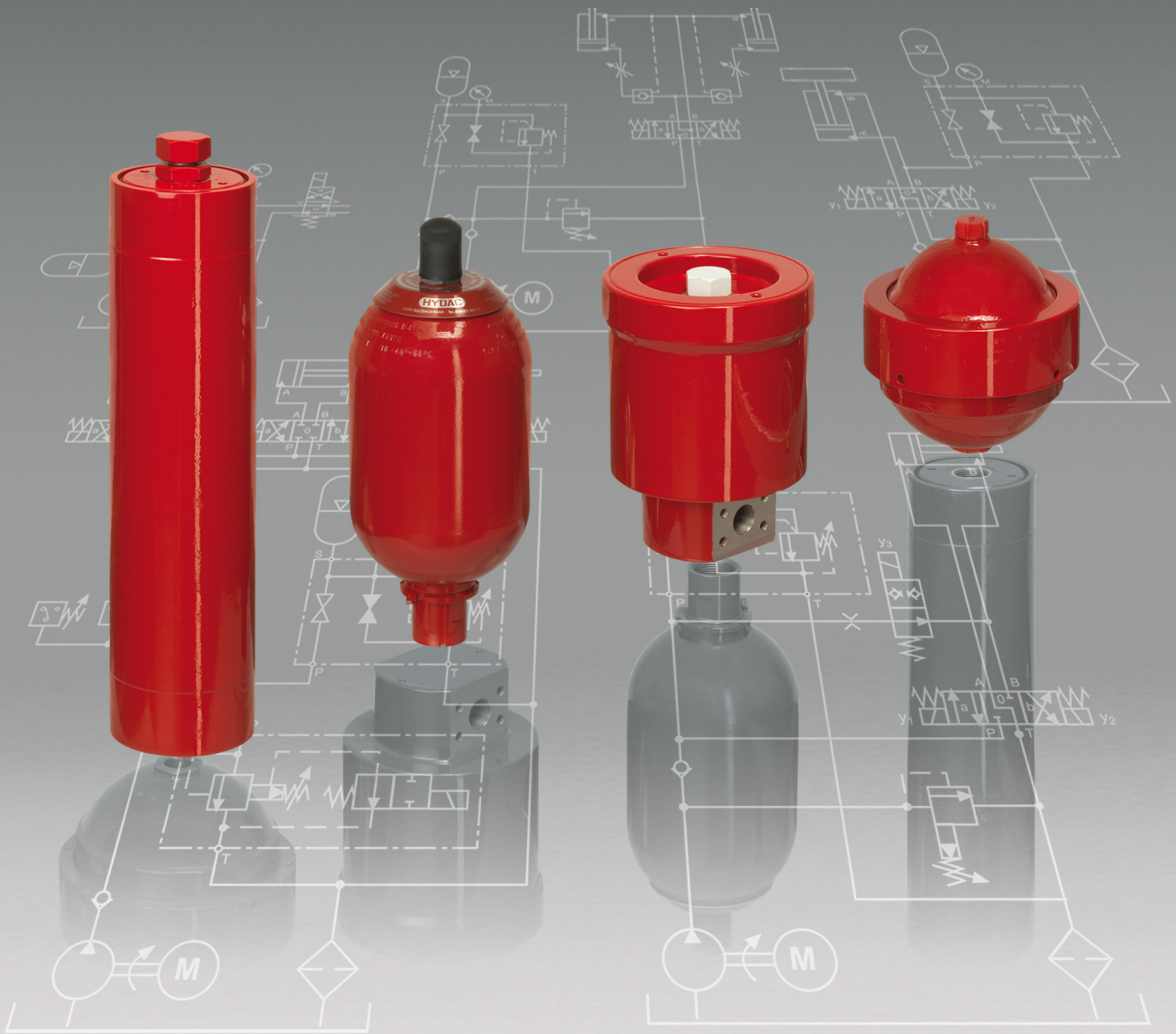
HYDAC INTERNATIONAL

Accumulator Technology. Product Catalogue.



HYDAC Accumulator Technology. Product Catalogue.

E 30.000.3/03.16

1. HYDAC ACCUMULATOR TECHNOLOGY FLUID ENGINEERING EFFICIENCY VIA ENERGY MANAGEMENT.

HYDAC Accumulator Technology has over 50 years' experience in research & development, design and production of Hydac accumulators.

Bladder, piston, diaphragm and metal bellows accumulators from HYDAC together form an unbeatable range and as components or units, support hydraulic systems in almost all sectors.

The main applications of our accumulators are:

- Energy storage,
- Emergency and safety functions,
- Damping of vibrations, fluctuations, pulsations (pulsation damper), shocks (shock absorber) and noise (silencer),
- Suction flow stabilisation,
- Media separation,
- Volume and leakage oil adjustment,
- Weight equalization,
- Energy recovery.

Using accumulators improves the performance of the whole system and in detail this has the following benefits:

- Improvement in the functions
- Increase in service life
- Reduction in operating and maintenance costs
- Reduction in pulsations and noise

On the one hand, this means greater safety and comfort for operator and machine.

On the other hand, HYDAC accumulators enable efficient working in all applications.

Basic criteria, such as:

- Design pressure,
- Design temperature,
- Fluid displacement volume,
- Discharge / Charging velocity,
- Fluid,
- Acceptance specifications and also
- Installation options

are important parameters required for sizing the correct accumulator.

In addition the knowledge developed by our accumulator specialists will help to select the right type of accumulator. The comprehensive range of HYDAC accessories simplifies installation and maintenance according to the specification.

2. QUALITY

Quality, safety and reliability are paramount for all HYDAC accumulator components.

They comply with the current regulations (or standards) for pressure vessels in the individual countries of installation.

In taking delivery of a HYDAC hydraulic accumulator therefore, the customer is assured of a high-quality accumulator product which can be used in every country in the world, depending on the certification.

For more details, please turn to Section 4.

All the processes involved, from development, engineering and production to approval and delivery are defined by HYDAC's certified management system and the relevant international accreditation for the manufacture of pressure vessels.

In conjunction with the customer service department at HYDAC's headquarters, service is possible worldwide.

HYDAC's worldwide distributor network means that trained staff are close at hand to help our customers.

This ensures that HYDAC customers have the support of an experienced workforce both before and after sale.

3. SAFETY INFORMATION

Accumulators are closed vessels which are designed and built to hold pressurized fluids. They are charged with nitrogen which is separated from the fluid section by a piston, bladder or diaphragm. Hydraulic accumulators are exclusively designed to store and then discharge pressure fluids.

The regulations for commissioning and operating hydraulic accumulators which are in force at the place of installation must be observed. The plant operator is solely responsible for ensuring compliance with these regulations.

Relevant instructions are provided in the Operating Manuals for our products.

Manufacturers of hydraulic accumulators and products must observe the following principles:

- Removal or reduction of risks, insofar as this is reasonably possible,
- Application of appropriate protective measures against risks which cannot be eliminated,
- If required, training of the users on the residual risks and instructions on appropriate special measures for reducing the risks during installation and/or operation.

For safe handling and operation, the operator must draw up a risk assessment for the installation site, particularly in combination with other components and risks.

The resulting measures must be implemented accordingly.

In the case of fundamental risks affecting hydraulic accumulators, e.g.

- Excessive pressure and
- Increase in temperature (in the event of fire)

we already have the relevant products available.

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely vented. Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

3.1. RISK OF EXCESSIVE PRESSURE

Products:

Safety and shut-off block for the fluid side in various sizes and versions.

See catalogue section:

- Safety and Shut-off Block SAF/DSV No. 3.551

Gas safety valve and gas safety block for the gas side

Bursting discs for gas and fluid sides

See catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552

3.2. RISK OF RISE IN TEMPERATURE

Products:

Safety and Shut-off Block with solenoid-operated valve (open when de-energised) in conjunction with temperature monitoring.

See catalogue section:

- Safety and shut-off block SAF/DSV No. 3.551 or on request

Temperature fuses

See catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552

4. REGULATIONS

4.1. EUROPEAN PRESSURE EQUIPMENT DIRECTIVE (PED)

The European Directive 2014/68/EU will come into effect in July 2016. It will replace Directive 97/23/EC and will govern the design, fabrication, conformity assessment and placing on the market of pressure equipment and assemblies with a maximum permitted pressure of more than 0.5 bar. It guarantees free movement of goods within the European Community. The EU member states must not prohibit, restrict or obstruct the placing on the market and the commissioning of pressure equipment on account of pressure-related hazards, if the equipment complies with the requirements of the pressure equipment directive and has the CE mark, and is subject to a conformity assessment.

Hydraulic accumulators with a capacity of **V ≤ 1 litre**, a maximum permitted pressure **PS ≤ 1000 bar** and a pressure capacity **PS • V ≤ 50 bar • l** for gases of fluid group 2 (non-hazardous fluids) are subject to Article 3, section 3 of the European Pressure Equipment Directive and do not receive the CE mark.

Inspection of the equipment and installation, operational safety and repeat testing are controlled as before by national laws.

The equipment relating to safety is described in AD2000, ISO 4126 and EN 14359.
The repeat testing intervals are stipulated in the new German health & safety regulations.

4.2. OTHER REGULATIONS

Pressure accumulators which are installed overseas (outside the EU), are supplied with the relevant test certificates required in the country of installation.

HYDAC pressure vessels can be supplied with virtually any test certificate.

Depending on the authority, the different material requirements must be observed

Details of some selected approvals are as follows:

4.2.1 CERTIFICATE CODE = S (ASME)

Since 1985, HYDAC Technology GmbH has been authorized to label pressure equipment that was manufactured in compliance with the ASME regulations with the "ASME" certification mark.

U

Such pressure vessels may be placed on the market in the jurisdiction (application area) of "The National Board of Boiler and Pressure Vessel Inspectors".

4.2.2 CERTIFICATE CODE = P (KHK certificate)

For the Japanese market, HYDAC Technology GmbH has had approval as a "Self Inspecting Manufacturer" since the year 2000. Consequently, HYDAC is authorized to manufacture and test pressure vessels for the Japanese market and to import them into Japan.

4.2.3 CERTIFICATE CODE = A9 (MANUFACTURER LICENSING CHINA)

Since 1998 HYDAC Technology GmbH has had approval from the Chinese authority "SELO" as a manufacturer of pressure vessels and valves. HYDAC is therefore authorized to import welded bladder, piston and diaphragm accumulators, and safety valves, into the Chinese market.

4.2.4 CERTIFICATE CODE = A11 (KGS code)

Since concluding the registration procedure in 2012 HYDAC Technology GmbH is authorized to place pressure vessels and safety equipment on the Korean market according to the Korean Gas Safety (KGS) Code for Korea.

4.2.5. CERTIFICATE CODE = A6 (TR-CU)

Since 2014, regulation TR-CU 032/2014 (technical regulation of the customs union "On the safety of pressure equipment") has applied for the countries of the Eurasian Economic Community.

HYDAC Technology GmbH has been certified in accordance with the regulation to supply its product range.

4.3. CERTIFICATE TABLE

The following table lists the codes recommended for use in the model code for different countries of installation.

The country of installation must be stated at the time of ordering (see code in Model Code for the particular product: Certificate Code).

For those countries not listed, please consult HYDAC. Alternative certificates and variations are also possible. Please consult HYDAC.

European member states and EFTA states	Certificate code (AKZ)
Austria	U
Belgium	
Bulgaria	
Cyprus	
Czech Republic	
Denmark	
Estonia	
Finland	
France	
Germany	
Great Britain	
Greece	
Hungary	
Iceland	
Ireland	
Italy	
Latvia	
Lithuania	
Luxembourg	
Malta	
Netherlands	
Norway	
Poland	
Portugal	
Romania	
Slovakia	
Slovenia	
Spain	
Sweden	
Switzerland	

Selection of other countries	Certificate code (AKZ)
Australia	F [1)]
Belarus	A6
Canada	S1 [1)]
China	A9
Hong Kong	A9
Japan	P
Korea (Republic)	A11
New Zealand	T
Russia	A6
South Africa	S2
Turkey	U
Ukraine	A10
USA	S

[1)] Registration required in the individual territories or provinces

others on request

4.4. TRANSPORT REGULATIONS FOR PRESSURE VESSELS

The transport of gas-filled accumulators must be carried out with the utmost care and in compliance with all relevant transport safety regulations (e.g. in the public domain, dangerous goods regulations, etc.).

5. PRODUCT OVERVIEW

The following overview shows the standard product range of HYDAC hydraulic accumulators.
For other models and sizes please ask.

5.1. BLADDER ACCUMULATORS

5.1.1 **Low Pressure**
Permitted operating pressure:
up to 40 bar

Nominal volume:
2.5 ... 450 l

5.1.2 **Standard**
Permitted operating pressure:
up to 550 bar

Nominal volume:
0.5 ... 200 l

5.1.3 **High pressure**
Permitted operating pressure:
up to 1000 bar

Nominal volume:
1 ... 54 l

Benefits of HYDAC bladder accumulators:

- high discharge velocities,
- no pressure differential between fluid side and gas side,
- compact, low-maintenance,
- high charge and discharge frequencies.

5.2. PISTON ACCUMULATORS

5.2.1 **Standard**
Permitted operating pressure:
210 ... 350 bar

Nominal volume:
up to 3300 l

5.2.2 **Series SK280**
Permitted operating pressure:
280 bar

Nominal volume:
0.16 to 10 l

5.2.3 **High pressure**
Permitted operating pressure:
up to 1000 bar

Nominal volume:
up to 50 l

Benefits of HYDAC piston accumulators:

- minimal pressure differential between fluid side and gas side,
- large effective volume,
- variable installation position,
- monitoring of the piston position possible using a variety of systems,
- particularly suitable for back-up configurations,
- extreme flow rates,
- no sudden discharge of gas when seals are worn.

5.3. DIAPHRAGM ACCUMULATORS

5.3.1 **Diaphragm accumulators Weld and screw type**
Permitted operating pressure:
up to 750 bar

Nominal volume:
up to 4 l

Benefits of HYDAC diaphragm accumulators:

- function-optimized and weight-optimized design,
- unlimited choice of installation positions,
- no pressure differential between fluid side and gas side,
- low-maintenance and long service life.

5.4. METAL BELLOWS ACCUMULATORS

5.4.1 **Metal bellows accumulator**

Please contact us

Benefits of the HYDAC metal bellows accumulator:

- durable
- wear-free
- media resistant over a wide range of temperatures

See also flyer

- "Heavy Diesel Engines - Metal Bellows Accumulators" No. 10.129.1

5.5. HYDRAULIC DAMPERS

5.5.1 **Dampers**

Permitted operating pressure:
10 ... 1000 bar

Nominal volume:
0.075 ... 450 l

5.5.2 **Silencer**

Permitted operating pressure:
330 bar

Advantages of the HYDAC hydraulic damper:

- reduces pressure pulsations,
- improves the suction performance of displacement pumps,
- prevents pipe breaks and damage to valves,
- protects measuring equipment and its function in a system,
- reduces noise level in hydraulic systems,
- reduces maintenance and servicing costs and
- extends service life of the system.

5.6. SPECIAL ACCUMULATORS

5.6.1 **Weight reduced hydraulic accumulators**

Over 80 % reduction in weight ompared to equivalent carbon steel accumulators.

The choice ranges from weight-optimized accumulators, e.g. by using aluminium, through to light-weight and ultra light-weight accumulators.

See also flyer

- "Weight-reduced accumulators" No. 3.305

5.6.2 **Spring type accumulators**

are equipped with a spring.
The energy is produced by the spring force, instead of gas.

Further information on request.

5.7. ACCUMULATOR STATIONS

HYDAC supplies fully assembled piston accumulator stations which are ready for operation, complete with all the necessary valve controls, ball valves and safety equipment

- as an individual accumulator unit or
- in a back-up version with nitrogen bottles to increase the effective volume.

5.8. ACCUMULATOR ACCESSORIES

5.8.1 **Hydraulic accumulators with back-up nitrogen bottles**

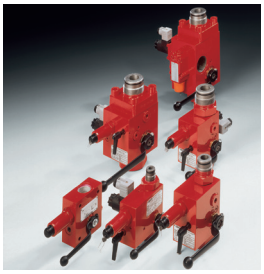
HYDAC also offers nitrogen bottles which can be used to back up bladder and piston accumulators. Nitrogen bottles used as back-ups increase the gas volume in the accumulator.

Using HYDAC nitrogen bottles provides the following benefits:

- cost-effective increase in the accumulator volume and as a result
- smaller accumulators for the same gas volume.

5.8.2 **Charging and testing unit FPU**

Charging hose, pressure gauge and pressure reducer for HYDAC and other brands of accumulator, up to 800 bar pre-charge pressure, higher pressures on request.



5.8.3 **Safety and shut-off block SAF/DSV**

Nominal size:
8 ... 50

Permitted operating pressure:
400 bar, higher pressures on request

Fluid-side protection, pressure relief valve, venting to tank and separation of the accumulator from the fluid-side system.

Benefits of the HYDAC Safety and Shut-off Block:

- minimum of space and maintenance required,
- minimum of pipework (1 SAF replaces up to 10 individual pipe connections, as a rule),
- considerable reduction in installation time,
- can be adapted to different types and also different brands of accumulator, and
- additional valves (pilot-operated check valves, flow control valves, etc).

5.8.4 **Safety equipment**

- Gas safety valve GSV6
- Temperature fuse
- Bursting disc

- Gas safety block

as safety equipment for
HYDAC accumulator products.

Approval according to Pressure Equipment Directive PED and CE mark.

Benefits of the HYDAC Gas Safety Block:

- A gas safety block simplifies the operation of the hydraulic accumulator on the gas-side and also offers the possibility of installing the above safety equipment using the various ports.

5.8.5 **Supports for hydraulic accumulators**

Accumulator sets, clamps and consoles for efficient installation of hydraulic accumulators.

5.8.6 **ACCUSET SB**

Permitted operating pressure:
330 bar

Nominal volume:
1 ... 50 l

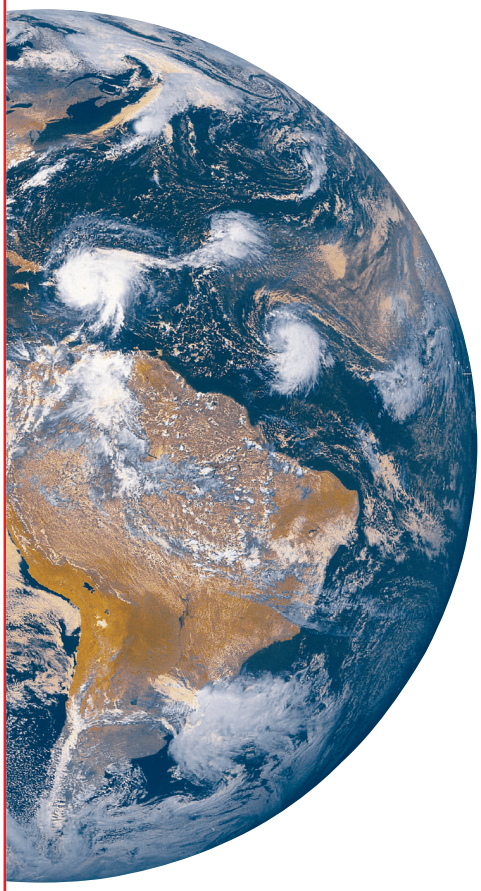
6. INDUSTRIES AND APPLICATIONS

HYDAC Technology GmbH is represented in almost all industries of the world which use hydraulic accumulators.

The main sectors are industrial hydraulics, mobile technology and process technology.

Further applications in oil & gas/ offshore as well as more energy efficient systems utilizing accumulators are gaining in importance.

Listed below is a selection of examples with accumulators/dampers which are typical for these industries:



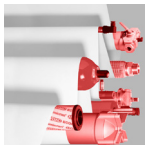
6.1. INDUSTRIAL HYDRAULICS

Automotive industry
- General industrial hydraulics, e.g. energy storage

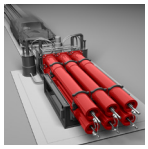
Mining machinery
- Hydraulic accumulators, e.g. in suspended monorails
- Pulsation damping
- Comfort and safety for mobile working machines

Iron and steel industry
- Accumulator to maintain the pressure in rolling mills
- Blast furnace hydraulics

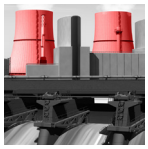
Plastics machinery
- Accumulator stations for energy storage during the injection moulding process
- Pulsation damping on the hydraulic drive



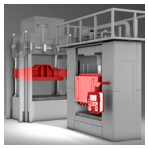
Paper industry
- Energy storage for emergency functions in friction bearing hydraulics
- Energy storage in high/low pressure power units



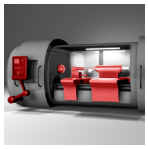
Test rigs and test systems
- Energy storage on crash test systems
- Pulsation damping on servo hydraulic axes



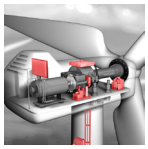
Thermal power plants
- Emergency supply for turbine control system
- Pulsation damping on pumps
- Lubrication, control and seal oil supply



Forming machines
- Accumulators used to store energy to support the pump



Machine tools
- Support for the hydraulics for tool drive or tool change
- Energy storage in the compact hydraulics of machining centres



Wind turbines
- Accumulators in the pitch control system
- Support of the pitch drive
- Accumulators on braking units

6.2. MOBILE TECHNOLOGY

Automotive technology

- Automatic and manual transmission
- Automatic clutch systems
- Engine management systems
- Accumulators for turbocharger emergency lubrication

Construction Machinery

- Accumulators in braking systems
- Chassis damping
- Bucket damping
- Boom damping on mobile cranes

Agricultural and forestry machines

- Front loader damping
- Accumulators in tractor suspension systems
- Stone strike protection for ploughs
- Boom suspension on field sprayers

Municipal machines

- Energy storage
- Boom damping
- Pulsation dampers
- Chassis damping

Lifting and material handling

- Noise damping
- Energy recovery
- Braking systems

Shipping

- Water treatment plants (pump support)
- Pulsation damping on diesel engines
- Heave compensation (cranes)
- Emergency function for lifeboats

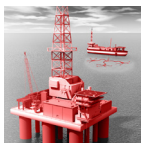
6.3. PROCESS TECHNOLOGY

Chemical industry

- Energy storage and pulsation damping on dosing pumps
- Suction flow stabilisation on the suction side of pumps

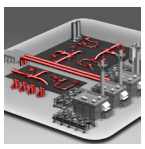
Loading stations / Refineries

- Shock absorption for valve closing
- Pulsation damping on pipelines



Offshore / Oil & Gas

- Accumulators to support valve closing systems
- Energy storage for deep sea rams
- Blow Out Preventers (BOP)
- Emergency function for safety systems
- Accumulators on wellhead control systems



Pipeline construction

- Energy storage for emergency actuation of valve stations
- Compressor stations

7. WEBSITE

Please visit us at the following address: www.hydac.com.

In addition to Industries, Service and Fluid Engineering, under **Products » Hydraulic Accumulators**, you will find the standard product range and the comprehensive range of accessories from HYDAC TECHNOLOGY GmbH.

Under Downloads you will find this product catalogue in different languages in PDF format as well as other information on HYDAC accumulator products.

You can find the required product via the product search tab and download the relevant CAD model.

The web version of **ASP***light* facilitates quick and simple input, calculation and evaluation of the required accumulator parameters. For further information on **ASP***light* see Section 9.4.

8. SPECIFICATION FORMS

Our aim is to provide optimal customer service both before and after purchasing the accumulator.

The following specification forms are designed to help pre-select the required accumulator/damper or accessories.

You can also download these as a pdf document from the intranet and the HYDAC website (www.hydac.com/Hydraulic accumulators) under the Downloads tab. You can then complete them at your convenience on your PC and send them to your HYDAC contact, e.g. by e-mail.

The areas highlighted in green constitute the minimum information required for a response or calculation.

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GENERAL ACCUMULATOR SPECIFICATION FORM (PAGE 1/2)

(Subject to technical modifications)

Company: _____ Project name: _____

Name, First name: _____ Application: _____

E-mail: _____ Requirement: _____ pieces/year

Telephone no.: _____ as ☐ spare part ☐ original equipment

Note:
The appropriate accumulator can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **ASP**.

Type of accumulator ☐ Bladder accumulator ☐ Piston accumulator ☐ Diaphragm accumulator ☐ _____

Fluids/medium

Fluid: _____ Viscosity at 20 °C: _____ cSt

Density: _____ kg/m³ Viscosity at operating temperature: _____ cSt

Functioning of the pump

☐ Continuous operation ☐ Intermittent operation

Accumulator data

Max. operating pressure: _____ bar

Min. operating pressure: _____ bar

Pre-charge pressure at 20 °C (nitrogen): _____ bar
(see catalogue section: No. 3.000, Sizing)

Ambient temperature: _____ °C

Operating temperature: _____ °C

Complete cycle time: _____ s

Fluid demand time schedule for ONE pump and ONE consumer:

Accumulator discharge rate: _____ l/min

Accumulator discharge time: _____ s

Flow rate of the pump: _____ l/min

Pump runs continuously: ☐

Pump starts after discharge: ☐

Alternatively:
Fluid demand diagram for SEVERAL pumps and/or consumers (see page 2)

Additional details on the accumulator

Industry: _____

Country of installation: _____

Design/Certification: _____

Specification: _____

Materials* _____

Accumulator shell: _____

Fluid connection: _____

Elastomer: _____

Additional information

Installation dimensions: _____ mm
(height x $Ø_{ext.}$)

Fluid connection: Type: _____

for thread ☐ internal _____

☐ external _____

Standard: _____

Gas connection: _____

Coating/finish: ☐ internal _____

☐ external _____

Spare parts / Accessories: see www.hydac.com under Products /Accumulators

* dependent on operating temperature and/or fluid resistance

Remarks: _____

Place, date: _____ Signature: _____

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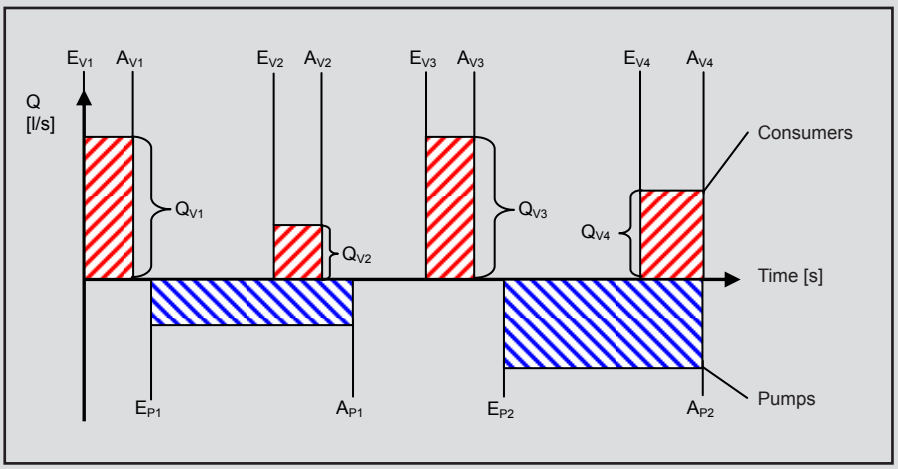
GENERAL ACCUMULATOR SPECIFICATION FORM (PAGE 2/2)

(Subject to technical modifications)

Fluid demand diagram for several pumps and/or consumers:

Designation / example:

Q_v = Consumer flow rate [l/s]
E_V = Switch-on time of consumer [s]
A_V = Switch-off time of consumer [s]
E_P = Switch-on time of pump [s]
A_P = Switch-off time of pump [s]



Please indicate cycle data below

Number of consumers: _____ Number of pumps: _____

Q_{V1}= _____ E_{V1}= _____ A_{V1}= _____ Q_{P1}= _____ E_{P1}= _____ A_{P1}= _____

Q_{V2}= _____ E_{V2}= _____ A_{V2}= _____ Q_{P2}= _____ E_{P2}= _____ A_{P2}= _____

Q_{V3}= _____ E_{V3}= _____ A_{V3}= _____ Q_{P3}= _____ E_{P3}= _____ A_{P3}= _____

Q_{V4}= _____ E_{V4}= _____ A_{V4}= _____ Q_{P4}= _____ E_{P4}= _____ A_{P4}= _____

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SHOCK ABSORBER SPECIFICATION FORM (Page 1/2)

(Subject to technical modifications)

Company: _____ Project name: _____

Name, First name: _____ Application: _____

E-mail: _____ Requirement: _____ pieces/year

Telephone no.: _____ as ☐ spare part ☐ original equipment

Note:
The appropriate accumulator can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **ASP**.

Type of accumulator ☐ Bladder accumulator ☐ Piston accumulator ☐ Diaphragm accumulator ☐ _____

Cause of the pressure shock

☐ When pump starts ☐ When pump switches off

☐ When check valve flap (valve) closes

Fluids / media

Fluid [1]: _____

Density: _____ kg/m³

Pipeline data for A SINGLE pipe

Length: _____ m

Diameter (internal): _____ mm

Wall thickness: _____ mm

Material of line: _____

Max. permitted pressure in the line: _____ bar

Total closing time of the valve: _____ s

Speed of sound in the system: _____ m/s

Alternatively:
Pipeline data for ADDITIONAL sections of pipe
(see page 2)

Pump data

Zero head: _____ m

Pressure of the pump at the operating point: _____ bar

Flow rate of the pump at the operating point: _____ l/min

* dependent on operating temperature and/or fluid resistance

[1] please send datasheet

Accumulator data

Max. operating pressure: _____ bar

Min. operating pressure: _____ bar

Pre-charge pressure at 20 °C (nitrogen): _____ bar
(see catalogue section: No. 3.000, Sizing)

Ambient temperature: _____ °C

Operating temperature: _____ °C

Fluid connection: Type: _____

for thread ☐ internal _____

☐ external _____

Standard: _____

Gas connection: _____

Coating/finish: ☐ internal _____

☐ external _____

Spare parts / Accessories: see www.hydac.com
under Products / Accumulators

Materials*

Accumulator shell _____

Fluid connection: _____

Elastomer: _____

Additional information on the accumulator/system

Available installation space: _____ m
(L x W x H)

Industry: _____

Country of installation: _____

Design/Certification: _____

Specification: _____

Remarks: _____

Place, date: _____ Signature: _____

E 3.000.14/03.16

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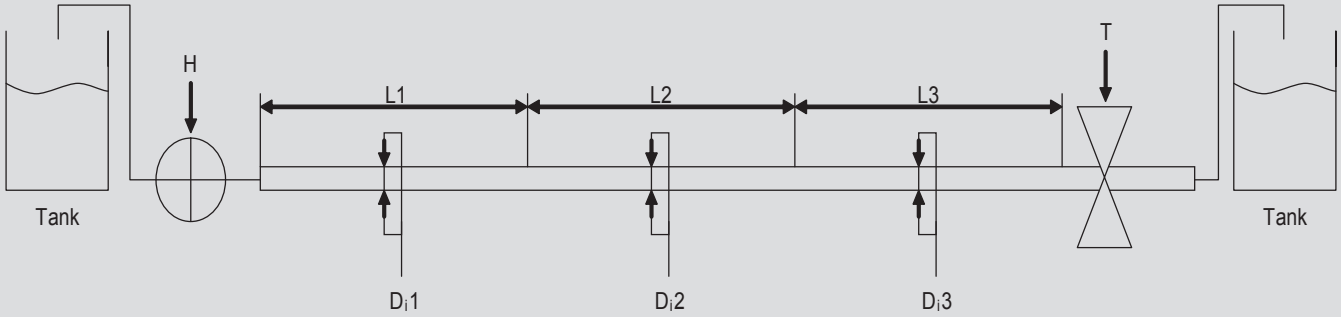
SHOCK ABSORBER SPECIFICATION FORM (Page 2/2)

(Subject to technical modifications)

Pipeline data for additional sections of pipe

Designation / Example

H = Zero head of the pump [m]
D_i = Internal diameter of the pipe [mm]
T = Closing time of the valve [sec]
(effectively approx. 30% of the total closing time)
L = Length of the pipeline [m]



Number of different pipes: 3

L1	= 200 m	D_i1	= 100 mm		
L2	= 50 m	D_i2	= 200 mm		
L3	= 20 m	D_i3	= 500 mm		

Typical values for speed of sound

Water = 1200 m/s
Fuel = 1100 m/s

Please complete below with the pipeline data

Number of different pipes: _____

L1	= _____ m	D_i1	= _____ mm	L5	= _____ m	D_i5	= _____ mm
L2	= _____ m	D_i2	= _____ mm	L6	= _____ m	D_i6	= _____ mm
L3	= _____ m	D_i3	= _____ mm	L7	= _____ m	D_i7	= _____ mm
L4	= _____ m	D_i4	= _____ mm	L8	= _____ m	D_i8	= _____ mm

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PULSATION DAMPER SPECIFICATION FORM

(Subject to technical modifications)

Company: _____ Project name: _____

Name, First name: _____ Application: _____

E-mail: _____ Requirement: _____ pieces/year

Telephone no.: _____ as ☐ spare part ☐ original equipment

Note:
The appropriate pulsation damper can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **ASP**.

Type of accumulator ☐ Bladder accumulator ☐ Piston accumulator ☐ Diaphragm accumulator ☐ _____

Fluids/medium

Fluid: _____ Viscosity at 20 °C: _____ cSt

Density: _____ kg/m³ Viscosity at operating temperature: _____ cSt

Pump and system data

Oper. press./pump pressure: _____ bar

Flow rate: _____ l/min

Speed: _____ 1/min

Number of displacements: _____

☐ single ☐ double acting

Pump factor: _____ optional (if available)

Stroke volume: _____ 1 dm³

→ for piston pumps: $V_H = \frac{d^2 \times \pi}{4} \times H \times 10^{-6}$

d = Ø piston: _____ mm

H = stroke length: _____ mm

→ for diaphragm pumps: see manufacturer's specifications

Accumulator data

Pre-charge pressure [1]: _____ bar

Operating temperature: _____ °C

Application: ☐ pressure side ☐ suction side

Required residual pulsation: _____ %

Result: _____ l gas volume [2]

* dependent on operating temperature and/or fluid resistance
[1] see catalogue section: No. 3.000, Sizing
[2] normally pre-charged with nitrogen (N_2)

Additional details on the accumulator

Industry: _____

Country of installation: _____

Design/Certification: _____

Specification: _____

Design pressure: _____ bar

Design temperature: _____ °C

Materials*

Accumulator shell: _____

Fluid connection: _____

Elastomer: _____

Additional information

Installation dimensions: _____ mm
(height x $Ø_{ext.}$)

Fluid connection: Type: _____

for thread ☐ internal _____

☐ external _____

Standard: _____

Gas connection: _____

Coating/finish: ☐ internal _____

☐ external _____

Spare parts/Accessories: see www.hydac.com under Products / Accumulators

Remarks: _____

Place, date: _____ Signature: _____

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SILENCER SPECIFICATION FORM

(Subject to technical modifications)

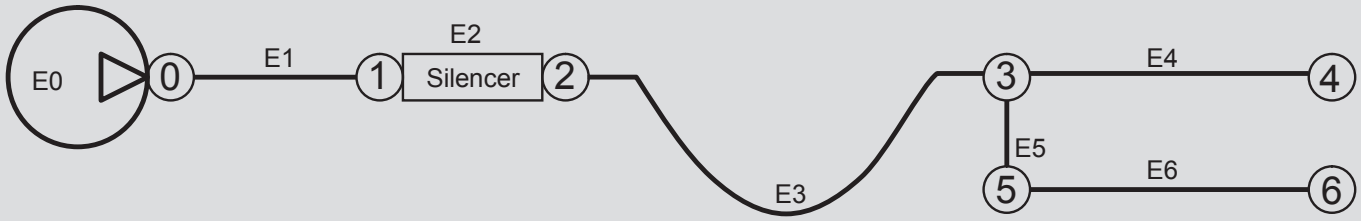
Company: _____ Project name: _____

Name, First name: _____ Application: _____

E-mail: _____ Requirement: _____ pieces/year

Telephone no.: _____ as ☐ spare part ☐ original equipment

Sizing example:



Pump:	**A10VSO71**	Design pressure:	**210 bar**	Silencer inlet:	**SAE 1 1/4“ 3000 psi**
Pump rpm:	**1500 1/min**	No. of pump pistons:	**9**	Silencer outlet:	**SAE 1 1/4“ 3000 psi**
Fluid:	**Aral Vitam GF**	Fluid density:	**890 kg/m³**	Design temperature:	**50 °C**

Element no.	Length [m]	Ø int. [m]	Ø ext. [m]	Subsequent connection type	Hose type
E1	0.5	0.020	0.030	Straight connection	–
E2	0.4	–	0.200	Straight connection	–
E3	1.5	0.025	0.040	T-junction	4SP (DIN EN 856)
E4	0.6	0.015	0.025	Pressure relief valve	–
E5	0.2	0.015	0.025	Right-angle	–
E6	0.6	0.015	0.025	Shut-off valve	–

Please enter design data here:

Pump:		Design pressure:	bar	Silencer inlet:	
Pump rpm:	1/min	No. of pump pistons:		Silencer outlet:	
Fluid:		Fluid density:		Design temperature:	°C

Element no.	Length [m]	Ø int. [m]	Ø ext. [m]	Subsequent connection type	Hose type
E1					
E2					
E3					
E4					
E5					
E6					
E7					
E8					
E9					
E10					
E11					
E12					

Remarks: _____

Place, date: _____ Signature: _____

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METAL BELLOWS ACCUMULATOR SPECIFICATION FORM FOR HEAVY DIESEL ENGINES

(Subject to technical modifications)

Company: _____ Project name: _____

Name, First name: _____ Application: _____

E-mail: _____ Requirement: _____ pieces/year

Telephone no.: _____ as ☐ spare part ☐ original equipment

Note:
The appropriate pulsation damper can be calculated using the HYDAC **A**ccumulator **S**imulation **P**rogram **ASP**.

Engine data

Manufacturer: _____ max. "spill volume" of the high pressure injection pumps: _____ ccm

Type: _____ max. flow of the supply line: _____ l/min

Design: ☐ Inline ☐ 2-stroke max. flow of the tank line: _____ l/min

☐ V motor ☐ 4-stroke

Fuel: _____

Operating conditions of the supply line:

	Proportion of operation		min. / max. speed		p_{max}	at	T_{min}		p_{min}	at	T_{max}	
Engine start			/	1/min		bar		°C				
Main operation		%	/	1/min		bar		°C		bar		°C
Auxiliary operation		%	/	1/min		bar		°C		bar		°C

Operating conditions of the tank line:

	Proportion of operation		min. / max. speed		p_{max}	at	T_{min}		p_{min}	at	T_{max}	
Engine start			/	1/min		bar		°C				
Main operation		%	/	1/min		bar		°C		bar		°C
Auxiliary operation		%	/	1/min		bar		°C		bar		°C

Additional information on the accumulator/system:

Available installation space: _____ m
(L x W x H)

Installation vertical: ☐ yes ☐ no
(accumulator gas valve at top)
If no, specify position: _____

Material: ☐ Carbon steel ☐ Stainless steel
(hydraulic accumulator)
Finish requirement: ☐ HYDAC Standard (RAL 7035)
☐ _____

see flyer "Heavy Diesel Engines - Metal Bellows Accumulators" No. 10.129.1

Gas and fluid connection:

Industry: _____

Country of installation: _____

Design/Certification: _____

or

Ship name (IMO): _____

Ship classification: _____

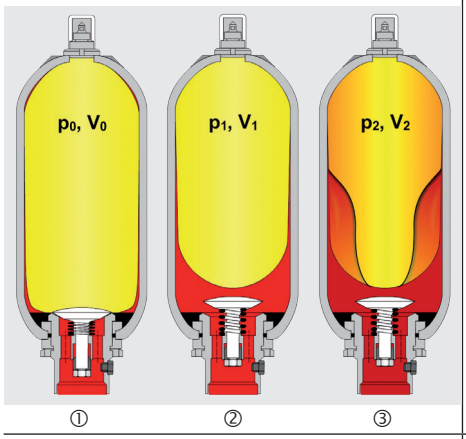
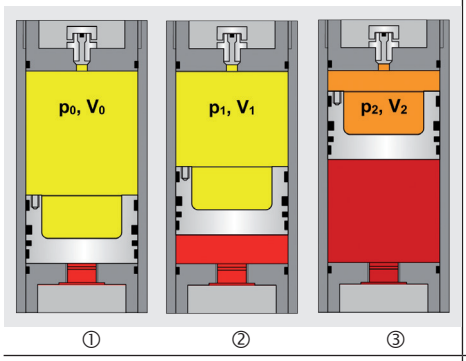
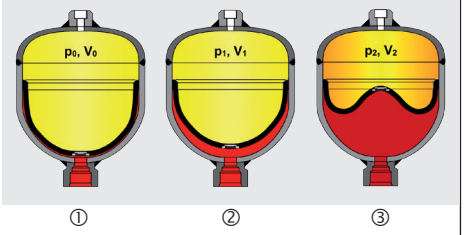
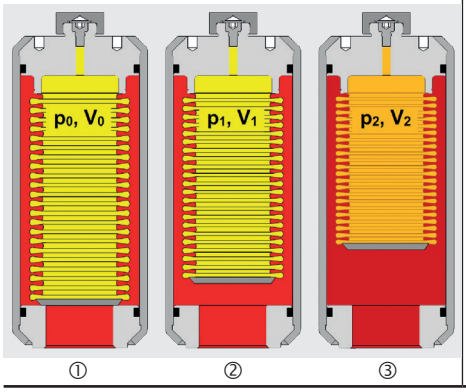
Spare parts/Accessories: see www.hydac.com under Products / Accumulators

Remarks: _____

Place, date: _____ Signature: _____

9. SIZING

9.1. DEFINITION OF VARIABLES FOR SIZING A HYDRAULIC ACCUMULATOR

Function principle	Limits for the gas pre-charge pressure
Bladder accumulators  	p_0 ≤ 0.9 • p_1 with a permitted pressure ratio of $p_2 : p_0$ ≤ 4 : 1 For HYDAC low pressure accumulators, the following must also be taken into account: Type SB40: $p_{0\,max}$ = 20 bar Type SB35H: $p_{0\,max}$ = 10 bar
Piston accumulators  	$p_{0,tmin}$ ≥ 2 bar (piston type 2) $p_{0,tmin}$ ≥ 10 bar (piston type 1) $p_{0,tmin}$ ≤ p_1 - 5 bar In extreme cases, during slow charging (isothermal) and rapid discharge (adiabatic) of the effective volume, and after accurate calculation, the gas pre-charge pressure $p_0 \geq p_1$ can be selected. Accumulator supplied uncharged or with 2 bar storage pressure.
Diaphragm accumulator  	a) Permitted pressure ratio: $p_2 : p_0$ Weld type: The pressure ratio of weld-type diaphragm accumulators is between 4 : 1 and 8 : 1, depending on the design, see catalogue Section Diaphragm Accumulators, No. 3.100, section 3.1. Screw type: All sizes: 10 : 1 Other pressure ratios on request b) $p_0 \leq 0.9 \cdot p_1$
Metal bellows accumulators  	a) Metal bellows accumulator with convoluted bellows: The max. permitted or optimal pre-charge pressure of a metal bellows accumulator with convoluted bellows must be determined for each application by providing the particular operating conditions and in consultation with HYDAC (see "Metal Bellows Accumulator Specification Sheet for Heavy Diesel Engines"). b) Metal bellows accumulator with diaphragm bellows: $p_0 \leq 0.9 \cdot p_1$ $p_2 : p_0 \leq 20:1$ at t_{min} The required pressure ratio must be indicated when ordering.

① The accumulator is pre-charged with nitrogen. The separating element (piston, bladder, diaphragm, corrugated bellows) shuts off the fluid.

② The minimum operating pressure should be higher than the gas pre-charge pressure. This should prevent the separating element from striking the fluid connection every time fluid is discharged.

③ Once the max. operating pressure is reached, the effective volume ΔV is available in the accumulator:

p_0 = pre-charge pressure
p_1 = minimum operating pressure
p_2 = maximum operating pressure
V_0 = effective gas volume
V_1 = gas volume at p_1
V_2 = gas volume at p_2
t_0 = pre-charge temperature
t_{min} = min. operating temperature
t_{max} = max. operating temperature

9.2. SELECTING THE PRE-CHARGE PRESSURE

The selection of the pre-charge pressure defines the accumulator capacity. In order to obtain optimum utilization of the accumulator volume the following pre-charge pressures are recommended:

9.2.1 Recommended values for energy storage:

$p_{0,t\,max}$ = 0.9 • p_1

for shock absorption:

$P_{0,t\,max}$ = 0.6 to 0.9 • p_m

(p_m = average operating pressure for free flow)

for pulsation damping:

$p_{0,t\,max}$ = 0.6 • p_m

(p_m = average operating pressure)

or

$p_{0,t\,max}$ = 0.8 • p_1

(for several operating pressures)

During operation the separating element (piston, bladder, diaphragm, corrugated bellows) must not touch the fluid-side connection.

Since the volume of the gas increases as the temperature increases, the pre-charge pressure must be determined at the maximum operating temperature using the recommended values.

9.2.2 Limits for gas pre-charge pressure

see section 9.1.

9.2.3 Temperature effect

So that the recommended pre-charge pressures can be maintained, even at relatively high operating temperatures, the $p_{0\,charge}$ for charging and testing cold accumulators must be selected as follows:

$$p_{0,\,t\,charge} = p_{0,t\,max} \cdot \frac{t_{charge} + 273}{t_{max} + 273}$$

$t_0 = t_{charge}$ (pre-charge temperature in °C)

To take the temperature effect into account when sizing accumulators, p_0 at t_0 must be selected as follows:

$$p_{0,\,t\,min} = p_{0,t\,max} \cdot \frac{t_{min} + 273}{t_{max} + 273}$$

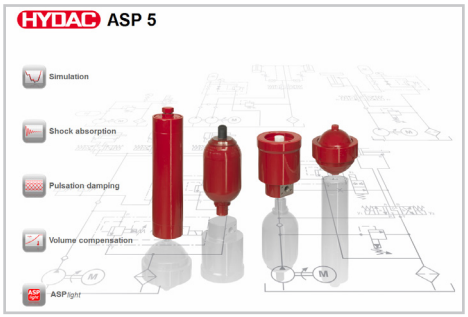
9.3. ACCUMULATOR SIZING ON YOUR PC – ASP 5

The most important parameters for calculating the accumulator gas volume are pressure, volume and temperature.
These parameters were previously used to calculate the required accumulator size in cumbersome and complex formulas.
In 1997, HYDAC revolutionized the calculation and simulation of hydraulic accumulators by applying program routines with real gas behaviour in its **ASP** - **A**ccumulator **S**imulation **P**rogram.

After years of experience, continuous improvement and the inclusion of new functions, **ASP** has developed into calculation software which makes it possible for the behaviour of accumulators to be simulated with great accuracy.

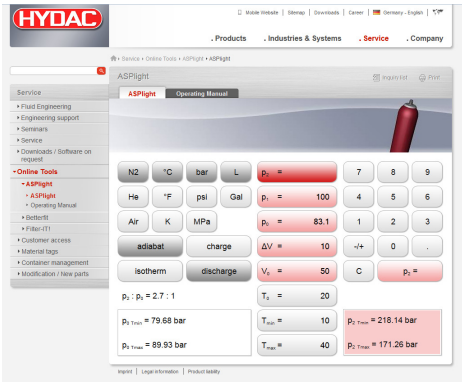
ASP 5 has five elements:

- simulation, with the familiar advantages but in a completely new format and additional visualizations of the most important parameters,
- pressure shock damping, clearly arranged in one program window,
- pulsation damping, including corrected pump factors, also clearly presented in a program window.
- volume compensation and
- integration of the stand-alone, simplified software **ASP***light*.



9.4. ACCUMULATOR CALCULATION SIMPLIFIED – **ASP***light*

Das **ASP***light* is an intelligent application which takes into account real gas behaviour. This simplified software from HYDAC Accumulator Technology enables you to calculate all the necessary parameters such as pressure, volume and temperature in different units for gases such as nitrogen or helium. The maximum input for pressure is 2500 bar. Additional information fields help to evaluate the result and to determine the type of accumulator.



ASP*light* is aimed at the user who is tasked with determining the essential accumulator parameters within a short time. The software will be a particularly useful tool in your role as sales consultant in the field, by providing quick, straightforward calculations for hydraulic accumulators.

ASP*light* is operated via a single window and is language neutral. The design is comparable to a pocket calculator. Simulation curves are not shown.

ASP*light* is available online at www.hydac.com, and it can also be operated from a smartphone via the mobile website.

10. NOTE

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

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

Subject to technical modifications.

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E 3.000.14/03.16

Bladder Accumulators
Low Pressure

1. DESCRIPTION

1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

The compressibility of a gas is utilised in hydraulic accumulators for storing fluids. HYDAC bladder accumulators are based on this principle, using nitrogen as the compressible medium.

A bladder accumulator consists of a fluid section and a gas section with the bladder acting as the gas-proof screen. The fluid around the bladder is connected to the hydraulic circuit so that the bladder 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.

HYDAC bladder accumulators can be used in a wide variety of applications, some of which are listed below:

- energy storage
- emergency operation
- force equilibrium
- leakage compensation
- volume compensation
- shock absorption
- vehicle suspension
- pulsation damping

See catalogue section:

- Hydraulic Dampers No. 3.701

1.2. DESIGN

HYDAC low pressure bladder accumulators consist of a welded pressure vessel, a flexible bladder with gas valve and a hydraulic connection with check valve or a perforated disc.

The table shows the different models which are described in greater detail in the pages that follow:

Designation	Perm. pressure [bar] 2)	Volume [l]	Q 1) [l/s]
SB40- 2.5 ... 50	40	2.5 - 50	7
SB40- 70 ... 220		70 - 220	30
SB35HB- 20 ... 50	35	20 - 50	20
SB16A- 100 ... 450	16	100 - 450	15
SB35A- 100 ... 450	35		
SB16AH- 100 ... 450	16		20
SB35AH- 100 ... 450	35		

1) Q = max. flow rate of pressure fluid
2) Higher pressures on request

1.3. BLADDER MATERIAL

The bladder material must be selected in accordance with the particular operating fluid or operating temperature, see section 2.1.

If discharge conditions are unfavourable (high p_2/p_0 pressure ratio, rapid discharge speed), the gas may cool to below the permitted temperature.
This can cause cold cracking in the elastomer. The gas temperature can be calculated using the HYDAC Accumulator Simulation Program **ASP**.

1.4. CORROSION PROTECTION

For operation with chemically aggressive media, the accumulator shell can be supplied with corrosion protection, such as plastic coating on the inside or chemical nickel-plating. If this is insufficient, then stainless steel accumulators must be used.

1.5. INSTALLATION POSITION

HYDAC bladder accumulators can be installed vertically, horizontally and at a slant. When installing vertically or at a slant, the oil valve must be at the bottom. On certain applications listed below, particular positions are preferable:

- Energy storage: vertical,
- Pulsation damping: any position from horizontal to vertical,
- Maintaining constant pressure: any position from horizontal to vertical,
- Pressure surge damping: vertical,
- Volume compensation: vertical.

If the installation position is horizontal or at a slant, the effective fluid volume and the maximum permitted flow rate of the operating fluid are reduced.

Bladder accumulators SB16A / SB35A and SB16AH / SB35AH must only be installed vertically with the gas side uppermost.

1.6. TYPE OF INSTALLATION

For strong vibrations and volumes above 1 litre, we recommend the use of HYDAC accumulator supports or the HYDAC accumulator installation set.

See catalogue sections:

- Supports for Hydraulic Accumulators No. 3.502
- ACCUSET SB No. 3.503

2. TECHNICAL SPECIFICATIONS

2.1. EXPLANATORY NOTES

2.1.1 **Operating pressure**
see section 3. for the particular series (may differ from nominal pressure for foreign test certificates)

2.1.2 **Nominal volume**
see section 3. for the particular series

2.1.3 **Effective gas volume**
see section 3. for the particular series
Based on nominal dimensions, this differs slightly from the nominal volume and must be used when calculating the effective fluid volume.

2.1.4 **Effective fluid volume**
Volume of fluid which is available between the operating pressures p_2 and p_1.

2.1.5 **Max. flow rate of the operating fluid**
In order to achieve the max. flow rate given in the tables, the accumulator must be installed vertically. It must be noted that a residual fluid volume of approx. 10% of the effective gas volume remains in the accumulator.
The maximum fluid flow rate was determined under specific conditions and is not applicable in all operating conditions.

2.1.6 **Operating temperature and operating fluid**
The permitted operating temperature of a bladder accumulator is dependent on the application limits of the metal materials and the bladder. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account.
The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-50 °C ... + 50 °C		
		9	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	-30 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
IIR	Butyl rubber	4	-50 °C ... +100 °C	● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
FKM	Fluorine rubber	6	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.2. Model code, material code, bladder accumulator

[2] others available on request

2.1.7 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 µm.
If other gases are to be used, please contact HYDAC for advice.

2.1.8 Limits for gas pre-charge pressure

$p_0 \leq 0.9 \bullet p1$
with a permitted pressure ratio of:
$p_2 : p_0 \leq 4 : 1$

p_2 = max. operating pressure
p_0 = pre-charge pressure

For HYDAC low pressure accumulators, the following must also be taken into account:

Type SB40: $p_{0\,max}$ = 20 bar*
Type SB35A/AH: $p_{0\,max}$ = 10 bar
Type SB35HB: $p_{0\,max}$ = 10 bar

* in model with perforated disc

2.1.9 Certificate codes

Country	Certificate code (AKZ)
EU member states	U
Australia	F [1]
Belarus	A6
Canada	S1 [1]
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

[1] Registration required in the individual territories or provinces
others on request

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely vented.

Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

Please read the operating manual! No. 3.201.BA

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

- HYDAC Accumulator Technology No. 3.000

2.2. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SB40 A – 100 F 7 / 112 U – 40 A

Series

Type code
no details = standard
H = high flow
N = increased flow, standard oil valve dimensions
A = shock absorber
B = bladder top-repairable
Combinations must be agreed with HYDAC

Nominal volume [l]

Fluid connection
A = standard connection, thread with internal seal face
F = flange connection
C = valve mounting with screws on underside
E = sealing surfaces on front interface (e.g. on thread M50x1.5 - valve)
G = male thread
S = special connection, to customer specification

Gas side
1 = standard model
2 = back-up model
3 = gas valve 7/8-14UNF with M8 female thread
4 = gas valve 7/8-14UNF with gas valve connection 5/8-18UNF
5 = gas valve M50x1.5 in accumulators smaller than 50 l
6 = 7/8-14UNF gas valve
7 = M28x1.5 gas valve
8 = M16x1.5 gas valve (with M14x1.5 bore in gas valve)
9 = special gas valve, to customer specification

Material code
dependent on operating medium
standard model = 112 for mineral oils
others on request

Fluid connection
1 = carbon steel
2 = high tensile steel
3 = stainless steel [2]
6 = low temperature steel

Accumulator shell
0 = plastic coated (internally)
1 = carbon steel
2 = chemically nickel-plated (internal coating)
4 = stainless steel [2]
6 = low temperature steel

Bladder accumulator [1] [3] [4]
2 = NBR [5]
3 = ECO
4 = IIR
5 = NBR [5]
6 = FKM
7 = other
9 = NBR [5]

Certification code
U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Connection
Thread, codes for fluid connections: A, C, E, G
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 B1.20.1 (NPT)
S = special thread, to customer specification

Flange, codes for fluid connection: F
A = EN 1092-1 welding neck flange
B = flange ASME B16.5
C = SAE flange 3000 psi
D = SAE flange 6000 psi
S = special flange, to customer specification

Required gas pre-charge pressure must be stated separately!

[1] when ordering a spare bladder, please state diameter of the smaller shell port
[2] dependent on type and pressure rating
[3] standard materials, all other materials on request
[4] elastomer types not available for all bladder sizes
[5] observe temperature ranges, see section 2.1.

3. LOW PRESSURE ACCUMULATORS

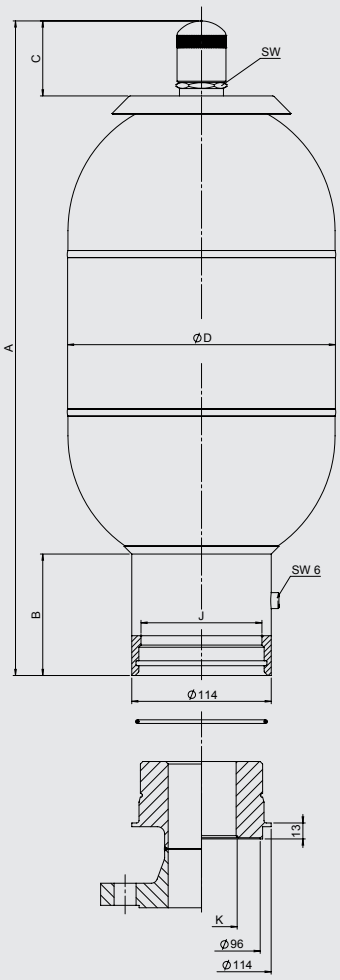
3.1. STANDARD BLADDER ACCUMULATORS SB40-2.5 ... 50

3.1.1 Design

HYDAC standard low pressure accumulators consist of:

- A welded pressure vessel which can be treated with various types of corrosion protection for chemically aggressive fluids, or can be supplied in stainless steel.
- A bladder with gas valve. The bladders are available in the elastomers listed under section 2.1.
- A hydraulic connection with a perforated disc which is held in place with retaining ring.
- In addition, we can offer suitable adapters for connection to the hydraulic system.

3.1.2 Dimensions SB40-2.5 ... 50



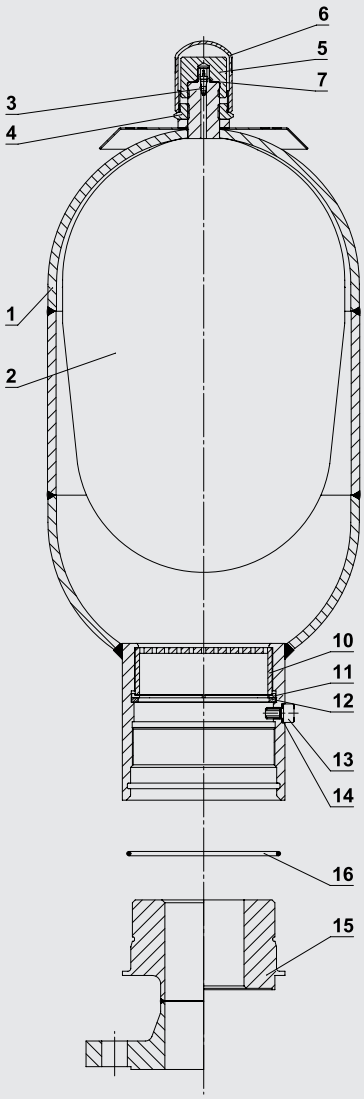
SB40-2.5 ... 50

Permitted operating pressure 40 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight [kg]	A [mm]	B [mm]	C [mm]	Ø D [mm]	J thread ISO DIN 13	K thread ISO 228	SW [mm]	Q [1] [l/s]
2.5	2.5	9	541	122	68	108	M100x2	G 2	36	7
5	5	13	891							
10	9.3	14	533	106		219				
20	18	23	843							
32	33.5	38	1363							
50	48.6	52	1875		78				68 [2]	

[1] Q = max. flow rate of operating fluid (at approx. 0.5 bar pressure drop via adapter)
[2] use C-spanner

3.1.3 Spare parts SB40-2.5 ... 50



Description	Item
Bladder assembly [1] consisting of:	
Bladder	2
Gas valve insert*	3
Retaining nut	4
Seal cap	5
Protection cap	6
O-ring	7
Seal kit consisting of:	
O-ring	7
Bleed screw	13
Seal ring	14
O-ring	15
Repair kit [1] consisting of:	
Bladder assembly (see above)	
Seal kit (see above)	
Hydraulic connection assembly consisting of:	
Perforated disc	10
Anti-extrusion ring	11
Retaining ring	12
Bleed screw	13
Seal ring	14
O-ring	15

* available separately
[1] When ordering, please state diameter of the smaller shell port.
Item 1 not available as a spare part.
Item 16 available as an accessory, please ask

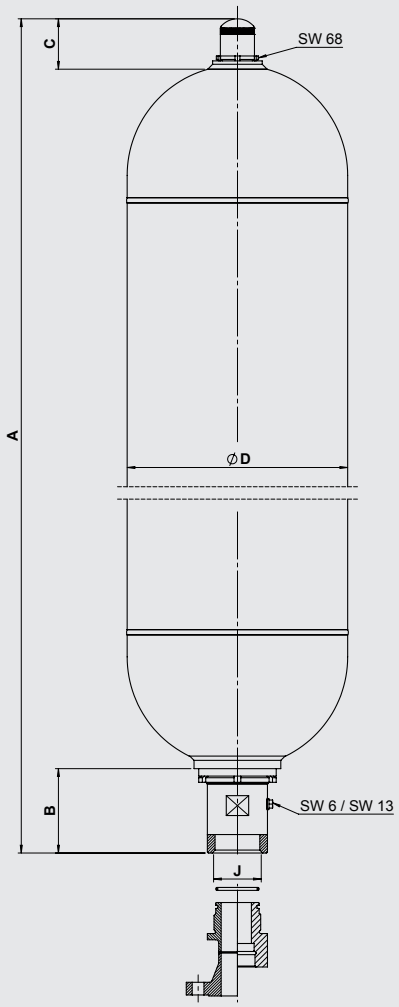
3.2. BLADDER ACCUMULATOR SB40-70 ... 220

3.2.1 Design

HYDAC low pressure accumulators, type SB40-70 ... 220 consist of:

- A welded pressure vessel which is compact and yet suitable for high flow rates and large volumes. The pressure vessel is manufactured in carbon steel or in stainless steel.
- A bladder with gas valve.
- A hydraulic connection with check valve.

3.2.2 Dimensions SB40-70 ... 220



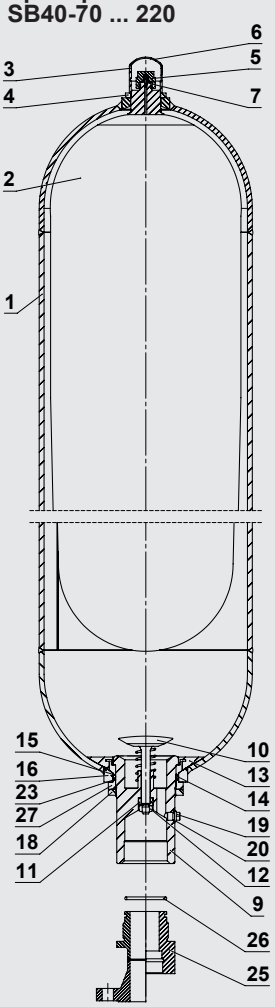
SB40-70 ... 220

Permitted operating pressure 40 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight [kg]	A max. [mm]	B [mm]	C [mm]	Ø D [mm]	J thread ISO 228	SW [mm]	Q [1] [l/s]
70	65	73	898	136	68	356	G 2 1/2	68 [2]	30
100	111	99	1423						
130	133	130	1675						
190	192	175	1871			406			
220	221	197	2119						

[1] Q = max. flow rate of operating fluid
[2] use C-spanner

3.2.3 Spare parts SB40-70 ... 220



Description	Item
Bladder assembly [1] consisting of:	
Bladder	2
Gas valve insert*	3
Retaining nut	4
Seal cap	5
Protection cap	6
O-ring	7
Seal kit consisting of:	
O-ring	7
Washer	15
O-ring	16
Bleed screw	19
Support ring	23
O-ring	27
Repair kit [1] consisting of:	
Seal kit (see above)	
Bladder assembly (see above)	
Anti-extrusion ring	14
Oil valve assembly consisting of:	
Valve assembly (items 9-13)	9
Anti-extrusion ring	14
Washer	15
O-ring	16
Spacer	17
Lock nut	18
Bleed screw	19
Support ring	23

* available separately

[1] When ordering, please state diameter of the smaller shell port).

