bürkert
FLUID CONTROL SYSTEMS

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Product Overview

# Solenoid Control Valves

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## Content



# Technology of Solenoid Control Valves

Bürkert has been hard at work on controlling and metering fluids for more than 60 years. Anyone focussing so much on fluid substances for so long will always also learn about their own attributes. Bürkert engineers are extremely practical in interpreting their experiences with fluids, and in the development of increasingly more efficient products, they work in accordance with the “what flows, flows in” principle. So the results of internal research, market requirements, feedback and specific customer orders, for example, are all integrated.

30,000 products have now been developed, resulting in a powerful complete catalogue. You will find a small portion of this impressive product range in this Solenoid Control Valve brochure. We claim market leadership in this segment. But let’s turn towards the technology and applications of solenoid control valves, often also called proportional valves.

Solenoid control valves are electromagnetic plunger valves which control flow rates of liquids or gases. They open with certain stroke positions – dependent on the valve control signal. Two forces counter one another in the valve: the spring force and the force by a proportional solenoid. Without a power supply the spring pushes the plunger directly on to the valve seat, which keeps the valve outlet closed. But when power is supplied to the solenoid, the plunger rises. The valve opens, and the fluid passes off.

You will find solenoid control valves in electronic devices in analytical or medical technology, in burner controls, in cooling loops, in fuel dosing systems, in fuel cell technology and in compact flow controllers. Everywhere these valves convince others by reliability and accuracy.

With their simple, direct-acting design for closed control loops Bürkert solenoid control valves are small, compact and cost-optimized. But even more: Our latest generation of solenoid control valves impresses through precision, less noise emission, sensitivity and long life.

In this catalogue we would like to present our products to you – products together with their respective features, functionalities and areas of application. On the other hand – please consider this brochure as a kind of snapshot taken at the current status of solenoid valve technology, because Bürkert is continuously on the move. After all, Bürkert will never stop measuring and controlling everything that flows.

# Welcome to the Fascinating World of Fluid Control Systems

Measurement and control: When it comes to working with liquids and gases, we are at your side – as a manufacturer of sophisticated products, as a problem-solver with an eye for the big picture, and as a partner offering you reliable advice. Since we started in 1946, we have developed into one of the world's leading suppliers of Fluid Control Systems. At the same time we have kept our status as a family-owned business with a foundation of strong basic values to highlight the way we think and act.

## EXPERIENCE

There are things which are not inherently yours. You have to gather them bit by bit. You receive them from others. And you constantly have to acquire them anew. That is what makes them so valuable. Experience is one of those things. For instance, because of our many years of experience with system solutions based on solenoid control valve technology, we can provide our extensive services to you – from consulting, development, and 3D CAD simulating to testing and after-sales service. Whether individual product solutions or a pioneering new system for the entire control process: Benefit from our experience!

## COURAGE

Those who only work toward optimizing things that already exist will eventually reach the limits – technically, financially, or personally. In order to overcome these limits, courage is needed: the courage to be different and trust one's own ideas; the courage to venture into the unknown, searching for new ways to develop products that have never existed before. We have this courage. By pooling and utilizing our competencies across all sectors, you benefit from our cumulative knowledge in controlling gases and liquids.

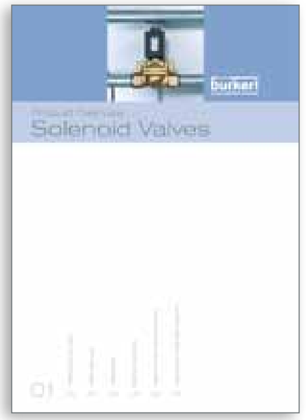
## CLOSENESS

There are things we simply take for granted. Only when they are gone, do we realize how important these things really were. This applies in particular to closeness. Without closeness, it is very difficult to build relationships and a good understanding of one another. As an established medium-sized company, we know that. And that is why we are always there for you. Working with you, we develop the best possible solutions for your projects in the area where gases or liquids have to be controlled. Our global presence in 35 locations enables us to press ahead with technical innovations for our customers around the world.



# Bürkert Product Program

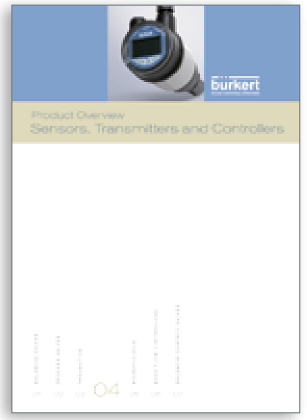
We are one of the few suppliers on the market to cover the complete control loop. Our current product range extends from solenoid valves through process and analytical valves to pneumatic actuators and sensors.




*Bürkert offers a remarkable range of servo-assisted and direct acting solenoid valves. Read more about them in this brochure.*


*Bürkert offers unlimited modularity for process control with angle-seat, globe and diaphragm valves in the widest range of configurations.*


*Here you can find our product range of pneumatic valves, valve units and automation systems as well as information on our control cabinet building.*




*Here you can find our sensors, transmitters and controllers for measuring and controlling flow, temperature, pressure, level, pH/ORP and conductivity.*

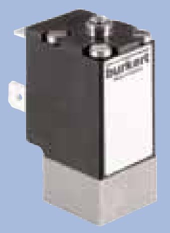
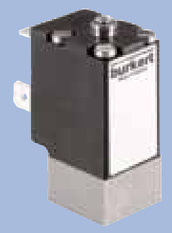

*The brochure contains an overview of Bürkert miniature valves and micro pumps, which allow for precise and safe handling of small volumes of liquids.*


*This brochure provides technical background information as well as a detailed product overview for the mass flow controller and meter product range.*


*This brochure presents our solenoid control valves including their respective features, functions and typical applications.*

