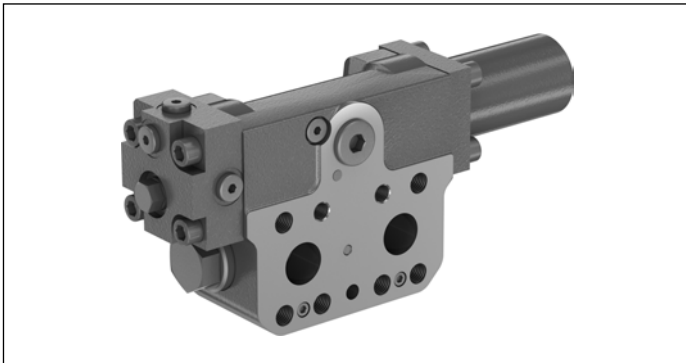


Counterbalance valve

BVE Series 53

RE 95526

Edition: 07.2018



- ▶ Size 25
- ▶ Nominal pressure Motor side 420 bar
 Pump side 350 bar
- ▶ For winch drives in open circuit

Features

- ▶ Single-acting counterbalance valve specifically for winch drives in open circuit
- ▶ Sensitive damping for stable lowering
- ▶ Simple adaptation to the application
- ▶ Compact design and direct mounting to axial piston motors A2FM, A2FE and A6VM, A6VE
- ▶ Available in a set with axial piston motors A2FM, A2FE and A6VM, A6VE
- ▶ Standard working ports according to SAE J518
- ▶ Integrated brake release port, with or without pressure reduction and electrical switch-off
- ▶ Good efficiency through reduced flow losses and low lowering pressure

Contents

Type code	2
Technical data	4
Characteristic curves	5
Functional description	6
Application example for winch drive	7
Dimensions	8
BVE installation variants for winch drives	11
Mounting the counterbalance valve	12
Project planning notes	13
Safety instructions	15

Type code

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
BVE	25		38	/	53	N	-	V	0	1	K00		T03	-	

Valve type

01	Counterbalance valve, single-acting	BVE
----	-------------------------------------	------------

Size

02	Flow, maximum 400 l/min	25
----	-------------------------	-----------

Control range (start/end of opening of counterbalance spool)

03	Spring value (without return flow pressure)	with unloading to C	18 to 38 bar	W
		(spring value + return flow pressure)		
		with reservoir unloading	18 to 38 bar	U

Working port

04	SAE J518 1 1/4 in, hole distance 84 mm	38
----	--	-----------

Ports for brake release

05	With high pressure		S
	With reduced high pressure, 21 ⁺⁴ bar (brake release valve)	Standard	L
		can be electrically switched on/off 24 V	M

Series

06	Series 5, index 3	53
----	-------------------	-----------

Version of port and fastening threads

07	Metric, port threads with profiled sealing ring according to DIN 3852	N
----	---	----------

Long spring cover on port side C

08	Alignment of long spring cover on motor side B	C
----	---	----------

Seal

09	FKM (fluoroelastomer)	V
----	-----------------------	----------

Counterbalance spool

10	Version 10	10
----	------------	-----------

Opening characteristics of counterbalance spool

11	Standard	0
----	----------	----------

Residual opening in counterbalance spool

12	without	K00
----	---------	------------

Damping D1 (channel to counterbalance spool)

13	Throttle pin, comparative diameter	Inlet	Outlet	
		Standard	0.4 mm	
		0.38 mm	1.0 mm	D0410
		0.4 mm	2.0 mm	D4599
	Load pressure dependent damping	0.4 mm	0.7 mm	H4580
		0.38 mm	1.0 mm	H0410
		0.4 mm	2.0 mm	H4599

Damping D2 (reservoir outlet)

14	With orifice Ø0.3 mm	T30
----	----------------------	------------

● = Available - = Not available

01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	
BVE	25		38		/	53	N	-	V	0	1	K00		T03	-	

Flushing passage

15	Standard	C20
----	----------	------------

Standard/special version

16	Standard version	0
	Standard version with installation variant, e.g. ports open or closed, contrary to standard	Y
	Special version	S

● = Available - = Not available

Notices

- ▶ Note the project planning notes on page 13.
- ▶ In addition to the type code, please specify the relevant technical data when placing your order.

Technical data

Hydraulic fluid

The axial piston motor used is decisive for the selection of hydraulic fluid. For further information, please refer to our data sheets during project planning.

Note: The temperature should never exceed 115 °C anywhere on the component.

Working pressure range

Pressure at working port C/D (on the pump side) or C'/D' (on the motor side)	Definition
Nominal pressure p_{nom}	350 bar The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	420 bar The maximum pressure is the maximum working pressure during a single operating period. The sum of single operating periods must not exceed the total operating period. Restrictions: ▶ Single operating period 10 s ▶ Total operating period 300 h

Determination of cracking pressure p_1 (values without return flow) The throttle chain from D_1 and D_2 is used to damp the opening and closing speeds of the counterbalance spool.

The pressure at port **D** (M_{P1}) passes via the inlet orifice D_1 to the front side of the counterbalance spool (M_k). When there is a differential pressure at the counterbalance spool

Cracking pressure p_1

Throttle pin in inlet channel D1	Orifice in reservoir outlet D2	Pressure value at counterbalance spool		Pressure value at port M_{P1}	
		Start of opening Δp_{KB} [bar] (approx.)	End of opening Δp_{KE} [bar] (approx.)	Start of opening Δp_1 [bar] (approx.)	End of opening Δp_1 [bar] (approx.)
0.45	0.3	18	38	24	51
0.38	0.3	18	38	18	40

Table of values

Valve type			BVE.W	BVE.U
Nominal pressure	p	bar on the pump side	350	350
		motor side	420	420
Maximum flow	$q_{v max}$	l/min	400	400
Start of opening of counterbalance spool at port M_k	Δp_{KB}	bar	18	18
End of opening of counterbalance spool at port M_k	Δp_{KE}	bar	38	38
Pressure reducing valve for brake release (fixed setting) ¹⁾	Maximum control pressure	p	bar BVE...L/	21 ⁺⁴
	Beginning of control	p	bar BVE...L/	10 ⁺⁴
Weight approx.	m	kg	18	18