Item 1 not available as a spare part.

Item 20 (seal ring) not required for carbon steel accumulators

3.3. LOW PRESSURE ACCUMULATORS SB16/35A AND SB16/35AH

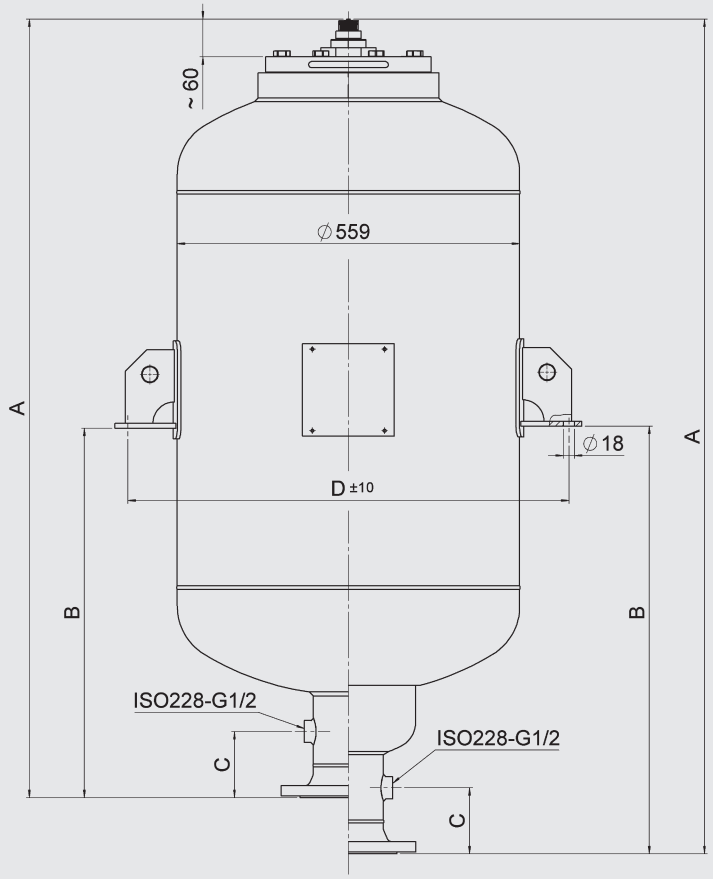
3.3.1 Design

HYDAC low pressure bladder accumulators for large volumes, type SB35A and SB16A are in a weld construction in carbon steel or stainless steel.

The hydraulic outlet is covered by a perforated disc which prevents the flexible bladder extruding from the shell. The bladder is top-repairable.

3.3.2 Dimensions

SB16/35A **SB16/35AH**



SB16/35A

Permitted operating pressure 16/35 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight [kg] SB16A	Weight [kg] SB35A	A (approx.) [mm] SB16A	A (approx.) [mm] SB35A	B (approx.) [mm] SB16A	B (approx.) [mm] SB35A	C (approx.) [mm] SB16A	C (approx.) [mm] SB35A	D ±10 [mm] SB16A	D ±10 [mm] SB35A
100	108	110	144	854	881	398	418	108	121	720	728
150	151	127	171	1044	1076	493	578				
200	205	149	208	1275	1318	691	699				
300	290	178	261	1644	1701	920	937				
375	376	214	315	2020	2086	1063	1083				
450	455	244	364	2361	2436	1234	1258				

* to EN1092-1/11 / PN16 or PN40
others on request

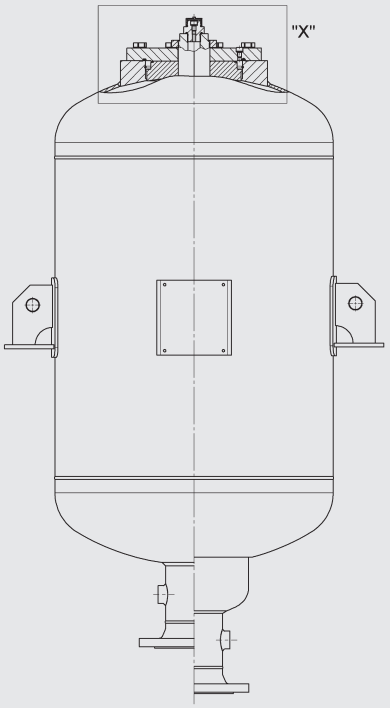
SB16/35AH

Permitted operating pressure 16/35 bar (PED)

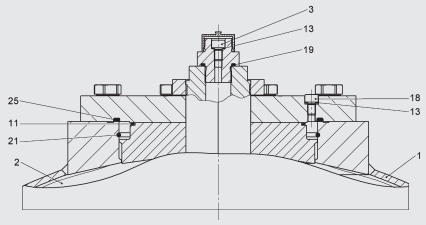
Nominal volume [l]	Eff. gas volume [l]	Weight [kg] SB16AH	Weight [kg] SB35AH	A (approx.) [mm] SB16AH	A (approx.) [mm] SB35AH	B (approx.) [mm] SB16AH	B (approx.) [mm] SB35AH	C (approx.) [mm] SB16AH	C (approx.) [mm] SB35AH	DN* SB16AH	DN* SB35AH
100	108	118	153	945	971	488	508	108	121	720	728
150	151	135	180	1135	1166	638	641				
200	205	157	217	1366	1408	754	762				
300	290	186	270	1735	1791	988	1000				
375	376	222	324	2111	2176	1127	1146				
450	455	252	373	2452	2526	1298	1321				

* to EN1092-1/11 / PN16 or PN40
others on request

3.3.3 Spare parts SB16/35A, SB16/35AH



Detail "X"



Description	Item
Bladder assembly	2
Gas valve assembly consisting of:	
Screw plug	3
Gas valve body	12
Seal ring	13
O-ring	19
Protection cap	29
Seal kit consisting of:	
O-ring	11
Seal ring	13
Air bleed screw	18
O-ring	19
Retaining ring	21
O-ring	25

Item 1 not available as a spare part.

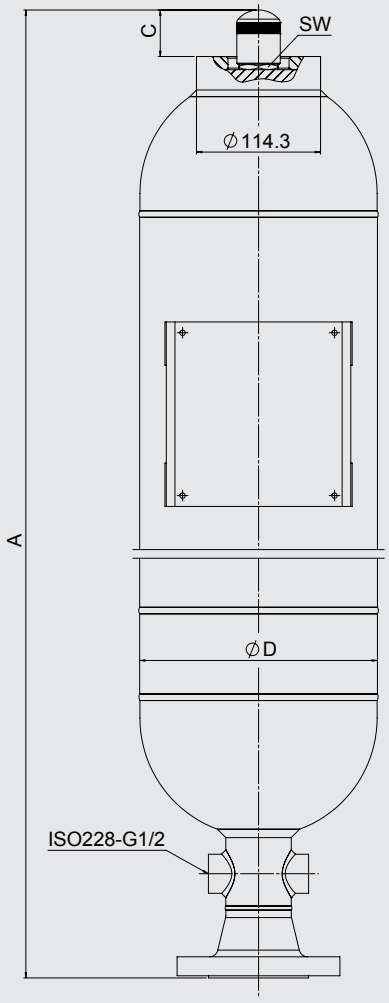
3.4. HIGH FLOW BLADDER ACCUMULATOR SB35HB

3.4.1 Design

HYDAC high flow bladder accumulators type SB35HB are high performance accumulators for flow rates of up to 20 l/s at 2 bar Δp.

They consist of a pressure vessel in a weld construction and a flexible bladder with gas valve.
The pressure vessel contains a fixed perforated disc, permitting a high flow rate through its large free cross-section. For use with chemically aggressive fluids, the shell can be manufactured in stainless steel. See section 2.1. for bladder materials.

3.4.2 Dimensions SB35HB



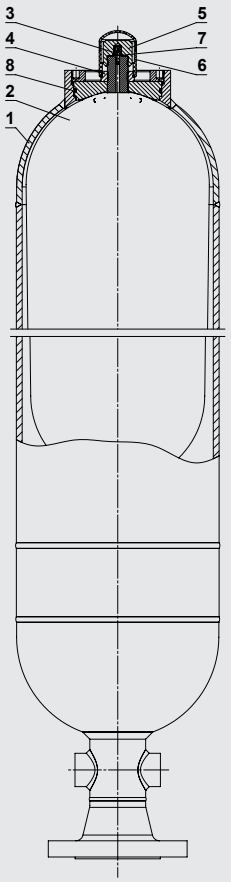
SB35HB

Permitted operating pressure 35 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight [kg]	A max. [mm]	C [mm]	Ø D [mm]	SW [mm]	Q [1)] [l/s]	DN*
20	19.8	43	1081	63	219	36	20	50
32	35	56	1591					
50	50	69	2091	78		Ø 68 [2)]		

* to EN1092-1/11 / PN40, others on request
[1)] Q = max. flow rate of operating fluid
[2)] Lock nut

3.4.3 Spare parts SB35HB



Description	Item
Bladder assembly [1)] consisting of:	
Bladder assembly	2
Gas valve insert*	3
Retaining nut	4
Seal cap	5
Protection cap	6
O-ring	7
Seal kit consisting of:	
Gas valve insert*	3
O-ring	7
O-ring	8
Repair kit [1)] consisting of:	
Bladder assembly (see above)	
Seal kit (see above)	

* available separately
[1)] When ordering, please state diameter of the smaller shell port.
Item 1 not available as a spare part.

4. NOTE

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

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

Subject to technical modifications.

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Bladder Accumulators
Standard

1. DESCRIPTION

1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

The compressibility of a gas is utilised in hydraulic accumulators for storing fluids. HYDAC bladder accumulators are based on this principle, using nitrogen as the compressible medium.

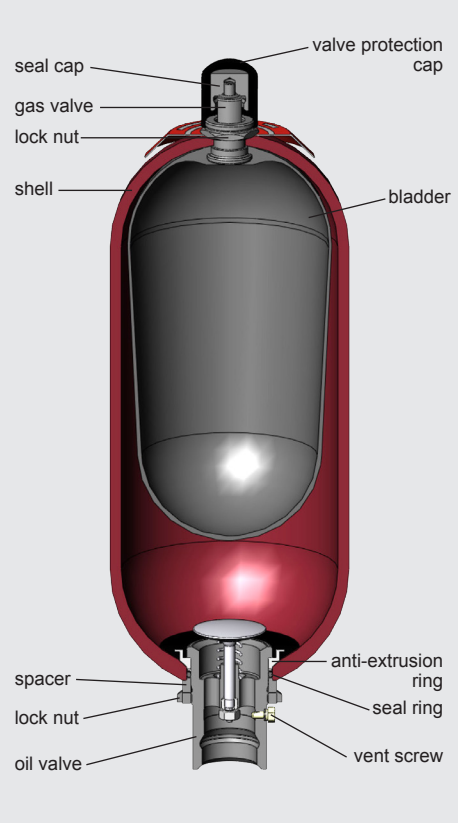
A bladder accumulator consists of a fluid section and a gas section with the bladder acting as the gas-proof screen. The fluid around the bladder is connected to the hydraulic circuit so that the bladder accumulator draws in fluid when the pressure increases and the gas is compressed.
When the pressure drops, the compressed gas expands and forces the stored fluid into the circuit.

HYDAC bladder accumulators can be used in a wide variety of applications, some of which are listed below:

- energy storage
- emergency operation
- force equilibrium
- leakage compensation
- volume compensation
- shock absorption
- vehicle suspension
- pulsation damping

See Catalogue section:
- Hydraulic Dampers
  No. 3.701

1.2. DESIGN



Design

- **Standard bladder accumulator SB330/400/500/550**
  The HYDAC standard bladder accumulators consists of the pressure vessel, the flexible bladder with gas valve and the hydraulic connection with check valve. The pressure vessels are seamless and manufactured from high tensile steel.
- **Bladder accumulator SB330N**
  The flow optimised design of the standard oil valve enables the maximum possible operating fluid flow rate to increase to 25 l/s on this accumulator type.
- **High flow bladder accumulator SB330H**
  HYDAC high flow bladder accumulators, type SB330H, are high performance accumulators with a flow rate of up to 30 l/s. The fluid connection is enlarged to allow higher flow rates.

1.3. BLADDER MATERIAL

The bladder material must be selected in accordance with the particular operating fluid or operating temperature, see section 2.1.
If discharge conditions are unfavourable (high p_2/p_0 pressure ratio, rapid discharge speed), the gas may cool to below the permitted temperature. This can cause cold cracking in the elastomer. The gas temperature can be calculated using the HYDAC Accumulator Simulation Program **ASP**.

1.4. CORROSION PROTECTION

For operation with chemically aggressive media, the accumulator shell can be supplied with corrosion protection, such as chemical nickel-plating. If this is insufficient, then stainless steel accumulators must be used.

1.5. INSTALLATION POSITION

HYDAC bladder accumulators can be installed vertically, horizontally and at a slant. When installing vertically or at a slant, the oil valve must be at the bottom. On certain applications listed below, particular positions are preferable:

- Energy storage: vertical,
- Pulsation damping: any position from horizontal to vertical,
- Maintaining constant pressure: any position from horizontal to vertical,
- Volume compensation: vertical.

If the installation position is horizontal or at a slant, the effective volume and the maximum permitted flow rate of the operating fluid are reduced.

1.6. TYPE OF INSTALLATION

By using an appropriate adapter, HYDAC accumulators, up to size 1 l, can be installed directly inline.

For strong vibrations and volumes above 1 litre, we recommend the use of HYDAC accumulator supports or the HYDAC accumulator installation set.

See catalogue sections:

- Supports for Hydraulic Accumulators No. 3.502
- ACCUSET SB No. 3.503

2. TECHNICAL SPECIFICATIONS

2.1. EXPLANATORY NOTES

2.1.1 **Operating pressure**

see tables in section 3.
(may differ from nominal pressure for foreign test certificates)

2.1.2 **Nominal volume**

see tables in section 3.

2.1.3 **Effective gas volume**

see tables in section 3.
Based on nominal dimensions, this differs slightly from the nominal volume and must be used when calculating the effective fluid volume.

2.1.4 **Effective fluid volume**

Volume of fluid which is available between the operating pressures p_2 and p_1.

2.1.5 **Max. flow rate of the operating fluid**

In order to achieve the max. flow rate given in the tables, the accumulator must be installed vertically. It must be noted that a residual fluid volume of approx. 10% of the effective gas volume remains in the accumulator. The maximum fluid flow rate was determined under specific conditions and is not applicable in all operating conditions.

2.1.6 **Operating temperature and operating fluid**

The permitted operating temperature of a bladder accumulator is dependent on the application limits of the metal materials and the bladder. Outside this temperature range, special material combinations must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-50 °C ... + 50 °C		
		9	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	-30 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
IIR	Butyl rubber	4	-50 °C ... +100 °C	● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
FKM	Fluorine rubber	6	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.2. Model code, material code, bladder accumulator

[2] others available on request

2.1.7 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 µm.
If other gases are to be used, please contact HYDAC for advice.

2.1.8 Limits for gas pre-charge pressure

$p_0 \leq 0.9 \bullet p1$

with a permitted pressure ratio of:
$p_2 : p_0 \leq 4 : 1$
p_2 = max. operating pressure
p_0 = pre-charge pressure

2.1.9 Certificate codes

Country	Certificate code (AKZ)
EU member states	U
Australia	F [1]
Belarus	A6
Canada	S1 [1]
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

[1] = Registration required in the individual territories or provinces.
others on request

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely vented.

Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

Please read the operating manual! No. 3.201.BA

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

- HYDAC Accumulator Technology No. 3.000

2.1.10 Gas side connection Standard

Series	Volume [l]	Gas valve type
SB330 / SB400	< 1	5/8-18UNF
	< 50	7/8-14UNF
	≥ 50	M50x1.5 / 7/8-14UNF

other pressure ranges on request

2.2. MODEL CODE

Not all combinations are possible. Order example.
For further information, please contact HYDAC.

SB330 (H) – 32 A 1 / 112 U – 330 A 050

Series

Type code
no details = standard
H = high flow
N = increased flow, standard oil valve dimensions
A = shock absorber
P = pulsation dampfer [3]
B = bladder top-repairable
E = bladder with foam filling
D = bladder integrity system
L = light-weight
Combinations must be agreed with HYDAC.

Nominal volume [l]

Fluid connection
A = standard connection, thread with internal seal face
F = flange connection
C = valve mounting with screws on underside
E = sealing surfaces on front interface (e.g. on thread M50x1.5 - valve)
G = male thread
S = special connection, to customer specification

Gas side
1 = standard design (see section 2.1.10)
2 = back-up version [4]
3 = gas valve 7/8-14UNF with M8 female thread
4 = gas valve 7/8-14UNF with gas valve connection 5/8-18UNF
5 = gas valve M50x1.5 in accumulators smaller than 50 l
6 = 7/8-14UNF gas valve
7 = M28x1.5 gas valve
8 = M16x1.5 gas valve (with M14x1.5 bore in gas valve)
9 = special gas valve, to customer specification

Material code
dependent on operating medium
standard model = 112 for mineral oils
others on request

Fluid connection
1 = carbon steel
2 = high tensile steel
3 = stainless steel [2]
6 = low temperature steel

Accumulator shell
0 = plastic coated (internally)
1 = carbon steel
2 = chemically nickel-plated (internal coating)
4 = stainless steel [2]
6 = low temperature steel

Bladder accumulator [1]
2 = NBR [5]
3 = ECO
4 = IIR
5 = NBR [5]
6 = FKM
7 = other
9 = NBR [5]

Certification code
U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Connection, fluid side
Thread, codes for fluid connections: A, C, E, G
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 B1.20.1 (NPT)
S = special thread, to customer specification
Flange, codes for fluid port: F
A = EN 1092-1 welding neck flange
B = flange ASME B16.5
C = SAE flange 3000 psi
D = SAE flange 6000 psi
S = special flange, to customer specification

Pre-charge pressure p_0 [bar] at 20 °C, must be stated clearly, if required!

[1] when ordering a replacement bladder, state diameter of smaller shell port
[2] dependent on type and pressure level
[3] see catalogue section Hydraulic dampers, no. 3.701
[4] see catalogue section Hydraulic accumulators with back-up nitrogen bottles, no. 3.553
[5] observe temperature ranges, see section 2.1.

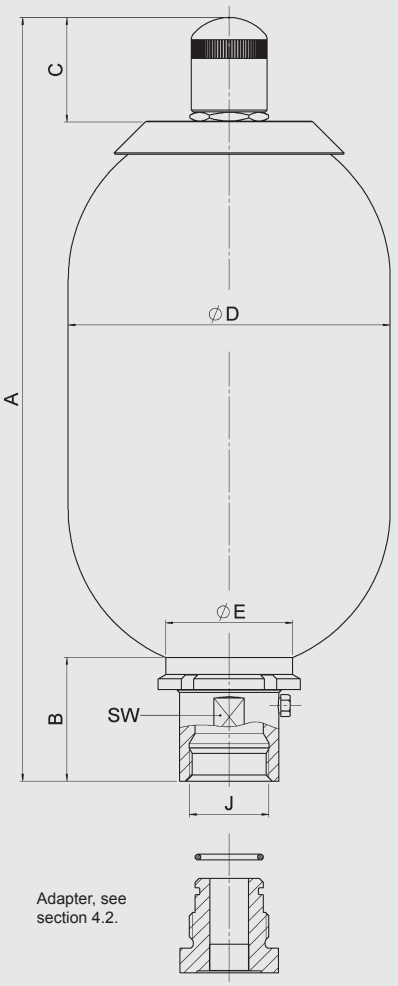
3. DIMENSIONS AND SPARE PARTS

3.1. DIMENSIONS

Nominal volume [l]	Type of valve, fluid side	Max. operating pressure (PED) [bar]	Eff. gas volume [l]	Weight approx. [kg]	A max. [mm]	B [mm]	C [mm]	Ø D max. [mm]	J thread ISO 228	Ø E [mm]	SW [mm]	Q [1] [l/s]
0.5	Standard	400	0.5	4	270	57	33.5	96	G 3/4	50	32	4
1		330	1	7	316		56	115				
		550		10	343	67		123	G 1	67	45	6
2.5		330	2.4	11	528	64		115	G 1 1/4		50	10
		550	2.5	14	550	67		123	G 1		45	6
4		330	3.7	15	412	65		170	G 1 1/4		50	10
		400										
5		550	4.9	17	876	64		123	G 1		45	6
6		330	5.7	18	534	65		170	G 1 1/4		50	10
10 [2]		330	9.3	31	810				G 1 1/4			
10	Standard	330	9.3	33	582	101	56	229	G 2	100	70	15
	N			34								25
	H		9	38	617	136			G 2 1/2	125	90	30
	Standard	400	9.3	41	578	101		234	G 2	100	70	15
		500	8.8	46	598		69	241				
13	Standard	330	12	46	695	101	56	229	G 2	100	70	15
	N			47								25
	H			45	730	136			G 2 1/2	125	90	30
	Standard	400		40	695	101		234	G 2	100	70	15
20	Standard	330	18.4	49	895	101	56	229	G 2	100	70	15
	N											25
	H		17.5	62	930	136			G 2 1/2	125	90	30
	Standard	400	18.4	71	895	101		234	G 2	100	70	15
		500	17	77	913		69	241		110	75	
24	Standard	330	23.6	72	1060	101	56	229	G 2	100	70	15
	N			73								25
	H		24	76	1095	136			G 2 1/2	125	90	30
32	Standard	330	33.9	80	1410	101	56	229	G 2	100	70	15
	N			81								25
	H		32.5	98	1445	136			G 2 1/2	125	90	30
	Standard	400	33.9	112	1410	101		234	G 2	100	70	15
		500	33.5		1423		69	241		110	75	
50	Standard	330	47.5	114	1933	101	69	229	G 2	100	70	15
	N			115								25
	H			128	1968	136			G 2 1/2	125	90	30
	Standard	400		137	1933	101		234	G 2	100	70	15
		500	48.3	167				241			75	
60	Standard	330	60	160	1210	138	69	360	G 2 1/2	125	90	30
80			85	200	1460							
100			105	234	1710							
130			133	283	2030							
160			170	345	2059	137		410				
200			201	403	2359							

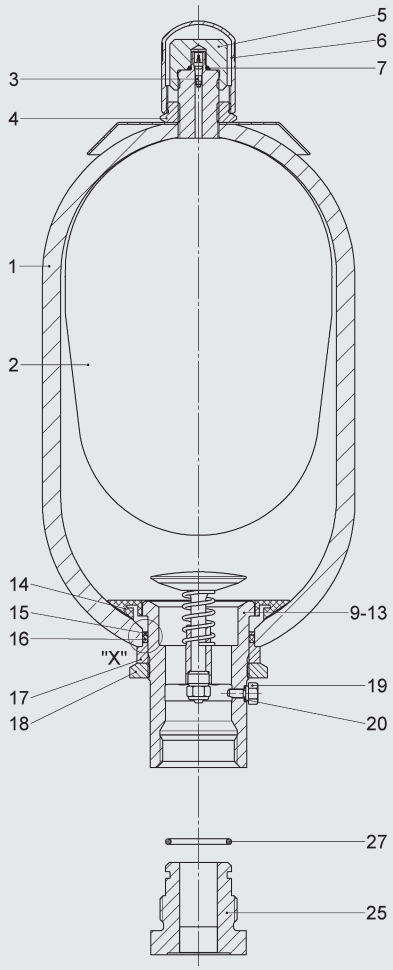
[1] Q =max. flow rate of the operating fluid under optimum conditions
[2] slimline version, for confined installation spaces

Dimensions

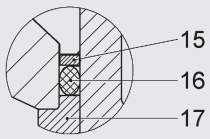


3.2. SPARE PARTS

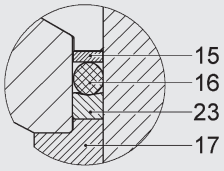
SB330/400/440/500/550
SB330H / SB330N



Detail "X"
SB330/400 – 0.5 ... 10 l



SB300/400/500 – 10 ... 200 l and
SB300H – 10 ... 50 l
SB550 – 1 ... 5 l



Description	Item
Bladder assembly consisting of:	
Bladder	2
Gas valve insert*	3
Lock nut	4
Seal cap	5
Protection cap	6
O-ring	7
Seal kit consisting of:	
O-ring	7
Washer	15
O-ring	16
Vent screw	19
Back-up ring	23
O-ring	27
Repair kit [1] consisting of:	
Bladder assembly (see above)	
Seal kit (see above)	
Anti-extrusion ring	14
Oil valve assembly consisting of:	
Valve assembly	9-13
Anti-extrusion ring	14
Washer	15
O-ring	16
Spacer	17
Lock nut	18
Bleed screw	19
Back-up ring	23

* available separately
[1] when ordering, please state diameter of the smaller shell port
Item 1 not available as a spare part
Item 19 for NBR/carbon steel: seal ring (item 20) included
Adapter (item 25) must be ordered as an accessory, see section 4.

SB300/400
NBR, carbon steel
Standard gas valve

Volume [l]	Bladder assembly	Seal kit	Repair kit
0.5	365263	353606	2128169 [2]
1	237624		2106261
2.5	236171	353609	2106200
4	236046		2106204
5	240917		2106208
6	2112097		2112100
10*	2127255		3117512
10	236088	353621	2106212
13	376249		2106216
20	236089		2106220
24	376253		2106224
32	235335		2106228
50	235290		2106252
60	3364274	3102043 [1]	3117513
80	3364312		3117514
100	3127313		3117515
130	3201384		3117516
160	3184769		3117517
200	3461300		3117558

* slimline version, for confined installation spaces
[1] only for SB330
[2] only for SB400
others on request

When replacing seals and/or bladders, please read the Instructions for Assembly and Repair (No. 3.201.M).

4. ACCESSORIES FOR BLADDER ACCUMULATORS

4.1. ADAPTERS (GAS SIDE)

The adapters shown below are available for standard connections on bladder accumulators and must be specified separately in the order.

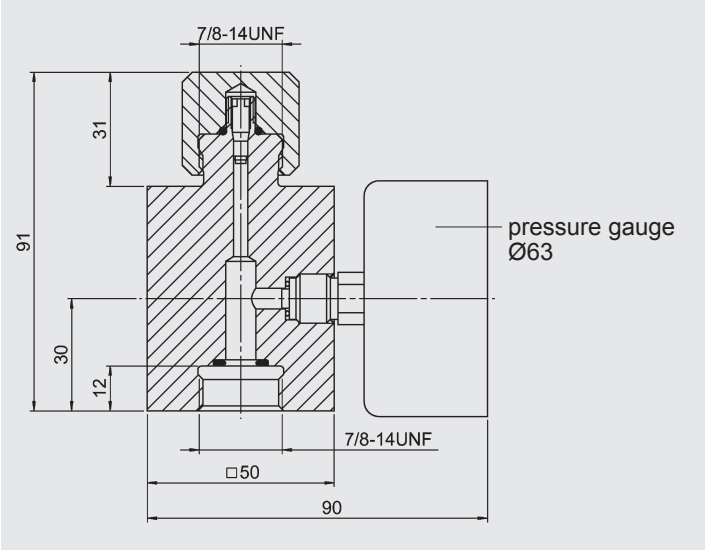
4.1.1 **Adapters for safety equipment**

Adapters for connecting of safety equipment, such as bursting disc or temperature fuse, see catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552

4.1.2 **Pressure gauge model**

Gas side connection on the bladder accumulator for permanent monitoring of the pre-charge pressure

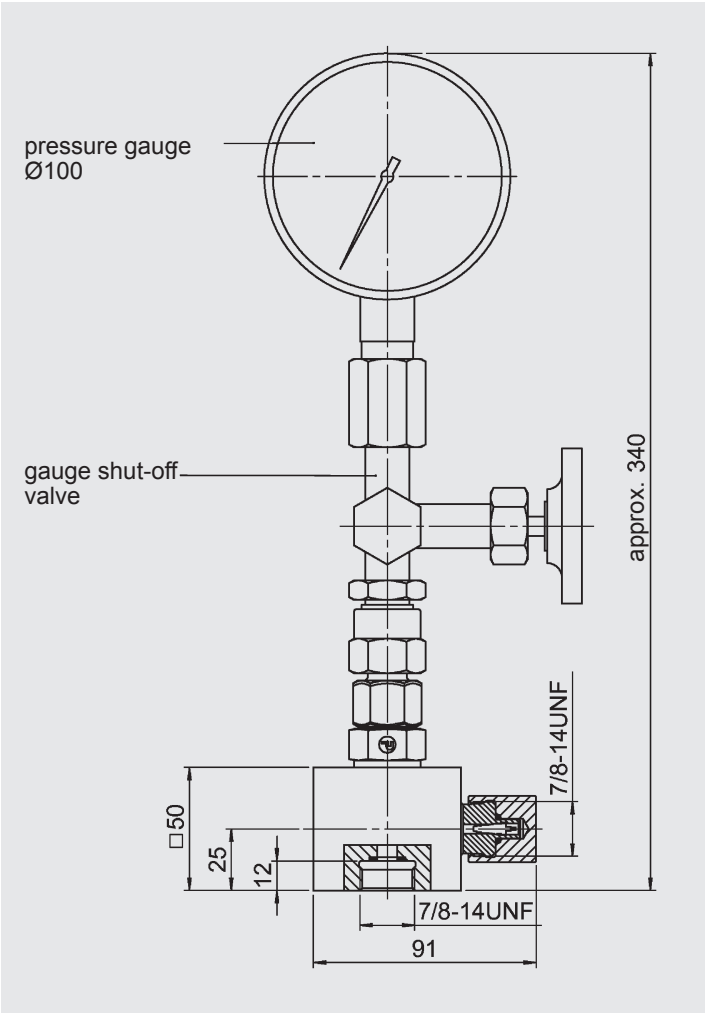


Gauge indication range	Pressure gauge Part no.	Adapter* assembly Part no.
–	–	366621
0 - 10 bar	614420	2108416
0 - 60 bar	606886	3093386
0 - 100 bar	606887	2104778
0 - 160 bar	606888	3032348
0 - 250 bar	606889	2100217
0 - 400 bar	606890	2102117

* p_{max} = 400 bar

4.1.3 **Pressure gauge model with shut-off valve**

Gas side connection on the bladder accumulator for permanent monitoring of the pre-charge pressure with shut-off option.



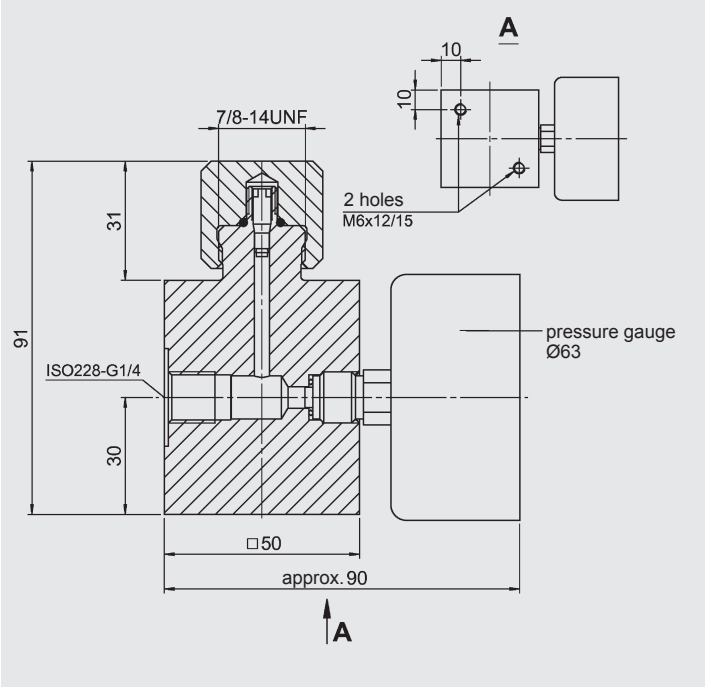
Gauge indication range	Pressure gauge Part no.	Adapter* assembly Part no.
–	–	2103381
0 - 25 bar	617928	3784725
0 - 60 bar	606771	2110059
0 - 100 bar	606772	3139314
0 - 160 bar	606773	3202970
0 - 250 bar	606774	3194154
0 - 400 bar	606775	2103226

* p_{max} = 400 bar

4.1.4 **Remote monitoring of the pre-charge pressure**

To monitor the pre-charge pressure in hydraulic accumulators remotely, gas side adapters with pressure gauge and mounting holes are available.

In order to connect these adapters directly with the hydraulic accumulator using appropriate lines, accumulator adapters are also available for connection at the top (see diagram 1) or for side-connection (see diagram 2).



Gauge indication range	Pressure gauge Part no.	Adapter* assembly Part no.
–	–	3037666
0 - 10 bar	614420	3095818
0 - 60 bar	606886	3095819
0 - 100 bar	606887	3095820
0 - 160 bar	606888	3095821
0 - 250 bar	606889	3095822
0 - 400 bar	606890	3095823

* p_{max} = 400 bar

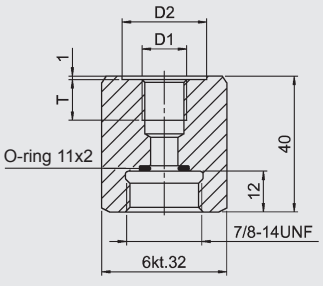


Diagram 1

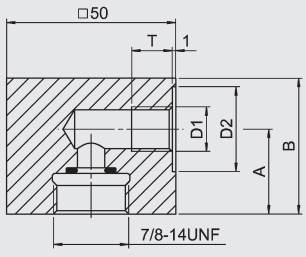


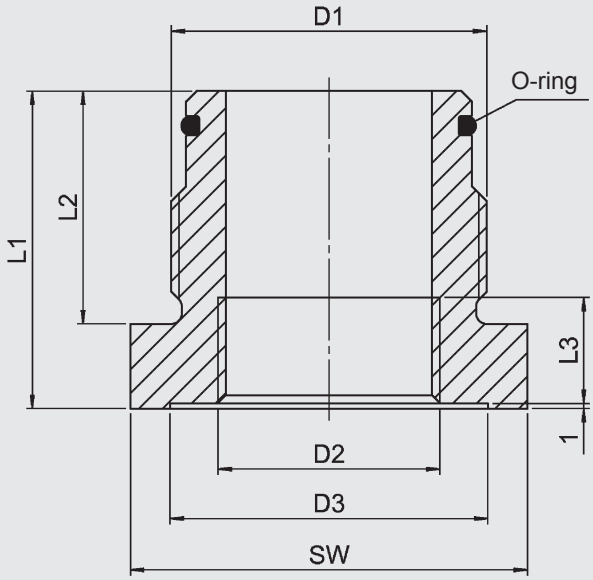
Diagram 2

D1 Threaded connection	D2 [mm]	T [mm]	A [mm]	B [mm]	Adapter* complete Part no.	Diag.
ISO228- G 1/4	25	14	-	-	2109481	1
			25	40	2102042	2
ISO228- G 3/8	28		-	-	2109483	1
			25	40	366607	2
ISO228- G 1/2	34	16	-	-	2110636	1
			31	55	366608	2

* p_{max} = 400 bar

4.2. ADAPTERS FOR STANDARD BLADDER ACCUMULATORS (FLUID SIDE)

To connect the bladder accumulator to pipe fittings.
These are available separately.



D1 Accum. conn.* ISO228-BSP	D2 ISO228-BSP	D3 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	SW [mm]	O-ring [mm]	Part no. NBR/ Carbon steel
G 3/4	G 3/8	28	55	28	12	32	17x3	2104346
	G 1/2		60		14	36		2104348
G 1 1/4	G 3/8	28	50	37	12	46	30x3	2116345
	G 1/2	34			14			2105232
	G 3/4	44			16			2104384
	G 1	50	67		18	65		2110124
G 2	G 3/4	44	60	44	16	65	48x3	2104849
	G 1	50			18			2124831
	G 1 1/4	60			20			2107113
	G 1 1/2	68	80		22	70		2105905
G 2 1/2	G 1 1/4	60	66	50	20	80	62x4	2127406
	G 1 1/2	68			22			3243831
	G 2	96	88		27	100		2113403

* others on request

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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Bladder Accumulators
High Pressure

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 bladder accumulators are based on this principle.

A bladder accumulator consists of a fluid section and a gas section with the bladder acting as the gas-proof screen.

The fluid around the bladder is connected to the hydraulic circuit so that the bladder 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.

HYDAC bladder accumulators can be used in a wide variety of applications and are also available in different pressure ranges, see catalogue sections:

- Bladder Accumulators
  Standard
  No. 3.201
- Bladder Accumulators
  Low Pressure
  No. 3.202
- HYDAC Accumulator Technology
  No. 3.000

1.2. DESIGN

The high pressure bladder accumulator consists of the pressure vessel, the flexible bladder with gas valve and the hydraulic connection with check valve.

1.2.1 **Shell material**

The forged pressure vessel is seamless and manufactured from high tensile chrome molybdenum steel.

1.2.2 **Bladder material**

The bladder material must be selected in accordance with the particular operating fluid or operating temperature, see section 2.2.
If discharge conditions are unfavourable (high p_2/p_0 pressure ratio, rapid discharge speed), the gas may cool to below the permitted temperature. This can cause cold cracking in the elastomer. The gas temperature can be calculated using the HYDAC Accumulator Simulation Program **ASP**.

1.2.3 **Corrosion protection**

For operation with chemically aggressive media, the accumulator shell can be chemically nickel-plated internally or supplied with a special plastic coating.

For external corrosion protection the accumulator can be supplied with an epoxy resin finish specially for offshore applications.

1.3. INSTALLATION POSITION AND TYPE OF INSTALLATION

Information on secure installation positions and mounting elements can be found in the following catalogue sections:

- Bladder Accumulators
  Standard
  No. 3.201
- Supports for Hydraulic Accumulators
  No. 3.502
- ACCUSET SB
  No. 3.503

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely vented.

Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

Please read the operating manual!
No. 3.201.BA

When replacing seals and/or bladders, please read the Instructions for Assembly and Repair (No. 3.201.M).

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

- HYDAC Accumulator Technology
  No. 3.000

2. TECHNICAL SPECIFICATIONS

2.1. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SB690 - 32 A 1 / 312 U - 690 D

Series

Nominal volume [l]

Fluid connection
A = standard connection

Gas-side connection
1 = standard design [1)]
9 = special design (example: 1/4" BSP)

Material code

Fluid connection
2 = high tensile steel
3 = stainless steel
6 = low temperature steel

Accumulator shell
0 = plastic coated (internally)
1 = carbon steel
2 = chemically nickel-plated (internal coating)
6 = low temperature steel
8 = plastic coated (e.g. Duroplast) internally and externally

Bladder accumulator
2 = NBR [2)]
3 = ECO
4 = IIR
5 = NBR [2)]
6 = FKM
7 = other
9 = NBR [2)]

Certification code
U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Connection
A = Thread to ISO228 (1/2" BSP)
D = Thread to ANSI B1.20.3 (1/2" NPTF)

Required gas pre-charge pressure must be stated separately!

[1)] Gas valve in SB < 10 l = 7/8 - 14 UNF,
in SB ≥ 10 l = M50x1.5
[2)] observe temperature ranges, see section 2.2.

2.2. EXPLANATORY NOTES

2.2.1 **Operating pressure**

690 bar (10000 psi)
higher pressures on request

2.2.2 **Operating temperature and operating fluid**

The permitted operating temperature of a bladder accumulator is dependent on the application limits of the metal materials and the bladder. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account.
The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-50 °C ... + 50 °C		
		9	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	-30 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
IIR	Butyl rubber	4	-50 °C ... +100 °C	● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
FKM	Fluorine rubber	6	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.1. Model code, material code, bladder accumulator

[2] others available on request

2.2.3 **Gas charging**

Hydraulic accumulators must only be charged with nitrogen.
Never use other gases.
Risk of explosion!

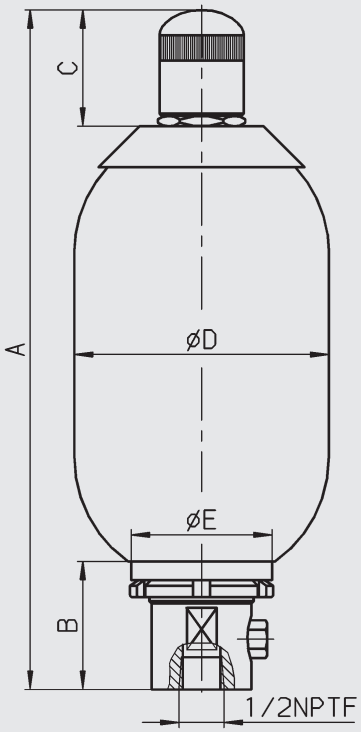
In principle, the accumulator may only be charged with nitrogen class 4.0, filtered to < 3 µm.

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

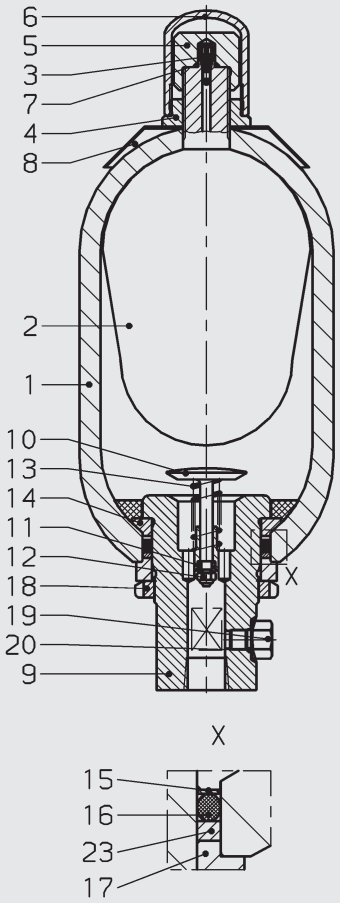
3. DIMENSIONS AND SPARE PARTS

3.1. DRAWINGS

3.1.1 Dimensions



3.1.2 Spare parts



3.2. DIMENSIONS

Max. operating pressure: 690 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight: [kg]	A max. [mm]	B [mm]	C [mm]	Ø D max. [mm]	Ø E [mm]	SW [mm]
1	1	8.5	324	61	58	122	67	45
2.5	2.5	13.5	531					
5	4.9	23	860					
10	9	54	522	77	68	250	110	75
20	17	114	865					
32	33.5	186	1385					
54	49.7	260	1900					

3.3. SPARE PARTS

3.3.1 Part numbers

NBR

Description	Item
Bladder assembly consisting of:	
Bladder	2
Gas valve insert	3
Retaining nut	4
Seal cap	5
Protection cap	6
O-ring	7
Seal kit consisting of:	
O-ring	7
Washer	15
O-ring	16
Bleed screw	19
Support ring	23
Repair kit consisting of:	
Seal kit (see above)	
Bladder assembly (see above)	
Anti-extrusion ring	14
Oil valve assembly consisting of:	
Valve assembly (items 9-13)	9
Anti-extrusion ring	14
Washer	15
O-ring	16
Spacer	17
Lock nut	18
Bleed screw	19
Support ring	23

Item 1 not available as a spare part

Nominal volume [l]	Seal kit Part no.	Bladder assembly Part no.	Repair kit Part no.	Anti-extrusion ring Part no.
1	3182615	3010110	3182617	293262
2.5		3211568	3201771	
5		3211569	3201772	
10	3182616	3120931	4102462	3028455
20		3211592	3211574	
32		3211571	3211585	
54		3116598	3211586	

4. NOTE

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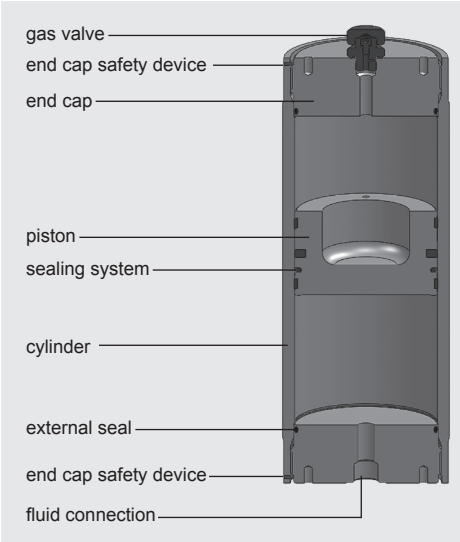
Piston Accumulators
Standard

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-proof screen.
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:

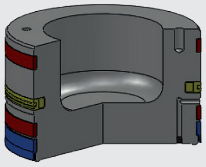
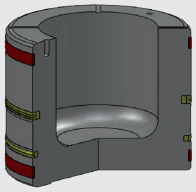
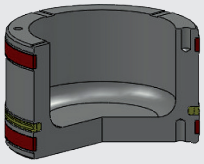
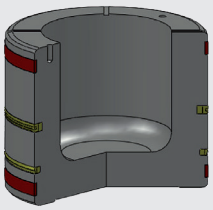
- A cylinder with very finely machined internal surface.
- End caps on the gas side and the oil side. Sealed with O-rings.
- A floating steel or aluminium piston which can easily be accelerated due to its low weight.
- A sealing system adapted to the particular application.
  The piston floats on two guide rings which 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 operating conditions is required in order to select the most appropriate sealing system. 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.

Piston design type		Application	Degree of contamination in the fluid	Comment
	1	● For general accumulator operation without special requirements Application limitations: max. piston velocity: 0.5 m/s	Optimized for applications with a high level of contamination	
	2	● Low-friction design ● For high piston speeds ● Slow movements without stick-slip effect Application limitations: max. piston velocity: 3.5 m/s	Filtration: NAS 1638 - Class 6 ISO 4406 - Class 17/15/12	
	3	● Low-friction design ● Simple-to-fit seals ● Slow movements without stick-slip effect Application limitations: max. piston velocity: 0.8 m/s		1 guide ring for pistons with Ø ≤ 150 mm 2 guide rings for pistons Ø ≥ 180 mm
	4	● Low-friction design with emergency safety features ● Slow movements without stick-slip effect ● Very low oil transfer to the gas side Application limitations: max. piston velocity: 5 m/s		

1.4. INSTALLATION POSITION

HYDAC piston accumulators operate in any position.
Vertical installation is preferable with the gas-side at the top, to prevent contamination 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 ≥ 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,
- gas-tight and leakage free,
- 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 adapter 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 density and the life expectancy 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 µm.
If other gases are to be used, please contact HYDAC for advice.

1.7.5 **Operating temperature and operating fluid**

The permitted operating temperature of a piston accumulator is dependent on the application limits of the metal materials and the piston. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

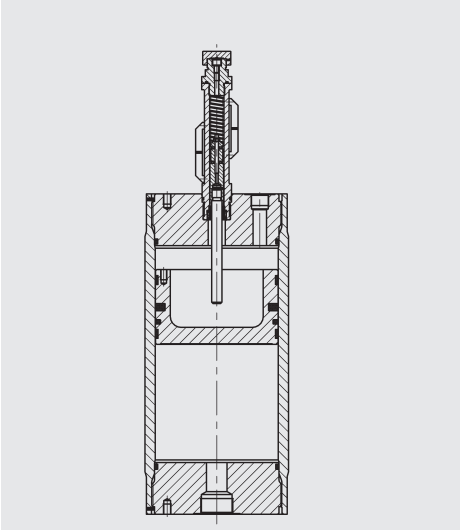
Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-20 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-40 °C ... + 80 °C		
PUR	Polyurethane	8	Standard application -30 °C ... + 80 °C Special application -40 °C ... +100 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFA	● Water and water-glycol mixture HFC ● Alkalis ● Acids
FKM	Fluorine rubber	6	-15 °C ... +160 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.2. Model code, material and piston code, material seals incl. piston

[2] 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 the piston and can only achieve a limited stroke, and an anti-magnetic housing and two or more switches.

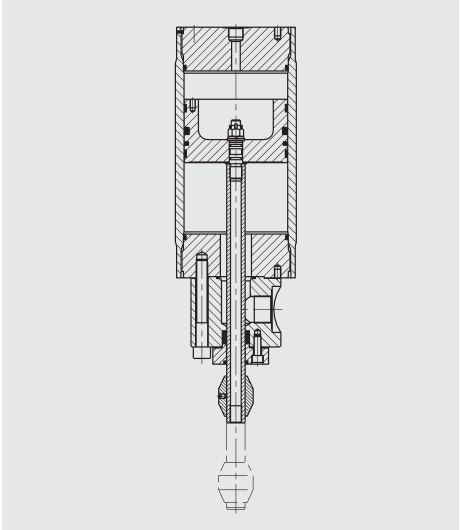
These switches can be normally closed or normally open or bistable. An N/C or N/O and a bistable switch cannot be fitted simultaneously to a limit switch. Our standard limit switch is fitted with a N/C and a N/O switch.

On another model, switching is carried out by inductive proximity switches.

The switch is reset by a spring or the force of gravity. Vertical mounting is preferable, due to the friction and possible wear and tear 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



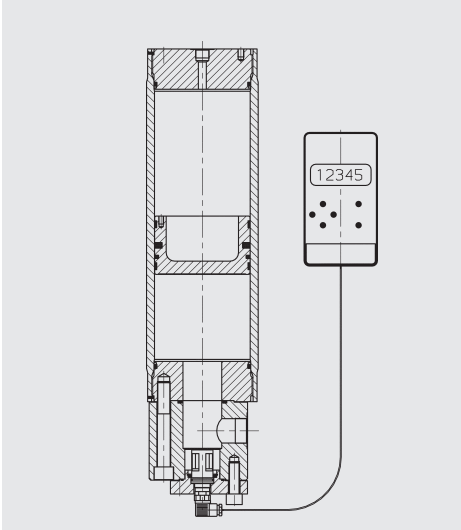
The protruding piston rod permits the position of the piston to be monitored over the whole stroke. It consists of the piston rod, which is fixed to the piston and sealed in, and what is known as the trip cam which actuates the limit switches.

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 piston to move in and out. The maximum piston velocity should not exceed 0.5 m/s.

1.8.3 Ultrasonic distance measurement



The piston position is determined by ultrasonic measurement.

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. turn the pump on and off.

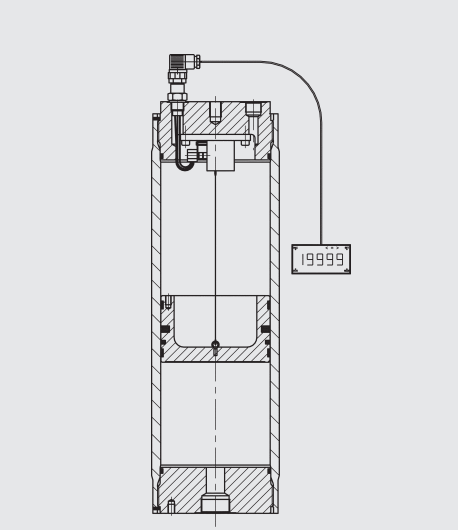
The most important features of the system are:

- Protection class IP 65 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.

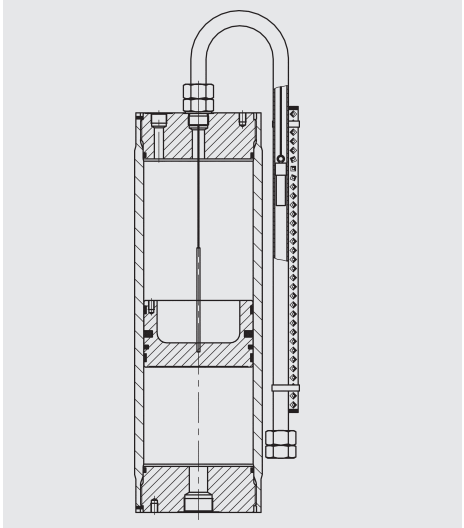
The cable is attached to a wheel which is tensioned by a spring. This wheel alters an electrical resistance via an attached rotary potentiometer during the piston movement. This resistance is converted by a transducer into an electrical signal so that it can be processed directly by a PLC system. The signal is supplied through the end cap via a pressure-tight cable gland. Alternatively various digital display units and transmitters 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 ... 30 g, and is limited to a max. velocity of 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 wiper. 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 flap indication

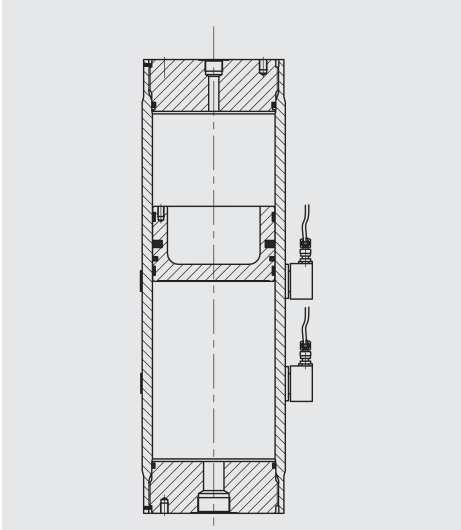


With magnetic flap indication, the position of a piston can be determined by the colour indicated by a set of magnetic flaps which are visible externally.

A non-magnetic tube installed externally on the piston accumulator contains a cable, one end of which is fastened to the gas side of the piston, and the other end is attached to a magnet. Movement in the cable causes red and white magnetic flaps to turn over.
As the piston moves, the change in colour of the flaps indicates the piston's position. When the piston moves in the direction of the gas side, the indicator moves towards 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 flap indication must only be installed vertically, 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 ultrasound.

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 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 fluid volume ΔV [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 [1]
Belarus	A6
Canada	S1 [1]
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

[1] Registration required in the individual territories or provinces

other fluids 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 type (see section 1.3.)

Piston material
1 = aluminium
2 = carbon steel
3 = stainless steel

Material of cylinder and end caps
1 = carbon steel
2 = carbon steel coated
3 = stainless steel
6 = carbon steel (low temperature)

Material seals incl. piston seals
2 = NBR [1] / PTFE compound
5 = NBR [1] / PTFE compound
6 = FKM / PTFE compound
8 = NBR [1] / 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 Table 2 + 3)
Size of connection (see Table 4 + 5)

Gas side connection or gas valve
Type of connection (see Table 1)
Standard or specification of the type of connection (see Table 2 + 3)
(no letter required with connection type V)
Size of connection (see Table 4; 5 + 6)

Piston diameter

04	= 40 mm	20	= 200 mm
05	= 50 mm	25	= 250 mm
06	= 60 mm	31	= 310 mm
08	= 80 mm	35	= 355 mm
10	= 100 mm	49	= 490 mm
12	= 125 mm	54	= 540 mm
15	= 150 mm	61	= 610 mm
18	= 180 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 flap 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!
[1] 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)

Table 4, Threaded model connection sizes

Type 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	G1 1/4	G1 1/2	G2	G2 1/2	G3
B	M10x1	M12x1.5	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M27x2	M33x2	M42x2	M48x2	M60x2
C	5/16-24UNF	3/8-24UNF	7/16-20UNF	1/2-20UNF	9/16-18UNF	3/4-16UNF	7/8-14UNF	1 1/16-12UNF	1 3/16-12UNF	1 5/16-12UNF	1 5/8-12UNF
D	1/16-NPTF	1/8-NPTF	1/4-NPTF	3/8-NPTF	1/2-NPTF	3/4-NPTF	1-11 1/2 NPTF	1 1/4-11 1/2 NPTF	11/2-11 1/2 NPTF	2-11 1/2 NPTF	2 1/2 - NPTF

Table 5, Flange model connection sizes

Type Table 3	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" - 1500 psi	1" - 1500 psi	1 1/2" - 1500 psi	2" - 1500 psi	2 1/2" - 1500 psi	3" - 1500 psi	1/2" - 2500 psi	1" - 2500 psi	1 1/2" - 2500 psi	2" - 2500 psi	2 1/2" - 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

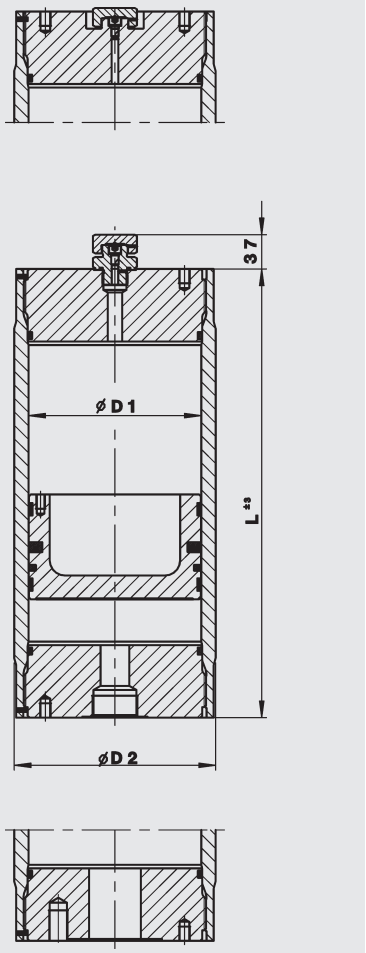
Code letter	Description
A	Gas valve G3/4 male, with M28x1.5/M8
B	Gas valve end connection M28x1.5/M8
C	Gas valve 1/2"-20UNF, male, with M16x2 (ISO 10945)
D	Gas valve M14x1.5 male with external M16x1.5 (Minimess)
E	Gas valve G3/4 male with 7/8-14UNF-VG8
F	Gas valve end connection M42x1.5/M12

Note:
Application examples, accumulator sizing 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 min. - max. [l]	Series	Perm. operating pressure (PED) [bar]	Ø D1 [mm]	Ø D2 [mm]	Length calculation [1] L = a + (b • V) a [mm]	b [mm/l]	Weight [2] min. - max. [kg]
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 – 550	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	580	700	5.3	1760 – 3180
	SK350	350					
300 – 3300	SK210	210	610	691	856	3.42	2500 – 11000
	SK350	350		710	950		

[1] The lengths calculated are usually rounded up or down in 5 mm increments
[2] Intermediate weights can be calculated approximately depending on the length/diameter required

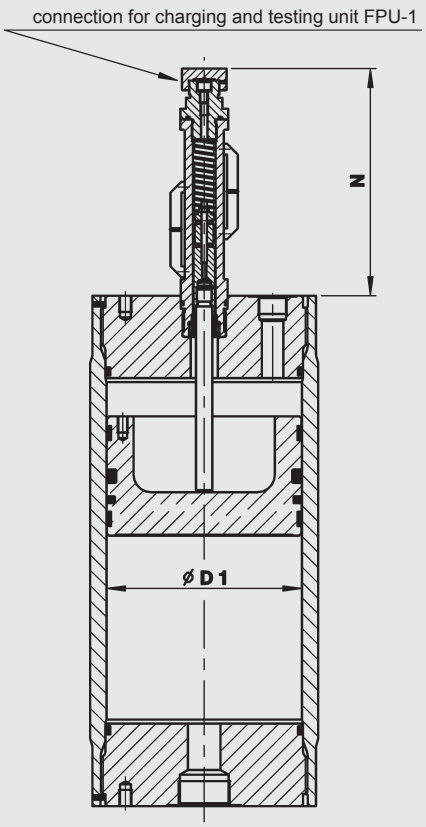
Other pressures, volumes, approvals etc possible on request.

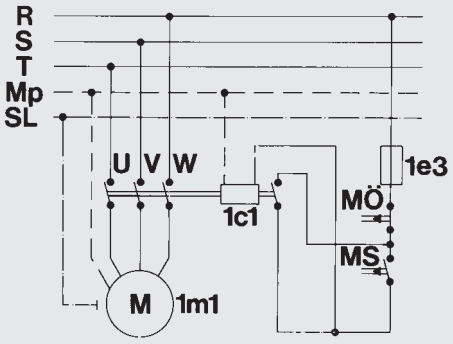
3.1.1 Effective gas volume V_0

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

Piston Ø D1	Piston design type			
	1	2	3	4
[mm]	Δ [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 [1] [l]	Series	Certification code U: Ø D1 [mm]	Gas side connection [2] ISO228	Fluid side connection [3]	Electrical limit switch stroke A = 35 mm: N [mm]	extra weight [kg]	B = 200 mm: N [mm]	extra weight [kg]	C = 500 mm: N [mm]	extra weight [kg]
0.2	SK350	60	-	-	electrical limit switch not possible					
0.5										
1										
0.5	SK350	80	-	-						
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									
	SK350									
20	SK350	200	G1	G 1 1/2	209	2.65	439	4.95	679	7.25
40										
100										
50	SK210	250	G 1 1/4	G 2	209	2.8	439	5.1	679	7.4
	SK350									
80	SK210									
	SK350									
120	SK210									
	SK350									
120	SK350	310	G 1 1/4	NW50	209	2.9	439	5.2	679	7.5
150										
200										
130	SK210	355	G 1 1/2	NW50	209	2.8	439	5.1	679	7.4
	SK350									
180	SK210									
	SK350									
250	SK210									
	SK350									
200	SK350	490	G 2	-	209	3	439	5.3	679	7.6
400										
600										

[1] volume details are examples, for others see section 3.1.
[2] standard connection for back-up type, others on request
[3] others on request
for further information, see section 1.7.

