Proportional pneumatics

Secure your advantage and create new potential
You want expertise.
You are looking for innovation.
We are the specialists in your industry.

→ WE ARE THE ENGINEERS OF PRODUCTIVITY.
Build on your technological advantage!

Enabling you to gain that extra edge over the competition has always been our main objective at Festo. As a driver of innovation in the field of pneumatics, Festo thus offers a wide range of proportional pressure and directional control valves. This will allow you to realise even the most complex of applications safely and easily.
Aim for higher productivity ...

... with our expertise in proportional technology. You will benefit from a huge choice of individual solutions and functions at the best possible price while keeping installation, parameterisation and commissioning to a minimum. Everything is generally preset at the factory, and the built-in technology also takes time-consuming routine tasks off your hands. Our new proportional valve VPPX is recommended ...

... if you ...

... want to keep your prices competitive.  ... want a high level of control precision.

Large portfolio of products
The familiar VPPE and VPPM series are part of the new generation of proportional valves. And now a new range of valves, based on the VPPM and VPPX series, has been developed with a built-in IO-Link interface. These operate in the “standard pressure control range” of up to 10 bar. Another new product is the high-pressure valve VPPL for up to 40 bar. With a nominal size of 2.5, the VPPL can be operated as a standalone valve, as a pilot valve with a directly flangemounted booster PREL, or with another pressure control valve piloted using external air, such as the MS9-LR...PO.
... prefer valves with low internal air consumption.

... always want the latest valve technology and electrical communication.

... want to optimise your control process and regulate pressure reliably, precisely and with high dynamic response using proportional pressure regulators.

... want to control not only the pressure, but also other physical variables. With VPPX, you can control almost any physical variable that is affected by air or an actuator.

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Pressure or flow rate
Whether the pressure rise for your application is highly dynamic or subtle, and the pressure range standard or customised – with proportional technology from Festo, you can’t go wrong.

User-friendly
With a selection of 3 different presets, we can offer the right parameters for almost any application – fast, normal or slow.

Integration possible
Integrating VPPM into the valve terminal combination CPX/MPA opens up a host of new possibilities for you – in terms of both electrical communication and pneumatics.

Versatile and high-performance
With settings such as pressure range and digital outputs, the VPPM can easily be adapted to suit your process. The VPPX offers top process quality and versatility with individual adjustment options such as PID controller, nominal and actual inputs and outputs, and an external sensor output.

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Your technological advantages in detail:
- Multi-sensor control for maximum precision
- Electrical and pneumatic function integration and extensions with VPPM on CPX/MPA
- Variable pressure zone regulation for greater flexibility
- 3 presets for simple control
- Multiplexing with CPX/MPA
- External sensor input for VPPX
- IO-Link

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Proportional pressure regulator VPPL
Performance with maximum precision

Unique on the market:
Cascade controller with integrated multi-sensor control
With this technology, built-in sensors provide steady control, even in the small signal range. The controller is also temperature-compensated so there is no drifting when the temperature fluctuates. This is based on the principle of cascade control. Multiple control circuits are nested inside each other, and the entire controlled system is divided into two smaller sub-systems that are easier to control. This greatly increases the control precision compared to conventional, simple “standard controllers”.

Benefits
• Greater control precision and dynamic response compared to single-acting controllers
• Unaffected by temperature fluctuations
• Precise, even over long distances

Multi-sensor control (cascade control) of the VPPM

Setpoint value
  - Working pressure regulator
  - Diaphragm pressure regulator
  - Pilot solenoid coils
  - Pilot control stage
  - Main stage
  - Working volume

Actual value
  - Sensor 1
  - Sensor 2
Ease of use

Maximum ease of use
The right parameters for each application – simply choose from 3 presets at the press of a button, activate, and you’re done!

Functional and clear

“Fast” mode
For applications that require large volumes of air for pressure adjustment.

“Normal” mode
For applications with medium air volumes.

“Slow” mode
For applications that only need small volumes of air to be supplied or vented within a set control time.