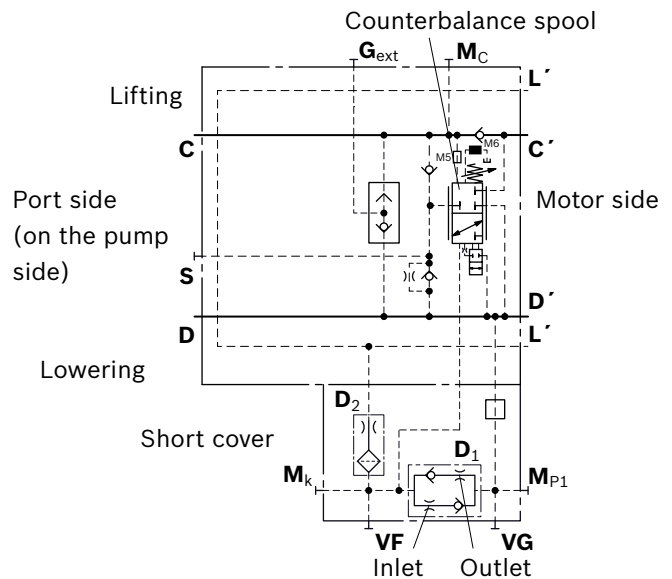
Notice

Theoretical values, without efficiency and tolerances; values rounded

Exceeding the maximum or falling below the minimum permissible values can lead to a loss of function, a reduction in operational service life or total destruction of the valve.

of approx. 18 bar, the valve starts to open and is fully opened at 38 bar. At the same time, oil flows off via the outlet orifice D_2 to the reservoir (L'). As a result, the valve not only closes faster but is stable. In addition, the opening circuit (control oil) of the valve (M_k) is automatically bled. Due to the different diameter ratios of the inlet (D_1) and outlet orifice (D_2), the characteristic and cracking pressure of the valve can be changed.

▼ Circuit diagram cracking pressure

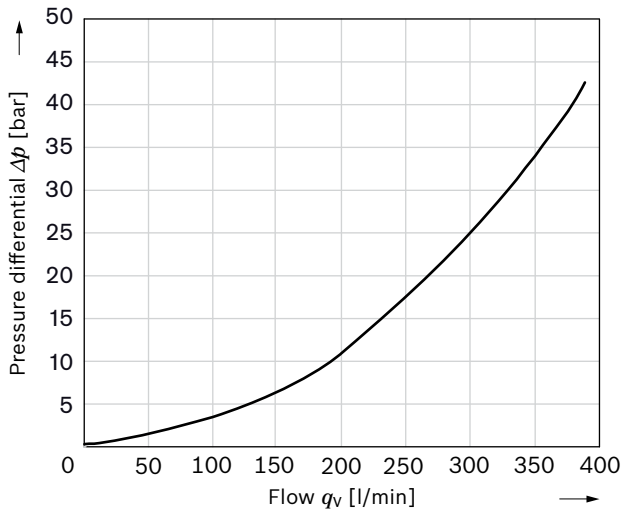


1) deviating values upon request

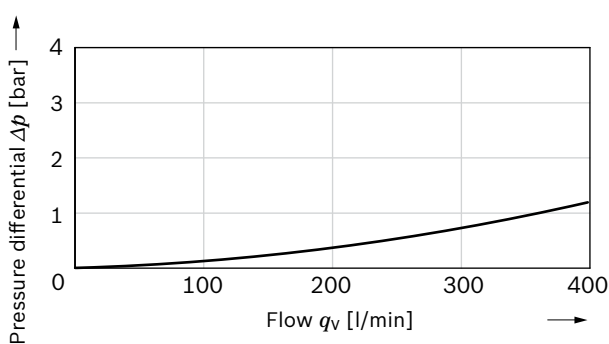
Characteristic curves

▼ Pressure difference $D' \rightarrow D$

(counterbalance spool opened to the maximum)



▼ Pressure difference $C' \rightarrow C$



The above parameters are based on:

- ▶ Oil viscosity ν = approx. 10 mm²/s
- ▶ Oil temperature ϑ = 50 °C
- ▶ Counterbalance spool fully open

Notice

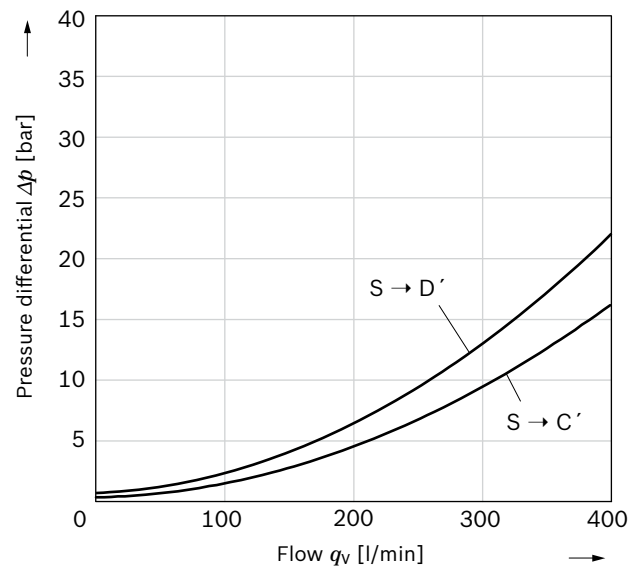
- ▶ Pressure Δp of approx. 20 to 50 bar is normal for determining the maximum flow in winch drives.
- ▶ If the desired flow (pressure difference) does not match the counterbalance spool described here, please contact us.

▼ Counterbalance spool closing time

(for choosing D1 outlet damping)

Diameter [mm]	0.7	1.0	2.0
Standard closing time (Dxxxx) [sec]	0.7	0.5	0.1
Load pressure dependent damping closing time (Hxxxx) [sec]	0.6	0.4	0.1

▼ Boost pressure at port S



Functional description

Counterbalance valves are designed to reduce the danger of overspeed and cavitation of axial piston motors in open circuits. Cavitation occurs if, during braking or load-lowering, the rotational speed of the motor is greater than it should be for the given inlet flow, causing the supply pressure to fall sharply. If the supply pressure drops below the given value Δp_{KE} , the counterbalance spool will move towards the close position. The cross-sectional area in the counterbalance valve return passage is then reduced, creating a bottleneck in the return flow of the hydraulic fluid. The pressure increases and brakes the motor until the rotational speed of the motor reaches the specified value for the given inlet flow.

