

MOTION CONTROL

Bosch Rexroth Oil Control manufactures a variety of valves for pressure, flow and motion control of actuators working in both forward and reverse direction. A few of these valves are designed to be line mounted on the 2 main hoses, but many of them are studied to match the port patterns of commercially available hydraulic motors and they can be flanged onto the motor directly simplifying plumbing and saving space.

This catalogue shows examples of valves for Rexroth A2FE Series and Sauer-Danfoss orbital motors, but the valve range extends to a number of other motors as well.

The valves are grouped by hydraulic function as follows:

4a) DUAL CROSS OVER RELIEF

4b) SINGLE COUNTERBALANCE WITH BRAKE RELEASE PORT

4c) DUAL COUNTERBALANCE WITH BRAKE RELEASE PORT

4d) MOTION CONTROL

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This family of valves performs the following main functions:

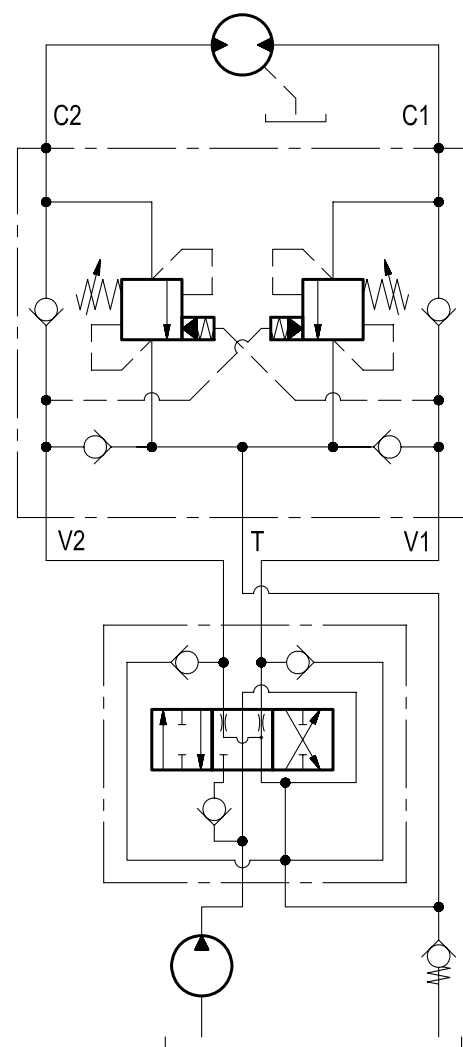
A – Free flow into the motor through the check valves from both the main supply lines.

B – Limitation of the inlet pressure through the cross-over type relief valves which transfer the exhausted oil to the other line (from V1 to V2 and vice-versa).

C – Locking of the motor by locking the reverse flow at both the motor ports, when the directional valve is in central position, or the pump is stopped.

D – Bi-directional control of the motion always metered by the pilot function: the pilot pistons modulate the openings of the relief valves which become counterbalance valves, and control the speed by metering the oil flow discharged from the motor. Motion is possible only in presence of pilot pressure, i.e. positive inlet pressure to the motor, also when the load tends to overrun.

E – Limitation of back-pressure at the motor exhaust ports especially **during braking**. The cross-over relief valves limit the braking pressure and transfer the exhausted oil to the other line in order to **re-fill the motor** and to **prevent cavitation** also during braking when no pump flow is delivered to either one of the motor ports.



F – Additional functions in “VF” and “PDRM” versions(see schemes):

“VF” version: it allows direct control of the mechanical parking brake, with the pressure delivered by a shuttle valve through “C3” port. If it is necessary to limit the pressure to the brake, a pressure reducer cartridge may be incorporated into the valve between the shuttle and C3.

For motion control of hydraulic motors, generally a high pilot ratio “R” is adopted in order to speed up motion and save energy; however, if the valve selected is a “VF” version, it must always be remembered that “R” must comply with the following limitations: the “pilot pressure” needed to open the relief cartridge and start motion must always be “higher” than the pressure capable to release the brake (generally 7 to 15÷20 bar). In fact, when motion is commanded in either direction, the pilot pressure must build-up to a level capable to release the brake before any motion starts.

With hydraulic motors, the pilot pressure needed to open the counterbalance valve can be calculated by the following formula:

$$P_{pil} = \frac{P_t - P_{load}}{R + 1}$$

and the lowest pilot pressure (P_{pil}) is:

$$(P_{pil \min}) = \frac{P_t - P_{load \max}}{R + 1}$$

where:

P_t = pressure setting (relief setting)

P_{load} = load induced pressure

R = pilot ratio

Example:

$P_{load \max}$ = 170 bar (maximum expected load induced pressure)

P_t = 325 bar (> 1.3 x 170 bar)

R = 8:1 (Pilot ratio)

