Proportional valves with piezo technology in medical technology

FESTO

Precisely mixing and dosing gases plays a decisive role in many areas. The most important factor is exact and reproducible pressure regulation and flow control. Piezo valves are small, lightweight, extremely precise, very durable, incredibly fast and above all save energy, making them perfect for this task.

You develop high-end medical technology.
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More information on piezo valves in medical technology and laboratory automation at:
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More information on proportional valves for factory and process automation at:
www.festo.com/proportional-valve

In focus

Festo is opening up a host of options for you
With a choice of various valve series with different working pressures, nominal widths, flow rate ranges and working temperatures, Festo offers you the optimal proportional valve for your needs. When you have special requirements, we can adapt the valves completely to your individual needs. Just ask us!

Your objective: a competitive edge thanks to innovation
Medical devices, too, are subjected to fierce and tough competition. The trends are moving towards ever smaller and lighter devices. At the same time, they have to be more cost-effective than previous models and withstand the stress of being used on a daily basis for long periods of time. The market also demands faster and more precise analytical devices as well as state-of-the-art medical equipment.

Our contribution: unique automation solutions with piezo technology
Festo is the world's leading supplier of electric and pneumatic automation technology. In close cooperation with customers, Festo automates motion and sequences for factory, process and laboratory automation as well as for medical devices. Piezo technology is one of several key technologies used by Festo for the efficient control of gas flows in medical devices.

Individually adapted – proportional valves with piezo technology from Festo

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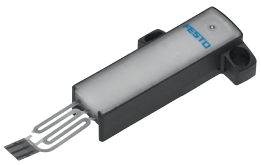

2/2-way proportional valve
VEMR, VEAE

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3/3-way proportional valve
VEMC, VEMP, VEA1

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E-Box VAVE-P

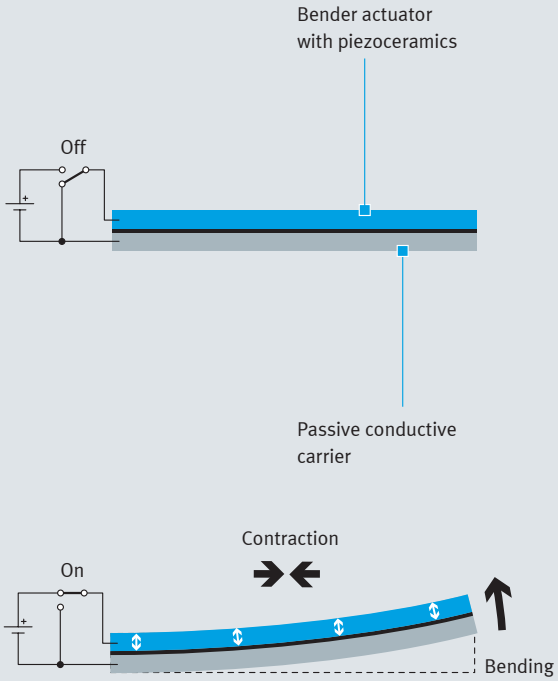
Pressure and flow regulator
VEMD, VEAA/VEAB

Mode of operation

Flow control: 2/2-way valve
The piezo valve has one bender and two ports. The more voltage is applied, the further it opens.

Pressure regulation: 3/3-way valve
The piezo valve has two benders and three ports. A complete pressure regulation system can be set up with this compact solution. There's one bender for pressurisation and a second one for exhausting. The third state is closed, thus maintaining the pressure.

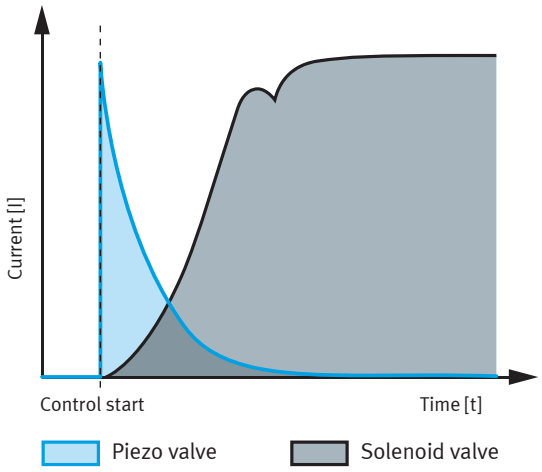
This is how piezo technology works
Festo uses the piezoelectric characteristics of certain ceramics that mechanically deform when a voltage is applied.



