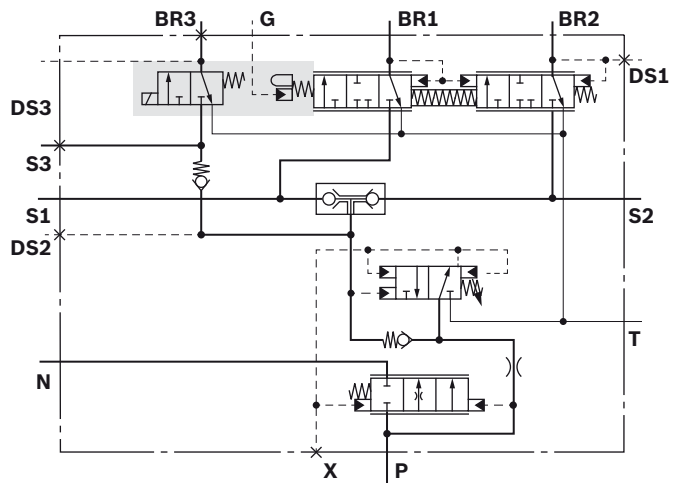


Combined mechanical/hydraulic actuation BBA, electric FBA

Ordering code:

LT 13	K	3X	/	...	E	...
-------	---	----	---	-----	---	-----

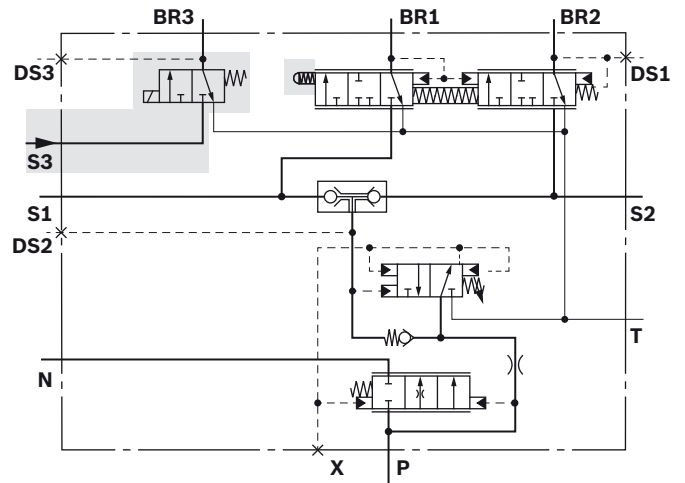
- ▶ The connection to port **G** has to be made by the customer.
- ▶ Bosch Rexroth recommends an upstream damping valve for directly switched actuation at port **G**.



Mechanical actuation BBA, electric FBA with external pressure supply

Ordering code:

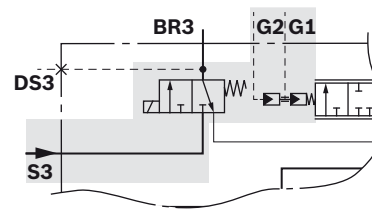
LT 13	M	3X	/	...	P	...
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Hydraulic actuation BBA, electric FBA with external pressure supply

Ordering code:

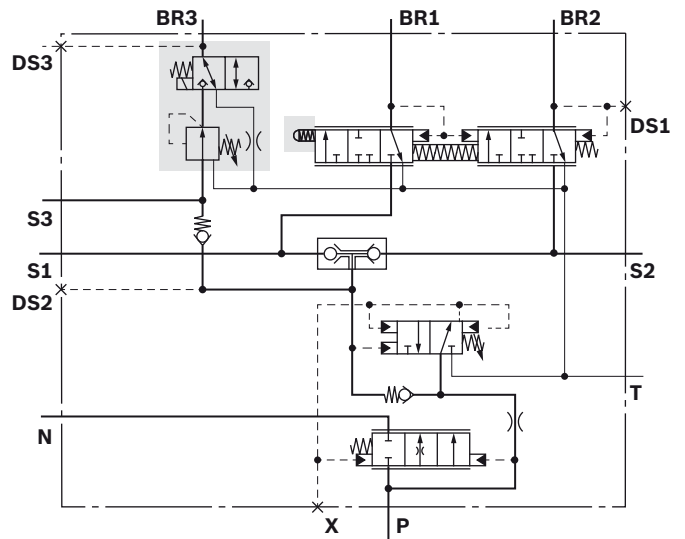
LT 13	H	3X	/	...	P	...
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Mechanical actuation BBA, electrically reduced FBA

Ordering code:

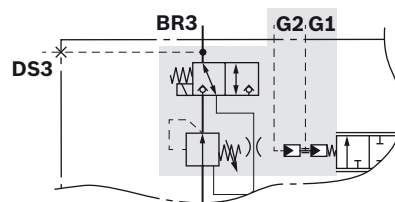
LT 13	M	3X	/	...	R	...
-------	---	----	---	-----	---	-----



Hydraulic actuation BBA, electrically reduced FBA

Ordering code:

LT 13	H	3X	/	...	R	...
-------	---	----	---	-----	---	-----



Overall set-up

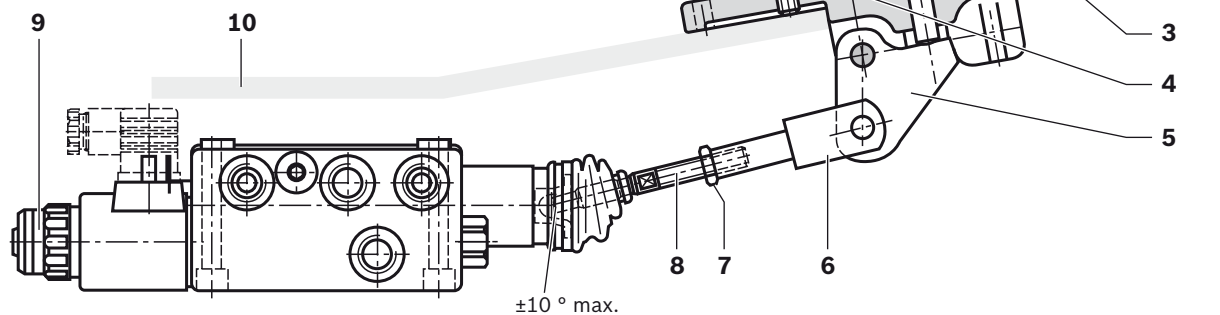
LT 13 with mechanical actuation BBA

- 1 Brake pedal LT 20, see page 19
- 2 Detent locking (optional)
- 3 Setscrew
- 4 Pedal adjustment screw
- 5 Diversion plate
- 6 Fork clevis according to DIN 71752¹⁾
- 7 Lock nut¹⁾
- 8 Actuation rod (optional)
- 9 Switching solenoid for the electrical actuation of the parking brake
- 10 Base plate (e.g. cabin)¹⁾

¹⁾ Not included in the scope of delivery

NOTICE

Valve and pedal with rod have to be mounted in an aligned manner!



Assembly

Low-friction operation requires good orientation of the valve to the pedal. In the top view, valve axis, actuation rod (8) and pedal (1) must be aligned! In the side view, the actuation rod may press against the valve actuation with an incline of max. 10°. Incline and height of the pedal influence the actuation angle and the force.

If due to the space required, the control is designed with a longer actuation unit, it has to be resistant to buckling (see actuating force).

Setting the pedal

Lock nut (7) and fork clevis (6) are screwed onto the actuation rod (8); after assembly of the valve and the pedal, the fork clevis (6) will be connected at the diversion plate (5) with the axis bolt.

Pedal (1) not operated

The actuation rod (8) is adjusted until the play between ball head and valve actuation is reduced to the minimum.

NOTICE

The valve actuation must not be preloaded. The operation rod must allow for minimum movement. This setting is secured by means of the lock nut (7).

Pedal (1) operated

The maximum brake pressure is set by means of the setscrew (3) as required and secured by means of the lock nut. When the pedal is released, only the tank pressure may be available.

Option – Pedal with detent locking (2)

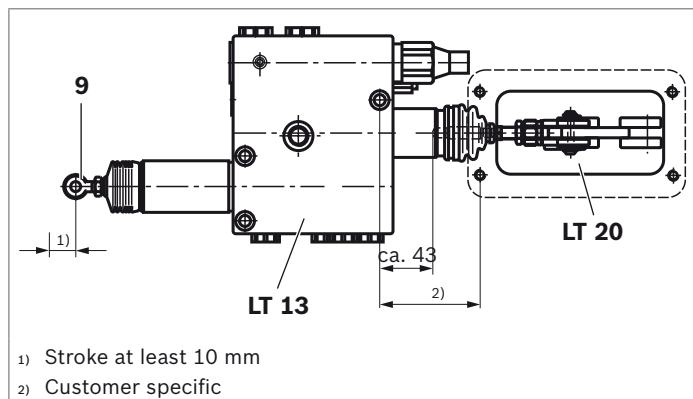
Lock nut (7) and fork clevis (6) are screwed onto the actuation rod (8), the fork clevis is connected at the diversion plate (5) with the axis bolt. Bring the pedal in the detented position. Set the actuation rod (8) so that the valve achieves the desired maximum pressure. Secure the pressure adjustment by locking the nut (7).

Releasing the detent locking

When the pedal (1) is not operated, rotate the pedal adjustment screw (4) until the smallest play possible is achieved.

Parking brake version M

The parking brake has been set to the desired pressure at the factory. If the parking brake is not activated, the parking brake pressure corresponds to the pressure set at the factory. The bowden cable must be set so that in the non-operated state, no traction force acts on the ring bolt (9). With increasing operation (pulling) of the parking brake, the brake pressure decreases to the tank pressure. Then, the entire force of the spring-loaded accumulator cylinder acts on the wheel brake. To this end, the bowden cable must allow for a stroke of at least 10 mm. The holding force corresponds to the connection force and is max. 1100 N. The bowden cable is to be laid so that low-friction operation is possible.



Parking brake version E

The electric FBA cannot be set.

With voltage applied to the solenoid (12 or 24 Volt), the accumulator pressure is switched to the parking brake. The minimum parking brake pressure corresponds to the switch-on pressure of the charging valve. If there is no voltage applied to the solenoid, the output pressure corresponds to the tank pressure.

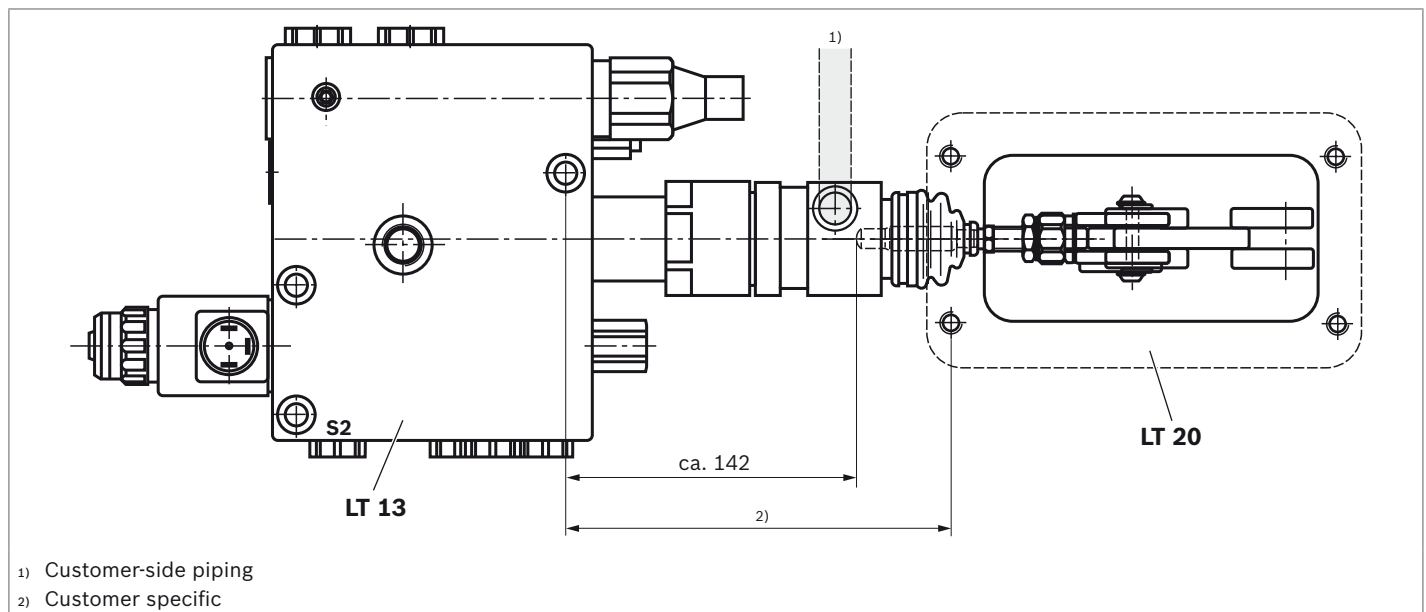
Parking brake version R

With voltage applied to the solenoid (12 or 24 Volt), the set pressure is switched to the parking brake. If there is no voltage applied to the solenoid, the output pressure corresponds to the tank pressure.