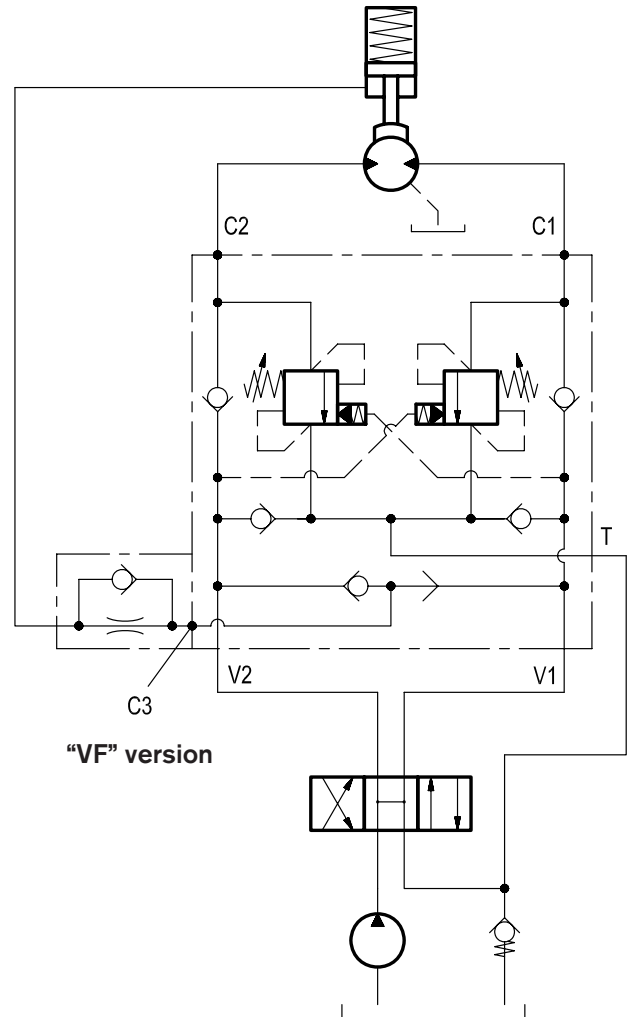
Brake release pressure: ≥ 17 bar

$$(P_{pil \min}) = \frac{325 - 170}{8 + 1} \text{ bar} = 17.2 \text{ bar} > 17 \text{ bar}$$

The selected motion control valve, with $R = 8 : 1$ and $P_t = 325$ bar, complies with the correct lowering sequence because the lowest pilot pressure is 17.2 bar > 17 bar: also with the highest load capacity, the holding brake is released before any motion of the hydraulic motor is started.

If compliance is not met, a different pilot ratio or a different pressure setting must be selected.

NOTE: for proper control of the parking brake, it is often necessary to add devices designed to delay the brake engagement after bringing the control spool in central position, until the motion has reached a definite full stop, without delaying the brake release at start (see scheme).



“PDRM” version: it has relief cartridges with two different pressure settings, both separately adjustable:

- a) high pressure setting for starting (oil flow from V1 to C1, or V2 to C2).
- b) low pressure setting for smooth braking during stopping (oil flow from C1 or C2), when the directional control valve is brought into the central position.

High and low settings can be achieved because each relief piston is pushed by two springs, a main spring and a secondary spring, acting in opposite directions.

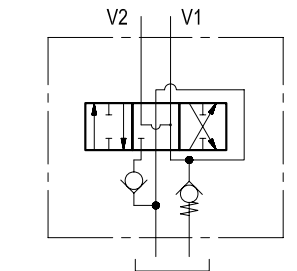
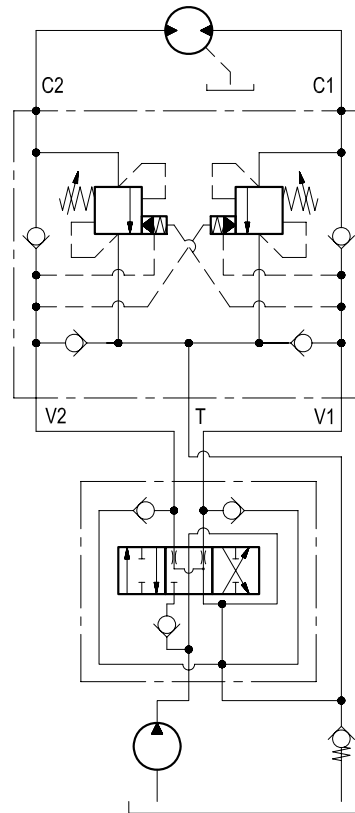
When oil is flowing from V1 to C1 (or V2 to C2), the secondary spring is neutralized by the incoming flow and the relief piston is controlled only by the main spring: the line pressure is at its highest value when load must be put into motion.

Vice-versa, when oil is discharged by the motor (from C1 or from C2) while braking, both V1 – V2 ports are at low pressure (directional valve in central position), the secondary spring pushes the relief piston toward opening, and the pressure setting drops to its lowest value for smooth stopping.

This PDRM version is most useful in slewing systems, or in traction of wheeled vehicles, since it provides automatic torque increase, at starting, without affecting deceleration.

For correct performance, the directional spool should have open or restricted ports in central position.

“PDRM” version and recommended scheme



POSSIBLE SOLUTION