TECHNICAL INFORMATION

Individual valves

A solenoid valve is selected most quickly and easily by pursuing a certain order which we describe hereunder:

First of all the application or function of the valve will have to be determined. Then you should Select the seal material required according to the medium and the medium temperature. After having determined the size of the valve by calculation of the KV value you may already select the best suited valve from the data sheets and will then choose the connection thread, the coil type and voltage.

We are giving you the technical information required in the same order as described above.

Note:

Please order the suitable coil for every valve separately according to the data sheet of the respective valve.

Order of selection	Example	Explanation on page
1. Operation	2/2 normally closed	1, 2 and 3
2. Seal material	P for water	4 and 5
3. Valve size	orifice 5, pressure 0-5 bar	5, 6, 7
4. Series	SV 04	see data sheets
5. Connection thread	R 3/8	8
6. Type of coil	M20	8 and 9
7. Operating voltage	230 V/ 50Hz	8 and 9
8. Assembly and maintenance		10

1. Operation of the solenoid valves (function)

1.1 2/2 directional solenoid valves

They have two ways (connections) and two switching positions (on and off). They are used to interrupt or release a flow of liquid or a gaseous medium by remote control and are available in two versions.

Normally closed:

Coil de-energised	Coil energised
Valve closed	Valve open

Normally open:

Coil de-energised	Coil energised
Valve open	Valve closed

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

RAPA

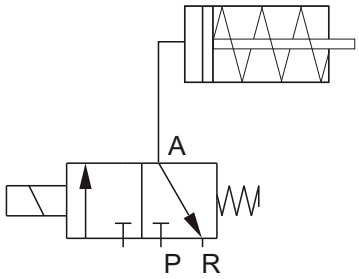
1.2 3/2 directional solenoid valves

They have three connections (ways) and two switching positions.They are used to direct the flow of liquids and gases and are available in four versions.

Operation method A
Cylinder control normally closed
To control single acting cylinders

Solenoid coil de-energised
Cylinder deaerated

Solenoid coil energised
Cylinder pressurised

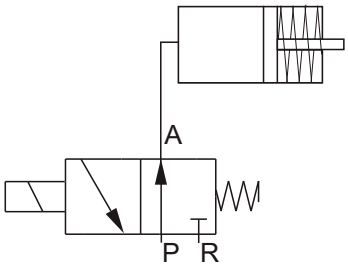


P ....pressure supply
A ... applicant
R ... return (evacuation)

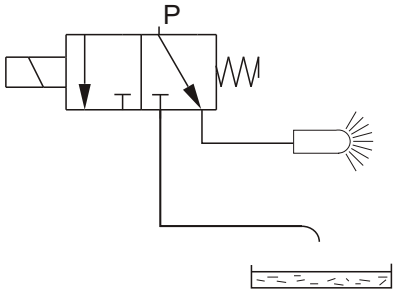
Operation B
Cylinder control normally open

Solenoid coil de-energised
Cylinder pressurised

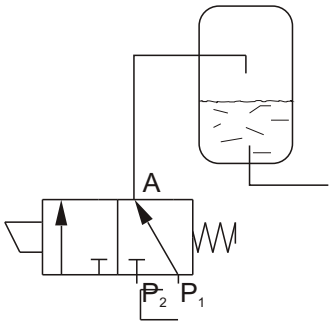
Solenoid coil energised
Cylinder deaerated



Operation C
Distribution of liquid or gas flows from one pressure line towards two appliances



Operation D
Mixing respectively adding of two different media or pressures towards an appliance .



Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

RAPA

2. Control

A solenoid valve is switched on or off by moving the armature. If the armature is directly connected to the seal element (washer, seal or diaphragm) by mechanical coupling, the valve is directly controlled.