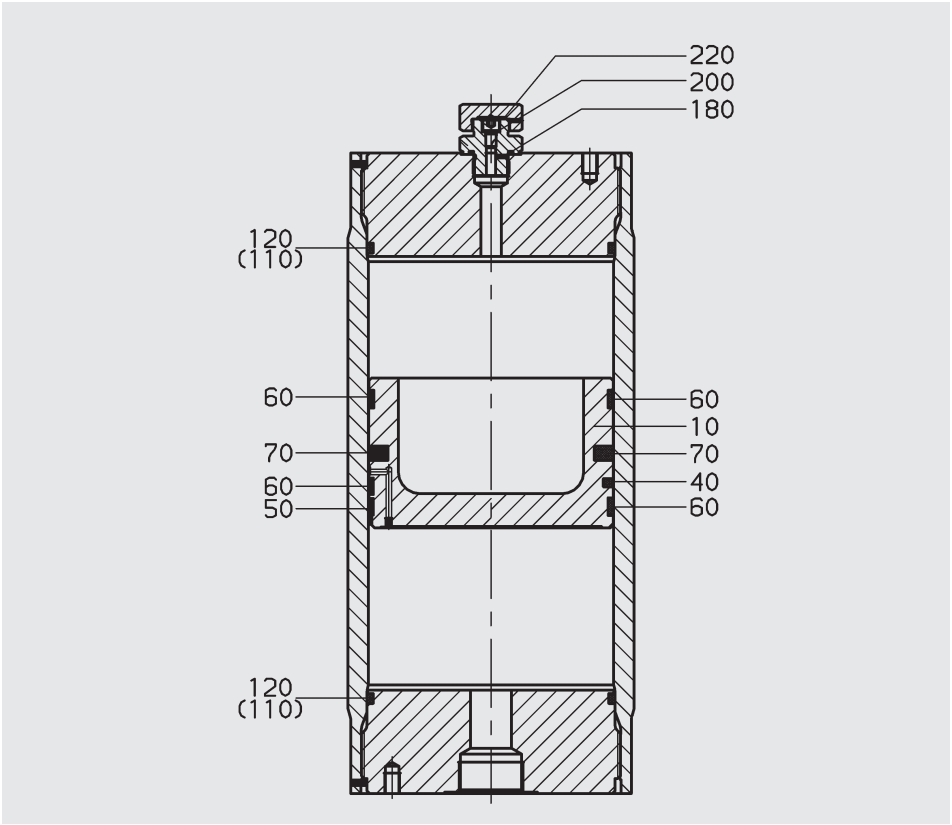
Table 7, Supplementary seal

Piston Ø [mm]	Type	NBR Part no.	FKM Part no.
All diam.	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, complete (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

Description	Qty.	Item
Piston assembly [2] consisting of:		
Piston	1	10
Seal ring	1	50
Guide ring	2	60
Centre seal	1	70
Seal kit assembly 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

Piston assembly [2] consisting of:		
Piston	1	10
Seal ring	1	40
Guide ring	2	60
Centre seal	1	70
Seal kit assembly 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

Piston assembly [2] consisting of:		
Piston	1	10
Guide ring [1]	1/2	60
Seal ring	1	70
Seal kit assembly consisting of:		
Guide ring [1]	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 int. Ø ≥ 310 mm
[1] Bottom guide ring, only for int. Ø = 180 mm and above
[2] Items (110,) 120, 180, 200 and 220 are supplied lose. Pressure resistant parts cannot be supplied as spares.

Spare parts for piston type 4 are available on request.

4.2. ASSEMBLY INSTRUCTIONS

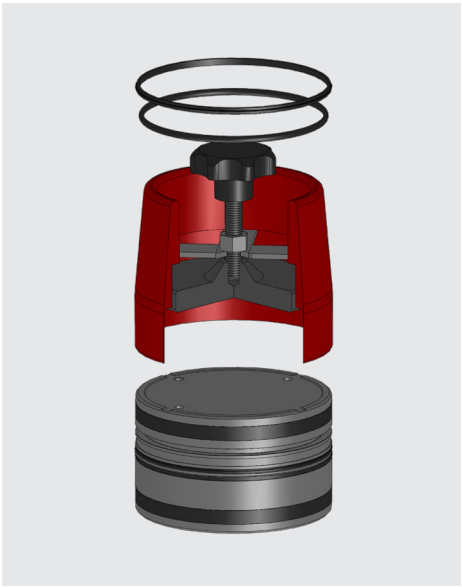
Before assembling or disassembling a piston accumulator or piston accumulator station, the system must always be depressurised.
The gas and fluid side must be depressurized and the gas valve unscrewed or opened before the accumulator is disassembled. Before the end caps are removed, ensure that the piston 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 staff.
On no account must any welding, soldering or mechanical work be carried out on the accumulator shell.
Please read the Operating Manual! No. 3.301.BA

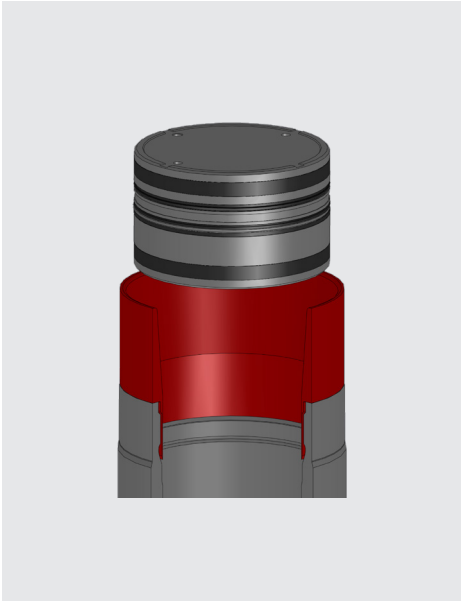
Assembly sleeves for piston accumulators (Table 11)

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) 2117672 (M110x3)
125	2128223
150	2124161 (SK210) 3680195 (SK350)
180	290049 (M186x3) 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/or operating conditions not described, please contact the relevant technical department.

Subject to technical modifications.

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E 3.301.16/03.16

Piston Accumulators
Series SK280

1. DESCRIPTION

1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

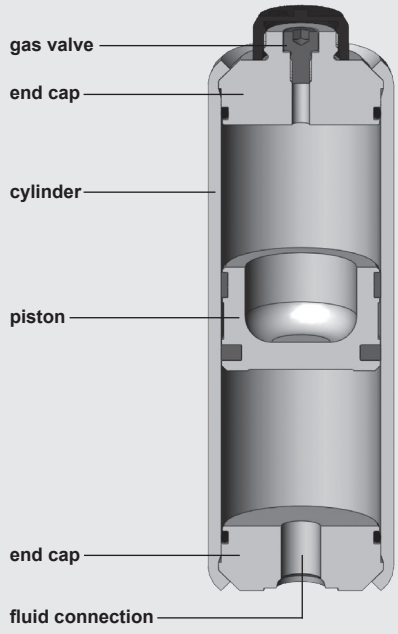
The compressibility of a gas (nitrogen) is utilised in hydraulic accumulators for storing fluids. HYDAC piston accumulators are based on this principle.

A piston accumulator consists of a fluid section and a gas section with the piston acting as the gas-proof screen. 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.
- a sealing system adapted to the particular application. The piston floats on two guide rings which prevent metal-to-metal contact between the piston and the accumulator wall. Suitable materials are also available for low temperature applications.

1.3. TYPE OF INSTALLATION

HYDAC can provide suitable accumulator clamps for the piston accumulator series SK280. The table at section 3 lists the appropriate clamps for each individual diameter. In order to prevent deformation of the cylinder, we recommend that the accumulators are mounted using two clamps, one at each end cap.

1.4. ADVANTAGES OF THE SK280

- Optimized production process, saving on material and manufacturing costs
- Reduced-weight series
- Reduced installation space
- Standard gas valve M28x1.5 integrated into end cap (non-refillable version possible)
- Endurance tested (function and fatigue tests)

1.5. DESIGN PRESSURE

- Standard 280 bar
- Manufactured and tested in accordance with European Pressure Equipment Directive (PED)

higher pressures on request

1.6. SEALING SYSTEM

- Piston type 3: NBR/PUR
- Temperature range:
  -30 °C to ... +80 °C
  Mobile special applications
  -40 °C to ... +100 °C

1.7. COMMISSIONING

Please read the Operating Manual!

- Piston accumulators
  No. 3.301.BA

For further information, please turn to the section:

- Piston Accumulators
  Standard
  No. 3.301

2. TECHNICAL SPECIFICATIONS

2.1. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SK280 - 1 / 3218 U - 280 AAD - VB - 05 - 030

Series

Nominal volume [l]

Material and piston code

Piston design type
(see section 1.6.)

Material: piston
2 = carbon steel

Material: cylinder and end caps
1 = carbon steel

Material: seals including piston seals
8 = NBR/PUR (polyurethane)

Certification code
U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Fluid connection
AAD = Threaded connection to ISO 228
Size G 1/2

AAE = Threaded connection to ISO 228
Size G 3/4

AAF = Threaded connection to ISO 228
Size G 1

ACE = Threaded connection to SAE J 514
Size 9/16-18 UNF, SAE #6

ACF = Threaded connection to SAE J 514
Size 3/4-16 UNF, SAE #8

ACH = Threaded connection to SAE J 514
Size 1 1/16-12 UN, SAE #12

ACK = Threaded connection to SAE J 514
Size 1 5/16-12 UN, SAE #16

Gas side connection or gas valve
VB = Gas valve type M28x1.5/M8 integrated into gas side end cap
000 = Non-refillable version (see drawing, section 3.1.) on request

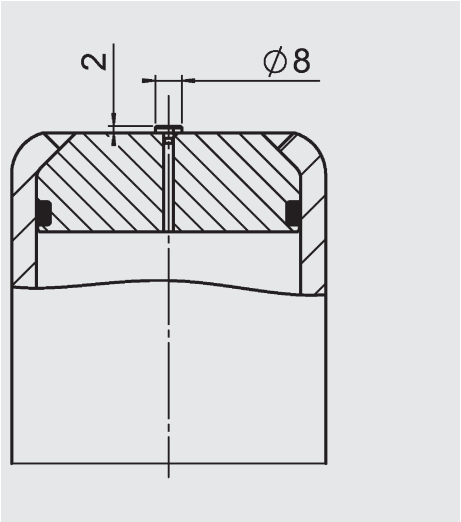
Piston diameter
05 = 50 mm

Pre-charge pressure p_0 [bar] at 20 °C, must be stated clearly, if required!

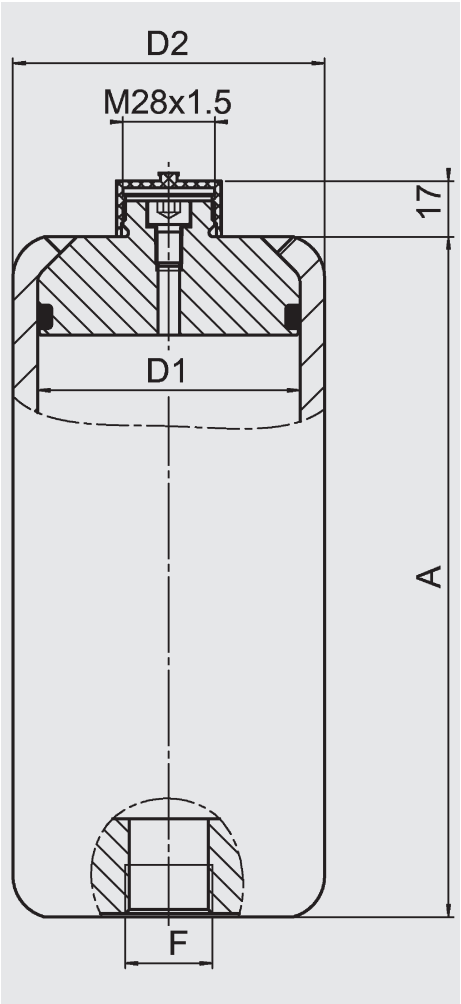
other sizes and versions on request

3. DIMENSIONS

3.1. TYPE -000-
(non refillable)



3.2. TYPE -VB-
(refillable)



Perm. operating pressure 280 bar (PED)
Carbon steel

Nominal volume [l]	D1 [mm]	D2 [mm]	A ±3 [mm]	F to ISO 228	Part no. [1]	F to SAE J 514	Part no. [1]	Weight [kg]	Mounting clamps [2]
0.16	50	60	160	G 1/2	3200525	9/16-18UNF	-	2	3018442 HRGKSM 0 R 58-61/62 ST
0.32			240		3200521		-	2.5	
0.5			335		3200528	3/4-16UNF	-	3.1	
0.75			460		3200522		-	4	
1			590		3200523		-	4.8	
0.32	60	75	205	G 1/2	3200524	3/4-16UNF	-	4	444912 HRGKSM 0 R 73-76/76 ST
0.5			265		3200546		-	4.7	
0.75			355		3200547		-	5.8	
1			445		3200548		-	6.9	
1.5			620		3200549		-	9.1	
2			800		3200550		-	11.4	
2.5			975		3200551		-	13.6	
0.5	80	95	210	G 3/4	3200552	1 1/16-12UN	-	6.5	444995 HRGKSM 0 R 92-95/96 ST
0.75			260		3200553		-	7.2	
1			310		3200554		-	8	
1.5			410		3200557		-	9.5	
2			510		3200558		-	11.5	
2.5			605		3200559		-	13	
3			705		3200560		-	14.5	
3.5			805		3200561		-	16	
4			905		3200562		-	17.5	
0.75	100	120	235	G 1	3200563	1 5/16-12UN	3984528	11.7	444505 HRGKSM 1 R 119-127/124 ST
1			265		3200564		3984529	12.5	
1.5			330		3200565		3984530	14.3	
2			395		3200566		3984531	16	
2.5			460		3984479		3984533	18	
3			520		3200568		3984534	19.5	
3.5			585		3984478		3984555	21.5	
4			650		3200569		3984556	23	
5			775		3200570		3984557	26.3	
6			900		3200571		3984558	30	
4	125	150	445	G 1	4092344	1 5/16-12UN	4092420	29	444321 HRGKSM 1 R 146-154/151 ST
5			528		4092395		4092421	32.5	
6			609		4092396		4092422	36	
7			691		4092397		4092423	39.5	
8			772		4092398		4092424	43	
9			854		4092399		4092445	46.5	
10			935		4092400		4092446	50	

[1] Preferred models, others on request

[2] Clamps must be mounted near the end caps in order to prevent deformation of the cylinder; for further information see following catalogue section:
- Supports for Hydraulic Accumulators No. 3.502

4. 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.
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Piston Accumulators
High Pressure

1. DESCRIPTION

1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

The compressibility of a gas is utilised in hydraulic accumulators for storing fluids.

HYDAC piston accumulators are based on this principle, using nitrogen as the compressible medium.

A piston accumulator consists of a fluid section and a gas section with the piston acting as the gas-proof screen. 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.

HYDAC piston accumulators can be used in a wide variety of applications and are also available in different pressure ranges, see also catalogue sections:

- Piston Accumulators
  Standard
  No. 3.301
- Piston Accumulators
  Series SK280
  No. 3.303

1.2. DESIGN

The high pressure piston accumulator consists of:

- a cylinder with very finely machined internal surface,
- end caps on the gas side and the oil side,
- O-ring seals,
- floating metal piston,
- high pressure sealing system.

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

For use with aggressive or corrosive fluids, the parts coming into contact with the fluid can be made of 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,
- Actual pressure differential,
- Switching frequency or cycles,
- Piston velocity,
- Operating temperature,
- Operating fluid,
- Cleanliness of fluid (micron rating of filter),
- Maintenance requirements.

On high pressure piston accumulators, a modified version of piston Type 2 is used, developed for applications up to 1000 bar. Hydraulic accumulators must only be operated using hydraulic fluids which are filtered to the following cleanliness class:

- NAS 1638 Class 6 or
- ISO 4406 Class 17/15/12.

1.4. INSTALLATION POSITION AND TYPE OF INSTALLATION

HYDAC piston accumulators operate in any position. Vertical installation with the gas-side uppermost is preferable, to prevent contamination from the fluid settling on the piston seals.

Information on secure installation and mounting elements can be found in the following catalogue sections:

- Piston Accumulators
  Standard
  No. 3.301
- Supports for Hydraulic Accumulators
  No. 3.502

Please read the operating manual!
No. 3.301.BA

2. TECHNICAL SPECIFICATIONS

2.1. EXPLANATORY NOTES

2.1.1 **Operating pressure**

690 bar / 800 bar / 1000 bar
others on request

2.1.2 **Operating temperature**

-20 °C ... +50 °C
others on request

2.1.3 **Operating temperature and operating fluid**

The permitted operating temperature of a piston accumulator is dependent on the application limits of the metal materials and the piston. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-20 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant ● Fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-40 °C ... + 80 °C		
FKM	Fluorine rubber	6	-15 °C ... +160 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.2. Model code, material and piston code, material seals incl. piston

[2] others available on request

2.1.4 **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 µm.
If other gases are to be used, please contact HYDAC for advice.

2.2. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SK690 – 1 / 2212 U – 690 ADE – VB – 08 UP2 – 1 – 300

Series

Nominal volume [l]

Material and piston code

Piston design type

High-pressure version, piston 2 (see section 1.3.)

Piston material

2 = carbon steel
3 = stainless steel

Material of cylinder and end caps

1 = carbon steel
3 = stainless steel

Material of seals including piston seals

2 = NBR [1] / PTFE
6 = FKM / PTFE

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 Table 2)
Size of connection (see Table 3)

Gas side connection or gas valve

Type of connection (see Table 1)
Standard or specification of the type of connection (see Table 2)
Size of connection (see Table 3)

Piston diameter

08 = 80 mm
12 = 125 mm
15 = 150 mm
18 = 180 mm

Supplementary equipment*

M = magnetic flap indication
UP.. = piston position switch
(e.g. UP2 = 2 position switches, UPEX = Atex version)

Safety equipment*

1 = bursting disc (please give nominal pressure and temperature)

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

* if required, please state at time of ordering!
[1] observe temperature ranges, see section 2.1.3

Table 1, Connection type

Code letter	Description
A	Threaded connection (female) → table 2 and then 3
K	High pressure port → table 4
V	Gas valve port → table 5
S	Special port on request

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, Threaded connection sizes

Type Table 2	Code letter, size						
	A	B	C	D	E	F	G
A	G 1/8	G 1/4	G 3/8	G 1/2	G 3/4	G 1	G 1 1/4
B	M10x1	M12x1.5	M14x1.5	M16x1.5	M18x1.5	M22x1.5	M27x2
C	5/16-24UNF	3/8-24UNF	7/16-20UNF	1/2-20UNF	9/16-18UNF	3/4-16UNF	7/8-14UNF
D	1/16-27 NPTF	1/8-27 NPTF	1/4-18 NPTF	3/8-18 NPTF	1/2-14 NPTF	3/4-14 NPTF	1-11 1/2 NPTF

Table 4, Connection size for preferred high pressure ports (e.g. Maximator)

	Code letter, size						
	KCQ	KCR	KCT	KUR	KUY	KWB	KWP
1st connection	13/16-16UNF (9MF)	13/16-16UNF (9MF)	9/16-18UNF (6MF)	9/16-18UNF (6MF)	1 3/8-12UNF (16MF)	9/16-18UNF (6MF)	3/4-16UNF (6HF)
2nd connection	13/16-16UNF (9MF)	-	-	9/16-18UNF (6MF)	-	G 3/4-ISO228	-

Other connections on request

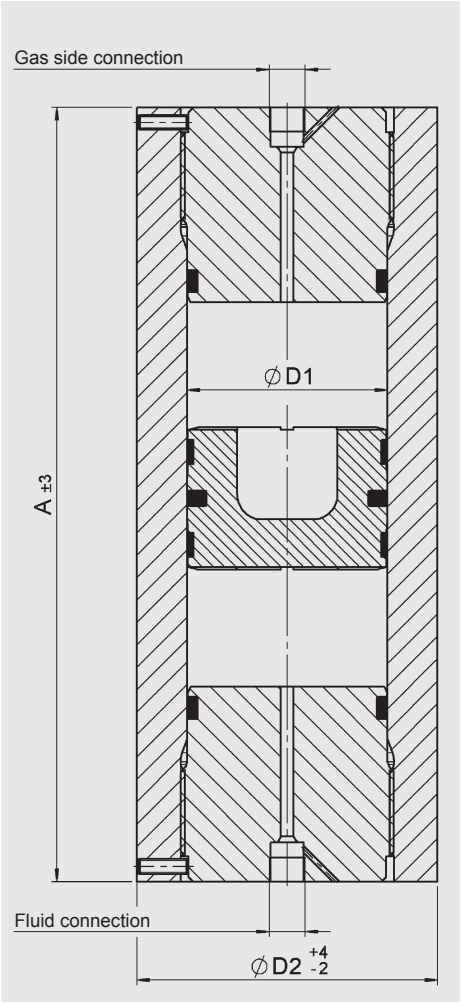
Table 5, gas valve port

Code letter	Description
B	Gas valve end connection M28x1.5/M8 (max. pre-charge pressure 800 bar with FPU-2)
M	Gas valve, male, for high pressure port 9/16-18UNF (6MP) (no limit for pre-charge pressure)

Note:
Application examples, accumulator sizing and extracts from approvals regulations on hydraulic accumulators can be found in the following catalogue section:

- HYDAC Accumulator Technology
  No. 3.000

3. DIMENSIONS



3.1. SERIES: SK690

Max. permitted operating pressure: 690 bar (PED)

Volume [l]	Ø D1 [mm]	Ø D2 Carbon steel [mm]	Ø D2 Stainless steel [mm]	A [mm]	Approx. weight Carbon steel [kg]	Approx. weight Stainless steel [kg]
0.5 - 10	80	107	110	280 - 2170	15 - 74	16 - 83
1 - 20	125	160	160	295 - 1845	37 - 133	37 - 133
5 - 30	150	190	200	535 - 1950	75 - 194	88 - 241
5 - 50	180	246	220	480 - 2250	136 - 443	94 - 269

3.2. SERIES: SK800

Max. permitted operating pressure: 800 bar (PED)

Volume [l]	Ø D1 [mm]	Ø D2 Carbon steel [mm]	Ø D2 Stainless steel [mm]	A [mm]	Approx. weight Carbon steel [kg]	Approx. weight Stainless steel [kg]
0.5 - 10	80	107	110	280 - 2170	15 - 74	16 - 83
1 - 20	125	162	160	295 - 1845	38 - 140	37 - 133
5 - 30	150	185	200	535 - 1990	80 - 182	87 - 240
5 - 50	180	246	224	480 - 2250	136 - 443	100 - 293

3.3. SERIES: SK1000

Max. permitted operating pressure: 1000 bar (PED)

Volume [l]	Ø D1 [mm]	Ø D2 Carbon steel [mm]	Ø D2 Stainless steel [mm]	A [mm]	Approx. weight Carbon steel [kg]	Approx. weight Stainless steel [kg]
0.5 - 10	80	120	119	310 - 2200	23 - 117	22 - 113
1 - 20	125	172	164	295 - 1840	44 - 178	40 - 148
5 - 30	150	200	250	575 - 1990	100 - 253	179 - 529
5 - 50	180	246	280	555 - 2325	168 - 475	229 - 732

4. NOTE

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

1. DESCRIPTION

1.1. FUNCTION

Fluids are practically incompressible and cannot therefore store pressure energy.

The compressibility of a gas is utilised in hydraulic accumulators for storing fluids. HYDAC diaphragm accumulators are based on this principle, using nitrogen as the compressible medium.

Diaphragm accumulators consist of a fluid section and a gas section with the diaphragm acting as a gas-proof screen.

The fluid section is connected to the hydraulic circuit so that the diaphragm 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.

Set into the base of the diaphragm is a valve poppet. This shuts off the hydraulic outlet when the accumulator is completely empty and thus prevents damage to the diaphragm.

Note:
HYDAC diaphragm accumulators when fitted with a HYDAC Safety and Shut-off Block comply with the regulations of the European Pressure Equipment Directive (PED) and the German Industrial Safety Regulations (Betr.Sich.V.).

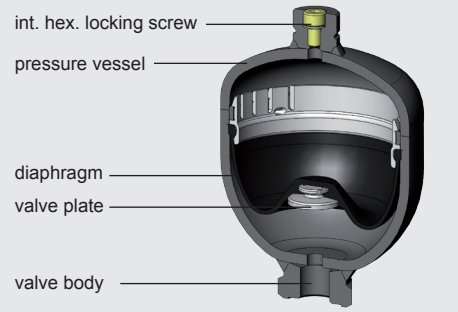
See catalogue section:

- Safety and Shut-off Block SAF/DSV No. 3.551

1.2. DESIGN

HYDAC diaphragm accumulators are available in two versions.

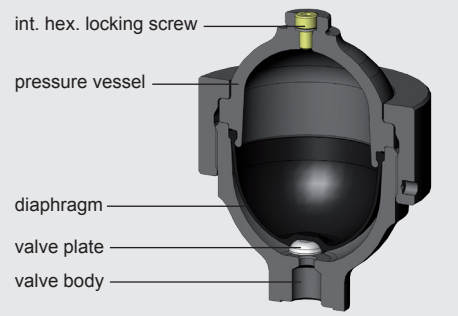
1.2.1 **Weld type**



This consists of:

- Welded pressure vessel, rechargeable on the gas side or, alternatively, completely sealed. Fluid connection available in various types.
- Flexible diaphragm to separate the fluid and gas sections.
- Valve poppet set into the base of the diaphragm.

1.2.2 **Screw type**



This consists of:

- Forged upper section with gas charging connection.
- Forged lower section with fluid connection.
- Exchangeable flexible diaphragm to separate the gas and fluid.
- Vulcanized valve poppet set into the base of the diaphragm.
- Lock nut to hold the upper and lower sections of the accumulator together.

1.2.3 **Diaphragm materials**

The diaphragm material must be selected in accordance with the particular operating fluid or operating temperature, see section 1.5.
If discharge conditions are unfavourable (high p_2/p_0 pressure ratio, rapid discharge speed), the gas may cool to below the permitted temperature. This can cause cold cracking in the elastomer. The gas temperature can be calculated using the HYDAC Accumulator Simulation Program **ASP**.

1.2.4 **Corrosion protection**

For use with chemically aggressive fluids the accumulator can be supplied with corrosion protection, such as plastic coating or a galvanic or chemical surface protection. If this is insufficient, then almost all types can be supplied in stainless steel.

1.3. INSTALLATION POSITION

Optional. However, if there is a risk of contamination collecting, a vertical position is preferable (fluid connection at the bottom).

1.4. TYPE OF INSTALLATION

Accumulators up to 2 l can be screwed directly inline.

Where strong vibrations are expected, the accumulator must be secured to prevent it working loose. For weld type accumulators we recommend HYDAC support clamps. For screw type accumulators with lock nut, a suitable support console can be ordered.

For additional male thread on the hydraulic connection for screwing into mounting holes, see table 3.1.

See catalogue section:

- Supports for Hydraulic Accumulators No. 3.502

1.5. GENERAL

1.5.1 **Permitted operating pressure**
see tables 3.1. and 3.2.

The permitted operating pressure can differ from the nominal pressure for foreign test certificates.

1.5.2 **Nominal volume**
see tables 3.1. and 3.2.

1.5.3 **Effective gas volume**
Corresponds to the nominal volume of the diaphragm accumulator.

1.5.4 **Effective fluid volume**
Volume of fluid which is available between the operating pressures p_2 and p_1.

1.5.5 **Gas charging**
All accumulators are supplied with a protective pre-charge. Higher gas pre-charge pressures are available on request (gas charging screw or sealed gas connection).

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 µm.

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

1.5.6 **Limits for gas pre-charge pressure**

$p_0 \leq 0.9 \bullet p_1$

For diaphragm accumulators with PTFE diaphragms, the following applies:
$p_{0tmax} \leq 200$ bar

For further information, see catalogue section:

- HYDAC Accumulator Technology No. 3.000

1.5.7 **Permitted pressure ratio**
Ratio of maximum operating pressure p_2 to gas pre-charge pressure p_0.

1.5.8 **Max. flow rate of the operating fluid**
In order to achieve the max. flow rate given in the tables, a residual fluid volume of approx. 10 % of the effective gas volume must remain in the accumulator.

The maximum fluid flow rate was determined under specific typical conditions and is not applicable in all operating conditions.

1.5.9 **Operating temperature and operating fluid**
The permitted operating temperature of a diaphragm accumulator is dependent on the application limits of the metal materials and the diaphragm. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-50 °C ... + 50 °C		
		9	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	-40 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
IIR	Butyl rubber	4	-50 °C ... +120 °C	● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
FKM	Fluorine rubber	6	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 2.1. Model code, material code, diaphragm

[2] others available on request

1.5.10 **Certificate codes**

Hydraulic accumulators which are installed in countries outside Germany are supplied with the test certificates required in that country. The user country must be stated at the time of ordering.

HYDAC pressure vessels can be supplied with virtually any test certificate.

Please note that the permitted operating pressure can differ from the nominal pressure.

The following table contains a few examples of the codes used in the model code for different countries of installation.

Country	Certificate code (AKZ)
EU member states	U
Australia	F [1]
Belarus	A6
Canada	S1 [1]
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

[1] Registration required in the individual territories or provinces.

others on request

On no account must any welding, soldering or mechanical work be carried out on the accumulator shell. After the hydraulic line has been connected it must be completely bled. Work on systems with hydraulic accumulators (repairs, connecting pressure gauges etc.) must only be carried out once the fluid pressure has been released.

Please read the Operating Manual! No. 3.100.BA

Note:

Application examples, accumulator sizing and extracts from approvals regulations on hydraulic accumulators can be found in the catalogue section:

- HYDAC Accumulator Technology No. 3.000

2. TECHNICAL SPECIFICATIONS

2.1. MODEL CODE

Not all combinations are possible. Order example.
For further information, please contact HYDAC.

SBO210 – 2 E1 / 112 U – 210 AK 050

Series

Nominal volume [l]

Type

Weld type:
E1 = rechargeable M28x1.5
E2 = sealed gas connection, with gas pre-charge as requested [3]
E3 = rechargeable, gas valve M16x1.5 / M14x1.5

Screw type
A6 = rechargeable M28x1.5, exchangeable diaphragm
A3 = gas valve M16x1.5 / M14x1.5, exchangeable diaphragm

Material code
dependent on operating medium
standard model = 112 for mineral oils

Fluid connection
1 = carbon steel
3 = stainless steel
4 = carbon steel with protective coating [1]
6 = low-temperature steel
7 = other materials

Accumulator shell
0 = plastic coating
1 = carbon steel
2 = carbon steel with protective coating [1] [2]
4 = stainless steel
6 = low-temperature steel
7 = other materials

Diaphragm
2 = NBR [4]
3 = ECO
4 = IIR
5 = NBR [4]
6 = FKM
7 = other materials (e.g. PTFE, EPDM, ...)

Certification code
U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Fluid connection form
Standard connection = AK or AB
e.g. Form AK = G 3/4
for SBO210-2 see section 3.

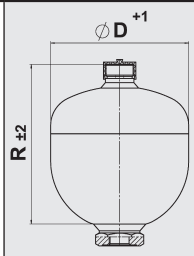
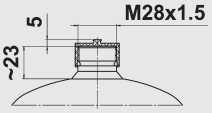
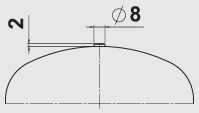
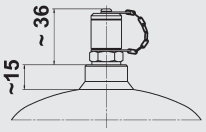
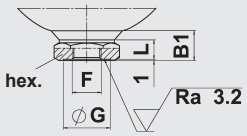
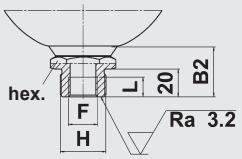
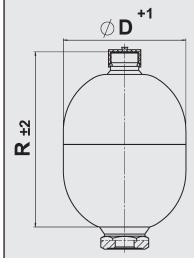
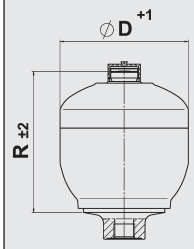
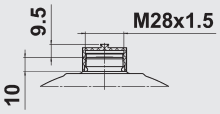
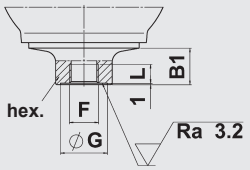
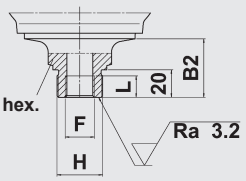
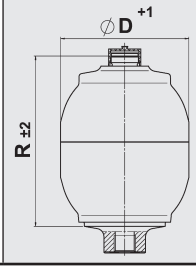
Pre-charge pressure p_0 [bar] at 20 °C, must be stated clearly, if required! [3]

[1] only for screw-type design
[2] only for parts that come into contact with fluid
[3] only for E1 or E2 design, when ordered as standard
[4] observe temperature ranges, see section 1.5.

3. TECHNICAL SPECIFICATIONS

3.1. WELD TYPE
– non-exchangeable diaphragms –

3.1.1 Drawings

Diag.	Type	Gas side connection			Fluid side connection*	
		E1	E2	E3	AK	AB
1						
2			–			
3			on request			
4			–			

* = alternative fluid connections on request

3.1.2 **Dimensions**

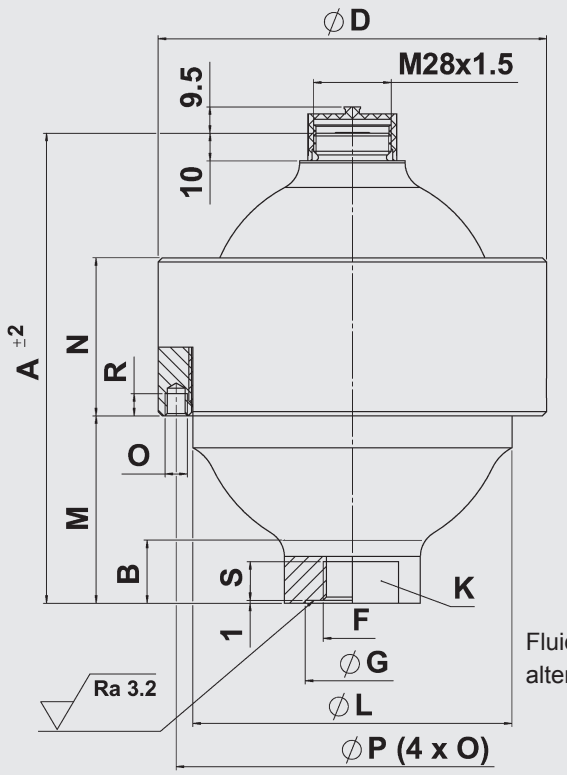
Nom. vol. [1] [l]	Perm. press. ratio $p_2 : p_0$	Series	Certificate code U Permitt. oper. pressure [bar] Carbon steel	Stainless steel	R [mm]	ØD [mm]	Weight [kg]	Q [2] [l/min]	Standard fluid connection Form AK F ISO 228	ØG [mm]	L [mm]	B1 [mm]	hex. SW	Form AB F ISO 228	H DIN 13	L [mm]	B2 [mm]	hex. SW	Diag.
0.075	8 : 1	250	250	–	91	64	0.7	38	G 1/2	–	14	21	30	not available					1
0.16	8 : 1	210	210	180	103	74	0.8	38	G 1/2	–	14	21	30						1
		300	300	–	108	78	1.1												
0.32	8 : 1	210	210	160	116	93	1.3	95	G 1/2	–	14	21	30						1
		300	300	–	120	96	1.8												
0.5	8 : 1	160	160	–	130	102	1.3	95	G 1/2	–	14	21	30	G 1/2	M33x1.5	14	37	41	1
		210	210	–	133	105	1.7												
0.6	8 : 1	330	330	–	151	115	3.3	95	G 1/2	34	14	21	41	G 1/2	M33x1.5	14	37	41	1
		350	350	–	130	121	3.5						50					50	3
0.7	8 : 1	100	100	–	151	106	1.8	95	G 1/2	34	14	21	41	G 1/2	M33x1.5	14	37	41	1
0.75	8 : 1	140	140	–	142	116	1.8	95	G 1/2	34	14	21	41	G 1/2	M33x1.5	14	37	41	1
		210	210	140	147	121	2.8												
		250	250	–	152	126	3.6									15	42		
		330	330	–	140	126	4					26							3
1	8 : 1	200	200	–	159	136	3.6	95	G 1/2	34	14	21	41	G 1/2	M33x1.5	14	37	41	1
	4 : 1	250	250	–	192	126	4.4												2
		330	330	–	169		4.8					26				15	42		4
1.4	8 : 1	140	140	–	173	145	3.9	95	G 1/2	34	14	21	41	G 1/2	M33x1.5	14	37	41	1
		210	210	–	178	150	5.4												
		250	250	–	185	153	5.9									15			
		330	330	–	172	155	7.6					33					42		3
2	8 : 1	100	100	100	190	160	4	150	G 3/4	44	16	28	46	G 3/4	M45x1.5	16	33	46	1
		210	210	–	198	167	6.6												
	4 : 1	250	250	–	232	153	7.4												2
	8 : 1	330	330	–	181	172	9.2					43					42		3
2.8	4 : 1	210	210	–	250	167	8.2	150	G 3/4	44	16	28	46	G 3/4	M45x1.5	16	33	46	2
		250	250	–	250	170	9.5												
		330	330	–	237	172	11					43					42		4
	6 : 1				231							44							3
3.5	4 : 1	250	210	–	306	170	11.2	150	G 3/4	44	16	28	46	G 3/4	M45x1.5	16	33	46	2
		330	330	–	274	172	13.8					44					42		4
4	4 : 1	50	–	50	294	158	5	150	G 3/4	44	16	44	46	G 3/4	M45x1.5	16	33	46	2
		250	–	180	306	170	11.2												

[1] others on request
[2] max. flow rate of operating fluid

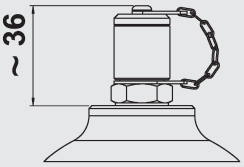
3.2. SCREW TYPE
– exchangeable diaphragm –

3.2.1 **Drawings**

Type A6



Type A3



Fluid connection AK
alternative fluid connections on request

Fig. 5

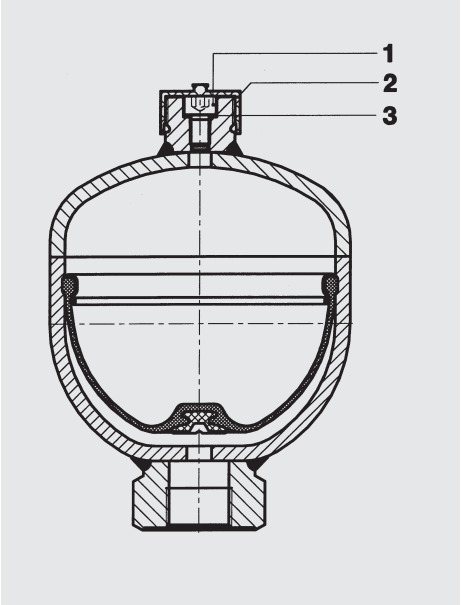
3.2.2 **Dimensions**

Nom. vol. [1] [l]	Perm. press. ratio $p_2 : p_0$	Series	Certificate code U: Permitt. oper. pressure [bar] Carbon steel	Certificate code U: Permitt. oper. pressure [bar] Stainless steel	Weight [kg]	A [mm]	B [mm]	ØD [mm]	ØL [mm]	M [mm]	N [mm]	O	ØP [mm]	R [mm]	Q [2] [l/min]	Standard fluid connection Form AK: F ISO 228	S [mm]	ØG [mm]	K SW	Diag.
0.1	10 : 1	500	500	–	1.9	110	30	95	–	53	35	–	–	–	95	G 1/2	14	–	36	
0.25	10 : 1	500	500	–	3.9	129	20	115	92	56	56	–	–	–	95	G 1/2	14	–	36	
			–	350	4.9			125			60									
		750	–	750	9	136	11	153	114	57.5	63	M6	140	12				27		
0.6	10 : 1	450	450	250	5.7	170	19	140	115	68	57	–	–	–	95	G 1/2	14	34	41	5
1.3	10 : 1	400	400	–	11.2	212	28	199	160	97	65	M8	180	10	150	G 3/4	16	44	50	
2	10 : 1	250	250	180	11.4	227	17	201	168	101	64	M8	188	10	150	G 3/4	16	44	50	
2.8	10 : 1	400	400	–	22	257	30	252	207	106	80	M8	230	10	150	G 3/4	16	44	50	
4	10 : 1	400	400	–	34	284	30	287	236	127.5	90	M8	265	10	150	G 3/4	16	44	50	

[1] others on request
[2] max. flow rate of operating fluid

4. SPARE PARTS

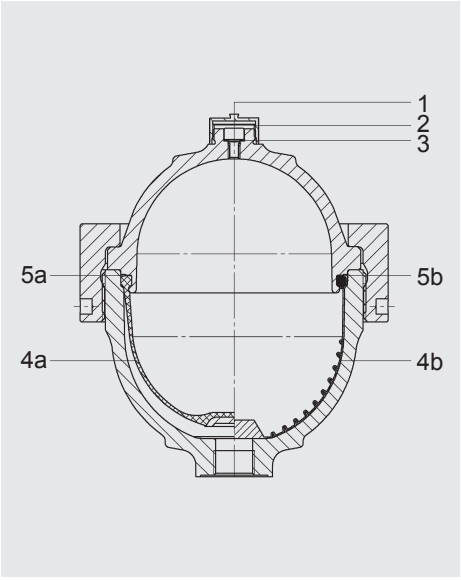
4.1. WELD TYPE
– non-exchangeable diaphragms –



Description	Quantity	Item
Spare parts set for gas side consisting of:		
Int. hex. locking screw	20	1
Protective cap	20	2
Seal ring	20	3

Nominal volume [l]	Part no.				
	NBR	ECO	FKM	IIR	PTFE
Spare parts set for gas side					
0.075 - 4	3262845	-	-	-	-

4.2. SCREW TYPE
– exchangeable diaphragm –



Description	Quantity	Item
Spare parts set for gas side consisting of:		
Int. hex. locking screw	20	1
Protective cap	20	2
Seal ring	20	3
Spare parts kit for elastomer diaphragm consisting of:		
Int. hex. locking screw	1	1
Seal ring	1	3
Elastomer diaphragm	1	4a
Back-up ring	1	5a
Spare parts kit for PTFE diaphragm consisting of:		
Int. hex. locking screw	1	1
Seal ring	1	3
PTFE diaphragm	1	4b
O-ring	1	5b

Nominal volume [l]	Part no.				
	NBR	ECO	FKM	IIR	PTFE
Spare parts set for gas side					
0.1 - 4	3262845	-	-	-	-
Spare parts kit					
0.1	3042668	3182526	-	-	-
0.25	3042709	3042712	3042714	3042713	3504798
0.6	3042710	3042715	3042717	3042716	3550388
1.3	3042681	3042682	3042684	-	3446897
2	3042711	3042719	3042721	3042720	3464205
2.8	3042700	3042701	3042704	3042702	-
4	3042705	3042706	3042708	3042707	-

When replacing seals and/or diaphragms, please read the Instructions for Assembly and Repair (No. 3.100.M).

4. 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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Metal Bellows Accumulators
for Heavy-Duty Diesel Engines

1. DESCRIPTION

In the fuel injection system of heavy-duty diesel engines (e.g. marine engines and engines for power plants / two and four-stroke), pressure fluctuations are generated during the injection process by the high pressure pumps.

In most heavy-duty diesel engines each cylinder has its own injection pump. During the phases of fuel extraction from the supply line, compression and injection as well as the release of unused fuel into the return line, cyclic pressure pulsations may result.

Example:

$$\frac{600\ [\text{rpm}] \times 8\ [\text{cylinders}]}{60\ [\text{s}] \times 2\ [\text{4-stroke}]} = 40\ [\text{Hz}]$$

The supply line and the return line are at a lower pressure than that required for fuel injection and in such dual-pipe systems the above-mentioned pressure fluctuations can cause problems, depending on the size of the pressure variations. It is for this reason that superimposed pressure fluctuations from 0 to approx. 13 bar can occur in a 4.5 bar return line (see the graph at section 2). In other systems pressure peaks of over 50 bar have been measured.

This fluctuating pressure with its unacceptable pressure peaks not only creates an additional stress on the pipe system but also an additional load for all integrated fittings and equipment. Valves, filters, measurement and monitoring devices, e.g. viscosity meters, ... can be seriously impaired, damaged, sometimes even irreparably.

Until now a standard method for reducing or eliminating the pulsations has been to use hydraulic accumulators with nitrogen as the damping element and an elastomer diaphragm or bladder as the separating element between the gas and the fuel. The best damping results may be obtained by installing one damper in the supply line and one in the return line close to the engine. However, standard diaphragm and bladder accumulators have two main limitations:

Problems with elastomer resistance to fuels and high temperatures.

Fuels other than diesel oil, such as bio-oils or heavy fuel oil, require higher injection temperatures. These can reach 160 °C. Even FKM used for the diaphragm or bladder has compatibility problems under such extreme conditions.

Gas loss through the elastomer

The accumulator gradually loses gas through the elastomer and the higher the temperature the higher the gas loss. If it is not possible to recharge the accumulator regularly, its function will deteriorate and the diaphragm or bladder will split.

These last two disadvantages can only be prevented by a relatively high investment in monitoring and maintenance. Depending on the type of fuel and its operating temperature, it can be necessary to replace the elastomer part after specific intervals.

HYDAC set itself the task of developing a pulsation damper without the problems outlined and which above all would also avoid the problems generated by other solutions (e.g. piston accumulators, spring-type accumulators, accumulators with elastic damping elements inside). These solutions have problems either with friction and abrasion or fuel leakage. One of the prime targets was to relieve the system operator of the burden of excessive monitoring and maintenance.

The recently developed solution from HYDAC is the Metal Bellows Accumulator. Instead of a bladder or diaphragm, a metal bellows is used as the flexible separating element between fluid and gas. This bellows is resistant to all conventional fuels over a very wide temperature range. Heavy fuel oil at temperatures of up to 160°C is no problem for these dampers. The metal bellows is welded to the other components and is therefore completely gas-tight. It is able to move up and down inside the accumulator without any friction or abrasion and it can operate for a very long time (years) with just one adjustment. Monitoring and maintenance for this type of damper is therefore reduced to a minimum.

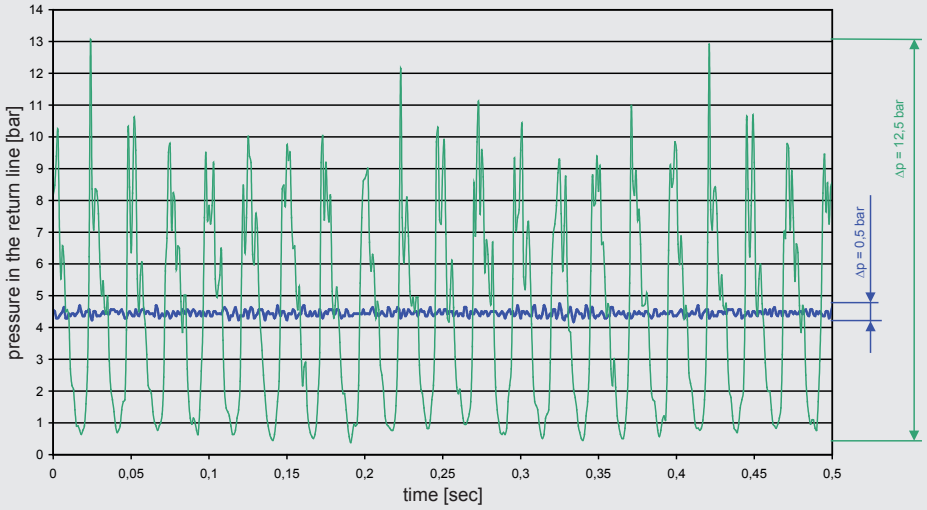
A diverting block is built into the fuel side of the damper which forces the fuel directly into the accumulator, thereby increasing the damping efficiency considerably. If two dampers are fitted to the fuel system (in both supply and return line), no pressure fluctuations can leave the engine before passing through one of the metal bellows dampers.

With this metal bellows accumulator, HYDAC has developed a competitively-priced damper which is unrivalled in terms of maintenance. The purchase costs will be recouped within a short time and as a result of reduced maintenance, the availability of the entire system is increased.
For further benefits, see below:

1.1. BENEFITS OF THE SM50P-...

- Maintenance-free
  – extremely gas-tight
  – frictionless parts (non-wearing)
- Fluid resistant across whole temperature range
- Cost-effective:
  "fit and forget"

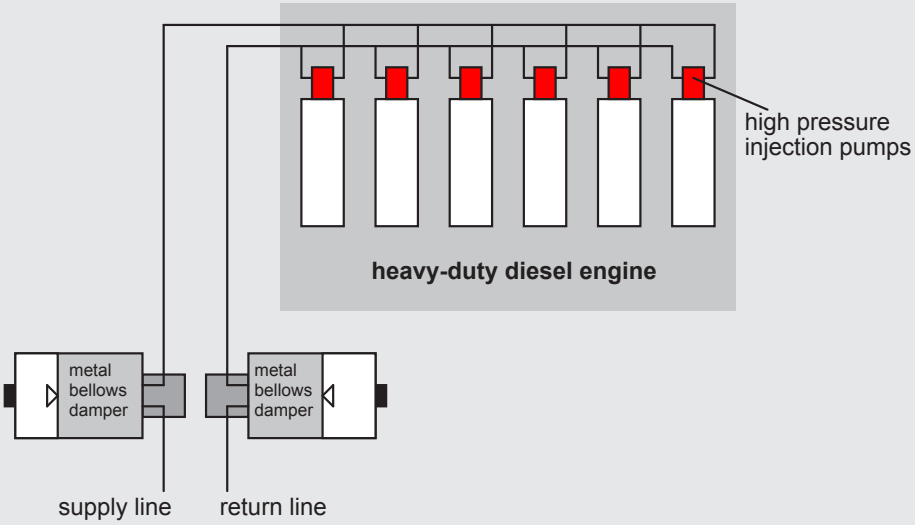
2. PRESSURE GRAPH



green = without damper
blue = with damper

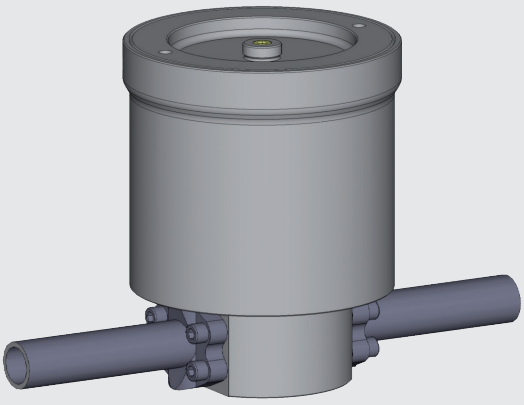
3. INSTALLATION OF THE SM50P-...

3.1. DIAGRAM



3.2. MODEL

3-D standard model, e.g. for inline installation.



Special connections on request

4. TECHNICAL SPECIFICATIONS

4.1. TECHNICAL DATA

Operating pressure:
3 ... 12 bar (others on request)

Max. pre-charge pressure:
4 bar (at max. operating temperature)

Design temperature range:
-10 °C ... +160 °C

Operating fluids:
Diesel and heavy fuel oil, biofuels

Total volume:
3.8 litres

Effective gas volume:
0.5 litre (nitrogen)

Gas-side fluid pre-charge:
0.6 litre (ethylene glycol)

Fluctuating volumes:
max. 0.04 litres (others on request)

Material:
Carbon steel (primed externally)

Design and Approval:
PED / ABS / DNV / GL /
LR / BV / AS1210 / ...

Fluid connection:
SAE 1 1/4" - 3000 psi
SAE 2" - 3000 psi
SAE 3" - 3000 psi

Gas connection:
M28x1.5 for Universal Charging and Testing Unit FPU-1
Part No.: 3398235

Mounting position:
Vertical (gas connection at top)
Others on request

Weight:
22 ... 33 kg depending on the connection size

4.2. MODEL CODE

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SM50 P – 0,5 W E 1/ 116 U – 50 AAJ – 2,5

Series

Type code
_ = accumulator without diverting block*
L = light-weight accumulator*
P = damper with diverting block

Capacity [l]

Version
W = convoluted bellows
M = diaphragm bellows*

Type of shell
A = screw type
E = weld type*
G = formed type*

Type of gas-side connection
1 = gas pressure adjustable (M28x1.5)
2 = gas pressure pre-set, non-adjustable gas locking screw*
3 = gas pressure adjustable (M16x1.5)

Material code

Fluid connection
1 = carbon steel
2 = carbon steel with corrosion protection
3 = stainless steel

Accumulator shell
1 = carbon steel
2 = carbon steel with corrosion protection
4 = stainless steel

Seal material
0 = no seal
2 = NBR*
5 = low temperature NBR*
6 = FKM

Certification code
U = European Pressure Equipment Directive (PED)

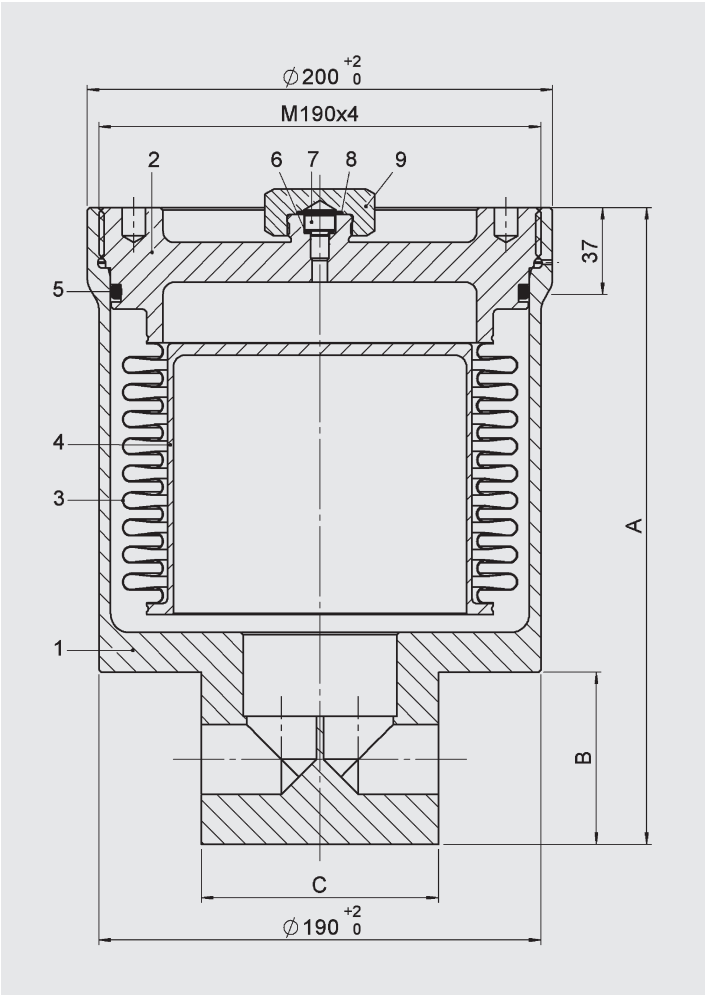
Permitted operating pressure [bar]

Fluid connection
See tables in catalogue section 3.301, Piston Accumulators

Pre-charge pressure p_0 [bar] at 20 °C,
must be stated clearly, if required!

* currently only on request

4.3. DIMENSIONS



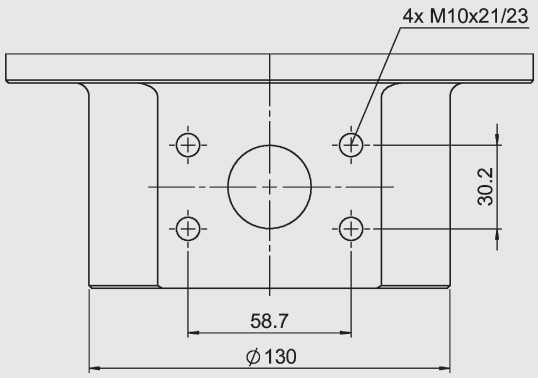
Item	Description
1	Accumulator lower section
2	Accumulator cover plate
3	Metal bellows
4	Bowl
5	O-ring
6	Seal ring
7	Adjustable locking screw
8	O-ring
9	Protective cap

4.4. ACCUMULATOR CONNECTION

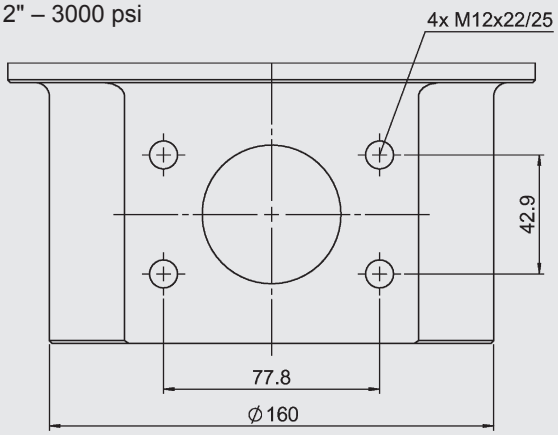
	Dimension [mm]		
	SAE 1 1/4" (FCD)*	SAE 2" (FCF)	SAE 3" (FCH)
A	274	294	333
B	74	94	134
C	102	120	133

* FCD = formerly AD

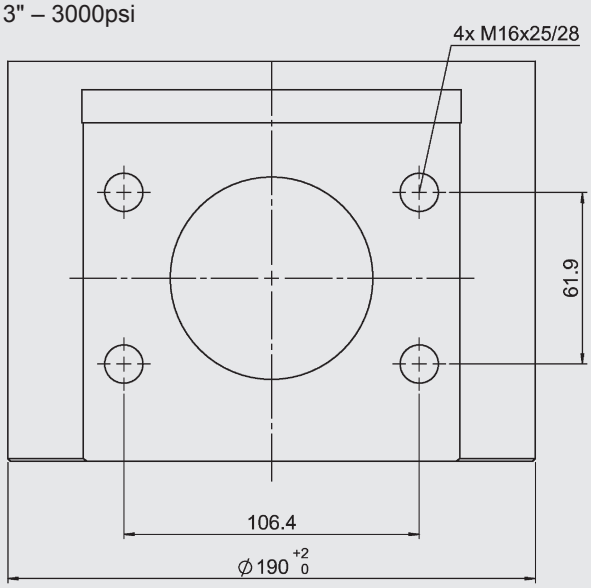
SM50P-3.8A6/116...FCD
SAE 1 1/4" – 3000 psi



SM50P-3.8A6/116...FCF
SAE 2" – 3000 psi



SM50P-3.8A6/116...FCH
SAE 3" – 3000psi

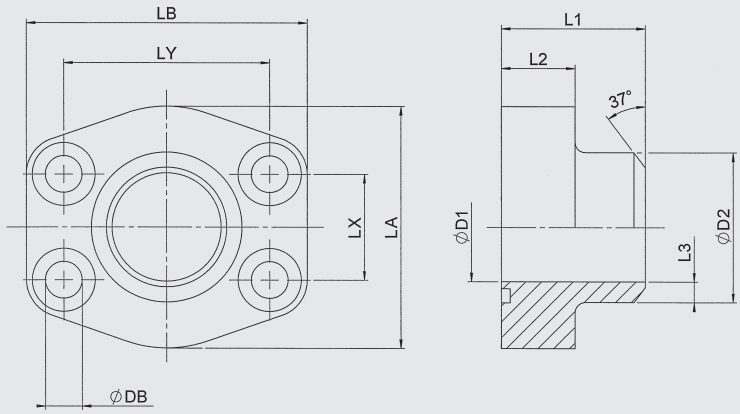


4.5. FLOW RATES / TEMPERATURE DEPENDENCY

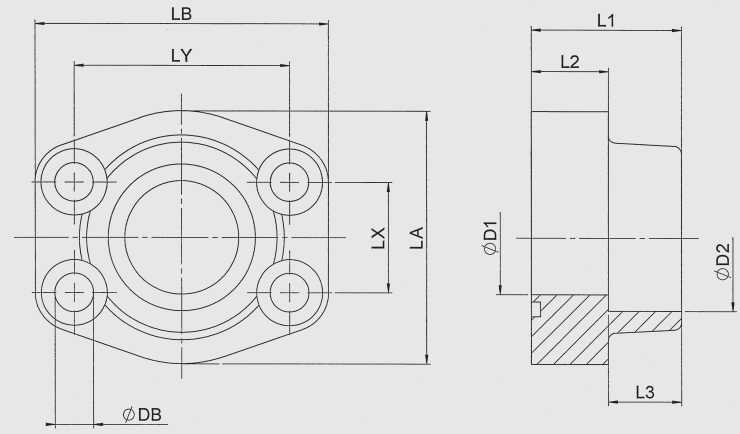
Series SM50P-... Flange SAE [inch] - 3000 psi		Bore [mm]	Max. flow rate Q_{max} [m³/h]	Weight [kg]	A [mm]	Ext. diam. D_a [mm]
1 1/4	**...FCD**	30	< 8	22	274	200
2	**...FCF**	50	8 - 21	25	294	
3	**...FCH**	73	> 21	33	333	

4.6. BUTT WELD AND SOCKET WELD FLANGES

Pressure: 3000 psi
Seal: FKM



Series SAE [inch]		D1 [mm]	D2 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	LA [mm]	LB [mm]	LX [mm]	LY [mm]	DB [mm]	Screws
1 1/4	**Butt weld flange**	31	42.8	41	21	3	< 74	≅ 80	30.2	58.7	10.5	M10x40
2		50	61	45	25	5.5	< 94	≅ 103	42.9	77.8	13.5	M12x45
3		73	89	50	27	8	< 134	≅ 135	61.9	106.4	17	M16x50



Series SAE [inch]		D1 [mm]	D2 [mm]	L1 [mm]	L2 [mm]	L3 [mm]	LA [mm]	LB [mm]	LX [mm]	LY [mm]	DB [mm]	Screws
1 1/4	**Socket weld flange**	31	42.8	41	21	20	< 74	≅ 80	30.2	58.7	10.5	M10x40
2		50	61	45	25	24	< 94	≅ 103	42.9	77.8	13.5	M12x45
3		73	90.5	50	27	28	< 134	≅ 135	61.9	106.4	17	M16x50

5. NOTE

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

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

Subject to technical modifications.

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Hydraulic Dampers

1. HYDRAULIC DAMPERS

1.1. DESCRIPTION

1.1.1 Function

The pressure fluctuations occurring in hydraulic systems can be cyclical or one-off problems due to:

- flow rate fluctuations from displacement pumps
- actuation of shut-off and control valves with short opening and closing times
- switching on and off of pumps
- sudden linking of spaces with different pressure levels.

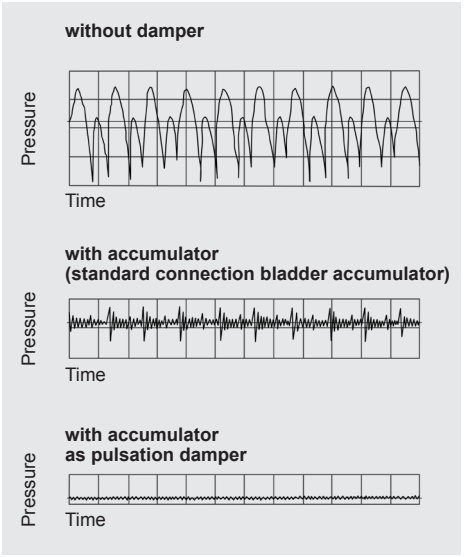
HYDAC hydraulic dampers are particularly suitable for damping such pressure fluctuations.

Selecting the most suitable hydraulic damper for each system ensures that

- vibrations caused by pipes, valves, couplings etc are minimised and subsequent pipe and valve damage is prevented
- measuring instruments are protected and their performance is no longer impaired
- the noise level in hydraulic systems is reduced
- the performance of machine tools is improved
- interconnection of several pumps in one line is possible
- a pump rpm and feed pressure increase is possible
- the maintenance and servicing costs can be reduced
- the service life of the system is increased.

1.2. APPLICATION

1.2.1 Pulsation damping TYPE SB...P / SBO...P



General

The HYDAC pulsation damper

- prevents pipe breaks caused by material fatigue, pipe oscillations and irregular flow rates,
- protects valves, control devices and other instruments,
- improves noise level damping.