Function of the bender actuator in piezo valves

Benefits of piezo technology

1 **Low energy consumption – no heat generation**
In comparison to solenoid valves, proportional valves with piezo technology require virtually no energy to maintain an active state, thanks to their capacitive principle. The piezo valve operates like a capacitor: it needs current only at the start in order to charge the piezoceramics. No further energy is needed to hold its state and it therefore generates no heat. Piezo valves consume up to 95% less energy than solenoid valves, which permanently require an electrical current.



2 **No operating noise**
Proportional valve with piezo technology are quieter than solenoid valves – the bender actuator moves freely, without any impact noise. In addition, there is no need for pulse-width modulation which controls the flow rate of a solenoid valve.

3 **Long service life**
Gas flows can be regulated proportionately with proportional valves. Their design makes them wear resistant and capable of achieving an unusually high number of cycles.

4 **Small installation space and light weight**
As the piezo valve has no solenoids or electrical coils, its design is light. That, combined with its compact size, makes it ideal for installation in mobile devices.

5 **High level of safety**
Proportional valves with piezo technology are characterised by their high level of intrinsic safety, because they can maintain the current state for a while even if there is a power failure.

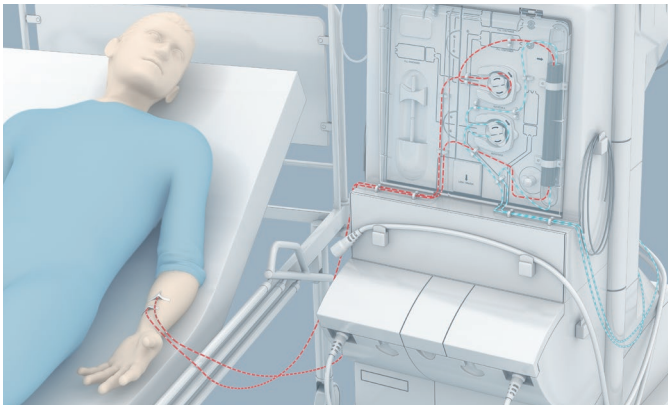
Piezo technology in medical technology applications

Improved quality of life for patients and their surroundings
Proportional valves with piezo technology are suitable for a huge variety of applications in medical technology. Thanks to their compact design and low power consumption, they are ideal for installation in battery-operated devices.

Mobile ventilator breathing devices
- Portable oxygen system devices (oxygen conserver and concentrator) for people with chronic respiratory ailments
- Clinical and mobile ventilator breathing devices
- PAP devices for patients with sleep apnoea

Oxygen/ventilation therapy
- Regulating gas flows and pressures

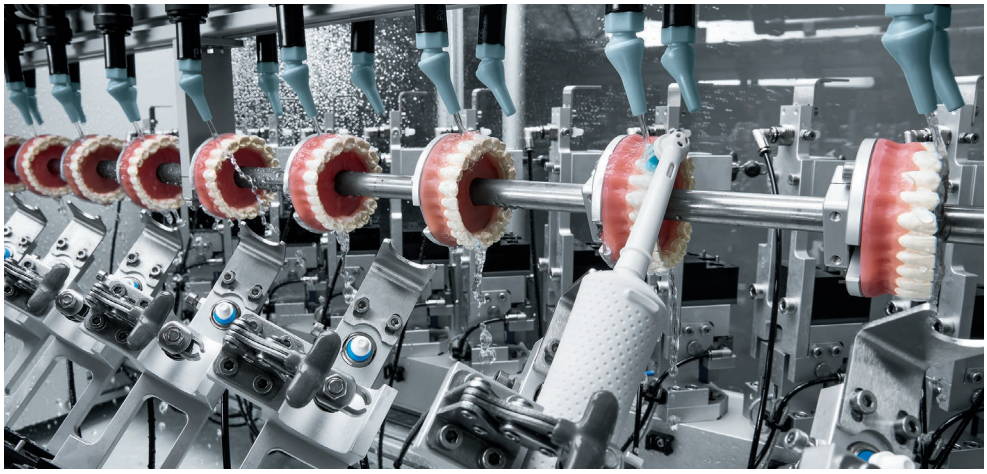
Ophthalmology
- Controlling pneumatically operated surgical tools for cataract surgery