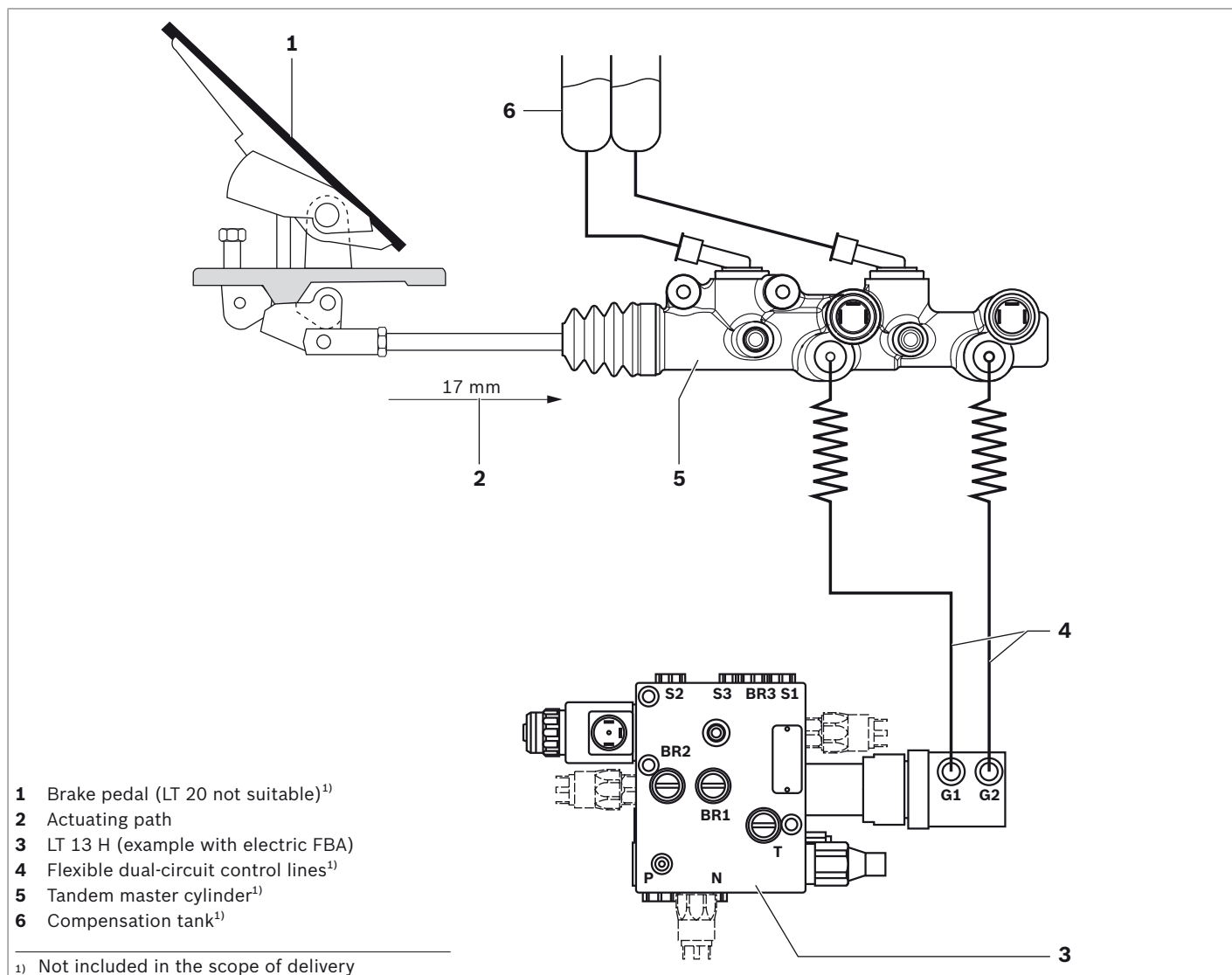
Parking brake version P

With voltage applied to the solenoid (12 or 24 Volt), the external pressure supply connected to **S3** is connected to port **BR3** and switched to the parking brake. If there is no voltage applied to the solenoid, the output pressure **BR3** corresponds to the tank pressure.

LT 13 with combined mechanical/hydraulic actuation BBA



LT 13 with hydraulic actuation



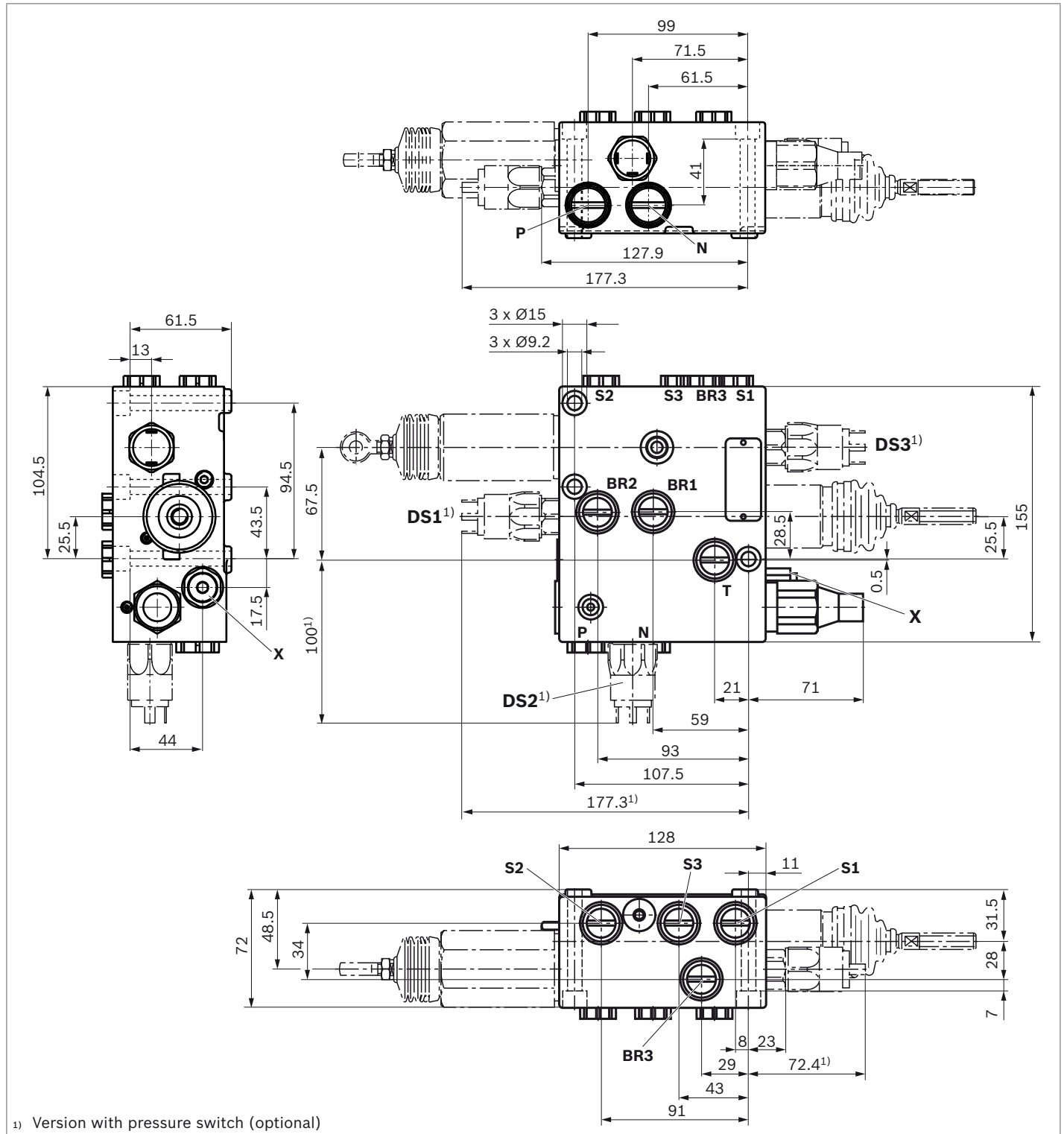
For the control, we recommend the tandem master cylinder MH17861.2.1 by FTE Automotive (Ebern). Stroke volume of encoder cylinder and displacement of the LT 13 H pickup head are adjusted to each other.

NOTICE

If one control line (4) fails, the tandem master cylinder requires twice the actuating path to achieve the brake pressure.

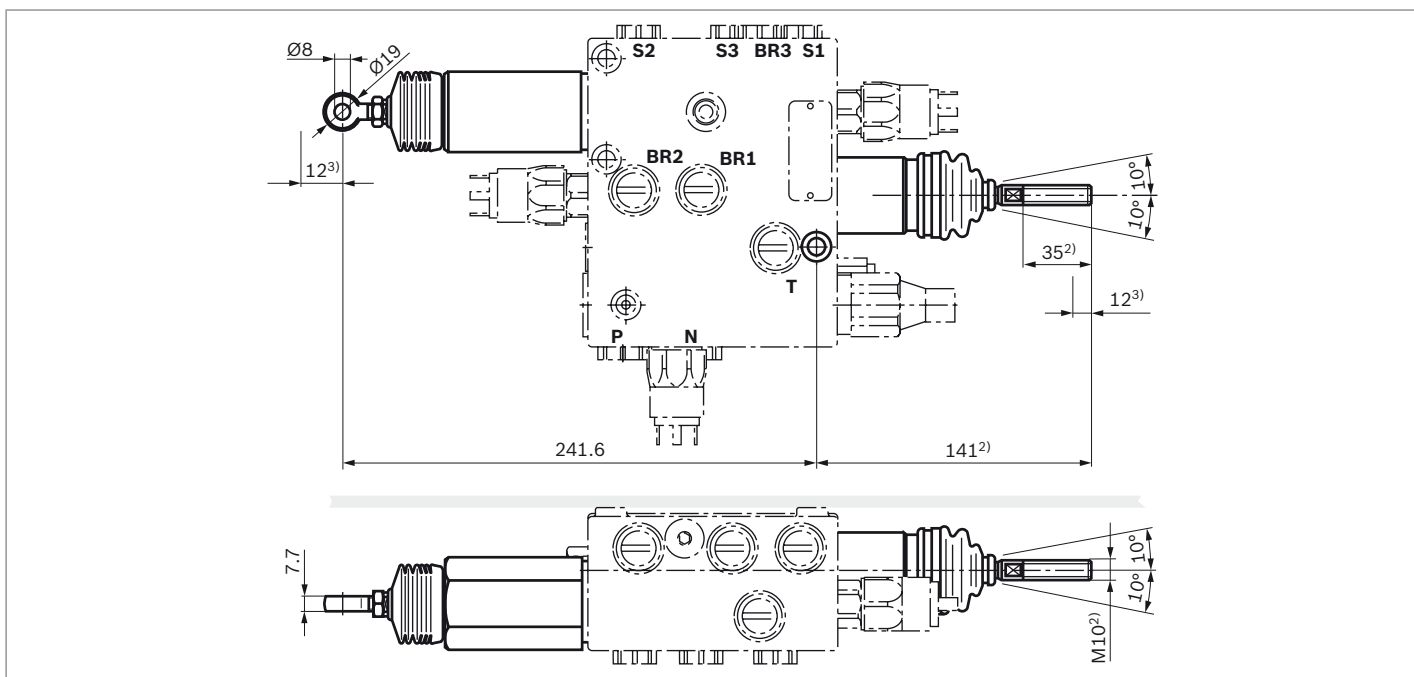
Dimensions

▼ Basic valve LT 13



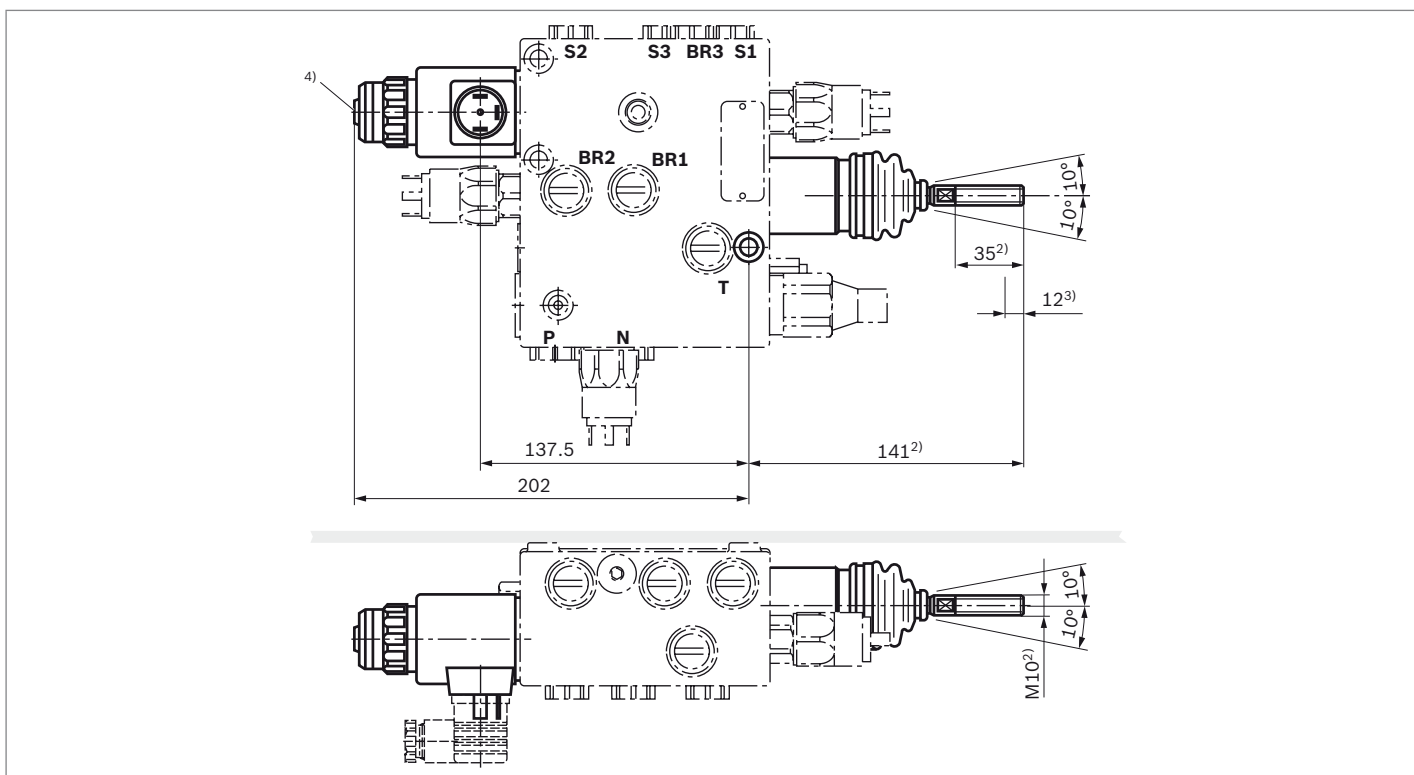
▼ Mechanical actuation BBA, mechanical FBA

Version	LT 13	M	3X	...	M	...
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▼ Mechanical actuation BBA, electric FBA

Version	LT 13	M	3X	...	E	...
	LT 13	M	3X	...	P	...

