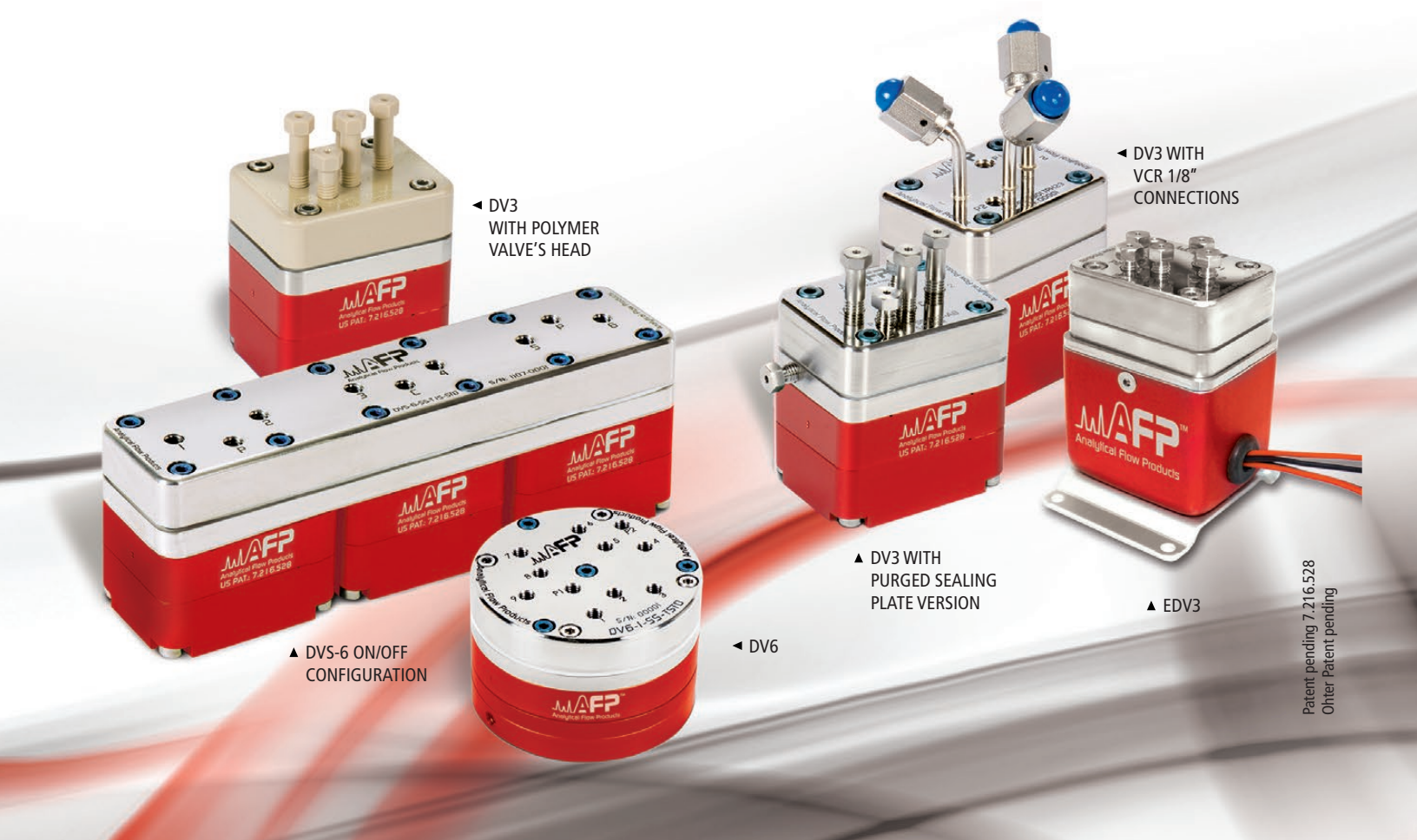
Analytical Flow Products

ANALYTICAL INSTRUMENTATION
TIGHT SHUT-OFF DIAPHRAGM VALVES



INTRODUCTION

This is the first real analytical tight shut-off diaphragm valve. They can be used in multiple places in gas chromatographic systems, auto-samplers, sampling and general instrumentation. No dead volume effects, continuous flowpath and purge system make them ideal in many situations. From simple 3-way to complex configuration with timing sequence, the job is easily done.

