Technical data for Compact Directional valves

Introduction:
Following technical data refers to Compact Hydraulics valves (RE 90010-06 chapters 2,3,4 and 5)

1. General

Bosch Rexroth Product Area 2 - Compact Hydraulics (CH) proposes a wide range of hydraulic components for applications in hydraulic circuits of mobile and industrial machinery. Detailed information about product performance, selection, installation and technical data can be obtained from our Customer Service Organization; here you may find a summary of general specifications which apply to all our CH hydraulic products with the aim to provide general guidance only.

2. Hydraulic fluids

Mineral oil based hydraulic fluids suitable for hydraulic systems can be used; they should have physical lubricating and chemical properties as specified by:

- MINERAL OIL BASED HYDRAULIC FLUIDS HL (DIN 51524 part 1)
- MINERAL OIL BASED HYDRAULIC FLUIDS HLP (DIN 51524 part 2).

For use of environmentally friendly fluids (vegetable or polyglycol base), or other fluids, please consult CH.

2.1 Fluid viscosity

When not differently specified in the individual data sheet, the fluid viscosity should remain within the range 5 to 420 cSt (centistokes). Hydraulic fluids are available in different viscosity classes identified by the ISO VG number, which corresponds to the kinematic viscosity at 40°C (104°F). Here is a table showing typical viscosity changes between 0°C and 100°C (32°F and 212°F) for mineral oil based fluids having various viscosity classes. The fluid should be selected with the aim to achieve an appropriate operating viscosity at the expected working temperatures.

VISCOSITY CLASS	KINEMATIC VISCOSITY - (cSt)		
	MAX at 0°C (32°F)	MED at 40°C (104°F)	MIN at 100°C (212°F)
ISO VG 10	90	10	2.4
ISO VG 22	300	22	4.1
ISO VG 32	420	32	5
ISO VG 46	780	46	6.1
ISO VG 68	1400	68	7.8
ISO VG 100	2560	100	9.9

Note: all main performance curves and specifications shown in CH technical literature are obtained using mineral based fluid ISO VG 32, i.e. 32 cSt at 40°C (104°F), with an oil temperature of 40-50°C (104-122°F).
More detailed technical characteristics are available at CH.

2.2 Fluid temperature recommendation

CH components are generally equipped with BUNA-N seals and, for this reason, the fluid temperature should remain within the -20°C and +80°C range (-4°F and +212°F). Temperature of -30°C (-22°F) is generally acceptable when the machine is not working. Temperature peaks up to 105°C (221°F) are allowed for short time. In case of temperatures outside this range, consult the company.

2.3 Fluid cleanliness requirements

The cause of malfunctions in hydraulic systems and components is often found to be excessive fluid contamination. The hard contaminant particles in the fluid wear the hydraulic components and can lead spools to stick in the valve body with consequent internal leakage and system inefficiency. For the correct operation of CH components it is necessary to adopt filtration methods which guarantee for life the specified fluid cleanliness level. It is important to ensure that hydraulic fluids are brought to the appropriate cleanliness level prior filling up the systems, and, when in doubt, also to flush the hydraulic components prior to installation.
Maximum allowed value of fluid contamination is mentioned on individual data sheet.
If not specified, please follow the table below

TYPE OF SYSTEM TYPE OF VALVE	OIL FILTRATION RECOMMENDATIONS		
	Cleanliness class recommended		Absolute filtration (micron rating) (**)
	ISO 4406 : 1999	NAS 1638 (*)	
Systems / components operating at HIGH PRESSURE > 250 bar (3600 psi) HIGH DUTY CYCLE APPLICATIONS Systems / components with LOW dirt tolerance	18 / 16 / 13	7 - 8	5
Systems / components operating at MEDIUM HIGH PRESSURE Systems / components with moderate dirt tolerance	19 / 17 / 14	9	10
Systems / components operating at LOW PRESSURE < 100 bar (1500 psi) LOW DUTY CYCLE APPLICATIONS Systems / components with GOOD dirt tolerance	20 / 18 / 15	10 - 11	20

(*) Contamination class NAS 1638 (National Aerospace Standard, conceived in the early 60's, officially superseded since June 2001): it is still followed and it is determined by counting the total particles of different size ranges contained in 100 ml of fluid.

