



## Piston Accumulators Standard

### 1. DESCRIPTION

#### 1.1. FUNCTION

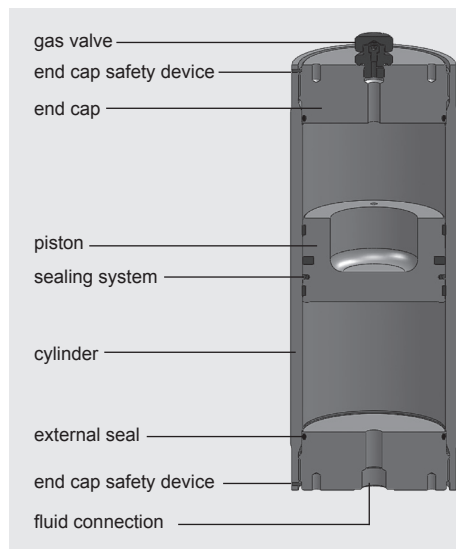
Fluids are practically incompressible and cannot therefore store pressure energy. The compressibility of a gas (nitrogen) is utilised in hydraulic accumulators for storing fluids. HYDAC piston accumulators are based on this principle.

A piston accumulator consists of a fluid section and a gas section with the piston acting as the gas-tight separation element. The gas section is pre-charged with nitrogen.

The fluid section is connected to the hydraulic circuit so that the piston accumulator draws in fluid when the pressure increases and the gas is compressed.

When the pressure drops, the compressed gas expands and forces the stored fluid into the circuit.

#### 1.2. DESIGN



HYDAC piston accumulators consist of:

- a cylinder with very finely machined internal surface.
- end caps on the gas side and the oil side. Sealed with O-rings.
- a floating steel or aluminium piston which can easily be accelerated due to its low weight.
- a sealing system adapted to the particular application.

The piston floats on two guide rings which effectively prevent metal-to-metal contact between the piston and the accumulator wall.

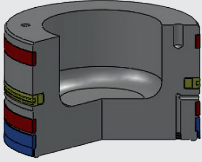
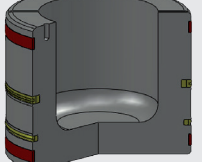
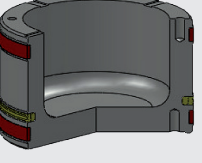
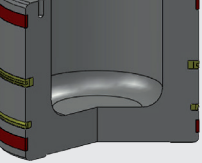
For use with certain aggressive or corrosive fluids, the parts coming into contact with the fluid can be nickel-plated for protection, or made entirely from corrosion-resistant material. Suitable materials are also available for low temperature applications.

#### 1.3. SEALING SYSTEMS

Precise information about the intended operating conditions is required in order to select the most appropriate sealing system for the application. Important criteria for this selection are, for example:

- Design pressure,
- Effective pressure differential,
- Switching frequency or cycles,
- Temperature fluctuation,
- Operating fluid,
- Cleanliness of fluid (micron rating of filter),
- Maintenance requirements.

The sealing systems differ according to the type of piston used, each of which has its own type and arrangement of seals. Various elastomers are available as sealing material, depending on the operating conditions – see section 1.7.5.

| Design  | Application   | Contamination level of fluid   | Comment  |
|---|---|--|--|
|    | <p>1</p> <ul style="list-style-type: none"> <li>● For general accumulator operation without special requirements</li> </ul> <p><u>Application limitations:</u><br/>max. piston velocity: 0.5 m/s</p>  | <p>optimised for applications with a high level of contamination</p>           |  |
|    | <p>2</p> <ul style="list-style-type: none"> <li>● Low-friction design</li> <li>● For high piston speeds</li> <li>● Slow movements without stick-slip effect</li> </ul> <p><u>Application limitations:</u><br/>max. piston velocity: 3.5 m/s</p>   |  |  |
|    | <p>3</p> <ul style="list-style-type: none"> <li>● Low-friction design</li> <li>● Simple-to-fit seals</li> <li>● Slow movements without stick-slip effect</li> </ul> <p><u>Application limitations:</u><br/>max. piston velocity: 0.8 m/s</p>  | <p><u>Filtration:</u><br/>NAS 1638 - Class 6<br/>ISO 4406 - Class 17/15/12</p> | <p>1 guide ring for pistons with <math>\varnothing \leq 150</math> mm</p>  |
|  | <p>4</p> <ul style="list-style-type: none"> <li>● Low-friction design with emergency safety features</li> <li>● Slow movements without stick-slip effect</li> <li>● Very low oil transfer to the gas side</li> </ul> <p><u>Application limitations:</u><br/>max. piston velocity: 5 m/s</p> |  | <p>2 guide rings for pistons with <math>\varnothing \geq 180</math> mm</p> |

## 1.4. INSTALLATION POSITION

HYDAC piston accumulators operate in any position.

Vertical installation is preferable with the gas side at the top, to prevent contaminant particles from the fluid settling on the piston seals. For accumulators with certain piston position indicators, vertical installation is essential (see 1.7.). Piston accumulators with a piston diameter  $\geq 355$  mm must only be installed vertically.

## 1.5. TYPE OF INSTALLATION

For strong vibrations and volumes above 1 litre, we recommend the use of two HYDAC accumulator supports, or more as appropriate, ideally in the cover area. See catalogue section:

- Supports for Hydraulic Accumulators No. 3.502

## 1.6. ADVANTAGES OF HYDAC PISTON ACCUMULATORS

- complete range to over 3300 litres nominal volume,
- high ratios possible between pre-charge pressure and max. working pressure,
- economic solution using back-up gas bottles for low pressure differentials,
- high flow rates possible; limitation: max. piston velocity,
- power savings,
- high level of efficiency of the hydraulic installation,
- no sudden discharge when seals are worn,
- requires little space,

monitoring of the volume across the entire piston stroke or electrical limit switch.

Further advantages of using the low-friction sealing system:

- minimum friction,
- also suitable for low pressure differentials,
- no start-up friction,
- no stick-slip,
- low noise, no vibration,
- high piston velocity up to 5 m/s for piston type 4,
- improved accumulator efficiency,
- good life expectancy of seals because of low wear,
- suitable for large temperature fluctuations,
- low maintenance requirement.

## 1.7. TECHNICAL REQUIREMENTS

HYDAC piston accumulators are suitable for high flow rates. With the largest piston accumulator diameter made to date of 800 mm, a flow rate of 1000 l/s can be achieved at a piston velocity of 2 m/s.

### 1.7.1 Effect of sealing friction

The permitted piston velocity depends on the sealing friction.

Higher piston velocities are possible where there is less sealing friction.

HYDAC piston accumulators of piston design type 2 allow velocities of up to 3.5 m/s.

### 1.7.2 Permitted velocities

#### Gas velocity

The flow velocities in the gas connection and pipe system should be limited to 30 m/s when using piston accumulators of the back-up type. Gas velocities of over 50 m/s should be avoided at all costs.