Wide choice of configurations, from simple pneumatic actuator to fully loaded microprocessor controlled electrical actuator.

DV series valves are available with welded tubes, VCR or analytical fittings. They can be made in a large selection of materials and configured for different operating conditions.

Have a look to the application note and see by yourself how these can make your life much easier.

DV series are also available for industrial platform, like NeSSI, see NeSSI brochure.

PRODUCTS AVAILABLE FOR ANALYTICAL INSTRUMENTATION

- **DV3, 3-way diaphragm valve**
  - Pneumatic actuation, i.e. DV3
  - Electronic actuation, i.e. EDV3
- **DVS, Sample stream selection**
  - Three configurations:
    - ON/OFF: Pneumatic or electronic actuation
    - Sample By-Pass: Pneumatic or electronic actuation
    - Double Block & Bleed: Pneumatic or electronic actuation
- **DGC, Tight shut-off diaphragm based GC injection valve**
  - Pneumatic or Electronic actuation
  - Internal or external sampling loop
- **DV6, 3 3-Way valve embedded in a compact substrate**
  - Pneumatic or electronic actuation

COMMON FEATURE DESCRIPTION

- **Purge feature to prevent inboard/outboard contamination/fugitive emission and permeation through the diaphragm (optionnal).**
- **100% Helium mass spectrometer leak tested.**
- **Elimination of any dead volume effects.**
- **Continuously sweeping flow path.**
- **Tight positive port shut-off design.**
- **Working pressure ranging from vacuum to 1000 psig.**
- **Usable with liquid or gas media.**
- **Low pressure drop.**
- **Ports are independently controlled.**
- **Pneumatic version intrinsically safe.**

FIELDS OF APPLICATION

- **Gas chromatograph/Liquid chromatograph/GCMS/LCMS**
- **On-line gas analyser/Various sampling system**
- **Automated laboratory sample injection system**
- **Sample preparation system/Sample concentration system**
- **Continuous flow analyser**
- **Purge and trap G.C. Sampler/Head space Sampling**
- **Total organic compound analyser**
- **Automated process analyser panel**
- **Refining and hydrocarbon analyser/Natural gas analyser**
- **Ion chromatographic system**
- **And more...**