(**) Absolute filtration: is a characteristic of each type of filter; approximately, it refers to the size (expressed in microns) of the largest spherical particle which may pass through the filter.

3. **Pressure setting**

Compact directional valves are supplied pre-set at the standard pressure setting shown by the relevant catalogue sheet.Whenever the application requires a re-adjustment, please ensure that the limits of the indicated pressure range and maximum working pressure are never exceeded.

4. **Sealing of valve adjusters**

Special plastic sealing caps for service are available for most CH valves and cartridges. Upon request, valves can be supplied factory sealed.

5. **Storage of new components**

The components shall not be exposed to direct sun light nor to sources of heat or ozone (like electric motors running), and should be stored in their original, protective packing at ambient temperature within the range -20°C and +50°C (-4°F and 122°F).

6. **Ports**

G type ports (ISO 228-1) are often standard on components with body for line connection; SAE sizes (straight thread), JIS or metric ports can be manufactured upon request.

7. **Body materials**

- Valves and integrated manifolds for medium working pressure (up to 250 bar) can be made of high strength wrought aluminium, black anodized upon request.
- Housings for modular, solenoid operated directional valves and flow diverters are made of high strength cast iron, zinc plated with yellow trivalent chrome treatment.

8. **Seals**

O-Rings: Buna N (acrylonitrile butadiene), also named NBR (according to ASTM), compatible with fluids having mineral oil base, water-in-oil emulsions, and water-glycol fluids. These seals are standard for temperatures within the range -30°C and +100°C (-22°F and +212°F).
Back-up rings and Slide rings: strengthened PTFE (Politetrafluoroetilene like Teflon®, Lubriflon®, Ecoflon®, or similar).
Note: the seal materials are compatible with the fluids normally used in hydraulic systems; in case of special fluids, if you suspect incompatibility between the fluid used and the standard seals, contact the CH service network.

9. **Installation / Maintenance**

- Ensure that all matching surfaces are clean, without contamination.
- Ensure that all seals and back-up rings for the matching surfaces are flawless and correctly placed.
- Do not put any sealing material other than the standard seals.
- Place in position the valve, then, by hand, insert the fittings and the locating screws.
- During the assembly of the valve and/or the group of valves, refer to the hydraulic scheme and to the name assigned to each port.
- Do not hang the valves and/or the group of valves to the hydraulics pipes, but always use the specific fixing holes.
- In case of use of screw and push and twist overrides, the command must be removed before starting the machine
- In case of cartridge valve, check that the cavity is clean, without sharp edges or chips. Dip the cartridge in clean oil, then insert it into the cavity and screw it in by hand, until you begin to compress the top O-Ring.
- Finally tighten with a calibrated torque wrench and torque up to the specifications shown in the catalogue.
- Use gloves in order to avoid accidental injuries during installation or maintenance.
- Do not grab / handle product from moving parts (i.e. cables, levers...etc.)
- All valves or groups of valves are attributable to pressure vessels. It‘s always recommended to place the components in a closed but ventilated compartment, able to protect the environment and users in case of accidental ejection of material under pressure (fittings, pipes, plugs expander ... etc.)
- Do not tamper with the valve. Only the substitution of the valve itself, the coil or the retainer kit are generally allowed

- Remove tension from the coils before any kind of maintenance / installation operation
- Check the connections and the cable section with reference to the coils nominal current
- During the first start of the machine, please ensure that the grounding system is connected and stay away from moving parts.

10. **Cavities for screw-in cartridges**

CH has developed a complete range of cartridges which fit the cavity patterns with UN/UNF threads, according to SAE standards, nominal sizes 08-10-12-16-20. Internal parts of cartridges are designed with a global view of our comprehensive variety of hydraulic products; accordingly, our technology has been optimized in order to employ few basic parts for many different valves for best reliability, cost effectiveness and availability. Further, we can propose our cartridges in different versions, with a variety of external shells in order to fit other cavity patterns, such as ISO/METRIC, or special industrial patterns.