Applications

The pulsation damper is particularly suitable for hydraulic systems, displacement pumps of all types, sensitive measurement and control instruments and manifolds in process circuits in the chemical industry.

Operation

The pulsation damper generally has two fluid connections and can therefore be fitted directly inline.

The flow is diverted in the fluid valve so that it is directed straight at the bladder or diaphragm. This causes direct contact of the flow with the bladder or diaphragm which, in an almost inertialess operation, balances the flow rate fluctuations via the gas volume.

It particularly compensates for higher frequency pressure oscillations. The pre-charge pressure is adjusted to individual operating conditions

Design

The HYDAC pulsation damper consists of:

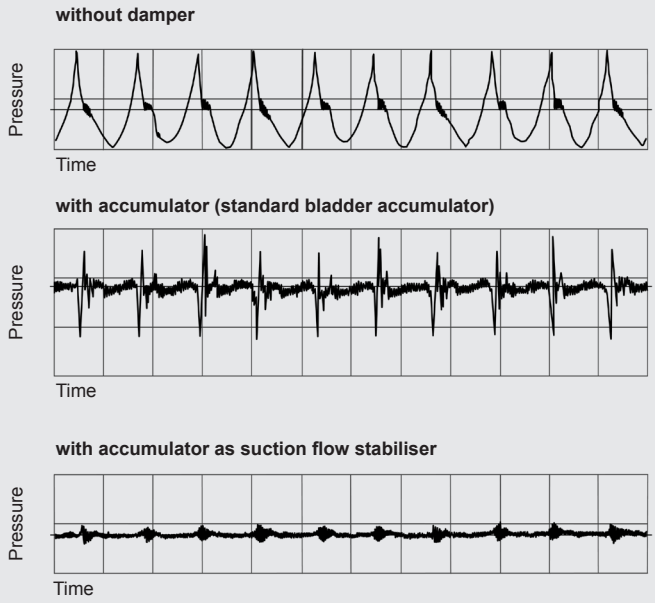
- the welded or forged pressure vessel in carbon steel; available with internal coating or in stainless steel for chemically aggressive fluids;
- the special fluid valve with inline connection, which guides the flow into the vessel (threaded or flange connection).
- the bladder or diaphragm in various elastomers as shown under 1.4.1.

Installation

As close as possible to the pulsation source. Mounting position preferably vertical (gas valve pointing upwards).

Preferred and alternative installation positions are shown in schematic form in section 1.3.

1.2.2 Suction flow stabiliser Type SB...S



General
The HYDAC suction flow stabiliser

- improves the NPSH value of the system;
- prevents cavitation of the pump;
- prevents pipe oscillations.

Applications
Main application areas are piston and diaphragm pumps in public utility plants, reactor construction and the chemical industry.

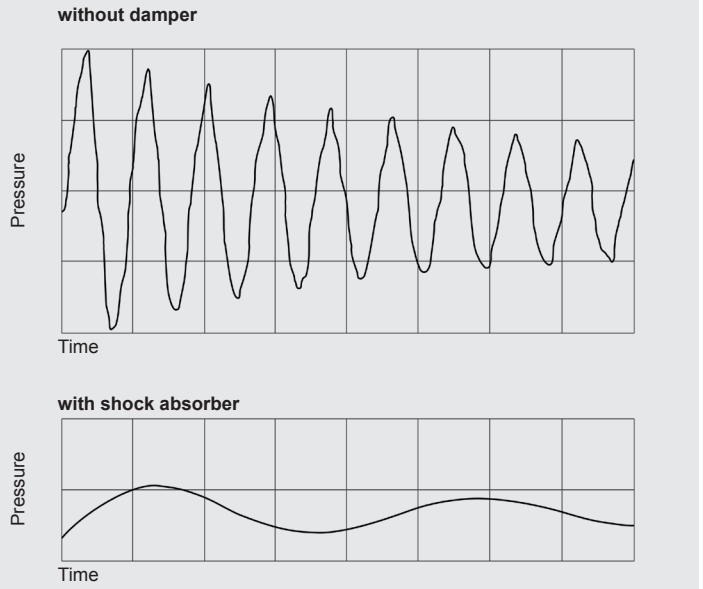
Operation
Trouble-free pump operation is only possible if no cavitation occurs in the pump suction and pipe oscillations are prevented.

A relatively high fluid volume in the suction flow stabiliser in relation to the displacement volume of the pump reduces the acceleration effects of the fluid column in the suction line. Also an air separation is achieved due to the extremely low flow rate in the suction flow stabiliser and the deflection on a baffle. By adjusting the charging pressure of the bladder to the operating conditions, the best possible pulsation damping is achieved.

Design
The HYDAC suction flow stabiliser consists of a welded vessel in steel or stainless steel.
Inlet and outlet are on opposite sides and are separated by a baffle. The upper part houses the encapsulated bladder. In addition, there is a vent screw in the cover plate and a drainage facility on the bottom.

Installation
As close as possible to the suction inlet of the pump. Mounting position vertical (gas valve uppermost).

1.2.3 Shock absorber Type SB...A



General
The HYDAC shock absorber

- reduces pressure shocks;
- protects pipelines and valves from being destroyed.

Applications
The accumulators are particularly suitable for use in pipelines with quick-acting valves or flaps and whilst pumps are being switched on and off.

They are also suitable for energy storage in low pressure applications.

Operation
Sudden changes in pipeline flow, such as those caused by pump failure or the closing or opening of valves, can cause pressures which are many times higher than the normal values.

The shock absorber prevents this by converting potential into kinetic energy and vice versa. This prevents pressure shocks and protects pipelines, valves, control instruments and other devices from destruction.

Design
The HYDAC shock absorber consists of:

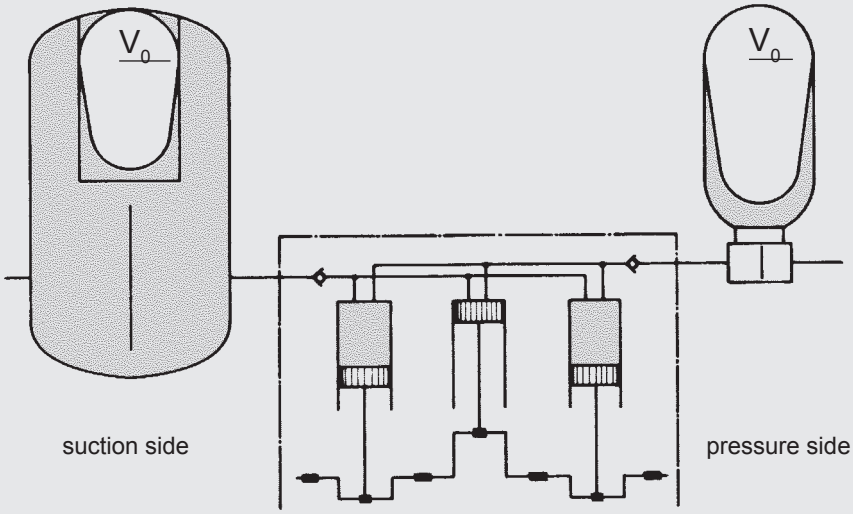
- the welded pressure vessel in carbon steel with or without corrosion protection or in stainless steel;
- the connection including perforated disc which prevents the flexible bladder from extruding from the vessel, and the flange;
- the bladder in various compounds as shown under section 1.4.1 with built-in gas valve, which is used for charging pressure p_0 and for possible monitoring activities.

Special version
Shock absorbers can also be in the form of diaphragm or piston accumulators. Available on request.

Installation
As close as possible to the source of the erratic condition. Mounting position vertical (gas valve pointing upwards).

1.3 SIZING

1.3.1 Pulsation damper and suction flow stabiliser



On the suction and pressure side of piston pumps almost identical conditions occur regarding irregularity of the flow rate. Therefore the same formulae for determining the effective gas volume are used for calculating the damper size. That in the end two totally different damper types are used is due to the different acceleration and pressure ratios on the two sides.

Not only is the gas volume V_0 a decisive factor but also the connection size of the pump has to be taken into account when selecting the pulsation damper.
In order to avoid additional variations in cross-section which represent reflection points for vibrations, and also to keep pressure drop to a reasonable level, the connection cross-section of the damper must be the same as the pipeline.

The gas volume V_0 of the damper is determined with the aid of the formula for adiabatic changes of state.

By giving the residual pulsation or the gas volume, the damper size can be calculated with the aid of the HYDAC software **ASP** (**A**ccumulator **S**imulation **P**rogram).

Designations:

ΔV = fluctuating fluid volume [l]
$\Delta V = m \bullet q$

q = stroke volume [l]
$$q = \frac{\pi \bullet d_\kappa^{\,2}}{4} \bullet h_\kappa$$

d_k = piston diameter [dm]

h_k = piston stroke [dm]

m = amplitude factor
$$m = \frac{\Delta V}{q}$$

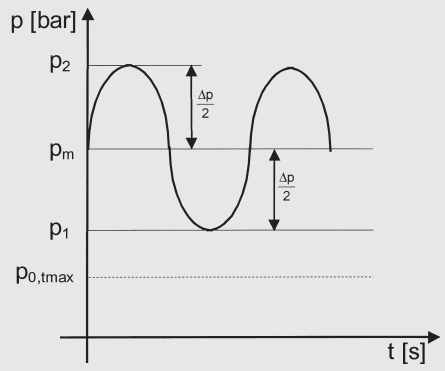
z = no. of compressions / effective cylinders per revolution

x = residual pulsation [± %]

κ = isentropic exponent

Φ = pressure ratio of pre-charge pressure to operating pressure [0.6 ... 0.9]
$$\Phi = \frac{p_0}{p_m}$$

Δp = height of pressure fluctuations
$\Delta p = p_2 - p_1$ [bar]



Formulae:

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

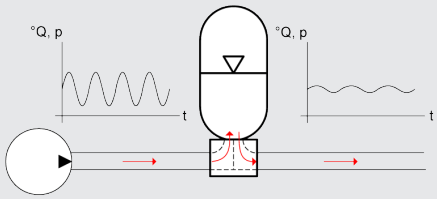
$$\Delta V = m \bullet q$$

$$x\,[\pm\%] = \left|\frac{p_1 - p_m}{p_m} \bullet 100\right|$$

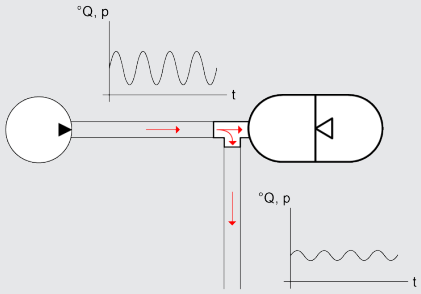
$$= \left|\frac{p_2 - p_m}{p_m} \bullet 100\right|$$

Schematic of installation options:

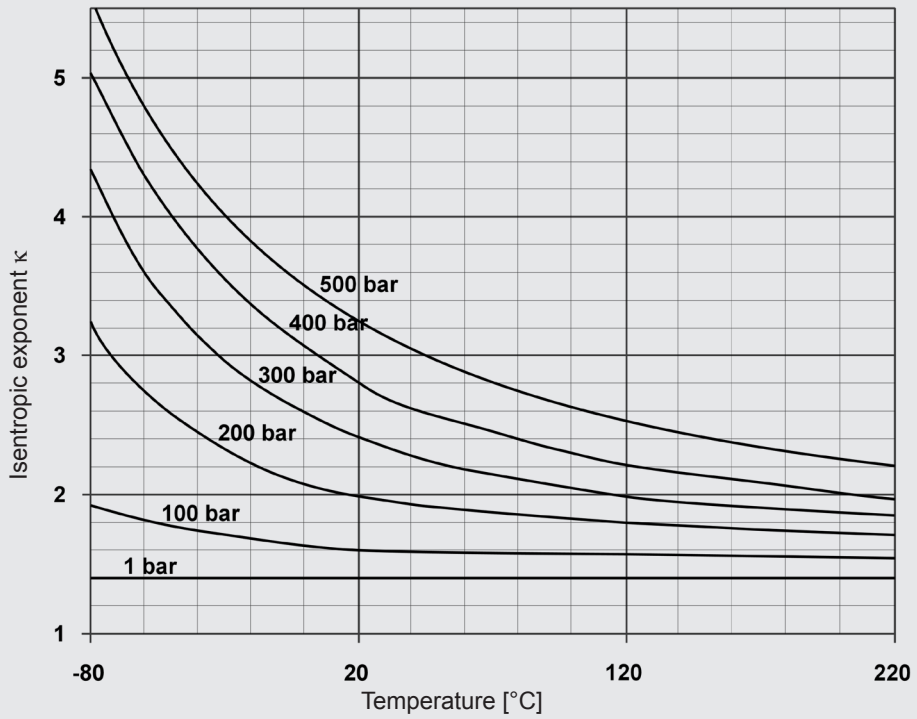
Preferred installation configuration with maximum damping effect



Alternative installation configuration using standard accumulator with a T-piece with reduced damping effect



Isentropic exponent κ dependent on pressure and temperature:



Amplitude factor (m) for piston pump:

	m value	
z	single acting	double acting
1	0.550	0.250
2	0.210	0.120
3	0.035	0.018
4	0.042	0.010
5	0.010	0.006
6	0.018	0.001
7	0.005	
8	0.010	
9	0.001	

others on request

Calculation example

Given parameters:

Single-acting 3-piston pump

Piston diameter:	70 mm
Piston stroke:	100 mm
Motor speed:	370 rpm
Output:	427 l/min
Operating temperature:	20 °C
Operating pressure	
- Outlet:	200 bar
- Inlet:	4 bar

Required:

a) Suction flow stabiliser for a residual pulsation of ± 2.5%

b) Pulsation damper for a residual pulsation of ± 0.5%

Solution:

a) Determining the required suction flow stabiliser

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

$$V_0 = \frac{0{,}035 \bullet \frac{\pi \bullet 0{,}7^2}{4} \bullet 1{,}0}{\left[\frac{0{,}6}{1-\frac{2{,}5}{100}}\right]^{\frac{1}{1{,}4}} - \left[\frac{0{,}6}{1+\frac{2{,}5}{100}}\right]^{\frac{1}{1{,}4}}}$$

V_0 = 0.54 l

Selected: SB16S-12 with 1 litre gas volume

b) Determining the required pulsation damper

$$V_0 = \frac{\Delta V}{\left[\frac{\Phi}{1-\frac{x}{100}}\right]^{\frac{1}{\kappa}} - \left[\frac{\Phi}{1+\frac{x}{100}}\right]^{\frac{1}{\kappa}}}$$

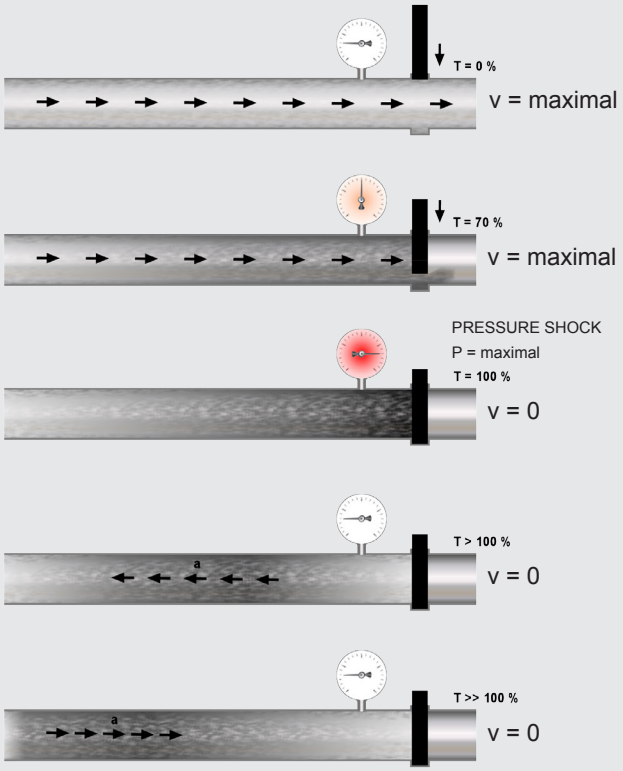
$$V_0 = \frac{0{,}035 \bullet \frac{\pi \bullet 0{,}7^2}{4} \bullet 1{,}0}{\left[\frac{0{,}7}{1-\frac{0{,}5}{100}}\right]^{\frac{1}{2{,}0}} - \left[\frac{0{,}7}{1+\frac{0{,}5}{100}}\right]^{\frac{1}{2{,}0}}}$$

V_0 = 3.2 l

Selected: SB330P-4

1.3.2 **Shock absorber**

Pressure shock produced when a valve is closed without a hydraulic accumulator



Simplified pressure shock calculation for the closing of a valve

Estimate of Joukowsky's max. occurring pressure shock

$\Delta p(N/m^2) = \rho \cdot a \cdot \Delta v$

ρ (kg/m³) = fluid density

$\Delta v = v - v_1$

Δv = change of fluid velocity

v (m/s) = fluid velocity before the change in its condition

v1 (m/s) = fluid velocity after the change in its condition

a (m/s) = propagation velocity of pressure wave

$$a\ [m/s] = \frac{1}{\sqrt{\rho \cdot \left[\frac{1}{K} + \frac{D}{E \cdot e}\right]}}$$

K (N/m²) = compression modulus of the fluid

E (N/m²) = modulus of elasticity of pipeline

D (mm) = internal diameter of pipeline

e (mm) = wall thickness of the pipeline

The pressure wave runs to the other end of the pipeline and will reach the valve again after time t (reflection time), whereby:

$$t\ [s] = \frac{2 \cdot L}{a}$$

L [m] = length of the pipeline

T [s] = effective operating time (closing) of the valve

If T < t then:

$p_{max} = p_1 + \Delta p$

If T < t then:

$$p_{max} = p_1 + \rho \cdot a \cdot \Delta v \cdot \frac{t}{T}$$

Determining the required damper size

The accumulator must absorb the kinetic energy of the fluid by converting it into potential energy within the pre-determined pressure range. The change of state of the gas is adiabatic in this case.

$$V_0 = \frac{m \cdot \Delta v^2 \cdot 0{,}4}{2 \cdot p_1 \cdot \left[\left[\frac{p_2}{p_1}\right]^{1-\frac{1}{\kappa}} - 1\right] \cdot 10^2} \cdot \left[\frac{p_1}{p_0}\right]^{\frac{1}{\kappa}}$$

m [kg] = weight of the fluid in the pipeline

v [m/s] = change in velocity of the fluid

p_1 [bar] = zero head of the pump

p_2 [bar] = permitted operating pressure

p_0 [bar] = pre-charge pressure

A special calculation program to analyse the pressure curve is available for sizing during pump failure or start-up and for manifolds.

Calculation example
Rapid closing of a shut-off valve in a re-fuelling line.

Given parameters:

Length of the pipeline L:
2000 m

NW of pipeline D:
250 mm

Wall thickness of pipeline e:
6.3 mm

Material of pipeline:
Steel

Flow rate Q:
432 m³/h = 0.12 m³/s

Density of medium ρ:
980 kg/m³

Zero feed height of pump p_1:
6 bar

Min. operating pressure p_{min}:
4 bar

Effective closing time of the valve T:
1.5 s (approx. 20% of total closing time)

Operating temperature:
20 °C

Compression modulus of the fluid K:
1.62×10^9 N/m²

Elasticity modulus (steel) E:
2.04×10^{11} N/m²

Required:

Size of the required shock absorber, when the max. pressure (p_2) must not exceed 10 bar.

Solution:

Determination of reflection time:

$$a = \frac{1}{\sqrt{\rho \cdot \left[\frac{1}{K} + \frac{D}{E \cdot e}\right]}}$$

$$a = \frac{1}{\sqrt{980 \cdot \left[\frac{1}{1.62 \cdot 10^9} + \frac{250}{2.04 \cdot 10^{11} \cdot 6.3}\right]}}$$

$$a = 1120 \text{ m/s}$$

$$t = \frac{2 \cdot L}{a} = \frac{2 \cdot 2000}{1120} = 3.575 \text{ s} *$$

* since T < t the max. pressure surge occurs and the formula as shown in section 1.3.2. must be used.

$$v = \frac{Q}{A}$$

$$v = \frac{0.12}{0.25^2 \cdot \pi/4} = 2.45 \text{ m/s}$$

$$\Delta_p = \rho \cdot a \cdot \Delta v$$

$$\Delta_p = 980 \cdot 1120 \cdot (2.45\text{-}0) \cdot 10^{-5}$$

$$= 26.89 \text{ bar}$$

$$p_{max} = p_1 + \Delta_p$$

$$p_{max} = 6 + 26.89 = 32.89 \text{ bar}$$

Determining the required gas volume:

$$p_0 \leq 0.9 \cdot p_{min}$$

$$p_0 \leq 0.9 \cdot 5 = 4.5 \text{ bar}$$

$$V_0 = \frac{m \cdot v^2 \cdot 0.4}{2 \cdot p_1 \cdot \left[\left[\frac{p_2}{p_1}\right]^{1-\frac{1}{\kappa}} - 1\right] \cdot 10^2} \cdot \left[\frac{p_1}{p_0}\right]^{\frac{1}{\kappa}}$$

with $m = V \cdot \rho = \frac{\pi}{4} \cdot D^2 \cdot L \cdot \rho$

$$V_0 = \frac{\frac{\pi}{4} \cdot 0.25^2 \cdot 2000 \cdot 980 \cdot 2.45^2 \cdot 0.4}{2 \cdot 7 \cdot \left[\left[\frac{11}{7}\right]^{1-\frac{1}{1.4}} - 1\right] \cdot 10^2} \cdot \left[\frac{7}{4.5}\right]^{\frac{1}{1.4}}$$

$$V_0 = 1641 \text{ l}$$

Selected:

4 x shock absorbers
SB 35AH-450

1.4. TECHNICAL SPECIFICATIONS

1.4.1 Model code

Pulsation damper, suction flow stabiliser, shock absorber
Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SB330 P – 10 A 1 / 112 U – 330 AI

Series

SB... = with bladder
SBO... = with diaphragm

Type

A = shock absorber
AH = high flow shock absorber
P = pulsation damper
PH = high flow pulsation damper
S = suction flow stabiliser

Nominal volume [l]

Fluid connection

A = threaded connection
E = threaded connection for weld type construction (diaphragm accumulators only)
F = flange [3]

Type code

1 = standard model (not for screw type diaphragm accumulators or pressure shock dampers)
2 = back-up type [1]
6 = standard model for screw type diaphragm accumulators
Type SBO...P-...A6

Material code

dependent on operating medium
standard model = 112 for mineral oils

Fluid connection

1 = carbon steel
2 = high tensile steel
3 = stainless steel (Niro)
4 = chemically nickel-plated (internal coating) [1]
6 = low temperature steel
7 = other materials

Accumulator shell

0 = plastic (internal coating) [1]
1 = carbon steel
2 = chemically nickel-plated (internal coating) [1]
4 = stainless steel (Niro) [1]
6 = low temperature steel
7 = other materials

Accumulator bladder/diaphragm [2]

2 = NBR [4]
3 = ECO
4 = IIR
5 = NBR [4]
6 = FKM
7 = other materials (e.g. PTFE, EPDM, ...)

Certification code

U = European Pressure Equipment Directive (PED)

Permitted operating pressure [bar]

Connection

AI = ISO 228 (BSP), standard connection
BI = DIN 13 to ISO 965/1 (metric) [3]
CI = ANSI B1.1 (UNF thread, sealing to SAE standard) [3]
DI = ANSI B1.20 (NPT thread) [3]

SBO250P-0.075E1 and for SBO210P-0.16E1:
AK = ISO 228 (BSP), standard connection

[1] not available for all versions
[2] when ordering a spare bladder, state diameter of smaller shell port
[3] specify full details of version
[4] observe temperature ranges, see section 1.4.2

1.4.2 General

Operating pressure
see tables (may differ from nominal pressure for foreign test certificates)

Nominal volume
see tables

Effective gas volume
see tables, based on nominal dimensions This differs slightly from the nominal volume and must be used when calculating the effective fluid volume.

For diaphragm accumulators, the effective gas volume corresponds to the nominal volume.

Effective fluid volume
Volume of fluid which is available between the operating pressures p_2 and p_1.

Gas charge
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 µm.
If other gases are to be used, please contact HYDAC for advice.

When supplied, the accumulator is only pre-charged for storage purposes. Higher pre-charge pressures are possible by arrangement.

Permitted pressure ratio
Ratio of maximum operating pressure p_2 to gas pre-charge pressure p_0.

See catalogue section:

- HYDAC Accumulator Technology No. 3.000

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

After the hydraulic line has been connected it must be completely vented. Work on systems with hydraulic dampers (repairs, connecting pressure gauges etc) must only be carried out once the pressure and the fluid have been released.

Please read the Operating Manuals!

- Bladder accumulators No. 3.201.BA
- Diaphragm accumulators No. 3.100.BA
- Piston accumulators No. 3.301.BA

Operating temperature and operating fluid
The permitted operating temperature of a hydraulic damper is dependent on the application limits of the metal materials and the separating element. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

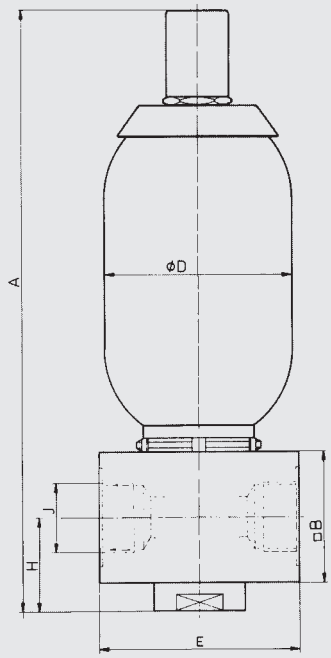
Materials		Material code [1]	Accumulator type	Temperature range	Overview of the fluids [2]	
					Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	SB, SBO	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	SB, SBO	-50 °C ... + 50 °C		
		9	SB, SBO	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	SB	-30 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
			SBO	-40 °C ... +120 °C		
IIR	Butyl rubber	4	SB	-50 °C ... +100 °C	● Hydraulic fluids of type HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
			SBO	-50 °C ... +120 °C		
FKM	Fluorine rubber	6	SB, SBO	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 1.4.1 Model code, material code, accumulator bladder/diaphragm

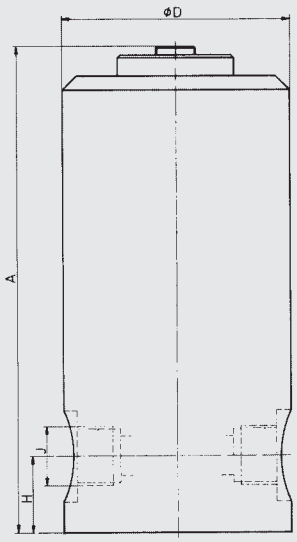
[2] others available on request

1.4.3 Pulsation dampers

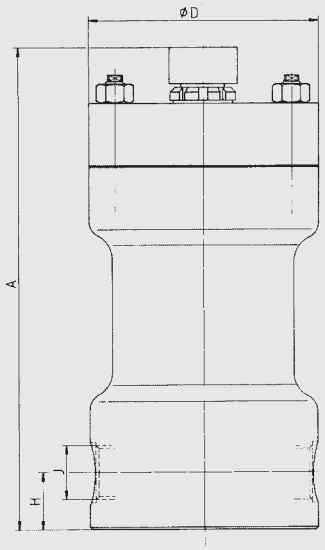
SB330/550P(PH)-...



SB800P-...



SB1000P-...

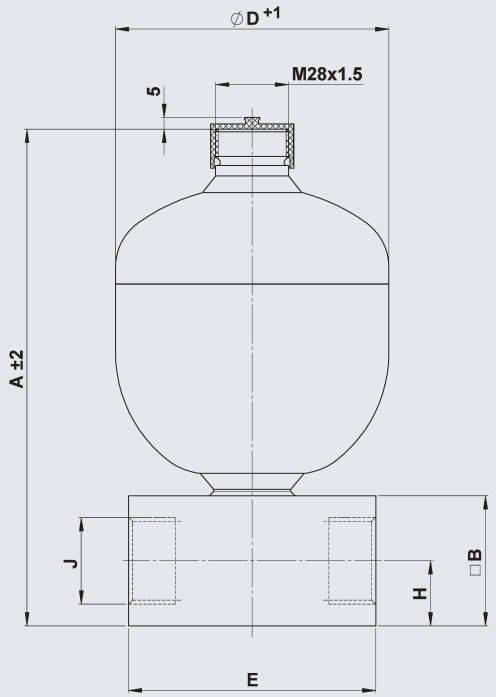


Dimensions SB

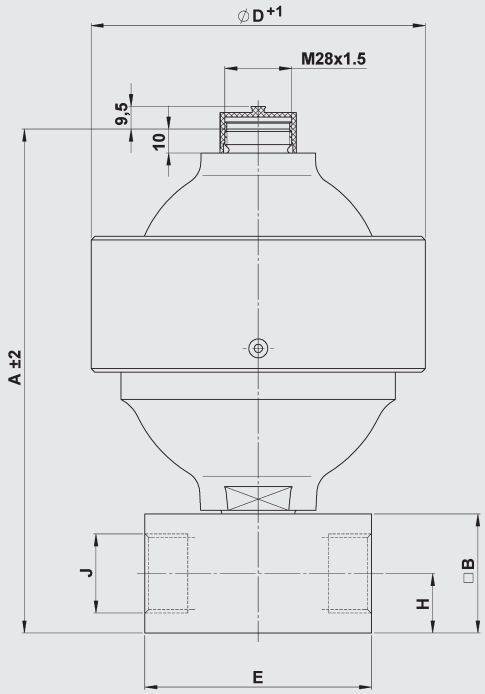
Nominal volume [l]	Max. operating pressure (PED) [bar]	Eff. gas volume [l]	Weight [kg]	A [mm]	□ B [mm]	Ø D [mm]	E [mm]	H [mm]	J [2] Thread ISO 228	Series
1	330	1	11	365	80	118	120	57	G 1 1/4	SB330P
	550		13	384	70	121		53		SB550P
1.5	800 [3]	1.3	36	346	–	160	–	55		SB800P
	1000 [3]		94	414	–	215	–	49	[1]	SB1000P
2.5	330	2.4	16	570	80	118	120	57	G 1 1/4	SB330P
	550	2.5	20	589	70	121		53		SB550P
4	330	3.7	18	455	80	171		57		SB330P
			26	491	100		150	85	G 1 1/2	SB330PH
5	550	4.9	26	917	70	121	120	53	G 1 1/4	SB550P
6	330	5.7	20	559	80	171		57		SB330P
			28	593	100		150	85	G 1 1/2	SB330PH
10		9.3	40	620		229				SB330P
			50	652	130x140			100	SAE 2" - 6000 psi	SB330PH
13	330	12	48	712	100			85	G 1 1/2	SB330P
20		18.4	70	920						SB330P
			80	952	130x140			100	SAE 2" - 6000 psi	SB330PH
24	330	23.6	82	986	100			85	G 1 1/2	SB330P
32		33.9	100	1445						SB330P
			110	1475	130x140			100	SAE 2" - 6000 psi	SB330PH

[1] M56x4, high pressure connection DN 16, others on request
[2] Standard connection code = AI, others on request
[3] Special design, on request

SBO...P...E



SBO...P...A6



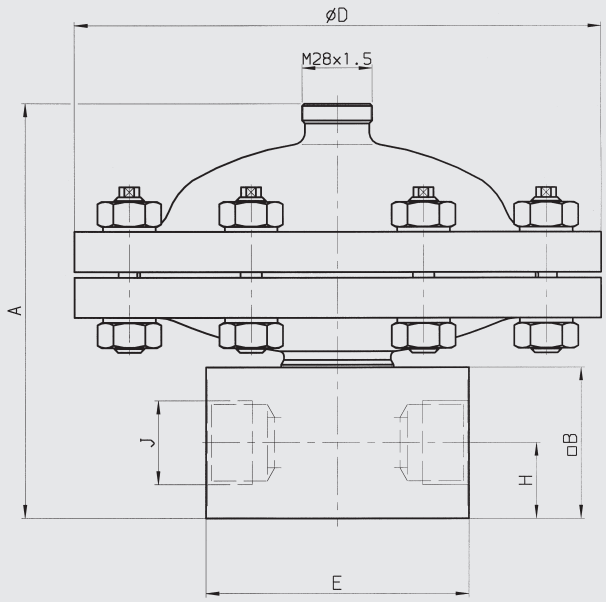
Dimensions SBO

Nominal volume	Max. operating pressure (PED)		Weight	A	□ B	Ø D	E	H	J thread	Series and connection type [1]	
[l]	Carbon steel [bar]	Stainless steel (NIRO) [bar]	[kg]	[mm]	[mm]	[mm]	[mm]	[mm]	ISO 228		
0.075	250	–	0.9	131	–	64	41 hex.	13	G 1/4	SBO250P-...E1...AK	weld-type
0.16	210	180	1	143	–	74				SBO210P-...E1...AK	
0.32		160	2.6	175	50	93	80	25	G 1/2	SBO210P-...E1...AI	
0.5		–	3	192		105					
0.6	330	–	5.6	222	60	115	105	30	G 1	SBO330P-...E1...AI	
0.75	210	140	5.1	217		121				SBO210P-...E1...AI	
1	200	–	6	231		136				SBO200P-...E1...AI	
1.4	140	–	6.2	244		145				SBO140P-...E1...AI	
	210	–	7.7	250		150				SBO210P-...E1...AI	
	250	–	8.2	255		153				SBO250P-...E1...AI	
2	100	100	6.3	261		160				SBO100P-...E1...AI	
	210	–	8.9	267		167				SBO210P-...E1...AI	
3.5	250	–	13.5	377		170				SBO250P-...E1...AI	
4	–	50	7.9	368		158				SBO50P-...E1...AI	
		250	13.5	377		170				SBO250P-...E1...AI	
0.25	500	350	5.2 (6.3)	162	50	115 (125)	80	25	G 1/2	SBO500P-...A6...AI	thread-type
0.6	450	250	8.9 (9.1)	202	60	140 (142)	95		G 1	SBO450P-...A6...AI	
1.3	400	–	13.8	267		199	105	30		SBO400P-...A6...AI	
2	250	180	15.6	285		201				SBO250P-...A6...AI	
2.8	400	–	24.6	308		252				SBO400P-...A6...AI	
4		–	36.6	325		287					

[1] Standard connection code = AK or AI, others on request
( ) Brackets indicate different dimensions for stainless steel version (NIRO)

Pulsation dampers for aggressive media

SBO...P-...A6/347...(PTFE)



Pulsation damper in stainless steel with PTFE coated diaphragm and PTFE or FFKM seals.
Also available without connection block.

Permitted operating temperature:
-15 °C ... +80 °C

Permitted pressure ratio $p_2 : p_0 = 2 : 1$

Nominal volume [l]	Max. operating pressure (PED) [bar]	Weight [kg]	A [mm]	□ B [mm]	Ø D [mm]	E [mm]	H [mm]	J [1] Thread ISO 228
0.2	40	11	140	60	210	105	30	G 1
	250	27	197		230			
0.5	40	12	165		210			
	250	26	200		230			

[1] standard connection code = AI, others on request

SBO...(P)-...A4/777... (PVDF/PTFE)

Diagram 1

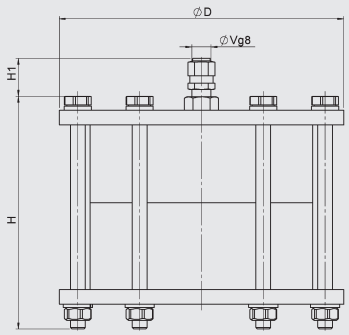
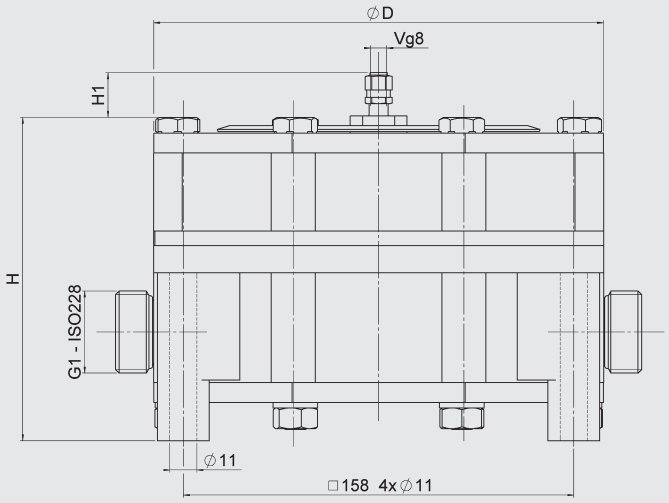


Diagram 2



Pulsation damper in PVDF with PTFE-coated diaphragm.

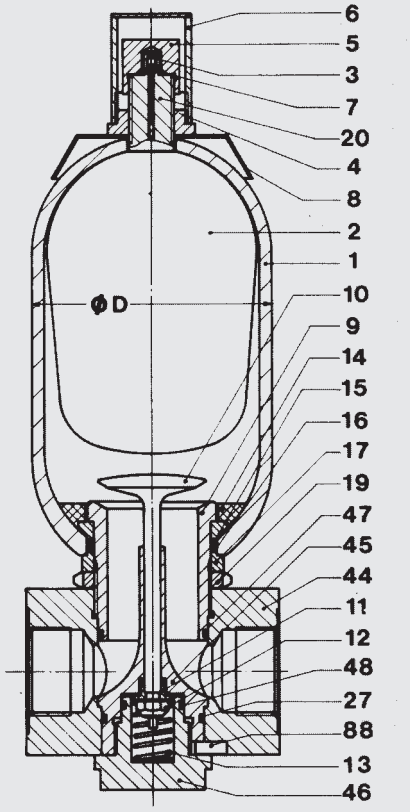
Permitted operating temperature:
-10 °C ... +65 °C

Permitted pressure ratio $p_2 : p_0 = 2 : 1$

Nominal volume [l]	Max. operating pressure (PED) [bar]	Weight [kg]	Ø D [mm]	H [mm]	H1 [mm]	Diag.
0.08	10	1.5	115	94	15	1
0.2	10	5.7	182	128	20	2
	16	6.4		130	18	
	25					
0.5	10	6		168	20	
	16	6.8		170	19	
	25					

Spare parts

SB...P



Description	Item
Bladder assembly* consisting of:	
Bladder	2
Gas valve insert	3
Retaining nut	4
Cap nut	5
Protection cap	6
O-ring	7
Seal kit* consisting of:	
O-ring	7
Washer	15
O-ring	16
Support ring	23
O-ring	27
O-ring	47
O-ring	48
Anti-extrusion ring*	14
Gas valve insert*	3

* recommended spares

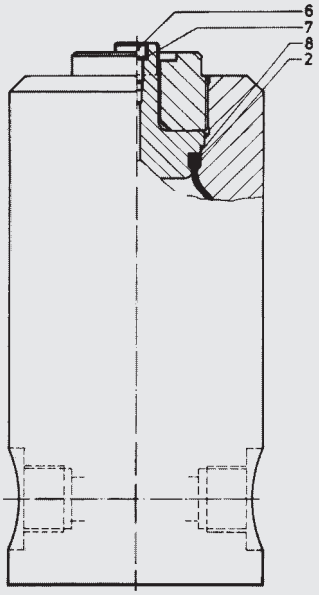
Description	Item
Connection assembly consisting of:	
Oil valve body	9
Valve poppet	10
Damping sleeve	11
Lock nut	12
Spring	13
Anti-extrusion ring	14
Washer	15
O-ring	16
Spacer	17
Lock nut	19
Support ring (only for 330 bar)	23
O-ring	27
Connector	44
Guide piece	45
Cap	46
O-ring	47
O-ring	48
Locking key	88

O-ring dimensions (mm)

Series	Nom. volumes	Item 7	Item 16	Item 27	Item 47	Item 48
SB330P	1- 6 l	7.5x2	55x3.5 [1)]	42.2x3 [1)]	46x3 [1)]	24.2x3 [1)]
SB550P	1- 5 l	7.5x2	50.17x5.33 [1)]	37.82x1.78 [1)]	40.94x2.62 [1)]	23.52x1.78 [1)]
SB330P/PH	10-32 l/4+6 l	7.5x2	80x5 [1)]	57.2x3 [1)]	67.2x3 [1)]	37.2x3 [1)]
SB330PH	10-32 l	7.5x2	100x5 [1)]	64.5x3 [1)]	84.5x3 [1)]	44.2x3 [1)]

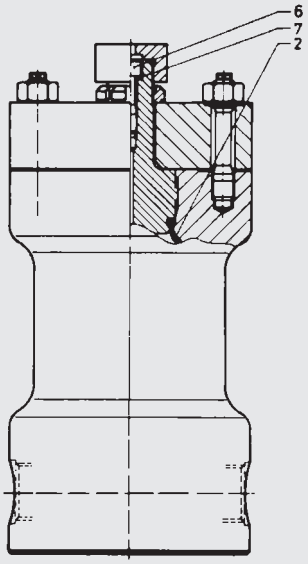
[1)] For code 663 and 665 different dimensions

SB800P



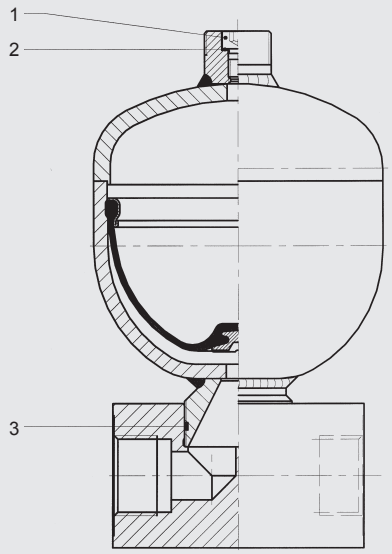
Description	Item
Bladder	2
Charging screw	6
Seal ring U 9.3x13.3x1	7
Support ring	8

SB1000P



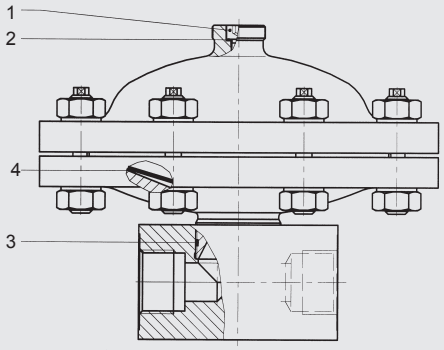
Description	Item
Bladder	2
Charging screw	6
Seal ring	7

SBO...P...E



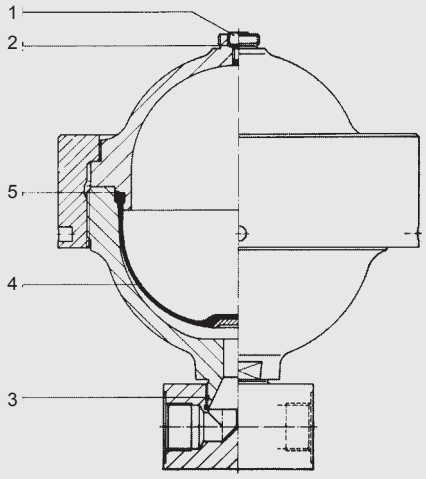
Description	Item
Charging screw	1
Seal ring	2
Seal ring	3

SBO...P-...A6/347...(PTFE)



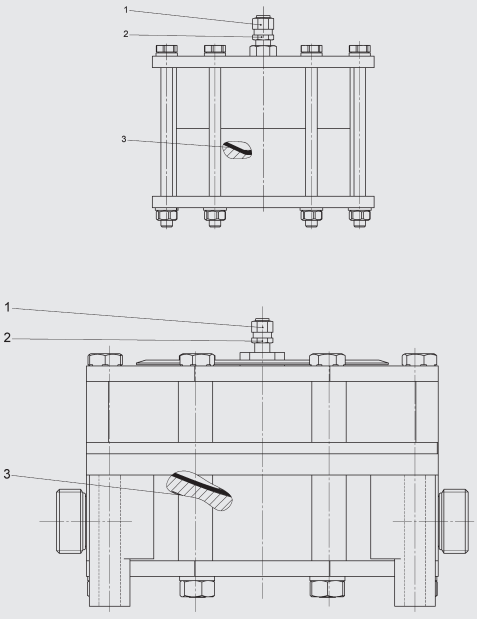
Description	Item
Charging screw	1
Seal ring	2
Seal ring	3
Diaphragm	4

SBO...P...A6



Description	Item
Charging screw	1
Seal ring	2
Seal ring	3
Diaphragm	4
Support ring	5

SBO...(P)-...A4/777... (PVDF/PTFE)

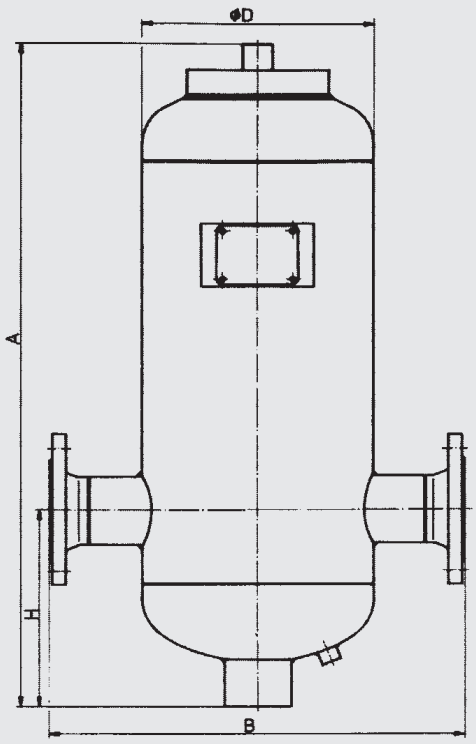


Description	Item
Gas valve complete	1
Gas valve insert brass / stainless steel	2
Diaphragm	3

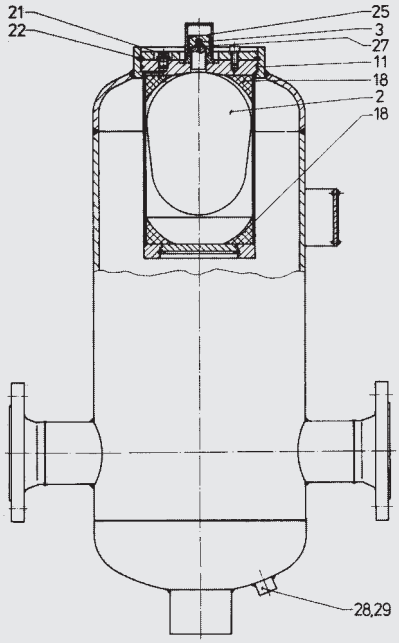
Relevant operating manual is available on request.

1.4.4 Suction flow stabiliser

SB16S



Spare Parts



Dimensions

SB16S – permitted operating pressure 16 bar (PED)

Nominal volume [l]	Fluid volume [l]	Eff. gas volume [l]	Weight [kg]	A [mm]	B [mm]	Ø D [mm]	H [mm]	DN*
12	12	1	40	580	425	219	220	65
25	25	2.5	60	1025				
40	40	4	85	890	540	300	250	80
100	100	10	140	1150	650	406	350	100
400	400	35	380	2050	870	559	400	125

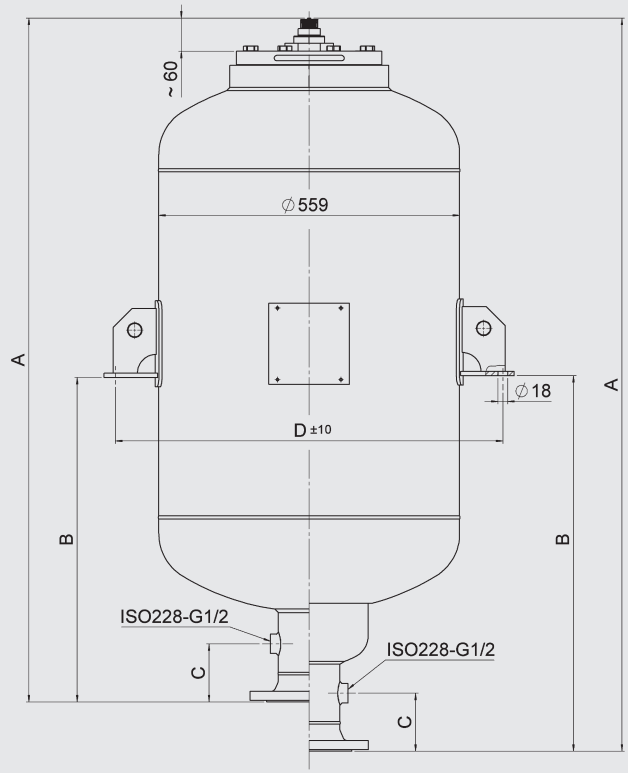
Further pressure ranges 25 bar, 40 bar; others on request.
Other fluid volumes on request

* to EN1092-1/11 /B1/PN16

Description	Item
Bladder	2
Gas valve insert	3
O-ring	11
Insertion ring, 2x	18
Lock nut	21
Retaining ring	22
Cap nut	25
O-ring	27
Seal ring	28
Lock nut	29

1.4.5 Shock absorber

SB16/35A, SB16/35AH



Dimensions

SB16/35A

Permitted operating pressure 16/35 bar (PED)

Nominal volume [l]	Eff. gas volume [l]	Weight [kg]		A (approx.) [mm]		B (approx.) [mm]		C (approx.) [mm]		D ±10 [mm]	
		SB16A	SB35A	SB16A	SB35A	SB16A	SB35A	SB16A	SB35A	SB16A	SB35A
100	108	110	144	854	881	398	418	108	121	720	728
150	151	127	171	1044	1076	493	578				
200	205	149	208	1275	1318	691	699				
300	290	178	261	1644	1701	920	937				
375	376	214	315	2020	2086	1063	1083				
450	455	244	364	2361	2436	1234	1258				

* to EN1092-1/11 / PN16 or PN40
others on request

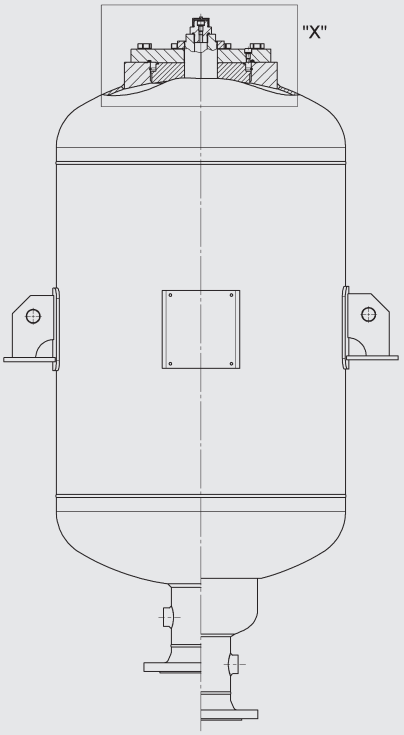
SB16/35AH

Permitted operating pressure 16/35 bar (PED)

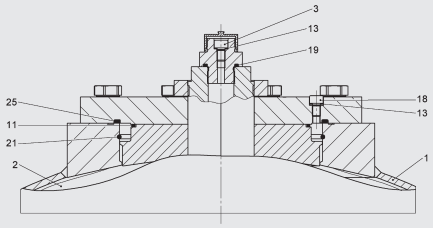
Nominal volume [l]	Eff. gas volume [l]	Weight [kg]		A (approx.) [mm]		B (approx.) [mm]		C (approx.) [mm]		DN*	
		SB16AH	SB35AH	SB16AH	SB35AH	SB16AH	SB35AH	SB16AH	SB35AH	SB16AH	SB35AH
100	108	118	153	945	971	488	508	108	121	720	728
150	151	135	180	1135	1166	638	641				
200	205	157	217	1366	1408	754	762				
300	290	186	270	1735	1791	988	1000				
375	376	222	324	2111	2176	1127	1146				
450	455	252	373	2452	2526	1298	1321				

* to EN1092-1/11 / PN16 or PN40
others on request

Spare Parts



Detail "X"



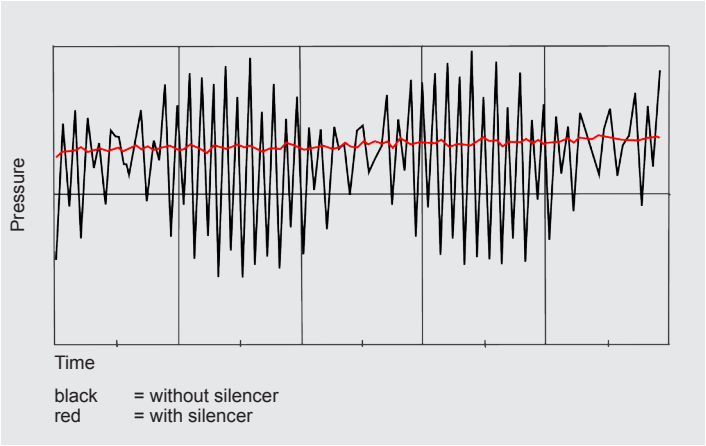
Description	Item
Bladder assembly	2
Gas valve assembly consisting of:	
Screw plug	3
Gas valve body	12
Seal ring	13
O-ring	19
Protection cap	29
Seal kit consisting of:	
O-ring	11
Seal ring	13
Air bleed screw	18
O-ring	19
Retaining ring	21
O-ring	25

Item 1 not available as a spare part

2. SILENCER

2.1. APPLICATION

2.1.1 Silencer for fluid noise damping Type SD...



General

All displacement pumps, such as axial and radial piston pumps, vane, gear or screw pumps produce volume and pressure fluctuations which are exhibited as vibrations and noises. Noises are not only generated and transmitted by the pump. They are also the result of mechanical vibrations and vibrations caused by the fluid pulsations, which are amplified when transmitted to larger surfaces. Insulation, the use of flexible hoses and silencer covers can provide only partial solutions to the problem as they do not prevent transmission to other areas.

Applications

Vehicles, machine tools, plastics machinery, aeroplanes, ships, hydraulic power stations and other systems with a large "surface" are all applications where the noise level can be reduced.

Operation

The HYDAC fluid SILENCER is based on the principle of an expansion chamber with interference line.

By reflecting the oscillations within the silencer the majority of the oscillations are dampened across a wide frequency spectrum.

Design

The HYDAC SILENCER consists of a welded or forged external housing, an internal tube and two pipe connections on opposite sides.

The SILENCER has no moving parts and no gas charge and is therefore absolutely maintenance free.

The HYDAC SILENCER can be used for mineral oils, phosphate ester and water glycol. A stainless steel model is available for other fluids.

Special model

SILENCERS can also be in the form of diaphragm or piston accumulators. Available on request.

Installation

It is recommended that one connection side is joined via a flexible hose in order to reduce the transmission of mechanical vibrations.

The installation position of the damper is optional, but the flow direction must be taken into account.

Please read the operating manual!
No. 3.701.BA

2.2. SIZING

2.2.1 Silencer

The sizing calculation of the HYDAC SILENCER is designed to result in a small unit with the best possible damping. The starting point for the selection table is to determine the level of transmission damping D from 20 dB upwards.

$$D = 20 \cdot \log \frac{\Delta p_o}{\Delta p_m}$$

Δp_o = height of pressure fluctuations without silencer
Δp_m = height of pressure fluctuations with silencer

When selecting the damper the following has to be taken into account:

1) the size of the silencer body
2) the fundamental frequency f of the pump
   f = i • n / 60 in Hz
   i = number of displacement elements
   n = motor speed in rpm

2.2.2 Calculation example

Given parameters:

Axial piston pump with 9 pistons

Motor speed:	1500 rpm
Connection:	G1 corresponds to D_i = 19 mm
Flow rate:	300 l/min
Operating medium:	mineral oil
Max. operating pressure:	210 bar

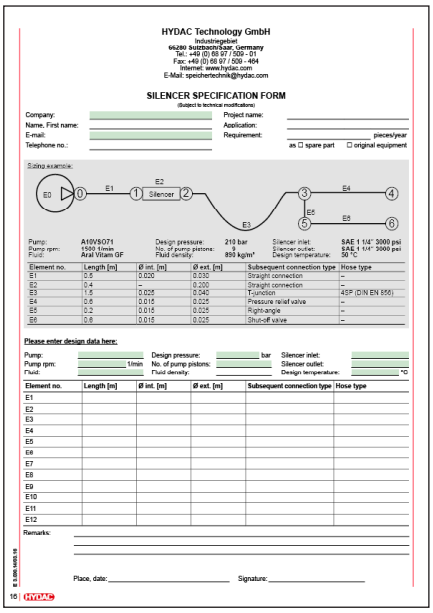
Solution:

Fundamental frequency f

f = i • n / 60 in Hz
= 9 • 1500/60
= 225 Hz

By calculating the fundamental frequency and using the system data (e.g. pipe length, ball valves, pressure, temperature, etc.) we can determine the correct size of silencer for you.
Use the specification sheet to provide the required data quickly and conveniently on the PC and send it to us.
See www.hydac.com or catalogue section

- HYDAC Accumulator Technology No. 3.000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SILENCER SPECIFICATION FORM
(Subject to technical modifications)

Company:
Name, First name:
E-mail:
Telephone no.:
Project name:
Application:
Requirement:
pieces/year
as ☐ spare part ☐ original equipment

Sizing example:

Pump:	A10VSO71	Design pressure:	210 bar
Pump rpm:	1500 1/min	No. of pump pistons:	9
Fluid:	Aral Vitam GF	Fluid density:	899 kg/m³
Silencer inlet:	SAE 1 1/4" 3000 psi
Silencer outlet:	SAE 1 1/4" 3000 psi
Design temperature:	50 °C

Element no.	Length [m]	Ø int. [m]	Ø ext. [m]	Subsequent connection type	Hose type
E1	0.5	0.020	0.030	Straight connection	–
E2	0.4	–	0.200	Straight connection	–
E3	1.5	0.025	0.040	T-junction	45° (DIN EN 856)
E4	0.6	0.015	0.025	Pressure relief valve	–
E5	0.2	0.015	0.025	Right-angle	–
E6	0.6	0.015	0.025	Shut-off valve	–

Please enter design data here:

Pump:
Pump rpm: 1/min
Fluid:
Design pressure: bar
No. of pump pistons:
Fluid density:
Silencer inlet:
Silencer outlet:
Design temperature: °C

Element no.	Length [m]	Ø int. [m]	Ø ext. [m]	Subsequent connection type	Hose type
E1					
E2					
E3					
E4					
E5					
E6					
E7					
E8					
E9					
E10					
E11					
E12					

Remarks:

Place, date: Signature:

E 3.000.1/05.10
16 HYDAC

2.3. TECHNICAL SPECIFICATIONS

2.3.1 Model code

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SD330 M - 4.2 / 212 U - 330 AD/AD

Series

Type code
no details = for SD 330
B = bladder accumulator base body*
K = piston accumulator base body*
M = diaphragm accumulator base body*

Nominal volume [l]

Damper
0 = without pipe
1 = damper for frequencies > 500 Hz
2 = narrow band damper - DR
3 = broadband damper - DR

Housing material
1 = carbon steel
2 = carbon steel with protective coating*

Seal material
2 = NBR (-15 °C ... + 80 °C)
6 = FKM (-10 °C ... +160 °C)

Certification code
U = European Pressure Equipment Directive (PED)

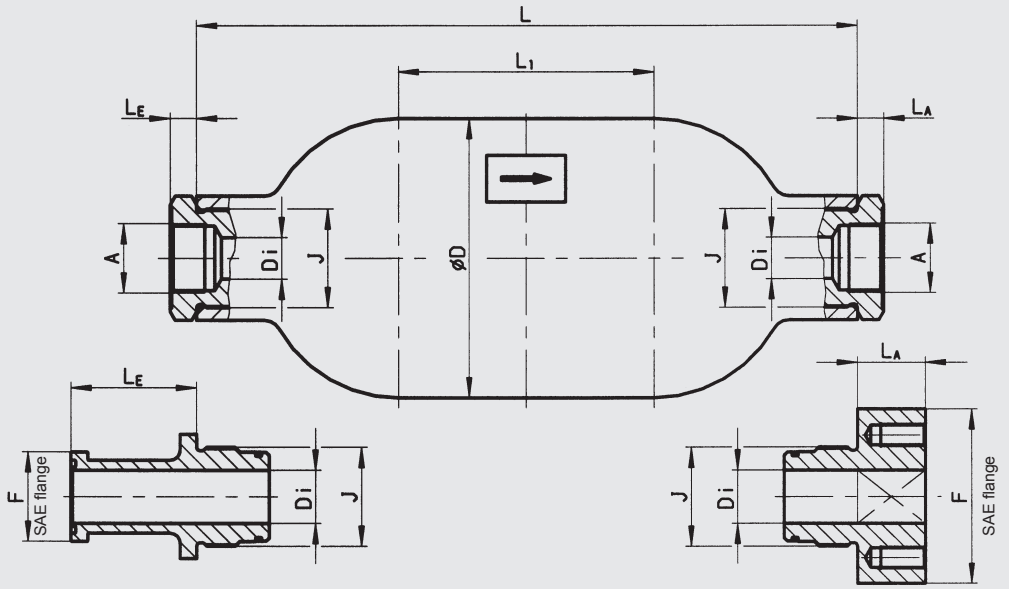
Permitted operating pressure [bar]

Inlet connector/outlet connector
see Table 2.3.3

* only on request

2.3.2 **Dimensions**

SD330



Nominal volume [l]	L [mm]	L1 [mm]	Ø D [mm]	J ISO 228	Weight [kg]
1.3	250	–	114	G 1	6.5
1.8	355	155		G 1 1/4	5.5
4.2	346	–	168	G 1 1/2	12.5
4.7	420	155		G 2	11.4

2.3.3 **Silencer connections**

a) Threaded connection to ISO 228

	Fluid connection A													
	AB G 3/8 D_i = 15 mm		**AC** G 1/2 D_i = 13 mm		**AD** G 3/4 D_i = 16 mm		**AE** G 1 D_i = 19 mm		**AF** G 1 1/4 D_i = 25 mm		**AG** G 1 1/2 D_i = 32 mm		**GG** G 1 1/2 D_i = J	
Nominal volume [l]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]
1.3	17	17	–		–		–		–		–		–	
1.8	–		13	13	13	13	30	30	33	33	–		–	
4.2	–		–		–		–		–		–		without adapter	
4.7	–		–		16	16	16	16	26	26	36	36	36	36

b) Flange connection SAE J518 (Code 62 - 6000 psi)

	Fluid connection F											
	FG SAE 1/2" D_i = 13 mm		**FH** SAE 3/4" D_i = 19 mm		**FI** SAE 1" D_i = 25 mm		**FK** SAE 1 1/4" D_i = 32 mm		**FL** SAE 1 1/2" D_i = 38 mm		**FM** SAE 2" D_i = 50 mm	
Nominal volume [l]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]	L_E [mm]	L_A [mm]
1.3	–		–		–		–		–		–	
1.8	53	31	59	36	65	36	–		–		–	
4.2	–		–		–		–		0	33	–	
4.7	–		105	36	120	36	76	28	76	28	*	

- not available
* on request

3. 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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Accumulator Stations

1. GENERAL

HYDAC supplies fully assembled piston accumulator stations which are ready for operation, complete with all the necessary valve controls, ball valves and safety equipment

- as an individual accumulator unit or
- in a back-up version with nitrogen bottles to increase the effective volume.