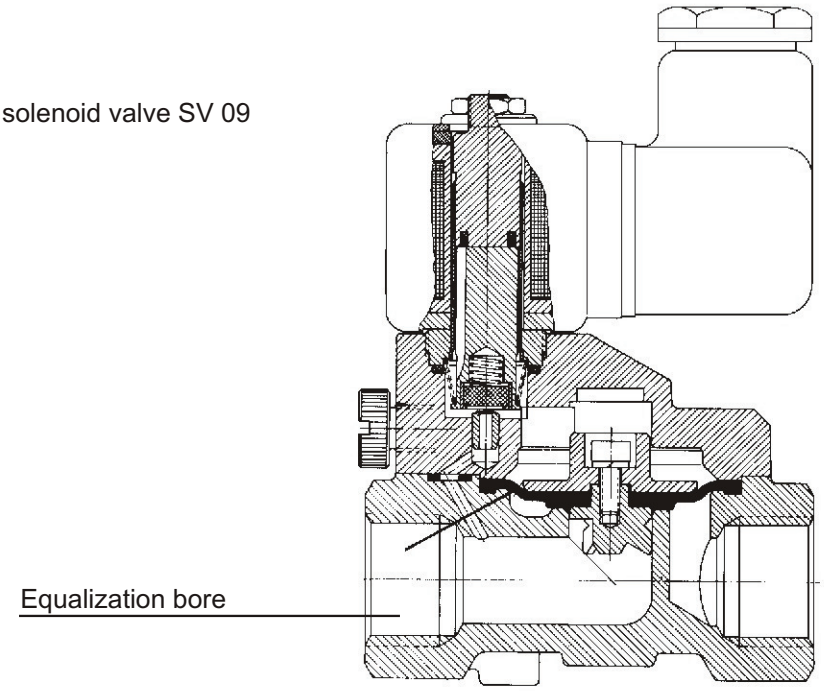
2.1 Directly controlled solenoid valves

The seal element is moved directly by the solenoid system and works independently of the flow conditions, from pressure zero up to a specified maximum service pressure. Directly controlled valves are suited for universal applications and thanks to their simple construction they are robust and very competitive in price. Their main applications are small nominal widths up to 10mm.

2.2 Pilot controlled solenoid valves

The pressure drop between inlet and outlet of the valve is used by a diaphragm or piston to operate the seal element. With de-energised solenoid coil the inlet pressure comes in through the equalizing bore to the space above the diaphragm and presses it firmly onto the seat as shown in the fig. below (fig. 1 - SV09) . When the solenoid opens the pilot channel the pressure above the diaphragm decreases. The diaphragm is therefore lifted by the inlet pressure and the valve opens. Full opening is obtained only when the minimum working pressure (differential pressure) at all working conditions is not smaller than the value given in the catalogue.

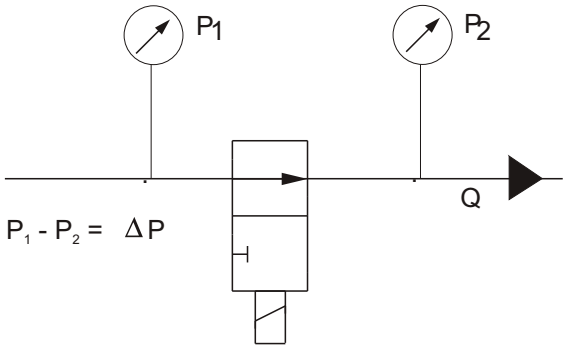
Fig.1
Section of a solenoid valve SV 09



Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

fig. 2
Test arrangement



The Kv value is to be calculated from the measured values as follows>

Formula 1 $$Kv = Q \cdot \sqrt{\frac{\varrho}{\Delta p}}$$

Check calculation by $$\Delta p = \frac{Q^2}{Kv^2} \cdot \varrho$$

$$Q = Kv \cdot \sqrt{\frac{\Delta p}{\varrho}}$$

Flow	Q	....	(l/min)
Pressure drop	Δp	....	(bar) $p = p_1 p_2$
Density	ϱ	....	(g/cm 3)
Kinematic viscosity	ν	....	(mm 2)

For media of viscosities exceeding 20 ($mm^2 s^{-1}$), the Kv value must be multiplied by a corrective factor to obtain the needed value (Kv_{tat}).