Dialysis for kidney diseases
- Regulating pressure for controlling the flow of liquids

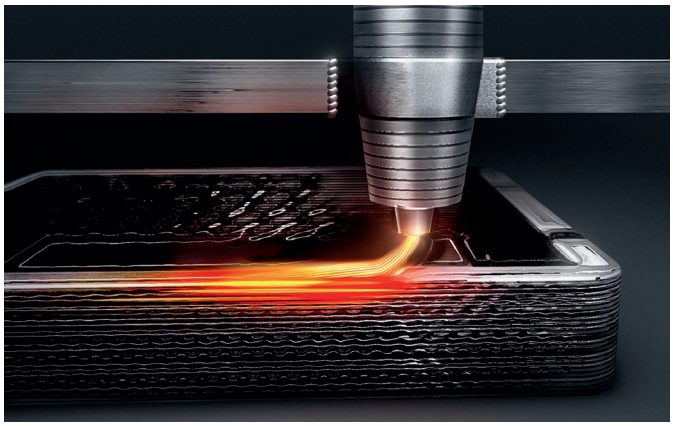
Medical mattresses and compression therapy
- Anti-decubitus mattresses against bed sores
- Devices for lymphatic drainage and compression applications

Piezo technology in industrial applications



Compact and energy-saving: tests to simulate cleaning teeth
To simulate people's behaviour as realistically as possible, 24 proportional pressure regulators VEAB from Festo control the contact pressure here in a constant and gradual process. In comparison with other proportional solutions, they are very reasonably priced, extremely compact and ultra-quiet.

The one-cable solution with standard connectors also makes the proportional valves extremely easy to install on a mounting plate. The valves VEAB can be placed close to the application or in a small control cabinet, which saves a significant amount of space. Thanks to their low energy consumption, they generate almost no heat and can be packed extremely closely together.



Faster and more versatile: build-up welding with argon
With build-up welding, the material is applied in layers. This is done with the help of a laser that applies layer after layer of metal or plastic powder and fuses them. These additively manufactured, complex components can be produced as a single, cohesive piece. The shape doesn't matter.

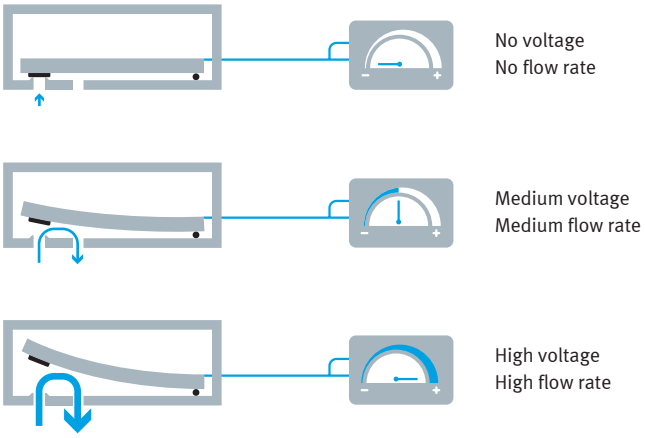
The powder is transported using argon. When dosing the powder in the laser, an appropriate amount of argon is added. The VEMD is suitable for this task when it is recalibrated for use with argon. This solution is significantly more cost-effective than conventional mass flow controllers, enabling enormous cost savings per machine.