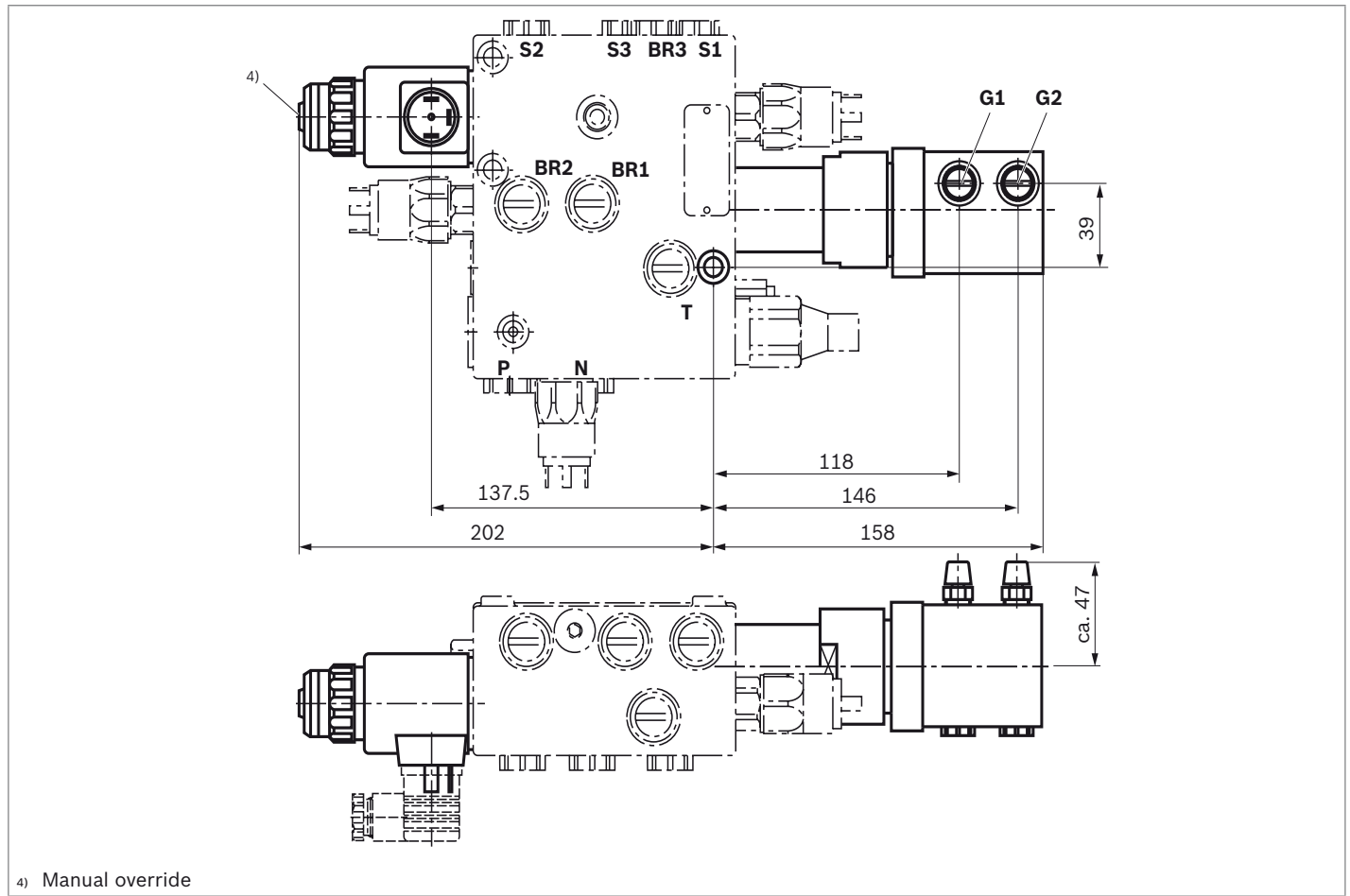


- 2) Version with actuation lever
- 3) Maximum stroke
- 4) Manual override

▼ Hydraulic actuation BBA, electric FBA

Version	LT 13	H	3X	...	E	...
---------	-------	---	----	-----	---	-----

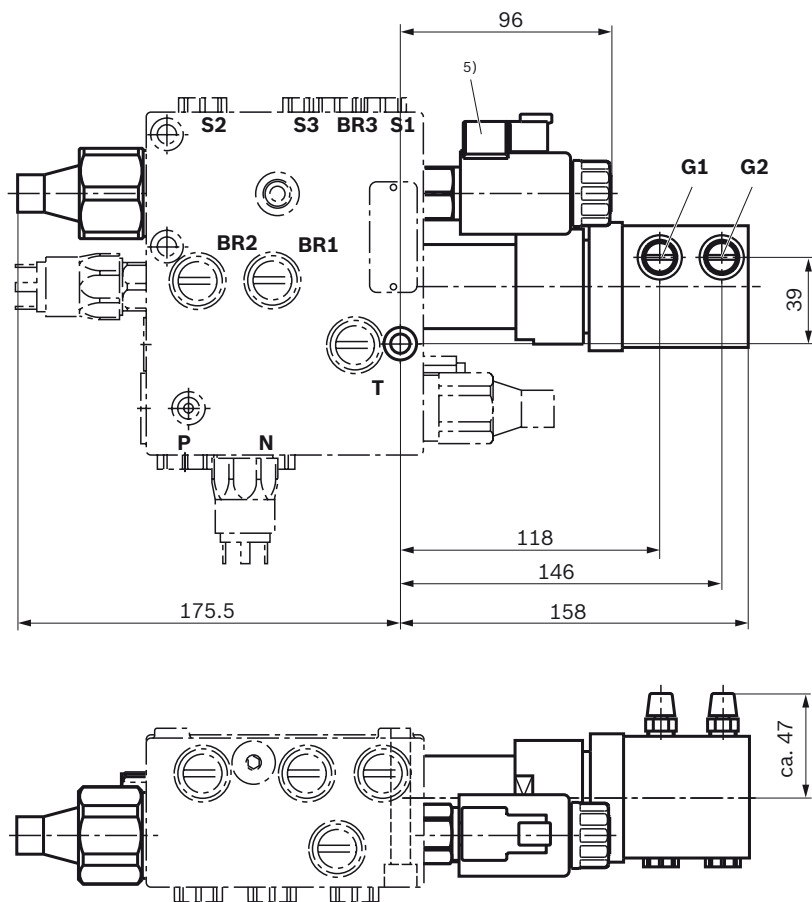
	LT 13	H	3X	...	P	...
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▼ Hydraulic actuation BBA, electrically reduced FBA

Version

LT 13	H	3X	...	R	...
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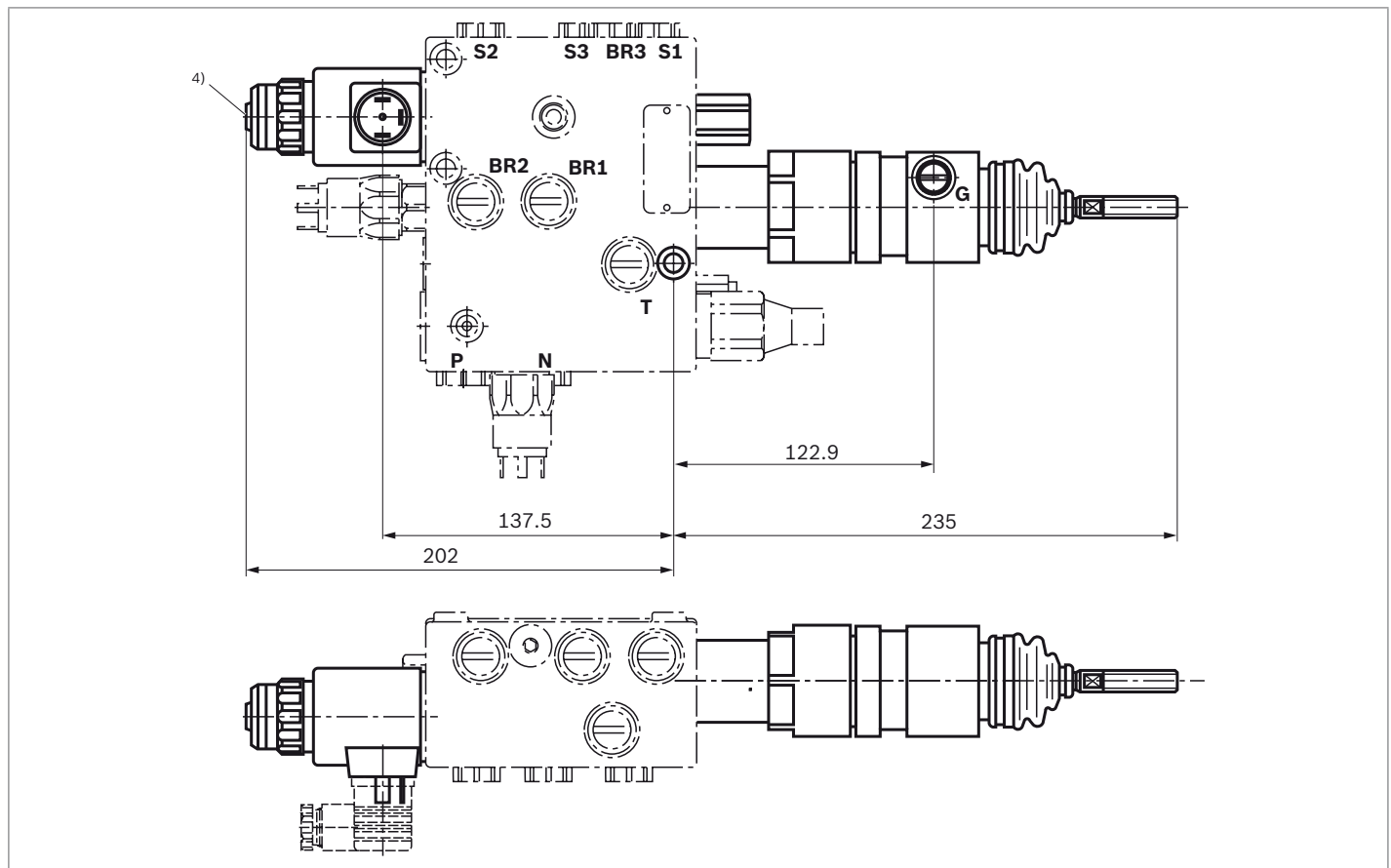


5) Depending on the version with connector type C4, K4 or K40

▼ Combined mechanical/hydraulic actuation BBA, electric FBA

Version

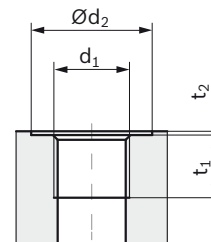
LT 13	K	3X	...	E	...
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Line connections