Connector plug M12, 8-pin

• Display of current pressure
• Adjustable pressure regulation range
• Different switching modes for switching output (diagnostic function)
• Choice of units (bar, kPa or psi)

Status LEDs
Power/Error

Bar display for identifying dynamic processes

3 preset LEDs
Fast/Normal/Slow

3 pushbuttons for simple operation (choice of presets)

Preset can be selected via buttons or digital inputs
High-tech, user-friendly and functional – make the most of it!

Custom solutions with the modular system
The proportional pressure regulator VPPM can be adapted to suit your requirements perfectly. It has everything you need for reliable, precise control: presets and a multi-sensor control system. Choose from the inline or flanged version, LED or LCD display or setpoint specification in current or voltage.

New: our VPPM IO-Link for simple point-to-point connection.

Want more? Integrated into the electrical terminal CPX-MPA, VPPM enables many additional diagnostic functions and variable pressure zones.

Operational safety, easy service and assembly
- Pressure is maintained if the supply voltage fails
- Wire break monitoring
- Long service life, tested units
- Choice of assembly methods: manifold block, H-rail mounting or individual mounting using mounting brackets

- Easy valve replacement and extension of the valve terminal
- Energy efficient:
  - Holding current reduction in pilot valves
  - Minimum power consumption in corrected state
  - Pressure zone regulation to the exact pressure required
  - Once the setpoint value has been reached, no further power is required to maintain the pressure

Add extra value to your processes with VPPM and its custom expansion options.
Multiplexing – same functionality with fewer proportional valves

Multiplexing saves up to 8 proportional valves per valve terminal. The process is simple: with multiplexing, multiple pressures are sequentially transferred to various actuators through downstream directional valves. This makes it possible to control up to 8 directional control valves on the valve terminal MPA with one proportional valve, depending on the application and connection frequency. Multiplexing is significantly cheaper and more efficient than a conventional design.

There are two types of multiplexing: time-controlled and pressure-controlled.

**Added performance with functional integration**
- Significantly reduced system costs
- Less installation effort
- Tested and preassembled module

**Time-controlled**
The output pressure of the VPPM is assigned to a suitable consumer via a 3/2 or 5/3-way valve. Instead of being monitored, the pressure is adjusted according to a specific time schedule.

**Pressure-controlled**
The output pressure of the VPPM is assigned to a suitable consumer via a 3/2 or 5/3-way valve. The pressure is monitored by a sensor module and adjusted depending on how much it drops.

24 V DC

24 V DC
Perfect interaction for added functionality: VPPM in combination with CPX/MPA

Proportional pneumatics on the fieldbus: innovation through functional integration
When integrated into the electrical terminal CPX/MPA, the VPPM/MPA opens up a variety of additional pneumatic and electrical functionalities to the user. Individual, modular and configurable at all levels.

These include the fast operating status check on the VPPM-MPA 1/4" with display for
- Pressure
- Setpoint/actual value
- Error codes

Optional: the display can be shut off.

Communication on all levels
The VPPM-MPA on the valve terminal CPX/MPA offers access to all conventional, open fieldbus and Industrial Ethernet systems.

Thanks to
- PROFIBUS
- DeviceNet
- InterBus
- CANopen
- Sercos III
- POWERLINK
- CC-Link
- Modbus/TCP
- EtherNet/IP
- PROFINET
- EtherCAT

communication is standardised and consistent, from the operation and management level to the field level. All in all, this allows an optimum connection to the relevant control concept.

Valve terminal MPA with terminal CPX
The CPX terminal is used for the flexible connection of pneumatic and electrical control chains to automation systems. With CPX, you have all the options for serial, real-time-capable communication over long distances on the valve terminal MPA:

- Transferring numerical data, e.g. for diagnostics and parameterisation
- Controlling the complete pneumatic and electrical control chain using I/O modules and valves on a fieldbus connection

Thanks to its IP65/IP67 degree of protection, your automation platform is perfectly suited to the harsh realities of day-to-day industrial work.
Parameterisation, configuration and diagnostics in no time at all

VPPM-MPA on CPX/MDA takes on specific tasks to make your work easier. Direct, convenient and reliable – you will have all your tasks under control.