# Product Overview

1) *For liquids only*
2) *See pages 10-13 for the respective flow rate performance*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| Type | 2822 MicroFLOW | 2824 | 2833 | 2835 | 2836 | 6024 Low-Δp | 6223 HighFLOW 1) |
| Operating principle | Plunger directly on valve seat (NC) | Plunger directly on valve seat (NC) | Plunger directly on valve seat (NC) | Plunger directly on valve seat (NC) | Plunger directly on valve seat (NC) | Plunger directly on valve seat (NC) | Plunger directly on servo pistons (NC) |
| Design feature | Dual flat spring | Single flat spring | Single flat spring | Single flat spring | Slide ring | Slide ring | Servo-assisted |
| Width of solenoid | 20 mm | 20 mm | 32 mm | 49 mm | 72 mm | 49 mm | 32-43 mm |
| Max. power consumption | 2 W | 5 W | 9 W | 16 W | 24 W | 18 W | 8-15 W |
| Orifice sizes 2) | 0.05-1 mm | 0.8-2 mm | 0.8-4 mm | 2-8 mm | 3-12 mm | 8-12 mm | 10-20 mm |
| Repeatability | 0.25 % of F. S. | 0.25 % of F. S. | 0.5 % of F. S. | 0.25 % of F. S. | 1 % of F. S. | 0.5 % of F. S. | 1 % of F. S. |
| Sensitivity | 0.1 % of F. S. | 0.25 % of F. S. | 0.25 % of F. S. | 0.25 % of F. S. | 0.5 % of F. S. | 0.5 % of F. S. | 1 % of F. S. |
| Span | 0.2-100 % | 1-100 % | 1-100 % | 1-100 % | 4-100 % | 4-100 % | 10-100 % |
| Response time | <10 ms | <20 ms | <20 ms | <50 ms | <100 ms | <50 ms | <200 ms |
| Valve material | Brass, stainless steel | Brass, stainless steel | Brass, stainless steel | Brass, stainless steel | Brass, stainless steel | Brass, stainless steel | Brass, stainless steel |
| Sealing material (typ.) | FKM, EPDM | FKM, EPDM | FKM, EPDM | FKM, EPDM | FKM, EPDM | FKM | FKM |
| Port connection | 1/8", sub-base | 1/8", sub-base | 1/8", 1/4", sub-base | 3/8", 1/2" | 1/2", 3/4" | 1/2", 3/4" | 3/8", 1/2", 3/4", 1" |
| Typical application | – Medical and analytical equipment<br>– Waste gas treatment | – Medical and analytical equipment<br>– Burner controls<br>– Fuel cell technology<br>– Plasma control<br>– Powder coating | – Burner controls<br>– Waste gas treatment<br>– Inert gas dosing<br>– Plasma control<br>– Vacuum control<br>– Fuel dosing | – Fuel cell technology<br>– Test stand technology<br>– Burner controls<br>– Vacuum control<br>– Filling level control | – Cooling<br>– Inert gas dosing | – Combustion gas dosing<br>– Forced air throttling | – Cooling/heating circuits<br>– Water dosing |

# Control Electronics for Solenoid Control Valves

| |  |  |
|---|---|---|
| Type | 8605 | 8611 |
| Function | Digital PWM control | Digital PI controller,<br>two-position controller |
| Versions | Rail or valve mounting | Fitting, wall, panel,<br>rail or valve mounting |
| Signals | – Set point<br>(0-5 V, 0-10 V, 0-20 mA, 4-20 mA)<br>– PWM output<br>(80 Hz-6 kHz) | – Set point<br>(0-10V or 4-20mA)<br>– Actual process value<br>(4-20mA)<br>– Sensor input<br>(4-20mA, Pt100 or frequency) e. g., pressure, temperature or flow<br>– Control output signal<br>(4-20mA or PWM)<br>– Binary input<br>– Binary output |
| Operating voltage | 12, 24 VDC | 24 VDC |
| Max. power consumption | 1 W (without valve) | 2 W (without valve) |
| Valve outlet | Max. 2 A (PWM) | Max. 2 A (PWM) |
| Software functions | – Valve setting<br>(frequency, min./max. opening)<br>– Zero point cut-off<br>– Temperature compensation<br>– Ramp function<br>– Down-/upload of parameterization | – Controller setting<br>– Configuration of switching (binary) signals<br>– Scaling of set point and process value signals<br>– Valve and sensor setting<br>– Code protection<br>– etc. |



# Precise and Repeatable Results with Solenoid Control Valves

| Feature | Benefits |
|---|---|
| Simple, compact and direct-acting,<br>without position feedback | Cost-effective design,<br>Very fast reaction |
| Guiding of plunger with flat spring | Extremely good repeatability resulting in reliable setting of processes again and again,<br>Very good sensitivity, high span |
| Epoxy resin moulded coil,<br>tight encapsulation of the valve system | High protection class (IP 65),<br>safety |
| PWM control | Lower hysteresis,<br>Static friction prevented,<br>Very good response sensitivity |
| Seat seal integrated in the plunger | Close tight function,<br>no additional shut-off valve required |

# Valve Selection

1) For an explanation of $k_{Vs}$ value and $c_V$ value and sizing please see page 22

2) Max. differential pressure allowed: 3 bar

| $k_{Vs}$ [m³/h]/ $c_V$ [US Gal/min] 1) | DN | Max. operating pressure [bar/psi] | | | | | | | | | | | | | | | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [mm] | 0 | 0.2 / 2.9 | 0.4 / 5.8 | 0.5 7.2 | 0.7 / 10.1 | 1 / 14.5 | 1.5 / 21.7 | 2 / 29.0 | 3 / 43.5 | 3.5 / 50.7 | 4 / 58.0 | 5 / 72.5 | 6 / 87.0 | 8 / 116.0 | 10 / 145.0 | 12 / 174.0 | 16 / 232.0 | 25 / 362.6 | | |
| 0.00006 / 0.00007 | 0.05 | | | | | | | | | | | | | | | | | | | MicroFLOW  | 2822 |
| 0.00025 / 0.00029 | 0.1 | | | | | | | | | | | | | | | | | | | | |
| 0.0010 / 0.0011 | 0.2 | | | | | | | | | | | | | | | | | | | | |
| 0.0020 / 0.0023 | 0.3 | | | | | | | | | | | | | | | | | | | | |
| 0.0040 / 0.0046 | 0.4 | | | | | | | | | | | | | | | | | | | | |
| 0.010 / 0.011 | 0.6 | | | | | | | | | | | | | | | | | | | | |
| 0.018 / 0.021 | 0.8 | | | | | | | | | | | | | | | | | | | | |
| 0.027 / 0.031 | 1.0 | | | | | | | | | | | | | | | | | | | | |
| 0.018 / 0.021 | 0.8 | | | | | | | | | | | | | | | | | | |  | 2824 |
| 0.027 / 0.031 | 1.0 | | | | | | | | | | | | | | | | | | | | |
| 0.038 / 0.044 | 1.2 | | | | | | | | | | | | | | | | | | | | |
| 0.055 / 0.064 | 1.6 | | | | | | | | | | | | | | | | | | | | |
| 0.090 / 0.105 | 2.0 | | | | | | | | | | | | | | | | | | | | |