Formula 2 $$Kv_{tat} = KV \cdot c$$

Formula 3 $$c = \frac{\nu \cdot \sqrt{Kv}}{200 \cdot Q} + 1$$

Correction factor
for viscosity exceeding 20 ($mm^2 s^{-1}$)

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

RAPA

3. Materials
All materials used on RAPA solenoid valves are selected, tested and processed according to the medium, function and environment required.
For standard valves the following metals are used for those parts that are in contact with the medium:

Valve body	pressed brass Cu Zn 39 Pb 3 F37 or machined from Cu Zn 40 Pb 2 F 44
Armature/Core and adjusting ring:	1.4104 (stainless steel as per DIN 17440)
Guide tube:	1.4301 “
Valve seat:	1.4305 “
Springs:	1.4310 “
Sleeve:	1.4104 “
Short circuit ring:	Cu

For aggressive media the d.c. valves may be made completely from stainless steel. a.c. valves require a short circuit ring of copper or silver.
Non-metal materials are used for O-ring seals, the armature seal and for some special body types.
Armature seal and O-rings have to be adapted to the medium, the medium temperature and the pressure. Suitable seals are shown for the most important media hereunder.
The materials indicated refer to the armature seals.
The O-ring material is automatically adapted accordingly.

Seal materials for RAPA valves:

Medium	Medium temperature °C	Designation as per ASTM D1418-72a	trade mark of the material	RAPA Code	Note
Cold water, purified benzine, water, heating oil, paraffine, kerosine, motor oils, soap solutions, synthetic detergents, brine, air, argon, hydrogene gas, natural gas, Co2, laughing gas, methane, propane	-15 to +60	NBR	Perbunan	P	for universal use up to 20 bar
Benzol, hot water, trichlo-ethylene, perchlo-ethylene, methyl-alcohol, gaseous and liquid chlorine, benzine-benzole mixtures	-20 to +100	FKM	Viton	V	for many aggressive media up to 15 bar

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

RAPA

Medium	Medium temperature °C	Designation as per ASTM D1418	Trade mark of material	RAPA code	Notes
Hot water, steam brake fluid, ethyl-and methyl-alcohol, photographic liquids, ozone	-10 to +130	EPDM	Ethylen Propylene	E	especially hot water and steam up to 18 bar
Heating oil, hydraulic oils H, H-L and H-LP, clean air, oiled air	-10 to +70	-	-	K	in particular hydraulic oils and high pressures up tor 150 bar
Hot heavy oil, steam hydraulic oils	-20 to +140	synthetic ruby	Ruby	R	for high pressures Up to 30 bar
Mineral oils, heating oil	-10 to +70	-	-	L	special applications Long life time
Refrigeration media, steam, acids and lyes	-40 to +180	PTFE	Teflon	T	limited use due to special characteristics

If you have to use a medium that is not mentioend above, please enquire accordingly indicating the exact details of the medium to be used as well as its temperature and the service pressure. If you have made already good or bad experience with certain materials, please tell us. This information will help us to quote earlier.

4. Valve sizes

The right valve size is very important. Too large valves will cause unnecessary high costs. Too small valves will have insufficient flow capacity and cause problems in the plant. The most important factors of selecting the right valve size are the maximum and minimum flow required, the maximum and minimum pressure drop in the valve as well as density and viscosity of the medium.

4.1 Valve dimensions for liquid media

The basic value to select a valve is the Kv value. It is measured according to the VDI/VDE standard 2173 for each valve and is given in the catalogue sheets for every nominal bore diameter. In addition to this method also the dimension (l/min) may be used up to 25mm nominal bore diameter.

The Kv value has to be calculated according to the service data of the plant into which the solenoid valve has to be mounted. Is this value available the valve size is found.

The following data are required to calculate the Kv value:

- the flow required
- the max. admissible pressure drop
- the medium density (only if substantially different from 1/water)

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

RAPA

4.2 Valve dimensions for gaseous media

As for liquid media the Kv value must be determined from the service data of the plant.

The following values are required:

Flow	Q	Nl/min
Pressure drop	Δp	bar
Absolute outlet pressure	p_2	bar
Absolute inlet pressure	p_1	bar
Gas density	ϱ	kg/m 3
Absolute gas temperature	T	K = (°C + 263)

Formula 4
(according to Früh “Control technics 6/57”)

$$Kv = \frac{Q}{512 \cdot \sqrt{\frac{\Delta p \cdot p_2}{\varrho \cdot T}}}$$

This relation applies for $\Delta p \leq 0{,}6\ p_1$

If Δp becomes larger than 0,6 p
formula 5 will be applied

$$Kv = \frac{2 \cdot Q \cdot \sqrt{\varrho \cdot T}}{512 \cdot p_1}$$

4.3 Nominal width and service pressure

Has the Kv value been determined, the suitable valve size be selected directly from the catalogue sheet, taking into account that the admissible service pressure must not be exceeded. The service pressure designates the difference between inlet and outlet pressure at the open or closed valve (fig. 2).

