V

nnovative design engineers are constantly finding new ways to do things in the area of control, and Clippard has once again provided a product that complements that innovation, contributing to our mission "to provide high quality miniature pneumatic components at economical prices".

In addition to the EVP Proportional Control Valve, Clippard offers thousands of other valves plus many other product lines as illustrated in a 600-page full color catalog.



# EVP Series Proportional Control Valves—the Next Generation of Flow Control!



Low power, fast response

A variety of easy mounting options are available



Fixed core provides variable power

Patented flexing spider armature provides precise flow control!



# **Quality in Manufacturing**

Quality remains a primary feature of every product Clippard produces. This is achieved through the excellence in manufacturing practices and craftsmanship that



Clippard Minimatic® miniature products have evolved into a widely used system of fluid power control devices, known for quality, value and performance.

has continued throughout the years. The high standards set by Leonard Clippard, in company relationships with customers, distributors, suppliers and employees continue to be upheld.



The company motto, "Quality People, Quality Products", emphasizes the important role every employee plays in maintaining the company's reputation. Over the past five decades, a diverse range of industries throughout the world have come to rely on Minimatics to control machines, systems and processes through an unlimited list of applications. Clippard's quality in design, engineering, and manufacturing, as well as expansive produce offering, make Clippard the preferred choice for miniature and sub-miniature pneumatic applications.

Our diverse range of valves is supported by an experienced team of engineers and application specialists devoted to finding a solution to all your engineering challenges.





#### Web Site

Clippard's complete line of Minimatic® Control Devices includes over 5,000 standard products. Some of the many products offered include valves, cylinders, fittings, modular components,

push buttons, stainless steel cylinders, electronic manifold cards, circuit analyzers and pre-piped manifold subplates. Visit www.clippard.com to find complete product information and specifications, engineering drawings, product configurators, ordering information, literature downloads, useful calculators, technical assistance, distributor Information and more.



#### **Full-Line Catalog**

Clippard offers a complete fullline, 400 page catalog which displays product photos, technical specifications and drawings, design tips and more. Request your free copy today.



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Controllability and overall value are the main features of the EVP Proportional Valve series. The valve may be controlled using DC current, open- or closed-loop control, and even PWM (pulse width modulation) to cover a broad range of applications.

Clippard is pleased to add the EVP series proportional control valve to our Electronic Valve product line. This product combines the features of the existing EV series valve—long life, low power, and Clippard's reputation for high quality components with the additional capability of proportional control.

The EVP series valve provides air or gas flow control, and varies the output flow based on the current input to the solenoid. The consistent gain (see graph) of this valve provides a high degree of control for many applications.

### **FEATURES & BENEFITS**

Fast Response • Long Life Small Package • Single Moving Part— Low Friction and Wear Five Orifice Sizes Three Voltage Ranges Three Connection Styles Two Mounting Types Three Seal Options Convenient Accessories

### **DESIGNED FOR**

Analytical Instruments Gas Chromatography • Automotive Dialysis • Blood Pressure Monitors Mass Flow Control • Respirators/ Ventilators • Patient Simulators Precise Pressure Control Semiconductor-CMP • Gas Controllers Many more!





### 513.521.4261 • www.clippard.com/evp-tr



Valve Type:	2-Way, Proportional
Medium:	Air, Gases
Temperature Range:	32° to 120°F
	(0° to 50°C)
<b>Power Consumption:</b>	1.9 watts at 23°C
	2.3 watts max.
Mounting:	In-line or Manifold
Ports:	#10-32 Female (In-line)
	#10-32 Male Stud (Manifold)
Seal Material:	Buna-N Standard; Viton®,
	EPDM and others available
Maximum Hysteresis:	10% of full current

Orifice Diameter	Rated Pressure	Flow Maxii Current	v at num (±10%)
Inches	psig	slpm	scfh
0.009	100	2.7	5.7
0.013	100	6.7	14.2
0.025	100	23.5	50.0
0.040	50	19.0	40.0
0.060	25	14.0	30.0