The HYDAC system approach creates a HYDAC system of, for example, bladder or piston accumulator stations, by integrating individual HYDAC components.

An accumulator station can be composed of

- piston accumulators with nitrogen bottles,
- bladder accumulators with nitrogen bottles or
- nitrogen bottles alone.

The modular construction of the accumulator stations enables HYDAC to incorporate all customer requirements. HYDAC can calculate the required accumulator volume using the accumulator sizing program, taking the customer's own operating data into account:

- **ASP** – **A**ccumulator **S**imulation **P**rogram.

Please read the relevant operating manual for the individual HYDAC components!

2. MODEL CODE

(also order example)

SS 350 K – 4 x 250 / 12 x 320 (U)

Type of accumulator
SS = accumulator station

Max. operating pressure [bar]

Series
K = piston accumulator
B = bladder accumulator
N = nitrogen bottles

Number of accumulators

Nominal volume [l] of the accumulators

Number of nitrogen bottles

Nominal volume [l] of the nitrogen bottles

Certification code
(U) = European Pressure Equipment Directive (PED)

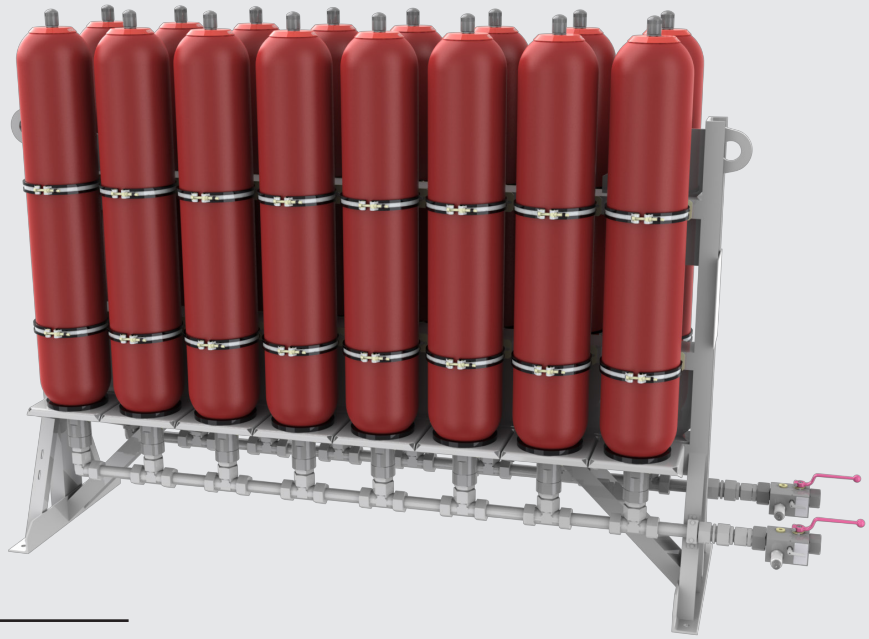
Piston accumulators and nitrogen bottles are connected up via a manifold block or pipework

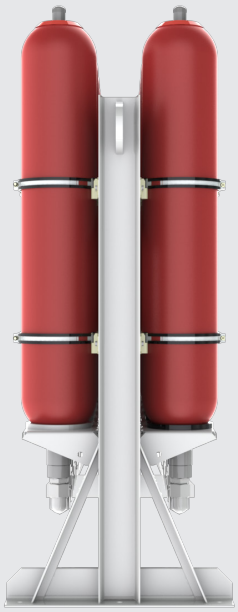
3. EXAMPLES OF ACCUMULATOR STATIONS

3.1. BLADDER ACCUMULATOR STATIONS

EXAMPLE: SS330B-16x32(U)

Technical specifications:
16 bladder accumulators, each with a volume of 32 l
max. operating pressure: 330 bar

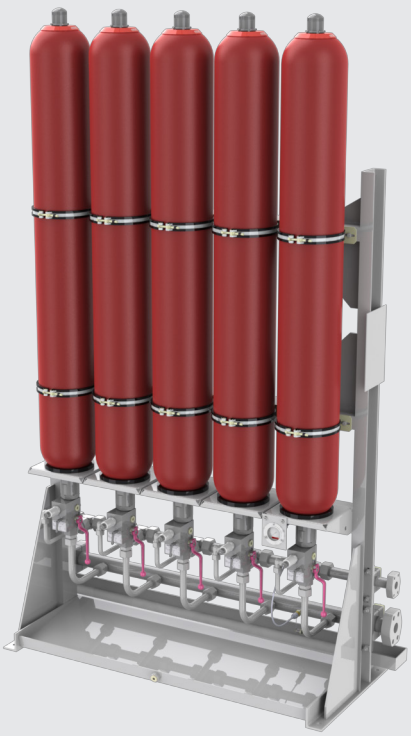




Dimensions		
Length [mm]	Width [mm]	Height [mm]
2780	660	1950

EXAMPLE: SS330B-5x50(U)

Technical specifications:
5 bladder accumulators, each with a volume of 50 l
max. operating pressure: 330 bar



Dimensions		
Length [mm]	Width [mm]	Height [mm]
1640	600	2750

3.2. PISTON ACCUMULATOR STATIONS

EXAMPLE: SS350K-1x110/8x50(U)

Technical data:
1 piston accumulator, volume 110 l
8 N_2-bottles, each with a volume of 50 l
max. operating pressure: 350 bar

Dimensions		
Length [mm]	Width [mm]	Height [mm]
1540	900	3300

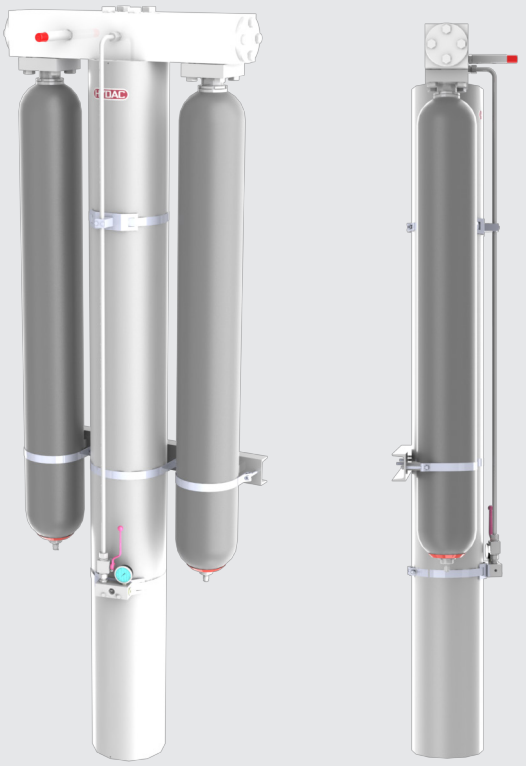
EXAMPLE: SS220K-1x120/1x75(U)

Technical data:
1 piston accumulator, volume 120 l
1 N_2-bottle, volume 75 l
max. operating pressure: 220 bar

Dimensions		
Length [mm]	Width [mm]	Height [mm]
520	800	3500

EXAMPLE: SS210K-1x110/2x50(U)

Technical data:
1 piston accumulator, volume 110 l
2 N_2-bottles, each with a volume of 50 l
max. operating pressure: 210 bar



Dimensions		
Length [mm]	Width [mm]	Height [mm]
950	475	2840

Example: SS350K-1x200/2x100(A9)

Technical data:
1 piston accumulator, volume 200 l
2 N_2-bottles, each with a volume of 110 l
max. operating pressure: 350 bar

Dimensions		
Length [mm]	Width [mm]	Height [mm]
1250	550	2900

3.3. NITROGEN BOTTLES

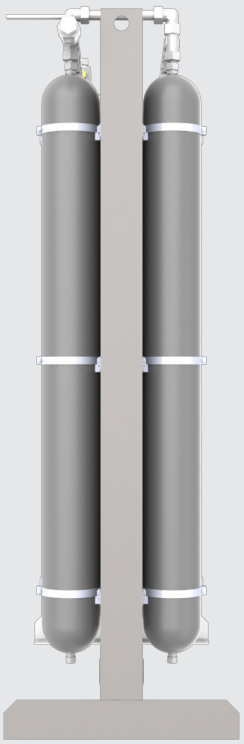
Nitrogen bottles in modular construction:
up to 24 bottles can be assembled in this version on a frame. For a larger number, a special model can be supplied.

See catalogue section:

- Hydraulic accumulators with back-up nitrogen bottles
  No. 3.553

Example: SS350N-16x75(U)

Technical data:
16 N_2-bottles, each with a volume of 75 l
max. operating pressure: 350 bar



Dimensions		
Length [mm]	Width [mm]	Height [mm]
2440	900	3000

4. NOTE

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Hydraulic Accumulators with Back-Up Nitrogen Bottles

1. GENERAL

To complete the accumulator range, HYDAC provides a variety of useful accessory products. They guarantee correct installation and optimum functioning of HYDAC hydraulic accumulators. These include, amongst others, nitrogen bottles which can be used to back up bladder and piston accumulators. Nitrogen bottles used as back-ups increase the gas volume in the accumulator. This means that smaller accumulators can be used for the same gas volume and costs can be reduced.

For further information, please turn to the sections:

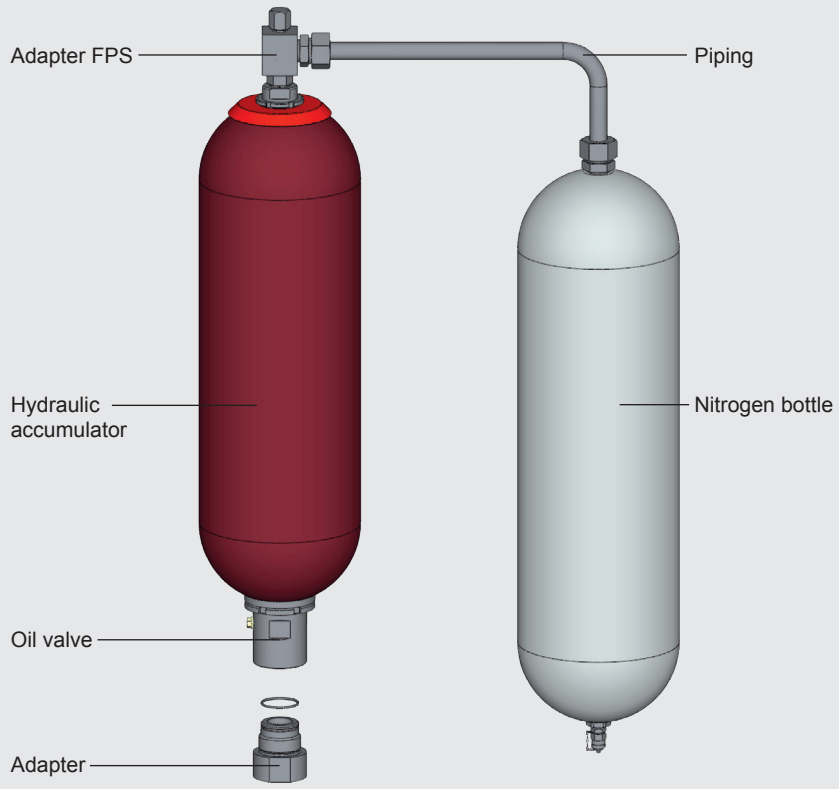
- Bladder Accumulators Standard No. 3.201
- Piston Accumulators Standard No. 3.301

2. BACK-UP VERSIONS

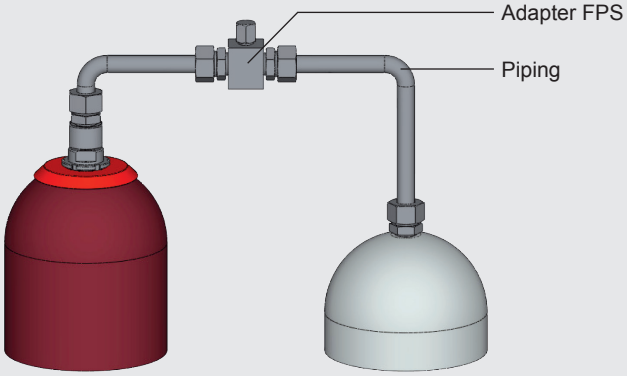
2.1. SET-UP USING THE EXAMPLE OF A BLADDER ACCUMULATOR

Based on bladder accumulator models 20 ... 50 l, the gas-side of these transfer accumulators is designed especially for connecting to nitrogen bottles. A diffuser rod prevents damage to the bladder when the accumulator is charged. This design can also be used for the separation of fluids (taking into account the volume ratios which apply to bladder accumulators).

Type 1

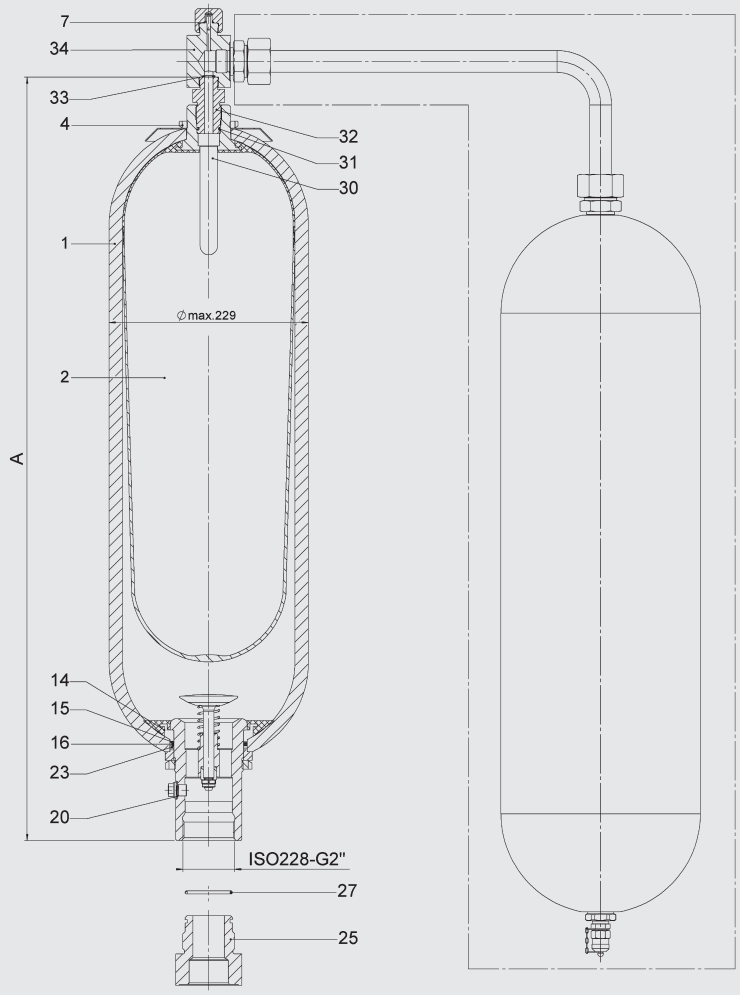


Type 2

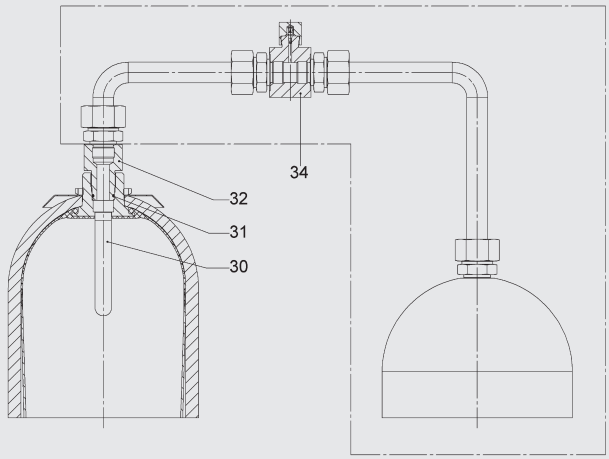


2.2. DIMENSIONS

Type 1



Type 2



Nominal volume [l]	Effective gas volume [l]	Weight [kg]	A max. [mm]
20	17.5	53.5	905
24	24	72	1070
32	32.5	89	1420
50	47.5	119.5	1930

others on request

2.3. SPARE PARTS

NBR, carbon steel, standard gas valve

Nominal volume of accum. [l]	Seal kit Part no.	Repair kit Type 1 Part no.	Repair kit Type 2 Part no.
20	353621	3119500	3897464
24		3119502	3897463
32		3119498	3897462
50		3119499	3897461

Description	Item
Bladder assembly consisting of:	
Bladder	2
Lock nut	4
Diffuser rod	30
O-ring 22x2.5 [1]	31
Adapter for Type 1/2	32
Seal kit consisting of:	
O-ring 7.5x2 [1]	7
Washer	15
O-ring 80x5 [1]	16
Seal ring	20
Back-up ring	23
O-ring 48x3 [1]	27
Repair kit consisting of:	
Bladder assembly (see above)	
Seal kit (see above)	
O-ring 11x2 [1]	33
Anti-extrusion ring	14
Adapter FPS for Type 1/2 [2]	34

Recommended spare parts

[1] For code 663 and 665 different dimensions

[2] see section 4.

Item 1 not available as a spare part.

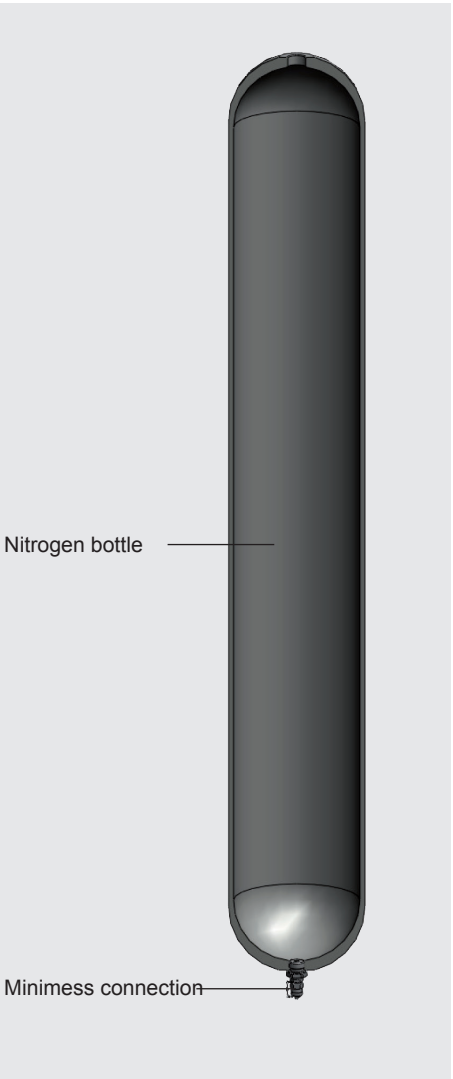
Item 25 must be ordered separately, See Bladder Accumulator Standard, No. 3.201 (section 4.2.)

Item 32 Type 1 is standard.

For other spare parts, see section 3.

3. NITROGEN BOTTLES

3.1. DESCRIPTION AND CONSTRUCTION



HYDAC nitrogen bottles are used for the receiving and storage of nitrogen.

HYDAC supplies various versions, such as standard nitrogen bottles made from forged vessels and special vessels based on bladder accumulator shells, piston accumulator tubes and diaphragm accumulator parts – see catalogue section:

- Bladder Accumulators
  Standard
  No. 3.201
- Piston Accumulators
  Standard
  No. 3.301
- Diaphragm Accumulators
  No. 3.100

The following technical specifications refer to standard nitrogen bottles. Please ask us for information regarding other versions.

3.2. ADVANTAGES

The use of HYDAC nitrogen bottles provides the following benefits:

- Cost-effective increase of the accumulator volume and as a result
- Smaller accumulators for the same gas volume.

3.3. TECHNICAL SPECIFICATIONS

3.3.1 Model code

Not all combinations are possible.
Order example. For further information, please contact HYDAC.

SN360 _ - 50 AA / 010 U - 360 D D - C

Series
Code
no details = standard
special types (see section 3.1.):
B = bladder accumulator shell
K = piston accumulator tube
M = diaphragm accumulator halves
Nominal volume [l]
Connection type
Version, drain side (condensate)
A = ISO 228 (BSP)
B = DIN 13 to ISO 965/1 (metric)
C = ANSI B1.1 (UNF seal SAE)
D = ANSI B2.1
F = flange
1 = sealed with blanking plug
2 = with condensate drain, hex. socket cap screw
3 = with condensate drain valve
4 = with Minimess valve
Connection type on connection side
A = ISO 228 (BSP)
B = DIN 13 to ISO 965/1 (metric)
C = ANSI B1.1 (UNF seal SAE)
D = ANSI B2.1
F = flange
Material code
Material (connection)
0 = no installed parts
1 = carbon steel
3 = stainless steel
4 = carbon steel with protective coating
6 = low temperature steel
Housing material
1 = carbon steel
2 = carbon steel with protective coating
4 = stainless steel
6 = low temperature steel
Seal material (elastomer)
0 = no elastomer used
2 = NBR
4 = IIR
5 = low temperature NBR
6 = FKM
Certification code
U = European Pressure Equipment Directive (PED)
Permitted operating pressure [bar]
Size for connection side (see Table 3.3.2)
Size for drain side (see Table 3.3.2)
0 = for type 1-4
Version
no details = standard
C = compact

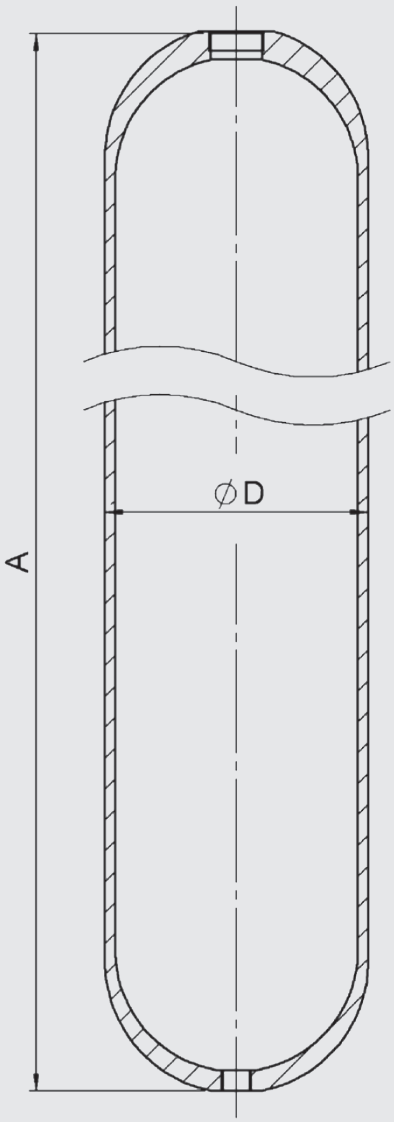
3.3.2 Connections

Standard connections are highlighted in grey.
All other designs available on request (not all combinations are possible).

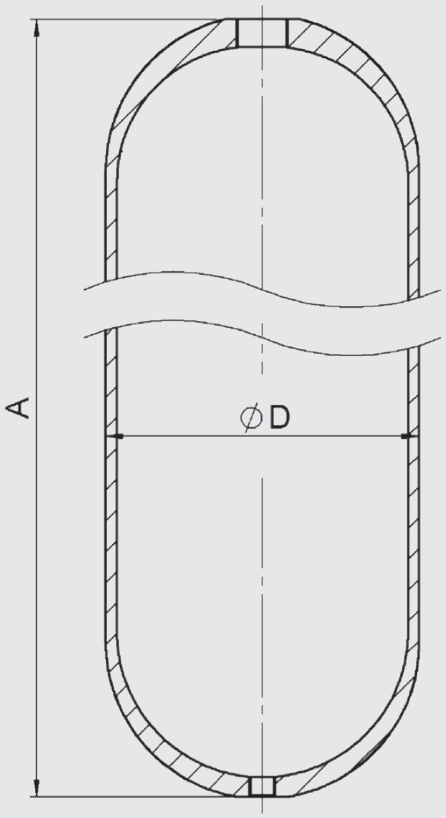
Type / Size	**A** BSP ISO228	**B** metric DIN13 ISO965/1	**C** SAE ANSI B1.1	**D** NPT ANSI B2.1	**F** Flange connection
A	G 1/4"	M12x1.5	7/16"-20UNF	1/4"	1/2" 3000 psi Code 61
B	G 3/8"	M18x1.5	9/16"-18UNF	3/8"	3/4"
C	G 1/2"	M22x1.5	3/4"-16UNF	1/2"	1"
D	G 3/4"	M27x2	1 1/16"-12UN	3/4"	1 1/4"
E	G 1"	M33x2	1 5/16"-12UN	1"	1 1/2"
F	G 1 1/4"	M42x2	1 5/8"-12UN	1 1/4"	2"
G	G 1 1/2"	M48x2	1 7/8"-12UN	1 1/2"	1/2" 6000 psi Code 62
H	G 2"	M14x1.5	2 1/2"-12UN	2"	3/4"
I	G 1 3/4"	M8	-	-	-
K	-	M16x1.5	-	-	1 1/4"
L	-	-	7/8"-14UNF	5/8"	1 1/2"
M	-	-	-	-	2"
S	Special version				

3.3.3 **Dimensions of standard bottle**

Version: standard



Version: compact



Series	Volume [l]	Version	Certification code	Connections to ISO 228 (Type AA)		A ± 25 [mm]	D ± 1% [mm]	Weight approx. [kg]	Part no.	Designation
				Drain side	Connec-tion side					
SN360	50	Standard	U	G 3/4	G 3/4	1650	229	87	3176324	SN360-50AA/010U-360DD
				G 3/4	G 1 1/2				3418347	SN360-50AA/010U-360DG
			S	G 3/4	G 1 1/2				3987605	SN360-50AA/010S-210DG
	75	Standard	U	G 3/4	G 1 1/2	2305	229	123	3561595	SN360-75AA/010U-360DG
			S	G 3/4	G 1 1/2				3987606	SN360-75AA/010S-210DG
		Compact	U	G 3/4	G 1 1/2	1690	273	120	3987162	SN360-75AA/010U-360DG-C
			S	G 3/4	G 1 1/2				3987163	SN360-75AA/010S-200DG-C
SN600	50	Standard	S	G 3/4	G 1 1/2	1730	232	135	3987613	SN600-50AA/010S-345DG
	75	Standard	S	G 3/4	G 1 1/2	2500	232	195	3987614	SN600-75AA/010S-345DG

4. ACCESSORIES

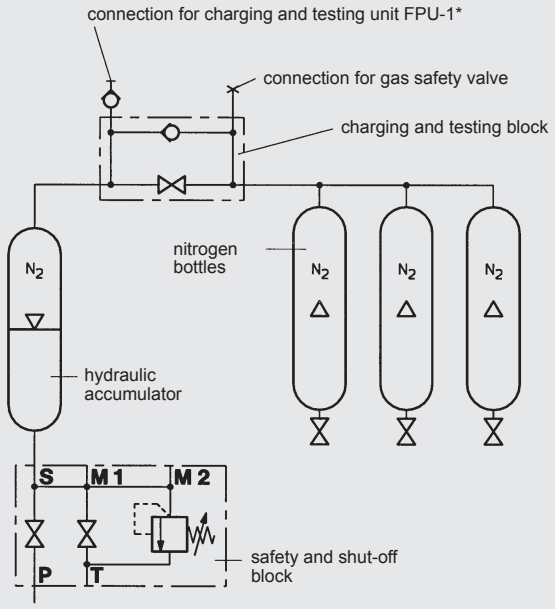
4.1. CHARGING AND TESTING BLOCK F + P

4.1.1 Description

The HYDAC charging and testing block F+P is used to charge and test back-up type hydraulic accumulators. It has connections for the charging and testing unit FPU-1 and for pressure gauges. As a safety function, a gas safety valve GSV6 (see catalogue section given below) can be fitted. In addition, it allows the back-up nitrogen bottles to be shut off from the hydraulic accumulator.

- Safety Equipment for Hydraulic Accumulators
  No. 3.552

4.1.2 Hydraulic circuit with charging and testing block

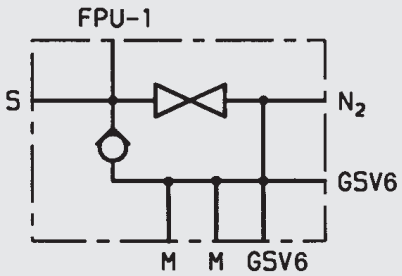


* For further information, see catalogue section:
- Charging and Testing Unit FPU
  No. 3.501

4.1.3 Preferred models / Spare parts

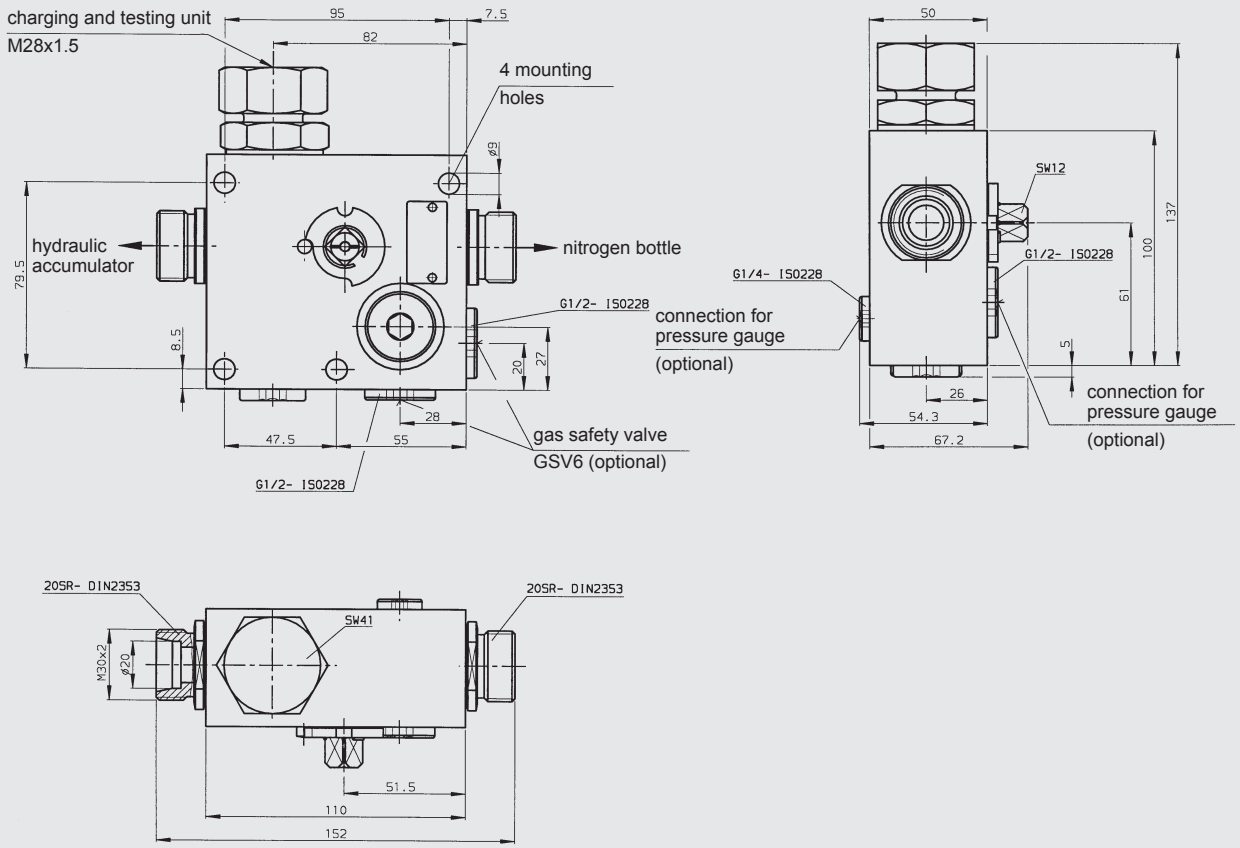
Designation	Max. operating pressure [bar]	Weight [kg]	Part no.	Seal kit [1)]
F+P-16-20SR-6112-02X	400	4.3	850233	2115776
F+P-32-38SR-6112-02X	350	14	552193	2112088

[1)] recommended spare parts

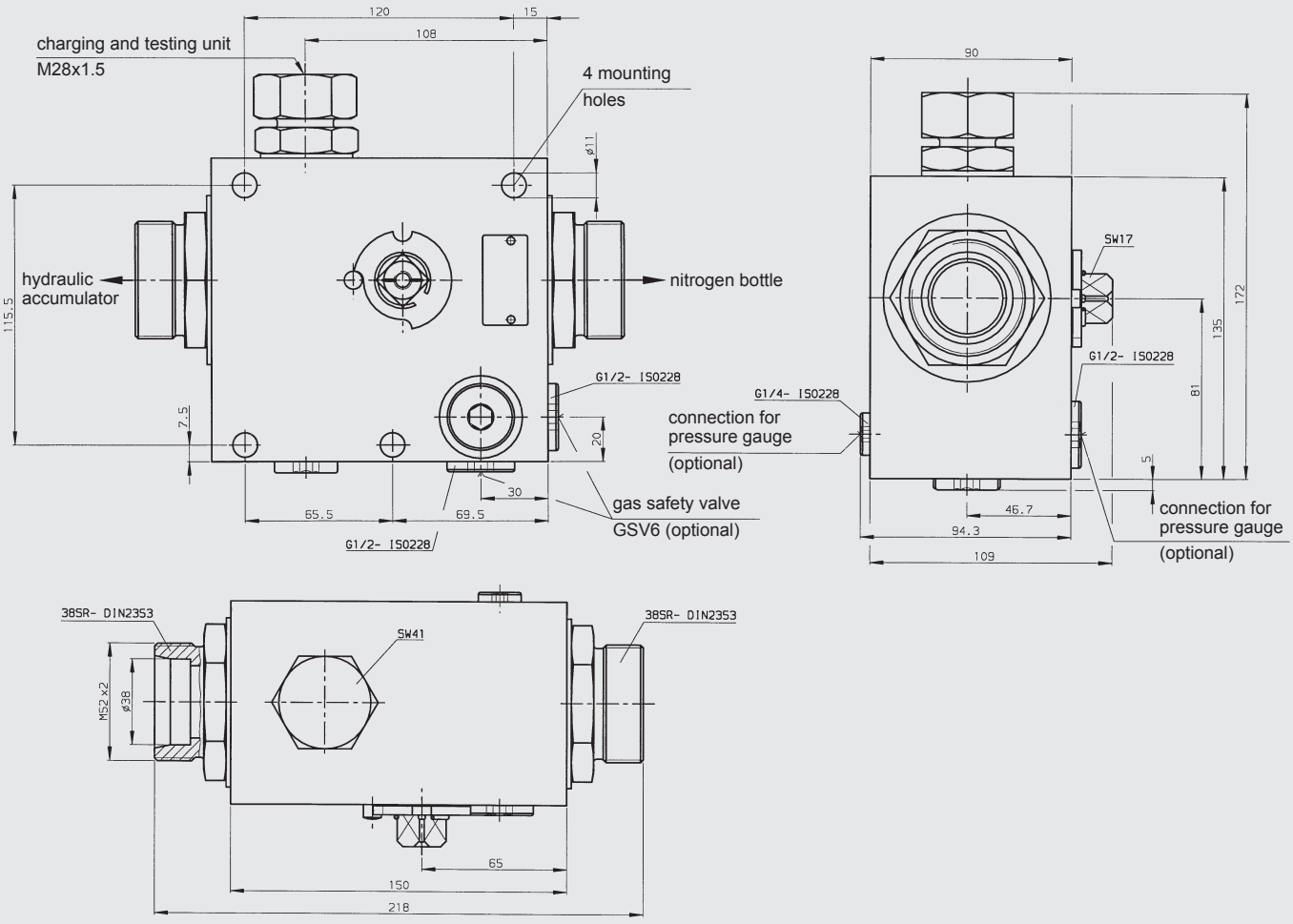


4.1.4 Technical specifications / dimensions

Charging and testing block DN 16

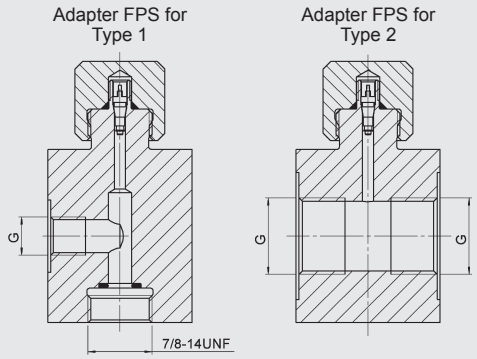


Charging and testing block DN 32



4.2. FPS ADAPTER

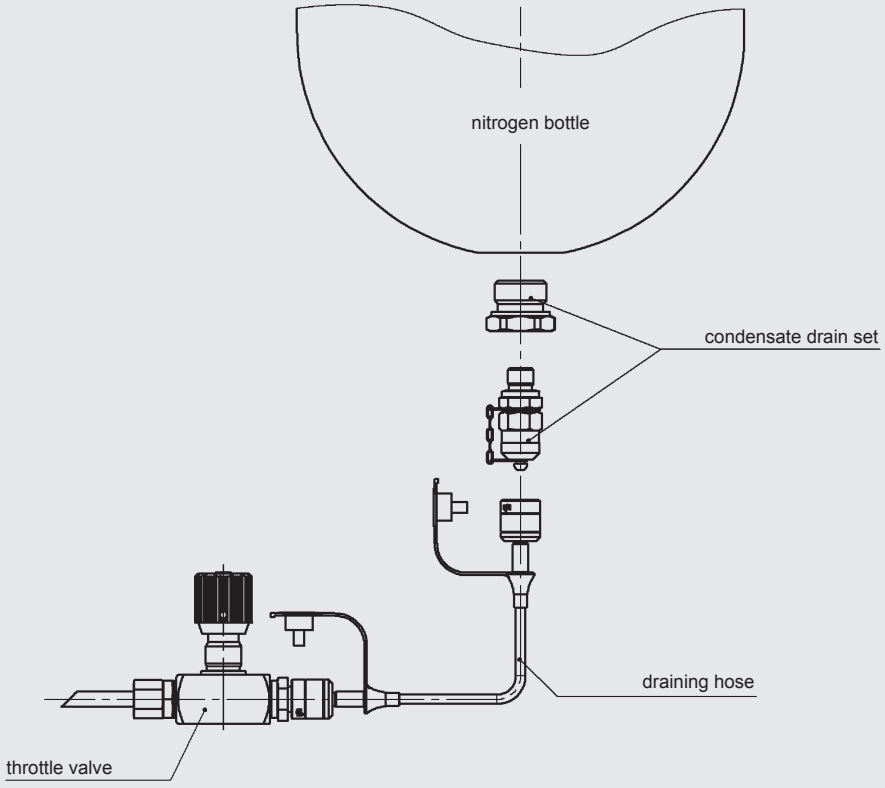
The HYDAC FPS adapter is used to charge back-up type hydraulic accumulators.
For this it has a connection for the Charging and Testing Unit FPU-1.



Designation	G ISO228	Part no.	Version
Adapter FPS 7/8-14UNF	G 3/4	363226	1
Adapter FPS	G 3/4	243218	2

4.3. CONDENSATE DRAIN SET

The condensate drain set consists of a throttle valve and a suitable condensate draining hose.
It is used to drain any condensate from the nitrogen bottle, in a controlled way.



Designation	Length [m]	Part no.
Condensate drain G 3/4 – Minimess M16x1.5	–	3219496
Condensate drain set	0.4	3472820
	1	3472823
	1.6	3472824

4.3. NITROGEN CHARGING UNIT

HYDAC nitrogen charging units facilitate fast and cost-effective charging or testing of the required pre-charge pressures in bladder, diaphragm and piston accumulators. They guarantee optimum use of standard nitrogen bottles up to a residual pressure of 20 bar and a maximum accumulator charging pressure of 350 bar. Portable, mobile and stationary types of N_2-Server are available.

For further information and technical specifications, see catalogue section:

- Nitrogen charging units N_2-Server No. 2.201

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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Charging and testing unit FPU

for Bladder, Piston and Diaphragm Accumulators

1. DESCRIPTION

1.1. FUNCTION

The HYDAC charging and testing unit FPU is used to charge accumulators with nitrogen or to check or to change the existing pre-charge pressure in accumulators.
For this purpose the charging and testing unit is screwed onto the gas valve of the hydraulic accumulator and connected via a hose to a commercial nitrogen bottle.
If the nitrogen pressure is only to be checked or reduced, the charging hose does not need to be connected. The unit has a screw-type fitting with a built-in pressure gauge, check valve and a spindle for opening the accumulator gas valve to control the pressure

HYDAC piston and diaphragm accumulators can be charged and checked without the need for adapters. Bladder accumulators, however, require an A3 adapter.

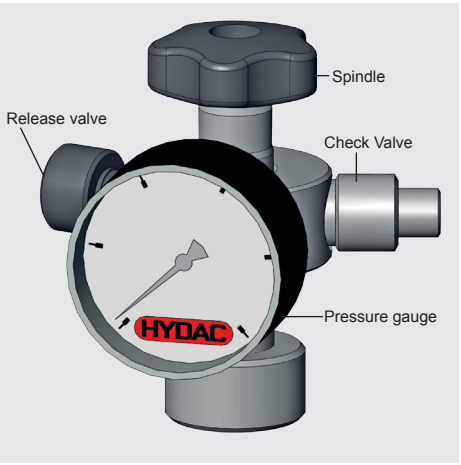
Information on how to check the pre-charge pressure, on testing intervals and other instructions relating to operation can be found in the Operating Manual.

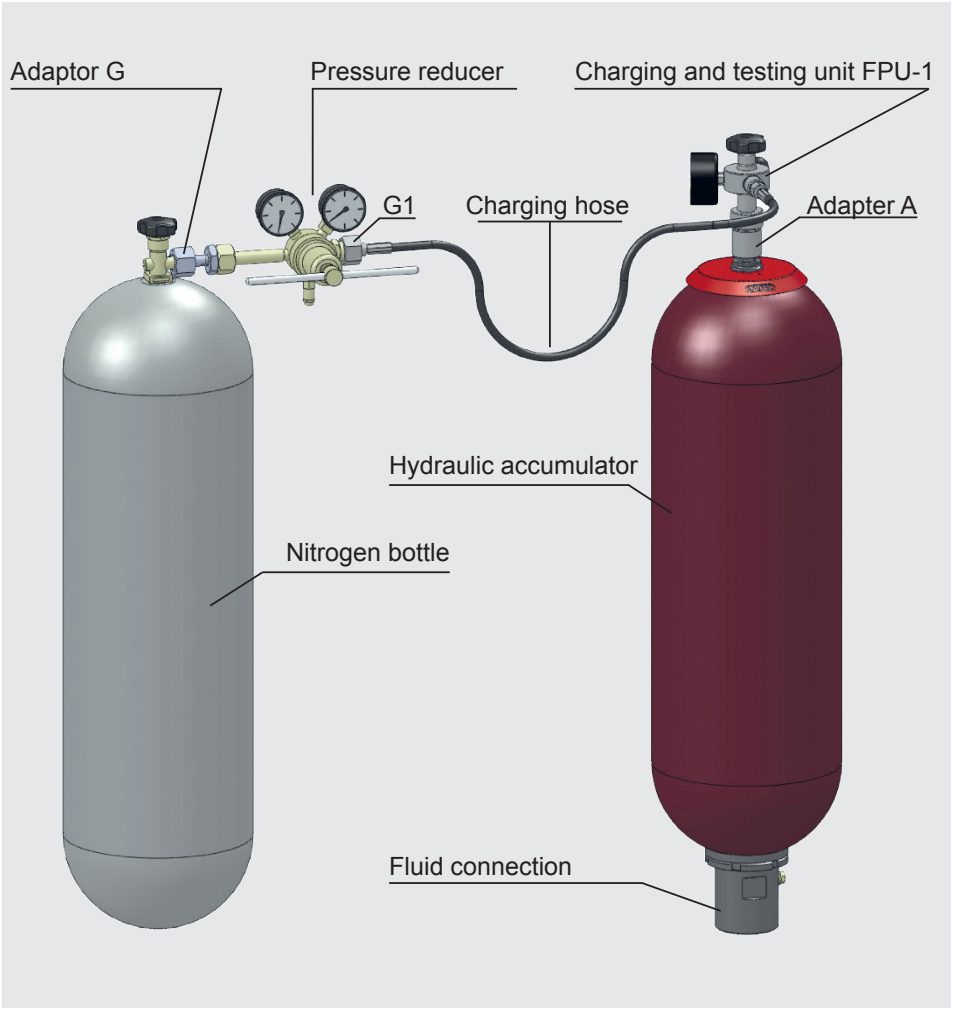
Please read the operating manual!
No. 3.501.BA

1.2. DESIGN

The HYDAC charging and testing unit FPU-1 for bladder, piston and diaphragm accumulators consists of:

- Valve body
- Spindle
- Check valve
- Release valve
- Pressure gauge





2. TECHNICAL SPECIFICATIONS

2.1. MODEL CODE

Not all combinations are possible. Order example.
For further information, please contact HYDAC.

FPU-1-350 / 250 F 2.5 G2 A1 K

Charging and testing unit
FPU-1-350 = Standard (p_{max} = 350 bar)
FPU-2-800 = High-pressure version (p_{max} = 800 bar)

Pressure gauge display range
10 = 0 - 10 bar (0 - 145 psi)
25 = 0 - 25 bar (0 - 363 psi)
100 = 0 - 100 bar (0 - 1450 psi)
250 = 0 - 250 bar (0 - 3625 psi)
400 = 0 - 400 bar (0 - 5800 psi)
1000 = 0 - 1000 bar (0 - 14500 psi high-pressure version)

Charging hose
F = for nitrogen bottle 200 bar with connection W24.32x1/14 (DIN 477, Part 1)
FM = for nitrogen bottle 300 bar with connection M30x1.5 (DIN 477, Part 5 up to April 2002)
FW = for nitrogen bottle 300 bar with connection W30x2 (DIN 477, Part 5 from April 2002)
FH = for pressure booster systems with connection 9/16-18UNF

Charging hose length
Standard
2,5 = 2.5 m
4,0 = 4 m
High pressure version
6,0 = 6 m
others on request

Adapter G for nitrogen bottles (only FPU-1)
see table section 3.4.

Adapter A
A3 = 7/8-14UNF, incl. in FPU-1 scope of delivery as standard
A3H= 7/8-14UNF (high pressure version), not incl. in FPU-2 scope of delivery
for others, see table section 3.3.

Protective case

Accessories - please give full details when ordering (see section 4.)

2.2. STANDARD TYPES FPU-1

The basic version of the FPU-1 is the minimum equipment required to test and set the pre-charge pressure (p_0) at the hydraulic accumulator. It comprises the FPU-1, a charging hose and the adapter A3 for bladder accumulators. The following standard types are available (others on request):

Models without protective case

Designation	Part no.
FPU-1-350/010F2.5A3	2114486
FPU-1-350/010F4A3	2115056
FPU-1-350/025F2.5A3	2114481
FPU-1-350/025F4A3	2116876
FPU-1-350/100F2.5A3	2114310
FPU-1-350/100F4A3	2115657
FPU-1-350/250F2.5A3	2114306
FPU-1-350/250F4A3	2114311
FPU-1-350/400F2.5A3	2115646
FPU-1-350/400F4A3	2119673

Models with protective case

Designation	Part no.
FPU-1-350/010F2.5A3K	2115365
FPU-1-350/010F4A3K	3013690
FPU-1-350/025F2.5A3K	2114305
FPU-1-350/025F4A3K	2116738
FPU-1-350/100F2.5A3K	2115314
FPU-1-350/100F4A3K	2114842
FPU-1-350/250F2.5A3K	2114302
FPU-1-350/250F4A3K	2114303
FPU-1-350/400F2.5A3K	2114307
FPU-1-350/400F4A3K	2114304

To enable nitrogen bottles from different countries to be used, HYDAC provides a selection of adapters as accessories. The following standard types are available (others on request):

Models with protective case and adapter G

Designation	Part no.
FPU-1-350/250F2.5G2A3K	2114309
FPU-1-350/250F2.5G3A3K	2114308
FPU-1-350/250F2.5G4A3K	2103046
FPU-1-350/250F2.5G5A3K	2117038
FPU-1-350/250F2.5G6A3K	2115420
FPU-1-350/250F2.5G7A3K	2120010
FPU-1-350/250F2.5G8A3K	2115216
FPU-1-350/250F2.5G9A3K	2115833
FPU-1-350/250F2.5G10A3K	2115403
FPU-1-350/250F2.5G11A3K	3104265
FPU-1-350/250F2.5G12A3K	3738731
FPU-1-350/250F2.5G13A3K	3820014

2.3. HIGH PRESSURE VERSIONS

The FPU-2 was designed specifically for high pressure applications.
Just like the FPU-1, the FPU-2 is universally applicable.
It can be screwed onto HYDAC piston and diaphragm accumulators directly to charge and/or to check the accumulator.
For use with a bladder accumulator, the high pressure adapter A3H must be used. This is not included in standard delivery.

2.3.1 Technical specifications

Model code:
see section 2.1.

Max. operating pressure:
800 bar

Pressure gauge display range:
0 - 1000 bar (0 - 14500 psi)

Material:
Stainless steel 1.4313

2.3.2 Standard types FPU-2

Models without protective case

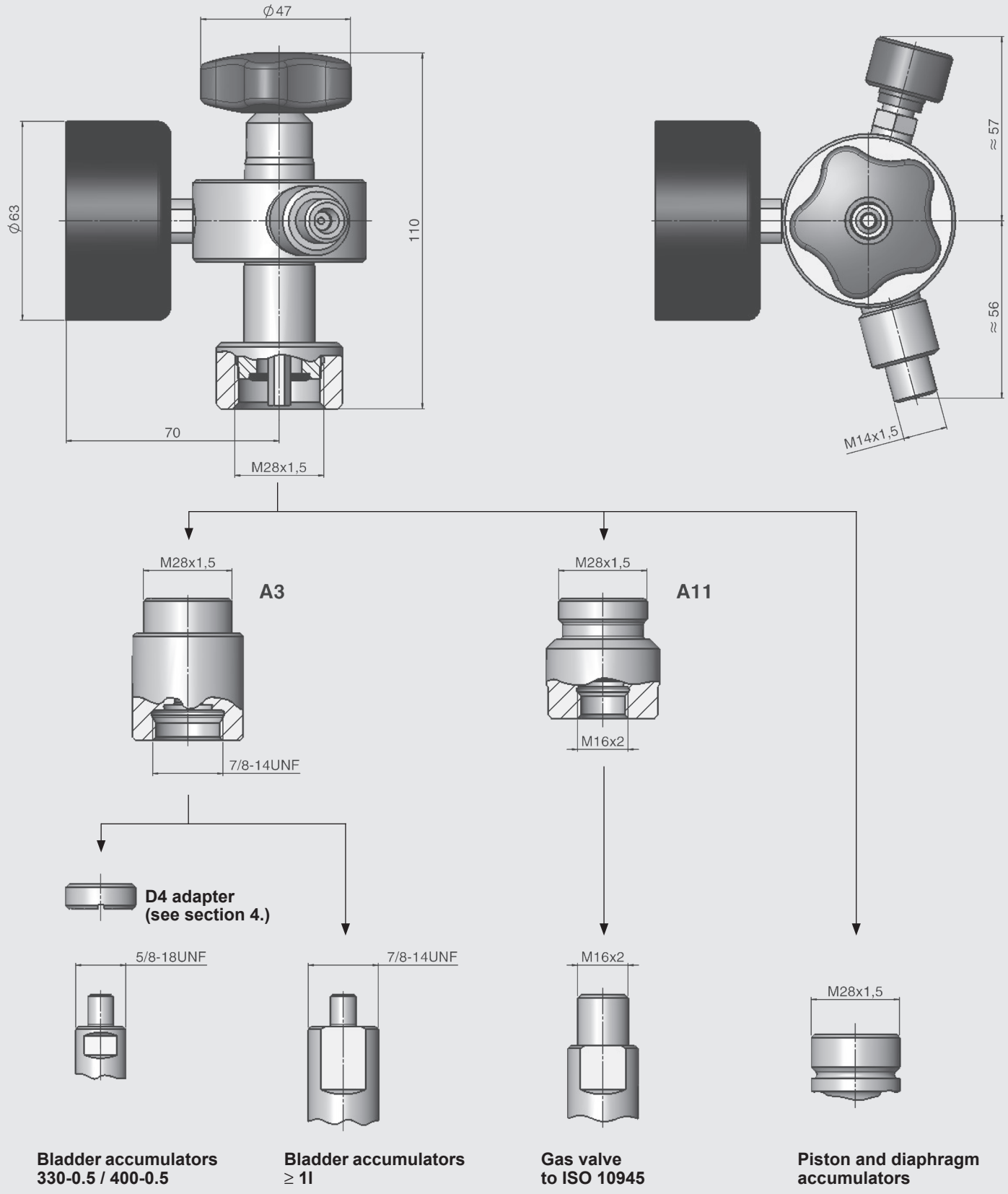
Code	Part no.
FPU-2-800/1000F6	4043456
FPU-2-800/1000F6A3H	4043455

Models with protective case

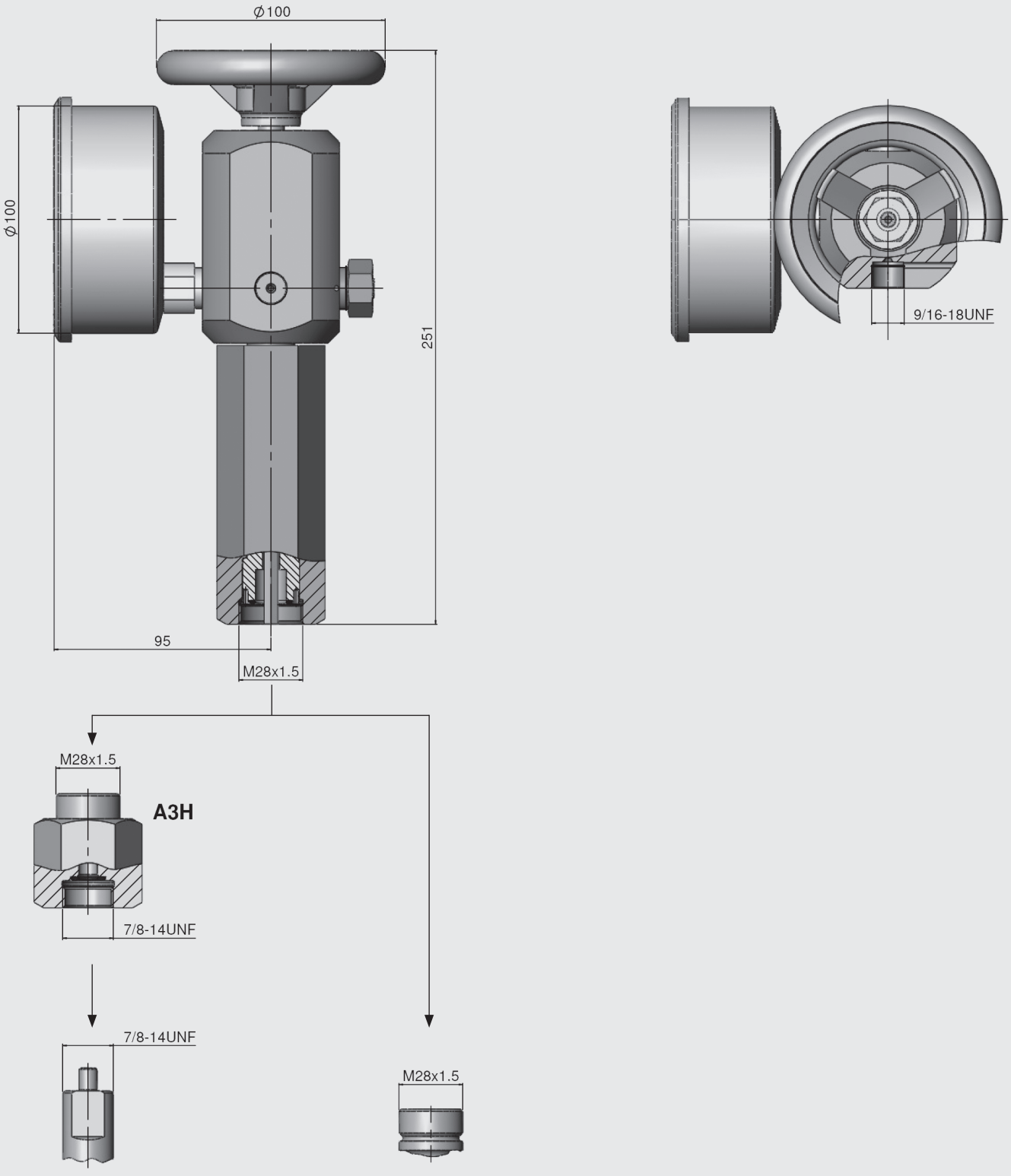
Code	Part no.
FPU-2-800/1000F6K	4029954
FPU-2-800/1000F6A3HK	4023260

3. DIMENSIONS

3.1. GAS-SIDE CONNECTION OF THE CHARGING AND TESTING UNIT FPU-1 USING ADAPTERS FOR HYDAC ACCUMULATORS



3.2. GAS-SIDE CONNECTION OF THE CHARGING AND TESTING UNIT FPU-2 USING ADAPTERS FOR HYDRAULIC ACCUMULATORS



Bladder accumulator ≥ 1 l

Piston and diaphragm accumulators

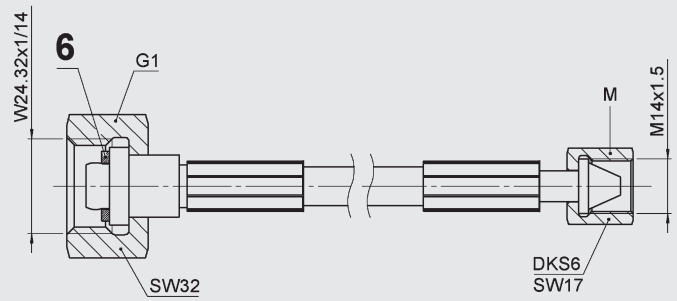
3.3. CHARGING HOSES

Charging hoses are designed for the particular maximum permitted operating pressure marked on them and 10,000 charging processes. (HYDAC charging hoses comply with DIN EN ISO 4413 and DIN EN 853 to 857)

3.3.1 **Charging hoses for nitrogen bottles up to 200 bar**

Charging hose **F**

Connection to DIN 477, Part 1

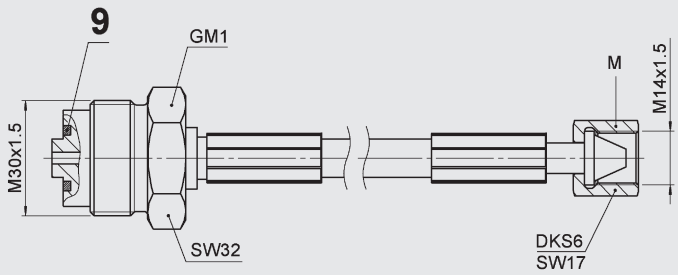


Type	Length [m]	Part no.
Charging hose **F**	2.5	236514
	4	236515
	10	373405
	15	2115552
	20	2109765
	28	2109574

3.3.2 **Charging hoses for nitrogen bottles up to 300 bar**

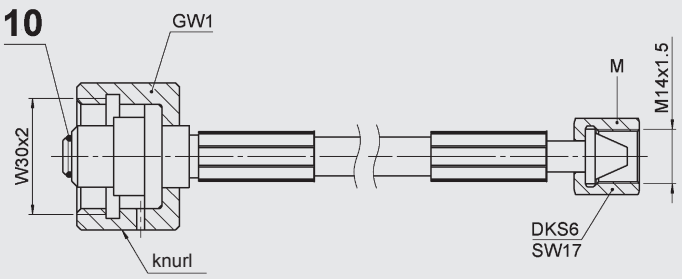
Charging hose **FM**

Connection to DIN 477, Part 5 up to April 2002



Charging hose **FW**

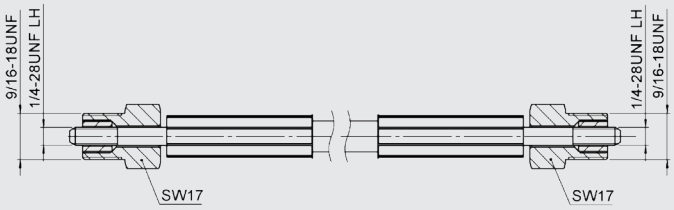
Connection to DIN 477, Part 5 from April 2002



Type	Length [m]	Part no.
Charging hose **FM**	2.5	3019417
	4	3019418
Charging hose **FW**	2.5	3019419
	4	3019420

3.3.3 **Pressure hose for pressure booster systems**

Charging hose **FH**

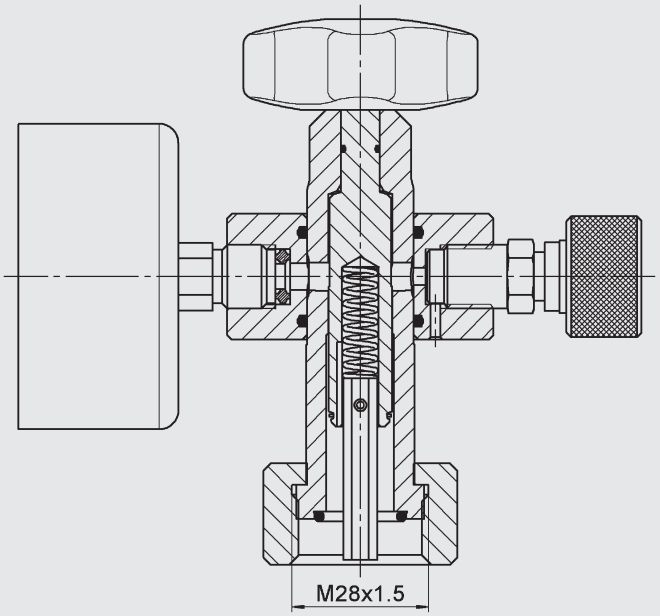


Type	Length [m]	Part no.
Charging hose **FH**	6	6169682

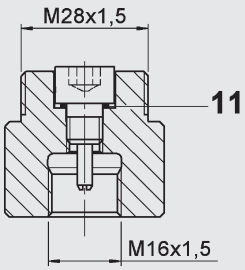
3.4. ADAPTERS A1 TO A13 FOR FPU-1

The FPU-1 is universally applicable because as well as HYDAC piston and diaphragm accumulators, bladder accumulators can also be charged and tested using the A3 adapter supplied as standard.
Additional adapters can be used to charge and test other brands of accumulator.