Lowering

Due to the pressure at port **D**, the control piston opens and connects the load pressure **C'** on the consumer with port side **C** of the counterbalance valve.

Rest position

The load pressure is applied at port **C'**, ports **C** and **D** are depressurized.

The spring, which acts on the control piston in the closing direction, closes the valve in the rest position (the differential pressure at the control piston is less than the start of opening of the counterbalance spool).

Lifting

When lifting, the valve is closed, which pressurizes the motor (and lifts the load). The draining oil flows via **D** into the reservoir.

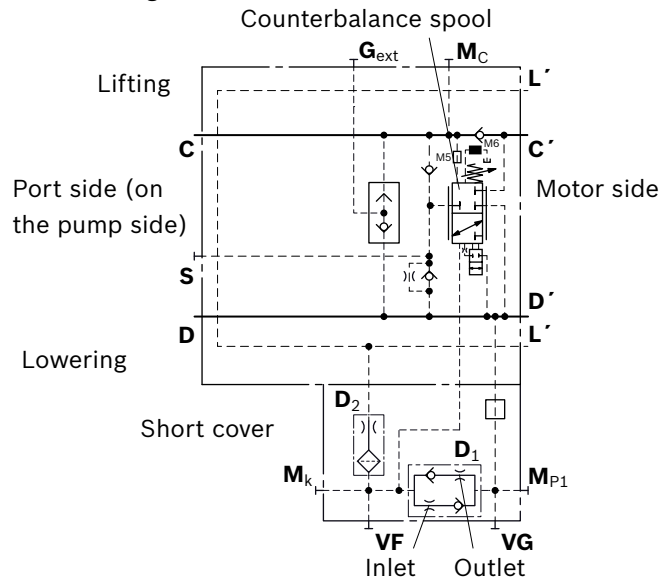
Brake release

Version S

Counterbalance valve with shuttle valve and port **G_{ext}** (plugged), without brake release valve (pressure reduction).

The respective high pressure is balanced via the shuttle valve and is available at port **G_{ext}** for venting the mechanical holding brake. The brake release function without pressure reduction via the brake release valve is only employed if the mechanical holding brake is approved for the maximum working pressure.

▼ Circuit diagram BVE...S

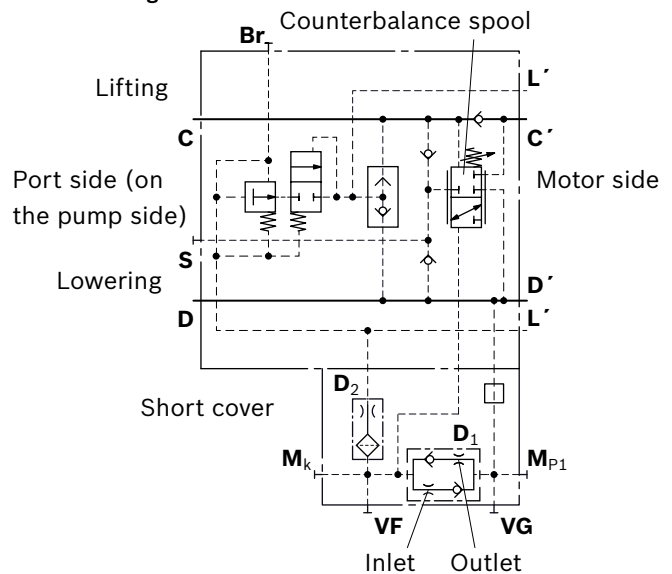


Version L

Counterbalance valve with shuttle valve, brake release valve for pressure reduction and port **Br** (plugged).

The respective high pressure is balanced and fed to the brake release valve (pressure reducing valve) via the shuttle valve. This opens from about 10 bar and reduces the respective working pressure to approx. 21^{+4} bar. This brake release function is employed when the mechanical brake on the gearbox cannot handle the full system pressure. The maximum permissible brake release pressure must be agreed with the winch manufacturer.

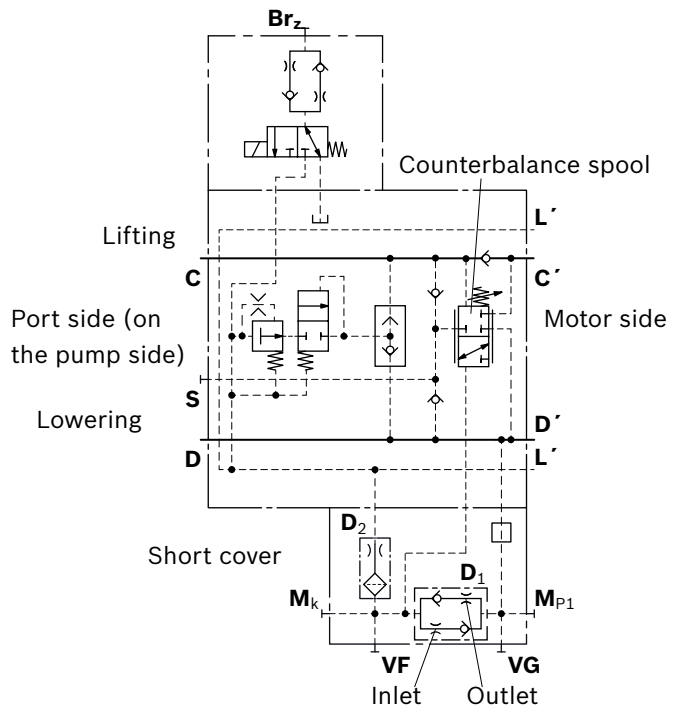
▼ Circuit diagram BVE...L



Version M

The basic function of the brake release valve corresponds to version L. With version M, the reduced brake release pressure at Brz can also be switched on or off via an electric valve.