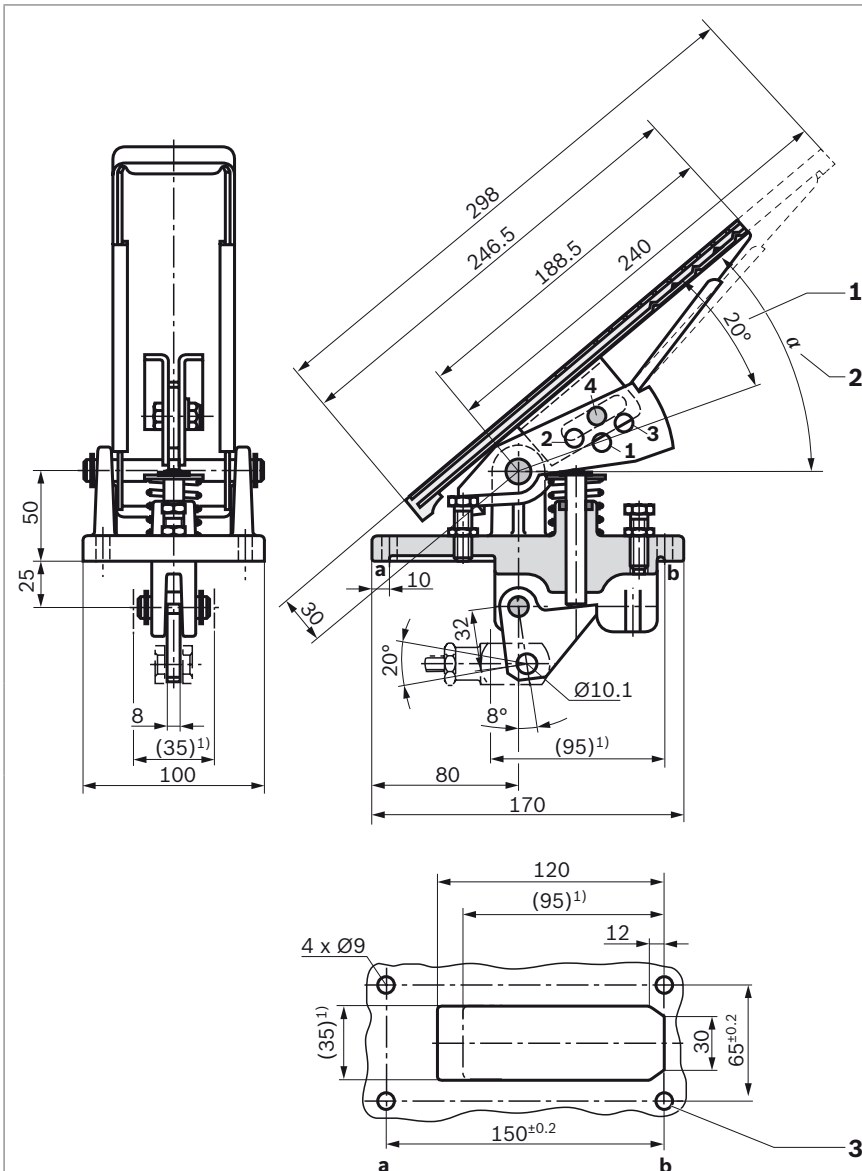
Thread design 02

Connection	d_1	$\varnothing d_2$	t_1	t_2
BR1, BR2, BR3	M16 × 1.5	26	12	1
DS1, DS3	M12 × 1.5	18	12	0.5
DS2	M10 × 1	–	6	–
S1, S2, S3	M16 × 1.5	26	12	1
G1, G2	M12 × 1.5	20	12	1
X	M12 × 1.5	18	12	1
P, N	M18 × 1.5	28	12	1.5
T	M16 × 1.5	26	12	1



Brake pedal variants

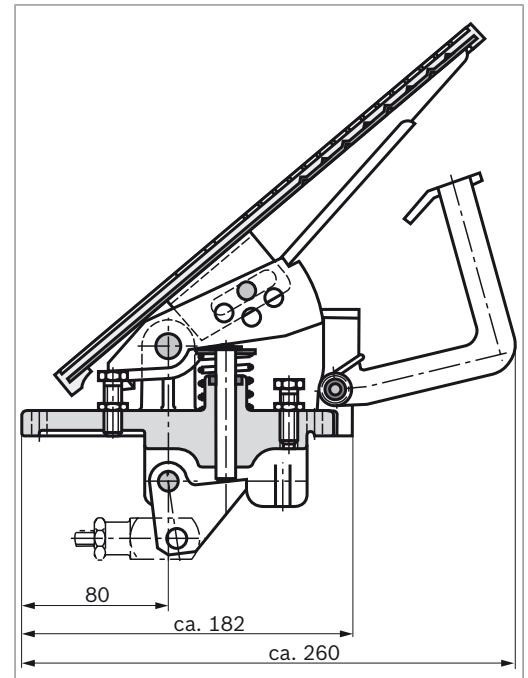
▼ **Standard version LT 20 (R900412420)/
version LT 20 with shortened pedal plate (R901056192)**



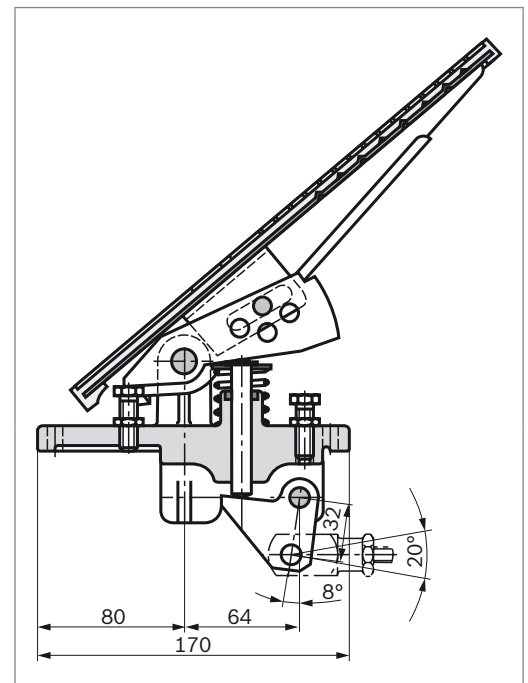
- 1 Actuation angle
- 2 **Pedal angle of attack α can be adjusted in 5° steps:**
 Hole 1 = 25°
 Hole 2 = 30°
 Hole 3 = 35°
 Hole 4 = 40° (standard version)
- 3 Assembly hole pattern in the base plate (proposal)

¹⁾ Minimum dimensions of the base plate for the pedal installation

▼ **Version LT 20 with locking hook (R900328536)**



▼ **Version LT 20 with actuation rod to the front (R900412421)**



NOTICE

All pedal variants are, by default, equipped with anti-slip pedal rubber that can be disassembled.

Accessories

Pressure switches

Connection	Function	Switching pressure	Order number
DS1	Braking light	5 bar	R901355130
DS2	Accumulator pressure	50 bar	R900015507
	Accumulator pressure	100 bar	R900014525
	Accumulator pressure	115 bar	R900026566
DS3	Parking brake	25 bar	R901355138

NOTICE

Bosch Rexroth uses pressure switches by SUCO / Bietigheim-Bissingen.

Brake pedals

Type	Description	Order number
LT 20 MKA-1X/000H/00-	Standard version	R900412420
LT 20 MKA-1X/000H/00-SO1	Version with locking hook	R900328536
LT 20 MKA-1X/000H/00-SO2	Version with actuation rod to the front	R900412421
LT 20 MKA-1X/000H/00-SO9	Version with shortened pedal plate	R901056192

Other components (recommendation, not sold by Bosch Rexroth)

Description	Type
Stepped tandem cylinder	MH17861.2.1 by FTE Automotive, Ebern
Bowden cable (remote operation FBA)	MFB GmbH, Mühlheim a. d. Ruhr
Fork clevis	FBA axis connection, fork clevis according to DIN 71752 G8 × 16/32
	BBA axis connection, fork clevis according to DIN 71752 G10 × 20/40
Accumulator	NOTICE: Use ECO diaphragms for brake accumulators (for extended temperature range!)

Related documents

The power brake valves LT 13 are hydraulic components in power brake systems in mobile machines.

Also observe the instructions for the other system components. Do not commission the product until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

Dual-circuit power brake valve of compact design

LT 17



- ▶ Series 4X
- ▶ Service brake pressure 40 to 125 bar

Features

- ▶ Dual-circuit brake valve, accumulator charging valve and shuttle valve in one housing
- ▶ Simple and quick assembly (Plug-and-Play solution)
- ▶ Optional electrical on/off parking brake valve
- ▶ Connection facility for separate parking brake valve
- ▶ Integration into existing hydraulic systems is possible
- ▶ Integrated actuation pedal
- ▶ Direct connection of the pressure accumulator is possible (separate accumulator block is not required)
- ▶ Quickly ready for operation
- ▶ Sensitive metering
- ▶ Low in maintenance
- ▶ Integrated maximum pressure limitation of the brake circuit
- ▶ Brake pressure proportional to actuation force and travel
- ▶ Synchronisation through low hysteresis
- ▶ Ergonomic adaption of the pedal blade angle possible
- ▶ All pedal variations with slip resistant, removable rubber plates

Fields of application

- ▶ Construction equipment
- ▶ Material handling vehicles
- ▶ Forestry and agricultural machines
- ▶ Municipal vehicles
- ▶ Special vehicles

Contents

Functional description	2
Technical data	4
Characteristic curve	5
Ordering code	6
Dimensions	8
Line connections	12
Accessory „14“	12
Related documents	12

Functional description

The LT 17 is a dual-circuit brake valve in compact design with assembled foot pedal, which combines all necessary functions in one housing.

Accumulator charging valve

The accumulator charging valve (**1**) loads, as a priority, the accumulator. When the accumulator pressure falls below the switch-on pressure of the charging valve, the accumulators are loaded until the switch-off pressure is reached. The switching pressure differential is approx. 18 % of the cut-off pressure. The accumulators are loaded with a flow of e.g. 17 l/min (version B40). If the pump supplies more than e.g. 17 l/min, then the subsequent consumers (**N**) are supplied with the difference.

Note

If subsequent consumers (**N**) generate a higher pressure than the cut-off pressure of the accumulator charging valve, the pressure of the accumulator circuit is raised to this level!

Circuit separation

The valve supplies two separate braking circuits. These are separated by an inverted shuttle valve (**2**).

Dual-circuit brake valve

The dual-circuit brake valve LT 17 is a directly operated pressure reducing valve in three-way design with stepless mechanical operation.

It has a maximum pressure relief of secondary circuits and infinitely adjustable pressure in the secondary circuits (brake circuits) which is in proportion to the actuation travel angle of the pedal.

The LT 17 basically consists of two tandem design 3-way pressure reducing valves, which were actuated via the assembled foot pedal (**5**). The pressure in both brake circuits rises proportional to the actuation force and the actuation travel angle of the pedal. With the deflection of the pedals kept constant, the defined pressure in channels **BR1** and **BR2** is kept constant. Thereby the pressure in **BR1** is only approx. 2 bar higher than in **BR2**. The valve of the 1st circuit (**4.1**) is directly operated. The pressure of the 2nd brake circuit (**4.2**) is controlled by the 1st brake valve.

If the hydraulic supply to the 1st brake circuit fails, then the 2nd brake circuit is directly actuated.

When the foot pedal is released, the two pressure reducing valves move back to the starting position. Thus the secondary circuits (**BR1** and **BR2**) are relieved.

Version without parking brake valve

On accumulator port **S3** a separate hydraulic parking brake valve (e.g. LT 08) can be connected. For this, we recommend the optional version **R (6)** with check valve in **S3**.