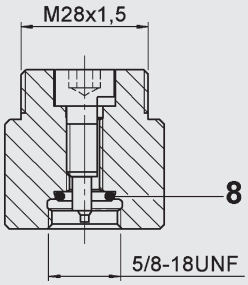
The following adapters are to be used exclusively with FPU-1, see section 3.1.



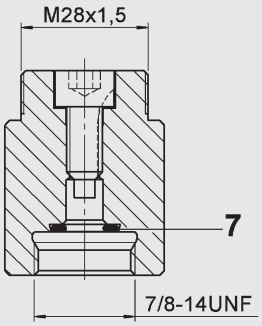
A1 (Part no. 361619)



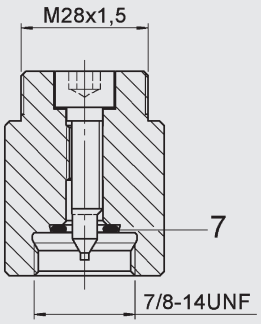
A2 (Part no. 361605)



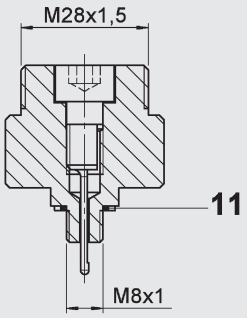
A3 (Part no. 291533)



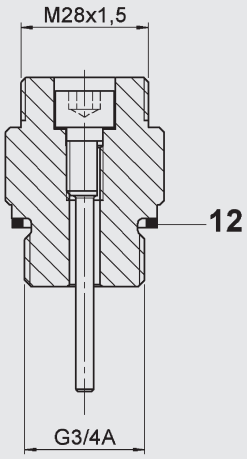
A4 (Part no. 291536)



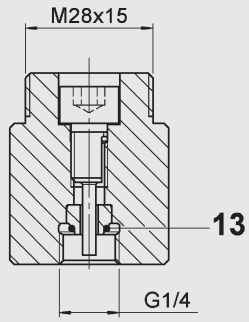
A5 (Part no. 291531)



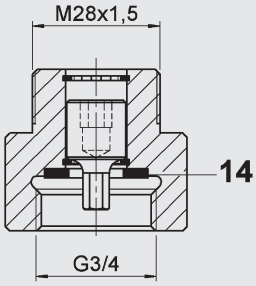
A6 (Part no. 2108819)



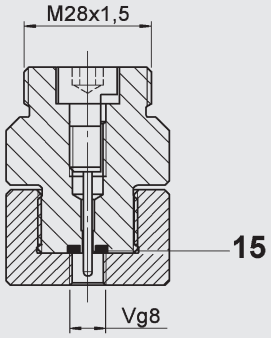
A7 (Part no. 2110629)



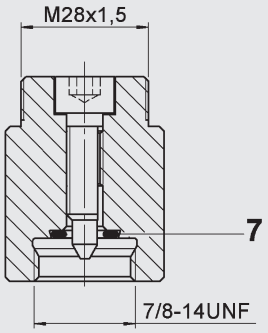
A8 (Part no. 2124524)



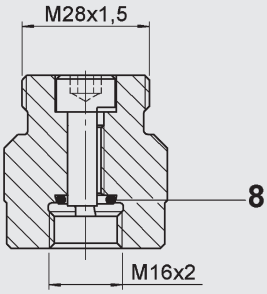
A9 (Part no. 2128638)



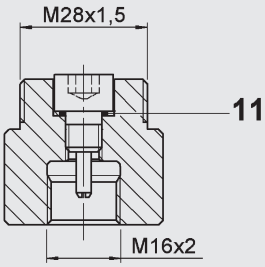
A10 (Part no. 2128849)



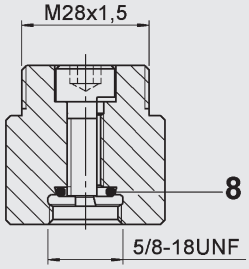
A11 (Part no. 3018210)



A12 (Part no. 3203185)



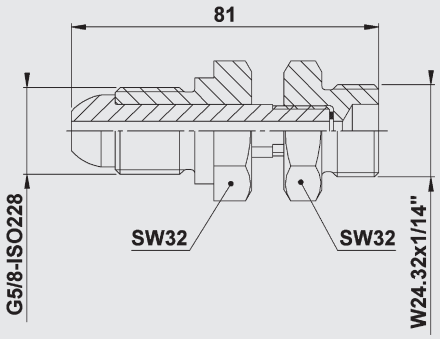
A13 (Part no. 3911267)



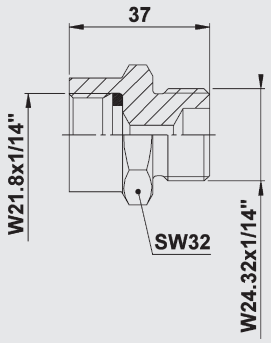
3.5. ADAPTERS G2 TO G13 FOR FPU-1

The FPU-1 can be used with nitrogen bottles from various countries. Depending on the particular country of manufacture for the nitrogen bottles (see list of countries), HYDAC offers the following G adapters, exclusively for use with the FPU-1.
The FPU-2 is connected to a pressure booster system.

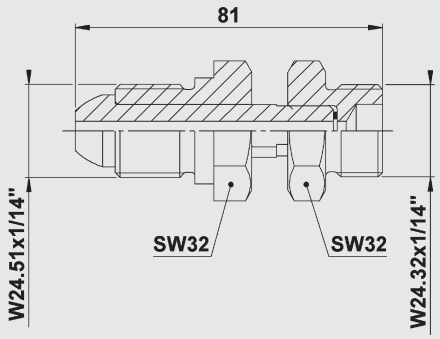
G 2 (Part no. 236376)



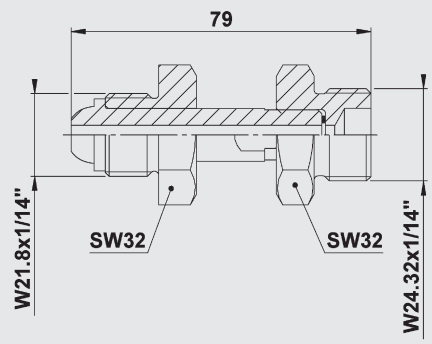
G 3 (Part no. 2103421)



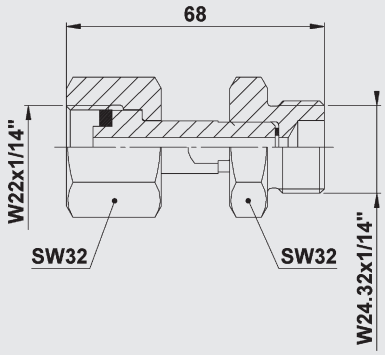
G 4 (Part no. 236374)



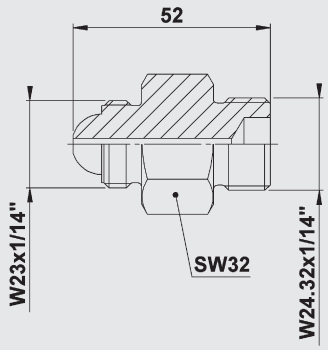
G 5 (Part no. 236373)



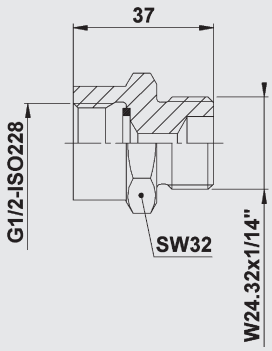
G 6 (Part no. 2103423)



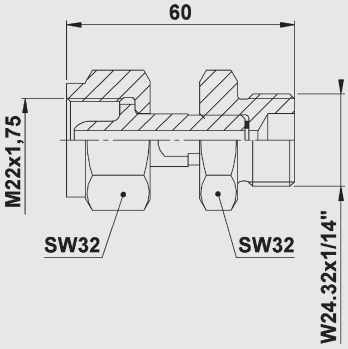
G 7 (Part no. 236377)



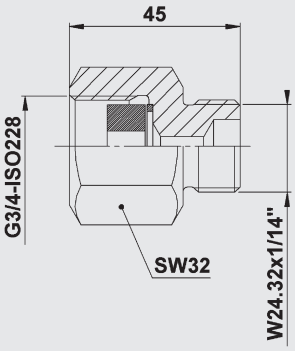
G 8 (Part no. 2103425)



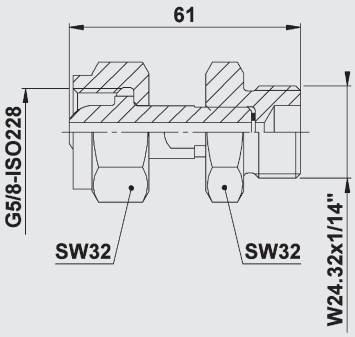
G 9 (Part no. 241168)



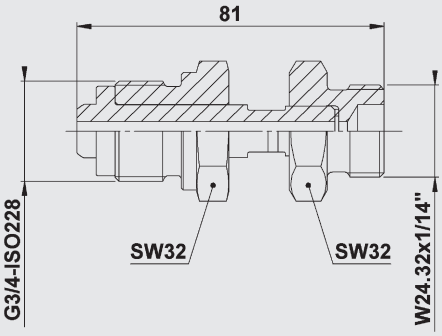
G 10 (Part no. 2103427)



G 11 (Part no. 3018678)



G 12 (Part no. 3195556)



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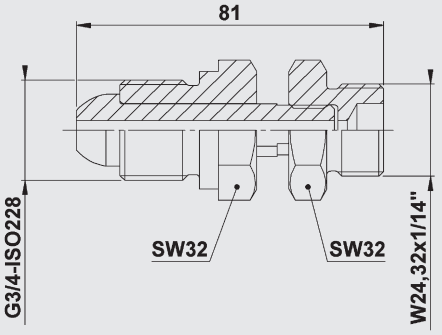


List of countries

Country	Type / part no.												
	G1 [1]	G2 236376	G3 2103421	G4 236374	G5 236373	G6 2103423	G7 236377	G8 2103425	G9 241168	G10 2103427	G11 3018678	G12 3195556	G13 3787884
Africa [3]													●
Albania										●			
Algeria			●										
Argentina		●											
Australia												●	
Austria	●												
Bahamas		●											
Bahrain			●										
Bangladesh		●											
Barbados		●											
Belgium	●												
Bolivia								●					
Brazil				●									
Bulgaria			●										
Burma		●											
Canada				●									
Chile								●					
China											●		
Colombia								●					
Costa Rica		●											
Cyprus		●											
Czech Republic	●												
Denmark	●												
Djibouti			●										
Dominican Republic								●					
Ecuador								●					
Egypt			●										
Ethiopia		●											
Fiji		●											
Finland	●												
France			●										
Gabon			●										
Gambia		●											
Germany	●												
Ghana		●											
Great Britain		●											
Greece		●											
Guatemala								●					
Guinea			●										
Guyana								●					
Honduras								●					
Hong Kong		●											
Hungary			●										
India		●											
Indonesia		●											
Iran			●										
Iraq			●										
Ireland		●											
Israel			●										
Italy					●								
Ivory Coast			●										
Jamaica		●											
Japan						●							
Jordan			●										
Kenya		●											
Korea							●						
Kuwait			●										
Lebanon			●										
Libya			●										
Malawi		●											
Malaysia		●											
Malta		●											
Mauritius			●										
Mexico			●										
Morocco			●										
Netherlands	●												
New Zealand		●											
Nigeria			●										
Norway	●												
Oman			●										
Pakistan		●											
Paraguay								●					
Peru								●					
Philippines		●											
Poland	●												
Portugal		●											
Puerto Rico				●									
Qatar			●										
Romania			●										
Russia										●			
Saudi Arabia			●										
Singapore		●											
Spain			●										
Sri Lanka		●											
Sudan		●											
Surinam		●											
Sweden	●												
Switzerland	●												
Syria			●										
Taiwan									●				
Tanzania		●											
Thailand		●											
Trinidad/Tobago										●			
Tunisia			●										
Turkey		●											
Ukraine										●			
United Arab Emirates			●										
Uruguay								●					
USA				●									
Venezuela										●			
Vietnam		●											
Yugoslavia [2]										●			
Zambia		●											

[1] = already fitted to hose
[2] = Bosnia, Herzegovina, Croatia, Macedonia, Slovenia
[3] = Angola, Botswana, Lesotho, Mozambique, Namibia, Somalia, South Africa, Swaziland, Zimbabwe

4. ACCESSORIES

4.1. PROTECTIVE CASE

for storing the charging and testing unit FPU and adapters – with foam insert and prefabricated recesses to hold all parts and any accessories (adapters, tools, etc.).

Different configurations are available, depending on customer requirement.

	Weight approx. [kg]	
	Without case	With case
FPU-1 (basic version)	1.4	3
FPU-2	8.2	14.2

4.2. GAS SAFETY VALVE FOR FPU-1

Provides protection by reducing the pressure in a controlled way if pressure exceeds the permitted level unexpectedly, see catalogue section:

- Safety Equipment for Hydraulic Accumulators No. 3.552

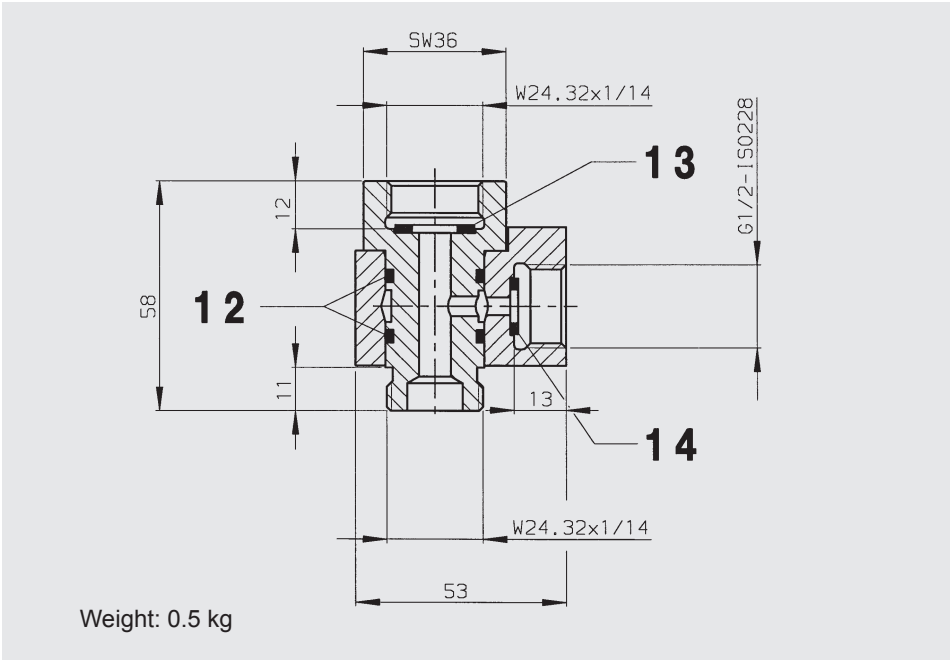
4.3. ADAPTER D4 FOR FPU-1

For screw connector D on bladder accumulators < 1 l (see section 3.)

D4 = 5/8-18UNF (Part no. 366374)

4.4. INTERMEDIATE PIECE GSV6-10-CE FOR FPU-1

Intermediate piece for installing the gas safety valve GSV 6 between the 200 bar nitrogen bottle and the charging and testing unit FPU-1.



Weight: 0.5 kg

Description	Quantity	Item	Part no.
Intermediate piece GSV6-10-CE	-	-	242558
Seal kit for intermediate piece consisting of:	-	-	2117287
O-ring 20x2.5x2	2	12	-
Seal ring 20x11.5x2	1	13	-
Seal ring 14x8.5x2	1	14	-

4.5. PRESSURE REDUCER

For adjusting the required pre-charge pressure between the nitrogen bottle and the accumulator.

4.5.1 **Pressure reducer for 200 bar nitrogen bottles**

Inlet: connection W24, 32x1/14-DIN477, Part 1

Outlet: male thread W24, 32x1/14-DIN477, Part 1

Bottle pressure [bar]	Pressure after reducer [bar]	Part no.
200	20	635409
	100	635411
	200	635412

4.5.2 **Pressure reducer for 300 bar nitrogen bottles**

Inlet: connection W30x2-DIN477, Part 5

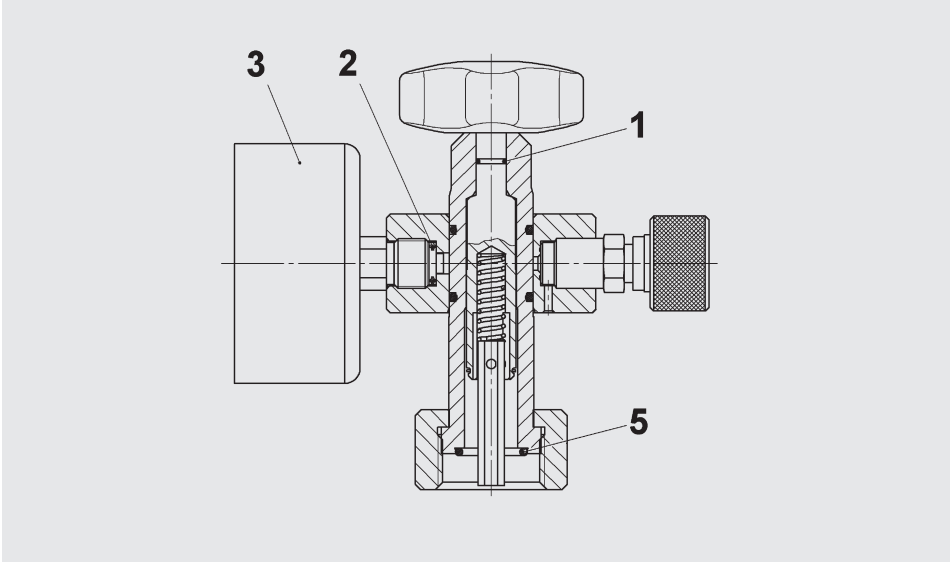
Outlet: male thread W24, 32x1/14-DIN477, Part 5

Bottle pressure [bar]	Pressure after reducer [bar]	Part no.
300	20	6004020
	100	6004021
	200	6004022
	270*	6004023

* for pressures after reducer > 200 bar, the outlet has an external thread W30x2-DIN477, Part 5

5. SPARE PARTS, ADAPTERS AND TOOLS

5.1. SPARE PARTS FOR FPU-1



Description	Quantity	Item	Part no.
Seal kit for FPU-1 consisting of:	1	-	2117669
O-ring 6x1	1	1	-
Seal ring	1	2	-
O-ring 15x2	1	5	-
Seal ring	1	6	-
O-ring 11x2	1	7	-
O-ring 9x2	1	8	-
O-ring 11x2.5	1	9	-
O-ring 5.7x1.9	1	10	-
Pressure gauge 0 - 10 bar	1	3	635139
0 - 25 bar			635140
0 - 100 bar			635141
0 - 250 bar			635142
0 - 400 bar			635143

5.2. ADAPTERS FOR FPU-1

Description	Quantity	Item	Part no.
Seal kit for adapters A1-13 consisting of:	1	-	3269153
O-ring 11x2	3	7	-
O-ring 9x2	3	8	-
Seal ring 9.3x13.3x1	3	11	-
Seal ring 27x32x2	1	12	-
O-ring 6x1.2	1	13	-
O-ring 19x2	1	14	-
Seal ring for adapter A9	1	15	-
Seal ring 6x13x2	1	50*	-

* only suitable for adapters A7 up to May 2006

5.3. TOOLS FOR FPU-1

Designation	Part no.
Wrench 14x15	1011065
Allen key SW6	1005164
Torque wrench	3136470
Valve tool for gas valve	616886

5.4. SPARE PARTS FOR FPU-2

The scope of delivery for FPU-2 already includes additional seals as replacements.

6. NOTE

The information in this brochure relates to the operating conditions and applications described.
For applications and/or operating conditions not described, please contact the relevant technical department.
Subject to technical modifications.

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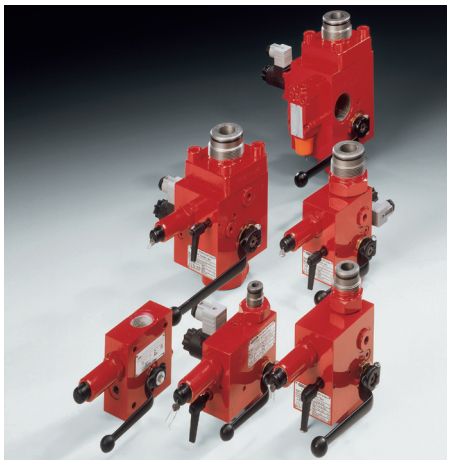
E 3.501.28/03.16



Safety and Shut-off Block
SAF/DSV

1. DESCRIPTION

1.1. GENERAL

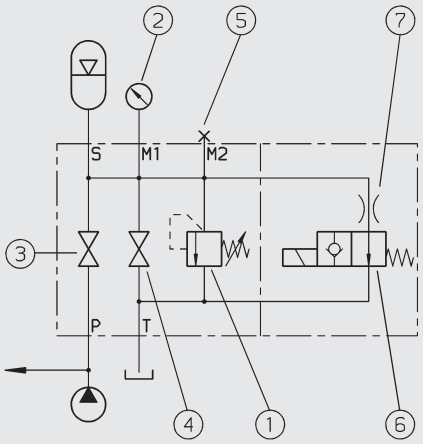
The HYDAC safety and shut-off block is used to shut off and discharge hydraulic accumulators.
It complies with the relevant safety standards in accordance with DIN ISO 4413 and the German Health & Safety at Work regulations, BetrSichV.

The HYDAC pressure relief valve DB12 is used in the SAF series. It is a direct-acting pressure relief valve in poppet valve construction with excellent opening and closing properties. This version of the DB12 complies with the requirements of the European Pressure Equipment Directive (PED) with CE marking and is supplied with a declaration of conformity and an operating manual.

Please read the Operating Manual! No. 5.169.B

1.1.1 Key to the circuit diagram

Circuit diagram

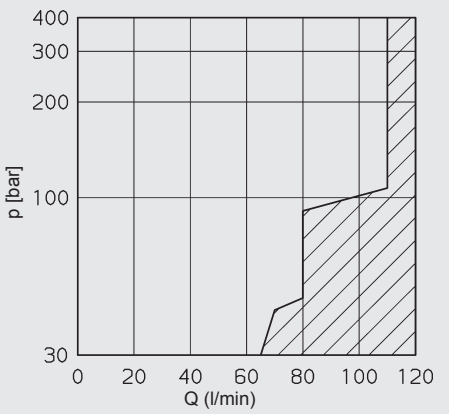


① Pressure relief valve to prevent excessive pressure in accordance with European Pressure Equipment Directive (PED)
② Pressure gauge
③ Shut-off valve
④ Pressure release valve
⑤ Connection for test gauge

These devices are combined in a compact HYDAC safety and shut-off block. The following devices are also available:

⑥ Solenoid-operated pressure release valve
⑦ Throttle

DB12-CE p-Q graph, see ① above



This valve cannot be set to values in the shaded area

1.1.2 Product benefits

The compact combination of components considerably simplifies the connection of an accumulator or consumer to the hydraulic system and provides the following benefits:

- Minimum of space and maintenance and installation required. As all the individual units are combined in one block, considerably fewer pipe fittings are necessary for installation.
- Considerable reduction in installation time.
- All types of connections for various accumulator designs and manufacturers are available - imperial and metric connections as well as manifold mounted and weld nipple.
- Additional valves such as pilot-operated check valves, flow control valves and combined flow control and check valves can be fitted to the system connection P.

1.2. DESIGN

The SAF safety and shut-off block consists of a valve block, an integrated HYDAC pressure relief valve, a main shut-off valve and a manually operated pressure release valve, and the necessary gauge connections are provided in addition to the tank connection.
In addition an optional solenoid-operated 2-way directional valve allows automatic discharge of the accumulator or consumer and therefore of the hydraulic system in an emergency or for shut-down.

1.3. PORTS

The safety and shut-off block has the following ports:

S – Accumulator port

P – Inline port
connects SAF to the system (pump)

T – Tank port
The connection to the tank must be piped separately.
This will ensure that when the pressure relief valve DB12 opens, flow can drain unpressurised to tank.

M1 – Test gauge port
G 1/2 - ISO 228
(G 1/4 at SAF 10)

M2 – Gauge connection
G 1/4 - ISO 228

1.4. SPECIFICATIONS

1.4.1 **Operating fluids**
Mineral oil to DIN 51524 Part 1 and Part 2
(other fluids on request)

Viscosity range
min. 10 mm²/s
max. 380 mm²/s

Filtration
Max. permitted contamination level of the operating fluid to ISO 4406 Class 21/19/16 or SAE AS 4059 Class 11.
We therefore recommend a filter with a minimum retention rate of $ß_{20} \geq 100$.
The fitting of filters and regular replacement of the filters guarantees correct operation, reduces wear and tear and extends the service life.

1.4.2 **Permitted operating temperature**
-10 °C ... +80 °C
(ambient temperature on E version limited to -10 °C ... +60 °C)

1.4.3 **Max. operating pressure**
400 bar

1.4.4 **Model with solenoid-operated pressure release**

Type
Solenoid-operated by means of pressure-tight, oil-immersed, single-stroke solenoids in accordance with VDE 0580.
Actuating solenoid with male connector to DIN 43650, standard for general industrial applications, available for 24 V DC and 230 V AC.

Type of current
DC solenoid
When connected to AC voltage, the necessary DC voltage is produced by means of a bridge rectifier connector.

VOLTAGE TOLERANCE:
+/- 15 % of the nominal voltage

Nominal current
Dependent on the nominal voltage
24 V DC 0.80 A
230 V AC 0.11 A

Power consumption
p_{20} = 18 W
DUTY: Continuous

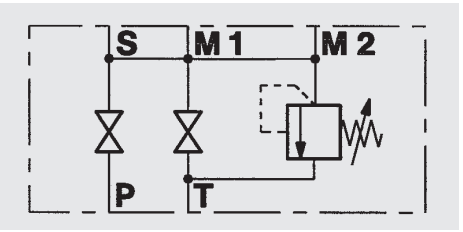
Switching time
Depending on symbol, pressure across the individual ports and flow rate:

WSM06020Y:
on: 50 ms
off: 35 ms

WSM06020Z:
on: 35 ms
off: 50 ms

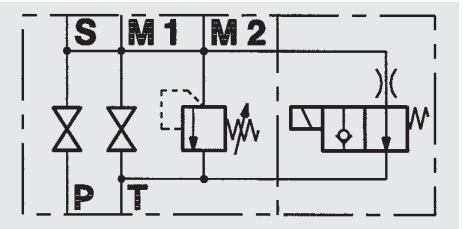
1.5. STANDARD TYPES

1.5.1 **Model with manually operated pressure release valve**
The basic model Safety and Shut-off Block has a manually operated pressure release valve, code "M", and a direct-acting pressure relief valve.



Sizes: SAF10M
SAF20M
SAF32M

1.5.2 **Model with solenoid-operated pressure release**
The E version of the safety and shut-off block has a solenoid-operated 2-way directional valve for automatic pressure release of the accumulator and the hydraulic system in an emergency or for shut-down.



Sizes: SAF10M
SAF20M
SAF32M

1.6. Δp-Q GRAPHS FOR SAF

Measured at:

ν = 32 mm²/s

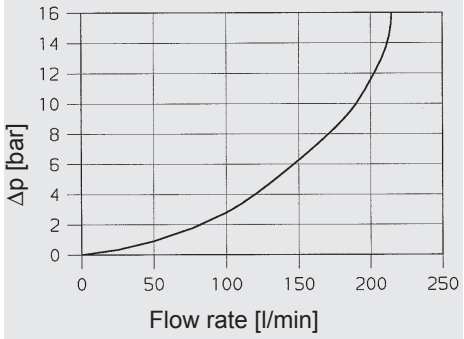
t_{oil} = 40 °C

Operating pressure = 400 bar

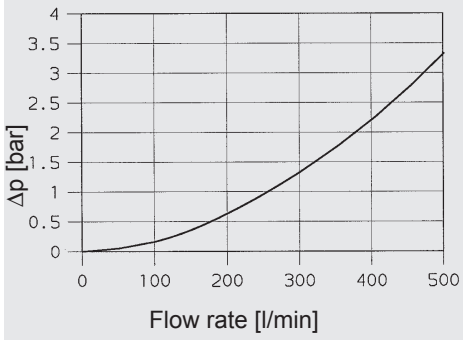
with DB12 pressure relief valve

1.6.1 Flow from the pump to the accumulator

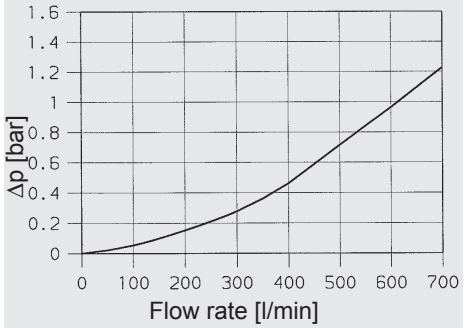
SAF10M/E



SAF20M/E

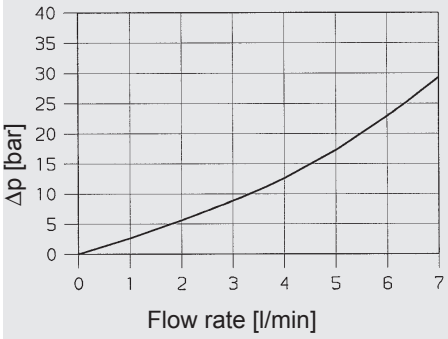


SAF32M/E

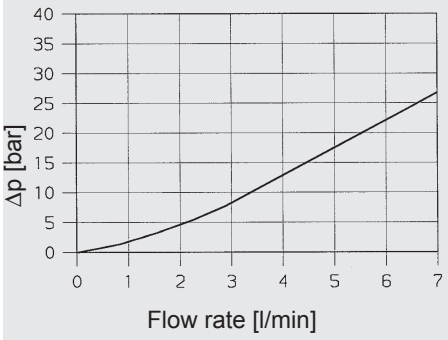


1.6.2 Flow from the accumulator via the solenoid-operated release valve to the tank

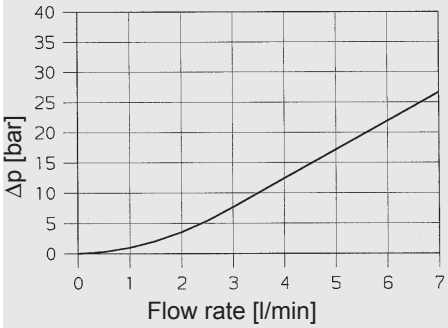
SAF10E



SAF20E

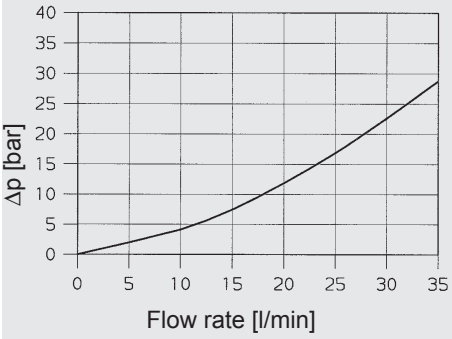


SAF32E

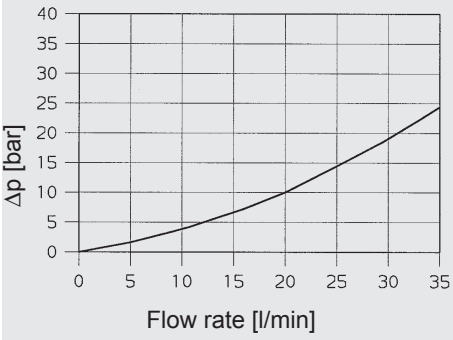


1.6.3 Flow from the accumulator via release valve to the tank

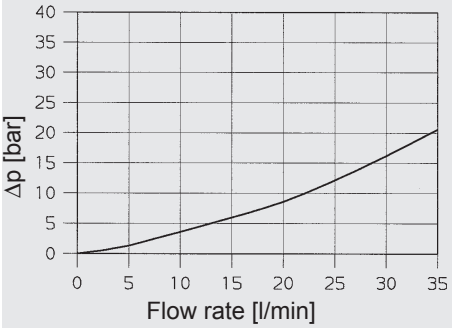
SAF10M/E



SAF20M/E



SAF32M/E



2. MODEL CODE FOR SAF

(also order example)

SAF 20 E 1 2 Y 1 T 210 A – S 13 – LPI

Safety and shut off block
Series SAF

Size of main shut-off valve
10 = DN10
20 = DN20
32 = DN32
32-3 = DN32 with 3 pressure relief valves NG12
50 = DN50

Type of discharge
M = manual discharge
E = solenoid-operated and manual discharge

Block material
1 = carbon steel
other materials [1)]

Seal material (elastomer)
2 = NBR
5 = EPDM
6 = FKM
7 = others

Type of directional poppet valve
Y = open when de-energised (2/2 directional valve WSM06020Y)
Z = closed when de-energised (2/2 directional valve WSM06020Z, only up to 350 bar)

Type of voltage - directional poppet valve
1 = 24 V DC
2 = 115 V AC
3 = 230 V AC
6 = 120 V AC
7 = others

Pressure relief valve
T... = pressure-set and lead-sealed by TÜV
N... = pressure-set without TÜV [1)]

Pressure setting
e.g. 210 bar

Threaded connection to
A = ISO 228 (BSP)
B = DIN 13, to ISO 965/1 (metric) [1)]
C = ANSI B1.1 (UNF, O-ring seal to SAE) [1)]

Adapter
to accumulator (see section 7.)
e.g. S13 = ISO 228 - G 2A

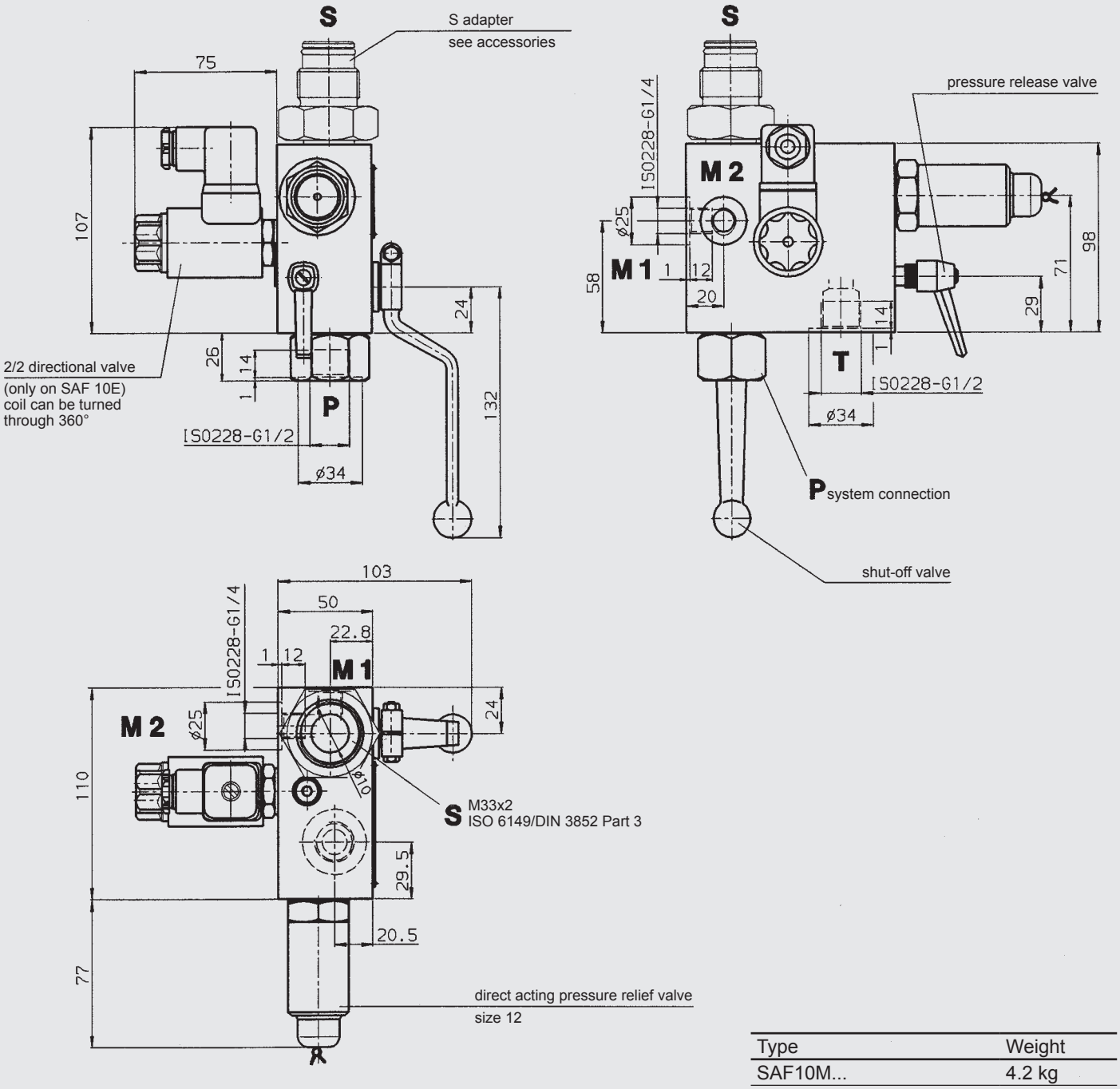
Additional equipment (see section 5.4.)
L = lockable main shut-off valve (for use with locking device)
LPI = model L with additional position monitoring (inductive proximity switch)
LPM = model L with additional position monitoring (mechanical limit switch with roller lever)
LS = lockable release valve

Accessories
(Please give full details when ordering: see section 7. Accessories)

[1)] on request

3. DIMENSIONS

3.1. SAF10 SAFETY AND SHUT-OFF BLOCK SIZE 10



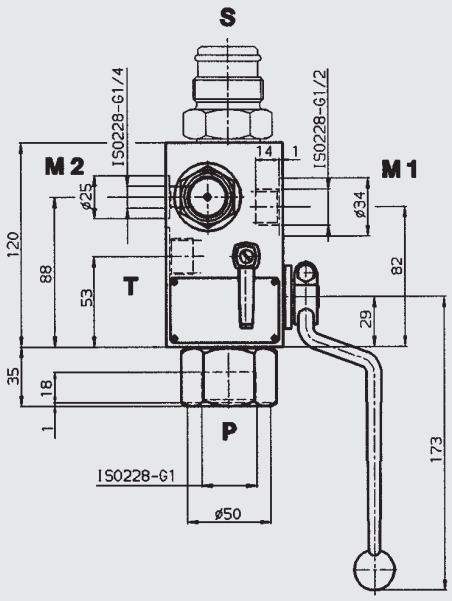
Type	Weight
SAF10M...	4.2 kg
SAF10E...	4.6 kg

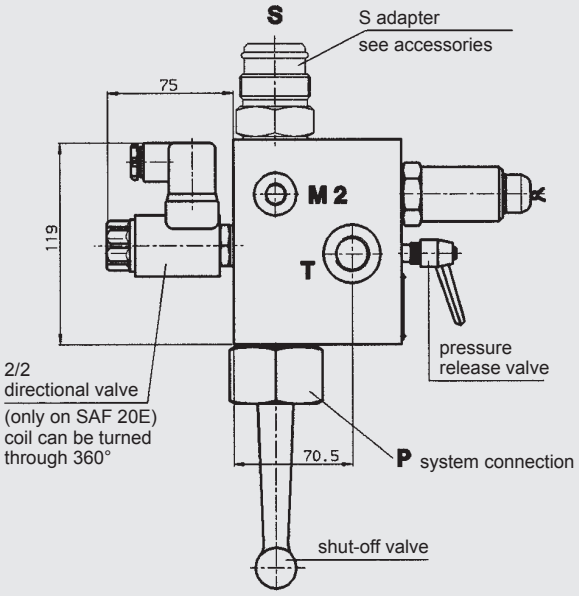
SAF10 Standard types

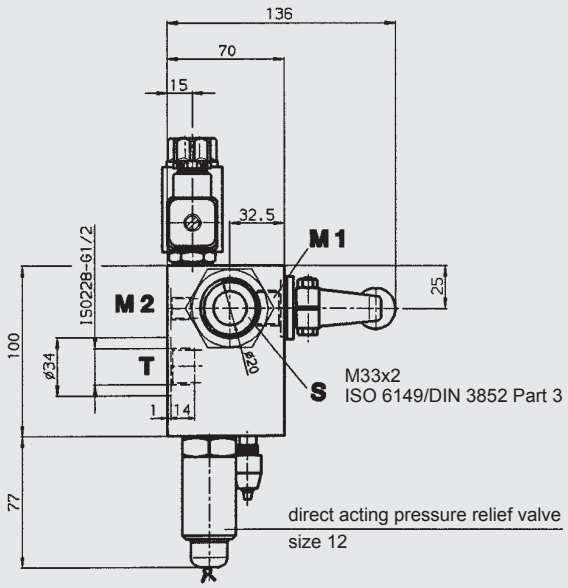
Type	Part no.	Type	Part no.
SAF10M12T400A	2121582	SAF10E12Y1T400A	2125858
SAF10M12T350A	2122208	SAF10E12Y1T350A	2122210
SAF10M12T330A	**2121236***	**SAF10E12Y1T330A**	**2122211***
SAF10M12T315A	2121121	SAF10E12Y1T315A	2122212
SAF10M12T300A	2121354	SAF10E12Y1T300A	2122213
SAF10M12T250A	2121353	SAF10E12Y1T250A	2122214
SAF10M12T210A	2121346	SAF10E12Y1T210A	2121662
SAF10M12T200A	2121351	SAF10E12Y1T200A	2122215
SAF10M12T150A	2121345	SAF10E12Y1T150A	2122216
SAF10M12T100A	2121344	SAF10E12Y1T100A	2122041
SAF10M12T070A	2121350	SAF10E12Y1T070A	2122217
SAF10M12T050A	2122207	SAF10E12Y1T050A	2122218
SAF10M12T035A	2121349	SAF10E12Y1T035A	2122219

* preferred models

3.2. SAF20 SAFETY AND SHUT-OFF BLOCK SIZE 20







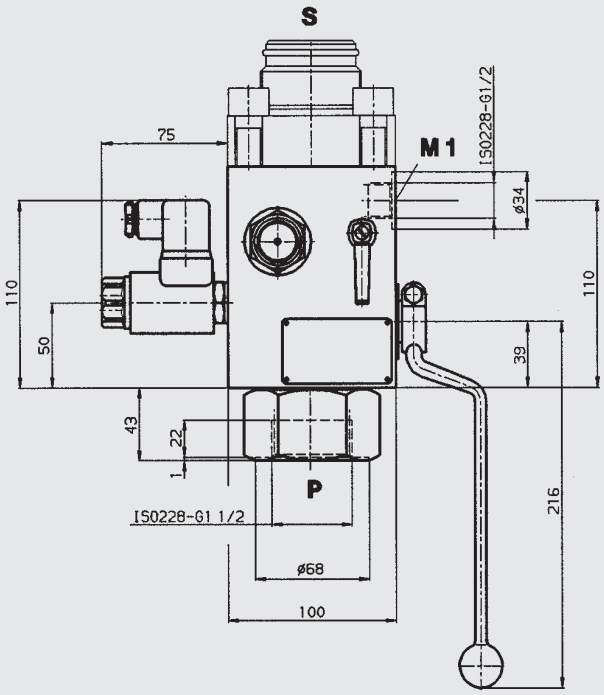
Type	Weight
SAF20M...	6.8 kg
SAF20E...	7.2 kg

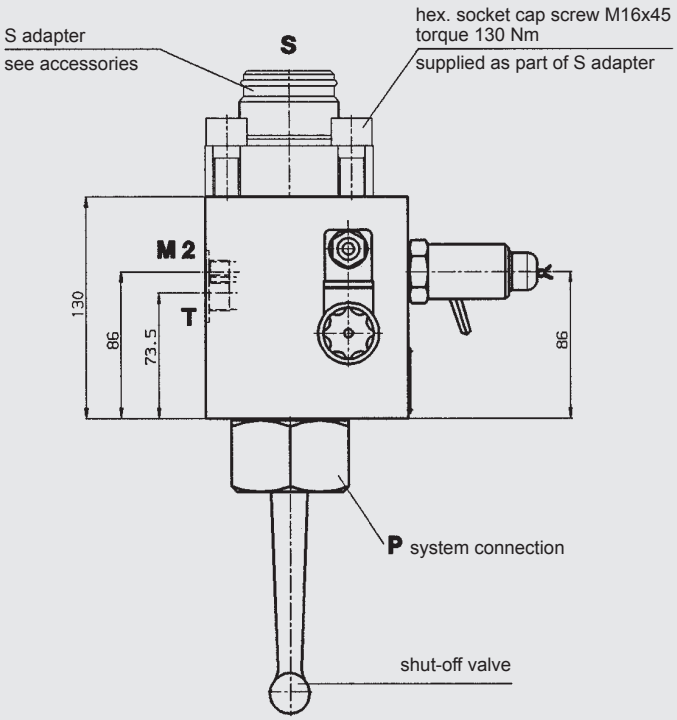
SAF20 Standard types

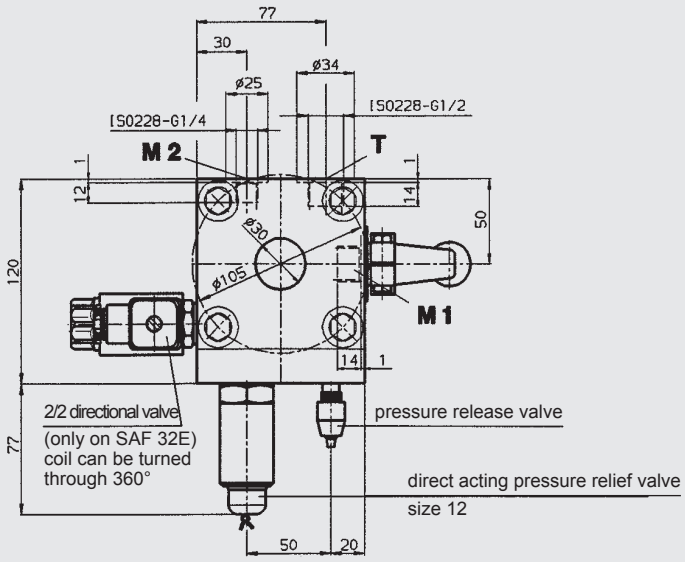
Type	Part no.	Type	Part no.
SAF20M12T400A	2120317	SAF20E12Y1T400A	2121022
SAF20M12T350A	2120434	SAF20E12Y1T350A	2121979
SAF20M12T330A	**2120323***	**SAF20E12Y1T330A**	**2120394***
SAF20M12T315A	2120324	SAF20E12Y1T315A	2120833
SAF20M12T300A	2120332	SAF20E12Y1T300A	2120836
SAF20M12T250A	2120432	SAF20E12Y1T250A	2120851
SAF20M12T210A	2120319	SAF20E12Y1T210A	2120320
SAF20M12T200A	2120325	SAF20E12Y1T200A	2120835
SAF20M12T150A	2120330	SAF20E12Y1T150A	2120832
SAF20M12T100A	2120401	SAF20E12Y1T100A	2120369
SAF20M12T070A	2120326	SAF20E12Y1T070A	2120849
SAF20M12T050A	2122172	SAF20E12Y1T050A	2121000
SAF20M12T035A	2120281	SAF20E12Y1T035A	2122220

* preferred models

3.3. SAF32 SAFETY AND SHUT-OFF BLOCK SIZE 32







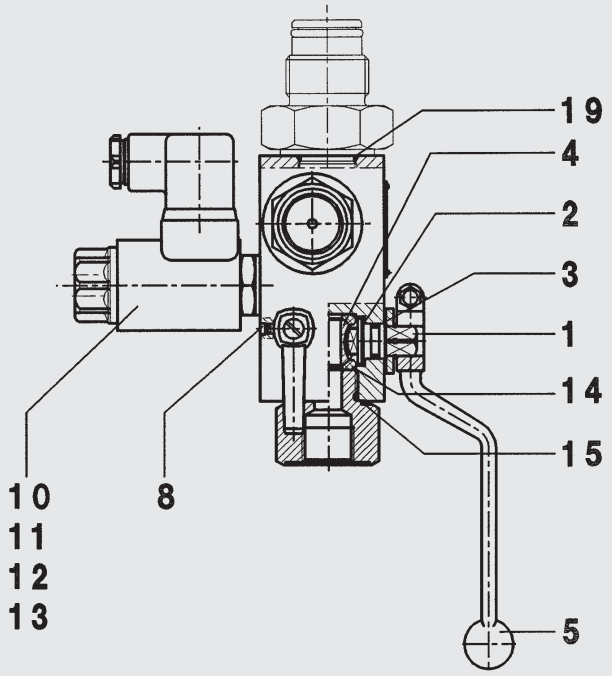
Type	Weight
SAF32M...	12.0 kg
SAF32E...	12.4 kg

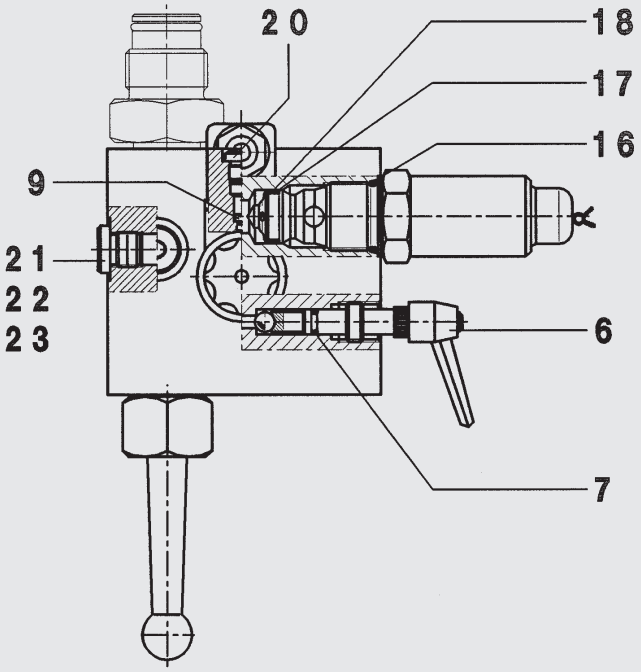
SAF32 Standard types

Type	Part no.	Type	Part no.
SAF32M12T400A	2125856	SAF32E12Y1T400A	2123123
SAF32M12T350A	2122230	SAF32E12Y1T350A	3125142
SAF32M12T330A	**2122231***	**SAF32E12Y1T330A**	**2120371***
SAF32M12T315A	2121136	SAF32E12Y1T315A	2122222
SAF32M12T300A	2120837	SAF32E12Y1T300A	2120834
SAF32M12T250A	2122233	SAF32E12Y1T250A	2122223
SAF32M12T210A	2120321	SAF32E12Y1T210A	2120318
SAF32M12T200A	2121135	SAF32E12Y1T200A	2122224
SAF32M12T150A	2121134	SAF32E12Y1T150A	2122225
SAF32M12T100A	2121129	SAF32E12Y1T100A	2122226
SAF32M12T070A	2122234	SAF32E12Y1T070A	2122227
SAF32M12T050A	2121137	SAF32E12Y1T050A	2122228
SAF32M12T035A	2121125	SAF32E12Y1T035A	2122229

* preferred models

4. SPARE PARTS



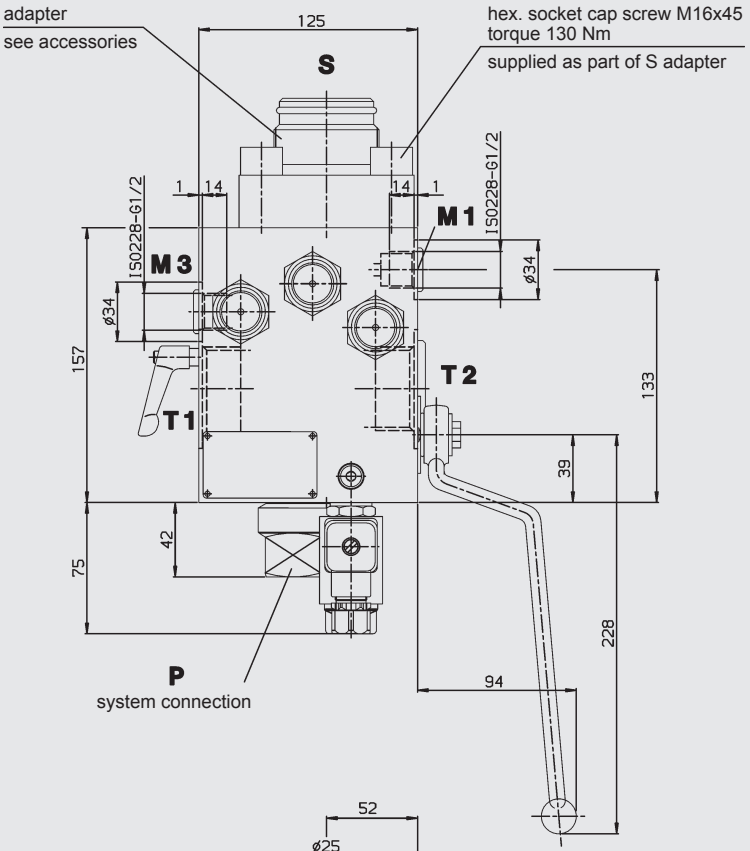


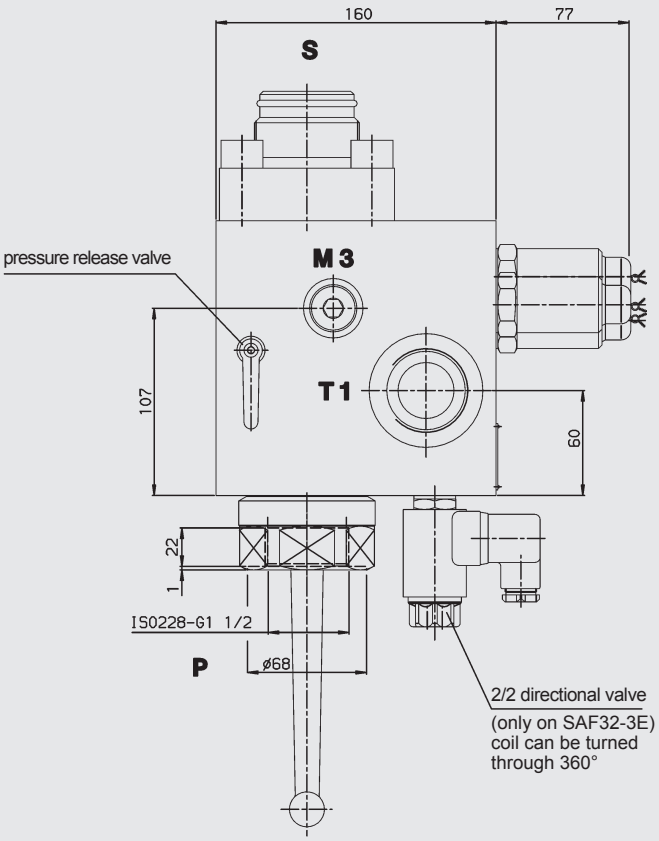
Type of safety and shut-off block		SAF10M, SAF10E	SAF20M, SAF20E	SAF32M, SAF32E
Description	Item	Dimensions or part no.		
Repair kit consisting of:		2122238 (NBR) 2122240 (FPM)	2122242 (NBR) 2122244 (FPM)	2122246 (NBR) 2122248 (FPM)
Spindle	1			
Disc	2			
O-ring	3	10x2	15x2.5	20x3
Ball	4			
Switching handle	5			
Spindle	6			
O-ring	7	6x2		
Threaded pin	8	M4x6	M4x10	
Orifice	9	Ø1.5 mm (Q_{max} - 25.5 l/min)		
O-ring	11	17x2		
Back-up ring	12	11.7x15x1		
O-ring	13	11x2		
Sealing cup	14			
O-ring	15	21x2	34x2.5	56.7x2.8
O-ring	16	23.47x2.62		
Back-up ring	17	18.3x21.5x1		
O-ring	18	18x2		
O-ring	19	29.7x2.8	29.7x2.8	37.2x3
Blanking plug	20 21 22 23	G 1/8 G 1/4 – –	G 1/8 G 1/4 G 3/8 G 1/2	G 1/8 G 1/4 G 3/8 G 1/2
2/2 directional valve assembly (only for E-version)	10	WSM06020Y - open when de-energised 3153871 (350 bar); 3156869 (400 bar) WSM06020Z - closed when de-energised 3153874 (350 bar); 3156873 (400 bar)		
Blanking plug assembly (converts "E" version to "M" version)		277645		
Seal kit consisting of: Items 3, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23		2121699 (NBR) 2121701 (FPM)	2121703 (NBR) 2121705 (FPM)	2121707 (NBR) 2121709 (FPM)
Spindle repair kit consisting of: Items 6, 7, 8		2115648 (NBR) 2115649 (FPM)		

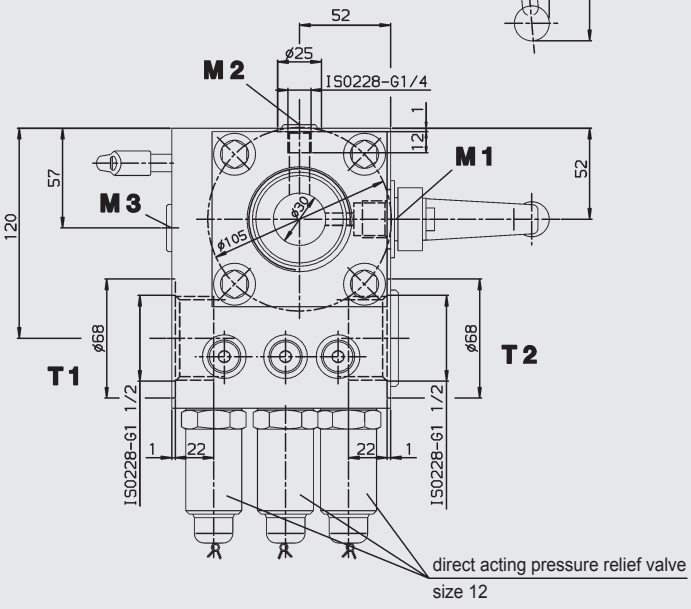
5. SPECIAL MODELS

5.1. TYPE SAF32-3M(E)

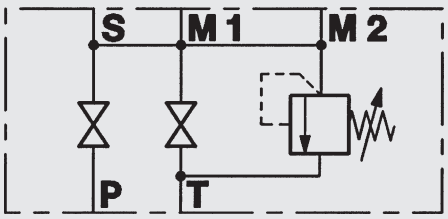
with 3 direct acting pressure relief valves size 12
(max. operating pressure 400 bar)



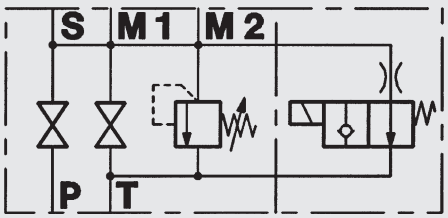




SAF32-3M



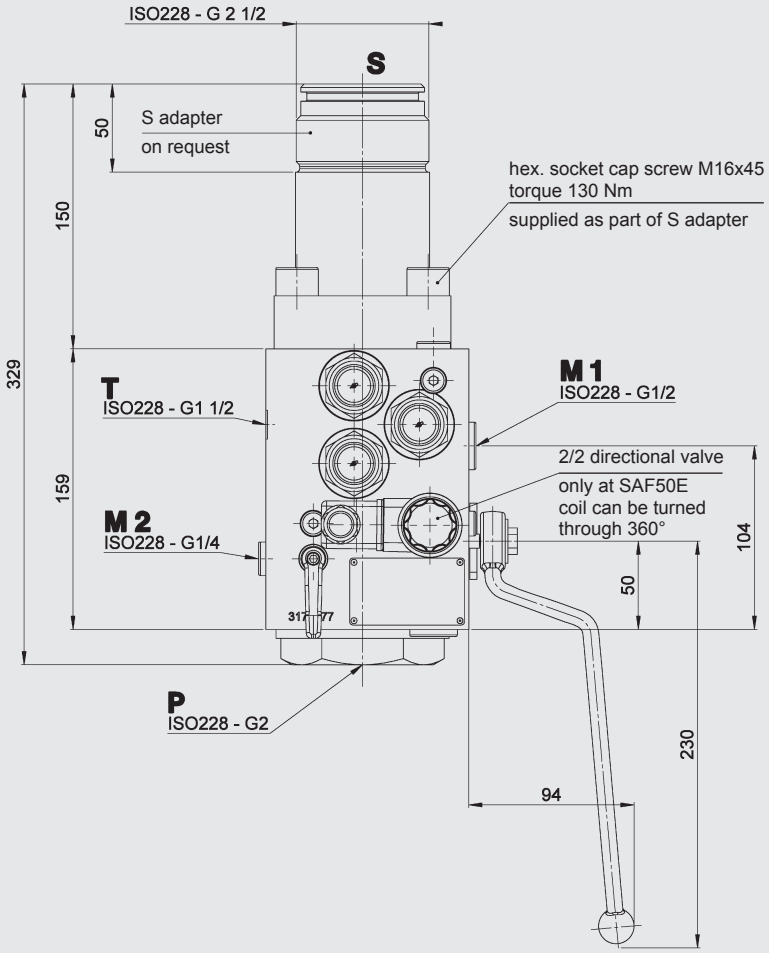
SAF32-3E

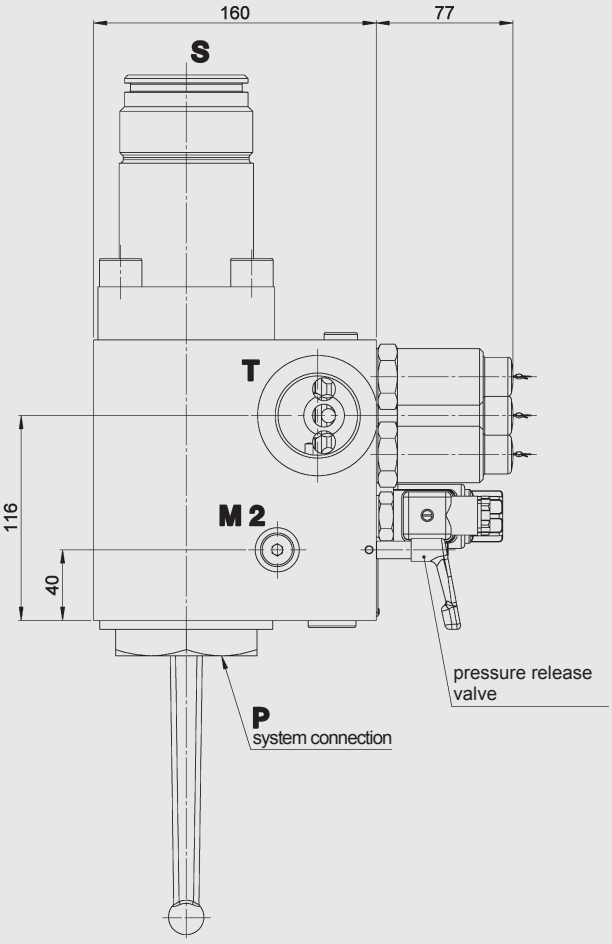


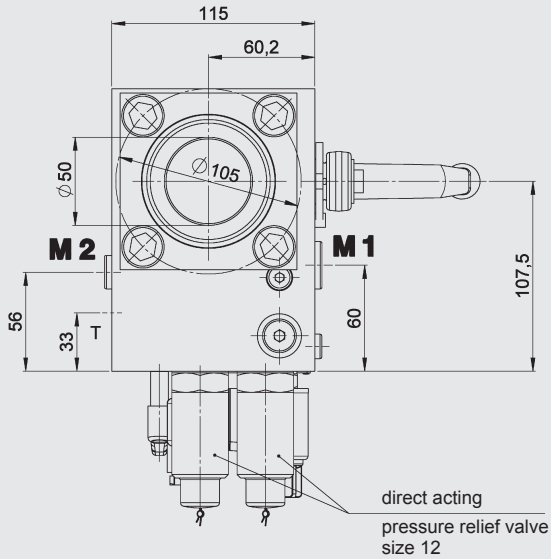
Type	Weight
SAF32-3M...	24 kg
SAF32-3E...	25 kg

5.2. TYPE SAF50M(E)

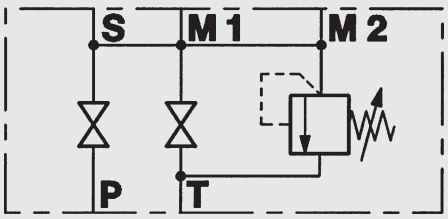
for large flows
with 3 direct acting pressure relief valves size 12
(max. operating pressure 400 bar)



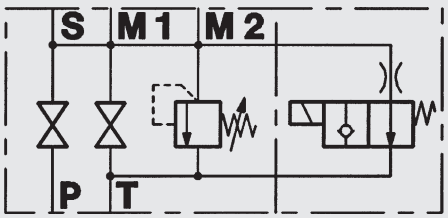




SAF50M



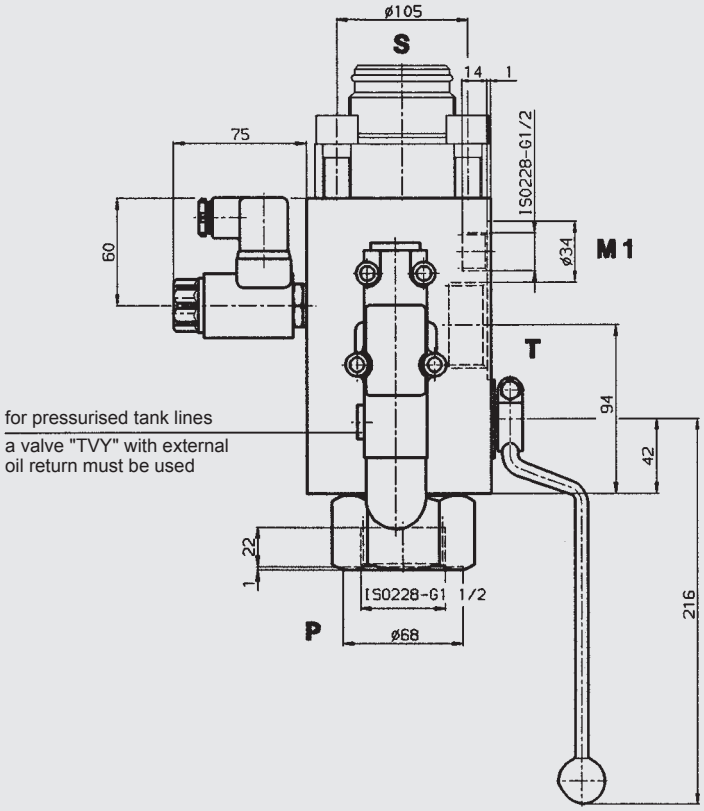
SAF50E

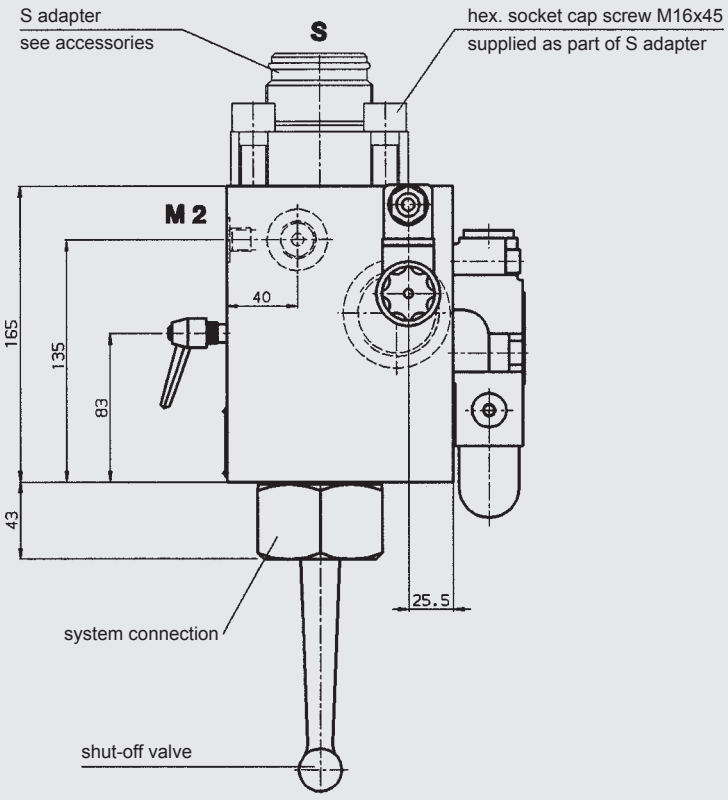


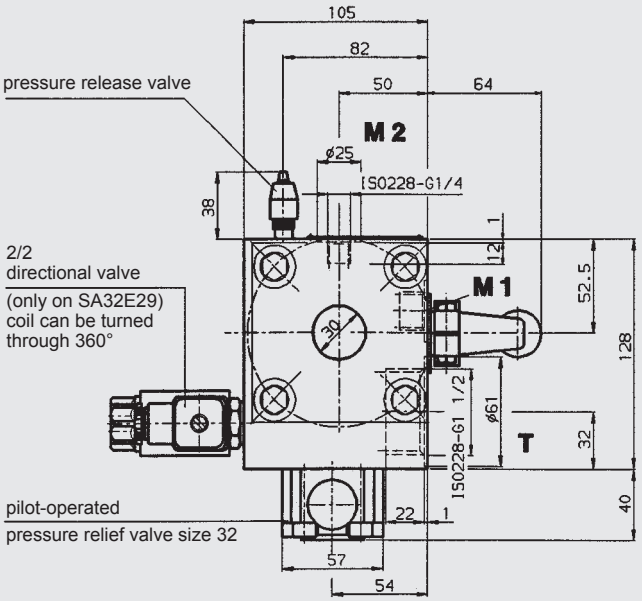
Type	Weight
SAF50M...	25 kg
SAF50E...	26 kg

5.3. TYPE SA32M(E)29

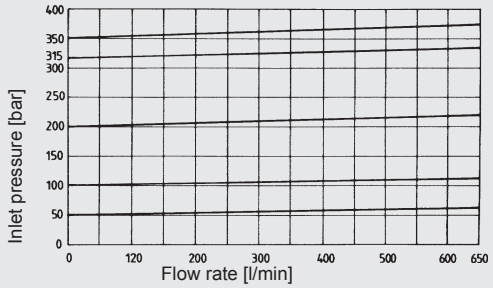
with pilot-operated pressure relief valve (Q_{max} = 600 l/min)
(max. operating pressure 330 bar)



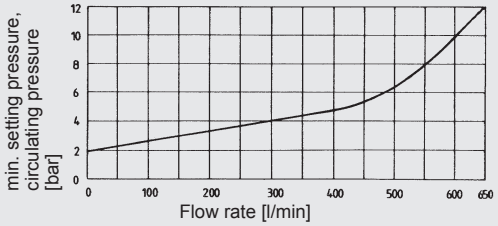




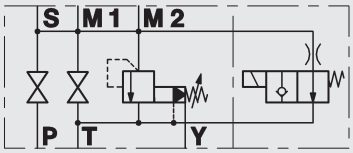
Pilot-operated pressure relief valve size 32



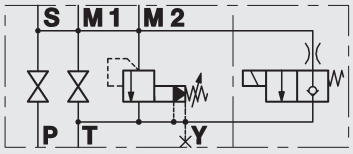
Lowest setting pressure [bar]



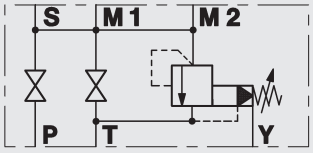
SA32E29TVY



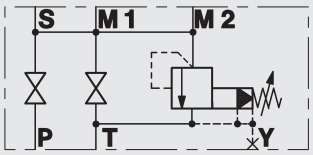
SA32E29TV



SA32M29TVY



SA32M29TV



The safety and shut-off block SA32M(E)29 is equipped with a pilot-operated pressure relief valve size 32 for high flow rates up to 600 l/min.