#### Oil velocity

In order to limit the pressure losses when the operating fluid is displaced, the flow velocity should not exceed 10 m/s in the fitting cross-section.

### 1.7.3 Function tests and fatigue tests

Function tests and fatigue tests are carried out to ensure continuous improvement of our piston accumulators.

By subjecting the accumulators to endurance tests under realistic as well as extreme working conditions, important data can be obtained about the long-term behaviour of the components. In the case of piston accumulators, important information on gas-tightness and the service life of seals is gained from such tests.

Vital data for use in accumulator sizing is gained by altering the working pressure and switching cycles.

### 1.7.4 Gas charging

Hydraulic accumulators must only be charged with nitrogen. Never use other gases.

#### Risk of explosion!

In principle, the accumulator may only be charged with nitrogen class 4.0, filtered to  $< 3 \mu\text{m}$ .

If other gases are to be used, please contact us for advice.

### 1.7.5 Working temperature and operating fluid

The permitted working temperature of a piston accumulator is dependent on the application limits of the metal materials and the piston seal. Outside these temperature ranges, special materials must be used. The operating fluid must also be taken into account. The following table displays a selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids, on a case-by-case basis, information must be requested regarding the resistance and the resistance must be tested specifically:

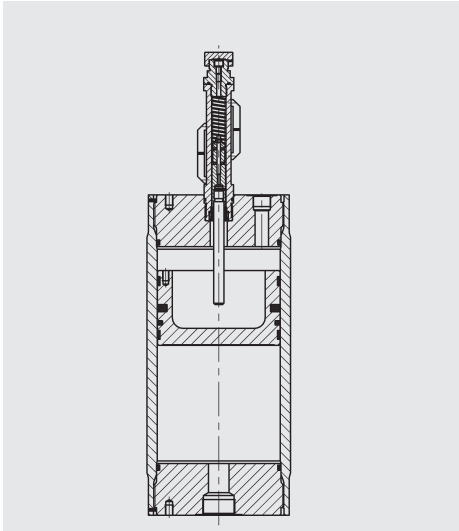
| Materials |                                | Material code <sup>1)</sup> | Temperature range                          | Overview of the fluids <sup>2)</sup>  |  |
|-----------|--------------------------------|-----------------------------|--|---|--|
|           |                                |                             |  | Resistant to  | Not resistant to   |
| NBR       | Acrylonitrile butadiene rubber | 2                           | -20 °C ... + 80 °C                         | <ul style="list-style-type: none"> <li>● Mineral oil (HL, HLP)</li> <li>● Flame-resistant fluids from the groups HFA, HFB, HFC</li> </ul>   | <ul style="list-style-type: none"> <li>● Aromatic hydrocarbons</li> <li>● Chlorinated hydrocarbons (HFD-S)</li> </ul>                      |
|           |                                | 5                           | -40 °C ... + 80 °C                         | <ul style="list-style-type: none"> <li>● Synthetic ester (HEES)</li> <li>● Water</li> <li>● Sea water</li> </ul>  | <ul style="list-style-type: none"> <li>● Amines and ketones</li> <li>● Hydraulic fluids of type HFD-R</li> <li>● Fuels</li> </ul>          |
| PUR       | Polyurethane                   | 8                           | Standard application<br>-30 °C ... + 80 °C | <ul style="list-style-type: none"> <li>● Mineral oil (HL, HLP)</li> <li>● Flame-resistant fluids from the HFA group</li> </ul>  | <ul style="list-style-type: none"> <li>● Water and water-glycol mixture HFC</li> <li>● alkalis</li> <li>● acids</li> </ul>                 |
|           |                                |                             | Special application<br>-40 °C ... +100 °C  |   |  |
| FKM       | Fluorine rubber                | 6                           | -15 °C ... +160 °C                         | <ul style="list-style-type: none"> <li>● Mineral oil (HL, HLP)</li> <li>● Hydraulic fluids of type HFD,</li> <li>● Synthetic ester (HEES)</li> <li>● Fuels</li> <li>● Aromatic hydrocarbons</li> <li>● Inorganic acids</li> </ul> | <ul style="list-style-type: none"> <li>● Amines and ketones</li> <li>● Ammonia</li> <li>● Skydrol and HyJet IV</li> <li>● Steam</li> </ul> |

<sup>1)</sup> see section 2.2. model code, material code and piston code, material of seals incl. piston

<sup>2)</sup> others available on request

## 1.8. PISTON POSITION INDICATORS

### 1.8.1 Electrical limit switch



The electrical limit switch usually monitors the max. charged condition of the piston accumulator.

It can, however, also permit control functions of the attached hydraulics to be carried out over a certain stroke length.

The limit switch consists of the switching rod with a permanent solenoid which is not attached to the piston and can only achieve a limited stroke, and an anti-magnetic housing and two or more switches.

These switches can be normally closed or normally open or bistable. An N/C or N/O and a bistable switch cannot be fitted simultaneously to a limit switch. Our standard limit switch is fitted with a N/C and a N/O switch.

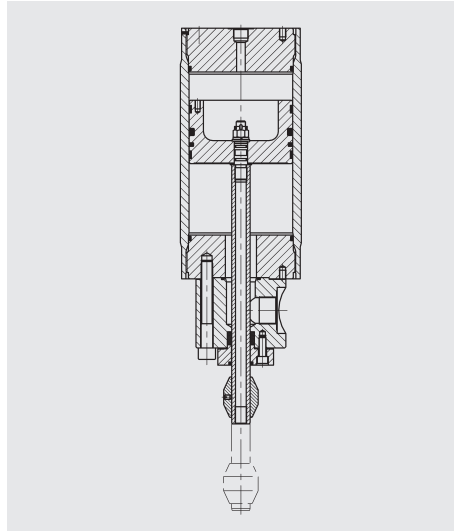
In another version, switching is carried out by inductive proximity switches.

The switch is reset by a spring or the force of gravity.

Vertical installation is preferable, due to the friction and possible wear in the rod guide. For limit switches with a stroke of >200 mm, vertical mounting with the gas side at the top is essential.

The maximum piston velocity must not exceed 0.5 m/s over the stroke range of the limit switch.

### 1.8.2 Protruding piston rod



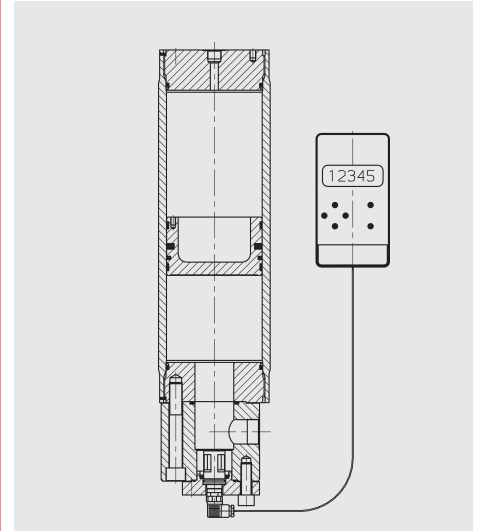
The protruding piston rod permits the position of the piston to be monitored over the whole stroke. It consists of the piston rod, which is fixed to the piston and sealed in, and what is known as the trip cam, which actuates the limit switches.