- Serial valve control and transfer of digitised analogue data for pneumatics – even over long distances
- Diagnostics at the fieldbus itself: all values can be controlled and monitored remotely, including upper and lower limits (e.g. to determine when the nominal outlet pressure has not been reached)
- Parameterisation with automatic adaptation of voltage and current interfaces, on pressure units and/or in digital format

Reduce your standstills by up to 35%

Unplanned machines and system standstills are expensive. This makes it even more important to detect, localise and eliminate errors quickly – or better yet, to avoid them. Festo offers a full package of diagnostic solutions precisely for this purpose, which you can use to collect data from and manage the entire valve terminal at a glance.

**Festo display and operating unit CPX-MMI**
The handheld terminal CPX-MMI is designed to carry out commissioning and diagnostics without a fieldbus, e.g. during servicing. Simply enter and read out analogue data in plain text and parameterise limit values. LED support makes the whole process child’s play.

The entire valve terminal at a glance: Festo Maintenance Tool CPX-FMT

The Festo Maintenance Tool for CPX makes all the modules of a valve terminal visible. Parameters can be easily altered, setpoints and actual values read and error messages displayed – no programming skills required.

**For simpler solutions, choose the CPX-MMI. If you prefer to keep an eye on the bigger picture, go for the CPX-FMT.**

Service and commissioning using the handheld CPX-MMI without programming
Extended electrical connection options – at the cutting edge with IO-Link

Safe communication!
VPMM with IO-Link interface communicates using a point-to-point connection. This benefits you as there are no conflicts, since the communication only takes place between the valve and the master.

The fieldbus connection is also quick to set up: every master that communicates with the VPPO IO-Link can be connected to an existing bus system.

Stable control behaviour, 3 presets
VPMM IO-Link offers the same performance as an analogue valve. Stable control behaviour – even in the small signal range – is guaranteed by the tried and tested cascade control system with 2 sensors. The version with IO-Link also has 3 presets that can be used as required. Of course, other additional functions from the standard series are also available.

Open to all fieldbus protocols
The convenient bridge to individual fieldbus connection: with an I-Port or IO-Link interface, the individual valves are open to all fieldbus protocols. The highspeed data rate of 230 kB/s and cycle times of 0.4 ms between the master and the device mean that even complex data packets can be transmitted quickly and securely. The valves can also be controlled using the CTEL from the CPX or any market-standard IO-Link module.

Proportional valve VPPM-12L ... LK
Fieldbus CTEU with CAPC
CTEL for CPX
VPPE – a valve for the basics

A simply classic alternative for basic applications
A proportional valve adapted for the functions you really need for your application. With or without the convenient display, the VPPE offers the exact features required for basic applications.

Benefits
- Attractive entry price
- Good control behaviour for simple tasks
- Degree of protection IP65
- Suitable for flanged connection
- High EMC resistance (Class A)

For the VPPE with display
- Menu navigation
- Display switch-off
- Pressure range adjustment
- Password protection
- 3 available presets
- Digital electronic control
- Rotating exhaust flange
- Compatible P-rails

Proportional valve VPPE
Proportional valve VPPE Display
The proportional valves VPPE are simply connected in series
The proportional pressure regulator VPPX leaves nothing to be desired. Simply adjust the controller to suit your needs and requirements. A plug-in developed specially for the configuration software FCT makes the VPPX more powerful than a standard controller for many applications.

Actual value input for external sensors
This input helps to significantly increase your process quality. Now, you can finally compensate for all the influencing factors and disturbances in the control chain! Whatever you want to control, the proportional pressure regulator VPPX can manage any physical variable that can be influenced by air or an actuator.

Maximum application flexibility
The free choice of setpoint and actual value inputs and outputs, for example, means that everything is individually adjustable, and can be set to the same or different units and defined as either current or voltage.

Even if you have a number of different applications or a need a replacement valve, you’ve never been more in control! Simply save the new PID control parameters in the valve and move on to the next application.

Maximum performance, top process quality, total flexibility: VPPX. The right choice for you.