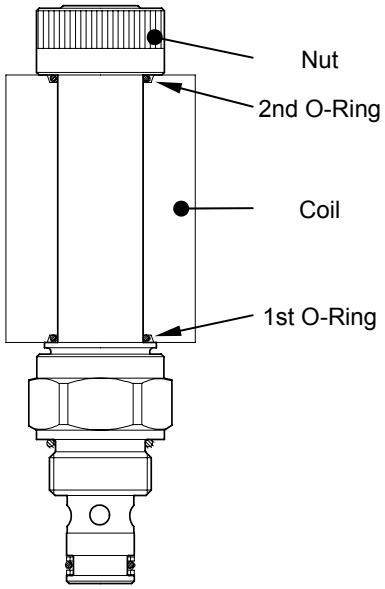
11. **Coils**

11.1 **Coil installation on solenoid cartridges**

COIL INSTALLATION

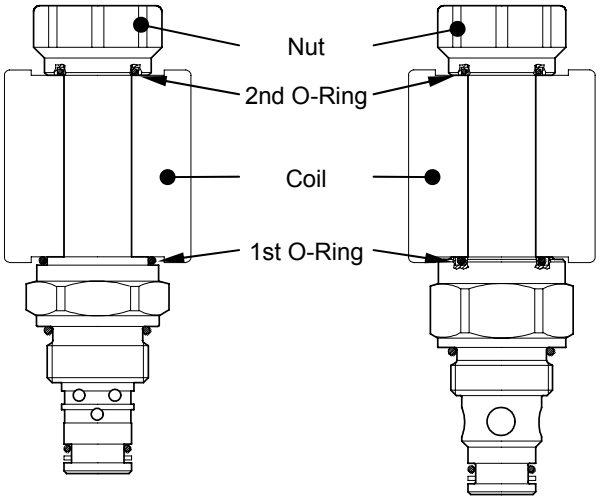
COIL WITH O-RING SEATS (S7-S5-R7)

- It is recommended to follow these steps:
- Insert 1st O-Ring (see drawing)
- Insert coil
- Insert 2nd O-Ring (see drawing)
- Tighten BY HAND coil retaning nut to the torque specified in the cartridge catalogue page.



OIL WITHOUT O-RING SEATS (S8-356)

- It is recommended to follow these steps:
- Insert 1st O-Ring (see drawing)
- Insert coil
- Tighten BY HAND coil retaining nut to the torque specified in the cartridge catalogue page. The 2nd O-Ring is fixed inside the nut.



IMPORTANT: O-Rings are the only protection against water infiltration between tube and coil, which may lead in short time to coil failure. The proper mounting of both O-Rings is therefore necessary to ensure normal life of coils when operating in presence of water, ice, moisture etc. Oil Control cannot guarantee any IP protection degree if both O-Rings are not properly mounted on coils.

11.2 **Working duty (DIN VDE 0580)**

The working duty ED of a coil is the ratio between energized time **ti** and full cycle time **tc** where **tc = ti + tr**, and **tr** = de-energized time.

$$ED = (ti / tc) \cdot 100\%$$

All CH coils are rated for **ED = 100%** (i.e. always energized), provided that the temperature limits of their insulation classes are not exceeded.

11.3 **Protection rating (DIN 40050 - Part 9 IEC 60529)**

Protection class is designated by the letter IP followed by two digits: the first digit refers to resistance against penetration of surrounding or foreign solid objects, the second against penetration of water. Protection class doesn't apply to explosion risks or to conditions such as moisture, corrosive agents, mildew etc.

- **IP65** means water protection against **LOW PRESSURE JETS**:water at 0.3 bar (43.5 psi) pressure sprayed from a distance of 2.5 – 3 m (8.2 – 9.8 ft) from every direction
  IP65 coils CANNOT BE PLUNGED INTO WATER OR REMAIN UNDER WATER.
- **IP67** means water protection against **30 MINUTES IMMERSION** under water 1 m (3.3 ft) deep.
- **IP69K** means water protection against **HIGH PRESSURE JETS**:

water at high pressure and temperature, 80-100 bar (1160–1450 psi) and 75-85°C (167°F-185°F), sprayed from a distance of 100–150 mm (3.9–5.9 in) from every direction.