The position of the piston can be monitored at any point using the trip cam. This facility is used mainly to switch the pump on and off.

Normally the piston rod protrudes from the accumulator on the fluid side to avoid possible points of leakage on the gas side. On the protruding piston rod version, the hydraulic connection will be on the side if the size of the end cap does not permit otherwise.

The protruding piston rod functions in any mounting position. There must however be sufficient space available for the protruding piston rod to move in and out. The maximum piston velocity should not exceed 0.5 m/s.

### 1.8.3 Ultrasonic distance measurement



The ultrasonic measurement system uses ultrasonic measurement to determine the position of the piston in the accumulator.

It is only possible to take the measurements from the fluid side because a continuous sound carrier medium is required for ultrasound. In order to eliminate false readings, the fluid must be as free of air bubbles as possible. The piston should be mounted so that no air can collect under the sensor.

The measurement data is evaluated by a microprocessor and is converted into a continuous measurement signal. It is possible to pick up interim measurement results to switch system parts, e.g. to turn the pump on and off.

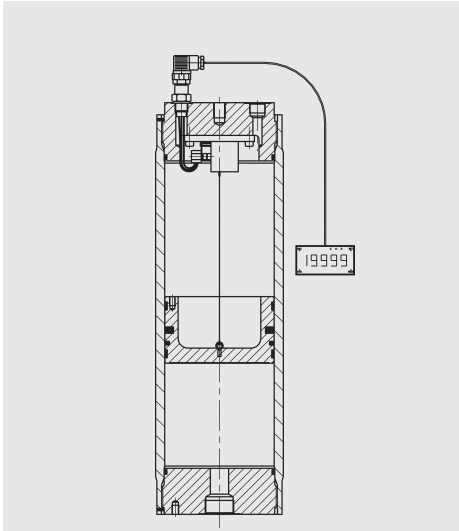
The most important features of the system are:

- Protection class  
IP65 according to DIN 40050
- LCD display
- Outputs
  - 5 floating relay change-over switches (with 125 V, 1A rating), of which 1 is error output and 4 are user-adjustable switching thresholds between 0 and 100 %
  - 4-20 mA

The maximum pressure for the sensor must not exceed 350 bar.

- Measuring frequency: 15 Hz
- Signal: no control signal
- max. measuring section: 5 m

### 1.8.4 Cable tension measurement system



Using the cable tension measurement system, the position of the piston can be determined by means of a cable which is fixed to the piston.

The cable is attached to a roller which is tensioned by a spring. This roller alters an electrical resistance via an attached rotary potentiometer during the piston movement. This resistance is converted by a transformer into an electrical signal so that it can be processed directly by a PLC system. The signal is supplied through the end cap via a pressure-tight cable gland. Alternatively various digital display units and measuring transducers can be connected.

- Digital display unit:
  - Supply voltage 230 V AC (or 24 V DC)
  - 4-channel limit comparator
  - 4 optical coupler outputs
  - 2 relay contact outputs
  - 1 RS 232 interface (optionally with analogue output 4 - 20 mA)
- Measuring transducer:
  - Supply voltage 24 V DC
  - Analogue output 4 - 20 mA

The maximum pressure must not exceed 350 bar. The piston acceleration is limited to certain values according to measurement system forces, approx. 7 to 30 g, and the piston velocity is limited to max. 0.5 m/s. The measuring system is not suitable for intensive load reversal or rapid fluctuations in volume.

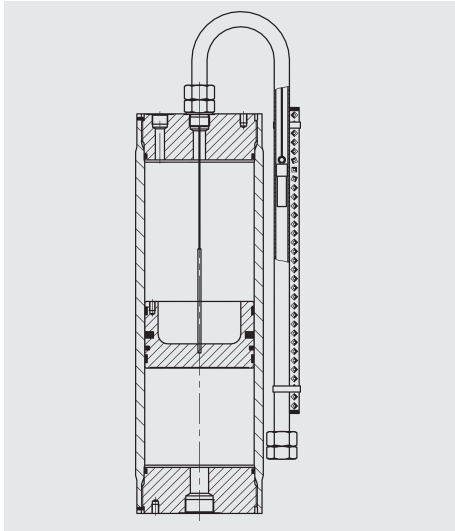
For such loads, please contact the technical department at our Head Office or your local HYDAC agent. The preferred installation position is with the gas side at the top.

The cable tension measurement system can only be fitted to the gas side of the piston accumulator.

#### Note:

For the potentiometer in the cable tension measurement system, as little current as possible should flow over the sliding contact. Input currents > 0.1 nA lead to a reduced service life and are therefore not recommended. The digital display unit and the measuring transducer have been designed accordingly.

### 1.8.5 Magnetic flapper indication



With magnetic flapper indication, the position of a piston can be determined by the colour indicated by a set of magnetic flaps which are visible externally.

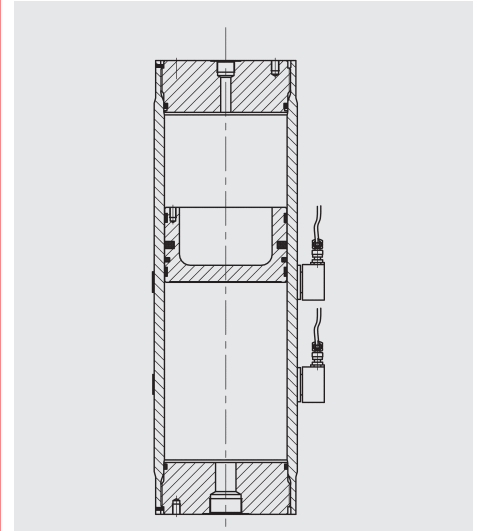
A non-magnetic tube is fitted to the piston accumulator containing a cable, one end of which is fastened to the gas side of the piston, and the other end is attached to a magnet. Along the length of the piston accumulator a housing is also fitted which contains red/white magnetic flaps.

As the magnet moves up or down its tube, the flaps turn to their opposite colour to indicate the piston's position.

When the piston moves towards the gas side, the indicator moves in the direction of the oil side. In addition, reed switches can be fitted to switch system parts or measurement scales can be fitted to the tube.

The maximum piston velocity must not exceed 0.5 m/s. No more than 5 cycles per day on average should be carried out. Piston accumulators with magnetic flapper indication must only be installed vertically, with the gas side at the top.

