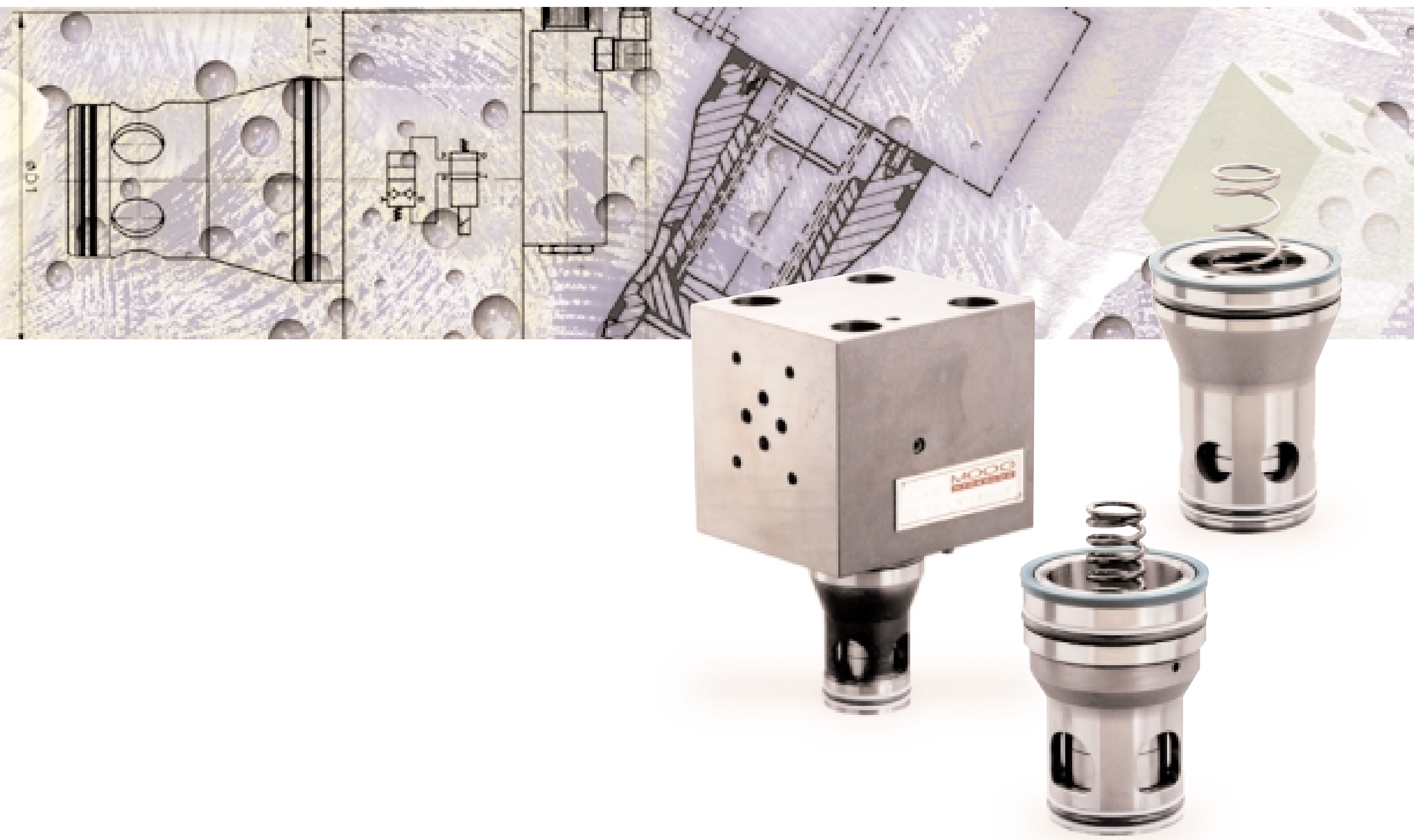
MOOG

Introduction to Cartridge Valves

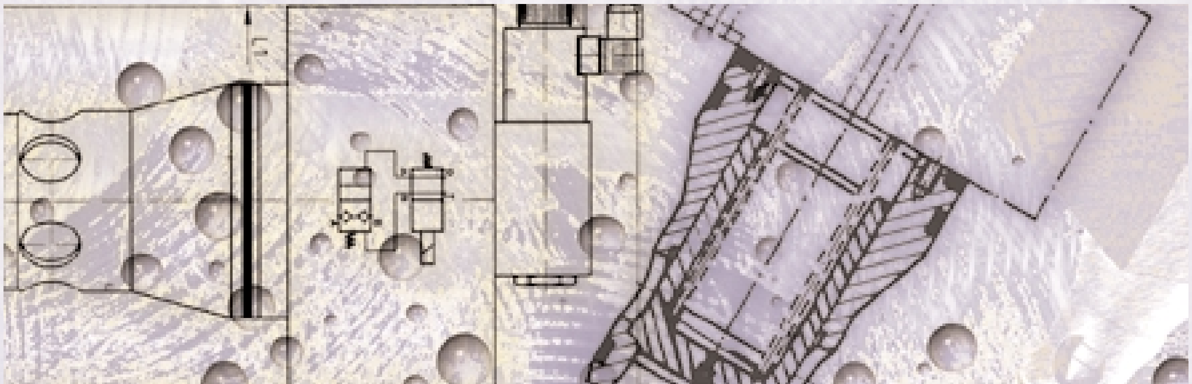


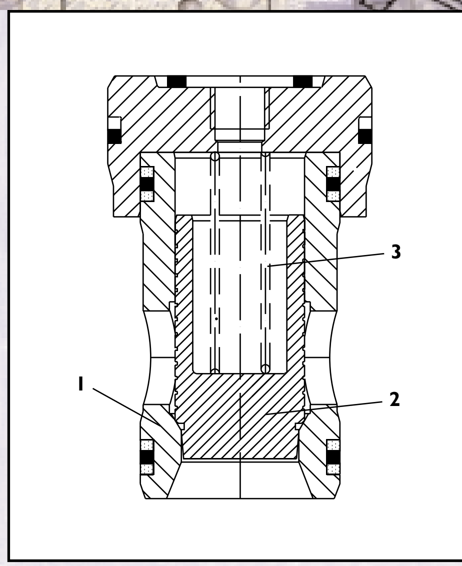
Cartridge Valves *Introduction*

The cartridge valve, with nearly 30 years of successful applications experience, holds a unique position in the fluid power industry. Its small size, fast switching speeds, and cost effective design, make it an integral part of many motion control and fluid power systems. Moog's extensive experience in the application of cartridge valve technology allows us to offer one of the most complete line of cartridge valves, ranging in sizes from 16 to 160, as per DIN standard 24342 for sizes 16 to 100. In addition to our standard cartridge valves, Moog also offers a complete line of high flow and active cartridge valves for more specialized and higher performance fluid power systems.

The combination of different Moog cartridge valves, cover plates and if necessary, pilot valves, can lead to configurations that replicate check, directional, pressure, and flow control device functionality. Individual Moog cartridge valve catalogs illustrate how cartridge valves and cover plates can be combined to produce different functions, and present the entire product offering in a way to make ordering easy.

Cartridge Valves *Introduction*





Cartridge valves consist basically of a sleeve (1), valve poppet or cone (2), and closing spring (3).

The cartridge assembly is designed to fit within a cavity defined by DIN 24342, and is held in place and sealed by a cover.

The manifold block acts as the valve housing and contains ports A and B together with the pilot control lines.

The control cover contains the pilot control drillings, thus also acts as the connection between the pilot side of the cartridge valve (spring side and the connection X).