2/2-way proportional valves with piezo technology

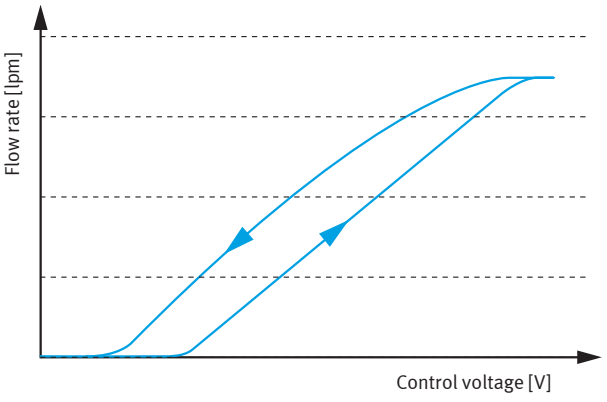
Flow control
The 2/2-way proportional valve controls, for example, the precise supply and metering of oxygen in oxygen therapy devices during inhalation. In combination with a flow sensor and control electronics it turns into a proportional flow control valve.

Specific opening to feed in/dose gases or gas mixtures

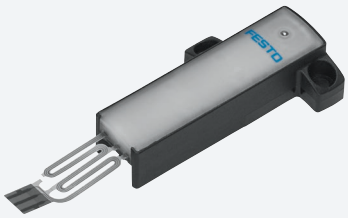
With a flow sensor and control electronics it becomes a proportional flow control valve
This makes piezo valves infinitely adjustable and simplifies the dosing of concentrations.



Characteristics of the 2/2-way proportional valve
A piezo valve is subject to hysteresis characteristics just like proportional solenoid valves. When combined with a flow sensor and control electronics, a linear characteristic can be achieved.

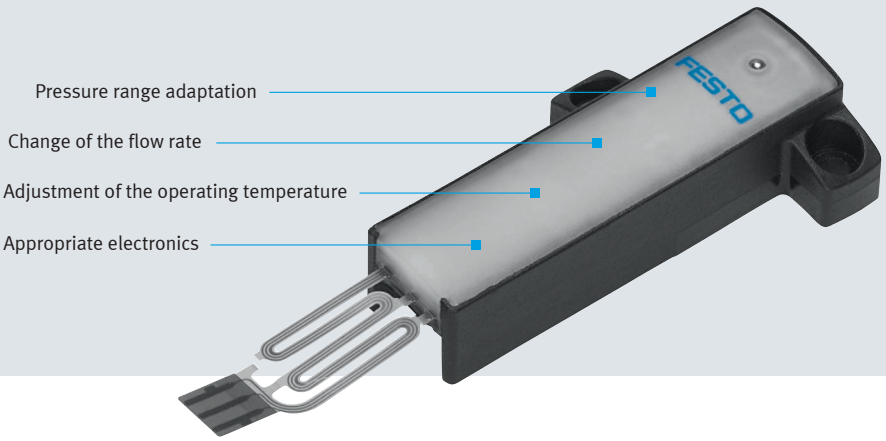


Flow in relation to the control voltage (sample curve)



Proportional valve VEMR	
Valve function	2/2-way valve (normally closed)
Connection type	Flange
Ambient temperature	5 ... 40 °C (41 ... 104 °F); 0 ... 60 °C (32 ... 140 °F)
Nominal width [mm]	0.7; 1.2; 1.3; 1.4
Pressure range [bar]	0 ... 1.7; 0 ... 2; 0 ... 3.8; 0 ... 6
Flow rate [l/min]	0 ... 30
Media	Air, inert gases, oxygen

Proportional valve VEAE	
Valve function	2/2-way valve (normally closed)
Connection type	Flange
Ambient temperature	–10 ... +85 °C (14 ... 185 °F)
Nominal width [mm]	1.2; 1.5; 1.7
Pressure range [bar]	0 ... 3; 0 ... 6
Flow rate [l/min]	0 ... 20 lpm at 0,5 bar 0 ... 55 lpm at 5 bar 0 ... 80 lpm at 6 bar
Media	Air, inert gases, oxygen



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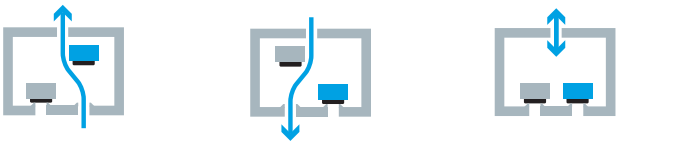
3/3-way proportional valves with piezo technology

Pressure regulation
For controlling pressure, for example in lymph drainage devices. The special bender actuator works on the basis of differential movements and thus provides almost complete compensation for temperature-related errors. In combination with a pressure sensor and control electronics the 3/3-way proportional valve turns into a proportional pressure regulating valve.