The E version of the safety and shut-off block has a solenoid-operated 2-way directional valve for automatic pressure release of the accumulator and the hydraulic system in an emergency or for shut-down.

For unpressurized tank lines, valve type "TV" must be used (with internal oil return to tank).

For pressurised tank lines, valve type "TVY" is recommended (with external oil return to tank).

Two different models of the 2-way directional valve are available:

– WSM06020Y (open when de-energised)

– WSM06020Z (closed when de-energised)

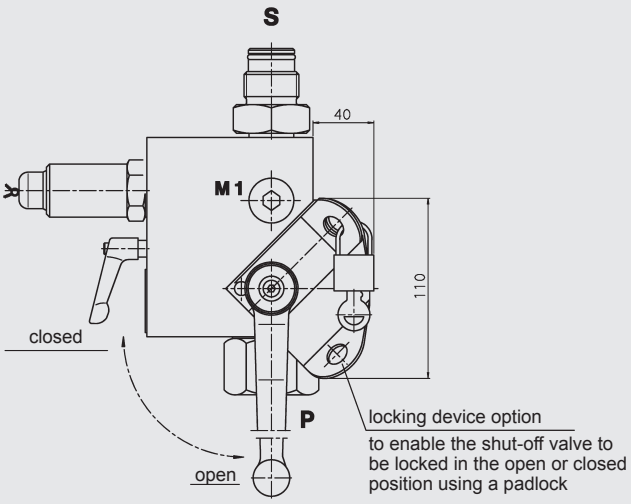
Type	Weight
SA32M29...	22.5 kg
SA32E29...	23.5 kg

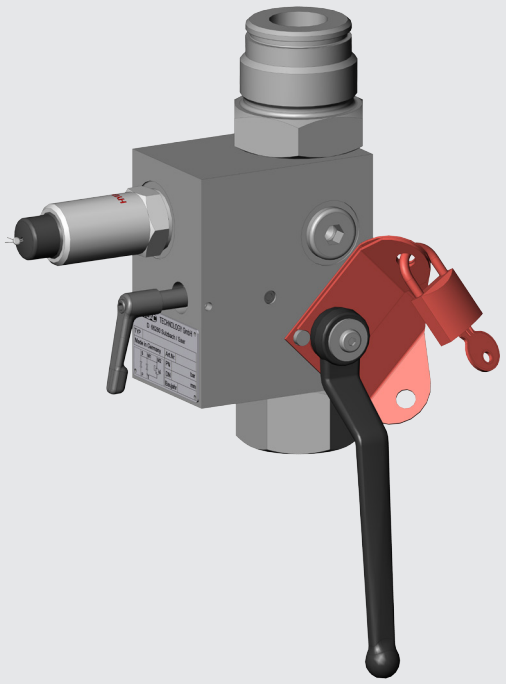
5.4. SAFETY AND SHUT-OFF BLOCK WITH ADDITIONAL EQUIPMENT

Safety and shut-off blocks can be supplied with different options for locking the shut-off valve in position (see section 2. Model code for SAF) and to lock the release valve (see section 7. Accessories).

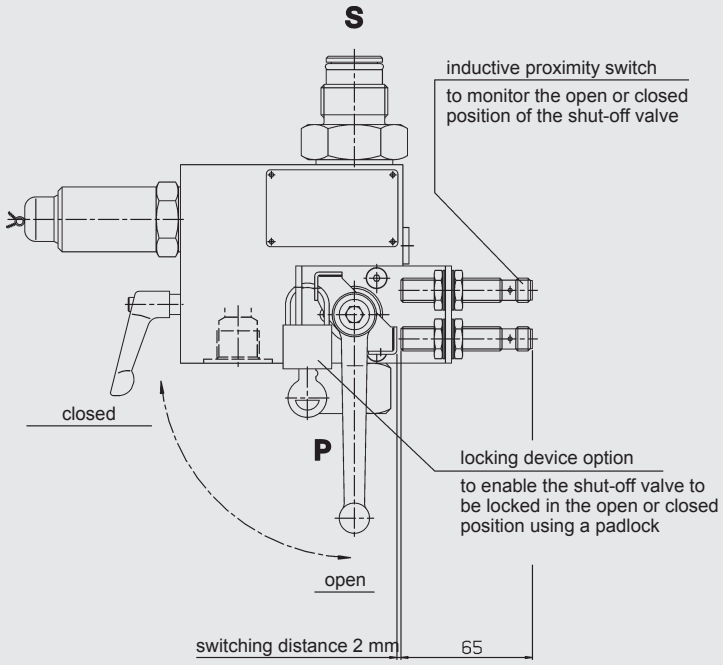
The following overview shows the individual models:

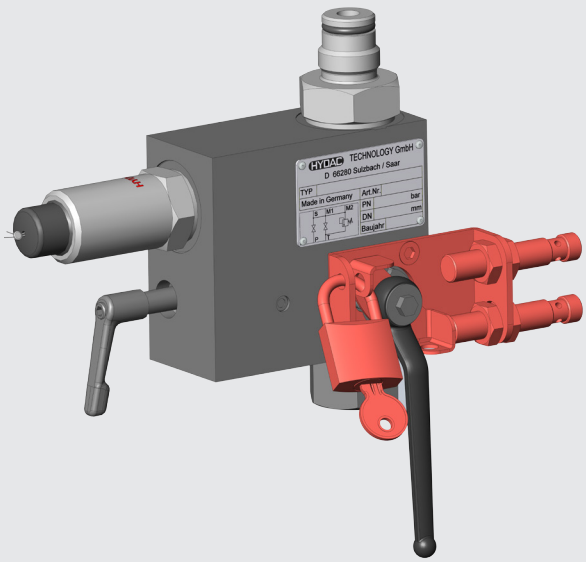
Additional equipment L



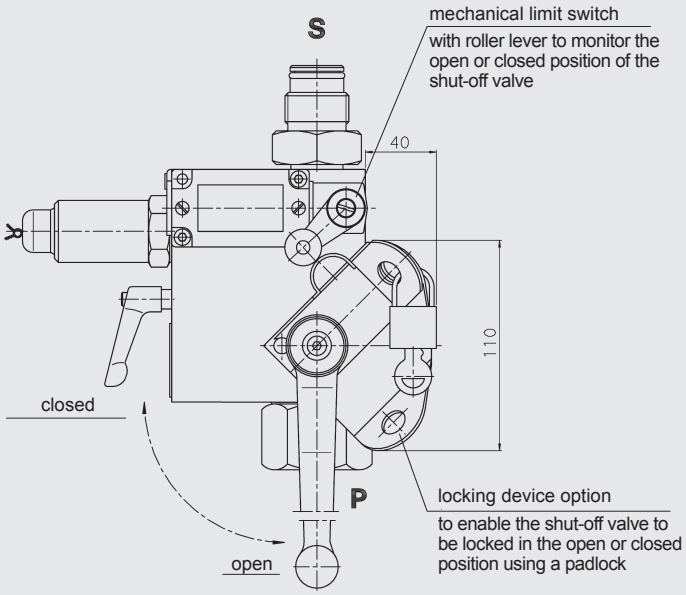


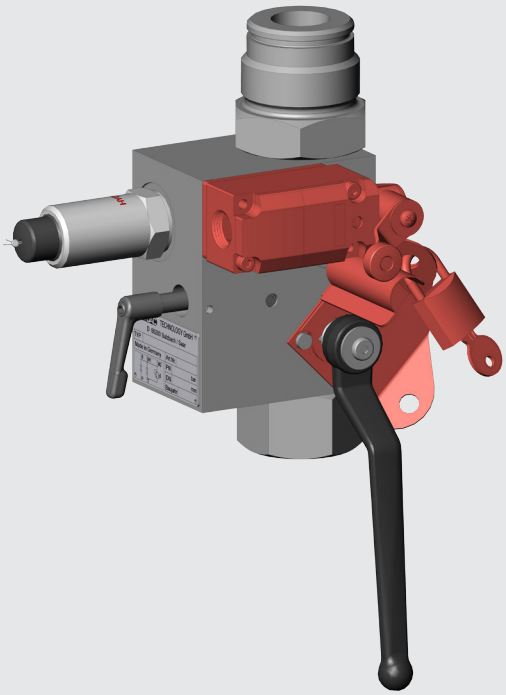
Additional equipment LPI



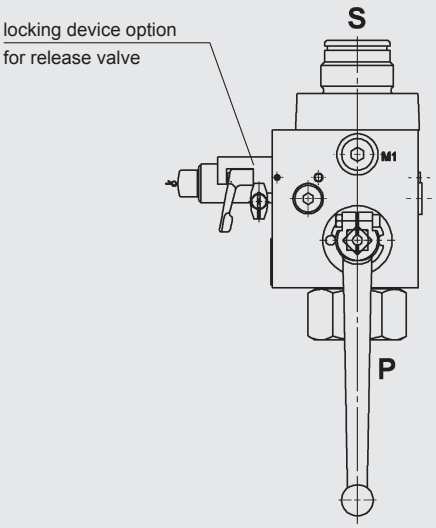


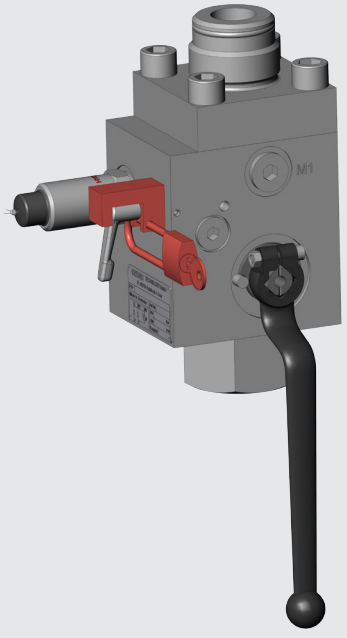
Additional equipment LPM





Supplementary equipment LS





5.5. SAFETY AND SHUT-OFF BLOCK FOR FRONT PANEL MOUNTING

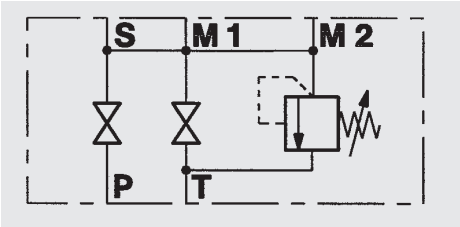
The safety and shut-off block consists of a valve block, a built-in pressure relief valve, a main shut-off valve and a manually operated pressure release valve.

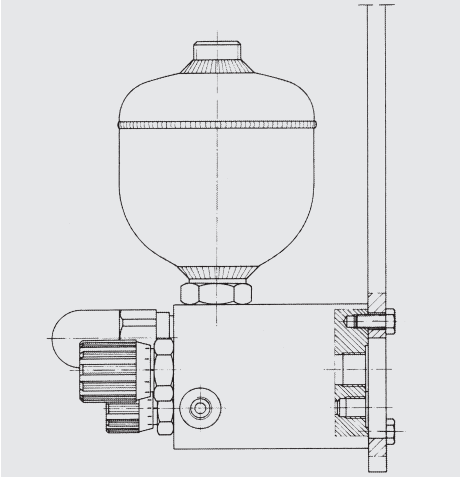
This block is mounted on a front panel with 3 M8 screws. Ports "P" and "T" are located on the mounting side.

Advantages:
The compact design means that the block occupies a minimum of space and ensures minimum maintenance.

Specifications

Type:	SA6M10T...
Size:	DN10
Max. operating pressure:	350 bar
Direct acting pressure relief valve:	NG6





5.6. SAFETY AND SHUT-OFF BLOCK WITH 2-WAY CARTRIDGE VALVE (LOGIC ELEMENT)

This safety and shut-off block consists of a valve block, an integrated pressure relief valve and a solenoid-operated 2-way cartridge valve which replaces the main shut-off valve.

Advantages:
In addition to its compact construction, this model is capable of rapid switching to control the oil flow.

5.6.1 Function when using 4/2 directional valve

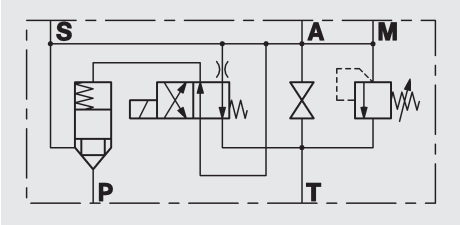
When the 4/2 directional valve is in the switching position shown (open when de-energised), the spring chamber of the logic element is pressurised via the accumulator pressure; the path from P to S is blocked and the hydraulic accumulator is automatically shut off from the system. By connecting the accumulator via the slip-in orifice in the pilot valve to the tank, it will slowly discharge.

When the 4/2 directional poppet valve is in the discharge position (energised) the spring chamber of the logic element is discharged, the path from P to S is open and the accumulator is charged.

Technical specifications:

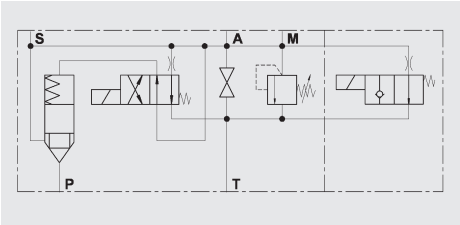
Type	Size	Max. operating pressure	Pressure relief valve [1]
SA20A50T...	DN20	400 bar	NG12 (2)
SA32A50T...	DN30	400 bar	NG12 (3)

[1] number of pressure relief valves



Type	Size	Max. operating pressure	Pressure relief valve [1]
SA20E50T...	DN20	400 bar	NG12 (2)
SA32E50T...	DN30	400 bar	NG12 (3)

[1] number of pressure relief valves



5.6.2 Function when using 3/2 directional poppet valve

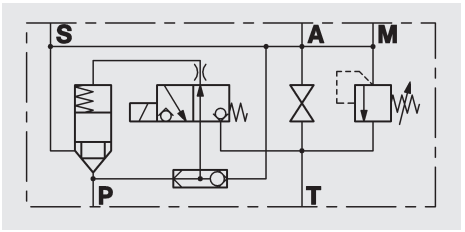
When the 3/2 directional poppet valve is in the switching position shown (open when de-energised), the spring chamber of the logic element is pressurised via the system pressure; the path from P to S is blocked and the accumulator is shut off from the system. When the 3/2 directional poppet valve is in the discharge position (energised) the spring chamber of the logic element is discharged, the path from P to S is open and the accumulator is charged.

If the pump breaks down or if it is switched off, the 3/2 directional poppet valve reverts to the "open when de-energised" position; the accumulator pressure shuts off the logic element via the shuttle change-over valve and shuts off the accumulator from the system.

Technical specifications:

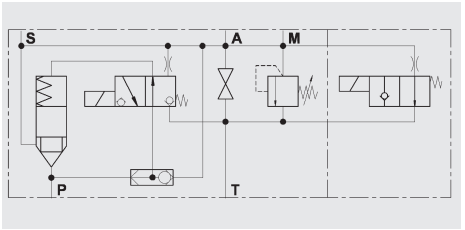
Type	Size	Max. operating pressure	Pressure relief valve [1]
SA20A51T...	DN20	400 bar	NG12 (2)
SA32A51T...	DN30	400 bar	NG12 (3)

[1] number of pressure relief valves



Type	Size	Max. operating pressure	Pressure relief valve [1]
SA20E51T...	DN20	400 bar	NG12 (2)
SA32E51T...	DN30	400 bar	NG12 (3)

[1] number of pressure relief valves



6. DESCRIPTION OF DSV10

6.1. GENERAL

DSV10 as a "Low Cost Alternative" to SAF10

The three-way safety block DSV10 is used to isolate and discharge hydraulic accumulators and consumers. It complies with relevant safety standards in accordance with DIN EN 4413 and the German industrial safety regulations BetrSichV.
The HYDAC pressure relief valve DB12 is used with the DSV series. It is a direct-acting pressure relief valve in poppet valve construction with excellent opening and closing characteristics.
This version of the DB12 complies with the requirements of the European Pressure Equipment Directive (PED) with CE marking.
There are four different versions:

- DSV10M
  anual discharge
  standard L-ball
- DSV10M-T-ball
  manual discharge,
  T-ball
- DSV10EY,
  manual/solenoid-operated discharge
  open when de-energised
- DSV10EZ
  manual/solenoid-operated discharge
  closed when de-energised

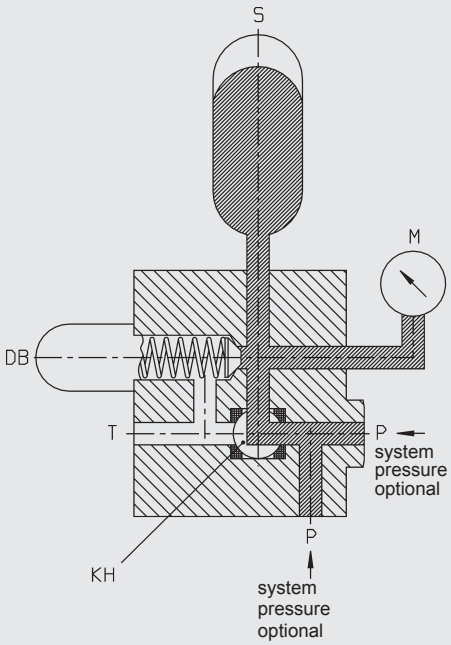
The essential difference compared to the SAF10 lies in the shut-off and discharge function of the DSV10. On request we can supply other models to cover almost all applications, e.g. for aggressive media.

On request we can supply test certificates to EN 10204 and quality test certificates to DIN 55350, Part 18.

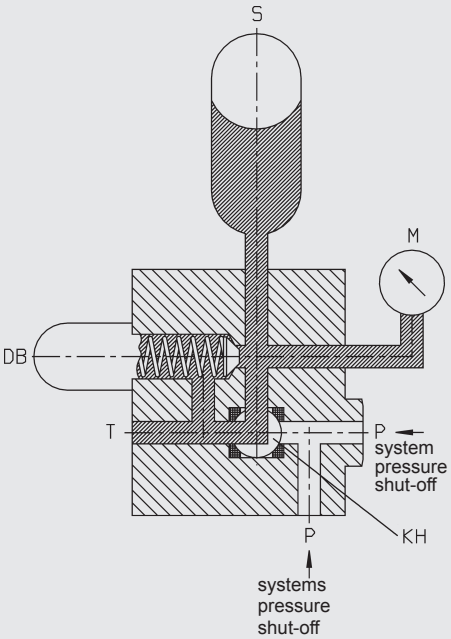
6.2. DESIGN

The DSV three-way safety block consists of a valve block with an integrated pressure relief valve and the shut-off valve. It has ports for the pump, pressure gauge, tank and accumulator.
In addition, an optional solenoid-operated 2-way directional valve allows automatic discharge of the accumulator or consumer.

Accumulator operation



Shutting off the system pressure and simultaneously discharging of the accumulator



P - pump connection
S - accumulator
KH - change-over ball valve
DV - pressure relief valve
M - pressure gauge
T - tank connection

The DSV10 can be used as a cost-effective alternative to the SAF 10. Unlike the SAF 10, the DSV10 shuts off when discharging simultaneously to the tank.

6.3. PORTS

The DSV has the following ports:

S – Accumulator port
(M33x2 DIN 3852 part 3)

P – Inline port
(G 3/8 and G 1/2)

T – Tank port
(G 1/4)

M – Pressure gauge port
(G 1/4)

6.4. FUNCTION

When the accumulator is in operation the change-over ball valve connects the pump port with the accumulator. At the same time the accumulator is monitored for pressure via the built-in pressure relief valve.
By switching over the ball valve, the pump port is shut off leakage-free on the inlet side and the accumulator is discharged simultaneously to the tank.

During switching all three ports (P, S and T) are momentarily interconnected (negative switching overlap). If a solenoid-operated 2/2 directional poppet valve is installed, automatic discharge is possible (e.g. in the event of a power failure or shut-down

6.5. NOTES

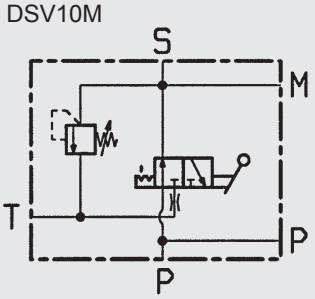
Ball valves are not designed to be used as flow control valves; therefore they should always be either fully open or fully closed to avoid damaging the sealing cups.

To ensure correct functioning, pressure and temperature specifications must be observed.

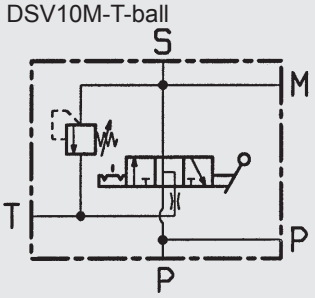
6.6. SPECIFICATIONS

6.6.1 **Symbols**

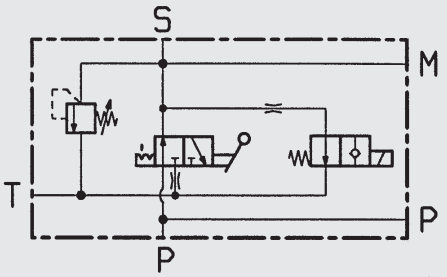
DSV10M



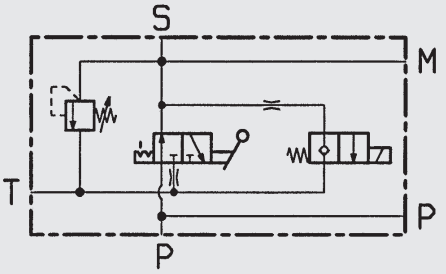
DSV10M-T-ball



DSV10EY



DSV10EZ



6.6.2 **Type of construction**

Ball valve isolating device

Pressure relief valve is a direct-acting poppet seat valve

Poppet valve is pilot-operated

6.6.3 **Materials**

Housing and blanking plug in steel, surface protection: phosphate-plated. Ball in steel, hard-chromed
Pressure relief valve and poppet valve in high tensile steel, closing element in hardened and ground steel, wear-resistant, surface protection: phosphate-plated
Ball seal in high quality synthetic material (POM)
Soft seals in Perbunan (NBR)
Cranked handle SW09 in red anodised aluminium.

6.6.4 **Mounting position**

optional

6.6.5 **Operating fluids**

Mineral oil to DIN 51524 Part 1 and Part 2
(other fluids on request)

Viscosity range

min. 10 mm²/s
max. 380 mm²/s

Filtration:

Max. permitted contamination of the operating fluid to ISO 4406 Class 21/19/16 or SAE AS 4059 Class 11.
We therefore recommend a filter with a minimum retention rate of $ß_{20} \geq 100$. The fitting of filters and the regular replacement of filter elements guarantees correct operation, reduces wear and tear and increases the service life.

6.6.6 **Permitted operating temperature**

-10 °C ... +80 °C

(ambient temperature for E version limited to -10 °C ... +60 °C)

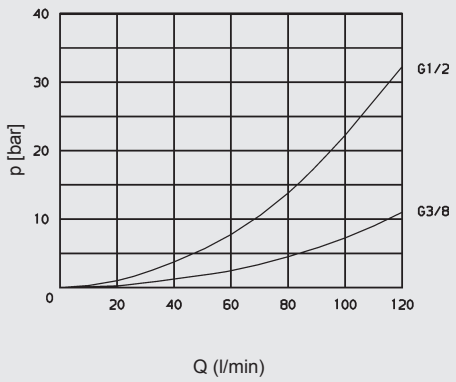
6.6.7 **Maximum operating pressure**

350 bar

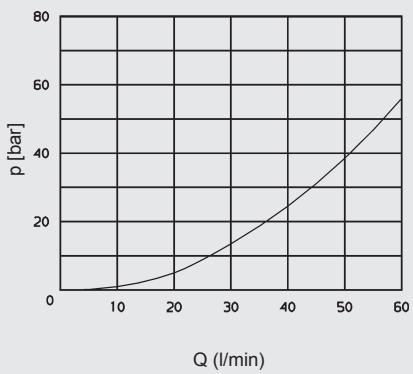
6.6.8 **Δp - Q graph**

measured at
t_{oil} = 50 °C
ν = 30 mm²/s

Flow rate from P to S



Flow rate from S to T



6.6.9 **Model with solenoid-operated pressure release**

Type

Solenoid-operated by means of pressure-tight, oil-immersed, single-stroke solenoids in accordance with VDE 0580. Actuating solenoid with male connector to DIN 43650, standard for general industrial applications, available for 24 V DC and 230 V AC.

Type of current

DC solenoid when connected to AC voltage, the necessary DC voltage is produced by means of a bridge rectifier connector.

Voltage tolerance

+/- 15 % of the nominal voltage

Nominal current

dependent on the nominal voltage

24 V DC 0.80 A

230 V AC 0.11 A

Power consumption

p_{20} = 18 W

Duty

continuous

Switching time

Depending on symbol, pressure across the individual ports and flow rate

WSM06020Y:
on: 50 ms
off: 35 ms

WSM06020Z:
on: 35 ms
off: 50 ms

6.7. SPARE PARTS

please see brochure:

- 3-way safety block DSV No. 5.251

6.8. MODEL CODE FOR DSV10

(also order example)

DSV 10 M . – 4 . 1 / 1 / X / T ... – G 24 – Z4 ...

3-way safety block

Nominal size
10

Discharge
M = manual discharge
E = solenoid-operated and manual discharge

For manual/ solenoid-operated discharge, also indicate
Y = open when de-energised
Z = closed when de-energised

Type of pressure relief valve
4 = DB12

With/without fitted pressure relief valve
1 = with pressure relief valve
0 = without pressure relief valve

Accumulator connection
1 = M33x2

Series
(determined by manufacturer)

Setting of pressure relief valve
T = pressure-set and lead-sealed by TÜV
V = adjustable using tool
F = preset by manufacturer
x = no details (for model without relief valve cartridge)

Pressure setting
... = pressure setting
... = pressure range
xxx = no details (for model without relief valve cartridge)

Pressure setting range
DB12 – 150 bar
DB12 – 250 bar
DB12 – 350 bar

Type of voltage for solenoid
G = DC voltage
W = AC voltage

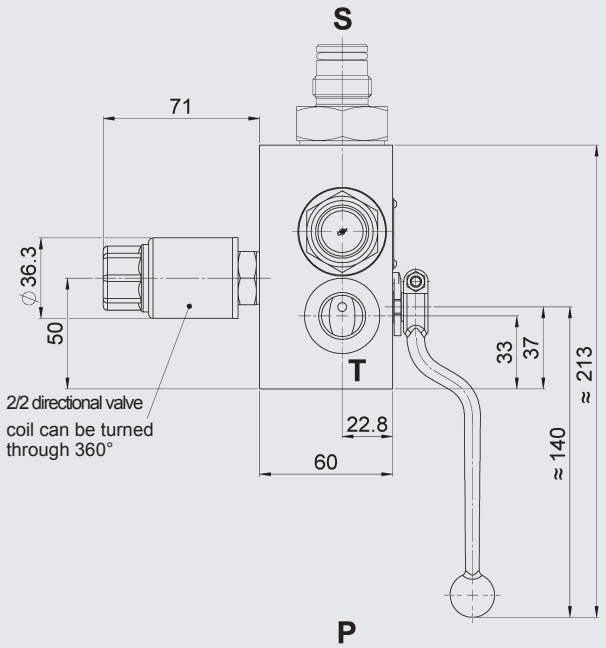
Nominal voltage for solenoid
24 = 24 Volt for type G voltage (DC)
230 = 230 Volt for type W voltage (AC)

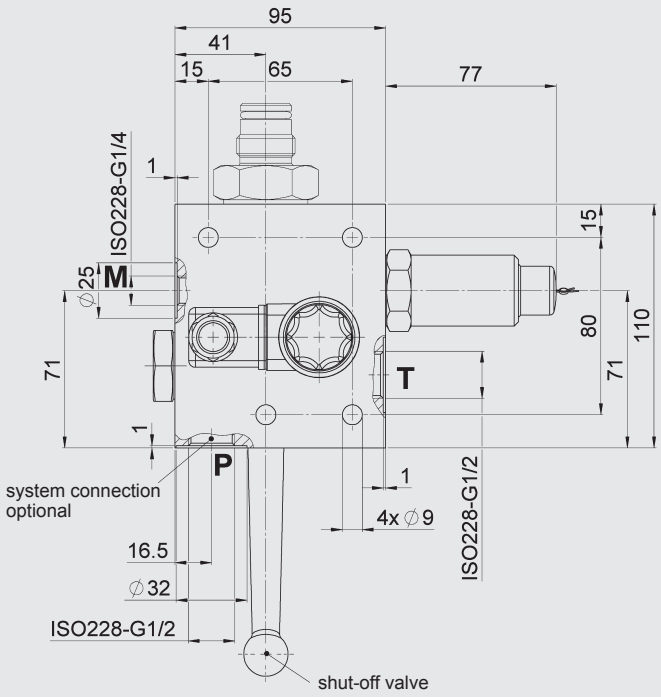
Type of connection for solenoid
Z4 = connector to DIN 43650 - AF2 - PG11

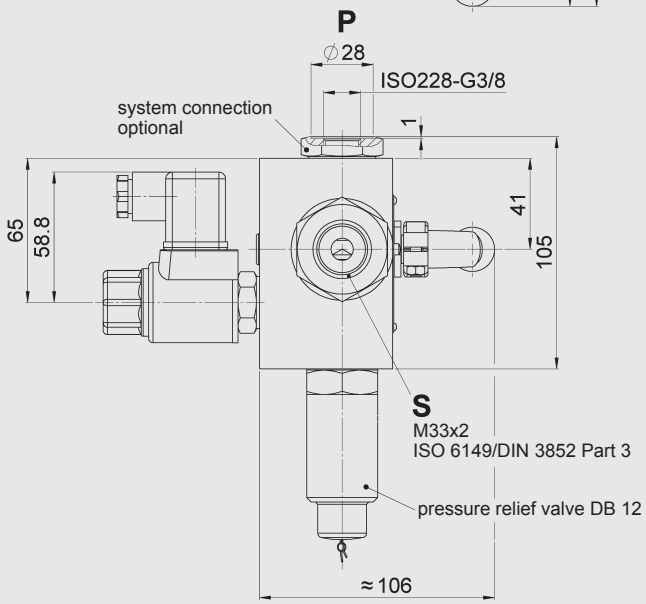
Additional details
T-ball = ball bore (switching travel 180 degrees)
FKM = O-ring seal

6.9. DIMENSIONS

DSV10 3-way safety block







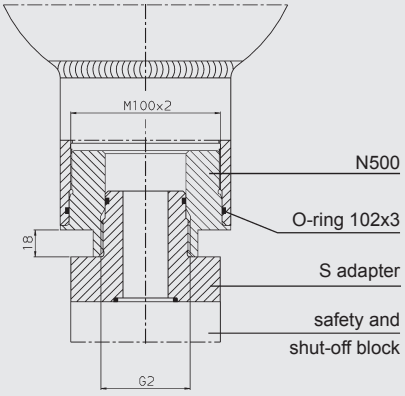
Type	Weight
DSV10M...	3.5 kg
DSV10E...	3.9 kg

SAF10 Standard types

Type	Part no.	Type	Part no.
DSV-10-M-4.0/1/X/XXXX	555999	DSV-10-EY-4.0/1/X/XXXX-G24-Z4	557367
DSV-10-M-4.1/1/X/T035	555968	DSV-10-EY-4.1/1/X/T035-G24-Z4	555980
DSV-10-M-4.1/1/X/T035	555969	DSV-10-EY-4.1/1/X/T050-G24-Z4	555981
DSV-10-M-4.1/1/X/T070	555970	DSV-10-EY-4.1/1/X/T070-G24-Z4	555982
DSV-10-M-4.1/1/X/T100	555971	DSV-10-EY-4.1/1/X/T100-G24-Z4	555983
DSV-10-M-4.1/1/X/T150	555972	DSV-10-EY-4.1/1/X/T150-G24-Z4	555984
DSV-10-M-4.1/1/X/T200	555973	DSV-10-EY-4.1/1/X/T200-G24-Z4	555985
DSV-10-M-4.1/1/X/T210	555974	DSV-10-EY-4.1/1/X/T210-G24-Z4	555986
DSV-10-M-4.1/1/X/T250	555975	DSV-10-EY-4.1/1/X/T250-G24-Z4	555987
DSV-10-M-4.1/1/X/T300	555976	DSV-10-EY-4.1/1/X/T300-G24-Z4	555988
DSV-10-M-4.1/1/X/T315	555977	DSV-10-EY-4.1/1/X/T315-G24-Z4	555989
DSV-10-M-4.1/1/X/T330	555978	DSV-10-EY-4.1/1/X/T330-G24-Z4	555990
DSV-10-M-4.1/1/X/T350	555979	DSV-10-EY-4.1/1/X/T350-G24-Z4	555991

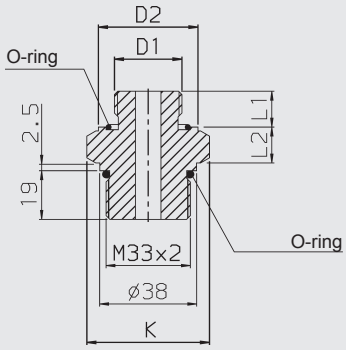
7. ACCESSORIES

7.1. ADAPTERS FOR LOW PRESSURE BLADDER ACCUMULATORS



Type	Accumulator type	Volume [l]	Adapter	Part no. [1] NBR/Carbon steel	Corresponding S adapter	Part no. [1] NBR/Carbon steel
SAF10/20 and DSV10	SB35	2.5 ... 50	N500	367229	S 13	369481
SAF32					S 309	366715

7.2. ADAPTERS FOR DIAPHRAGM ACCUMULATORS



Type	Accumulator type	Volume [l]	D1 Thread	Part no. [1] NBR/Carbon steel	Adapter	K SW	L1 [mm]	L2 [mm]	D2 [mm]	O-ring
SAF10/20 DSV10	SBO...E-	0.075 ... 1.4	G 1/2 A	369485	S 30	41	14	17.5	33	22x3
	SBO...A6-	0.1 ... 210-1.3								
	SBO...E-	2 ... 3.5	G 3/4 A	369486	S 31		16		40	28x3
	SBO...A6-	1.3 ... 4								

[1] Others on request

7.3. ADAPTERS FOR PISTON ACCUMULATORS

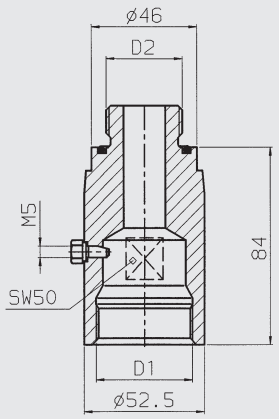


Diagram 1

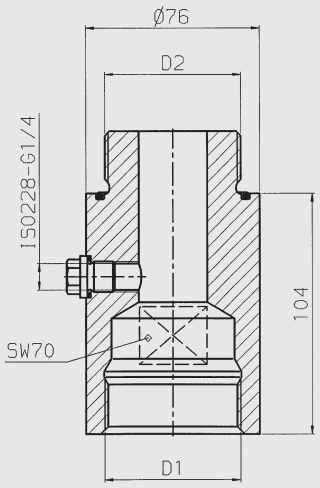
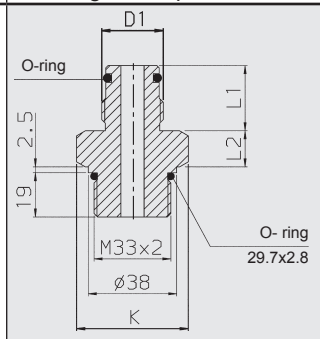
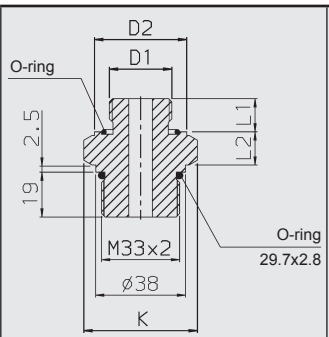
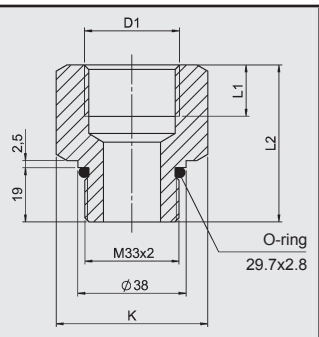
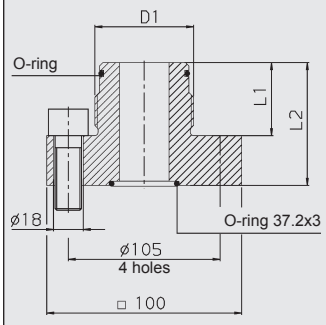
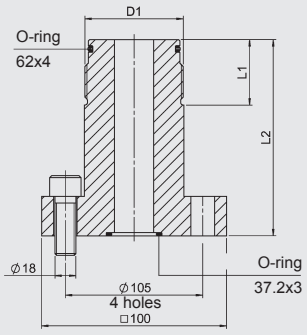
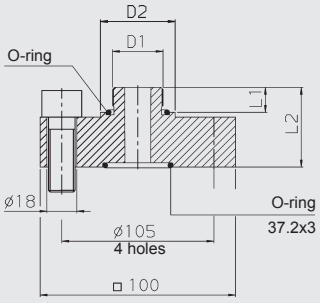
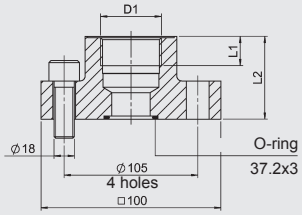


Diagram 2

Type	Accumulator type	Volume [l]	Adapter	Part no. [1] NBR/Carbon steel	Diag.	D1 [mm]	D2 [mm]	O-ring	Corresponding S adapter	Part no. [1] NBR/Carbon steel
SAF10/20 DSV10	SK210/350 -	2.5 ... 7.5	K 406	374929	1	G 1 1/4	G 1	35x3	S 12	369480
	SK210/350 -	10 ... 45	K 408	374931	2	G 2	G 1 1/2	53x3	S 13	369481
SAF32	SK210/350 -	50 ... 120	K 409	374933			G 2	62x3	S 309	366715

[1] others on request.

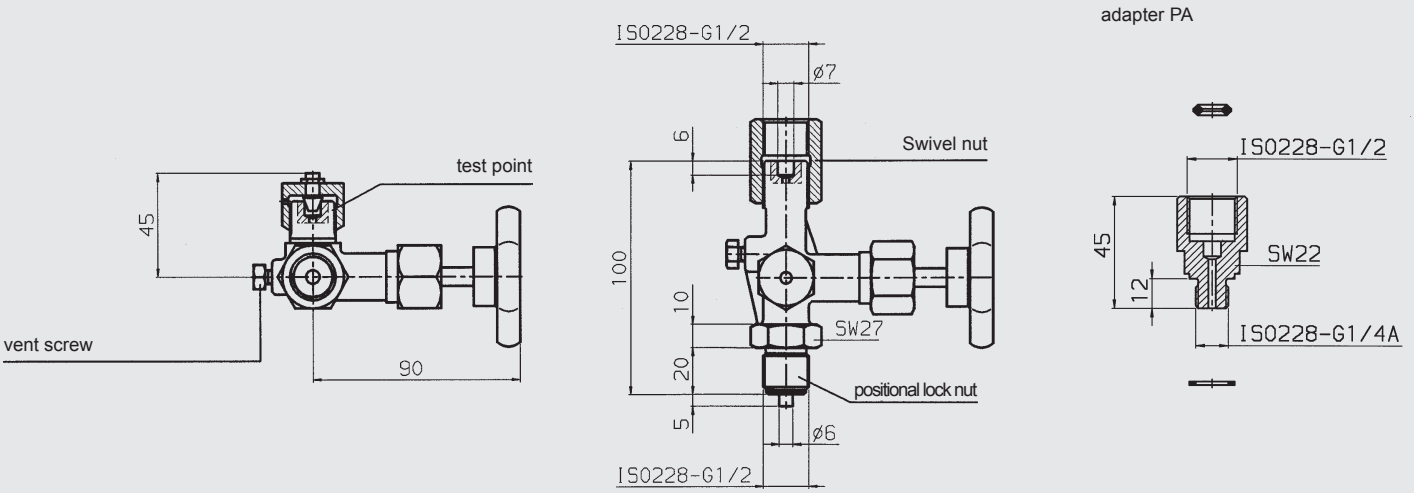
7.4. ADAPTERS FOR STANDARD BLADDER ACCUMULATOR

Type	Drawing of adapters
SAF10 SAF20 DSV10	 Diagram 1  Diagram 2  Diagram 3
SAF32	 Diagram 4  Diagram 5  Diagram 6  Diagram 7

Type	Accumulator type	Volume [l]	D1 Thread	Adapter	Part no. [1] NBR/Carbon steel	K SW [mm]	L1 [mm]	L2 [mm]	D2 [mm]	O-ring [mm]	Diag.
SAF10 SAF20 DSV10	SB330/400-	0.6 ... 1	G 3/4A	S 10	**369479***	41	28	16	–	17x3	1
	SB550/690-	1 ... 5	G 1A	S 11	372750	46	34	17	–	22x3	
	SB330/400-	2.5 ... 6	G 1 1/4A	S 12	**369480***		37		–	30x3	
	SB330/400/550/600-	10 ... 50	G 2A	S 13	**369481***	65	44	21	–	48x3	
	Connection with metric fine thread	–	M30x1.5	S 20	369482	41	15	18	40	32x2	2
		–	M40x1.5	S 21	369483	55	20	21	54	43x3	
		–	M50x1.5	S 22	369484	65			64	53x3	
	SB330/400-	2.5 ... 50	G 3/4	S 367861	369489	41	18	50	–	–	3
			G 1	S 379766	369490	46	20	55	–	–	
			G 1 1/4	S 379767	369498	65	22	60	–	–	
SAF32	SB330/400-	0.6 ... 1	G 3/4A	S 305 [1]	366723	–	28	58	–	17x3	4
	SB550/690-	1 ... 5	G 1A	S 306 [1]	2102855	–	34	64	–	22x3	
	SB330/400-	2.5 ... 6	G 1 1/4A	S 307 [1]	366724	–	37	67	–	30x3	
	SB330/400/600-	10 ... 50	G 2A	S 309 [1]	**366715***	–	44	74	–	48x3	
	SB550-	10 ... 50		S 308 [1]	376813	–		115	–		5
	SB330H-	10 ... 50	G 2 1/2A	S 365922	377283	–	50	150	–	62x4	
	Connection with metric fine thread	–	M30x1.5	S 330 [1]	366735	–	15	47	45	32x2	6
		–	M40x1.5	S 340 [1]	366736	–	20	51	60	43x3	
		–	M50x1.5	S 350 [1]	366737	–			75	53x3	
	SB330/400-	10 ... 50	G 1	S 365637	2106583	–	20	60	–	–	7
			G 1 1/4	S 369658	2106578	–	22		–	–	
			G 1 1/2	S 237838	2103869	–	24	65	–	–	

* preferred models
[1] adapter supplied with 4 off hex. socket cap screws M16x45 (part no. 6032726) torque 130 Nm
[2] others on request

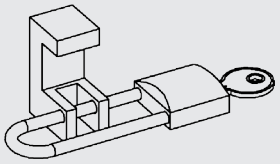
7.5. GAUGE ISOLATOR VALVE



Part no.	Description	consisting of:
611903	Shut-off valve AG DIN 16271	elease valve
		Swivel nut
		Positional lock nut
		Test point
370754	Adaptor PA G1/4A-G1/2	

7.6. SPINDLE SAFETY MECHANISM

Safety mechanism on the release valve on the SAF block to prevent adjustment.
For attachment on SAF, see section 5.4. Safety and Shut-Off Block with supplementary equipment, type LS.



Part no.	Description	consisting of:
3580490	Spindle safety mechanism SAF	- Spindle safety mechanism SAF - Padlock

7.7. ACCUMULATOR CHARGING VALVE

HYDAC accumulator charging valves control, within an adjustable switching range, the charging of the accumulator. By combining the charging valve with an accumulator, pumps and motors on hydraulic plants with fluctuating flow requirements can be sized smaller. This saves costs and energy - thus preventing unnecessary heat development.

For further information and technical specifications, see catalogue section:

- DLHSD DLHSR Accumulator charging valve
  No. 5.190.1

8. NOTE

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

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

Subject to technical modifications.

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Safety Equipment for Hydraulic Accumulators

1. DESCRIPTION

1.1. GENERAL

Hydraulic accumulators are pressure equipment, as defined by the European Pressure Equipment Directive (PED), and as such their manufacture is subject to the statutory regulations.

For safety in the workplace, system manufacturers and operators must draw up risk assessments for the particular site. These must take into account possible risks at the installation site, particularly in combination with external factors.

Fundamental risks affecting hydraulic accumulators are:

- Excessive pressure and
- Temperature increase (e.g. in the event of an external fire).

HYDAC provides the appropriate safety equipment to protect accumulators from the maximum permitted operating pressure PS of a hydraulic accumulator on the gas and fluid side; see also catalogue section:

- HYDAC Accumulator Technology No. 3.000

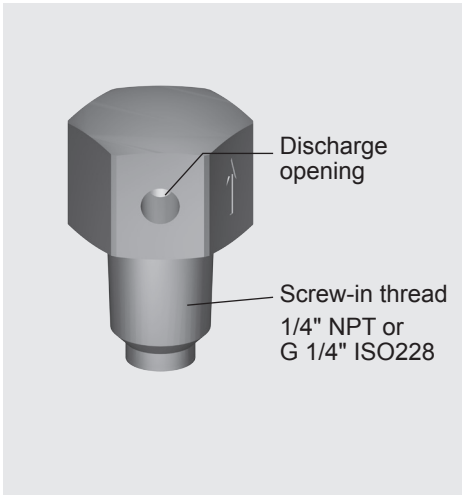
When selecting safety equipment, consideration must be given to the material (elastomers and housing material) as regards material compatibility in the application.

The pressure setting of safety equipment must **not** exceed the max. permitted operating pressure PS of a hydraulic accumulator.

2. PROTECTION ON THE GAS SIDE

2.1. BURSTING DISC

2.1.1 Design



2.1.2 Function

If the pressure exceeds the permitted level, the bursting disc shatters, permanently opening the port. This reduces the gas pressure by discharging the nitrogen completely.

Bursting discs are designed for different burst pressures and are supplied with a certificate of conformity.

Bursting discs are made either entirely of stainless steel, or from an alloy based on stainless steel and nickel.

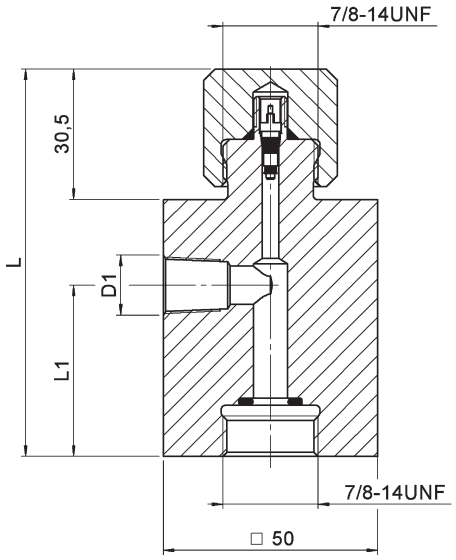
2.1.3 Standard types

Description	Burst pressure ± 10 % at 50 °C	Part no.
Bursting disc plug 1/4" NPT	210 bar	3156148
	250 bar	3156150
	300 bar	3156151
	330 bar	**3341280***
	350 bar	3156152
Bursting disc plug G 1/4" ISO228	210 bar	3516441
	330 bar	3560189
	400 bar	3358418

* preferred models
others on request

2.1.4 FPS adapter for bursting disc

To protect standard and low pressure bladder accumulators, the adapter shown below must be ordered with the bursting disc:



L [mm]	L1 [mm]	D1	Carbon steel	Stainless steel
90.5	40	1/4" NPT	366694	-
81.5	30	1/4" NPT	-	3117711
90.5	40	G 1/4" ISO228	364802	-
81.5	30	G 1/4" ISO228	-	3521154

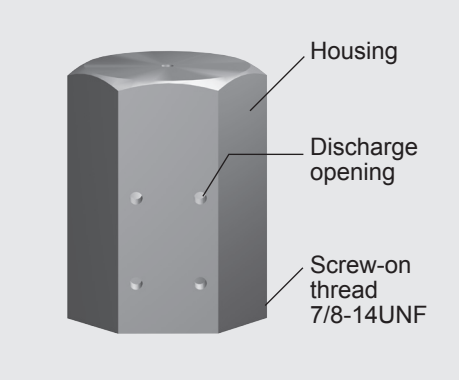
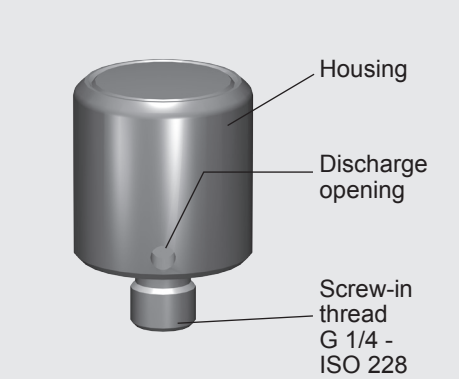
2.2. TEMPERATURE FUSE

HYDAC offers two different kinds of temperature fuse. In addition to the temperature fuse in carbon steel and stainless steel, which is suitable for bladder accumulators, HYDAC also offers a temperature fuse of the type GMP6, which is approved according to the European Pressure Equipment Directive (PED). It is made of stainless steel and has a CE mark.

2.2.1 **Function**

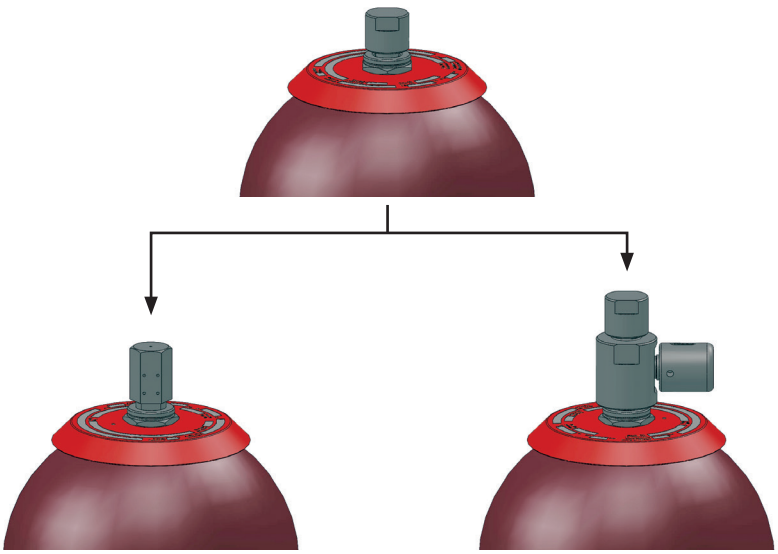
Temperature fuses are "devices with a safety function" and are used to release the gas pressure by discharging the nitrogen completely when a rise in temperature reaches unacceptable levels (e.g. in the case of fire).

2.2.2 **Design/Technical data/Standard types**

Type	Temperature fuse		Temperature fuse GMP6	
Design				
Permitted operating pressure	≤ 450 bar		50 … 420 bar	
Temperature range	-10 °C ... +80 °C		-40 °C ... +120 °C	
Melting temperature	between +160 °C and +170 °C		between +160 °C and +170 °C	
Standard types	**363501***	Temperature fuse 7/8-14UNF	3517438	GMP6-10-CE1637...
	3094166*	Temperature fuse 7/8-14UNF with eye bolt (for crane hook)	3521196	GMP6-10-CE1637... with adapter for bladder accumulators
			3584817	GMP6-10-CE1637... with adapters for piston and diaphragm accumulators

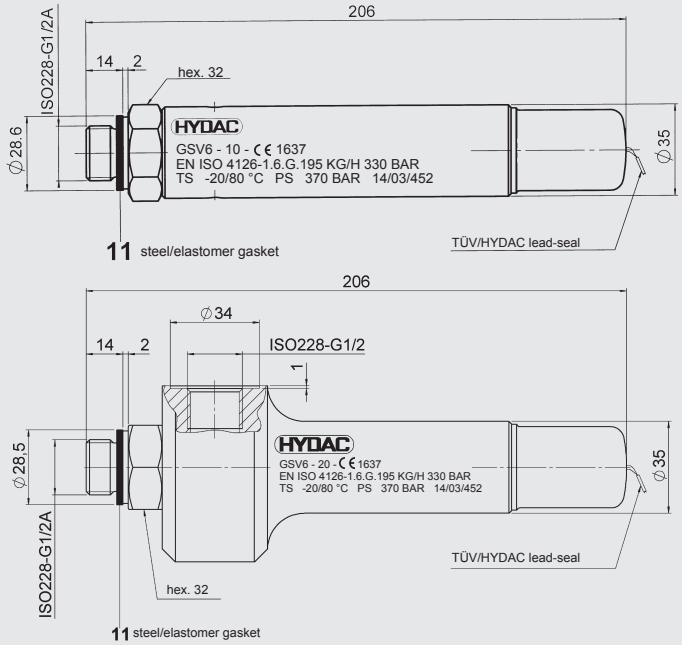
* preferred models

2.2.3 **Installation instructions**

Design	Temperature fuse	Temperature fuse GMP6
The instruction manual must be followed! ● GSV/GMP No. 3.504.BA	Simple to retrofit (using the example of a bladder accumulator) by replacing the sealing cap with the temperature fuse.	Simple to retrofit (using the example of a bladder accumulator) by replacing the sealing cap with the temperature fuse GMP6 with adapter.
Bladder accumulator without temperature fuse		
Temperature fuse or temperature fuse GMP6 and adapter		

2.3. GAS SAFETY VALVE

2.3.1 Assembly and dimensions



2.3.2 Function

The gas safety valve provides protection by reducing the pressure in a controlled way if pressure exceeds the permitted level unexpectedly. It is pre-set on the pressure side and lead-sealed by the authorised representative. It is also supplied with a certificate of conformity and a type approval.