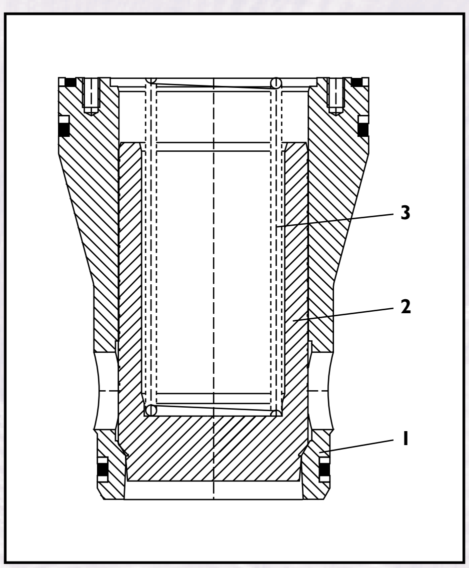


Figure 2

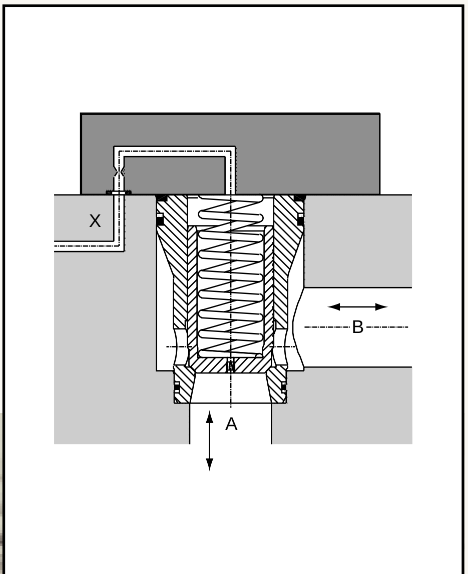
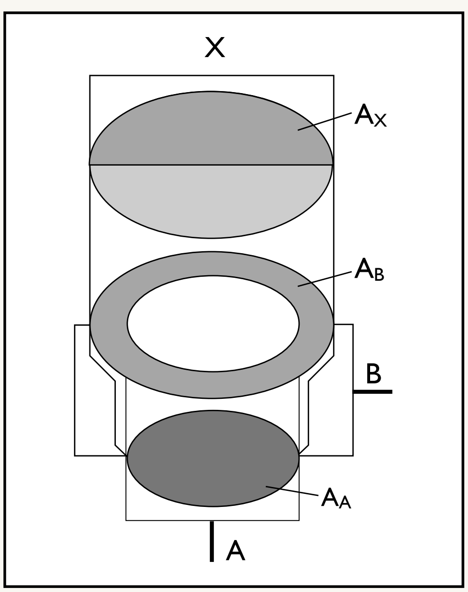


Figure 3



Cartridge valves, also known as 2/2–way valves or logic valves, have two operational ports A and B.
The flow path between these two connections is controlled hydraulically by a pilot pressure applied to X. The basic cartridge valve includes a valve poppet sleeve which is normally held in the closed position by a spring. The poppet valve has a seated cone, giving a near zero leakage (dependent upon pilot control) condition across the two ports. The closing spring is retained by the control cover which encloses the cartridge valve and provides pilot connections from the X port. Various types of pilot control can be mounted either to the control cover or to an adjacent manifold face, to provide direct control of the cartridge valve.

The effective areas of the basic element are A_A, A_B and A_X. Pilot oil can be taken from port A, B or both A and B (with a shuttle valve), or an external source. Hydraulic fluid can flow through the 2–way cartridge valve from A→B or B→A.

If a pilot valve is used, it can directly control the switching function of the cartridge valve, either between two extreme positions, open or closed, or in any number of intermediate positions. The exact position of the valve cone depends on the ratio of control surface A_X to the pressures acting from the working connections A and B on the seating surface of A_A and the annular area of A_B.
(See Figure 3)

If the valve cone is open, by reducing the pressure seen at X, then flow can move from A and B or vice-versa. By applying a control pressure at X, the working connections A to B are shut off as the valve cone is closed by the seat mounting. If there is a pressure difference between connection B and pilot connection X as a result of clearance tolerance between the cone and sleeve, then leakage can be eliminated by using a leakproof seat valve and hooking up the pilot connection X to the working connection B. If the desired function does not permit such a switching operation, a cartridge valve with an additional sealing surface can be used to seal the connections A, B and X from each other.

Cartridge Valves *How They Work*

The Operation of Logic Elements is Always Purely Pressure Dependent

The three areas which are important for the functioning of a cartridge valve are:

- The area of the valve seat A_A.
- The annulus area at port B (A_B).
- The area on the spring side A_X, which is the sum of the areas A_A and A_B.
- The ratio of A_A to A_X is normally 1:1.6 for standard cartridge valves and 1:2 for high flow valves.

The Following is then Valid:

Areas A_A and A_B operate in the opening direction. Area A_X and the spring have a closing effect on the valve. The summation of the opening and closing forces determines whether the logic element will open or close. When no pressure is applied to the valve, the poppet sits down on its seat. By applying pressure to area A_X usually from port A, or port B, or A and B via a shuttle valve, the valve poppet can allow a free connection A to B.