Gap-type bending actuator: three functions in one valve

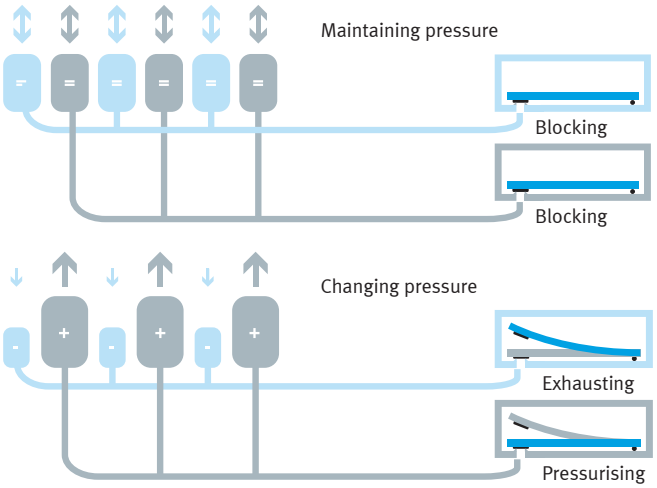


Supply air
Pressure is increased

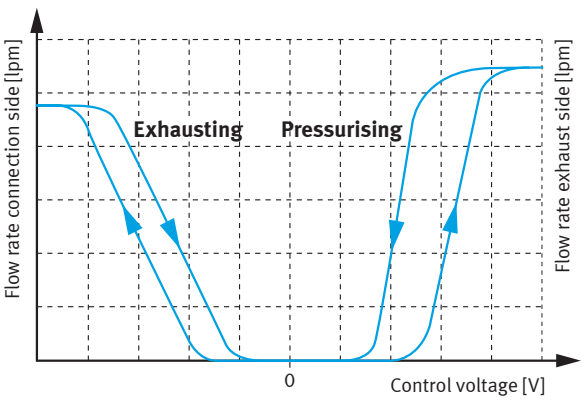
Exhaust air
Pressure is reduced

Valve normally closed
No air flow
Pressure is maintained

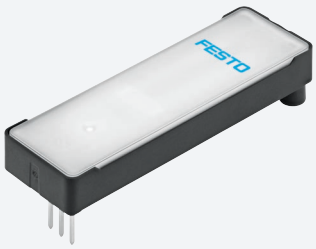
With pressure sensor and control electronics it becomes a proportional pressure regulating valve
Controlled pressure increase and decrease with soft-start function.



Characteristics of the 3/3-way proportional valve
Flow in relation to the control voltage (sample curve).



Proportional valve VEMC	
Valve function	3/3-way valve (normally closed)
Connection type	Flange
Ambient temperature	5 ... 40 °C (41 ... 104 °F)
Nominal width [mm]	0.9
Pressure range [bar]	0 ... 2
Flow rate [l/min]	0 ... 16 at 2 bar
Media	Air, inert gases, oxygen



Proportional valve VEMP	
Valve function	3/3-way valve (normally closed)
Connection type	Flange
Ambient temperature	–10 °C ... +60 °C (14 °F ... 140 °F)
Nominal width [mm]	1.3; 1.6
Pressure range [bar]	0 ... 0.7; 0 ... 1.1; 0 ... 1.7
Flow rate [l/min]	0 ... 27 at 1.5 bar
Media	Air, inert gases, oxygen

Proportional valve VEA1	
Valve function	3/3-way valve (normally closed)
Connection type	Flange
Ambient temperature	5 ... 40 °C (41 ... 104 °F); 0 ... 60 °C (32 ... 140 °F)
Nominal width [mm]	0.4
Pressure range [bar]	0 ... 10
Flow rate [l/min]	0 ... 14 at 10 bar
Media	Air, inert gases

E-box VAVE-P: electronics module for piezo valves

Simple and effective
The simple open-loop control electronics are suitable for the Festo portfolio of piezo valves. Voltage generation and the 2-channel driver stage with current limitation for the piezo valves are built in.