| $k_{Vs}$ [m³/h]/ $c_V$ [US Gal/min] 1) | DN | Max. operating pressure [bar/psi] | | | | | | | | | | | | | | | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [mm] | 0 | 0.2 / 2.9 | 0.4 / 5.8 | 0.5 7.2 | 0.7 / 10.1 | 1 / 14.5 | 1.5 / 21.7 | 2 / 29.0 | 3 / 43.5 | 3.5 / 50.7 | 4 / 58.0 | 5 / 72.5 | 6 / 87.0 | 8 / 116.0 | 10 / 145.0 | 12 / 174.0 | 16 / 232.0 | 25 / 362.6 | | |
| 0.018 / 0.021 | 0.8 | | | | | | | | | | | | | | | | | | |  | 2833 |
| 0.04 / 0.047 | 1.2 | | | | | | | | | | | | | | | | | | | | |
| 0.06 / 0.07 | 1.5 | | | | | | | | | | | | | | | | | | | | |
| 0.10 / 0.12 | 2.0 | | | | | | | | | | | | | | | | | | | | |
| 0.15 / 0.18 | 2.5 | | | | | | | | | | | | | | | | | | | | |
| 0.22 / 0.26 | 3.0 | | | | | | | | | | | | | | | | | | | | |
| 0.32 / 0.37 | 4.0 | | | | | | | | | | | | | | | | | | | | |
| 0.12 / 0.14 | 2.0 | | | | | | | | | | | | | | | | | | |  | 2835 |
| 0.25 / 0.29 | 3.0 | | | | | | | | | | | | | | | | | | | | |
| 0.45 / 0.52 | 4.0 | | | | | | | | | | | | | | | | | | | | |
| 0.80 / 0.93 | 6.0 | | | | | | | | | | | | | | | | | | | | |
| 1.10 / 1.28 | 8.0 | | | | | | | | | | | | | | | | | | | | |

# Valve Selection

1) *For an explanation of $k_{Vs}$ value and $c_V$ value and sizing please see page 22*
2) *Max. differential pressure allowed: 3 bar*

| $k_{Vs}$ [m³/h]/ $c_V$ [US Gal/min] 1) | DN | Max. operating pressure [bar/psi] | | | | | | | | | | | | | | | | | | | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | [mm] | 0 | 0.2 / 2.9 | 0.4 / 5.8 | 0.5 7.2 | 0.7 / 10.1 | 1 / 14.5 | 1.5 / 21.7 | 2 / 29.0 | 3 / 43.5 | 3.5 / 50.7 | 4 / 58.0 | 5 / 72.5 | 6 / 87.0 | 8 / 116.0 | 10 / 145.0 | 12 / 174.0 | 16 / 232.0 | 25 / 362.6 | | |
| 0.25 / 0.29 | 3.0 | | | | | | | | | | | | | | | | | | |  | 2836 |
| 0.40 / 0.46 | 4.0 | | | | | | | | | | | | | | | | | | | | |
| 0.90 / 1.05 | 6.0 | | | | | | | | | | | | | | | | | | | | |
| 1.5 / 1.7 | 8.0 | | | | | | | | | | | | | | | | | | | | |
| 2.0 / 2.3 | 10.0 | | | | | | | | | | | | | | | | | | | | |
| 2.5 / 2.9 | 12.0 | | | | | | | | | | | | | | | | | | | | |
| 1.4 / 1.6 | 8.0 | | | | | | | | | | | | | | | | | | | Low-Δp  | 6024 |
| 2.0 / 2.3 | 10.0 | | | | | | | | | | | | | | | | | | | | |
| 2.8 / 3.2 | 12.0 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 1.4 / 1.6 | 10.0 | | | | | | | | | | | | | | | | 2) | | | HighFLOW  | 6223 |
| 2.5 / 2.9 | 13.0 | | | | | | | | | | | | | | | | 2) | | | | |
| 5 / 5.8 | 20.0 | | | | | | | | | | | | | | | | 2) | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |

*Note:*
*- All valves for medium temperatures of -10 to +90 °C*
*- Typical power supply 24V DC*
*- All valves offer protection class IP 65*
*Generally valid:*
*The bigger the valve orifice, the lower the maximum possible operating pressure at which the valve closes tight*


# Setup and Functioning of Solenoid Control Valves

Control valve, control armature, metering valve: the terms might be different – but it is the same product that they actually mean. In process-related practical use these components are usually called control valves, and the name refers to their function. They control and regulate the rate of flowing media (fluids). Control valves are operated in different ways: pneumatically, electro-motorized, piezo-electrically and electro-magnetically.

The various drive principles essentially differ in price, size, type of media separation, dynamics and force properties.

Electro-magnetically activated control valves are called "solenoid control valves" or "proportional valves", which cover the orifice range below 12 mm (direct-acting valves) and 8-25 mm (servo-assisted valves). Solenoid control valves are used as metering valves in closed control loops. The valve eliminates the difference here between the reference and actual value of the mapped process value (see fig. 1). However solenoid control valves – depending on valve type and application – are also used in open control loops in which the valve is operated without any feedback of the actual process value.

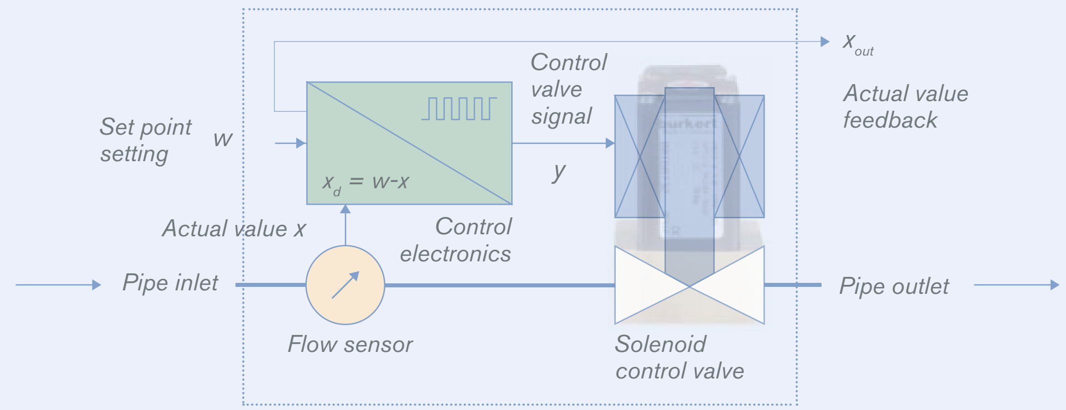



*Fig. 1: Schematic diagram of a closed control loop*

Solenoid shut-off valves are the basis for Bürkert solenoid control valves. Without electrical power the spring forces the plunger directly on the valve seat. With that the valve is closed. Electrical current through the solenoid (coil) causes a magnetism which lifts the plunger against the spring force. The valve opens. With constructive changes in the solenoid shut-off valves, a balance between spring and magnetic force can be produced for any coil current. The intensity of the coil current or the magnetic power influences both the stroke of the plunger and the valve's opening degree, whereby valve opening (flow rate) and coil current (control signal) are ideally linear dependent on one another (see fig. 2).