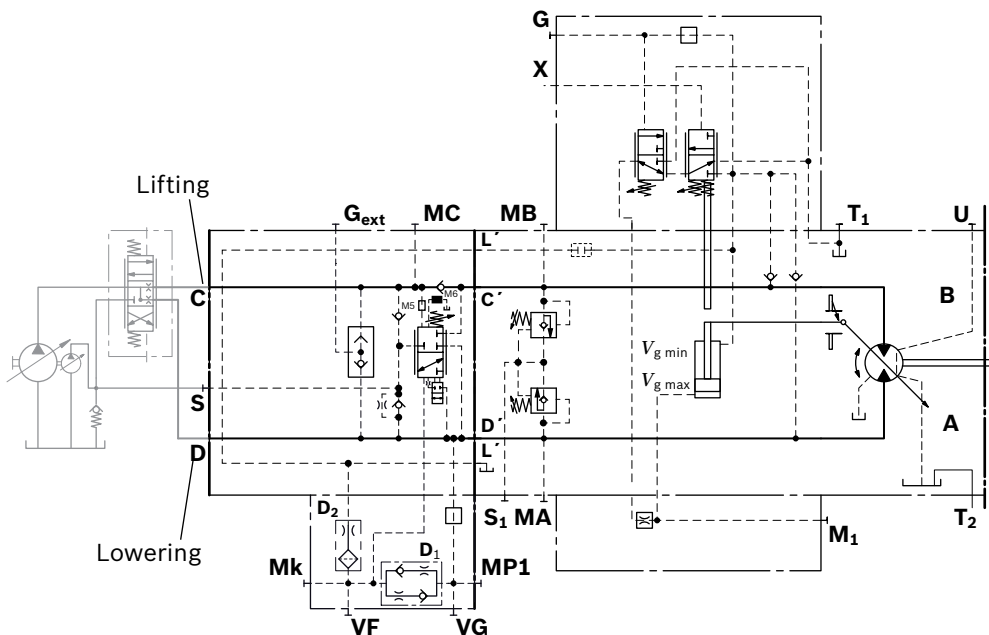
▼ **Circuit diagram BVE...M**



Application example for winch drive

Variable motor with integrated pressure relief valve in the port plate and mounted counterbalance valve. Counterbalance valve for size 25 winches with unloading to **C (W)**, without brake release valve (**S**), with counterbalance spool version (**10**), without internal residual opening (K00, mandatory for winches), with load pressure dependent damping (H4580). E.g.: A6VM170HP5D1P001B/71MWV0R4A15W0-0 + BVE25W38S/53NC-V100K00H4580T30C20-0 mounted on a Rexroth winch drive

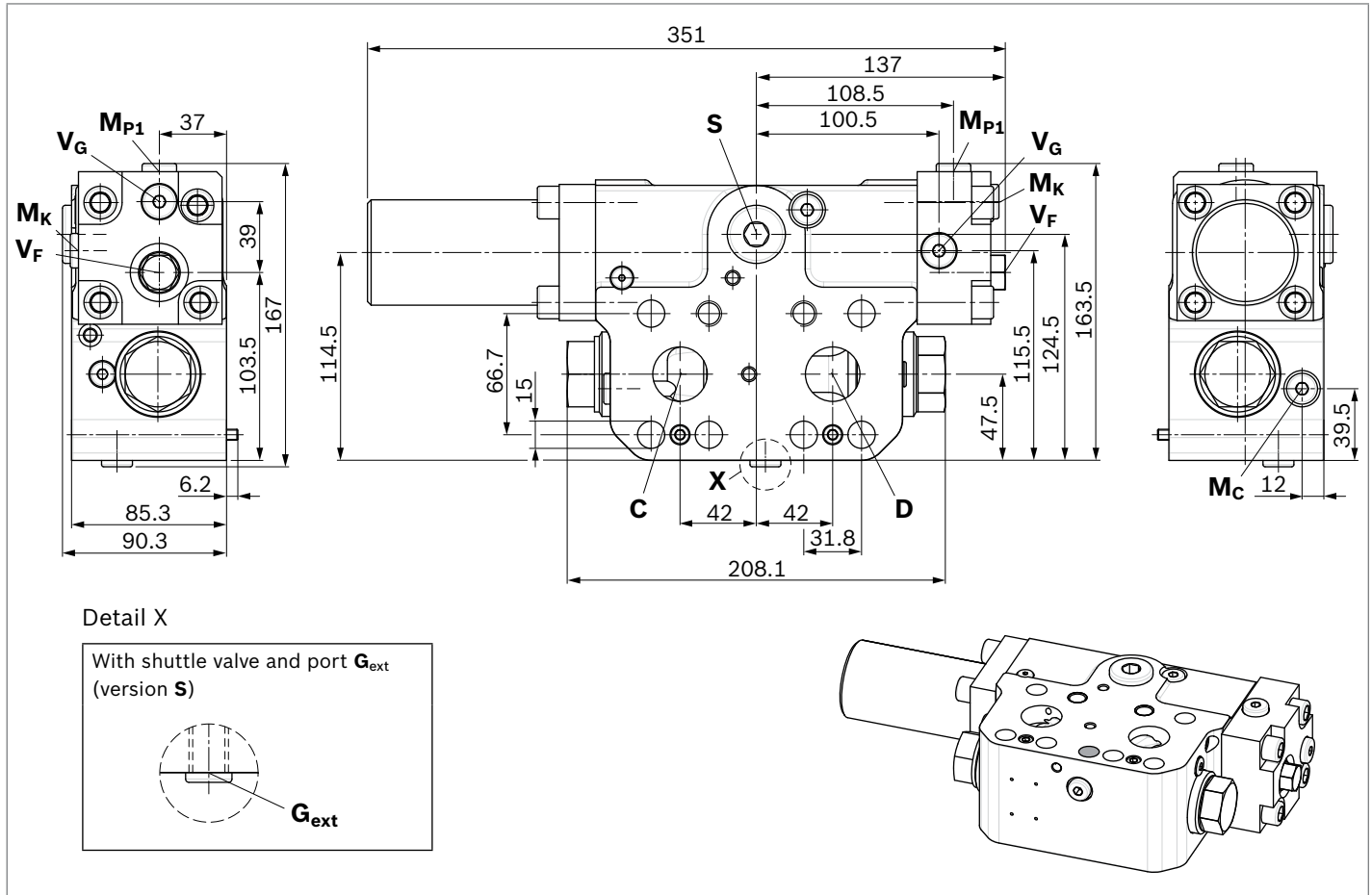
▼ **Circuit diagram example for winch drive in cranes (BVE)**



As an alternative to the above example, other Bosch Rexroth axial piston motors (A2FM, A2FE and A6VM, A6VE) can also be used.