Suitable for all piezo valves
The piezo E-box VAVE-P comes in a number of variants that are suitable for all piezo valves from Festo. The two channels can each be used for two 2/2-way piezo valves VEMR and VEAE or one 3/3-way piezo valve VEMC and VEMP.

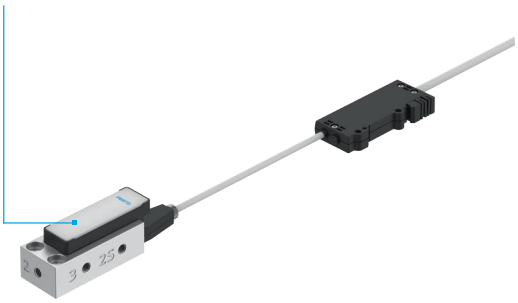
Electrical connection	300 mm cable with open wires at the end, 100 mm cable to the piezo valve
Supply voltage	12 ... 24 V DC ±10%
Input voltage	0 ... 10 V DC 10 V leads to 310V at the piezo output
Operating temperature	–10 °C ... 60 °C

The variants

VEMC

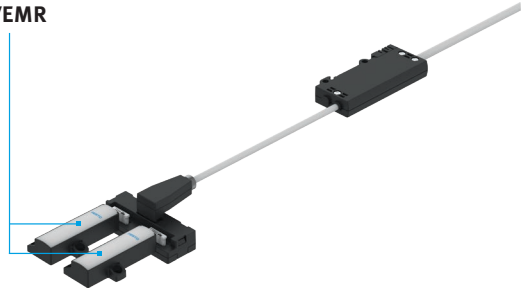
E-box for piezo valve VEMC

VEMP



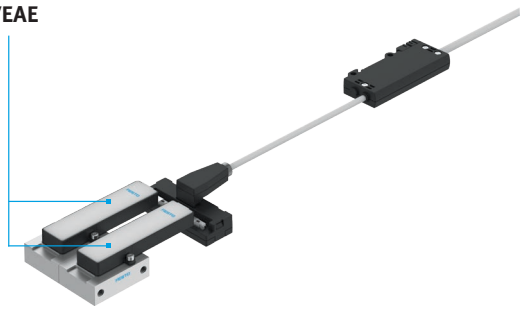
E-box for piezo valve VEMP or the plug base

VEMR



E-box and plug base for two piezo valves VEMR

VEAE

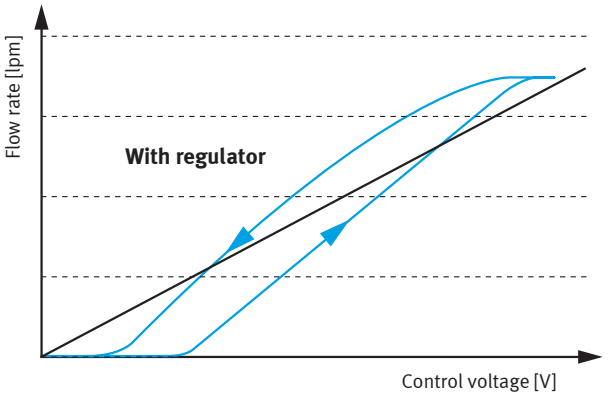


E-box and plug base for two piezo valves VEAE

To connect two piezo valves VEMR, you need the E-box for VEMP/plug base and the plug base for the piezo valves VEMR; for two piezo valves VEAE you need the E-box for VEMP/plug base and the plug base for the piezo valves VEAE.