The flow direction in direct-acting solenoid control valves is typically from below seat. The medium flowing in from below presses together with the generated magnetic force against the tension force of the return spring, pressing from above. For this reason alone it makes sense to set the minimum and maximum flow rate value of the working range (coil current) under operating conditions. Bürkert solenoid control valves are closed without electrical power (NC, normally closed).

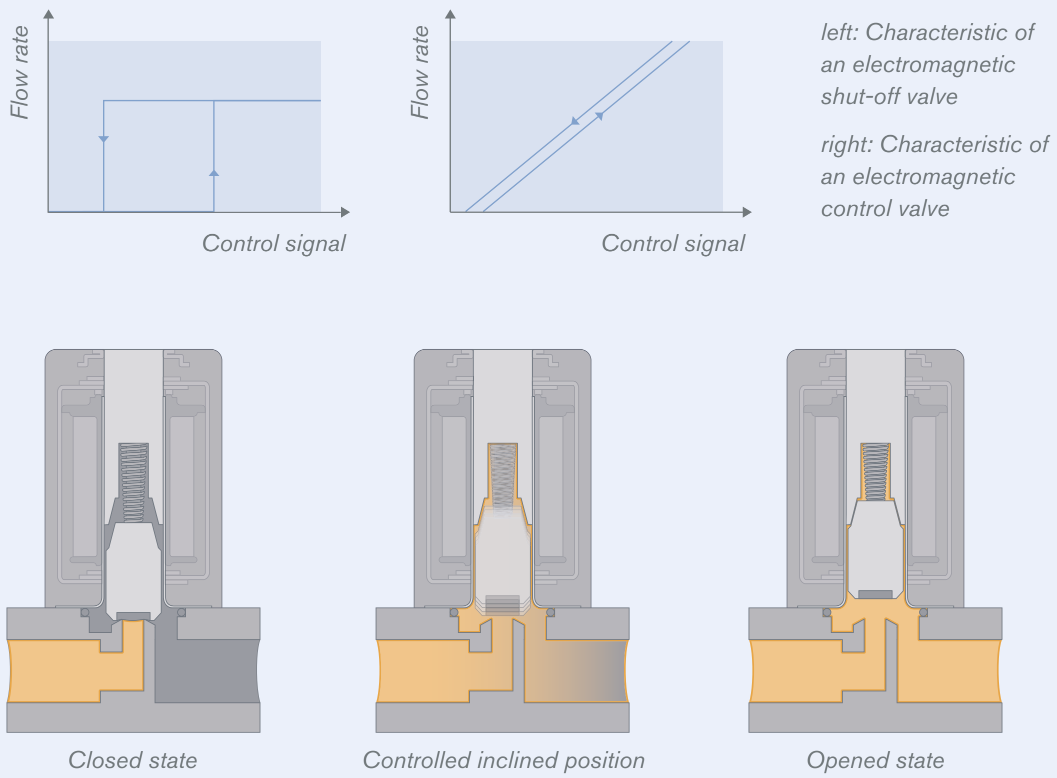



*Fig. 2: Functional principle of direct-acting solenoid control valves*



With an even geometry of the plunger and the plunger counterpart/stopper (flat stopper geometry) the magnetic force drops too much with rising air gap making it impossible to use the valve as a control valve. Equal balance states between spring and magnetic force at different values of the electrical current can only be achieved with a specific design of both components. With the design of a conically shaped area on the outside part of the stopper and a virtually mirror-inverted slant in the top part of the plunger (see conical stopper geometry in fig. 3).

In the power off state the spring force alone closes the valve. A seal integrated in the bottom of the plunger ensures that the fluid does not leak through the closed valve.

The plunger is guided through the valve unit by a guide pin (top) and a flat spring (bottom). The more flexibly the plunger slides through the coil, the more pronounced the response sensitivity and the more reproducible the control positions. This is because, in addition to the magnetic force and spring force, a third unavoidable force, unwanted because of its consequences, enters the picture: friction force. Friction disturbs the adjustment characteristic. It can, however, be significantly reduced with a precise guiding of the plunger and special electronic controlling.

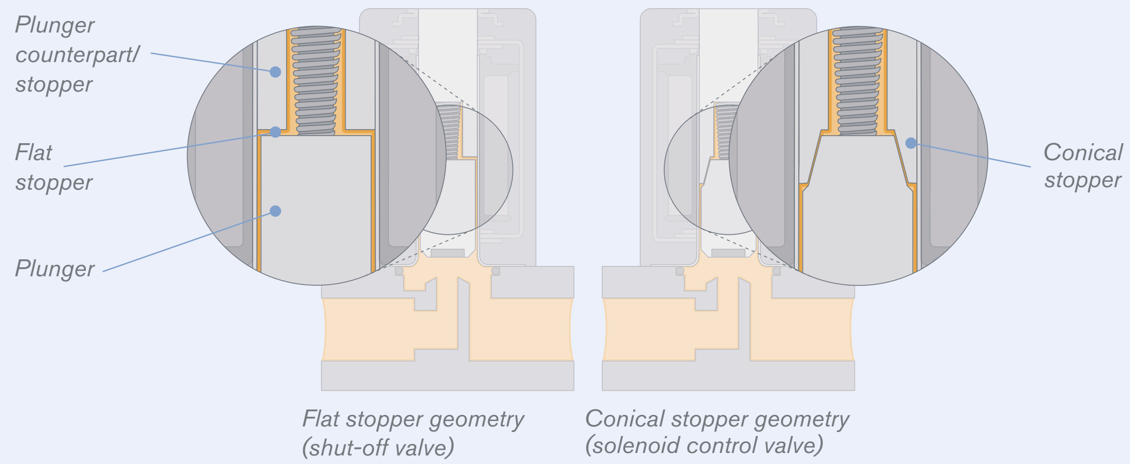



*Fig. 3: Comparison flat stopper design – conical stopper design*

# Controlling Solenoid Control Valves

In principle it is possible to control the proportional magnet with variable DC voltage, but static friction can appear here on the plunger's guide points. This impairs the sensitivity of the valve, and results in greater hysteresis effects. To prevent static friction, the normal inlet signal is converted with a special control electronics – usually into a pulse width modulated voltage signal (PWM controlling, see fig. 4). This kind of control puts the plunger into a very fast but weak amplitude oscillation. Despite, or moreover because of the oscillation, the plunger's balanced state is maintained, as is its constant sliding friction. And the plunger's oscillation motion has absolutely no effect on the fluid's flow behaviour.