Dimensions

Version S without brake release valve



Ports	Standard	Size	p_{max} [bar] ¹⁾	State ⁵⁾
C, D	Working port fastening thread SAE J518 ²⁾ DIN 13	1 1/4 in M14 × 2; 19 deep	420	O
G _{ext}	Brake release, high pressure DIN 3852 ³⁾	M14 × 1.5; 12 deep	420	X
S	Boost pressure supply DIN 3852 ³⁾	M27 × 2; 16 deep	4) ⁴⁾	X
B _r	Brake release, reduced high pressure DIN 3852 ³⁾	M12 × 1.5; 12 deep	40	X
M _{P1}	Measuring pressure A, before filter DIN 3852 ³⁾	M14 × 1.5; 12 deep	420	X
M _C	Measuring pressure in counterbalance spool DIN 3852 ³⁾	M12 × 1.5; 12 deep	420	X
M _K	Measuring pressure in counterbalance spool DIN 3852 ³⁾	M14 × 1.5; 12 deep	420	X

1) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

2) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

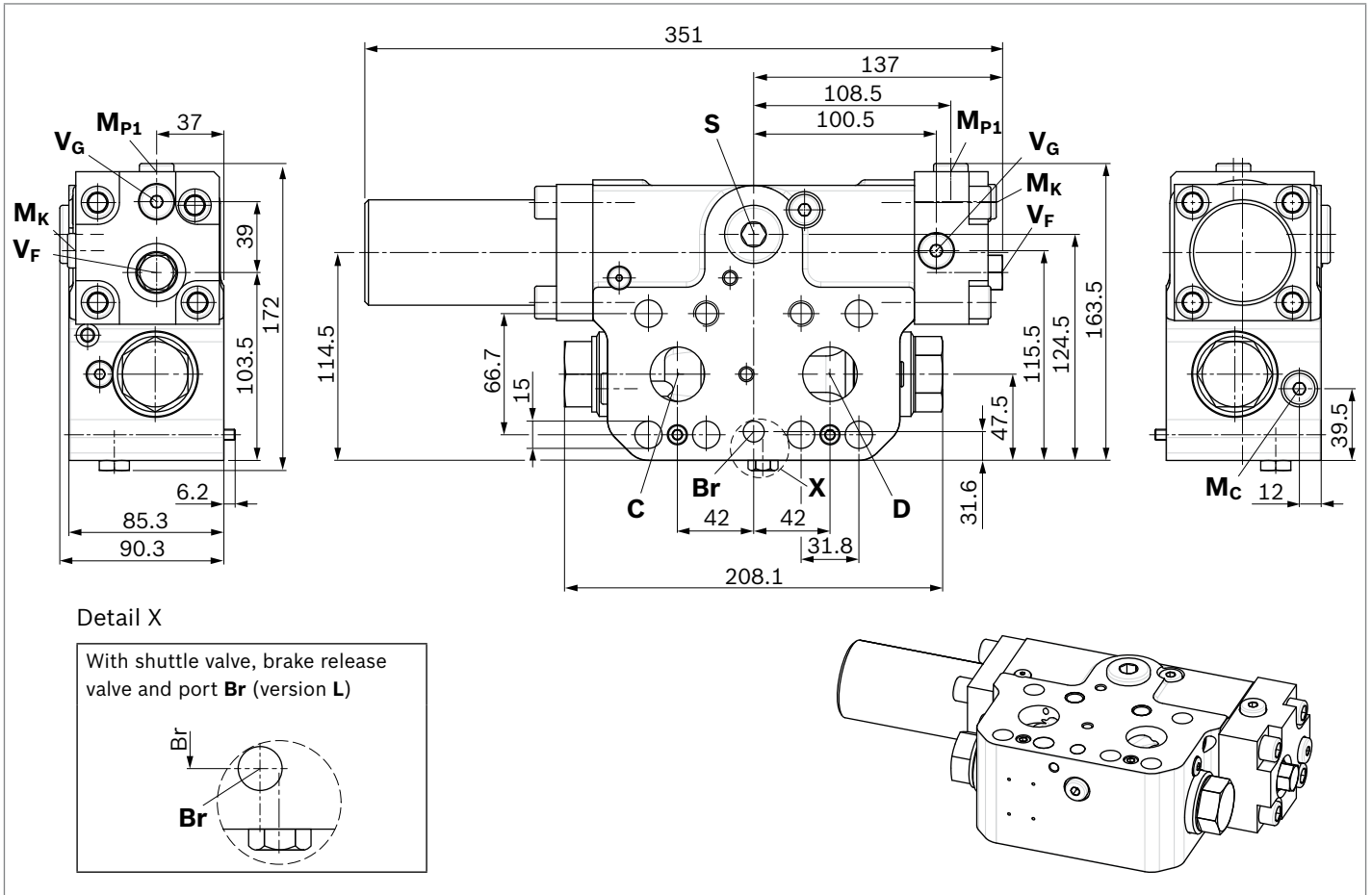
3) The countersink may be deeper than specified in the standard.