11.4 **Coil resistance to thermal shock dunk test**

This test, well known and commonly applied in the construction, agricultural and mobile equipment markets, includes several steps :
1) Coil is maintained energized for 1 hour at nominal voltage and ambient temperature 25°C (77°F), or is not energized but heated for 2 hours in oven at 105°C (221°F).
2) Coil is immediately immersed in water at 20 - 25°C (68 – 77°F) for 30 minutes, at minimum depth 300 mm (11.8 in).
3) Coil, when still wet, is tested for moisture ingression and dielectric breakdown with a dielectric tester, like the "Hypot". With this tester, a voltage differential of 500V DC is applied between the winding and the coil external surface in order to measure the current leakage which must not exceed 100µA (micro-amps).
4) The complete test is performed on samples of 10 coils minimum, and is repeated at least five times.

All coils with EN 175301-803 (ex DIN 43650) connector correctly mounted comply with IP65 protection class.
Coils with integrated Deutsch DT04-2P connector have IP69K protection class, and pass the thermal shock dunk test.

11.5 **Heat insulation (DIN VDE 0580)**

The actual coil temperature **T** is the result of (**TA** + **ΔT**), where:
TA = ambient temperature, and ΔT = temperature rise due to coil operation.
Example: with TA = 40°C (104°F) and ΔTmax = 115°C (239°F), **T = 155°C (311°F)**; with TA = 40°C (104°F) and ΔTmax = 140°C (284°F), **T = 180°C (365°F)**.
The coil ΔT is determined following a standard procedure (DIN VDE 0580):

- the coil is mounted on a standard cartridge, inserted in a standard steel manifold placed on a wooden surface.
- the coil is maintained energized for 1 hour at nominal voltage, with ambient temperature TA = 20-25°C (68-77°F) and with natural ventilation.

CLASS H coils are rated for **T max = 180°C (356°F)**:
if ambient temperature exceeds the value **Tx = 180°C (356°F)** - **ΔT**, a class H coil cannot be used under continuous duty cycle (ED = 100%); the coil must be periodically de-energized to prevent exceeding the MAX temperature.
In any case, for the correct operation of coils, it is always necessary to provide means for heat dissipation and, at least, natural ventilation.

Caution: when energized, the coil and valve surface temperature can reach quickly (in few minutes of continuous operation) temperature levels of 80-100°C (176-212°F), which is not directly related to the coil ΔT: **care should be taken to avoid any accidental contact of people with the coil and valve surfaces.**

11.6 **AC Service**

All CH solenoid valves are designed to operate exclusively with DC power supply. All coil windings are DC.
AC operation is possible using EN 175301-803 (ex DIN 43650) connectors with rectifier.

11.7 **Optional manual emergency for solenoid cartridges**

Please refer to the data sheet RE 18350-50

12. Technical data for Proportional valves CH

GLOSSARY OF TERMS AND DEFINITIONS

Current is the flow of electrons in a conductor, measured in Amperes (A) or milli-amperes (mA) and abbreviated “I”.

Voltage is the potential for current flow in an electrical circuit. It is measured in Volts (V) and abbreviated “V.”

Resistance is a material’s opposition to the flow of electrical current. It depends on physical properties as well as temperature, size and shape of the material. It is measured in Ohms (Ω) and abbreviated “R”. The tolerance allowed on resistance at ambient temperature 20-25°C (68 - 77°F) is ± 7 %.

Hysteresis is the difference in regulated hydraulic parameter (flow / pressure) at a fixed current level when current is increasing vs. when current is decreasing. It is normally expressed as a percentage of the total change in regulated hydraulic parameter (flow / pressure).
Example: With 900 mA input current and increasing current, 20 bar (290 psi) regulated pressure is achieved. With 900 mA input current and decreasing current, 20.8 bar (302 psi) regulated pressure is achieved. There is a 0.8 bar (12 psi) difference in regulated pressure achieved with the same current depending on whether current is increasing or decreasing.
If Maximum Regulated Pressure = 25 bar (363 psi) and Minimum Regulated Pressure = 4 bar (58 psi), the total regulated parameter change is 25 (363) – 4 (58) = 21 bar (305 psi).
Hysteresis = (0.8 / 21) x 100 = 3.8%.

Proportional Controller is a device that converts a low-power input signal into an output signal that is capable of operating the valve. This output signal can be modified to include PWM, ramping, etc.
Pulse Width Modulation (PWM) is a method used to vary the average current induced in a coil using a square wave of fixed frequency, and variable ratios of on/off times.

Dither is a method used to reduce hysteresis by applying a square or triangle wave to the coil voltage. It can be applied to straight DC or PWM.