Should the calculated Kv value not allow to obtain the service pressure required for the model in question, you may try another way:

Practical test with a small inside diameter (Kv value);
Use a solenoid coil with shortened duty cycle;
maybe other seal material will be required.

The service pressure indicated in the data sheets has been determined by the capacity of the solenoids considering the strength of the armature seal. That is why for equal orifices often different service pressures are indicated.

Selecting valves by their orifices is much more incertain than selecting them by their Kv values. Different constructions will result in essentially different flow values even for equal orifices.
A comparison of the valves by their Kv value is also only precise for water and a pressure drop of 1 bar.

The conversion of Kv values with different dimensions is possible with the following facts:

Kv (l/min)	= 16,7 x Kv (m^3/h)	
Kv (m^3/h)	= 0,06 x Kv (l/min)	
Cv (Gal/min)	= 0,07 x Kv (l/min)	(common in the USA)
Kv (l/min)	= 14,3 x Cv (Gall/min)	(common in the USA)

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

RAPA

5. Connection thread

All series valves are equipped with an inside threading as per ISO 228/1. It is recommended to adapt connection thread and nominal width (orifice) by means of table 2:

Table 2 Dimensions of the connection threads

Rated orifice mm	Kv value l/min	Connection thread
1	0,7	R 1/8
1,5	1,3	R 1/8
2	2	R 1/8
2,5	2,7	R 1/8, R 1/4
3	3,7	R 1/4
4	5	R 1/4
5	8	R 1/4, R 3/8
6	10	R 1/4, R 3/8
7	18	R 1/4, R 3/8
10	26	R 3/8, R 1/2
12	40	R 1/2
20	150	R 3/4
25	185	R 1

The dimensions of the connection thread correspond largely to BSP and ISO 228/I.
Too small connections may reduce the Kv value, too large ones will require unnecessary expenditure for the screwings.

6. Solenoid coils

Like the careful selection of the valve also that of the coil is essential for the function and the efficiency of the valve. See data sheet “Solenoid coils”.

Structural design

It is recommended to select the structural shape first according to the connection mode required (plug or calbe), taking into account arguments like after-sales service, space required, assembly effort, earth connection.

7. Service voltage and temperature rise

For selecting the service voltage please keep to the versions offered in the data sheet. The valveswill work without problems within a range of +/- 10% or 10/-15% of the nominal voltage. On permanent use temperatures up to 145°C will arise inside the solenoid coil so that temperatures up to 90°C will arise at the outer surface of the solenoid coil. As the unsulating material is temperature resistant up to 155 resp. 170°C there is no risk that the ocil will break down. In case of serial mounting with small distances good ventilation must be ensured. Moreover, individual valves must not be encapsulated in narrow housings to avoid any heat build-up. Please enquire with us in such casses.

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

TECHNICAL INFORMATION
Individual valves

If solenoid coils are to be used under alternating voltages 50Hz and 60Hz this will involve a capacity reduction in the 60Hz range. 2/2 NC valves may be used in nearly all cases only for about 60% of their service pressure. From the electrical values every coil designed for 50Hz may be operated with 60Hz and with a 10% higher nominal voltage. A solenoid coil of 110V/50Hz may thus be operated with nominal voltage 110V/60Hz or 120V/60Hz.

7.1 Switching frequency

The admissible switching frequency for directly controlled valves is 1200 operations per hour, for pre-controlled valves 600 operations per hour. Short-term also higher values are allowed. Please consider the service life indicated.