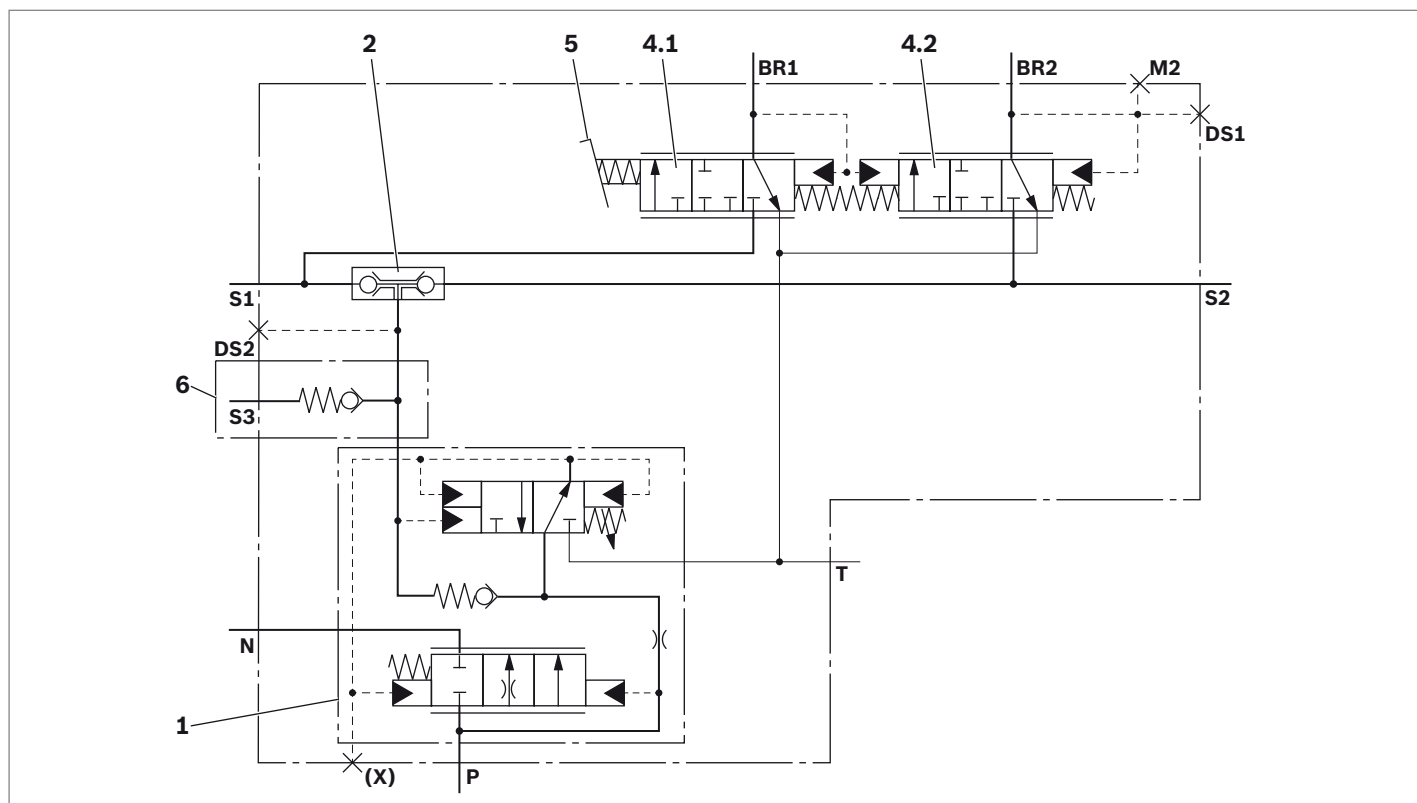
Version with parking brake valve

The electrically switched parking brake (**3**) is a 3/2-way directional valve. When the valve is switched with an electrical signal, then the port **BR3** is connected with port **S3**. The present accumulator pressure **S3** supplies the parking brake via **BR3**. By switching off or failure of the electrical signal, the parking brake valve connects **BR3** with **T** and the applied pressure in the parking brake valve can be released. The auxiliary brake function cannot be performed.

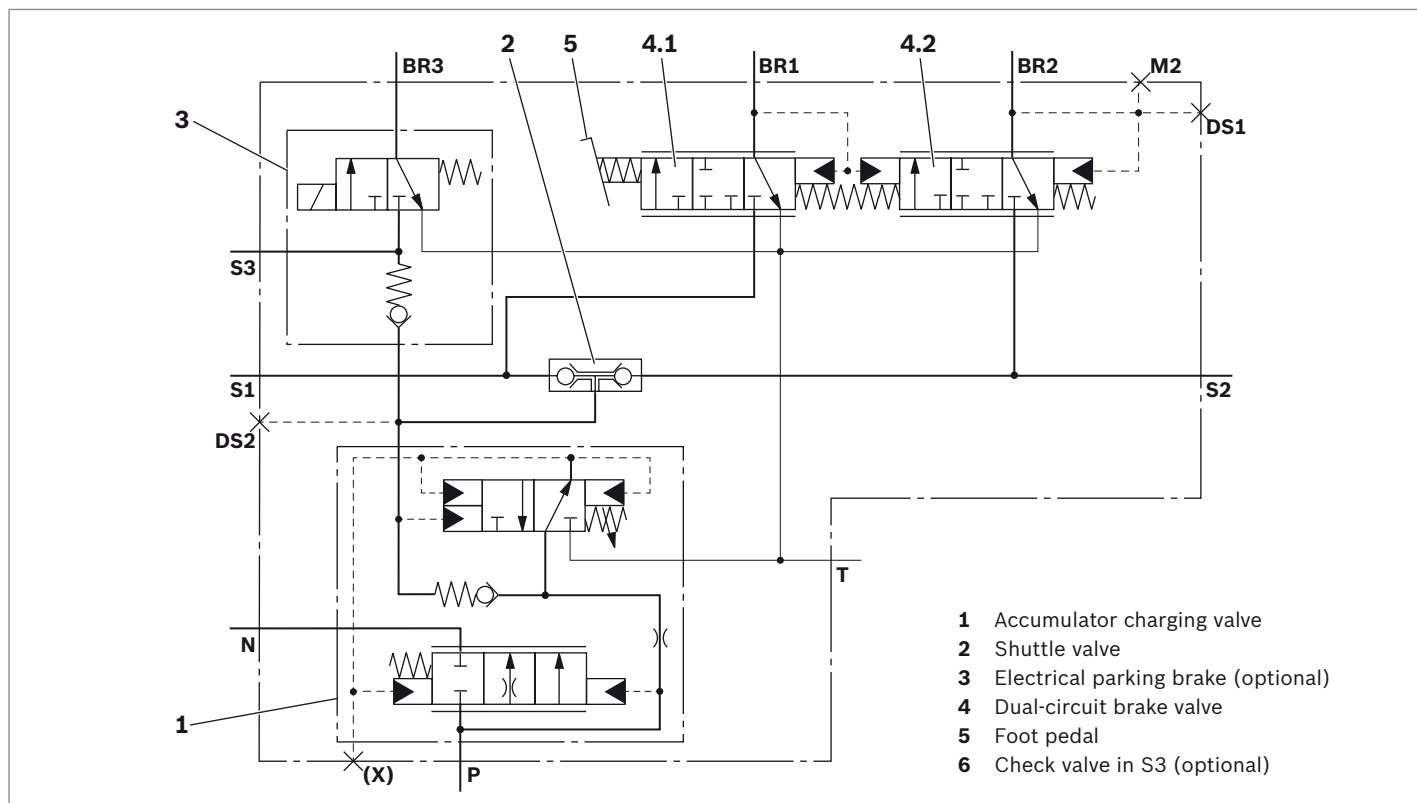
Ports	
BR1	Service brake (1st brake circuit)
BR2	Service brake (2nd brake circuit)
BR3	Parking brake
DS1	Pressure switch brake light
DS2	Pressure switch accumulator pressure
S1	Supply service brake (1st brake circuit)
S2	Supply service brake (2nd brake circuit)
S3	Supply parking brake
P	Pump
T	Tank
N	Subsequent consumers
M2	Pressure switch brake light (alternative to DS1)
X	Load-sensing (LS) (optional, version SO4*)

Symbols

▼ **Version without parking brake valve**



▼ **Version with parking brake valve**



- 1 Accumulator charging valve
- 2 Shuttle valve
- 3 Electrical parking brake (optional)
- 4 Dual-circuit brake valve
- 5 Foot pedal
- 6 Check valve in S3 (optional)

Technical data

General				
Weight			kg	12
Installation position				Upright preferred
Type of connection				Metric threads
Ambient temperature range		θ	°C	-25 to +80
Priming				Priming RAL 5010
Hydraulic				
Maximum service brake pressure at port	BR1, BR2		p_{Br}	bar 125
Maximum parking brake pressure with version E at port	BR3		p	bar 210 (according to the set accumulator pressure)
Maximum inlet pressure	without FBA at port	P	p	bar 250
	with FBA at port	P	p	bar 210
Maximum tank pressure at port	T		p	bar 0.5 (Tank pressure must not exceed the pressure being applied by the brake.)
Maximum accumulator pressure at port	S1, S2		p	bar 250
	S3		p	bar 210
Maximum pressure at port	N		p	bar 30 % less than the set accumulator pressure
Maximum accumulator charging pressure	Switch-off pressure		p	bar 210
	Switch-on pressure		p	bar ca. 18 % below switch-off pressure
Maximum flow	P → S			l/min ca. 4.5 (Standard, B18) ca. 17 (B40)
	P → N			l/min 70
Hydraulic fluid				Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568 as well as hydraulic fluids as specified in the data sheet 90221, on inquiry.
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum permitted degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)				Class 20/18/15, for this we recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$
Electric (version E with parking brake valve) ¹⁾				
Power consumption at 20 °C			W	14.4
Duty cycle			%	100
Protection category according to DIN 40050				IP6K5

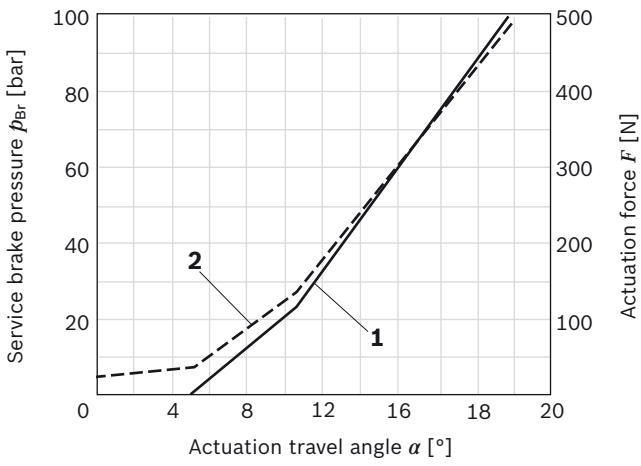
Note

For applications outside these parameters, please consult us.

1) Further details see data sheet 58007

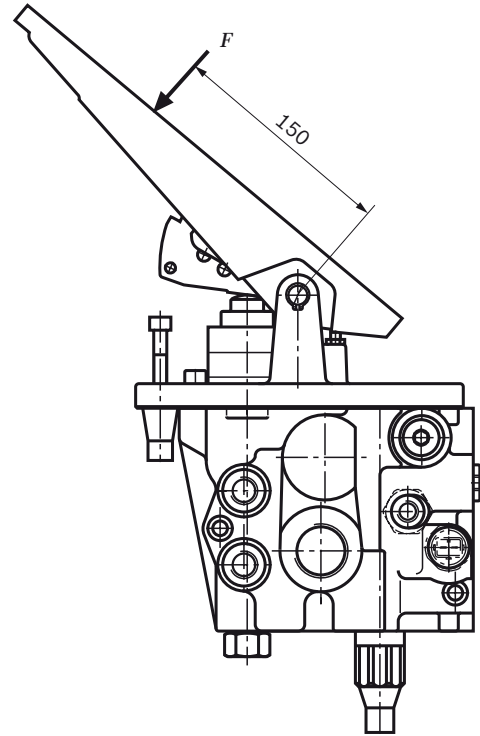
Characteristic curve

▼ Service brake pressure and actuation force depending on the pedal angle, z. B. 100 bar (Standard)



- 1 Service brake pressure
- 2 Actuation force

▼ Actuation force F at pedal with lever of 150 mm



Ordering code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
LT 17	M	4X	/							/		M	14	*

Model code

01	Dual-circuit power brake valve of compact design LT 17	LT 17
----	--	-------

Type of actuation service brake (BBA)

02	Mechanical	M
----	------------	---

Series

03	40 to 49 (unchanged installation and connection dimensions)	4X
----	---	----

Characteristic curve

04	Linear characteristic curve	L
	Progressive characteristic curve	P

Service brake pressure (BBA)

05	40 bar	040
	60 bar	060
	65 bar	065
	70 bar	070
	80 bar	080
	85 bar	085
	90 bar	090
	95 bar	095
	100 bar	100
	105 bar	105
	120 bar	120
	125 bar	125

Type of actuation parking brake (FBA)

06	Without FBA	-
	Electrically switched ¹⁾	E

Parking brake pressure (FBA)

07	¹⁾	XXX
	Without FBA	000

Accumulator charging pressure

08	100 bar	A
	120 bar	B
	150 bar (Standard)	C
	160 bar	D
	185 bar	E
	200 bar	F
	210 bar	G

Accumulator charging flow

09	Approx. 4.5 l/min (standard)	B18
	Approx. 17 l/min	B40
	Approx. 4.5 l/min with check valve	R18
	Approx. 17 l/min with check valve	R40

1) With electrically switched FBA, the parking brake pressure of the FBA corresponds to the accumulator charging pressure. Observe the switching hysteresis!