Closing forces

$P_X \cdot A_X$ + spring force

Opening forces

$P_A \cdot A_A$ +

$P_B \cdot A_B$

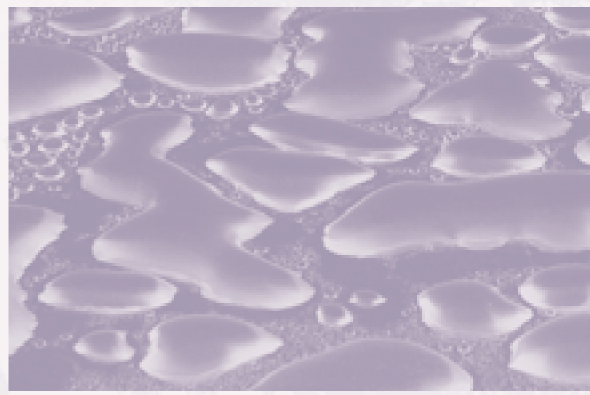
Cartridge Valves *Application*

Application

Again, cartridge valves have two working connections A and B where the main flow is hydraulically operated by a controlling current applied to the connection X.

Depending on the control input, these valves can be used as:

- ➣ Directional control valves (start, stop, directional control)
- ➣ Pressure control valves (pressure relief, pressure control, pressure sequence and unloading function)
- ➣ Check valves (check valve function and pilot operated check valve function)
- ➣ Flow control valves



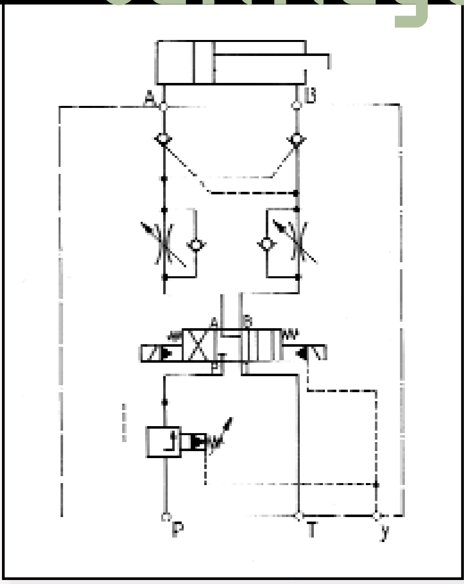
The preferred mode of mounting is the manifold block, which can be equipped with several valves depending on the hydraulic circuit for the specific application. Each valve is connected to each other in the manifold block.

The Moog manifold systems product line contains valves of nominal bores 16, 25, 32, 40, 50, 63, 80 and 100 as per DIN 24342 for flows up to 10,000 l/min., and sizes 125, 160 up to 24,000 l/min. with cover plates and pilot valves for various functions.

In addition to this, our product offering also contains cartridge housings for a great number of applications for subplate, pipe and flange mounting.

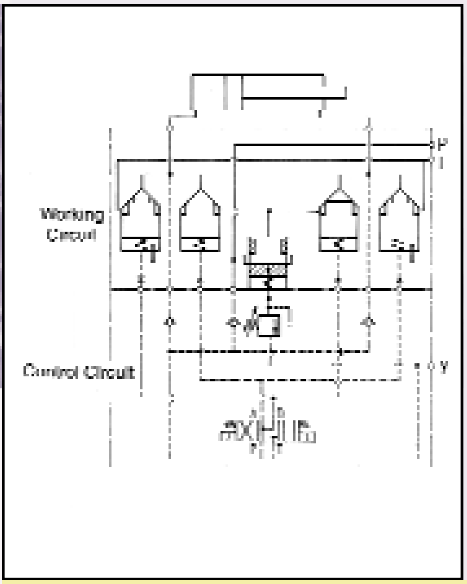
Cartridge Valves

Comparative Advantages



Conventional Control with Single Function Valves

In a conventional hydraulic system, the system's functionality is achieved by connecting single function valves in a parallel or serial fashion. The inclusion of flow, directional, pressure or check control single function valves results in a system which requires more valves, more space, greater system losses and increased weight.



Cartridge Valve Control

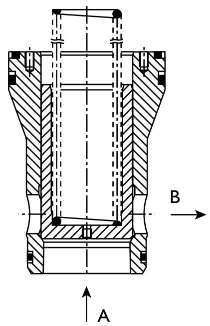
Since cartridge valves can be utilized in such a manner as to replicate the functionality of flow, pressure, directional and check control, a system comprised of cartridge valves mounted in a manifold block can be designed to reproduce the functionality of the conventional hydraulic system. The valve functionality can be relocated from the working circuit to the control circuit, thereby simplifying the circuit complexity. Furthermore, the number of space intensive single function valves is reduced, or eliminated outright, creating a space savings. Lastly, the pressure drop across a cartridge valve is often less than a corresponding single function valve, resulting in a reduction of system losses.