	Nominal Voltage	Input Current	Coil Resistance	Max. Voltage
	Range at 23°C	Range	at 23°C	Required
-	0 - 5 vdc	0 - 0.370 amps	13.5 ohms	6.2 vdc
	0 - 10 vdc	0 - 0.185 amps	54 ohms	12.4 vdc
	0 - 20 vdc	0 - 0.092 amps	218 ohms	24.8 vdc

### Standard & Manifold Mount Models





All dimensions are stated in inches (millimeters)

## **Coil Styles**



EC 0.025" Pin Connector

EV 18" Wire Leads, 26 Gauge



ET 0.110" x 0.020" Space Connector



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### **Multi-Valve Manifolds**



8 Valves Mounted on #15482-8

# **Specialized Manifolds**

**Pilot Manifolds** allow proportional valve to be easily adapted to any air-piloted device using a 1/8" NPT connection.





All dimensions are stated in inches (millimeters)

# Models 15481-4 and 15482-8



15481-4 Mounts Four Valves on One Side Only15482-8 Mounts Eight Valves, Four Each on Opposite Sides

## Models 15481-6 and 15482-12



15481-6 Mounts Six Valves on One Side Only15482-12 Mounts 12 Valves, Six Each on Opposite Sides

**Single Supply Manifolds** use a 1/8" NPT male inlet to allow for secure mounting. #10-32 port outlet.





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3831

#26 wire.

Insulated lug connectors are

available for wiring up leads to

connect electronic circuit to ET

style valves. Accepts #22, #24 or

# Connectors



#### ET-C48 ET-C120

Black molded lug connectors are available for easy push on connection. ET-C48 is 48" in length, ET-C120 is 120" in length.

#### C2-RB18

AMP connector #103959-1 with 18" wire leads for EC valves.

All dimensions are stated in inches (millimeters)

# **Order Information**

Electrical Connection		Mounting		Voltage		Orifice Options		Maximum Pressure		Seal	
	Order No.		Order No.		Order No.		Order No.	*see note	Order No.		Order No.
Connector	С	Base	(blank)	0 to 5 vdc	05	0.009″ dia.	09	25 psig	25	Buna-N	(blank)
Terminal	Т	Mount		0 to 10 vdc	10			50 psig	50	EPDM	E
Spades		Manifold	м	0 to 20 vdc	20			100 psig	A0	Viton®	V
Wire Leads	V	Mount				0.013″ dia. 0.025″ dia.	13 25	25 psig 50 psig 100 psig 25 psig 50 psig 100 psig	25 50 A0 25 50 A0	1	
	V					0.040″ dia. 0.060″ dia.	40 60	25 psig 50 psig 25 psig	25 50 25		V
Part Number		- P		-		-				-	

\* Note: The EVP Proportional Valve can be calibrated for pressures less than the maximum shown here. Lower pressures may be substituted, and will be used for calibration. The pressures shown above are standard options. For pressures less than 10 psig, please consult factory.



# FLUID POWER

# Proportional valves eliminate design headaches

New design produces consistent flow and gain.

# Paul Gant Rich Humason

Clippard Instrument Laboratory Cincinnati, Ohio *www.clippard.com* 

Proportional valves are a great alternative when an application requires more than on-off control, but not the high precision and expense of servo valves. As such, proportional valves are widely used in a multitude of applications, including the control of gas and air flow from medical respirators, dialysis machines, and paint-delivery and semiconductor-manufacturing systems.

The beauty of the valves is the ease with which they can vary the rate of flow, with output proportional to input current. However, most such valves have several major characteristics that can make precise control difficult, including hysteresis and variable maximum flow and gain.