2.3.3 Model code

(also order example)

GSV6 – 10 – CE1637.ENISO4126-1.6.G. 195. 330

Gas safety valve

Series
10 = Standard with 2 discharge openings size 6 mm
20 = 1 discharge opening G 1/2 ISO228

Component code

Flow rate Q [kg/h]
(see table, section 2.3.6)

Pressure setting p [bar]
(see table, section 2.3.6)

2.3.4 Technical specifications

Dimensioning
European Pressure Equipment Directive (PED), EN ISO4126-1, EN 13445-6, others on request

Module category
IV to European Pressure Equipment Directive (PED)
Module B + D (EC type examination)
Module G (EC individual examination)
on request

Nominal size
6 mm

Material
Stainless steel, closing element with flexible seat seal

Medium
Nitrogen (N_2)

Operating pressure range
30 ... 370 bar

Temperature range:
-20 °C ... +80 °C
Others on request

Weight
1.1 kg

2.3.5 Installing the gas safety valve GSV

The self-centring gasket means that this valve can be installed simply and securely in any position.

Please read the Operating Manual!

- GSV/GMP
  No. 3.504.BA

2.3.6 Preferred models

Selection of the pressure setting is based on the maximum operating pressure of the hydraulic accumulator, according to the application.

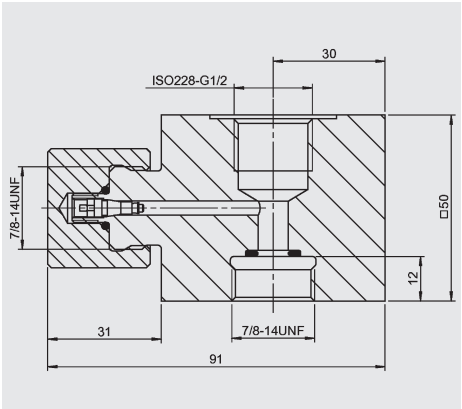
Q [kg/h]	p [bar] ± 10 %	Part no. [1]
15	30	3123965
20	40	3123966
28	50	3123967
35	60	3124028
40	70	3124029
45	80	3124030
50	90	3124031
58	100	3124032
65	110	3124033
70	120	3124034
75	130	3124035
83	140	3124036
88	150	3124037
95	160	3124038
100	170	3124039
105	180	3124040
110	190	3124041
118	200	3124042
125	210	3124043
130	220	3124044
135	230	3124045
140	240	3124046
148	250	3124047
155	260	3124048
160	270	3124049
165	280	3124050
170	290	3124051
178	300	3124052
185	310	3124053
190	320	3124054
195	330	3124055
200	340	3124056
205	350	3124057

[1] Others on request.

> 350 bar = additional price required for EC type examination, please ask

2.3.7 Adapter for gas safety valve GSV6

To protect standard and low pressure bladder accumulators, the adapter shown below must be ordered with the gas safety valve GSV6.

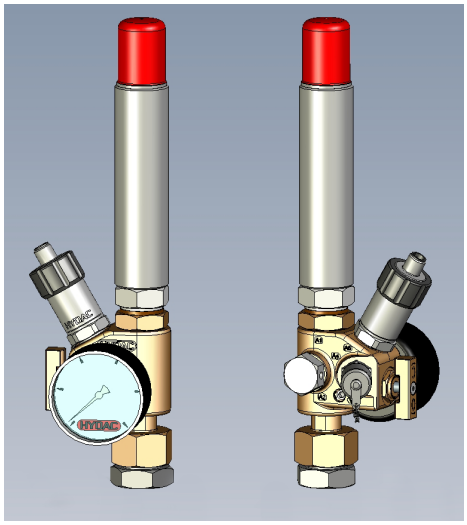


Designation	Part no.
Adapter assembly	2103381

others on request

2.4. GAS SAFETY BLOCK

2.4.1 Design



Gas safety block GSB450 consists of a brass block (other materials on request) with integrated vent valve and shut-off valve and ports for:

- Pressure gauge
- Gas safety valve (GSV6)
- Gas charging valve (e.g. Minimess)
- Pressure transmitter or pressure switch
- Bursting disc or temperature fuse

The gas safety valve connection is designed as a check valve. Therefore the valve can be changed, even if the system is pressurized

2.4.2 Function

The GSB450 is an adapter block, which is mounted on an accumulator on the gas side and which can be fitted with various pressure devices, charging equipment, safety valves and other safety components.

2.4.3 Advantages

- Compact design
- Flexible connection options
- Variable indication options: bar, MPa or psi, analogue or digital (optional)
- Pressure gauge can be oriented according to customer requirement
- Accumulator can be charged with nitrogen, directly via Minimess valve
- Pre-charge pressure can be checked without FPU-1

2.4.4 Model code

(also order example)

GSB450 – 1 – 1 – 5 – 1 – 1 – 350

Series

Material
1 = standard
(brass and add-on parts in carbon steel)
2 = stainless steel
(brass and add-on parts in stainless steel)
3 = stainless steel
(on request)

Accumulator connection
1 = Connection for SK/SBO
2 = Connection for SB 7/8-14UNF
3 = Connection for SB 5/8-18UNF
8 = Connection for threaded pipe fitting DKS18
9 = Special connection

Pressure gauge display
0 = None
1 = 0 - 25 bar
2 = 0 - 100 bar
3 = 0 - 160 bar
4 = 0 - 250 bar
5 = 0 - 400 bar
9 = Special pressure gauge

Gas charging connection
0 = None
1 = Minimess valve M16x2
2 = Minimess valve M16x1.5
3 = Minimess valve M16x1.5 for permanent monitoring
(see section 2.4.6)
9 = Special connection

Safety equipment
0 = None
1 = GSV
2 = Bursting disc
3 = Temperature fuse

Pressure range of the safety equipment

2.4.5 Technical data

Medium
Nitrogen (N_2)

Permitted operating temperature
-20°C ... +80 °C

Max. operating pressure
400 bar / 5800 psi

Accumulator connection
Bladder accumulator:
7/8-14UNF with adapter

For bladder accumulators, the appropriate adapter is supplied. All other connections are sealed with blanking plugs.

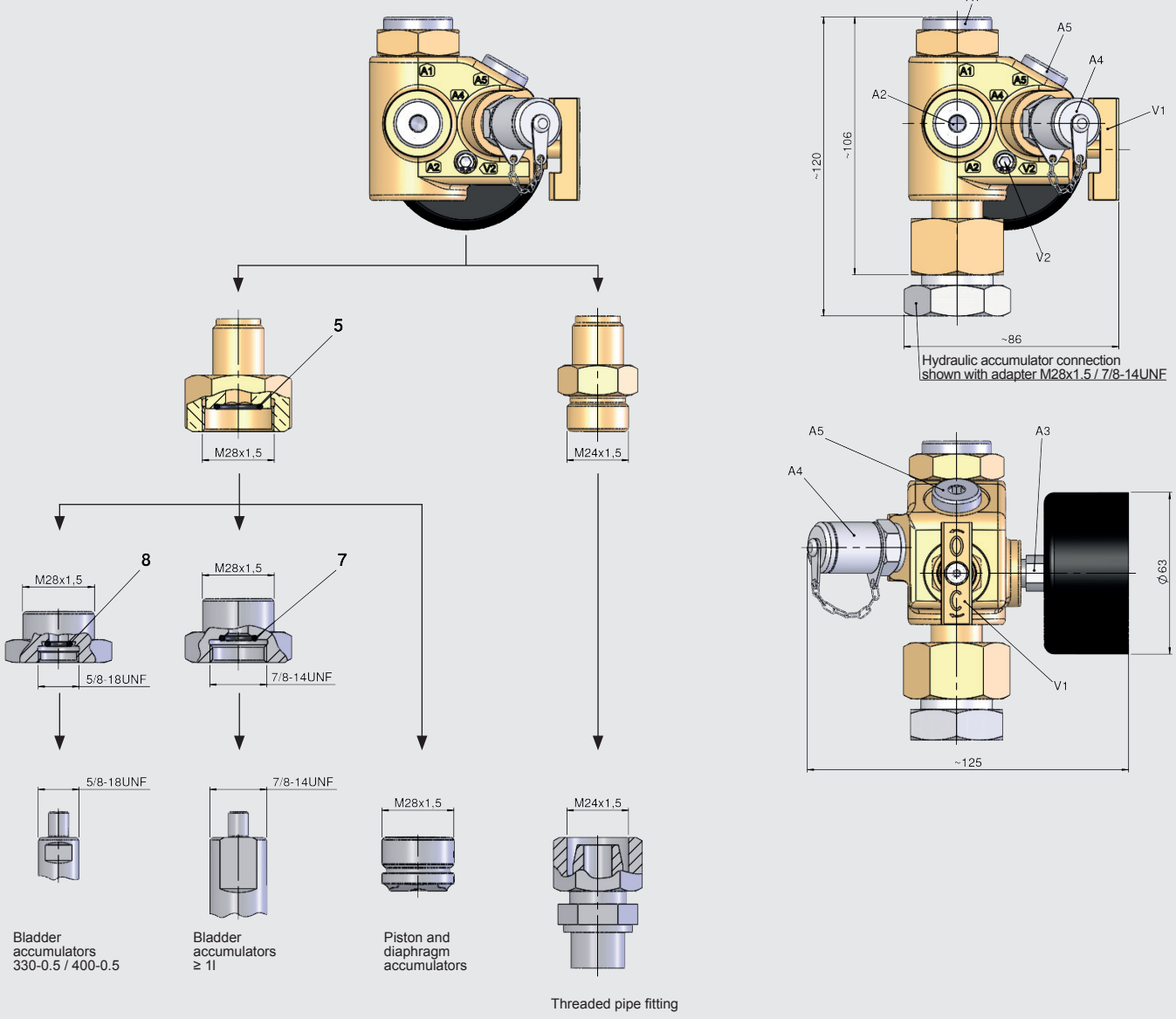
Piston and diaphragm accumulators:
M28x1.5

For piston and diaphragm accumulators the connection is a lock-nut with M28x1.5 thread as standard.

Weight

- Standard model for SB
  1.6 kg
- Standard model for SBO and SK
  1.5 kg

2.4.6 Dimensions and models



Standard model

The GSB450 is delivered with the following as standard:

- Shut-off valve,
- Vent valve,
- Pressure gauge (0 - 400 bar, Ø 63 mm) and
- Gas charging connection, code 1 (Minimess threaded coupling, series 1620, M16x2)

The shut-off valve (V1) must always be closed following the charging and testing procedure to protect the pressure gauge (A3), Minimess valve (A4) and pressure switch/pressure transmitter (A5) from long-term pressure load.
The pressure chamber must be unloaded at the vent valve (V2).
If a pressure switch/pressure transmitter for permanent monitoring of the accumulator pre-charge pressure is screwed in at connection A5, the shut-off valve (V1) must be open. We recommend the gas charging connection with code 3 for this, see also options.

Options

The GSB450 can be supplied with the following options*:

- Special pressure gauge, e.g.
  - units other than bar/psi
  - glycerin-filled
- Minimess gas charging valve with code 3 for permanent monitoring (series 1615, M16x1.5; stainless steel version)
- Version where all steel parts are stainless steel (A4)
- Safety devices (gas safety valve GSV6, bursting disc, temperature fuse)

* on request and must be ordered separately and at additional cost

2.4.7 Standard types

Designation	Part no.
GSB450-1-1-1-1-0	3534710
GSB450-1-1-2-1-0	3534711
GSB450-1-1-3-1-0	3534712
GSB450-1-1-4-1-0	3528946
GSB450-1-1-5-1-0	3426882
GSB450-1-2-1-1-0	3534713
GSB450-1-2-2-1-0	3534714
GSB450-1-2-3-1-0	3484861
GSB450-1-2-4-1-0	3433824
GSB450-1-2-5-1-0	3426905

2.4.8 Installation of gas safety block GSB Please read the Operating Manual!

- GSB
  No. 3.505.BA

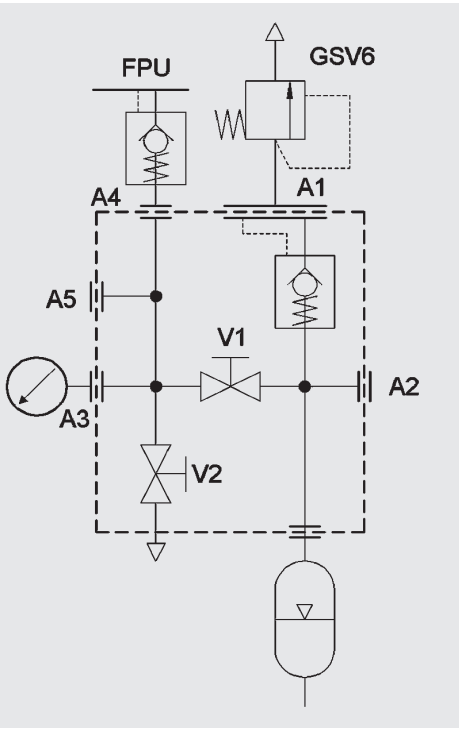
2.4.9 Accessories

Block connections

Ports	Size	Standard configuration	Optional configuration
A1	G1/2-ISO228	Blanking plug	Gas safety valve GSV6
A2	G1/4-ISO228	Blanking plug	● Remote charging (on customer side) ● Bursting disc ● Temperature fuse
A3		Pressure gauge 0 - 400 bar	● for other measurement ranges, see section 2.4.4 ● Special pressure gauge (please specify)
A4		Minimess valve M16x2	Minimess valve M16x1.5 (various versions possible, please request, see section 2.4.4)
A5		Blanking plug	Pressure transmitter e.g. HYDAC HDA, EDS

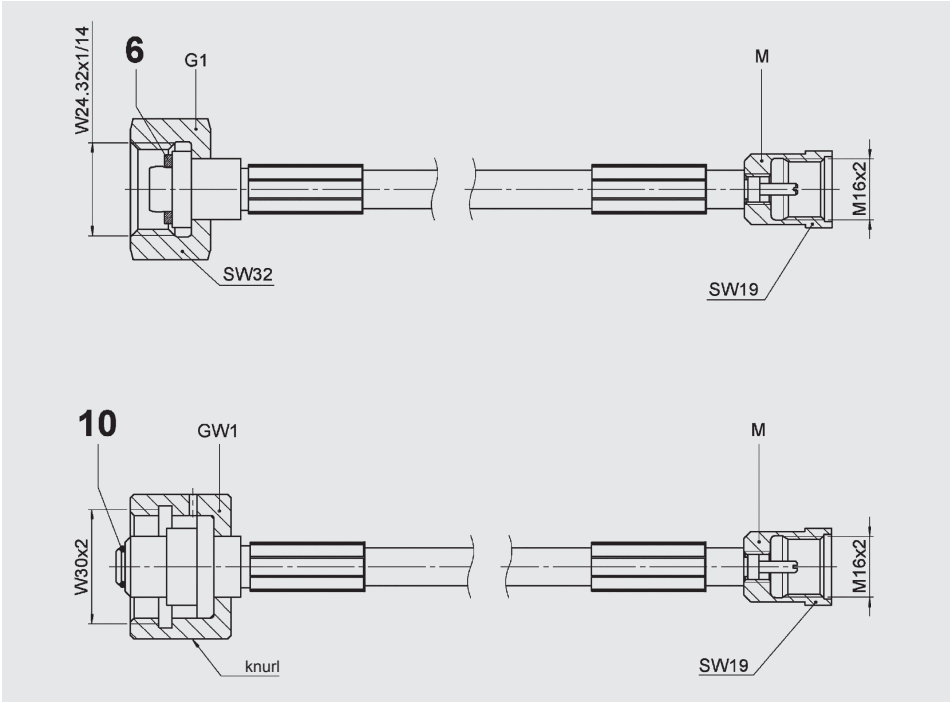
Valves

Type	Designation
V1	Shut-off valve
V2	Vent valve (int. hex. SW4)



Connecting hoses

Connecting hoses are designed for the particular maximum permitted operating pressure marked on them and 10,000 charging processes.
(HYDAC charging hoses comply with DIN EN ISO 4413 and DIN EN 853 to 857)



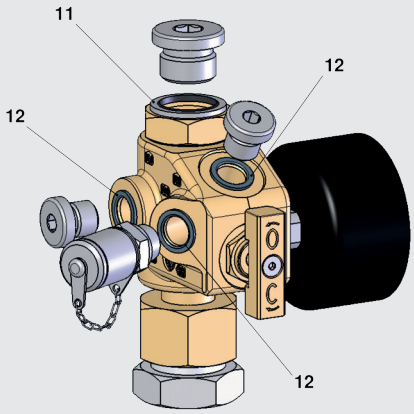
Gas connection of nitrogen bottles	Minimess connection	Length [m]	Part no.
W30x2	M16x2	2.5	3434454
		4	3434457
W24.32x1/14	M16x2	2.5	3434424
		4	3434451
		10	3526858

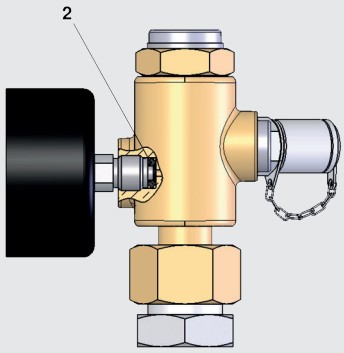
Suitable adapters for foreign nitrogen bottles can be found in the following catalogue section:

- Charging and testing unit FPU
  No. 3.501

2.4.10 **Spare parts**
The following spare parts for GSB450 relate to the standard version:

carbon steel/NBR





Description		Quantity	Item	Part no.
Seal kit for GSB450 consisting of:		1	-	4024196
Rhombic seal 1/4"		1	2	-
O-ring 15x2		1	5	-
Seal ring		1	6	-
O-ring 11x2		1	7	-
O-ring 9x2		1	8	-
O-ring 5.7x1.9		1	10	-
Seal ring		1	11	-
Seal ring		3	12	-
Pressure gauge	0 - 10 bar	1	3	635139
	0 - 25 bar			635140
	0 - 100 bar			635141
	0 - 250 bar			635142
	0 - 400 bar			635143

3. PROTECTION ON THE FLUID SIDE

3.1. GENERAL

The fluid side must be protected against pressures which exceed the permitted operating pressures by installing approved and appropriate safety valves.

HYDAC offers pressure relief valves (DB12) which have a pressure setting of up to 400 bar (set by HYDAC). The valve carries the CE mark and is built into Safety and Shut-off Blocks in the series DSV10 and SAF in nominal sizes DN10 and DN50 and is lead-sealed.

Further information is available from the following catalogue section:

- Safety and Shut-off Block SAF/DSV No. 3.551

4. 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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E-Mail: speichertechnik@hydac.com

Supports for Hydraulic Accumulators

1. DESCRIPTION

1.1. GENERAL

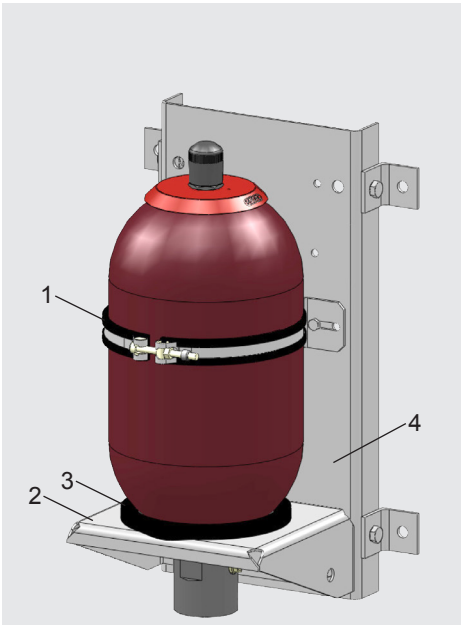
HYDAC supports are used to install all types of hydraulic accumulator safely and simply, irrespective of the installation position and location. Clamps, consoles and complete accumulator sets are available.

1.2. APPLICATION

The supports are designed for static use. For dynamic stresses, specially designed clamps are available on request.

2. SELECTION TABLES FOR SUPPORTS

2.1. BLADDER ACCUMULATORS

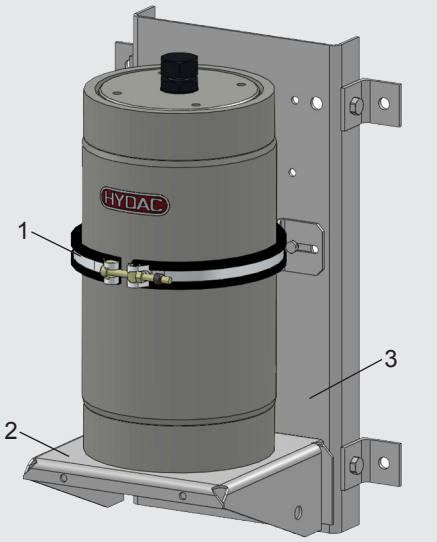


1 Clamp
2 Console
3 Rubber support ring
4 Back plate

Designation	Nominal volume [l]																											
	SB330								SB400				SB550		SB500 / SB600		SB35			SB40			SB35H		SB35HB		SN
	1	2.5+5	4+6	10-24	32-50	60-80	100-130	160-200	0.5	4	10-20	32-50	1	2.5-5	10-20	32-50	2.5-5	10-20	32-50	2.5-5	10-20	32-50	20	32-50	20	32-50	50
Clamps*																												
HyRac 89-92 ST									1																			
HyRac 106-114/115 H3 ST																	2			2								
HyRac 110-118/124 H10 ST	1	2																										
HyRac 121-129/133 H8 ST													1	2														
HyRac 167-175/178 H5 ST			1							1																		
HyRac 202-210/214 H8 ST																		1	2				1	2				
HyRac 216-224/226 H5 ST																					1	2			1	2		
HyRac 223-230/231 H3 ST				1	2																						2	
HyRac 225-234/234 H3 ST											1	2																
HSS 242															1	2												
HRGKSM 4 R 352-363/360 ST						2	3																					
HRRBS 17 B1L 406 PP ST M ZN B145 H525								3																				
Consoles																												
KBK 167 / G			1							1																		
KBK 222 / G				1	1						1	1			1	1		1	1		1	1						1
KBK 360 / G						1	1																					
KHF 210 / G																							1	1	1	1		
Accumulator set																												
SEB		1	1	1	1					1	1	1																
SEBL						1	1																					
SEH														1	1	1												
SEM																				1	1	1						
SEHB																									1	1		

* The number of clamps can vary depending on the requirements and on the length of the accumulator. These are recommendations.

2.2. PISTON ACCUMULATORS

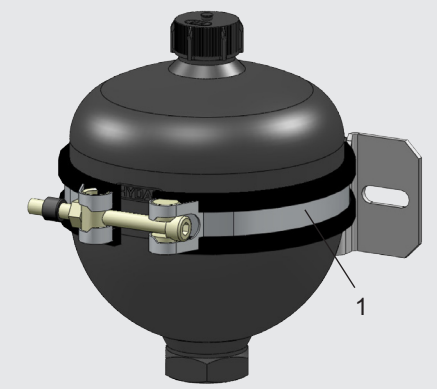


1 Clamp
2 Console
3 Back plate

Type	Piston diameter [mm] 50	60	80	100	125	150	180	250	> 250
	Accumulator external diameter [mm] 60	75	95	100	120	125	150	180	210	220	286	300	> 300
Clamps SK280*													
HRGKSM 0 R 58-61/62 ST	●												on request
HRGKSM 0 R 73-76/76 ST		●											
HRGKSM 0 R 92-95/96 ST			●										
HRGKSM 1 R 119-127/124 ST					●								
HRGKSM 1 R 146-154/151 ST						●							
Clamps SK Standard*													
HyRac 96-100/100 ST				●									on request
HyRac 121-129/133 H8 ST						●							
HyRac 176-185/187 H5 ST								●					
HyRac 209-217/223 H10 ST									●				
HyRac 216-224/226 H5 ST										●			
HSS 286											●		
HSS 310												●	
Consoles													
KBK 126						1							on request
KBK 219									1	1			
KBK 310											1	1	

* Selecting the correct clamp depends on the external diameter of the accumulator. Depending on the application and length of the accumulator, we recommend that several clamps are used. Clamps must be mounted near the end caps in order to prevent deformation of the cylinder.

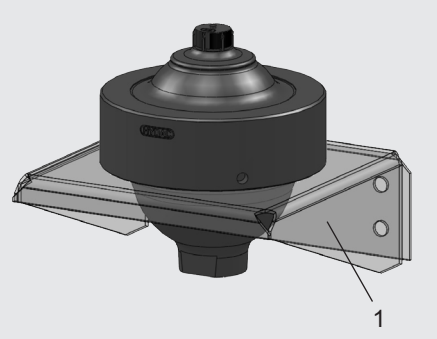
2.3. DIAPHRAGM ACCUMULATORS (WELD TYPE)



1 Clamp

Accumulator type	Clamps
SBO250-0.075E	HyRac 62-65 ST
SBO210-0.16E	HyRac 73-76 ST
SBO210-0.32E	HyRac 92-95/96 ST
SBO210-0.5E	HyRac 100-105/106 H3 ST
SBO100-0.7E	HyRac 106-114/115 H3 ST
SBO330-0.6E	HyRac 110-118/124 H10 ST
SBO330-0.7E	
SBO210-0.75E	HyRac 121-129/133 H8 ST
SBO330-0.75E	
SBO200-1E	HyRac 133-142/142 H3 ST
SBO140-1.4E	HyRac 143-151/151 H3 ST
SBO210-1.4E	
SBO330-1.4E	HyRac 152-159/160 H3 ST
SBO100-2E	HyRac 160-167/169 H5 ST
SBO210-2E	HyRac 167-175/178 H5 ST
SBO210-2.8E	
SBO250-3.5E	
SBO330-2E	
SBO330-2.8E	
SBO330-3.5E	

2.4. DIAPHRAGM ACCUMULATORS (SCREW TYPE)

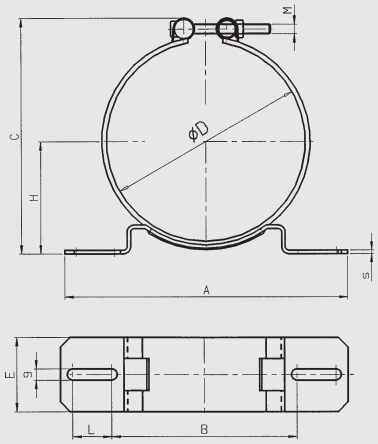


1 Console

Accumulator type	Console
SBO210-1.3A6	KMS 200
SBO400-1.3A6	KMS 210
SBO100-2.0A6	KMS 220
SBO250-2.0A6	
SBO210-2.8A6	KMS 250
SBO400-2.8A6	KMS 280
SBO210-4.0A6	KMS 300
SBO400-4.0A6	KMS 310

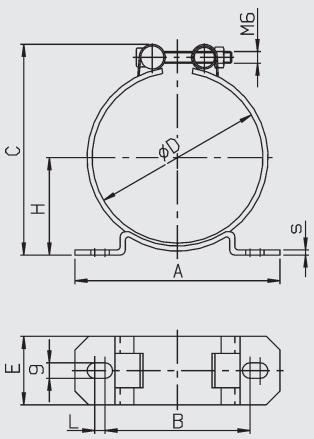
3. CLAMPS

HRGKSM



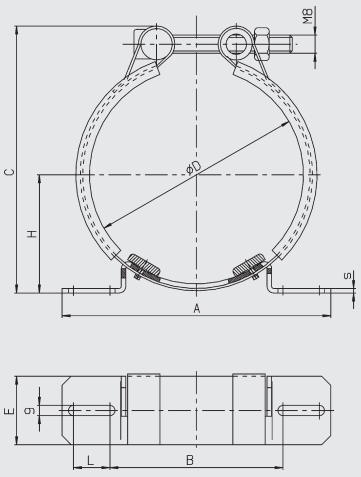
Fastening, foot zinc-plated
Clamping band stainless steel
Insert LDPE

HyRac (ØD ≤ 100 mm)



Fastening, foot zinc-plated
Clamping band stainless steel
Insert PE

HyRac (ØD ≥ 100 mm)



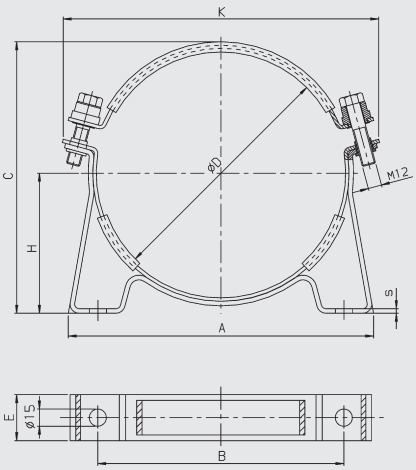
Fastening, foot zinc-plated
Clamping band stainless steel
Insert PE, NBR

Designation	Part no.	A [mm]	B [mm]	C max [mm]	ØD (from - to) [mm]	H (from - to) [mm]	E [mm]	L [mm]	s [mm]	K max. [mm]	Weight [kg]
HRGKSM 0 R 58-61/62 ST	3018442	120	85	83	58 - 61	37.3 - 38.8	40	6	3	–	0.16
HRGKSM 0 R 70-73/73 ST	3018444			93	70 - 73	42 - 43.5					0.21
HRGKSM 1 R 119-127/124 ST	444505	156	100	154	119 - 127	66.8 - 70.8	50	18			0.36
HRGKSM 1 R 146-154/151 ST	444321			181	146 - 154	80.5 - 84.5	50	18	3		0.39
HRGKSM 4 R 352-363/360 ST	444795	400	322	398	352 - 363	187.7 - 193.2	60	28	4		1.4
HyRac 62-65 ST	445037	120	85	85	62 - 65	38 - 39.5	40	8	3	–	0.16
HyRac 73-76 ST	445038			96	73 - 76	43.5 - 45					0.16
HyRac 89-92 ST	445039			112	89 - 92	51 - 52.5					0.17
HyRac 92-95/96 ST	445040			115	92 - 95	52.5 - 54					0.17
HyRac 96-100/100 ST	445041			120	96 - 100	54.5 - 56.5					0.17
HyRac 100-105/106 H3 ST	444904	156	100	135	100 - 105	59 - 62	60	18	3	–	0.4
HyRac 106-114/115 H3 ST	444905			143	106 - 114	62.5 - 66					0.41
HyRac 110-118/124 H10 ST	445042			156	110 - 118	72.5 - 77					0.42
HyRac 121-129/133 H8 ST	444906			165	121 - 129	75.5 - 80					0.43
HyRac 133-142/142 H3 ST	444907			174	133 - 142	76.5 - 82.5					0.44
HyRac 143-151/151 H3 ST	444908			182	143 - 151	83 - 86.5					0.45
HyRac 152-159/160 H3 ST	444909			191	152 - 159	87 - 91					0.46
HyRac 160-167/169 H5 ST	444910	236	152	197	160 - 167	89 - 93	60	32	4	–	0.7
HyRac 167-175/178 H5 ST	445043			207	167 - 175	92.5 - 96.5					0.72
HyRac 176-185/187 H5 ST	445044			241	176 - 185	97 - 102.5					0.75
HyRac 202-210/214 H8 ST	445045			245	202 - 210	116 - 120					0.76
HyRac 209-217/223 H10 ST	445046			255	209 - 217	122.5 - 126.5					0.77
HyRac 216-224/226 H5 ST	445047			256	216 - 224	120 - 124					0.77
HyRac 223-230/231 H3 ST	445048			259	223 - 230	120.5 - 123.5					0.78
HyRac 225-234/234 H3 ST	445049			265	225 - 234	123 - 127.5					0.79

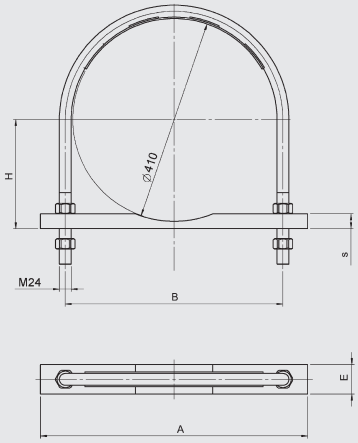
Model/order code (example):

HyRac 167-175/178 H5 ST	445043

HSS



HRRBS



Clamp	zinc-plated	Clamp	zinc-plated
Insert	NBR	Insert	NBR

Designation	Part no.	A [mm]	B [mm]	C max [mm]	ØD (from - to) [mm]	H (from - to) [mm]	E [mm]	L [mm]	s [mm]	K max. [mm]	Weight [kg]
HSS 222/229	235224	270	216	244	226	123	40	Ø15	4	295	1.7
HSS 242	362712	268	216	265	242	136				305	1.7
HSS 286	237395	332	280	314	286	163				355	2.1
HSS 310	237389	332	280	333	310	170				380	2.1
HSS 360	355592	427	365	383	360	195				424	2.5
HRRBS 17 B1L 406 PP ST M ZN B145 H525	3434519	540	440	450	410	220	60	-	30	-	6.15

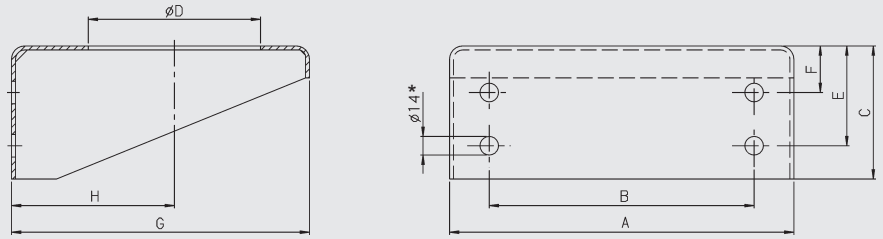
Model/order code (example):

HSS 222/229	235224

4. CONSOLES

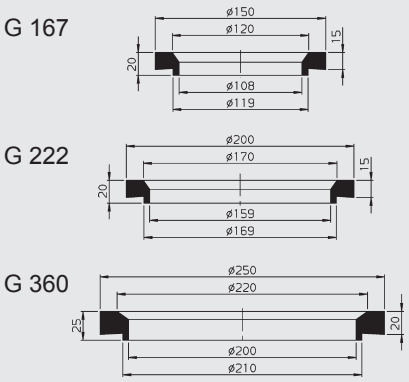
4.1. CONSOLE KBK FOR BLADDER AND PISTON ACCUMULATOR

Console KBK



* Ø22 on KBK 310 and KBK 360

Rubber support ring G



Type	Mat.	Part no.	A [mm]	B [mm]	C [mm]	ØD [mm]	E [mm]	F [mm]	G [mm]	H [mm]	Weight [kg]
126	STZN	290530	175	100	60	65	36	–	150	77	1.1
167		238526	260	200	100	120	75	35	225	92	2.5
219		238042	270	180		135	80	40	250	123	6.5
222		3002160	260	200		170	75	35	225		2.4
310		238043	330	220	200	190	140	60	340	170	18.3
360		357959	390	270	240	211	180		390	195	20.1

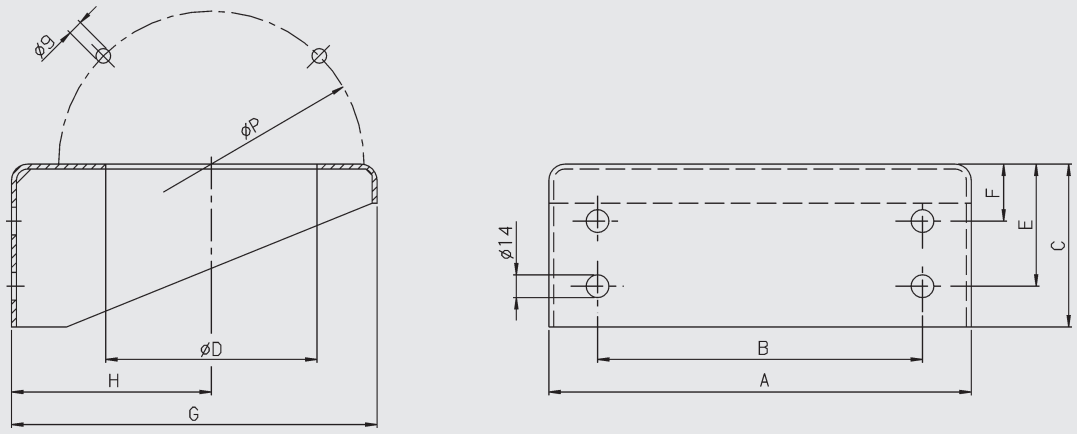
Type	Material	Part no.
–	NBR	–
167		236997
–		–
222		236996
–		–
360		355966

Model/order code (example):

KBK	167	STZN	238526

G	167	NBR	236997

4.2. KMS CONSOLES FOR DIAPHRAGM ACCUMULATOR (SCREW TYPE)



The screw type diaphragm accumulator has threaded bores M8 in the lock nut for fixing to the KMS console.

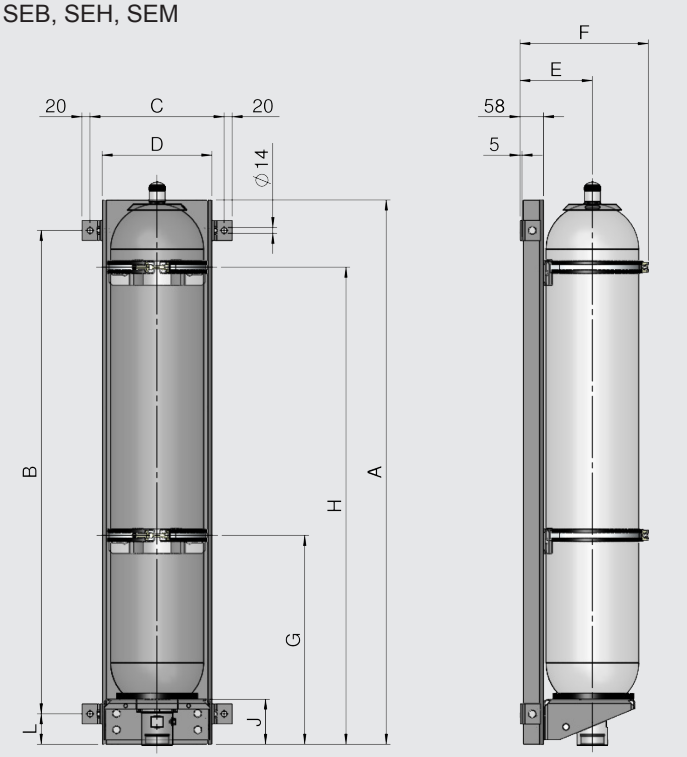
Type	Mat.	Part no.	A [mm]	B [mm]	C [mm]	ØD [mm]	ØP [mm]	E [mm]	F [mm]	G [mm]	H [mm]	ØI [mm]	Weight [kg]
200	STZN	359931	270	180	100	148	160	80	40	250	123	14	6.5
210		358989	260	200		170	180	75	35	225			2.4
220		359922				170	188						
250		359924				192	204						
280		359925	330	220	200	215	230	140	60	340	170	22	18.3
300		359926				220	235						
310		359927				245	265						
320		359928				290	305						

Model/order code (example):

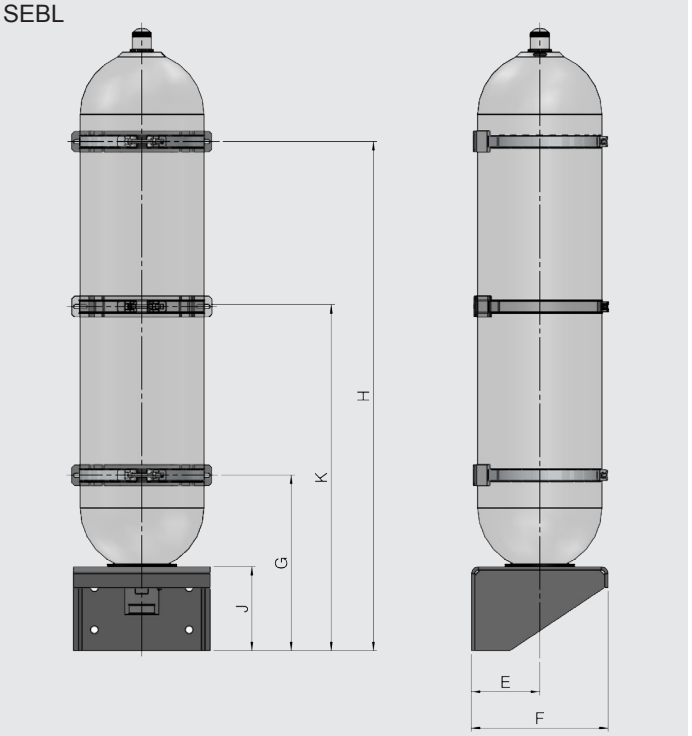
KMS	200	STZN	359931

5. ACCUMULATOR SET FOR BLADDER ACCUMULATORS

SEB, SEH, SEM



SEBL

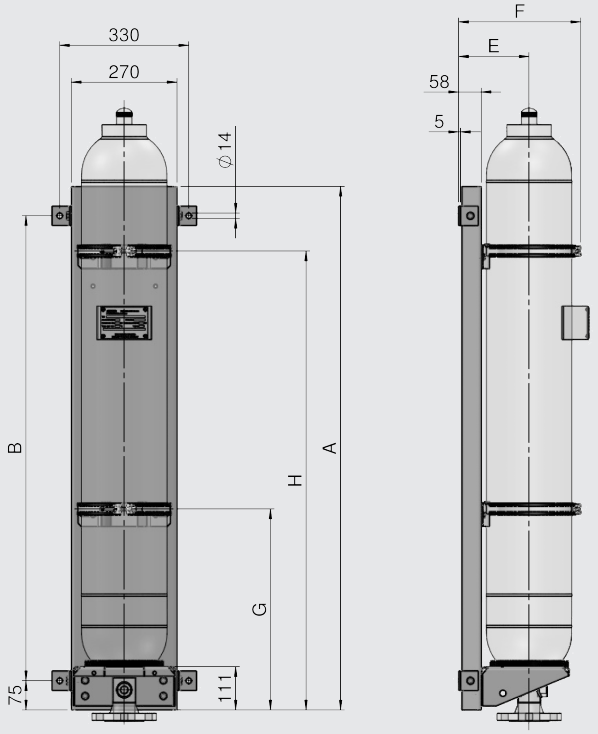


Accumulator set	Part no.	Vol. [l]	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	G [mm]	H [mm]	K [mm]	L [mm]	J [mm]
SEB for SB330/440													
SEB 2.5	290787	2.5	460	310	198	138	133	214	220	410		75	–
SEB 4	238403	4	410	320			152	265		270		45	95
SEB 6	2115851	6								415			
SEB 10	238407	10	570	420	330	270			–	330			
SEB 20	240598	20					180	317		500	–	75	111
SEB 32	238409	32	1340	1190						1160			
SEB 50	240599	50							500				
SEBL 60-80	3605561	60	–	–	–	–	195	390		930		–	240
		80								1200			
SEBL 100-130	372132	100								1450	950		
		130								1750	1100		
SEH for SB500/550/600													
SEH 2.5	2105194	2.5	460	310	198	138	133.5	223	220	410		75	–
SEH 5	2105195	5	750	600						650			
SEH 10	378952	10	570	420	330	270	194	323	–	330	–		111
SEH 20	298181	20								500			
SEH 32	298182	32	1340	1190					500	1160			
SEH 50	298183	50											
SEM for SB40													
SEM 2.5	3007402	2.5	460	310	198	138	121.5	201	220	410		75	–
SEM 5	3007423	5	750	600						650			
SEM 10	3007424	10	570	420	330	270	172	310	–	330	–		111
SEM 20	3007425	20								500			
SEM 32	3007426	32	1340	1190					500	1160			
SEM 50	3007427	50											

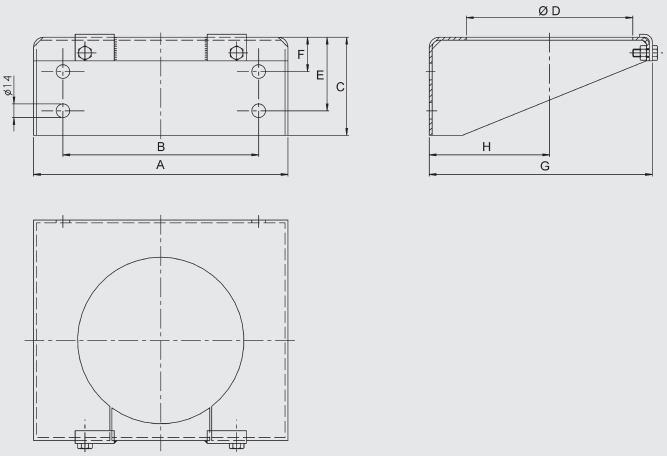
This accumulator set SEB is also available with a SAF and SB330 as a compact unit (ACCUSET SB330).
See catalogue section:

- ACCUSET SB
  No. 3.503

SEHB



KHF 210



	Mat.	Part no.	Vol. [l]	A [mm]	B [mm]	C [mm]	ØD [mm]	E [mm]	F [mm]	G [mm]	H [mm]	L [mm]	J [mm]	Weight [kg]
Accumulator set SEHB for SB35HB														
SEHB 20	–	3007431	20	1340	1190	–	–	172	310	–	500	75	111	–
SEHB 32		3007432	32							500	1160			
SEHB 50		3007433	50											
Console KHF														
KHF 210	STZN	239965	–	260	200	100	170	75	35	230	123	–	–	2.5

Code key (example):

SEB 10	238407

The accumulator sets SEHF/SEHB are supplied with console KHF 210 / G which can be opened at the front for easier installation of the bladder accumulator.

6. 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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E-Mail: speichertechnik@hydac.com

ACCUSET SB

1. DESCRIPTION

The HYDAC accumulator unit ACCUSET SB consists of a bladder accumulator SB, a safety and shut-off block SAF and the appropriate accumulator set SEB. The parts are designed for optimum compatibility and provide a compact, ready-to-install unit.

This space-saving combination simplifies the connection of the accumulator to the hydraulic system, reduces maintenance costs and considerably reduces installation costs.

Advantages:

- Simple and secure mounting of the accumulator at the installation site
- Connection of the accumulator with a hydraulic system via a safety and shut-off block
- Protects the accumulator from excessive pressure
- Discharge of the accumulator to the tank via a pressure release valve
- Separation of the accumulator from the system
- Two additional hydraulic connections on the shut-off block for accessories (e.g. pressure gauge).

1.1. STANDARD BLADDER ACCUMULATOR SB330

With a nominal volume of 1 ... 50 litres.

Special accumulators available on request.

See catalogue section:

- Bladder Accumulators Standard No. 3.201

Please read the Operating Manual! No. 3.201.BA

1.2. SAFETY AND SHUT OFF BLOCK SAF

In nominal sizes 10, 20 and 32, with manual or solenoid-operated/manual discharge and with the direct-acting pressure relief valve DB12 with CE marking, in accordance with the regulations of DIN EN 14359 “Hydraulic accumulators for hydraulic applications” and the European Pressure Equipment Directive (PED).

See catalogue section:

- Safety and Shut-off Block SAF/DSV No. 3.551

1.3. ACCUMULATOR SET SEB

For mounting the bladder accumulator with clamps, back plate, console and rubber support ring.

See catalogue section:

- Supports for Hydraulic Accumulators No. 3.502

2. TECHNICAL SPECIFICATIONS

Design:
European Pressure Equipment Directive (PED) [1)]

Permitted operating pressure:
330 bar [1)]

Bladder material:
The bladder material must be selected in accordance with the particular operating fluid or operating temperature, see table "Operating temperature and operating fluid" on the following page.

If discharge conditions are unfavourable (high p_2/p_0 pressure ratio, rapid discharge speed), the gas may cool to below the permitted temperature. This can cause cold cracking in the elastomer. The gas temperature can be calculated using the HYDAC Accumulator Simulation Program **ASP**.

Pressure limit:
DB12 set to 330 bar [1)]

Release valve:
Operating voltage 24 V DC [1)]

Fluid connection P:
see table section 5.

Surface:
Accumulator primed, SAF block phosphate-plated, accumulator set zinc-plated.

See catalogue section:

- HYDAC Accumulator Technology No. 3.000
- Charging and Testing Unit FPU No. 3.501

[1)] others on request.

Operating temperature and operating fluid:
The permitted operating temperature of a bladder accumulator is dependent on the application limits of the metal materials and the bladder. Outside this temperature range, special materials must be used. The operating fluid must also be taken into account. The following table shows the standard selection of elastomer materials with temperature range and a rough overview of resistant and non-resistant fluids:

Materials		Material code [1]	Temperature range	Overview of the fluids [2]	
				Resistant to	Not resistant to
NBR	Acrylonitrile butadiene rubber	2	-15 °C ... + 80 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the groups HFA, HFB, HFC ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Fuels
		5	-50 °C ... + 50 °C		
		9	-30 °C ... + 80 °C		
ECO	Ethylene oxide epichlorohydrin rubber	3	-30 °C ... +120 °C	● Mineral oil (HL, HLP) ● Flame-resistant fluids of the group HFB ● Synthetic ester (HEES) ● Water ● Sea water	● Aromatic hydrocarbons ● Chlorinated hydrocarbons (HFD-S) ● Amines and ketones ● Hydraulic fluids of the group HFD-R ● Flame-resistant fluids of the groups HFA and HFC ● Fuels
IIR	Butyl rubber	4	-50 °C ... +100 °C	● Hydraulic fluids of type HFD-R ● Flame-resistant fluids of the group HFC ● Water	● Mineral oils and mineral greases ● Synthetic ester (HEES) ● Skydrol and HyJet IV ● Aliphatic, chlorinated and aromatic hydrocarbons ● Fuels
FKM	Fluorine rubber	6	-10 °C ... +150 °C	● Mineral oil (HL, HLP) ● Hydraulic fluids of the group HFD ● Synthetic ester (HEES) ● Fuels ● Aromatic hydrocarbons ● Inorganic acids	● Amines and ketones ● Ammonia ● Skydrol and HyJet IV ● Steam

[1] see section 3. Model code, accumulator bladder/seal material

[2] others available on request

Temperatures exceeding this range (e.g. in the event of an external fire) can result in the accumulator bursting. To prevent this, HYDAC can provide additional temperature fuses and bursting discs, see catalogue section:

● Safety Equipment for Hydraulic Accumulators
No. 3.552

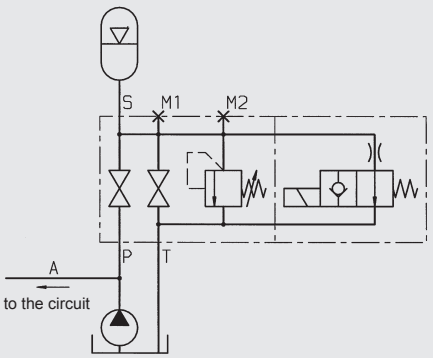
3. MODEL CODE

Not all combinations are possible. Order example.
For further information, please contact HYDAC.

ACCUSET SB 330 – 10 A 1 / 1 1 2 U – 10 Y 1 – 330

Type of accumulator
SB = bladder accumulator
Accumulator series
Nominal volume [l]
Fluid connection
A = standard connection
Gas valve
1 = standard model
Material of fluid connection / block
1 = carbon steel
2 = stainless steel
Shell material
1 = carbon steel
Accumulator bladder/seal material
2 = NBR / NBR
3 = ECO / NBR
4 = IIR / EPDM
6 = FKM / FKM
Certification code
SAF block series
Type of directional poppet valve
M = manual discharge
Y = solenoid-operated and manual discharge (open when de-energised))
Z = solenoid-operated and manual discharge (closed when de-energised)
Type of voltage - directional poppet valve
1 = 24 V DC (only on Y or Z model)
Permitted operating pressure/ cracking pressure of the pressure relief valve [bar]

Circuit diagram

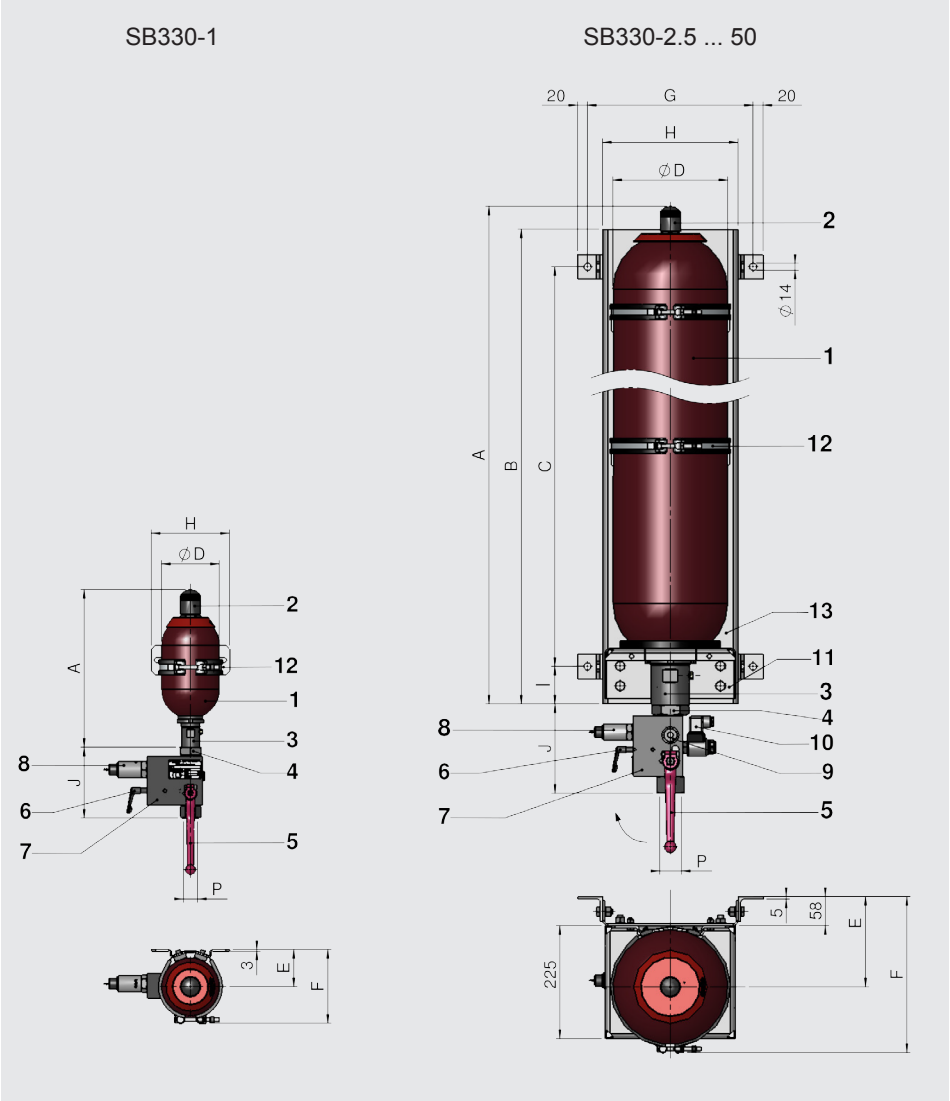


4. PREFERRED MODELS

Designation	Part no.	SB330-1A1/112U-330A	SB330-2.5A1/112U-330A	SB330-4A1/112U-330A	SB330-6A1/112U-330A	SB330-10A1/112U-330A	SB330-13A1/112U-330A	SB330-20A1/112U-330A	SB330-24A1/112U-330A	SB330-32A1/112U-330A	SB330-50A1/112U-330A	SAF10M12T330A	SAF10E12Y1T330A	SAF20M12T330A	SAF20E12Y1T330A	SAF32M12T330A	SAF32E12Y1T330A
ACCUSET SB330-1A1/112U-10M-330	3033471	●										●					
ACCUSET SB330-1A1/112U-10Y1-330	3033472	●											●				
ACCUSET SB330-2.5A1/112U-10M-330	3033473		●									●					
ACCUSET SB330-2.5A1/112U-10Y1-330	3033474		●										●				
ACCUSET SB330-4A1/112U-10M-330	3033475			●								●					
ACCUSET SB330-4A1/112U-10Y1-330	3033476			●									●				
ACCUSET SB330-6A1/112U-10M-330	3033477				●							●					
ACCUSET SB330-6A1/112U-10Y1-330	3033478				●								●				
ACCUSET SB330-10A1/112U-10M-330	3033479					●						●					
ACCUSET SB330-10A1/112U-10Y1-330	3033480					●							●				
ACCUSET SB330-13A1/112U-10M-330	3033481						●					●					
ACCUSET SB330-13A1/112U-10Y1-330	3033482						●						●				
ACCUSET SB330-13A1/112U-20M-330	3033483						●							●			
ACCUSET SB330-13A1/112U-20Y1-330	3033484						●								●		
ACCUSET SB330-20A1/112U-20M-330	3033485							●						●			
ACCUSET SB330-20A1/112U-20Y1-330	3033486							●							●		
ACCUSET SB330-24A1/112U-20M-330	3033487								●					●			
ACCUSET SB330-24A1/112U-20Y1-330	3033488								●						●		
ACCUSET SB330-32A1/112U-20M-330	3033489									●				●			
ACCUSET SB330-32A1/112U-20Y1-330	3033490									●					●		
ACCUSET SB330-32A1/112U-32M-330	3033491									●						●	
ACCUSET SB330-32A1/112U-32Y1-330	3033492									●							●
ACCUSET SB330-50A1/112U-20M-330	3033493										●			●			
ACCUSET SB330-50A1/112U-20Y1-330	3033494										●				●		
ACCUSET SB330-50A1/112U-32M-330	3033495										●					●	
ACCUSET SB330-50A1/112U-32Y1-330	3033496										●						●

Other combinations and models available on request.

5. DIMENSIONS



Description	Item
Accumulator shell	1
Gas valve	2
Oil valve	3
Adapter S	4
Switching handle	5
Release spindle	6
SAF safety block	7
Pressure relief valve	8
Connection for pressure gauge	9
Release valve	10
Console	11
HyRac clamp	12
Back plate	13

Bladder accumulator	A_{max} [mm]	B [mm]	C [mm]	$ØD_{max}$ [mm]	E [mm]	F [mm]	G [mm]	H [mm]	I [mm]
SB330-1 [1]	302	–	–	118	74	147	–	156	–
SB330-2.5 [2]	571	460	310		133	214	198	138	75
SB330-4	440	415	320	173	152	253	330	270	50
SB330-6	560	570	420						75
SB330-10	568			229	180	317			
SB330-13	686								
SB330-20	896								
SB330-24	1062								
SB330-32	1411	1340	1190						
SB330-50	1931								

[1] without back plate and console, with one HyRac clamp 110-118/124 H10 ST
[2] without console, with back plate and two HyRac clamps 110-110/124 H10 ST

SAF series	Nominal size SB330 [l]	P ISO 228	Connection for pressure gauge	J [mm]
SAF	1	G 1/2	2 x G 1/4	142
	2.5			104
	4			113
	6			102
	≥ 10			147
SAF20	2.5	G 1	G 1/4, G 1/2	135
	4			142
	6			132
	≥ 10			178
SAF32	≥ 10	G 1 1/2		203

6. 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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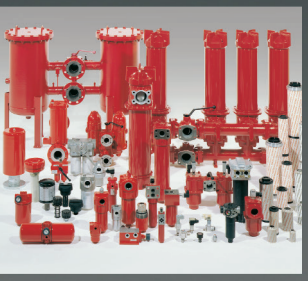

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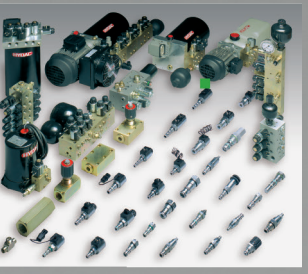

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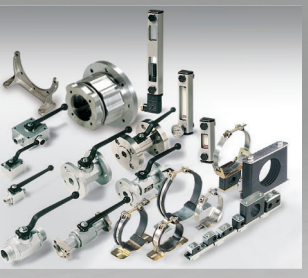

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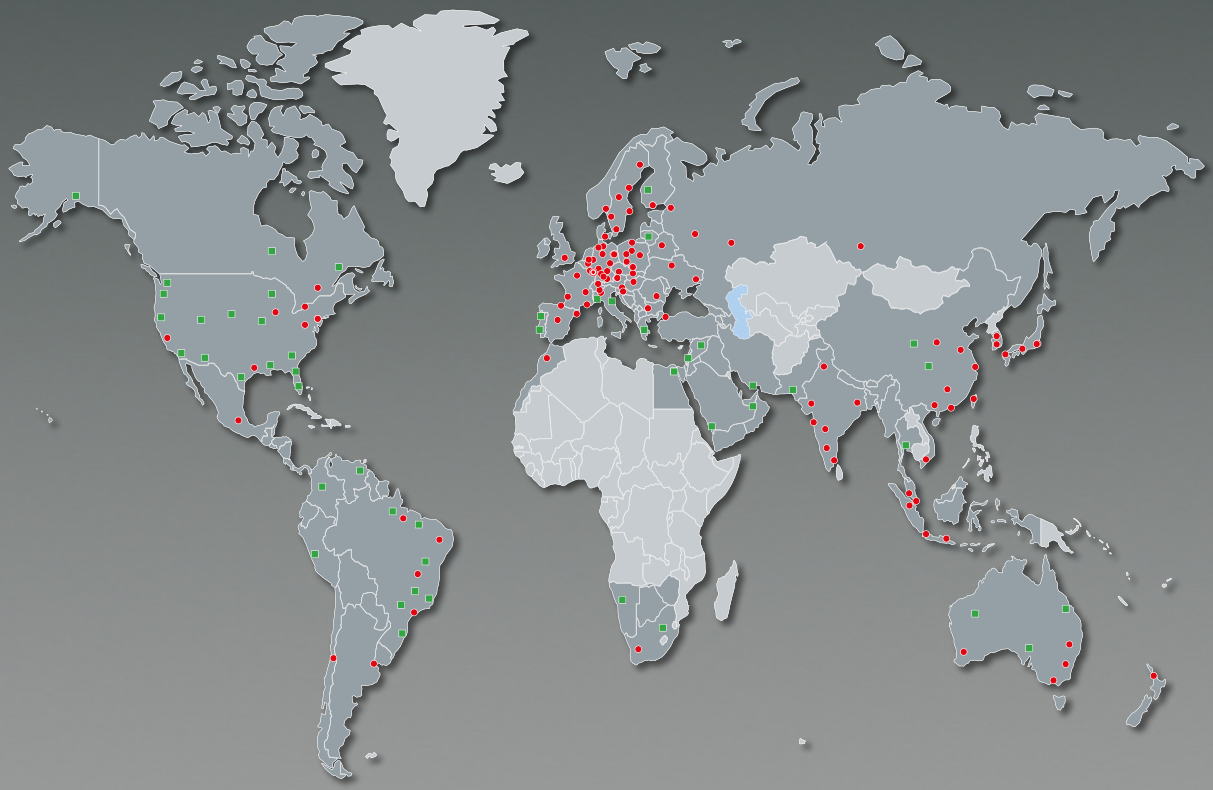

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