With PWM control the effective coil current with constant voltage supply is set via the duty cycle of the rectangular signal. The PWM frequency is harmonized here on the one hand with its resonance frequency and the damping of the spring-plunger-system, and on the other hand with the magnetic circuit's inductance. If the duty cycle $t_1/T$ ($t_1$: power-on time, T: cycle duration, f=1/T: frequency) increases, the effective coil current "I" also increases, because the rectangular signal has also increased. If, however, the duty cycle falls, the effective coil current also falls.

Generally speaking: Small coils (e. g., types 2822, 2824) with low magnetic force react sensitively to higher frequencies. With low frequencies these generate high motion amplitudes and an unnecessarily high noise level. Big coils with a high magnetic force (e. g., type 2835), however, only result in dither movements, and therefore sliding friction with low frequencies.

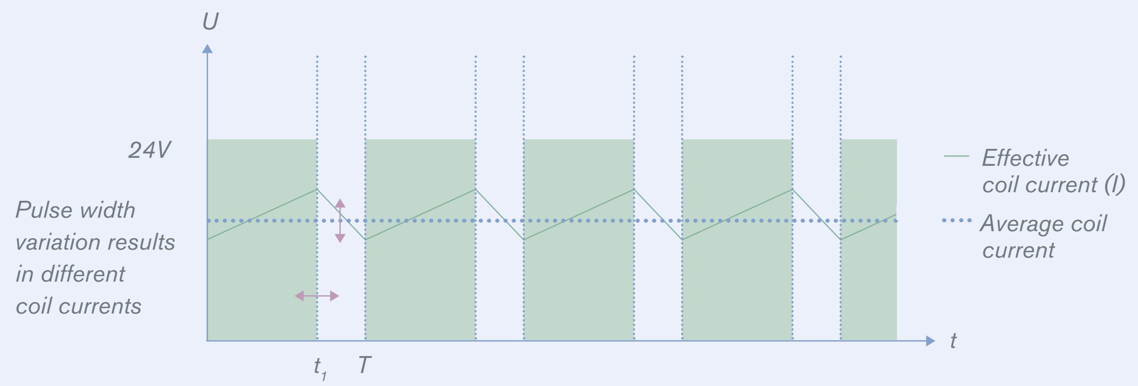



*Fig. 4: PWM control signal*



# Typical Functions of the Control Electronics

**Current control for coil heating compensation**

Coil heating changes the temporary effective electrical resistance. It is therefore beneficial to control the coil current electronically. Current control is especially important in open control loops, whereby it is irrelevant in closed process control loops.

**Adjusting the minimum and maximum coil current to application-specific pressure conditions**

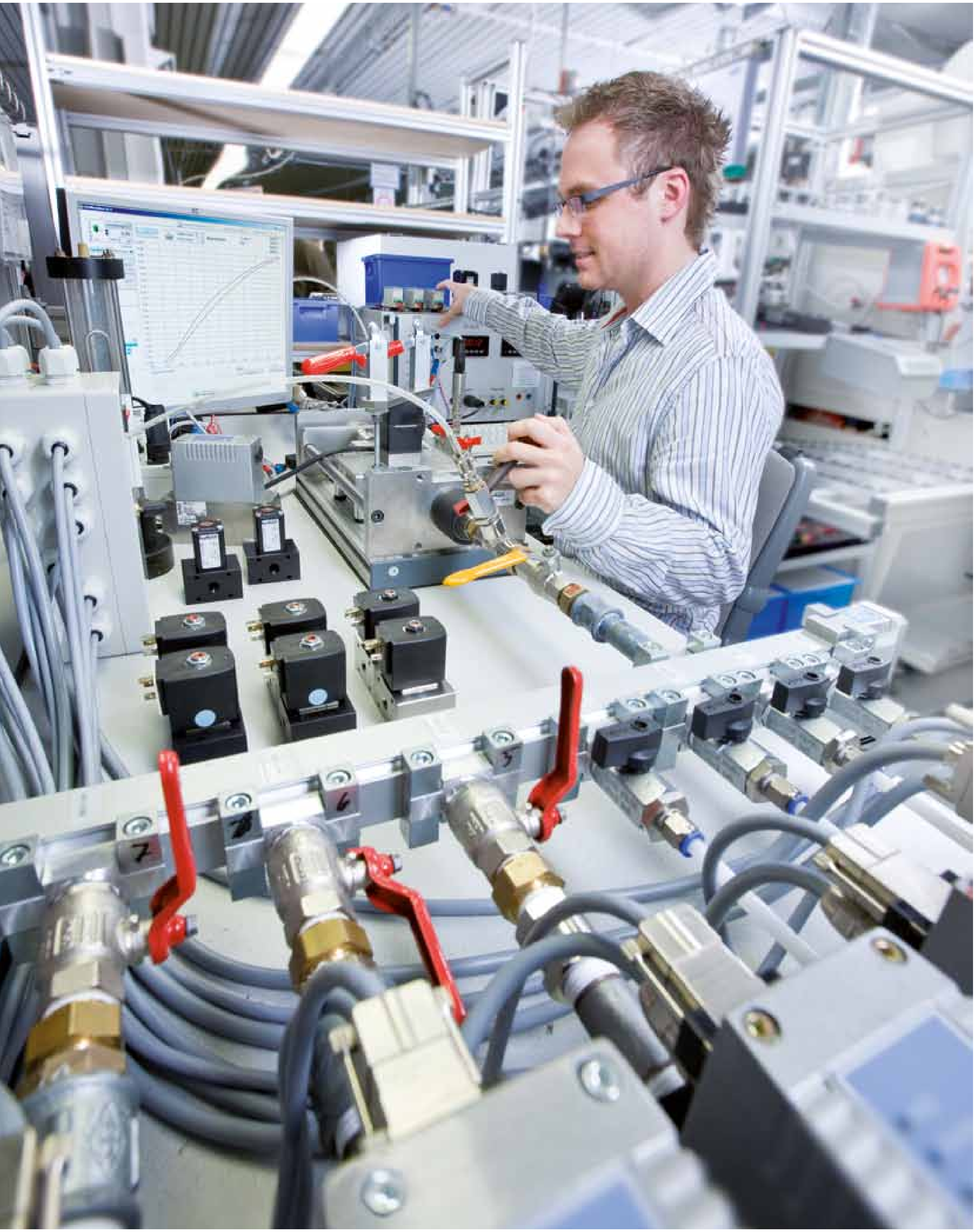
The current values must be set under operating conditions – when the valve begins to open, and when the valve is fully opened. The working range of the respective valve types depends on their orifice and the respective pressure conditions in the system (primary pressure and back pressure). For all direct-acting solenoid control valves that are inflowed under the seat, the current value for the opening start falls with increasing inlet pressure. With an increasing pressure drop via the valve, the current value at which maximum flow rate is reached falls.