### 1.8.6 Piston position switch



With the piston position switch it is possible to detect the piston position in a piston accumulator using ultrasonic sound.

The indicator can be retrofitted using a clamp. No other modification is required. It is possible to fit without disrupting the operation.

The piston position switch detects the change-over from oil to piston at which point the signal is switched off. This is the case if the piston is in the sound path or has passed it.

There are three different versions available:

- Standard version for hydraulic fluid with a viscosity of up to 100 cSt.
- Special version for hydraulic fluid with a viscosity of 500 cSt.
- Special version for use in explosion protected areas.

Supply voltage  
18 ... 30 V DC  
Switching output:  
NPN (or PNP)

Detailed documentation for all piston position indicators is available on request.

## 2. TECHNICAL SPECIFICATIONS

### 2.1. EXPLANATORY NOTES

2.1.1 **Nominal volume [l]**  
see table at section 3.1.

2.1.2 **Eff. gas volume  $V_0$  [l]**  
These differ slightly from the nominal volume and form the basis of the calculations of the effective fluid volume.

See section 3.1.1.

2.1.3 **Effective volume  $\Delta V$  [l]**  
The volume (on the fluid side) between the working pressure  $p_2$  and  $p_1$ .

2.1.4 **Permitted operating temperature (fluid)**

-10 °C ... +80 °C

263 K ... 353 K

standard material, others on request

#### 2.1.5 Certificate codes

| Country          | Certificate code (AKZ) |
|------------------|------------------------|
| EU member states | U                      |
| Australia        | F <sup>1)</sup>        |
| Belarus          | A6                     |
| Canada           | S1 <sup>1)</sup>       |
| China            | A9                     |
| Hong Kong        | A9                     |
| Iceland          | U                      |
| Japan            | P                      |
| Korea (Republic) | A11                    |
| New Zealand      | T                      |
| Norway           | U                      |
| Russia           | A6                     |
| South Africa     | S2                     |
| Switzerland      | U                      |
| Turkey           | U                      |
| Ukraine          | A10                    |
| USA              | S                      |

<sup>1)</sup> Registration required in the individual territories or provinces.

others on request

### 2.2. MODEL CODE

Not all combinations are possible.

Order example. For further information, please contact HYDAC.

SK350 - 20 / 2212 U - 350 AAG - VA - 18 A - 1 - 050

Series

Nominal volume [l]

Material and piston code

Piston design (see section 1.3.)

Piston material

- 1 = aluminium
- 2 = carbon steel
- 3 = stainless steel <sup>1)</sup>

Material of cylinder and end caps

- 1 = carbon steel
- 2 = carbon steel with surface protection
- 3 = stainless steel <sup>1)</sup>
- 6 = carbon steel (low temperature)

Material of seals incl. piston seals

- 2 = NBR <sup>2)</sup> / PTFE compound
- 5 = NBR <sup>2)</sup> / PTFE compound
- 6 = FKM / PTFE compound
- 8 = NBR <sup>2)</sup> / PUR
- 9 = special qualities

Certification code

- U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Fluid connection

Type of connection (see Table 1)

Standard or specification of the type of connection (see Tables 2 + 3)

Size of connection (see Tables 4 + 5)

Gas-side connection or gas valve

Type of connection (see Table 1)

Standard or specification of the type of connection (see Tables 2 + 3)

(no letter required with connection type V)

Size of connection (see Tables 4; 5 + 6)

Piston diameter

- 04 = 40 mm
- 05 = 50 mm
- 06 = 60 mm
- 08 = 80 mm
- 10 = 100 mm
- 12 = 125 mm
- 15 = 150 mm
- 18 = 180 mm
- 20 = 200 mm
- 25 = 250 mm
- 31 = 310 mm
- 35 = 355 mm
- 49 = 490 mm
- 54 = 540 mm
- 61 = 610 mm

Supplementary equipment\*

- A = electrical limit switch – 35 mm stroke
- B = electrical limit switch – 200 mm stroke
- C = electrical limit switch – 500 mm stroke
- K = protruding piston rod
- M = magnetic flapper indication
- S = cable tension measurement system
- U = ultrasonic measurement system
- E.. = special switch fixed or adjustable
- P = magnetic piston
- UP.. = piston position switch  
(e.g. UP2 = 2 position switches, UPEX = ATEX version)
- W = limit switch with linear distance sensor

Safety equipment\*

- 1 = burst disc (please give nominal pressure and temperature)
- 2 = gas safety valve
- 3 = temperature fuse

Pre-charge pressure  $p_0$  [bar] at 20 °C\*

\* if required, please state at time of ordering!

<sup>1)</sup> dependent on type and pressure level

<sup>2)</sup> observe temperature ranges, see section 1.7.

**Table 1, Connection type**

| Code letter | Description                                 |
|-------------|---|
| A           | Threaded connection (female)                |
| B           | Threaded connection (male)                  |
| F           | Flange connection                           |
| H           | Protruding flange                           |
| K, S        | Combination connection / Special connection |
| V           | Gas valve type                              |

**Table 2, Threaded connection: standard or specification**

| Code letter | Description                                    |
|-------------|--|
| A           | Thread to ISO 228 (BSP)                        |
| B           | Thread to DIN 13 or ISO 965/1 (metric)         |
| C           | Thread to ANSI B1.1 (UN...-2B, seal SAE J 514) |
| D           | Thread to ANSI B1.20.3 (NPTF)                  |

**Table 3, Flange connection: standard or specification**

| Code letter | Description  |
|-------------|--|
| A           | Flanges to DIN standards (pressure range + standard) |
| B           | Flanges to ANSI B 16.5                               |
| C           | SAE flange 3000 psi                                  |
| D           | SAE flange 6000 psi                                  |
| E           | High pressure block flange (Bosch-Rexroth) PN320     |
| F           | High pressure block flange (AVIT, HAVIT) PN320       |

**Table 4, Threaded model connection sizes**

| Type.<br>Table 2 | Code, size     |               |                |               |                |               |                  |                      |                     |                  |                 |
|------------------|----------------|---------------|----------------|---------------|----------------|---------------|------------------|----------------------|---------------------|------------------|-----------------|
|                  | A              | B             | C              | D             | E              | F             | G                | H                    | J                   | K                | L               |
| A                | G 1/8          | G 1/4         | G 3/8          | G 1/2         | G 3/4          | G 1           | G 1 1/4          | G 1 1/2              | G 2                 | G 2 1/2          | G 3             |
| B                | M10x1          | M12x1.5       | M14x1.5        | M16x1.5       | M18x1.5        | M22x1.5       | M27x2            | M33x2                | M42x2               | M48x2            | M60x2           |
| C                | 5/16-<br>24UNF | 3/8-<br>24UNF | 7/16-<br>20UNF | 1/2-<br>20UNF | 9/16-<br>18UNF | 3/4-<br>16UNF | 7/8-<br>14UNF    | 1 1/16-<br>12UNF     | 1 3/16-<br>12UNF    | 1 5/16-<br>12UNF | 1 5/8-<br>12UNF |
| D                | 1/16-<br>NPTF  | 1/8-<br>NPTF  | 1/4-<br>NPTF   | 3/8-<br>NPTF  | 1/2-<br>NPTF   | 3/4-<br>NPTF  | 1-11 1/2<br>NPTF | 1 1/4-11 1/2<br>NPTF | 11/2-11 1/2<br>NPTF | 2-11 1/2<br>NPTF | 2 1/2 -<br>NPTF |