Pressure/flow regulating valve

Linear characteristic curve
A proportional valve with piezo technology is subject to hysteresis – just like a proportional solenoid valve – and thus has a non-linear characteristic curve. If you add a sensor and control electronics, the result is a linear correlation between control voltage and the outlet pressure or flow rate.



Proportional flow control valve VEMD
Mass flow controller (MFC) specifically for medical applications such as dosing oxygen. It is very quiet and precise and has short response times. Compact module with 2/2-way valve, flow sensor and control electronics.

VEMD	
Valve function	2/2-way valve (normally closed)
Connection type	UNF10-32, M5
Ambient temperature	0 ... 40 °C (32 ... 113 °F)
Nominal width [mm]	1.4
Pressure range [bar]	0 ... 2
Flow rate [l/min]	0 ... 20 at 2 bar
Media	Oxygen, air, inert gases

Proportional pressure regulating valve VEAA/VEAB
3/3-way valve including pressure sensor and control electronics. Ideal for many applications with pressure regulation for vacuum supply pressure up to 6 bar. Its short response times of ‹10 ms are impressive, as is its highly precise pressure regulation and very low power consumption. Without switching noises!

VEAA/VEAB	
Valve function	3/3-way valve (normally closed)
Connection type	Plug connector for 4 mm tubing
Ambient temperature	0 ... 60 °C (32 ... 140 °F)
Nominal width [mm]	0.4; 0.7; 1.4
Pressure range [bar]	VEAA: 2; 6; 10 VEAB: –1; 0.2; 1; 2; 6
Flow rate [l/min]	VEAA: 0 ... 7 at 6 bar VEAB: 0 ... 20 at 6 bar
Media	Air, inert gases

Robots for training purposes

Piezo technology from Festo simulates lifelike movements


01

To help future dentists and dental assistants practise dealing with young children, the Japanese company tmsuk has developed a humanoid robot that can realistically simulate the behaviour of children, complete with fidgeting, flinching or closing the mouth. The dummy's realistic movements are produced using proportional pressure regulators with piezo technology from Festo.

This kind of simulation robot is more than practical when preparing for young patients who experience anxiety, loss of blood pressure and shock. After all, it is not really feasible to practise on real people when teaching dentistry and oral surgery.

Pneumatic robot

The Pedia Roid is 110 cm tall and weighs 23 kg, equivalent to a five-year-old, and sometimes needs to be held by the limbs during treatment simulations. While this could damage the gear unit and spindles of electric drives, the Pedia Roid's pneumatic design has proven itself to be extremely sturdy and flexible.

Smooth movements with piezo technology

The secret to the smooth, lifelike movements is the piezo technology of the proportional pressure regulators VEAA and VEAB from Festo used in the robot. They control most of the robot's 24 pneumatic cylinders and deliver the deceptively realistic movements of the arms, legs and fingers as well as the mouth, eyelids and irises. Virtually silent and with low energy consumption, they do not make the clicking sounds that classic pneumatic solenoid valves make when they switch.

Customer application

01: Whether it's fidgeting, flinching or suddenly closing the mouth, the humanoid training robot simulates the possible behaviour of children during a dental treatment. (photo: tmsuk)

02: The Pedia Roid robot for training dentists and dental assistants with piezo technology for simulating realistic movements. (photo: tmsuk)

“We would not have been able to realise this humanoid robot without piezo technology,” explains Yusuke Ishii, Director of tmsuk. The proportional pressure regulators VEAA/VEAB are 3/3-way valves with a pressure sensor and control electronics. Thanks to piezo technology, they require virtually no energy to maintain an active state compared with solenoid valves.

Long service life, small footprint

The design of the proportional pressure regulators VEAA/VEAB makes them resistant to wear and capable of achieving a high number of cycles. Thanks to their low intrinsic weight and space-saving installation, they are particularly suitable for pressure regulation applications with low to very low cylinder air consumption, and for applications requiring high dynamic response.

Silent, smooth and fast thanks to piezo technology: the proportional pressure regulators VEAA/VEAB. (photo: Festo SE & Co. KG)

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