**Zero point shut-off for closing the valve tight**

Zero point shut-off can be set up to a value of 5 % of the maximum inlet signal. This guarantees that the valve is closed tight. With inlet signals that are lower than originally set, the coil current is immediately set to zero. This then closes the valve. If no zero point shut-off is specified, the valve is controlled with the lowest duty cycle, even with 0 % set point given.

**Ramp function**

Set point changes (with rising or falling flank) can be set with an effective delay of up to 10 seconds. This balances the effects of volatile set point changes, which can cause fluctuations in some systems.



# Characteristic Data of Solenoid Control Valves

**$k_{Vs}$ value/$Q_{Nn}$ value**

Fluidic valve comparisons can be made via the $k_{Vs}$ value (m³/h unit). This value is measured at water's flow rate at 20 °C and 1 bar relative pressure at the valve inlet, compared with 0 bar at the valve outlet. A second flow rate value is often given for gases. This is the $Q_{Nn}$ value. The $Q_{Nn}$ value provides the nominal flow rate value in $l_N$/min air (20 °C) at 6 barg at the valve inlet and 1 bar pressure loss via the valve. Standard conditions for the gas are 1013.25 mbar absolute and a temperature of 273.15 K (0 °C).

**Hysteresis**

The highest fluidic output signal difference with an upward and downward run through of the full electric input signal range; given in % of the maximum fluidic output signal. Hysteresis is a result of friction and magnetism.

**Sensitivity**

The lowest set point difference that results in a measurable change in the fluidic output signal; given in % of the maximum fluidic output signal.

**Linearity**

Dimension for maximum deviation from the linear (ideal) characteristics; given in % of the maximum fluidic output signal.

**Repeatability**

Range in which the fluidic output value disperses when the same electric input signal coming from the same direction is repeatedly set; given in % of the maximum output signal.

**Turn-down ratio (span)**

Ratio of the $k_{Vs}$ value ratio to the lowest $k_V$, at which the height and incline of the characteristics remains within a tolerance range in the ideal characteristic curve.

In applications in practice the correct configuration of the valve is a prerequisite for proper functioning (see "Sizing of Valve Orifice").

# Use as Control Valve: Sizing of Valve Orifice

For correct and accurate control functioning, solenoid control valves must be configured and selected according to their special purpose. The most important parameters for selecting a solenoid control valve are, on one hand, the $k_V$ value (given in cubic meters per hour) and, on the other hand, the application's pressure range. The lower the valve's orifice or the stronger the coil, the higher the pressure the valve can shut-off. The highest $k_V$ value needed is calculated on the basis of the following parameters: Valve inlet pressure, valve outlet pressure, the fluid's density, maximum flow rate required, and the fluid's temperature. With the sizing formulas (see one of Bürkert's data sheets for solenoid control valves), supercritical or subcritical flow and aggregate states (gaseous, liquid or vaporous) are distinguished.

On the basis of the calculated $k_V$ value and the pressure range of the planned application, a correspondingly appropriate valve type and its required orifice can now be determined. The spreadsheets with the valve performance data on pages 10 to 13 of this brochure will help you to find the right valve type for this. Please observe: The application's $k_V$ value must be lower than the valve's $k_{Vs}$ value that is reached at maximum opening.

You will find more information on the $k_{Vs}$ value on page 21.

Some countries use the $c_V$ value instead of the $k_{Vs}$ value. This flow rate is given in US gallons per minute (1 GPM = 0.227 $m^3/h$) and determined with water at 60° Fahrenheit and a pressure difference via the valve of 1 psi (equal to 0.069 bar). The conversion factor between $k_V$ and $c_V$ is 0.857 ($k_V$ is smaller than $c_V$).

The correct configuration (determining the valve's orifice) is extremely important for the solenoid control valve's correct functioning. With a high orifice setting the valve can already reach full flow rate at a very small opening (stroke). The remaining stroke then is useless, which, more to the point, impairs resolution and the general control quality of the valve. With an orifice size that is too small on the other hand, the valve won't reach full flow rate. In the interests of the system's acceptable flow characteristics, the "valve authority" should not be below 0.3 … 0.5. That means that 30 to 50 % of the system's pressure should be available to drop over the control valve.

Bürkert provides a calculation tool for the correct control valve sizing: the Easy Valve Sizer, which makes finding the optimum valve orifice so easy.

# Brief Instructions – How do I Find the Right Solenoid Control Valve?

**1. What medium (fluid) do you want to control?**
With regard to its chemical-physical reaction behaviour, it must be checked whether the valve parts in contact with the medium are compatible with the medium itself.

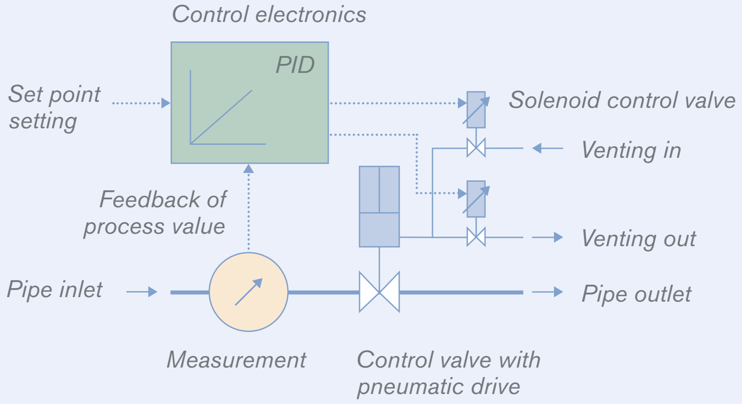
**2. How high is the maximum operating pressure?**
The valve must be able to shut off the highest pressure in the application.

**3. What are the process data?**
For optimal sizing of the valve orifice there are some issues to be cleared up. At first there is the scope of the required maximum flow rate, $Q_{nom}$, which typically has to be controlled. The valve's maximum flow rate can, however, actually be higher, and the figures of the pressure values at $Q_{nom}$ must be measured immediately before and after the valve ($p_1$, $p_2$). These values are often not identical to the inlet and outlet pressure of the overall system, because additional flow resistances have an effect both before and after the valve (pipes, shut-off valves, nozzles, etc.). If the inlet ($p_1$) and outlet pressure ($p_2$) cannot be determined, both must be estimated taking all pressure drops into account. Information on the medium temperature ($T_1$) and the standard density ($p_N$) of the medium at 273 Kelvin (0 °C) and 1013 mbar (1 bar) also helps in calculating the valve orifice. Whether or not the minimum flow rate can be adjusted ($Q_{min}$) is checked using the achievable turn-down ratio of the valve considered.