**Table 5, Flange model connection sizes**

| Type.<br>Table 2 | Code, size         |                  |                      |                  |                      |                  |                    |                  |                      |                  |                      |
|------------------|--------------------|------------------|----------------------|------------------|----------------------|------------------|--------------------|------------------|----------------------|------------------|----------------------|
|                  | A                  | B                | C                    | D                | E                    | F                | G                  | H                | J                    | K                | L                    |
| A                | DN15               | DN25             | DN40                 | DN50             | DN65                 | DN80             | DN100              | DN125            | DN150                | DN200            | –                    |
| B                | 1/2" -<br>1500 psi | 1" -<br>1500 psi | 1 1/2" -<br>1500 psi | 2" -<br>1500 psi | 2 1/2" -<br>1500 psi | 3" -<br>1500 psi | 1/2" -<br>2500 psi | 1" -<br>2500 psi | 1 1/2" -<br>2500 psi | 2" -<br>2500 psi | 2 1/2" -<br>2500 psi |
| C                | 1/2"               | 3/4"             | 1"                   | 1 1/4"           | 1 1/2"               | 2"               | 2 1/2"             | 3"               | 3 1/2"               | 4"               | 5"                   |
| D                |                    |                  |                      |                  |                      |                  | –                  | –                | –                    | –                | –                    |
| E                | DN32               | DN40             | DN50                 | DN65             | DN80                 | DN100            | DN125              | DN150            | –                    | DN25             | –                    |
| F                |                    |                  |                      |                  |                      |                  |                    |                  |                      |                  |                      |

**Table 6, Gas valve models**

| Code letter | Description  |
|-------------|--|
| A           | Gas valve G 3/4 male, with M28x1.5/M8                  |
| B           | Gas valve end connection M28x1.5/M8                    |
| C           | Gas valve 1/2"-20 UNF, male, with M16x2 (ISO 10945)    |
| D           | Gas valve M14x1.5 male with external M16x1.5 (Minimes) |
| E           | Gas valve G 3/4 male with 7/8-14 UNF-VG8               |
| F           | Gas valve end connection M42x1.5/M12                   |

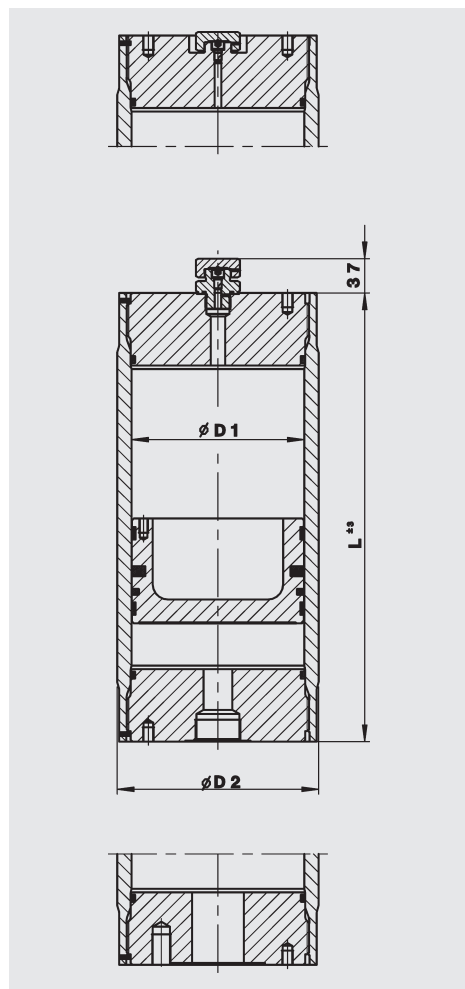
**Note:**

Application examples, accumulator dimensioning and extracts from approvals regulations relating to hydraulic accumulators can be found in the following catalogue section:

- HYDAC Accumulator Technology  
No. 3.000

### 3. DIMENSIONS

#### 3.1. PISTON ACCUMULATORS



| Nominal volume V<br>min. - max. | Series | Perm. operating pressure (PED)<br>[bar] | $\varnothing D1$<br>[mm] | $\varnothing D2$<br>[mm] | Length calculation <sup>1)</sup><br>$L = a + (b \cdot V)$ |             | Weight <sup>2)</sup><br>min. - max.<br>[kg] |
|---------------------------------|--------|---|--------------------------|--------------------------|---|-------------|---|
|                                 |        |   |                          |                          | a<br>[mm]   | b<br>[mm/l] |   |
| 0.2 – 5                         | SK350  | 350                                     | 60                       | 80                       | 126   | 353.7       | 6 – 35                                      |
| 0.5 – 10                        | SK350  | 350                                     | 80                       | 100                      | 157   | 198.9       | 11 – 48                                     |
| 0.5 – 15                        | SK350  | 350                                     | 100                      | 125                      | 184   | 127.3       | 19 – 85                                     |
| 1 – 50                          | SK350  | 350                                     | 125                      | 160                      | 185   | 81.5        | 32 – 280                                    |
| 2.5 – 70                        | SK210  | 210                                     | 150                      | 180                      | 210   | 56.6        | 45 – 280                                    |
|                                 | SK350  | 350                                     |                          |                          | 234   |             | 49 – 283                                    |
| 2.5 – 100                       | SK210  | 210                                     | 180                      | 210                      | 262   | 39.3        | 70 – 346                                    |
|                                 | SK350  | 350                                     |                          | 220                      |   |             | 79 – 458                                    |
| 2.5 – 200                       | SK210  | 210                                     | 200                      | 235                      | 290   | 31.8        | 86 – 452                                    |
|                                 | SK350  | 350                                     |                          |                          |   |             |   |
| 10 – 200                        | SK210  | 210                                     | 250                      | 286                      | 408   | 20.4        | 170 – 631                                   |
|                                 | SK350  | 350                                     |                          | 300                      |   |             | 200 – 860                                   |
| 25 – 400                        | SK350  | 350                                     | 310                      | 350                      | 462   | 13.2        | 390 – 1110                                  |
| 25 – 750                        | SK210  | 210                                     | 355                      | 404                      | 534   | 10.1        | 468 – 1338                                  |
|                                 | SK350  | 350                                     |                          | 434                      |   |             | 590 – 2048                                  |
| 200 – 1300                      | SK210  | 210                                     | 490                      | 570                      | 700   | 5.3         | 1760 – 3180                                 |
|                                 | SK350  | 350                                     |                          |                          |   |             |   |
| 300 – 3300                      | SK210  | 210                                     | 610                      | 691                      | 856   | 3.42        | 2500 – 11000                                |
|                                 | SK350  | 350                                     |                          | 710                      |   |             |   |

<sup>1)</sup> The lengths calculated are usually rounded up or down in 5 mm increments

<sup>2)</sup> Intermediate weights can be calculated approximately depending on the length/diameter required

Other pressures, volumes, approvals etc possible on request.