Hysteresis can be as high as 15%, which can wreak havoc in a closed-loop control system. The second problem is maximum flow can vary significantly from one unit to another of the same size and from the same manufacturer. Finally, gain tends to vary from one unit to another with the current generation of valves. Gain for a proportional valve is the rate of flow change in response to a change in valve input current. Variations in gain result in a large performance envelope for a given family of valves. This puts the burden on the OEM to adapt its design to compensate for these variations when performance of the end product is to be identical from one machine to another. Design, installation, and testing can be laborious and expensive when trying to achieve matched performance levels.

Gain varies from valve to valve mainly because of mechanical and geometrical tolerances in normal



The EVP proportional valve has standard and manifold mounting options, a variety of orifice sizes and control voltage ranges, and three different electrical connectors

manufacturing processes. Most manufacturers use a chemically-etched or stamped flat spring to counter-act plunger or armature movement. Electric current in the valve coil creates a magnetic force that pulls the armature. Manufacturers tend to compensate for variations in gain and flow by making the valve's specification window quite large.



Clippard Instrument Laboratory has developed a new proportional valve, the EVP Series, that significantly reduces the variation in gain. It is based on the reliable and rugged design of the company's EV Series directional valve, which combines a simple design, low-power consumption, fast response, and long life—exceeding a billion cycles in some operations. The armature is the heart of the valve. It resembles a metal spider with flexing legs.



This new spider and included mating surface provide proportional flow characteristics. A key advantage of the new valve is its factory-adjustable core. core enables The the adjustment of the magnetic field to compensate for mechanical tolerance variations which plague other proportional valves.

For example, press fitting the core closer to the armature increases the magnetic field and creates more force or pull on the armature. This design makes it possible to control the magnetic field strength on

the armature.

Therefore, even with varying spring rates and mechanical part tolerances, the new design provides a consistent gain relationship between flow rate and electrical current. Consistent valve gains will greatly improve closed-loop systems that need precise control at ramp up and ramp down. Morepredictable gain will also improve PID-algorithm control and lessen the chance of instability. In addition, there will be relatively consistent linear

gain over the entire flow range. The value also maintains tighter tolerances on maximum flow,  $\pm 10\%$  or better.

The EVP valves can enhance proportional control in analytical machines, mass-flow controllers, and medical applications such as non-invasive blood-pressure monitoring, dialysis, and respirators. The valve is also suited for a host of other control applications, including anesthesia machines, gas chromatograph equipment, paint-delivery mass-flow systems, controllers, and semi-conductor CMP (chemical-mechanical-planarization) Finally, adding a pressure operations. sensor and comparator circuit results in an economical electronic pressure controller.

# Hydraulics & Pneumatics

# Proportional valve design meets control system challenges

lippard Instrument Laboratory, long a pioneer in the miniature pneumatic industry, has achieved a breakthough in proportional valve technology with the introduction of the EVP series proportional valve. 1974. Clippard Since (clippard.com) has produced the EV series valve, said to combine simplicity of design, low power, fast operation and long life (applications have exceeded 3 billion cycles with a single valve), resulting in one of the most successful and reliable products in its 60+ year history.

The heart of the valve is the armature, which is the valve's only moving part. Dubbed the 'spider' because of its flexing 'legs,' it has contributed to make the EV valve both very reliable and versatile. This valve has been used in thousands of applications by OEMs with exacting requirements.

Now the spider has again provided the spark for a new product series for Clippard. By re-engineering the (now) conventional spider element, an engineering team at Clippard has created a valve which provides a variable output flow that is proportional to input current. The unique and patented design of the new proportional valve delivers an accurately positioned spider giving a precise, variable output flow. This provides the OEM design engineer what he needs to solve control system challenges for a wide variety of applications.

When considering the existing state of proportional control in analytical machines, mass flow controllers, and medical applications (especially noninvasive blood pressure monitoring, dialysis, and respirators), Clippard saw some challenges. Valves currently on the market can have a hysteresis as high as 15% that can wreak havoc in open- or closed-loop control systems. Valve-to-valve variation in the maximum flow can cause problems, as well. Lastly, the variation in gain that is typical with the current generation of valves can cause the design engineer the most headaches.