Features and Benefits of Cartridge Valves

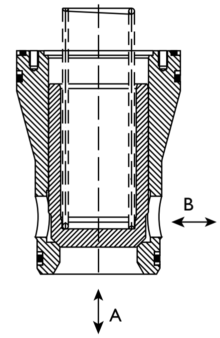
Feature	Benefit
➢ Increased power density	➢ Smaller system size
➢ Several functions at one mounting position	➢ Reduced system cost
➢ Fast switching times	➢ Enhanced system response
➢ Mounting within a manifold	➢ Reduced chance of oil leakage
➢ Soft switching	➢ Fewer system pressure spikes
➢ Single contact point within valve	➢ Improved component life
➢ Large flow range	➢ More cost effective control in high flow systems
➢ Low pressure drop	➢ Reduced energy consumption
➢ Higher permissible operating pressures (up to 5,000 psi)	➢ More cost effective control
➢ Low sensitivity to contamination	➢ Longer field life without maintenance
➢ Unlimited holding time and special safety certifications	➢ Ideal for safety circuits
➢ Insensitive to water based fluids	➢ Greater stability across all operating conditions
➢ Insensitive to high pressure drops	➢ Can be used in super high flow systems and hazardous environments

Cartridge Valves

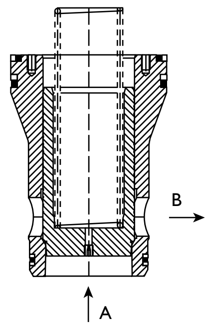
Create Single Valve Functionality



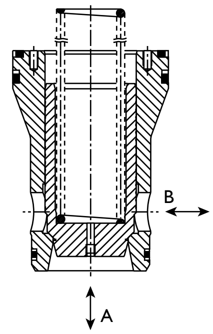
A cone/A sleeve



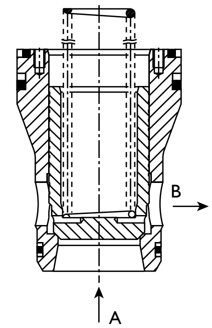
B cone/B sleeve



D cone/A sleeve



C cone/B sleeve



R cone/B sleeve

Pressure Control Valves

To reproduce the functionality of a pressure control valve, the cartridge valve is usually utilized as a main stage; therefore, the control surface area A_X and the cone surface area A_A should correspond to a ratio of 1:1 for an optimized function. This is guaranteed by a cartridge valve with cone A and the matching sleeve A. Note, however, that there can only be a flow from A to B in this cartridge valve.

In order to improve the control reaction within the same range, a cartridge cone with a dampening nose can be used. Accordingly, the cartridge is then composed of a sleeve A and a cone D with a cone ratio of 1:1.

Again, the flow direction is only from A to B.

Directional Control Valves, Check Valves and Flow Control Valves

A cartridge valve which permits flows in either direction ($A \longleftrightarrow B$), is required for directional control, check, and flow control valve applications. In these situations, cones with a control surface area A_X that is larger than the cone surface A_A ($A_X > A_A$) must be used, therefore, the cone surface area A_B must not be 0.

For directional control, check, and flow control applications, a cartridge with a sleeve B and cone B is specified. Soft switching operations are the result of the difference between control surface area A_X and cone surface A_A.

In order to avoid pressure peaks in tank circuits, or to better adjust flow control valves, the cone B can be replaced by a cone with a dampening nose such as cone C.

Check Valves

If a cartridge valve is to be used as a check valve, the control surface area A_X must be bigger than the cone surface area A_A.

A special cone R makes it possible to minimize the installation effort of the check valve function in the control unit, by eliminating the need for additional control drillings and special cartridge covers. A cartridge valve comprised of sleeve B and cone R flows freely from A to B and completely shuts off flow from B to A.

Cartridge Valves *Product Line*

The Moog Cartridge Valve Product Line

Moog's cartridge valve product line consists of three types of valves:

- ➣ Standard cartridge valves
- ➣ High flow cartridge valves
- ➣ Active cartridge valves

The below matrix illustrates the flow ranges that delineate our standard and high flow lines.