4) Application-specific, please contact us

5) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

Version L with brake release valve

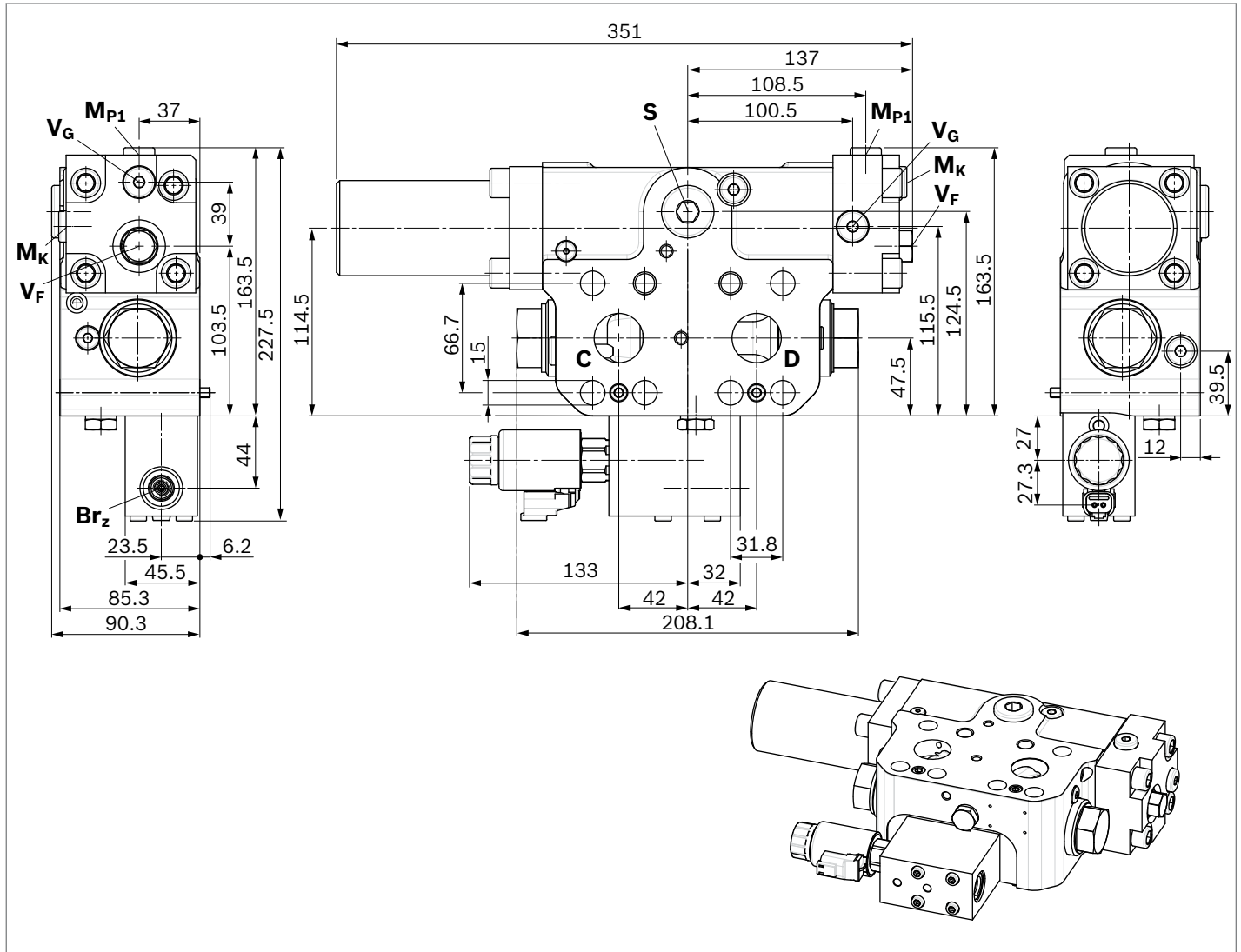


Ports	Standard	Size	p_{max} [bar] ¹⁾	State ⁵⁾
C, D	Working port fastening thread SAE J518 ²⁾ DIN 13	1 1/4 in M14 × 2; 19 deep	420	O
S	Boost pressure supply DIN 3852 ³⁾	M27 × 2; 16 deep	4)	X
Br	Brake release, reduced high pressure DIN 3852 ³⁾	M12 × 1.5; 12 deep	40	X
M _{P1}	Measuring pressure A, before filter DIN 3852 ³⁾	M14 × 1.5; 12 deep	420	X
M _C	Measuring pressure in counterbalance spool DIN 3852 ³⁾	M12 × 1.5; 12 deep	420	X
M _K	Measuring pressure in counterbalance spool DIN 3852 ³⁾	M14 × 1.5; 12 deep	420	X

1) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
2) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

3) The countersink may be deeper than specified in the standard.
4) Application-specific, please contact us
5) O = Must be connected (plugged when delivered)
X = Plugged (in normal operation)

Version M with brake release valve that can be electrically switched on / off



Ports	Standard	Size	p_{max} [bar] ¹⁾	State ⁵⁾
C, D	Working port fastening thread	SAE J518 ²⁾ DIN 13	1 1/4 in M14 × 2; 19 deep	420 O
S	Boost pressure supply	DIN 3852 ³⁾	M27 × 2; 16 deep	4) X
Br _z	Brake release, reduced high pressure	DIN 3852 ³⁾	M12 × 1.5; 12.5 deep	40 X
M _{P1}	Measuring pressure A, before filter	DIN 3852 ³⁾	M14 × 1.5; 12 deep	420 X
M _C	Measuring pressure in counterbalance spool	DIN 3852 ³⁾	M12 × 1.5; 12 deep	420 X
M _K	Measuring pressure in counterbalance spool	DIN 3852 ³⁾	M14 × 1.5; 12 deep	420 X

1) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.

2) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.

3) The countersink may be deeper than specified in the standard.

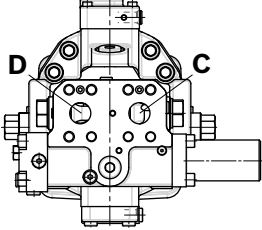
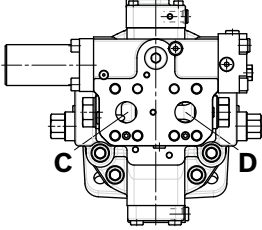
4) Application-specific, please contact us

5) O = Must be connected (plugged when delivered)

X = Plugged (in normal operation)

BVE installation variants for winch drives

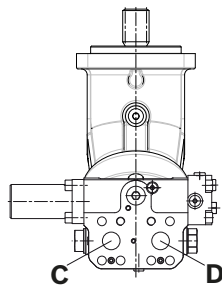
Design: A6VM/A6VE

Motor direction of rotation (lift)	Clockwise	Counterclockwise
Flow direction at motor	A to B	B to A
Braking effect at the motor port plate	A	B
Beginning of control, motor	Beginning of control $V_{g \max}$	Beginning of control $V_{g \max}$
Installation variants		

- ▶ When operating lifting winches, only motors with beginning of control at $V_{g \max}$ (negative control) are permitted, e.g. HP5, HP6, EP5, EP6, HZ5, HZ7, EZ5, EZ6, EZ7, EZ8
- ▶ The beginning of control at $V_{g \min}$ (positive control) is not permissible for lifting winches. e.g. HP1, HP2, EP1, EP2, HA1, HA2

Design: A2FM/A2FE

Direction of rotation (lifting)	Clockwise
Flow direction at motor	A to B
Counterbalance valve effect at motor port	A
Long spring cover at BVE	On port side C
Counterbalance valve type code	BVE25.../53.C