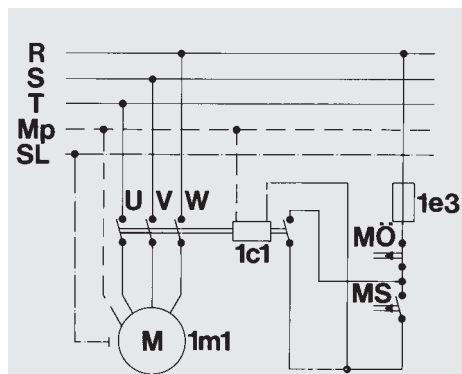
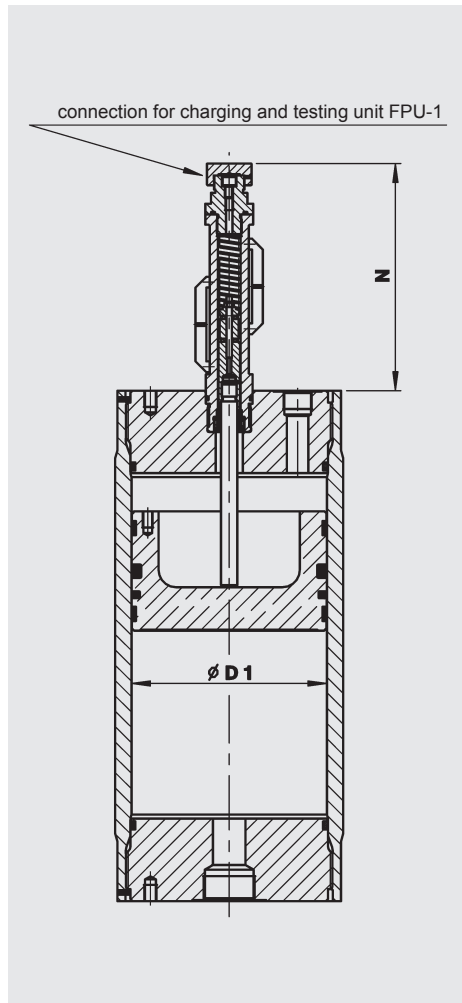
#### 3.1.1 Effective gas volume $V_0$

The gas volume  $V$  is larger than the nominal volume given in the tables in section 3.1. by the amount shown below.

| Piston $\varnothing D1$<br>[mm] | Piston design type |        |       |        |
|---------------------------------|--------------------|--------|-------|--------|
|                                 | 1                  | 2      | 3     | 4      |
|                                 | $\Delta$ [l]       |        |       |        |
| 60                              | –                  | 0.040  | –     | 0.040  |
| 80                              | –                  | 0.044  | 0.081 | 0.044  |
| 100                             | 0.062              | 0.062  | 0.270 | 0.062  |
| 125                             | –                  | 0.169  | 0.546 | 0.169  |
| 150                             | –                  | 0.653  | 0.824 | 0.653  |
| 180                             | 1.213              | 1.213  | 1.286 | 1.213  |
| 200                             | –                  | 0.999  | 1.601 | 0.999  |
| 250                             | 3.034              | 3.034  | 2.617 | 3.034  |
| 310                             | –                  | 6.221  | –     | 6.221  |
| 355                             | 4.514              | 4.514  | –     | 4.514  |
| 490                             | –                  | 12.705 | –     | 12.705 |



### 3.2. PISTON ACCUMULATOR WITH ELECTRICAL LIMIT SWITCH



- 1m1 = Motor
- 1c1 = Motor contactor
- 1e3 = Control cut-out
- Mö = Solenoid switch – N/C
- Ms = Solenoid switch – N/O

| Nominal volume <sup>1)</sup> | Series | Certification code U |                                   |                                     |                                      |                    |            |                    |            |                    |
|------------------------------|--------|----------------------|-----------------------------------|-------------------------------------|--------------------------------------|--------------------|------------|--------------------|------------|--------------------|
|                              |        | Ø D1                 | Gas-side connection <sup>2)</sup> | Fluid-side connection <sup>3)</sup> | Electrical limit switch stroke       |                    |            |                    |            |                    |
|                              |        |                      |                                   |                                     | A = 35 mm                            |                    | B = 200 mm |                    | C = 500 mm |                    |
| [l]                          | [mm]   | ISO228               | N                                 | addit. weight [kg]                  | N                                    | addit. weight [kg] | N          | addit. weight [kg] | N          | addit. weight [kg] |
| 0.2                          | SK350  | 60                   | -                                 | -                                   | Electrical limit switch not possible |                    |            |                    |            |                    |
| 0.5                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 1                            |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 0.5                          | SK350  | 80                   | -                                 | -                                   | Electrical limit switch not possible |                    |            |                    |            |                    |
| 1                            |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 2                            |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 2.5                          | SK350  | 100                  | G 3/4 lateral                     | G 1                                 | 209                                  | 2.55               | 439        | 4.85               | 679        | 7.15               |
| 5                            |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 7.5                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 2                            | SK350  | 125                  | G 3/4 lateral                     | G 1                                 | 209                                  | 2.55               | 439        | 4.85               | 679        | 7.15               |
| 5                            |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 15                           |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 6                            | SK350  | 150                  | G 3/4                             | G 1 1/2                             | 209                                  | 2.6                | 439        | 4.9                | 679        | 7.2                |
| 20                           |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 40                           |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 10                           | SK210  | 180                  | G 1                               | G 1 1/2                             | 209                                  | 2.6                | 439        | 4.9                | 679        | 7.2                |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 20                           | SK210  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 50                           | SK210  | 250                  | G 1 1/4                           | G 2                                 | 209                                  | 2.8                | 439        | 5.1                | 679        | 7.4                |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 80                           | SK210  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 120                          | SK210  | 310                  | G 1 1/4                           | NW50                                | 209                                  | 2.9                | 439        | 5.2                | 679        | 7.5                |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 120                          | SK210  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
|                              | SK350  |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 150                          | SK350  | 355                  | G 1 1/2                           | NW50                                | 209                                  | 2.8                | 439        | 5.1                | 679        | 7.4                |
| 130                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
|                              |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
|                              |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 180                          | SK350  | 490                  | G 2                               | -                                   | 209                                  | 3                  | 439        | 5.3                | 679        | 7.6                |
| 250                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 200                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |
| 600                          |        |                      |                                   |                                     |                                      |                    |            |                    |            |                    |

<sup>1)</sup> volume details are examples, for others see section 3.1.  
<sup>2)</sup> standard connection for back-up type, others on request  
<sup>3)</sup> others on request  
for further information, see section 1.7.