Enhanced efficiency with software from Festo

FCT oscilloscope function for a quick overview of the controller settings

Proportional valve VPPX-12L...
VPPL – pressure control up to 40 bar

Control at a high level
The VPPL has been specifically designed for higher pressures of 10 ... 40 bar. As an individual device with threaded connections, the proportional valve can be used in a variety of applications, such as stretch blow moulding of PET bottles in the food and beverage industry or on tyre and brake test benches in the automotive industry.

Flexible actuation
The VPPL can be actuated with either current or voltage via a standardised M12 plug connector (In). The regulated pressure can also be read out as a current or voltage signal via a second standardised M12 connector (Out).

Higher flow rate
When coupled directly with the flow rate booster PREL, the VPPL increases your flow rate. With this combination in nominal sizes of 25 and 45, the flow rate can be increased from about 300 l/min to a maximum of 6,000 m³/h.

More accurate control
For a higher-order control circuit, the proportional valve VPPL in the series PREL also has a second pressure sensor with which the outlet pressure and pilot pressure of the PREL are monitored and controlled. This further improves the control precision of the entire pressure regulator.

Please note: you can only order VPPL using the type code. For more information, contact your sales engineer.

For example for tyre and brake test benches in the automotive industry.
## Key features

<table>
<thead>
<tr>
<th>Connection</th>
<th>Input pressure</th>
<th>Control range</th>
<th>Max. flow rate</th>
<th>Max. power consumption</th>
<th>Internal air consumption</th>
<th>Filtering</th>
<th>Repetition accuracy</th>
<th>Design</th>
<th>Safety setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>G1/8</td>
<td>0 – 11 bar</td>
<td>1400 l/min</td>
<td>7 W</td>
<td>40 l/h</td>
<td>0,50 %</td>
<td>Pilot actuated diaphragm regulator</td>
<td>Pressure retained in case of power failure</td>
<td></td>
</tr>
<tr>
<td>Pneumatic</td>
<td>G1/4</td>
<td>0 – 6 bar</td>
<td>2750 l/min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pressure regulators

<table>
<thead>
<tr>
<th>Model</th>
<th>Connection</th>
<th>Input pressure</th>
<th>Control range</th>
<th>Max. flow rate</th>
<th>Max. power consumption</th>
<th>Internal air consumption</th>
<th>Filtering</th>
<th>Repetition accuracy</th>
<th>Design</th>
<th>Safety setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPPL *</td>
<td>G1/8</td>
<td>0 – 11 bar</td>
<td>1250 l/min</td>
<td>4,2 W</td>
<td>40 l/h</td>
<td>&lt; 0,70 %</td>
<td>Pilot actuated diaphragm regulator</td>
<td>Pressure retained in case of power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VPPE</td>
<td>G1/8</td>
<td>0 – 6 bar</td>
<td>600 l/min</td>
<td>3,6 W</td>
<td>40 l/h</td>
<td>&lt; 0,70 %</td>
<td>Pilot actuated diaphragm regulator</td>
<td>Pressure retained in case of power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VPPE Display</td>
<td>G1/8</td>
<td>0 – 2 bar</td>
<td>1250 l/min</td>
<td>4,2 W</td>
<td>40 l/h</td>
<td>&lt; 0,70 %</td>
<td>Pilot actuated diaphragm regulator</td>
<td>Pressure retained in case of power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MPPE</td>
<td>G1/8</td>
<td>0 – 1 bar</td>
<td>8800 l/min</td>
<td>3,6 W</td>
<td>40 l/h</td>
<td>0,50 %</td>
<td>Pilot actuated piston regulator</td>
<td>Pressure retained in case of power failure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VPWP</td>
<td>G1/8</td>
<td>0 – 6 bar</td>
<td>8500 l/min</td>
<td>20 W</td>
<td>40 l/h</td>
<td>0,50 %</td>
<td>Pilot actuated piston regulator</td>
<td>Pilot actuated piston regulator</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Volumetric flow control valves