Here is a brief summary of the sizing criteria once again:
– The valve's $k_{Vs}$ is greater than the application's $k_V$; ideally by approx. 10 %
– The pressure that can be withstood by the valve is greater than the max. operating pressure before the valve

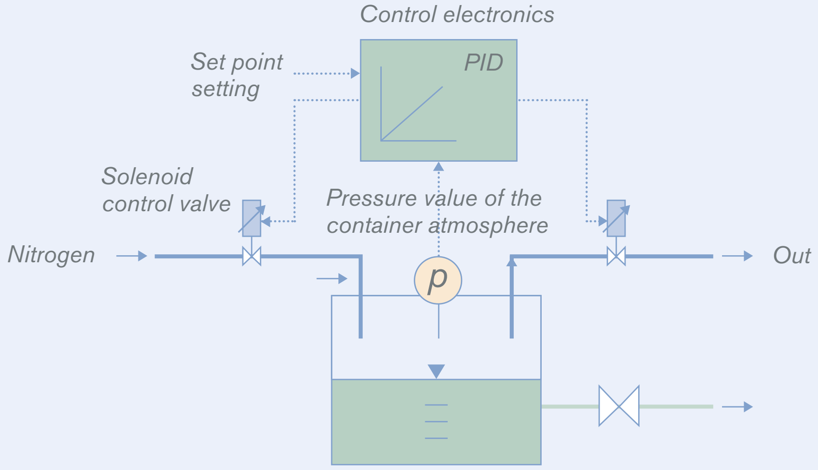
# Typical Applications

## Actuator Control (Static Pressure Control)




*Two solenoid control valves control the air for pneumatic drive (piston valve, cylinder, etc.). The PID controller determines which of the two valves must open. The control electronics set the drive via the solenoid control valves so that the process value corresponds with the set point given.*

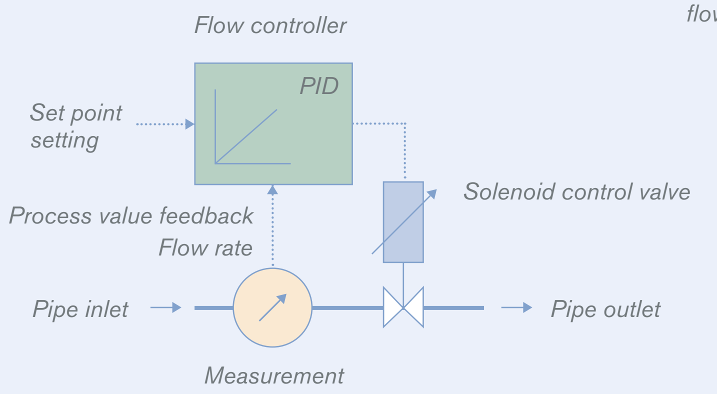
## Level Control with Pressurization (Flow Pressure Control)




*Atmospheric pressure control is one possible type of level control. Via two solenoid control valves, a PID controller supplies enough air or nitrogen here so that there is always the same pressure pressing against the fluid that changes when the fluid pressure drops through removing a portion of the fluid.*

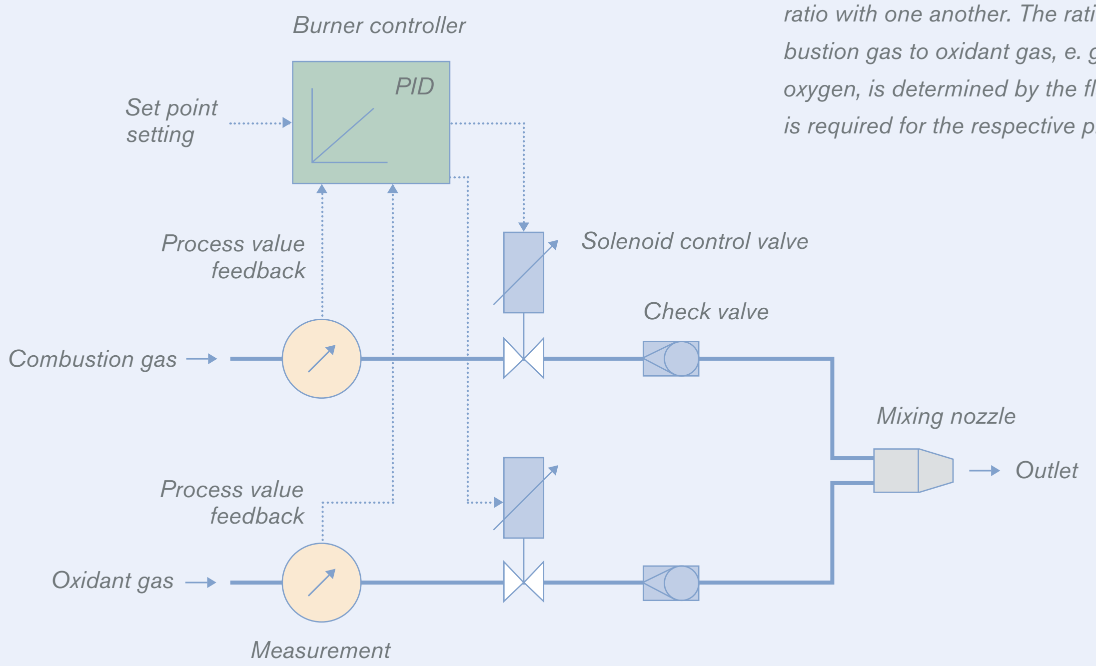
## Flow Control

*A solenoid control valve can be used directly as a control valve, for direct flow control, for example.*



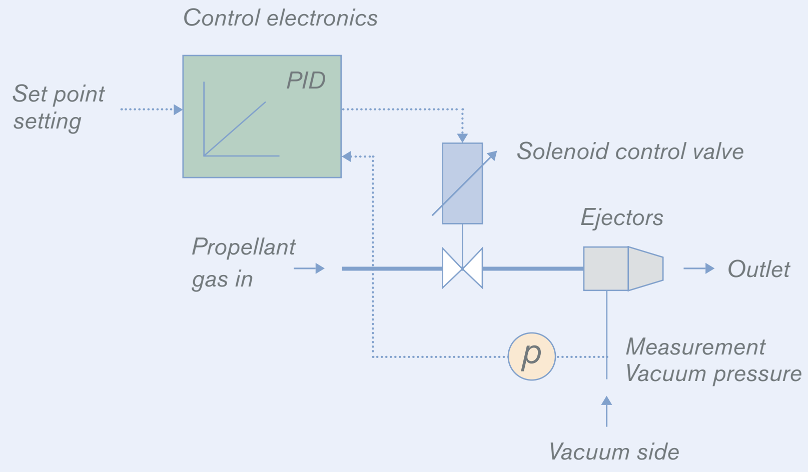

## Burner / Flame Control

*Two gases must be controlled in a burner control system; both are in a desired ratio with one another. The ratio of combustion gas to oxidant gas, e. g., air or oxygen, is determined by the flame that is required for the respective process.*