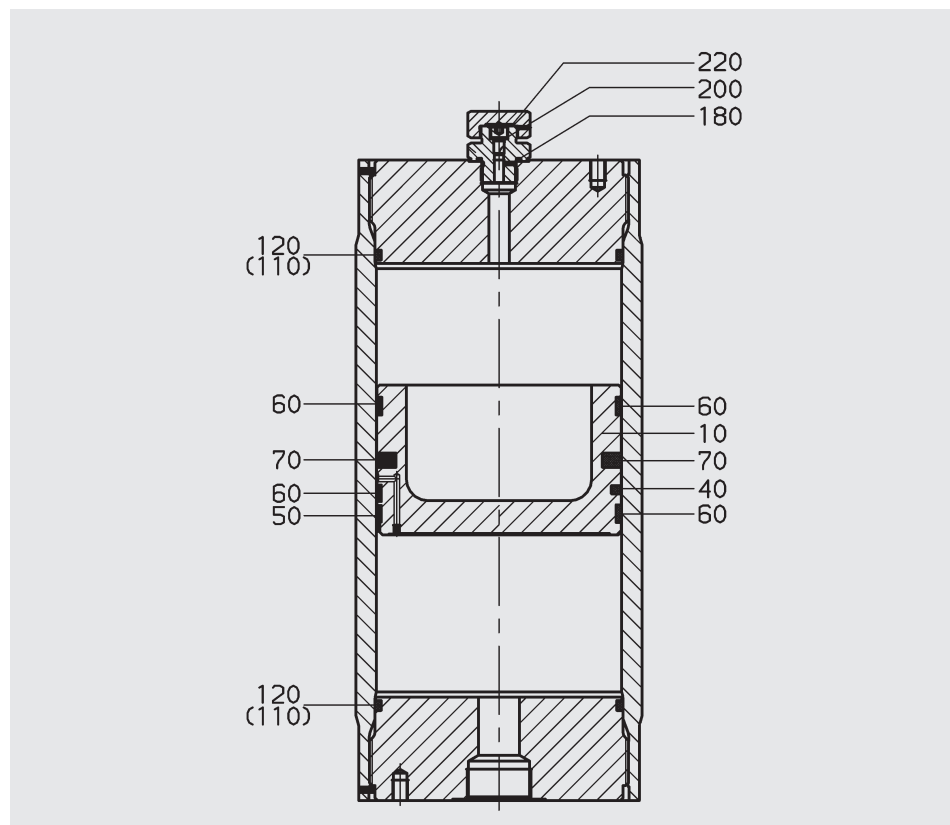
**Table 7, Supplementary seal**

| Piston Ø [mm] | Type | NBR Part no. | FKM Part no. |
|---------------|------|--------------|--------------|
| all diameters | 1    | 601078       | 601109       |
|               | 2    |              |              |
|               | 3    |              |              |
|               | 4    | on request   |              |

**Note:**  
The supplementary seal must be ordered in addition to the seal kit (section 4.).

## 4. SPARE PARTS

### 4.1. PISTON ACCUMULATORS



**Piston assembly (Table 8)**

| Piston Ø [mm] | Piston | NBR Part no. | FPM Part no. | PUR Part no. |
|---------------|--------|--------------|--------------|--------------|
| 60            | 1      | -            | -            | -            |
|               | 2      | 3183495      | -            | -            |
|               | 3      | -            | -            | 3009372      |
| 80            | 1      | -            | -            | -            |
|               | 2      | 3183496      | 3183497      | -            |
|               | 3      | -            | -            | 2119931      |
| 100           | 1      | 3128922      | 3128926      | -            |
|               | 2      | 3175476      | 3183117      | -            |
|               | 3      | -            | -            | 2115547      |
| 125           | 1      | -            | -            | -            |
|               | 2      | 3016232      | 3016253      | -            |
|               | 3      | -            | -            | 3016150      |
| 150           | 1      | -            | -            | -            |
|               | 2      | 3016228      | 3016229      | -            |
|               | 3      | -            | -            | 3016231      |
| 180           | 1      | 3141888      | 3182493      | -            |
|               | 2      | 2118451      | 2112535      | -            |
|               | 3      | -            | -            | 3046277      |
| 200           | 1      | -            | -            | -            |
|               | 2      | 3110811      | 3016215      | -            |
|               | 3      | -            | -            | 3016218      |
| 250           | 1      | 3128924      | 3128938      | -            |
|               | 2      | 353980       | 353981       | -            |
|               | 3      | -            | -            | 3016171      |
| 310           | 1      | -            | -            | -            |
|               | 2      | 3016195      | 3016197      | -            |
|               | 3      | -            | -            | -            |
| 355           | 1      | 3128925      | 3128939      | -            |
|               | 2      | 356382       | 354079       | -            |
|               | 3      | -            | -            | -            |
| 490           | 1      | -            | -            | -            |
|               | 2      | 3128989      | 3128990      | -            |
|               | 3      | -            | -            | -            |

**Seal kit assembly (Table 9)**

| Piston Ø [mm] | Piston | NBR Part no. | FPM Part no. | PUR Part no. |
|---------------|--------|--------------|--------------|--------------|
| 60            | 1      | -            | -            | -            |
|               | 2      | 3090507      | -            | -            |
|               | 3      | -            | -            | 3016210      |
| 80            | 1      | -            | -            | -            |
|               | 2      | 3041573      | 3015745      | -            |
|               | 3      | -            | -            | 3013230      |
| 100           | 1      | 3128940      | 3128944      | -            |
|               | 2      | 363268       | 363269       | -            |
|               | 3      | -            | -            | 2123414      |
| 125           | 1      | -            | -            | -            |
|               | 2      | 3116665      | 3016234      | -            |
|               | 3      | -            | -            | 2128104      |
| 150           | 1      | -            | -            | -            |
|               | 2      | 3016235      | 3016237      | -            |
|               | 3      | -            | -            | 3007546      |
| 180           | 1      | 3128941      | 3128945      | -            |
|               | 2      | 363270       | 363271       | -            |
|               | 3      | -            | -            | 2123415      |
| 200           | 1      | -            | -            | -            |
|               | 2      | 3110810      | 3016242      | -            |
|               | 3      | -            | -            | 3113127      |
| 250           | 1      | 3128942      | 3128946      | -            |
|               | 2      | 363266       | 363267       | -            |
|               | 3      | -            | -            | 3016213      |
| 310           | 1      | -            | -            | -            |
|               | 2      | 3016200      | 3016201      | -            |
|               | 3      | -            | -            | -            |
| 355           | 1      | 3128943      | 3128947      | -            |
|               | 2      | 363272       | 363273       | -            |
|               | 3      | -            | -            | 3726888      |
| 490           | 1      | -            | -            | -            |
|               | 2      | 3104100      | 3128991      | -            |
|               | 3      | -            | -            | 3894300      |