<table>
<thead>
<tr>
<th>Model</th>
<th>Connection</th>
<th>Input pressure</th>
<th>Control range</th>
<th>Max. flow rate</th>
<th>Power consumption</th>
<th>Design</th>
<th>Safety setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPYE</td>
<td>M12 x 1</td>
<td>G1/8</td>
<td>0 – 10 bar</td>
<td>2000 l/min</td>
<td>2,4 W</td>
<td>Piston spool</td>
<td>Closed mid-position in case of power failure</td>
</tr>
<tr>
<td>VPWP</td>
<td>G1/8</td>
<td>0 – 10 bar</td>
<td>-</td>
<td>1400 l/min</td>
<td>28,8 W</td>
<td>Piston spool</td>
<td>Closed mid-position</td>
</tr>
</tbody>
</table>

*Please note: you can only order VPPL using the type code. For more information, contact your sales engineer.*
Proportional valves are suited to a wide range of applications, such as assembly and handling tasks, or in machine tools and welding technology. With Festo the choice is yours: there is a well-matched, efficient solution for any requirement. Simply search based on the characteristics, functions and features that you define, and the decision will practically make itself.

| Selection table |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Regulation      | External sensor | Application     | Operating medium | Special features |
| Pressure        | Flow rate       | Few setpoint changes | Continuously changing setpoints | Low-level signal control | Filtered compressed air | Neutral gases | Lubricated | Unlubricated |
| LCD panel, clear menu, multi-sensor control | LCD display (G1/4"), Setup via fieldbus, multi-sensor control |
| Low-cost valve | Multi-sensor, external sensor input, free plug-in for FCT software |
| Red LED display, setup menu | | Flow rate booster PREL for 6000 l/h |
| External actual value input | | Directly actuated 1/8" variant, SA variants for vacuum |
| Highly dynamic, even for positioning control | | Soft-stop, position and force control |
Automotive industry

Proportional valves VPPM to regulate axial forces in automatic screwdrivers

The use of specialised screws in the drilling and screwing process means preparatory work such as pre-drilling or punching is no longer necessary. The usual tolerance problems are also eliminated. The axial force for flow drilling is applied via a tandem cylinder ADVU and regulated by a proportional valve VPPM during the process. The control system adapts the force applied via the cylinder individually depending on the process status and the material.

What we can control for you – application examples
Filling and packaging technology

Proportional valves VPPM for vacuum, pressure and cylinder force control
In a lid fitting station, suction cups are used to convey the lids. The vacuum pressure must be adjusted in proportion to the ejector supply, depending on the lid size and material.

Proportional valves VPPM control the pressure for the Venturi nozzle. They are also used in the sealing station where the lids are pressed onto the containers. Here, they control the cylinder force so that the contact pressure can be adjusted to suit the product in question.
<table>
<thead>
<tr>
<th>Machine and system building</th>
<th>Test machines</th>
<th>Rubber and plastics machines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proportional valves VPPM for web tension control</strong>&lt;br&gt;A consistent web tension is critical for good results in winding machines. To achieve this, the friction roller must always be braked optimally in accordance with the roller diameter. The VPPM controls the braking force according to the setpoint it receives from the machine controller.</td>
<td><strong>Proportional valves VPPM for contact pressure regulation</strong>&lt;br&gt;Laboratory presses are used to test the adhesive forces of adhesives. The test specimens are compressed at a specific force by heated press plates, then allowed to cool and examined. VPPM allows the contact pressure to be varied for each test.</td>
<td><strong>Proportional valves VPPM for back pressure regulation</strong>&lt;br&gt;In extrusion machines, proportional valves VPPM allow precise control during removal of the profile. They ensure a continuous, constant speed when processing thermoplastics.</td>
</tr>
</tbody>
</table>
Printing and paper industry

Proportional valves VPPM for setpoint control
In order to prevent the cardboard rolls in roll slitters from slipping during the winding process, a contact winding roller is fitted with a ductile profile. The pressure increase regulated by the VPPM is used to adjust the clamping pressure according to the material, the web tension or the surface quality of the cardboard rolls, for example.

Laminating and coating machines

Proportional valves VPPM for pre-tensioning the material webs
Coating and laminating a variety of different materials for every industry from automotive to sports and packaging in a way that ensures uniform results and meets the required quality standards is no easy task. It requires a variety of web tensions, which can be set using the proportional valves VPPM.