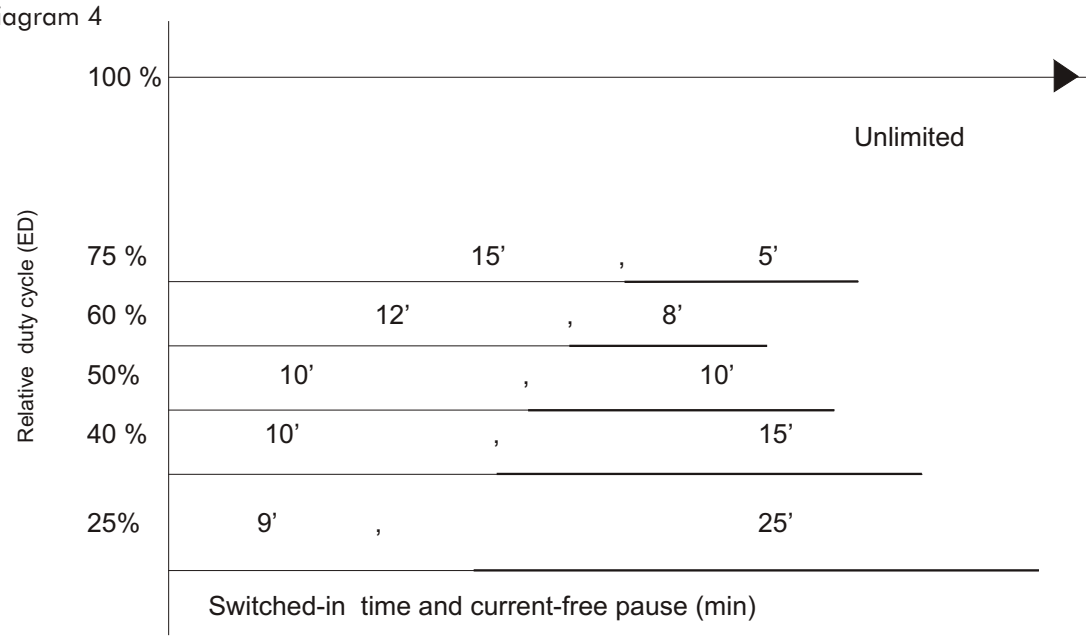
7.2 Intermittend and short-term service

Upon switching on the service voltage the solenoid coil reaches its final temperature after about 30-80 minutes. If in a special application a shorter switch-in time is required (for example 10 minutes - but please do not confuse with the duty cycle) the magnetic capacity may be increased by reinforcing the solenoid coil. In order to avoid any overload of the coil, regular pauses must be included to allow the coil to cool down.

$$\frac{\text{Switched-in time(coil excited)} \cdot 100}{\text{Cycle period (coil excited + pause)}} = \text{relative duty cycle \% ED}$$

It is essential that the switched-in perod indicated will not exceed the time indicated in diagram 4 and that after every operation the current-free pause will follow.

Diagram 4



If the maximum admissible switched-in time is not completely used, also the current-free pause may be shortened accordingly.

I.e. 40% ED: switched-in time only 5 min., Current-free pause required 7,5 min.

VV-ip/30.06.2005/001
Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com

8.Assembly and maintenance

Before mounting: Check the valve as to possible transport damages; compare the operating voltage and the pressure conditions with the data on the plate; in case of contaminated media build in a filter in front of the valve.

Fitting position

The valves may be mounted in every position, but in order to avoid deposits of contaminated media in the guide tube we recommend upright position (solenoid coil on top).
The valve should be protected against impact and oscillation stress especially towards the axle of the coil.

Mounting

Mount the valve with flow in direction of the arrow.
Pay attention that no chips or sealing material enter the valve.
When screwing the valve down , set the key at the surfaces of the valve body!
Never use the solenoid coil as lever!
Connect the valve electrically, observing the national standards.
Please use the rectifier plug if one is added to the coils.
All RAPA solenoid valves are tested in the factory and are maintenance-free if mounted in the right way.
Should, nevertheless, problems arise they are in most of the cases caused by contaminated media. In such cases send us the valve or carefully open and clean it on your own.

Attention! Solenoid coils must be connected to alternating voltage only if mounted to the valve. Otherwise they risk to be overheated. The solenoid coil may also overheat or even be destroyed because of stuck armatures (due to contamination in the guide tube or to damages thereof).

Are the valves used in pneumatics applicaitons it is recommended to slightly oil the air. This will essentially extend the life time of the valve.

Rausch & Pausch GmbH • Albert-Pausch-Ring 1 • 95100 Selb
Tel. (+49) 09287 884-0 • Fax (+49) 09287 884-220 • kc@rapa.com • www.rapa.com