Standard and High Flow Valve Flow Rates

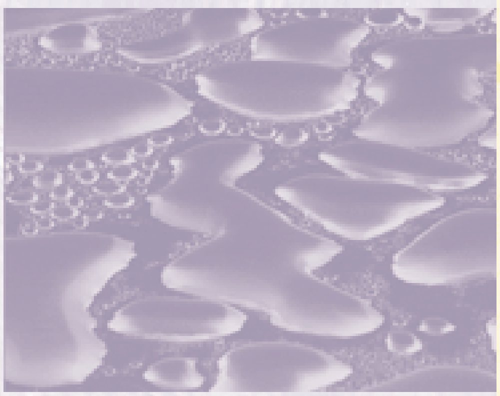
Flow at 90 psi drop (6 bar)

Size	Standard		High Flow	
NB16	53 gpm	(200 lpm)	86 gpm	(325 lpm)
NB25	120 gpm	(450 lpm)	178 gpm	(675 lpm)
NB32	225 gpm	(850 lpm)	290 gpm	(1,100 lpm)
NB40	400 gpm	(1,500 lpm)	422 gpm	(1,600 lpm)
NB50	800 gpm	(3,000 lpm)	925 gpm	(3,500 lpm)
NB63	1,200 gpm	(4,500 lpm)	1,385 gpm	(5,250 lpm)
NB80	1,850 gpm	(7,000 lpm)	2,180 gpm	(8,250 lpm)
NB100	2,640 gpm	(10,000 lpm)	3,350 gpm	(12,700 lpm)
NB125	3,700 gpm	(14,000 lpm)		
NB160	6,340 gpm	(24,000 lpm)		

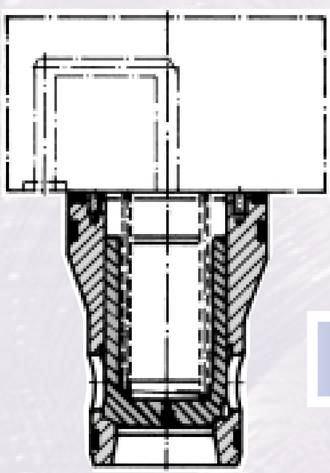
Cartridge Valves *Product Line*

Moog's active cartridge valves are a separate line of product which is based on our standard valve, but offers enhanced levels of control. Moog's active cartridges were designed to address the limitation of standard cartridges – closing time, opening time, tightness, prefill valve function, control pressure, closing under load, and lack of feedback.

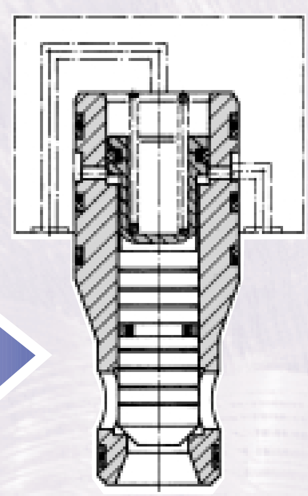
Our active cartridge valves include an additional control area, which provides enhanced control of switching forces. This enhanced level of control is critical for higher speed or faster response applications, where low system pressure can delay the closing process.



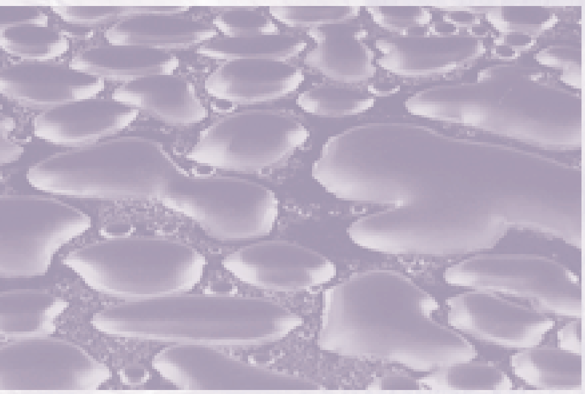
Standard Cartridge



Active Cartridge



Cartridge Valves *Unique Benefits*



The Primary Benefits of Moog's Active Cartridge Valves are:

- ➣ Large flow range
- ➣ Compact installation dimension
- ➣ Short operational times
- ➣ Minimal pressure peaks
- ➣ High functional reliability

Furthermore, Moog active cartridge valves can perform a prefill function, something traditional cartridges cannot.

In conclusion, Moog proudly offers to you our most complete line of cartridge valves yet. We present the details of each of our cartridge valves – standard flow, high flow and active – in a series of separate brochures. Each valve is profiled in its own brochure, with product options consisting of:

- ➣ Size
- ➣ Cone and sleeve configuration
- ➣ Cover type
- ➣ Orifice

Argentina
Australia
Austria
Brazil
China
England
Finland
France
Germany

India
Ireland
Italy
Japan
Korea
Luxembourg
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