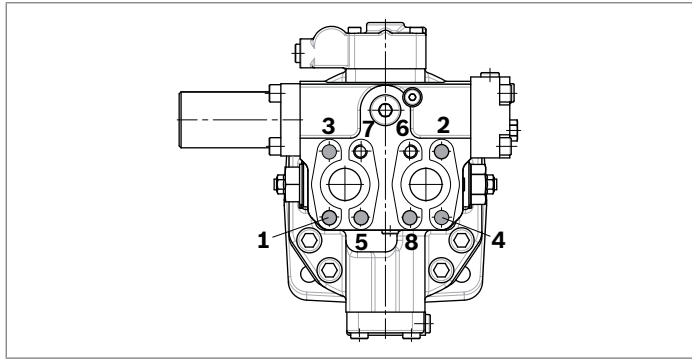


Mounting the counterbalance valve

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

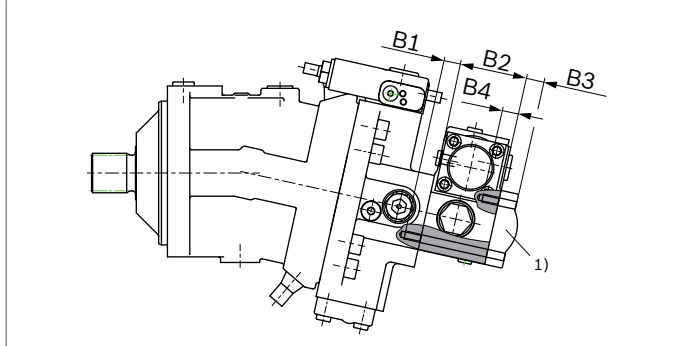
6 screws (**1, 2, 3, 4, 5, 8**) Length B1+B2+B3
2 screws (**6, 7**) Length B3+B4

Tighten the screws in two steps following the specified sequence from 1 to 8 (see figure below). In the first step, the screws must be tightened with half the tightening torque, and in the second step with the maximum tightening torque (see table below).

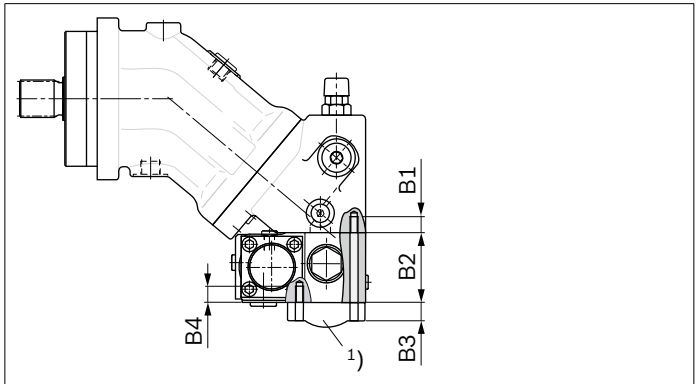


Thread	Property class	Tightening torque [Nm] ¹⁾
M10	10.9	63
M12	10.9	108
M14	10.9	172

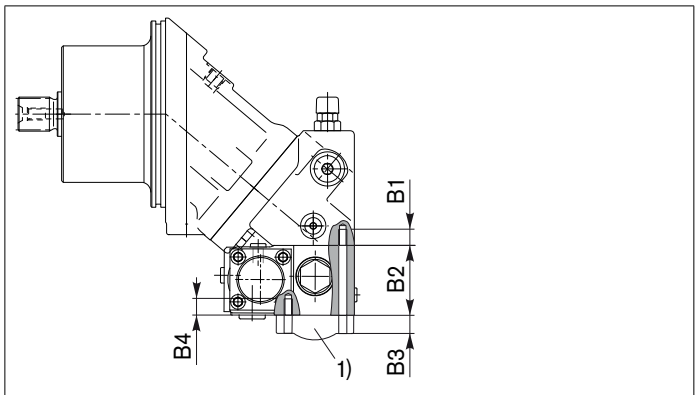
A6VM



A2FM



A2FE



Axial piston motor	A6VM/65	A6VE/65	A6VM/71	A6VE/71
Size	107, 140, 160, 200	107, 160, 200	115, 150, 170, 215, 280	115, 170, 215
Dimension B1	M14 × 2; (19 deep ²⁾)			
Dimension B2	154 -0.5			
Dimension B3	Customer-specific			
Dimension B4	M14 × 2; 19 deep			

Notes on the motor port plate

- ▶ All four threaded bores at the SAE port and additional bores for tacking screws must always be present
- ▶ The drain bores must be present
- ▶ Minimum thread reach according to VDI2230

1) The tightening torque applies to the thread friction rate of $\mu = 0.10$ (corresponds to the "lightly oiled" state of the screws)

2) The depth depends on the motor

Project planning notes

- ▶ The BVE counterbalance valve is intended for use in an open circuit.
- ▶ The project planning, installation and commissioning of the counterbalance valve require the involvement of qualified skilled personnel.
- ▶ Before using the counterbalance valve, please read the corresponding motor instruction manual completely and thoroughly. If necessary, this can be requested from Bosch Rexroth.
- ▶ Before finalizing your design, please request a binding installation drawing.
- ▶ The specified data and notes contained herein must be observed.
- ▶ For safety reasons, controls with beginning of control at $V_{g\ min}$ (e.g. HA) are not permissible for winch drives, e.g. lifting winches!
- ▶ Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- ▶ Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or the motor instruction manual.
- ▶ Not all versions of the product are approved for use in safety functions according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g. $MTTF_d$) for functional safety.
- ▶ Please note the details regarding the tightening torques of port threads and other threaded joints in the motor instruction manual.
- ▶ Working ports:
 - The ports and fastening threads are designed for the specified maximum pressure of the counterbalance valve. The machine or system manufacturer must make sure the connecting elements and lines meet the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
 - The working ports and function ports are only intended for hydraulic lines.
- ▶ System optimization (acceptance) for the first prototype is recommended with regard to the valve block, axial piston motor, counterbalance valve and holding brake.
- ▶ The counterbalance valve converts the entire kinetic energy/potential energy into heat during the braking/lowering process. For this reason, sufficient cooling and/or reservoir capacity must be provided.
- ▶ We recommend ordering an axial piston motor and counterbalance valve as a single unit. This guarantees optimum configuration and joint testing.