The gain of a proportional valve is the rate of flow change to valve input current. Differences in the gain of a given valve cause the performance envelope to be quite large, putting the burden on the OEM to make its equipment adapt to those weaknesses.

In order to improve all three of these characteristics, while still providing a good value, Clippard's redesign of the proven spider element and the sloped ramp that it acts upon needed to achieve a better result. As it tackled these challenges, one of the unique characteristics of the original EV valve, its factory-adjustable core, proved to have a decisive advantage over existing proportional valves.

It gives Clippard the ability to adjust the magnetic field to compensate for the mechanical tolerance limitations with which all proportional valve manufacturers have had to contend. As a result, the Clippard proportional valve has an improved maximum flow variation - as little as  $\pm 10\%$  - and also has more consistency and linearity of gain. These two improvements should prove to make the OEM design engineers job much easier, due to better controllability.

The main cause of varying gains from valve to valve is the mechanical geometrical and tolerances that occur in normal manufacturing processes. Most manufacturers use a chemicallyetched or stamped flat spring to resist plunger or armature movement. The spring, in conjunction with the surface it makes contact with, is used to create the proportionality between flow rate and valve coil current. As

electrical current is increased the armature is subjected to a magnetic field. The magnetic field creates a magnetic force on the armature that pulls on it. The flat spring resists this travel until the magnetic force on the armature equals the force that the flat spring subjects on the armature.

The flat spring is the critical component in maintaining consistent gains from valve to valve. But typical tolerances for flat springs can cause changes in spring rate. For example, the spring rate of flat springs is inversely proportional to the thickness of the material it is made of to the third power. Which means that if manufacturer's tolerances vary by 5% in thickness, a spring rate fluctuation of 35% could exist. Therefore, large swings in gains will exist when there is only slight variations in flat spring thickness.

Clippard's unique design incorporates a low mass element, properly selected materials and virtually no friction. These design elements are combined to produce a valve that is highly responsive, has a long life and exhibits a hysteresis of less than 10%. This means a much improved platform for use in open- and closed- loop control systems.

Ventilators, anesthesia machines, non-invasive blood pressure monitoring, gas chromatograph equipment, and a host of other control applications are suitable for the Clippard valve. In addition, applications from paint delivery systems and flow controllers to semiconductor CMP and environmental analysis can use the EVP proportional valve. Technically speaking, this valve controls flow - but add a pressure sensor and comparator circuit, and you have an electronic pressure controller.



Sectional view of the EVP proportional valve: By press fitting the core closer to the armature, Clippard has increased the magnetic field to create more pull on the armature. The result is a tolerance of  $\pm 10\%$  of maximum flow or better.

The EVP proportional valve is offered with standard and manifold mounting options, a variety of orifice sizes and control voltage ranges, and three difference electrical connector options.



Above: Two typical valve performance curves of a competitor's valve. To compensate for the extreme variations of valve gains, the specification window has been made quite large. Since the gains from valve to valve vary, so does the maximum flow of the valve. Below: A typical Clippard proportional valve hysteresis curve. A relatively consistent linear gain over the entire flow range is much better than the typical "S" shaped gain offered in the market now.

# NEWS

#### FLUID POWER



**BREATHE DEEP:** Not just for respirators, Clippard's EVP valve can control flowing gas chromatographs and anesthesia machines as well.

#### **PNEUMATICS**

# **Proportional Valve Could Improve Respirators**

Cutting parts count boosts accuracy, life

Designers of ventilators, respirators, and blood pressure monitors could benefit from a new proportional pneumatic valve that reportedly offers greater air flow control accuracy.