Maximum Control Current is the point where increasing current input no longer results in an increase in regulated hydraulic parameter (flow / pressure).

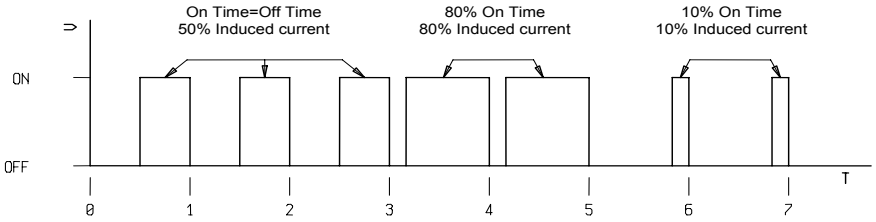
I-Min and I-Max represent the minimum and maximum control current induced into a proportional valve coil. The tolerance allowed is ± 10 % and depends largely from coil´s resistance tolerance.

Ramping is the ability to control the rate of change of the output of an electronic controller.

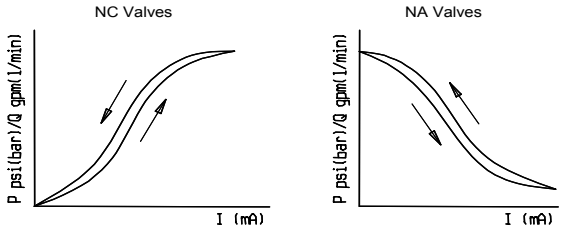
VERY IMPORTANT:

a. It is strongly recommended to use pulse-width-modulation (PWM) as input signal to coils rather than straight DC. Our tests indicate that PWM input signal allows best valve performance, significantly reducing hysteresis and response times of all our proportional valves. All features shown and explained in next pages are available from many industry-common electronic controllers, including Proportional Controllers described in this catalogue.
b. CH recommends to use always 12 V DC coils in combination with 24 V DC supply voltage to the electronic controller. This allows to use a much wider control current range independently from coil temperature, since anyway current is regulated by the electronic controller and there is no coil overheating risk.

PULSE WIDTH MODULATION

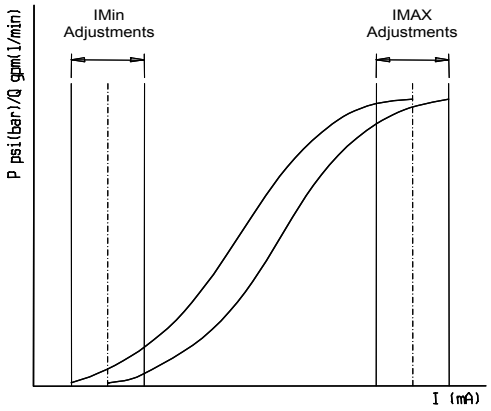


HYSTERESIS CHARACTERISTIC WITH 120 Hz PWM



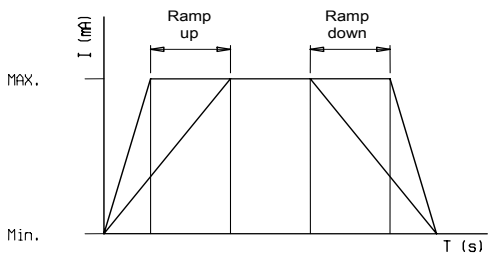
For normally closed proportional valves, the hysteresis curve with increasing current is always lower than the curve with decreasing current.
The opposite is true for normally open proportional valves as shown.

REPEATABILITY RANGE



An important control feature of electronic controllers is I-Min / I-Max adjustment.
This feature allows control of the regulated hydraulic parameter across the full range of the electronic controller by eliminating deadband.

RAMP SLOPE CONTROL



Many commercially available controllers also offer a ramping control feature.
This feature allows to adjust the current rate of change between the I-Min and I-Max setpoints.

13. **European machine directive 2006/42/CE**

The CH valves or components described in this catalogue can be employed in machinery or systems which need to comply with the European Machine Directive
In such case, the CH valves, manifolds, components and assemblies must be fitted in compliance with all the relevant technical data sheet applicable to the product, and shall not be operated, adjusted or disassembled before the complete machinery where they are incorporated has been declared to be in compliance with the Machine Directive 2006/42/CE.

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