Process engineering

Proportional valves VPPM for diaphragm valve control
In order to simulate a wide variety of different road conditions on an automobile test track, the required amount of water is signalled by a potentiometer to proportional valves VPPM. These build up a pneumatic pressure, which then activates the diaphragm valves.

Welding machines

Proportional valves VPPE for setpoint control
In ultrasonic welding, different materials and particular material thicknesses require welding and contact pressures to be precisely matched. Retooling and set-up times can be reduced via the machine control system – and controlled by proportional valves VPPE.
The latest directional control valves – from proportional pneumatics to servopneumatics

5/3-way proportional valve MPYE
The directly actuated proportional directional control valve has a position-controlled spool. This transforms an analogue input signal into a corresponding opening cross-section at the valve outputs. In combination with an external position controller and displacement encoder, a precise pneumatic positioning system can be created.

Benefits
• Short machine cycle times: fast switching of programmed flow rates
• Flexible cylinder speeds: achieving variable flow rates
• Use as the final control element: dynamic and fast changing of flow rates

Example: proportional directional control valves in use
To ensure the Japanese robot woman’s movements are as realistic as possible, like those of a real human, the Japanese manufacturer uses 50 proportional directional control valves type MPYE. These control the small drives that move the limbs under her fine silicone skin. No other automation supplier was able to provide proportional valves like those developed specially by Festo based on the series product. They were tailored specifically to meet the individual requirements as part of a joint project by Festo and the client.

Other key criteria included the special flow control system that allowed even more precise control in spite of the larger tubing lengths, together with the fast response time of the series product MPYE.

The Japanese client was also impressed by the durability and relatively low costs of the MPYE.

Fast, durable and low-cost: each of the drives that move the limbs under the robotic woman’s fine silicone skin are controlled by 50 tailor-made proportional directional control valves MPYE.
Ideal for servopneumatics: 5/3-way proportional valve VPWP
Based on the MPVE technology, the VPWP allows you to vary the direction of movement.

Benefits
• Secure: integrated interface for digitalised data transmission
• Precise: with integrated pressure sensors and cascade control
• Operational safety: adaptive “self tuning” control algorithm
• Simple: supports auto-identification
• Productive: comprehensive diagnostic capabilities
• Flexible: integrated pressure sensors enable you to switch between position and force control

Outstanding motion performance
• Direct control of a brake or clamping cartridge
• Safe stationing in the midposition thanks to new standstill control
• Integrated option for force control
• Unambiguous diagnostics in a fully digital system

Cutting-edge servopneumatics
Positioning large loads even more dynamically – with the third generation of servopneumatic systems from Festo, you can easily pull ahead of the competition. Designed for gentle, vibration-free functioning, the compact powerhouses with VPWP will reduce your positioning times by up to 30%, while also using 30% less compressed air.

Together with the automation platform CPX and the servopneumatic positioning module CMAX or the electronic end position controller CMPX for soft stop, VMMP accelerates a wide range of drives.
Types of control
Controllers independently influence one or more physical variables at a pre-defined level. To do this, the controller continuously calculates the deviation between the setpoint signal and the actual value signal – known as the system deviation – which is reduced to a minimum by the manipulated variable from the controller. In general, a distinction is made between two different types of control:
• Discontinuous control (two-point or multiple-point control)
• Continuous control: the controller continuously intervenes in the control process.

Discontinuous control
A process completed in jumps is referred to as discontinuous. In these cases, the controller intervenes in the control process with switching jumps and a constant energy level. These controllers are therefore also known as switching controllers. The difference between the two switching points “On” and “Off” is referred to as the switching hysteresis. This is how irons work, for example. If the specified temperature drops below the setpoint, a bimetal switch turns on the radiator; if the setpoint is exceeded, the radiator is switched off.

Continuous regulation
Continuous controllers intervene continuously in the process. To do this, they continuously alter the control signal in order to keep the system deviation as low as possible. The controller can accept any manipulated variable within a specific adjusting range.