The new valve, introduced by Clippard Instrument Laboratory, Inc. (Cincinnati, OH; www.clippard.com) and known as the EVP, uses a design that incorporates only one moving part to improve accuracy and boost its life.

"We have a maximum flow accuracy of ±10%," notes Paul Gant, International Sales Manager. "And at a minimum, we expect its life to be between 200 million and 300 million cycles," he adds.

Clippard executives say they foresee the new pneumatic valve being employed in mass flow controllers, gas chromatographs, and anesthesia machines, in addition to respirators and ventilators. The valve's long life could make it particularly desirable in such applications where human lives could depend on its ability to keep operating. The EVP joins other small (20-25 l/min flow rate) proportional pneumatic valves in providing a variable output flow that is proportional to an input current. The company says that its valve differs, however, in its ability to consistently and accurately meter flow.

"Valves currently on the market can have a hysteresis as high as 15% that can wreak havoc in a closed loop control system," Gant says. SPIDER accurat

The company claims that such problems can undermine flow accuracy, thus placing a burden on equipment designers to make their products adapt to those weaknesses.

Clippard engineers say they solved those problems by employing a variation on a time-tested design that the company has employed in its other pneumatic valves. By using a diaphragm-like device that the company calls a "spider", Clippard engineers say they were able to create a valve that offers a variable output flow that is truly proportional to input current.

The flat, circular "spider" accomplishes that by acting as a spring in the one direction and a magnet in the other. Made from a magnetic material, it is attracted to the force of a magnetic field. As a result, when current is applied to the electrical coil in the valve, the spider is drawn away from the closed orifice of the valve When current is removed, the spring force causes the spider to flex back to its original position, thus closing the valve's orifice. "The more current that is applied to the coil, the more the spider moves away from the closed orifice," Gant explains.

The orifice's opening is always proportional to the amount of current applied. Clippard engineers claim that their new proportional valve's hysteresis is less that 10% of full current over its entire flow regime. Moreover, they say that the use of only one moving part eliminates sliding friction inside the valve, causing it to be consistently accurate throughout its useful life.

"Mechanical friction causes accuracy problems, which we eliminate because the spider is our only moving part," Gant says. "That's the real benefit of this valve: It's accurate throughout its life."

SPIDER INSIDE: Using Clippard's magnet/spring "spider" accurately proportions valve opening to input current.



**Edited by Stephen Mraz** 

# **Proportional valve** gives precise, variable flow



To solve these problem Clippard Instrument Laboratory, Cincinnati (www.clippard.com), redesigned its EV valves, combining elements of low power and fast operation with a single moving part of provide a high cycle life. They found these characteristics could be used to make superior proportional valves.

The company adjusts the valve's magnetic field to compensate for mechanical tolerance limitations. This adjustment, combined with a low-mass element and virtually no internal friction, makes gain more consistent and linear. Maximum flow variation is held to  $\pm 10\%$ , and hysteresis to less than 10%, thus improving performance of most closed-loop systems.

The new valves, dubbed the EVP Series, are said to provide the same reliability and long life as the company's EV valves. The new valves have standard and manifold mounting options, a variety of orifice sizes and control voltage ranges, and three electrical connector options.







# PROPORTIONAL VALVE OVERCOMES LIMITATIONS

Application of proportional pneumatic controls has been hampered by inconsistent valve performance, which prompted development of a new valve that overcomes these limitations.

Since 1974, Clippard Instrument Laboratory has produced their EV series valve, which combines simple design, low power consumption, fast operation, and long life (applications have exceeded 3 billion cycles with a single valve). The heart of that valve is its armature, which is the only moving part. Dubbed the spider, because of its flexing legs, it has helped make the EV valve reliable and versatile enough to be used in thousands of applications.

Now, the spider has again provided the spark for a new product series. By re-engineering the (now) conventional spider element, an engineering team at Clippard added another dimension to the valve variable output flow that is proportional to input current. The result is the new EVP valve.