Voltage at the switching solenoid

10	12 Volt	AG12
	24 Volt	AG24

Connector type (standard with manual override)²⁾

11	Cubic connector	K4
	Deutsch plug	K40
	Junior timer, 2-pole (AMP)	C4

Line connections

12	Metric threads	02
	Metric threads, reduced	40
	UNF threads	19

Seal material

13	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
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Additional equipment

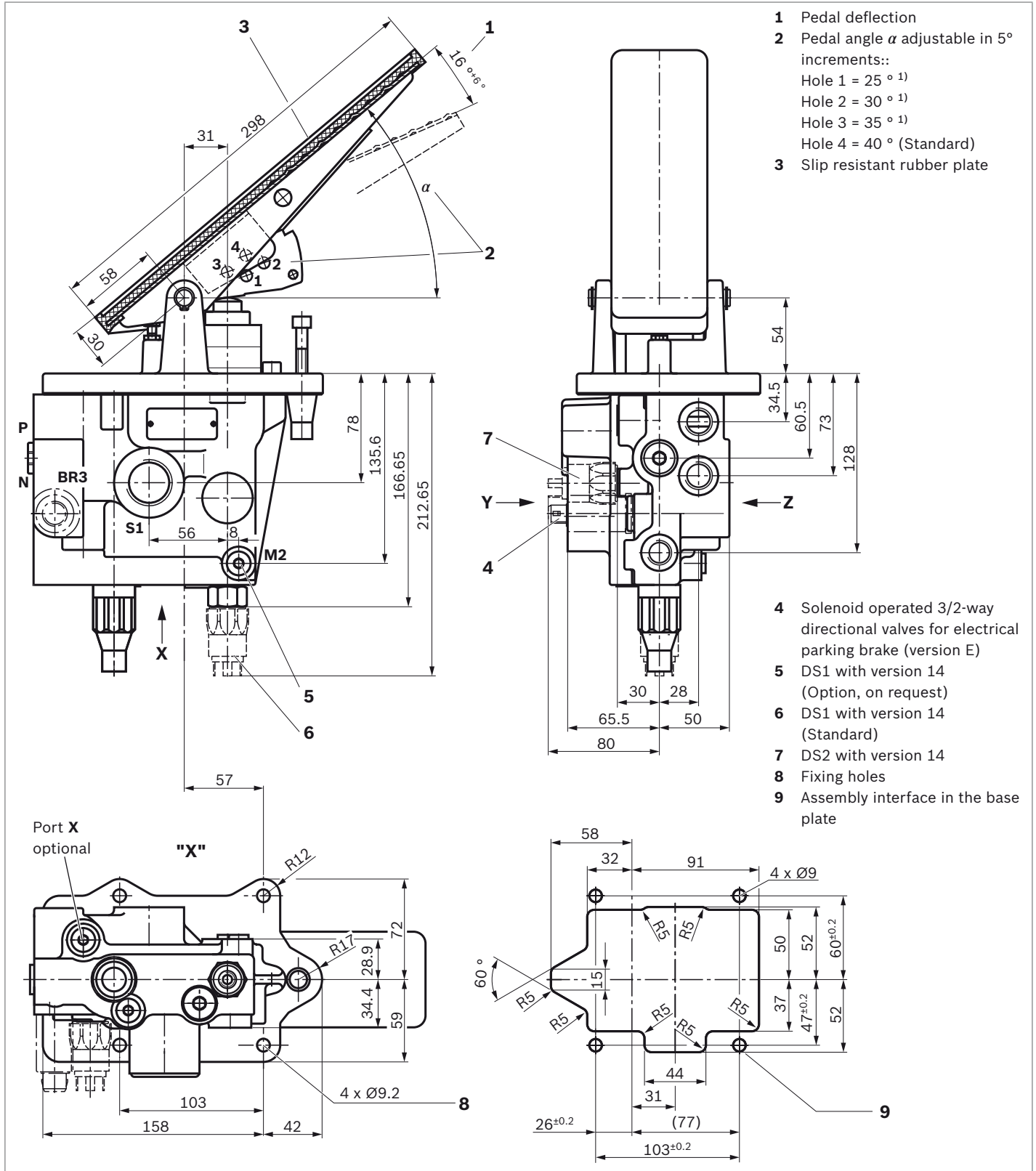
14	With pressure switch	14
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15	Further details in clear text	*
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²⁾ Mating connectors are not included in the scope of delivery and must be ordered separately, see data sheet 08006.