To avoid cavitation in the axial piston motor, the following must be observed:

- ▶ The complete system in the customer vehicle must be designed so that the counterbalance valve closes more quickly than the control block. A proportional valve with programmable ramp is recommended.
- ▶ Control block: the control spool should be designed with a throttled A-B-T connection in the neutral position, to achieve a depressurized state at the working ports.
- ▶ A boost pressure supply at port S of the motor reduces the risk of cavitation. Ensure sufficient pressure and volume is available for the boost pressure supply. A boost pressure supply at the motor is recommended. The boost pressure must not relieve the mechanical holding brake.
- ▶ During commissioning, it must be ensured that all boundary conditions, e.g. minimum pressure at the motor input, are observed.

Ordering details

When placing the order, the following parameters are necessary to ensure correct acceptance at our test benches:

- ▶ Motor type code
- ▶ Counterbalance valve type code
- ▶ Flow
- ▶ Application (e.g. winch)
- ▶ Pressure setting of the secondary pressure relief valves in the motor
- ▶ Specify the orientation on the motor

For the design of the brake release valve, we require the minimum pressure and the maximum pressure (holding brake is fully open at p_{max}) for releasing the mechanical holding brake. Counterbalance valve and axial piston motor can be ordered as a ready-assembled and tested assembly group.

Type selection (type code)

Control range

The control range defines the pressure range at which the counterbalance spool starts to open. The mechanical holding brake and the start of opening of the counterbalance spool must be coordinated with one another.

With standard W, the spring chamber is pressurized with the pressure in **C** and has to be added to the control range of the spring.

With variant U, only the reservoir pressure is added to the control range of the spring. Make sure that when lifting, the return flow pressure at port D never exceeds the cracking pressure of 18 bar.

It is absolutely necessary that the commissioning of variant U is done by Bosch Rexroth.

Brake release

The integrated pressure reducing valve is necessary when the mechanical brake on the gearbox cannot handle the full system pressure. The maximum permissible brake release pressure must be agreed with the gearbox manufacturer.

The brake release valve reduces the high pressure to the value stated.

Controlling the mechanical holding brake via the counterbalance valve supply pressure is recommended. Versions **L** or **S** are suited to the different pressure ranges of the holding brake.

Make sure that the boost pressure at port **S** does not open the holding brake. We therefore recommend a boost pressure of < 10 bar.

Counterbalance spool version

The counterbalance spool version depends on the maximum flow required through the counterbalance valve.

If the desired flow is not within the range of the counterbalance spool supplied, please contact us.

Residual opening in counterbalance spool

In winch applications, any kind of residual opening is prohibited, since otherwise the load would not stay suspended. For that reason, version "K00" is prescribed.

Damping

The throttle pin from **D₁** (inlet), the orifice **D₂** (reservoir outlet), and the counter pressure at the counterbalance spool determine the actual cracking pressure of the counterbalance spool at the working port.

The damping **D₁** (outlet) and **D₂** determine the closing speed of the counterbalance spool. The larger the

comparative diameter **D₁** (outlet), the faster the counterbalance spool will close (see table on page 4).

To enable the load to be lowered faster, the opening speed can be increased from a certain piston stroke by means of damping version Hxxxx.

For the initial equipment (prototype), we recommend damping **D₁** = D4580 and **D₂** = T30 for winch drives.

Safety instructions

Failure to observe any of the following points can lead to uncontrolled operating conditions, resulting in serious personal injury and property damage.

- ▶ The counterbalance valve does **not** replace the mechanical holding brake. If necessary, provide mechanical braking systems.
- ▶ The mechanical holding brake in the winch gearbox may only be operated once the counterbalance spool has closed. Otherwise, the brake will be subject to wear.
- ▶ Note the maximum permissible cracking pressure of the holding brake. If necessary, use the integrated pressure reducing valve for brake release valve with reduced high pressure (version “L”).
- ▶ In the event of a valve malfunction, the pressure in **A** or **B** must never exceed > 10 bar, because there is a risk that the mechanical holding brake will open or not close automatically, depending on the system design. This must be checked by the machine manufacturer and secured, if necessary.
- ▶ When unloading the spring chamber to **C** (BVE25W), the lifting pressure acts additionally on the counterbalance spool. When unloading the spring chamber to the reservoir (BVE25U), the counterbalance spool is closed only by the spring, the lifting pressure in **C** no longer acts on the counterbalance spool.
- ▶ Counterbalance valves should only be operated in combination with close-by secondary pressure relief valves in order to protect the motor against pressure peaks. The motor port plate already contains the secondary pressure relief valves.
- ▶ Cavitation must be prevented for safety reasons – see project planning notes for remedial measures
- ▶ During and shortly after operation, there is a risk of getting burned on the axial piston unit, especially on the solenoids. Take the appropriate safety measures (e.g. by wearing protective clothing).
- ▶ Moving parts in control equipment (e.g. valve spools) can, under certain circumstances, get stuck in position as a result of contamination (e.g. contaminated hydraulic fluid, abrasion, or residual dirt from components). As a result, the hydraulic fluid flow and the build-up of torque in the axial piston unit can no longer respond correctly to the operator’s specifications. Even the use of various filter elements (external or internal flow filtration) will not rule out a fault but merely reduce the risk. The machine/system manufacturer must test whether remedial measures are needed on the machine for the application concerned in order to bring the driven consumer into a safe position (e.g. safe stop) and ensure any measures are properly implemented.
- ▶ In certain conditions, moving parts in high pressure relief valves might get stuck in an undefined position due to contamination (e.g. contaminated hydraulic fluid). This can result in restriction or loss of load holding functions in lifting winches. Therefore it is the machine and/or system manufacturer’s responsibility to make sure that the load can always be put in a safe mode if needed. Also, he needs to ensure that these measures are properly implemented.
- ▶ When using the axial piston motor in winch drives, make certain that the technical limit values are not exceeded under all operating conditions. If the axial piston motor is extremely overloaded (e.g. if the maximum permissible rotational speeds are exceeded during weighing of the anchor while the ship is in motion), the rotary group may be damaged and, in the worst case, the axial piston motor may burst. The machine manufacturer/system manufacturer is to undertake additional measures, up to and including encapsulation.

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