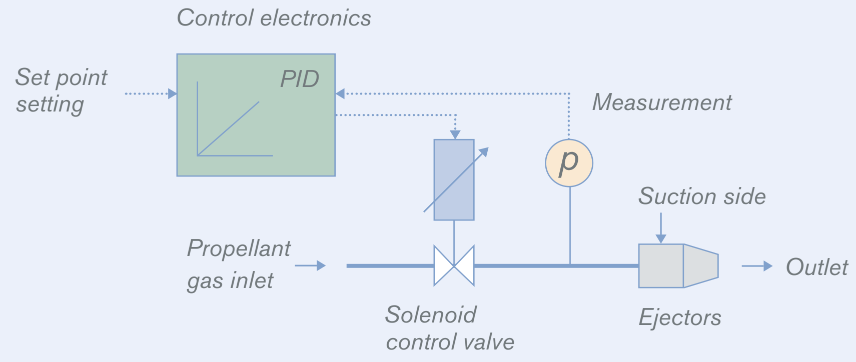



## Ejectors / Pressure Control

*The solenoid control valve controls the propellant gas flow rate. More propellant gas creates greater suction power and a deeper vacuum in the suction line. The controller sets the valve according to the vacuum pressure.*

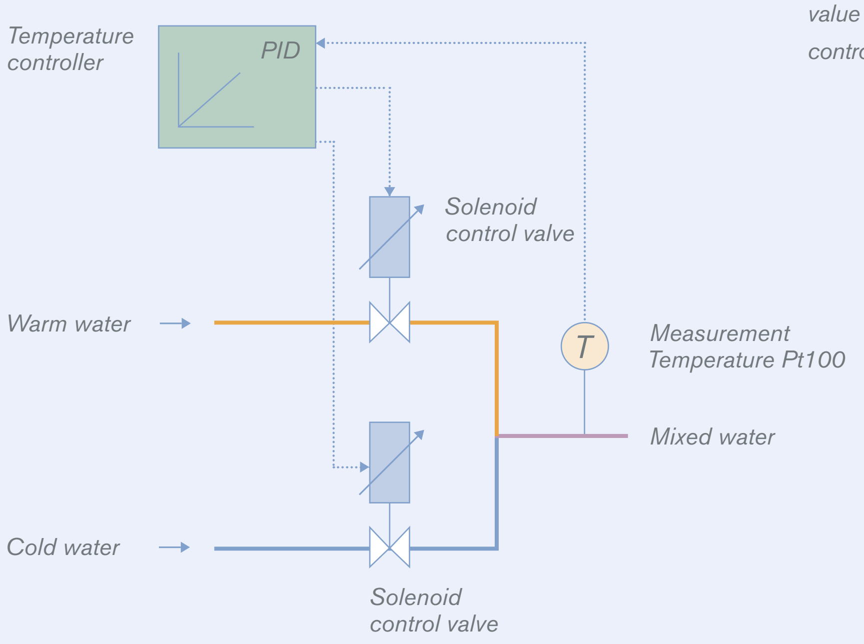



*As before, the suction power is controlled by the solenoid control valve. In this case the inlet pressure on the propellant side is kept constant at a reference value.*



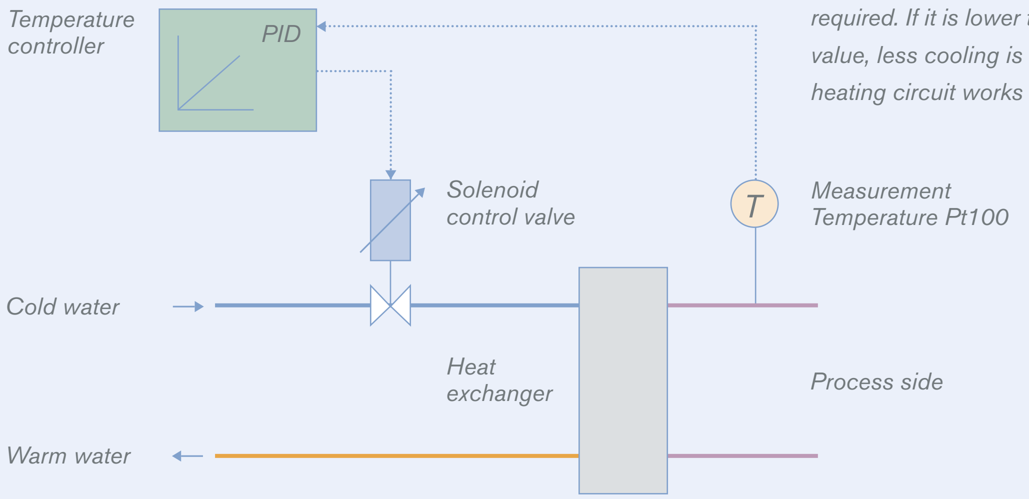
## Mixture of Cold and Warm Water

*A Pt100 temperature sensor measures the temperature of the mixed water. The temperature controller brings this temperature to the given reference value by controlling the two solenoid control valves accordingly.*




## Temperature Control

*The solenoid control valve sets the cold water supply to the heat exchanger in accordance with the measured process water temperature. If this is higher than the reference value, more cold water (cooling water) is required. If it is lower than the reference value, less cooling is required. A heating circuit works in a similar way.*

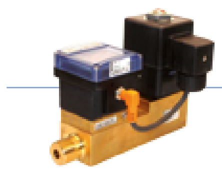





# System Engineering

A global network of Bürkert system engineering facilities and long-standing years of experience in the systems business allow us to develop and quickly implement tailor-made solutions for your requirements. Engineers and scientists from the most diverse specialist fields are at your disposal for competent and expert consulting. Our range of customized solutions is highly diversified and ranges from connection plates, plastic injection components, the integration of additional components, electronics, software and connections via special interfaces, right through to the use of customized bus technology.

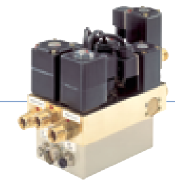
We can therefore ensure that you get the perfect product for your application. The focus of our work is both on the optimization of procurement and installation costs, and a higher level of integrating functions into the system. Furthermore, with its geometric dimensions and the mechanical and electrical interfaces we put in place, the system is optimized to fit into its later application environment.



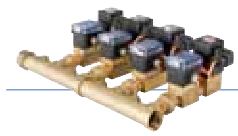
System for controlling cooling water with reference to the temperature of the process water

Compact, space-optimized solenoid control valve system with plastic moulded base

Five channel gas controller, featuring one common electronic board only



Fieldbus controlled, three channel pressure controller



System for controlling cooling water into different transmission lines

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