When regulating room temperature, for example, the setting on the thermostat acts as the setpoint value, while the actual value is supplied by a temperature sensor, which is usually built into the thermostat. If the temperature deviates, the controller continuously alters the water flow rate by actuating the water pump. This keeps the deviation lower, and the controller also throttles the output of the water pump.
Control systems

Open control circuit
In an open control circuit, the control unit receives no feedback on the actual value. Open control circuits are rare in proportional control systems.

Closed control loop
In a closed-loop control circuit, the control unit receives continuous feedback on the actual value. Based on its control principle (controller type), the control unit uses the system deviation between the setpoint value and the actual value to calculate the manipulated variable, which minimises the deviation.

Controller types
A variety of controller types can be used to perform control tasks. These range from simple P controllers, which only weight the control error proportionally, to the well-known PID controller and more modern approaches, such as cascade and status controllers.

Cascade controller
In a cascade controller, several closed-loop control circuits are nested inside each other. The overall controlled system is divided into smaller circuits that are easier to control. Compared to a directly acting controller, this improves the control precision and stability of the control circuit.

In a cascade controller, the output variable of one controller acts as the reference variable for the next one.

Analogue controllers
The most common controller is the P controller. It is good for balancing out large deviations, but is only used in situations where accuracy is not important.

Digital controller (microprocessor)
This controller uses modern microprocessor technology and offers many advantages, such as allowing modern controller types (cascade controllers) to be used in practice and thus improving stability and accuracy. Other important benefits include the high level of flexibility (presets), bus compatibility (valve terminal CPX-MPA) and improved diagnostic capabilities.

Cascade control
Proportionally controlled ("P") circuits are simple and have an average speed compared to other controllers. The problem is the remaining deviation.

The "D" element is a derivative unit. Due to vibrations in the system, it can only be used as a controller in combination with controllers with "P" and "I" characteristics.

An integrally controlled circuit ("I") is relatively slow, but can completely eliminate deviations.

The PI controller combines the average-speed P controller with the exact I controller. The PI control circuit is thus precise and has an average speed.

The fastest controllers are those with a derivative unit (PD and PID). These are perfect for situations that require a high dynamic response or where the controlled system itself is already unstable.

Digital controllers
Digital controllers can save various control parameters in a table stored on the processor. They then call up these parameters based on changes in the setpoint value, disturbance variables or the trigger level. This is ideal for compensating for even the most complicated control applications, which makes systems and their processes more reliable and productive.
Hysteresis
There is always a linear relationship within a certain tolerance between the setpoint value entered and the pressure output. Nevertheless, it makes a difference whether the setpoint value is entered as rising or falling. The difference between the maximum deviations is referred to as hysteresis.

Linearity error
A perfectly linear progression of the control characteristic of the output pressure is theoretical. The maximum percentage deviation from this theoretical control characteristic is referred to as the linearity error. The percentage value refers to the maximum output pressure (full scale).

Response sensitivity
The response sensitivity of the device determines how sensitively one can change, i.e. adjust, a pressure. The smallest setpoint value difference that results in a change in the output pressure is referred to as the response sensitivity. In this case, 0.01 bar.

Zero offset
If, for example, a VPPM cannot be vented for safety reasons, the minimum pressure can be increased from the zero point. The smallest setpoint value is then assigned an output pressure of 5 bar, for example, and the largest setpoint value an output pressure of 10 bar. Zero point suppression is automatically switched off if the zero offset is used.

Repetition accuracy (reproducibility)
The repetition accuracy is the margin within which the fluid output variables are scattered when the same electrical input signal coming from the same direction is set repeatedly. It is expressed as a percentage of the maximum fluid output signal.

Pressure range adaptation
In the delivery status, 100% setpoint value equals 100% fluid output signal. Pressure range adaptation or adjustment enables the fluid output variable to be matched to the setpoint value.

Zero point suppression
In practice, it is possible for there to be a residual voltage or residual current at the setpoint input of the VPPM via the setpoint generator. Zero point suppression is used so that the valve is reliably vented at a setpoint value of zero.
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