#### 4.1.1 Piston type 1

| Designation  | Qty. | Item  |
|--|------|-------|
| <b>Piston assembly <sup>2)</sup></b><br>consisting of: |      |       |
| Piston   | 1    | 10    |
| Seal ring  | 1    | 50    |
| Guide ring   | 2    | 60    |
| Centre seal  | 1    | 70    |
| <b>Seal kit assembly</b><br>consisting of:             |      |       |
| Seal ring  | 1    | 50    |
| Guide ring   | 2    | 60    |
| Centre seal  | 1    | 70    |
| (Support ring)   | (2)  | (110) |
| O-ring   | 2    | 120   |
| O-ring   | 1    | 180   |
| Seal ring  | 1    | 200   |
| O-ring   | 1    | 220   |

#### 4.1.2 Piston type 2

| Designation  | Qty. | Item  |
|--|------|-------|
| <b>Piston assembly <sup>2)</sup></b><br>consisting of: |      |       |
| Piston   | 1    | 10    |
| Seal ring  | 1    | 40    |
| Guide ring   | 2    | 60    |
| Centre seal  | 1    | 70    |
| <b>Seal kit assembly</b><br>consisting of:             |      |       |
| Seal ring  | 1    | 40    |
| Guide ring   | 2    | 60    |
| Centre seal  | 1    | 70    |
| (Support ring)   | (2)  | (110) |
| O-ring   | 2    | 120   |
| O-ring   | 1    | 180   |
| Seal ring  | 1    | 200   |
| O-ring   | 1    | 220   |

#### 4.1.3 Piston type 3

| Designation  | Qty. | Item  |
|--|------|-------|
| <b>Piston assembly <sup>2)</sup></b><br>consisting of: |      |       |
| Piston   | 1    | 10    |
| Guide ring <sup>1)</sup>                               | 1/2  | 60    |
| Seal ring  | 1    | 70    |
| <b>Seal kit assembly</b><br>consisting of:             |      |       |
| Guide ring <sup>1)</sup>                               | 1/2  | 60    |
| Seal ring  | 1    | 70    |
| (Support ring)   | (2)  | (110) |
| O-ring   | 2    | 120   |
| O-ring   | 1    | 180   |
| Seal ring  | 1    | 200   |
| O-ring   | 1    | 220   |

(...) for SK690, for standard SK internal Ø ≥ 310 mm  
<sup>1)</sup> the bottom guide ring only for internal Ø = 180 mm and above

<sup>2)</sup> Items (110,) 120, 180, 200 and 220 are supplied loose. Pressure resistant parts cannot be supplied as spares.

Spare parts for piston type 4 are available on request.

## 4.2. ASSEMBLY INSTRUCTIONS

Before assembling or disassembling a piston accumulator or piston accumulator station, the system must always be depressurised.

The gas and the fluid side must be depressurised and the gas valve unscrewed or opened before the accumulator is disassembled. Before the end caps are removed, ensure that the piston is moving freely. This may be achieved by using a rod. Only authorised persons should repair piston accumulators where the piston is jammed.

Piston accumulators with internal diameters up to 250 mm are fitted with a securing pin. This pin is to prevent the end cap being removed incorrectly. It must be taken out before removing the end cap.

There may be a danger to life due to stray components.

All work must only be carried out by suitably trained specialist staff.

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell.

**The operating instruction must be followed!**

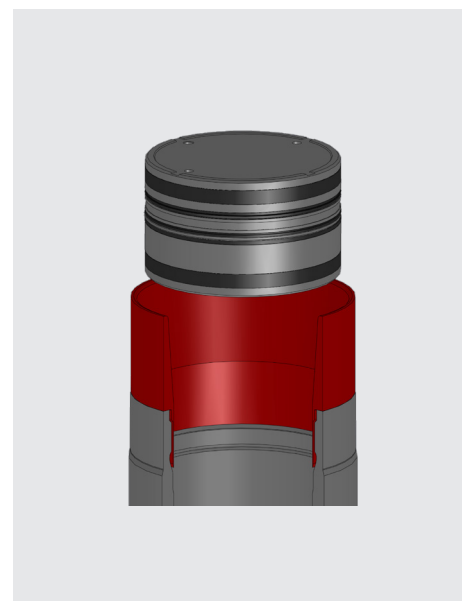
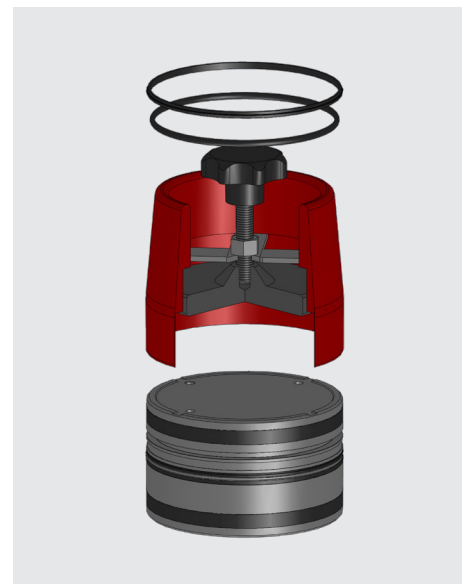
**No. 3.301.BA**

### Assembly sleeves for piston accumulators (Table 11)

| Piston Ø [mm] | to fit the seals |
|---------------|------------------|
| 60            | 297430           |
| 80            | 244991           |
| 100           | 352198           |
| 125           | 370734           |
| 150           | 2124157          |
| 180           | 3713269          |
| 200           | 3644938          |
| 250           | 3715658          |
| 310           | 3721000          |
| 355           | 3728790          |
| 490           | 3114220          |

| Piston Ø [mm] | to install the piston               |
|---------------|-------------------------------------|
| 60            | 2120188                             |
| 80            | 359614                              |
| 100           | 290056 (M105x2)<br>2117672 (M110x3) |
| 125           | 2128223                             |
| 150           | 2124161 (SK210)<br>3680195 (SK350)  |
| 180           | 290049 (M186x3)<br>3028679 (M190x4) |
| 200           | 3600690                             |
| 250           | 3026807                             |
| 310           | 3027403                             |
| 355           | 3389677                             |
| 490           | 3440695                             |

**When replacing seals and/or pistons, please read the Instructions for Assembly and Repair (No. 3.301.M).**



## 5. NOTE

The information in this brochure relates to the operating conditions and applications described.

For applications and operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

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