Dimensions

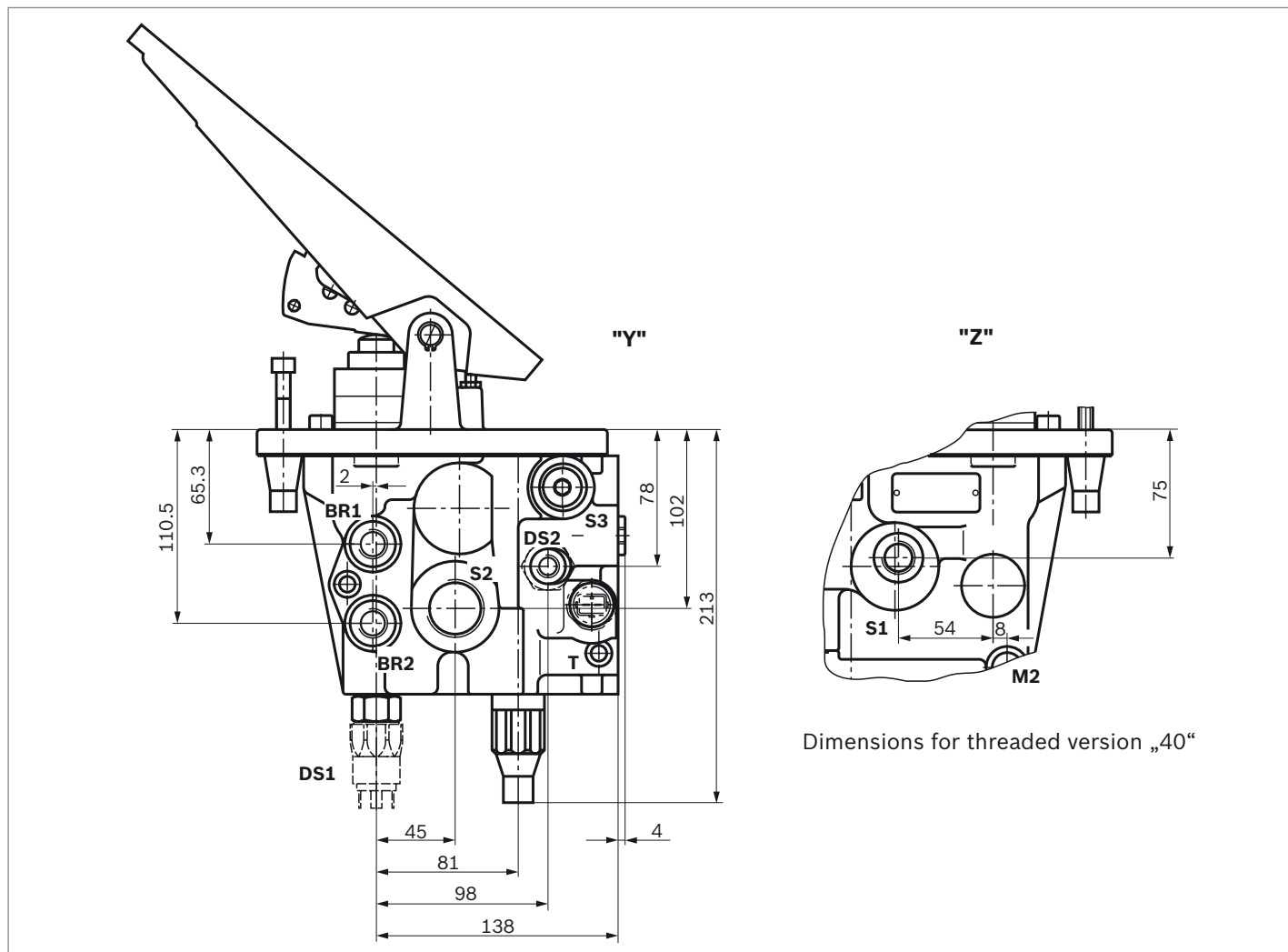
Standard version



Line connections see page 12

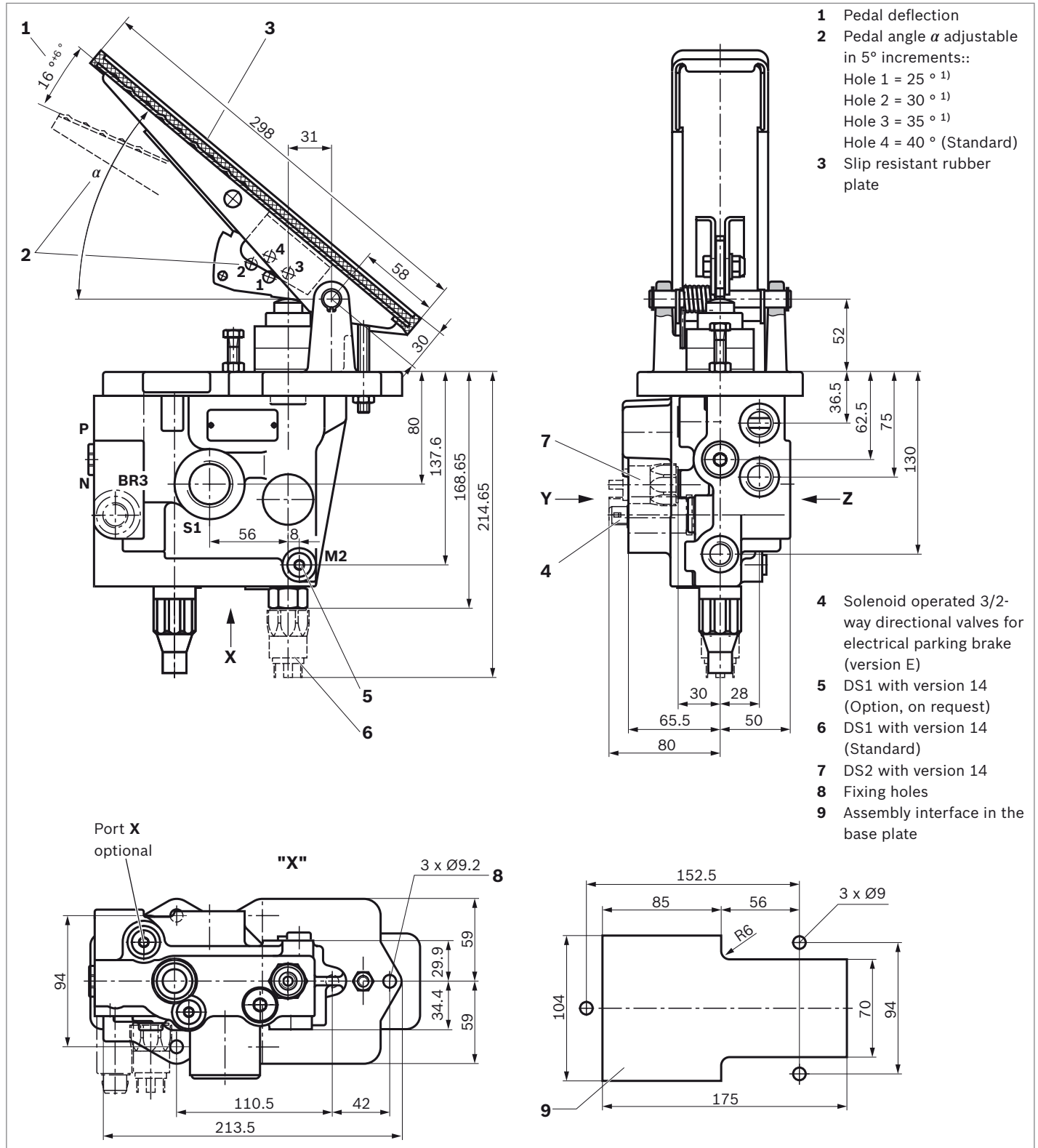
1) Possible as a special version

Standard version



2-pole plug for solenoid:: AMP Junior Timer
 Line connections see page 12

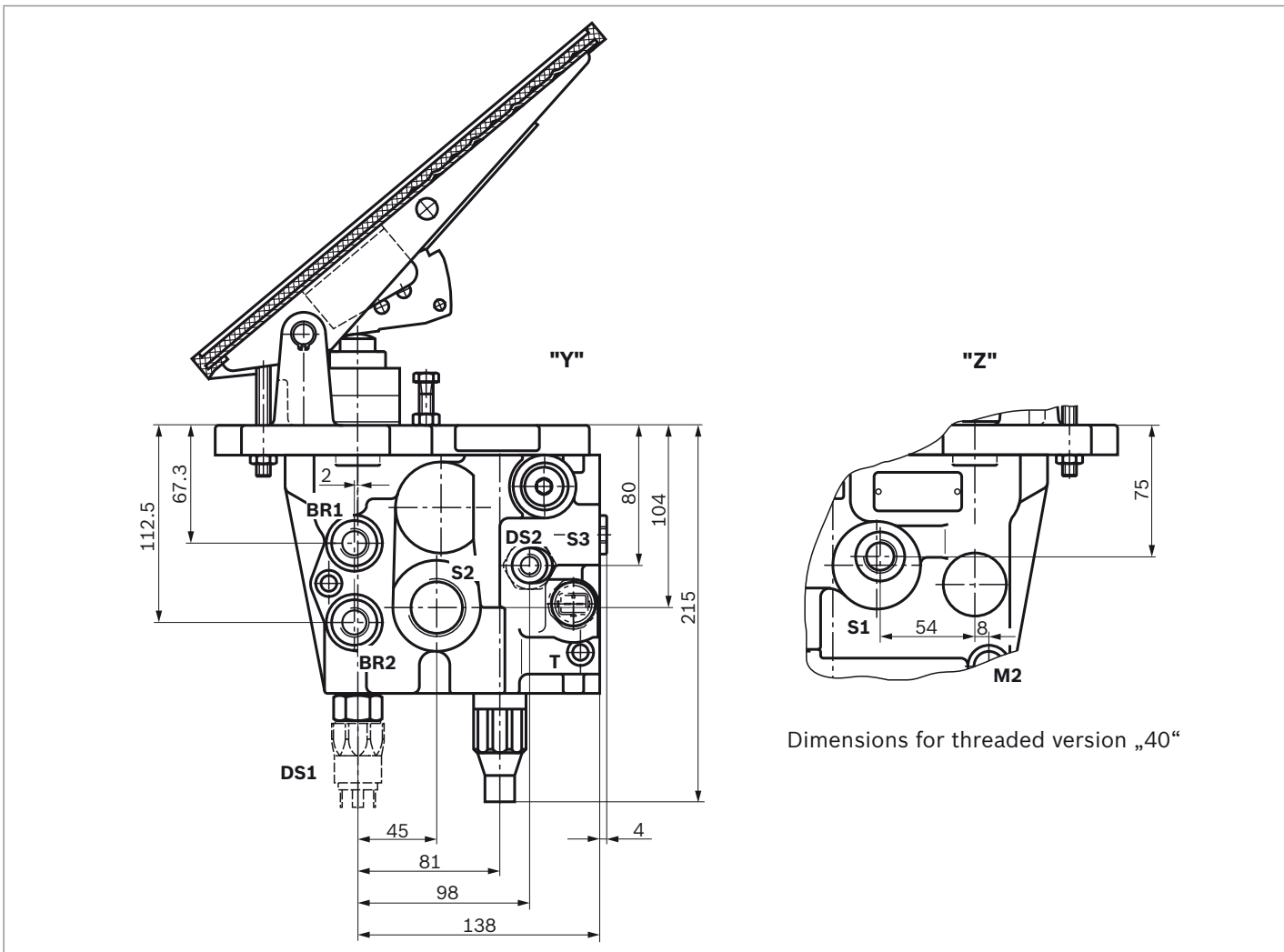
Version...S06 – Replaces for series 3X



Line connections see page 12

1) Possible as a special version

Version ...SO6 – Replaces for series 3X



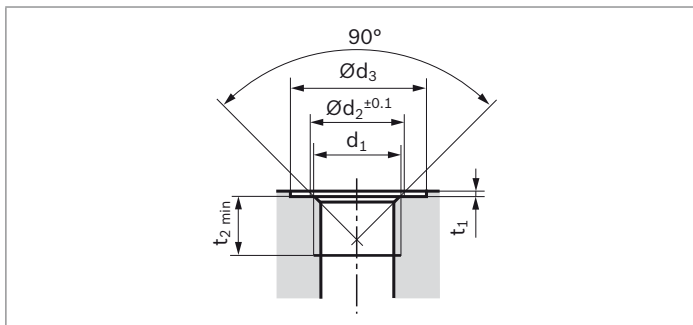
2-pole plug for solenoid: AMP Junior Timer
 Line connections see page 12

Line connections

Thread type 02 (ports similar to DIN 3852-1)

Port	d ₁	Ød ₂ ^{±0.1}	Ød ₃	t ₁	t _{2 min}
BR1, BR2, BR3¹⁾	M16 x 1.5	16.4	26	1.4	12
DS1	M12 x 1.5	12.4	20	0.9	11
DS2	M12 x 1.5	12.4	–	–	11
S1, S2	M33 x 1.5	33.5	–	–	20
S3	M16 x 1.5	16.4	26	1	12
M2	M12 x 1.5	12.4	–	–	11
P, N	M18 x 1.5	18.4	28	1.5	12
T	M16 x 1.5	16.4	26	1	12
X	M12 x 1.5	12.4	24	4	12

Port **M2** plugged by default.



Accessory „14“

Pressure switch (optional accessories and spare parts)

Port	Function	Switch pressure	Material no.
DS1	Brake light	5 bar	R901355130
DS2	Accumulator pressure	100 bar	R901373063

Related documents

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

Thread type 40 (ports similar to DIN 3852-1)

Port	d ₁	Ød ₂ ^{±0.1}	Ød ₃	t ₁	t _{2 min}
BR1, BR2, BR3¹⁾	M16 x 1.5	16.4	26	1.4	12
DS1	M12 x 1.5	12.4	20	0.9	11
DS2	M12 x 1.5	12.4	–	–	11
S1, S2	M18 x 1.5	18.4	28	1.6	12
S3	M16 x 1.5	16.4	26	1	12
M2	M12 x 1.5	12.4	–	–	12
P, N	M18 x 1.5	18.4	28	1.5	11
T	M16 x 1.5	16.4	26	1	12
X	M12 x 1.5	12.4	24	4	12

Port **M2** plugged by default.

Note

Bosch Rexroth uses pressure switches manufactured by SUCO / Bietigheim-Bissingen.

Hydraulic inch power brake valve LT 31



- ▶ Series 1X
- ▶ Service brake pressure 60, 80 and 100 bar
- ▶ Inch pressure 25 bar

Features

- ▶ Integrated inch valve
- ▶ Inch and brake pressure proportional to the actuating force
- ▶ Low hysteresis
- ▶ Integrated maximum pressure limitation for inch and brake pressure
- ▶ All ports on one side
- ▶ Perfect piping possible due to freely rotatable mounting flange
- ▶ Ergonomic adjustment of the pedal's angle of attack possible
- ▶ All pedal variants are equipped with anti-slip pedal rubber that can be disassembled

Fields of application

- ▶ Construction machines
- ▶ Conveyor vehicles
- ▶ Forestry and agricultural machinery
- ▶ Municipal vehicles
- ▶ Special vehicles

Contents

Functional description	2
Technical data	3
Characteristic curve	3
Ordering code	4
Dimensions	5
Application example	7
Related documents	8

Functional description

The inch power brake valve LT 31 is a combination of 1-circuit braking valve (3-way pressure reducing valve) and inch valve (2-way pressure reducing valve) with stepless mechanical operation.

The inch power brake valve basically consists of housing (1), main control spool (2), inch control spool (3), return spring (4), main control spring (5), actuation element (6), inch pressure limitation spring (7) and inch pressure control spring (8).

Hydraulic inching

The valve is usually actuated via a foot pedal (11) moving the actuation element (6). The latter pushes against the return spring (4) and - via the rod (9) - acts on the inch pressure control spring (8) together with the inch pressure against the inch pressure limitation spring (7).

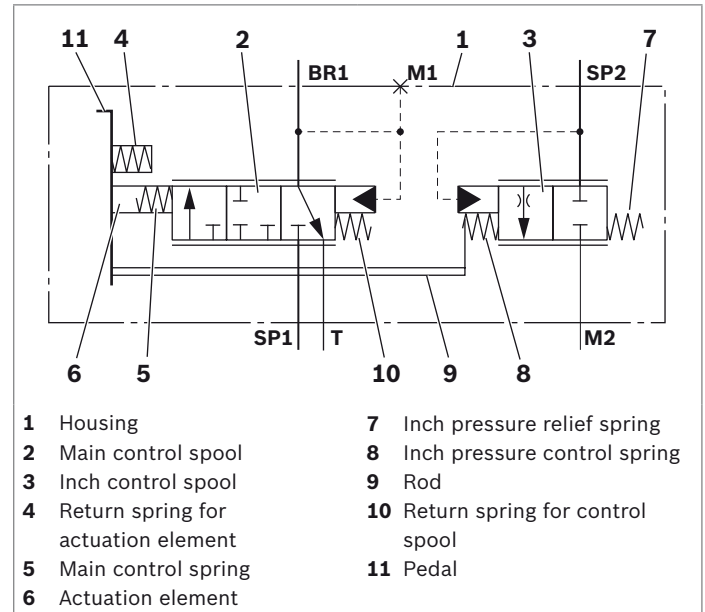
With increasing actuation, the inch control spool (3) is moved and opens from **SP2** to **M2**. The inch pressure available at **SP2** can be discharged, the traction drive pump swivels back and the vehicle is hydrostatically braked (see application example on page 7).

Hydraulic braking

If the actuation element (6) is deflected further, it acts on the main control spring (5) which moves the main control spool (2). First of all, the control edges at channel **T** are closed, then, the control edges from **SP1** to **BR1** are opened and the pressure in the brake circuit builds up. The flow from the accumulator to the brake cylinder is released. The brake pressure that builds up acts on the back side of the main control spool (2). Dependent on the actuation, the main control spool (2) controls the brake pressure proportionally to the actuating force and to the actuating path.

Any pedal path limitation will act as maximum pressure limitation of the secondary circuit (brake pressure). If the main control spring (5) is unloaded, the return spring (10) will move the main control spool (2) back into the basic position and open from **BR1** to **T**; in this way, the service brake circuit is unloaded. In case of further unloading, the inch pressure limitation spring (7) moves the inch control spool (3) into its basic position. The opening from **SP2** to **M2** is closed and consequently, the inch pressure of the traction drive can build up so that the vehicle is no longer braked. The return spring (4) brings the actuation element (6) and the pedal (11) back into the initial position.

▼ Symbol LT 31



Connections

SP1	Service brake supply (1st brake circuit)
SP2	Inch pressure input
T	Tank
BR1	Service brake (1st brake circuit)
M1	Pressure switch (braking light)
M2	Tank, traction drive

Technical data

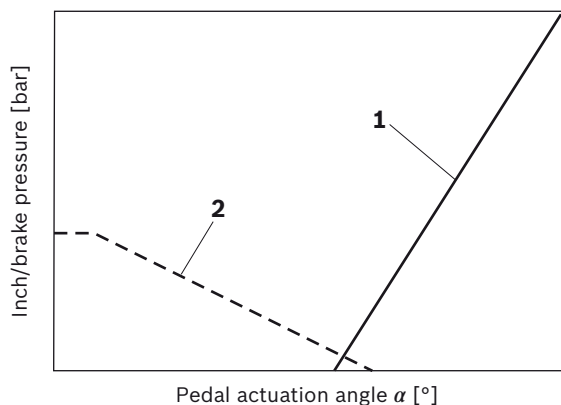
general				
Weight	without pedal		kg	5.0
	with pedal		kg	6.6
Installation position	Preferably vertical			
Type of connection	Metric thread according to DIN 3852-1			
Ambient temperature range		θ	°C	-25 to +80
Priming	Single-layer coating RAL 5010			
hydraulic				
Maximum operating pressure at the port	BR1	p_{Br}	bar	100
Maximum inlet pressure at the port	SP1	p	bar	210
Maximum inch pressure at the port	SP2	p_{Inch}	bar	30
Maximum tank pressure at the port	T	p	bar	0.5 (The tank pressure must not exceed the application pressure of the brake.)
Maximum brake cylinder volume (braking valve)				cm ³ 120
Rated flow (inch valve)				l/min 12
Hydraulic fluid	Mineral oil (HL, HLP) according to DIN 51524, other hydraulic fluids, such as HEES (synthetic esters) according to VDMA 24568, as well as hydraulic fluids as specified in data sheet RE 90221, upon request			
Hydraulic fluid temperature range		θ	°C	-20 to +80
Viscosity range		ν	mm ² /s	2.8 to 380
Maximum admissible degree of contamination of the hydraulic fluid, cleanliness class according to ISO 4406 (c)	Class 20/18/15, for this, we recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$			

Notice

For applications outside these parameters, please consult us!

Characteristic curve

▼ Pressure depending on the pedal's actuation angle



- 1 Brake pressure p_{Br}
- 2 Inch pressure p_{Inch}

Ordering code

01	02	03	04	05	06	07	08	09				
LT 31	MKA	-	1X	/		-	025	/	02	M		*

Model code

01	Hydraulic inch power brake valve LT 31	LT 31
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Type of actuation

02	Mechanical	MKA
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Series

03	10 to 19 (unchanged installation and connection dimensions)	1X
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Service brake pressure

04	60 bar	060
	80 bar	080
	100 bar	100

Inch pressure

05	25 bar	025
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Line connections

06	Metric thread similar to DIN 3852-1 (see table on page 5)	02
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Seal material

07	NBR seals, suitable for mineral oil (HL, HLP) according to DIN 51524	M
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Additional equipment (optional)