### What's out there

When considering the existing state of proportional control in analytical machines, mass flow controllers, and medical



Redesigning a spider-shaped armature allowed Clippard to develop a proportional valve with low hysteresis, plus consistent maximum flow and gain from one valve to another.

# PNEUMATIC SYSTEMS

applications, Clippard found that existing valves can exhibit hysteresis as high as 15%. This can present serious limitations to both open- and closedloop control systems. Second, variation in the maximum flow from one valve to another can cause problems. And third, variation in gain typically found in the current generation of valves can cause similar problems.

The gain of a proportional valve is the rate of flow change to valve input current. Differences in the gain of a given valve can cause the performance envelope to be quite large, putting the burden on the OEM to make their equipment adapt to the limitations of high hysteresis, maximum flow variation, and non-uniform gain.

### A need for change

To improve all three of these characteristics, Clippard's efforts focused on redesigning the spider element—and the sloped ramp it acts upon. Designers found that one of the characteristics of the original EV valve, its factory-adjustable core, proved to have a decisive advantage in achieving their goals. They found that adjusting the magnetic field could compensate for the limitations imposed by mechanical tolerances.

As a result, the valve has an improved maximum flow variation—as little as  $\pm 10\%$ —and also has more consistent gain. These two improvements result in better controllability. Furthermore, the valve's low mass element, materials of construction, and virtual absence of friction combine to produce high response, long life, and hysteresis of less than 10%. And even though the valve is intended to control flow, adding a pressure sensor and comparator circuit



Near linear gain of the EVP valve and low hysteresis make it especially well suited to closed loop control applications.

produces a low-cost electronic pressure controller.

### **Causes and effects**

The main cause of gain variation from one valve to another is the mechanical and geometric tolerances that occur in manufacturing processes. Most manufacturers use a chemicallyetched or stamped flat spring to resist plunger or armature movement. The spring, in conjunction with the surface it makes contact with, creates the proportionality between flow rate and valve coil current. Increasing electrical current applied to the armature subjects it to a magnetic field, which creates a magnetic force on the armature that pulls on it. The flat spring resists this travel until the magnetic force on the armature equals the force that the

flat spring subjects on the armature.

Although the flat spring is the critical component in maintaining consistent gains from valve to valve, typical tolerances for flat springs can cause substantial changes in spring rate. For example, the spring rate of flat springs is inversely proportional to the thickness of the material it is made of to the third This means if thickness power. tolerance varies by 5%, a spring rate fluctuation of 35% could exist. Therefore, large swings in gains can exist from only slight variations in flat spring thickness.

Another limitation in the current valves is maintaining a relatively constant linear gain over the entire flow range of a valve. As seen in the illustration, the valve gain has an S shaped gain curve, rather than a consistently linear one. Also, the hysteresis of the valve is 15% of the

# PNEUMATIC SYSTEMS

full current to the valve. This can cause major problems when using this valve in a closed-loop control system.

### Adjustability it the key

This design makes it very easy to control the amount of the magnetic field strength the armature is subjected to. By simply press-fitting the core closer to the armature this will increase the magnetic field which creates more force or pull on the armature.

The adjustment of the magnetic field compensates for the mechanical tolerance problems that all proportional valve manufacturers must contend with. Therefore, even with varying spring rates and mechanical part tolerances, the valve can create a consistent gain relationship between flow rate and electrical current to the valve. Clippard can also maintain the same tight tolerances on maximum flow that it presently has on the standard EV series valves. This tolerance is ±10% of maximum flow or better.

The consistent valve gains will greatly improve closed-loop control systems that need precise control at ramp up and ramp down. The predictability of gain will allow for improved PID algorithm control and less chance of instability or inconsistencies.



you of true cost savings.

The EVP Series Valve provides air or gas flow control, and varies the output flow based on the current input to the solenoid. The consistent gain of this valve provides a high degree of control for many applications. Controllability and value are some of the features of the





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