08	With attached pedal LT 19	12
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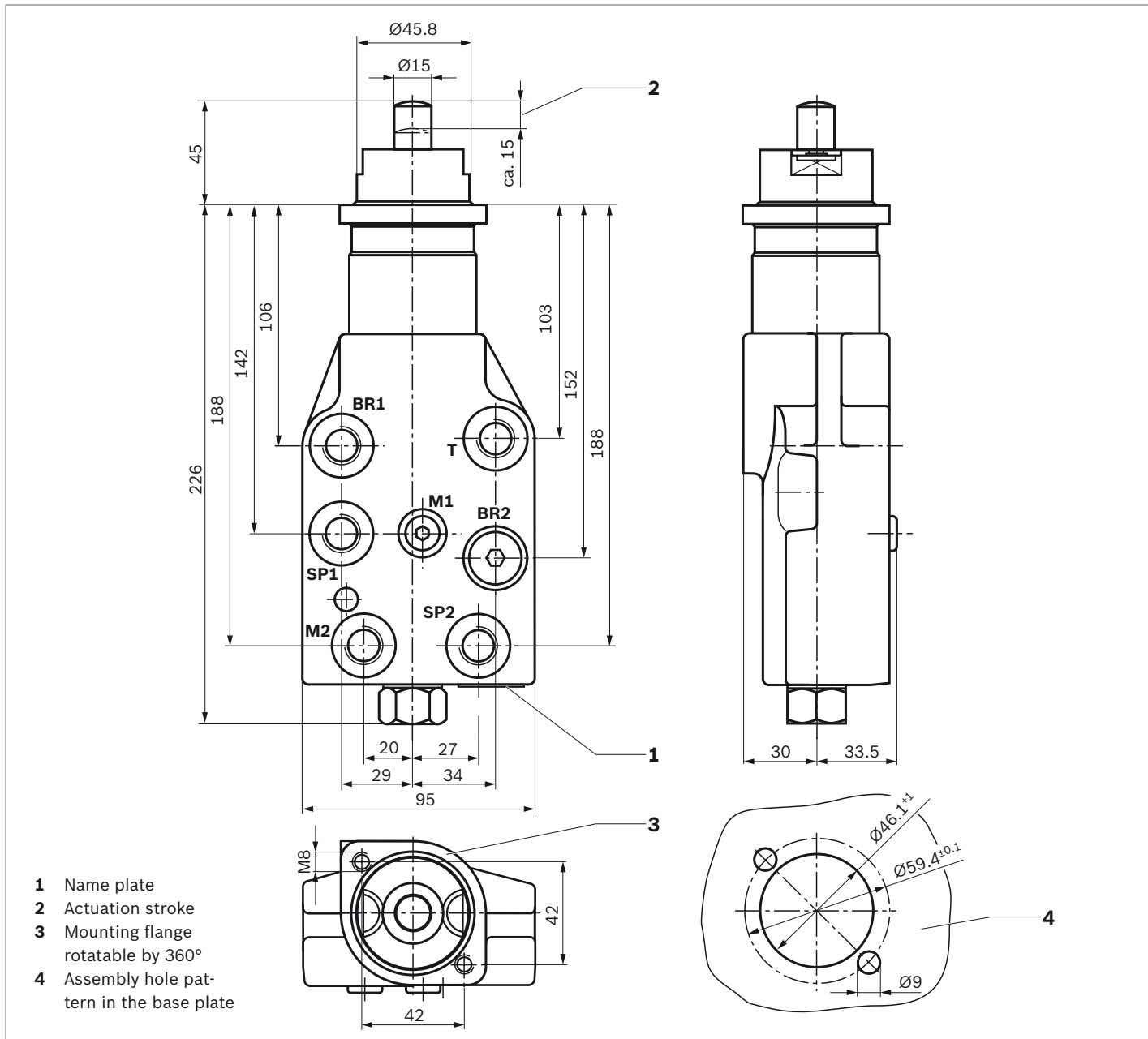
09	Further details in the plain text	*
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Preferred types

Service brake pressure [bar]	LT 31 without pedal Material number	LT 31 with attached pedal Material number
060	R901146632	R901092968
080	R901092974	R900978598
100	R900956835	R900976108

Dimensions

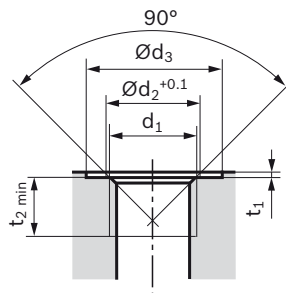
Without pedal



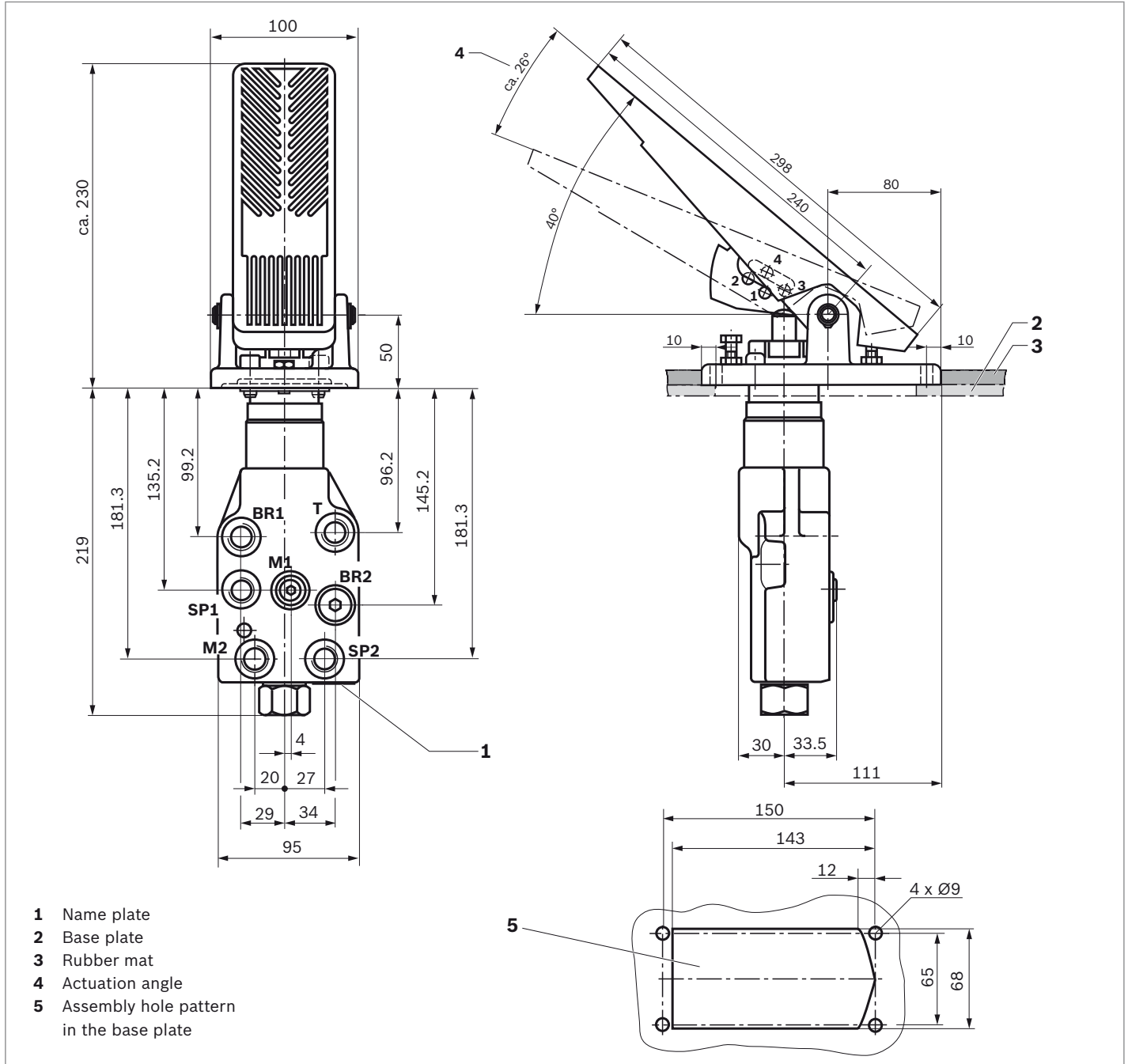
Connections similar to DIN 3852-1

Connection	d_1	$\varnothing d_2^{+0.1}$	$\varnothing d_3$	t_1	$t_2 \text{ min}$
BR1	M16 x 1.5	16.4	26	1.5	12
BR2	Port closed				
SP1, SP2	M16 x 1.5	16.4	26	1.5	12
T	M16 x 1.5	16.4	26	1.5	12
M1	M12 x 1.5	12.4	20	1.5	12
M2	M16 x 1.5	16.4	26	1.5	12

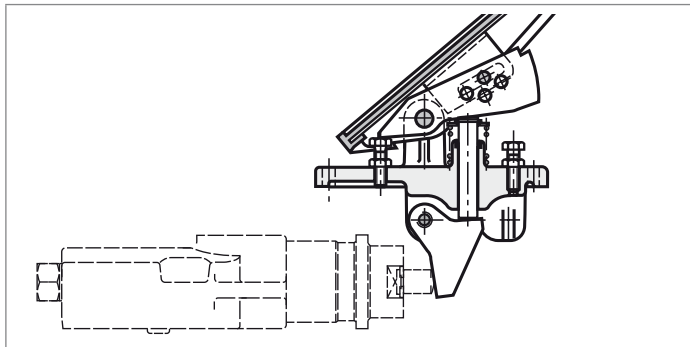
Port **M1** closed by default.



With attached pedal LT 19



▼ Version LT 20 for horizontally installed braking valve

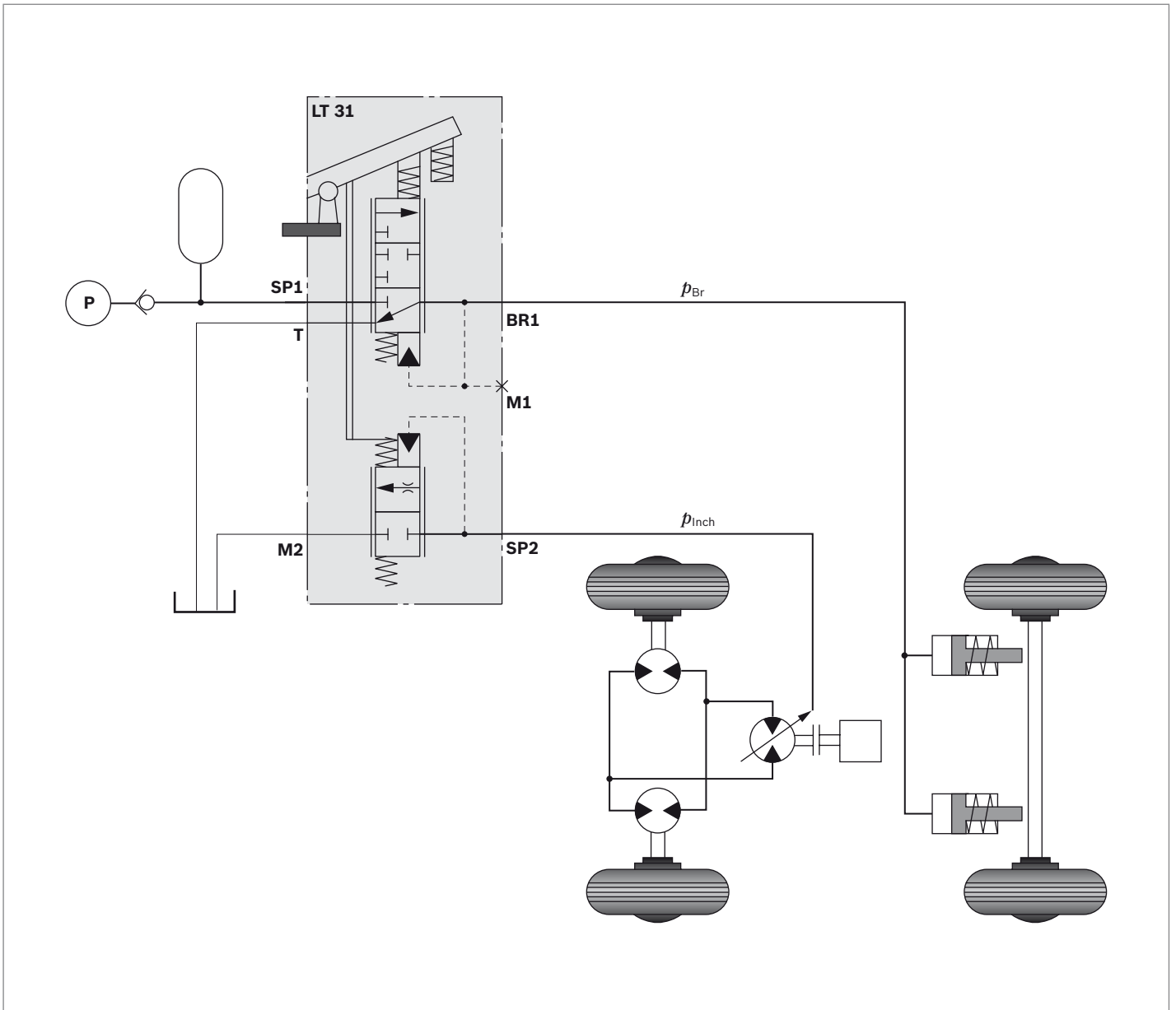


The power brake valve LT 31 is optionally supplied with or without pedal. Pedals LT 19 and LT 20 are available (other variants upon request).

Notice

All pedal variants are, by default, equipped with anti-slid pedal rubber that can be disassembled.

Application example



Related documents

The power brake valves LT 31 are hydraulic components in power brake systems in mobile machines.

Also observe the instructions for the other system components. Do not commission the product until you are provided with the following documentation and have understood and observed it.

Title	Document number	Document type
Hydraulic power brake valves for mobile applications	66200-B	Operating instructions
System documentation from the machine manufacturer		Operating instructions

По вопросам продаж и поддержки обращайтесь:

Алматы (7273)495-231	Казань (843)206-01-48	Новокузнецк (3843)20-46-81	Смоленск (4812)29-41-54
Архангельск (8182)63-90-72	Калининград (4012)72-03-81	Новосибирск (383)227-86-73	Сочи (862)225-72-31
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Ижевск (3412)26-03-58	Набережные Челны (8552)20-53-41	Севастополь (8692)22-31-93	Череповец (8202)49-02-64
Иркутск (395)279-98-46	Нижний Новгород (831)429-08-12	Симферополь (3652)67-13-56	Ярославль (4852)69-52-93
Россия (495)268-04-70	Киргизия (996)312-96-26-47	Казахстан (7172)727-132	