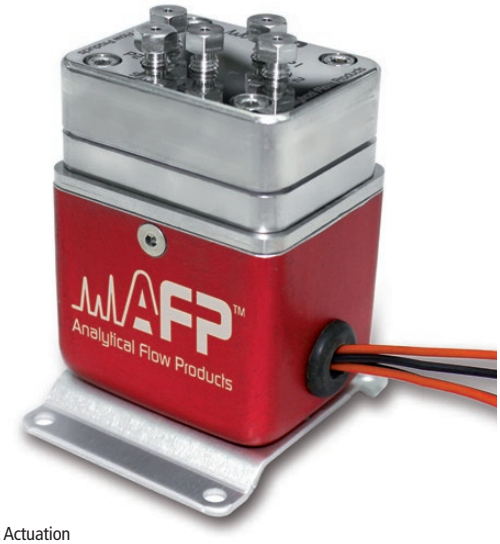
DV3-SERIES 3-WAY DIAPHRAGM VALVE

POSITIVE PORT SHUT-OFF DIAPHRAGM VALVE

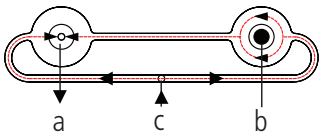
DV3-SERIES

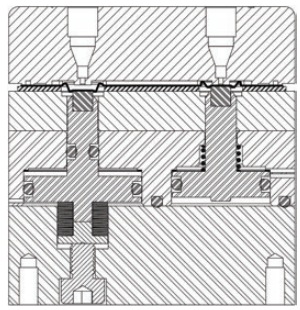
Pneumatic Actuation

EDV3-SERIES



Electronic Actuation





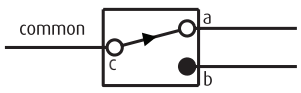
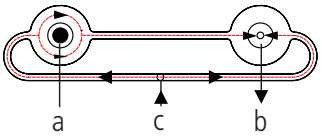
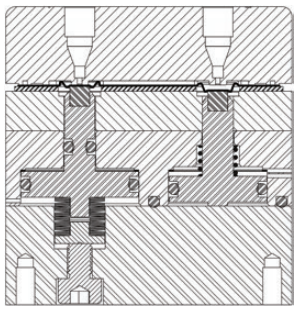


FIGURE 1A:
PORTS a OPEN AND b CLOSED





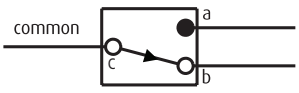
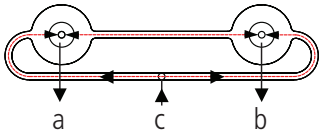
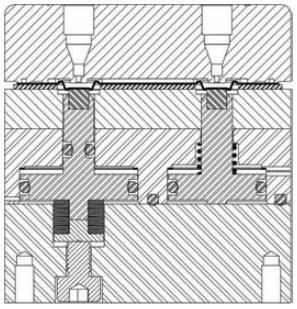


FIGURE 1B:
PORTS a CLOSED AND b OPEN





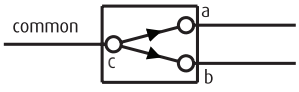
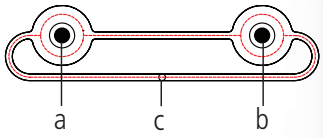
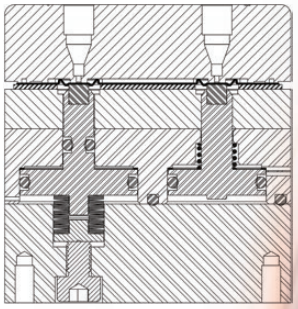


FIGURE 1C:
BOTH PORTS OPEN





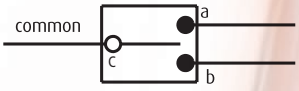


FIGURE 1D:
BOTH PORTS CLOSED

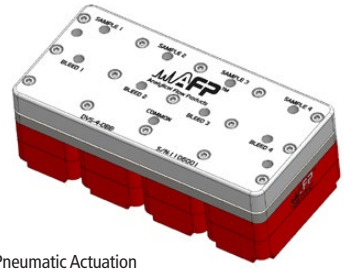
1.2 DVS-SERIES SAMPLE STREAM SELECTION DIAPHRAGM VALVE

■ DVS-SERIES

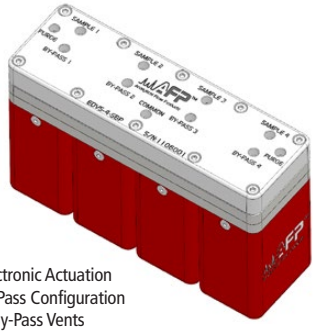
DVS-6 Pneumatic Actuation
ON/OFF Configuration

■ EDVS-SERIES

Electronic Actuation
ON/OFF Configuration



DVS-4 Pneumatic Actuation
Double Block & Bleed Configuration
Individual Bleed Vents



EDVS-4 Electronic Actuation
Sample By-Pass Configuration
Individual By-Pass Vents

ON/OFF STREAM CONFIGURATION

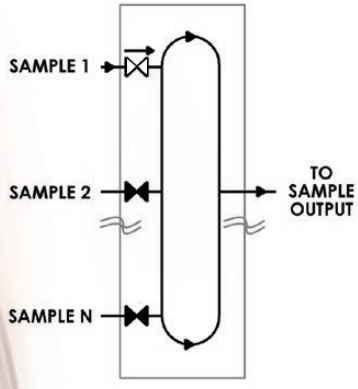
■ SINGLE STREAM
OPERATIONAL STATE #1

OPEN POSITION

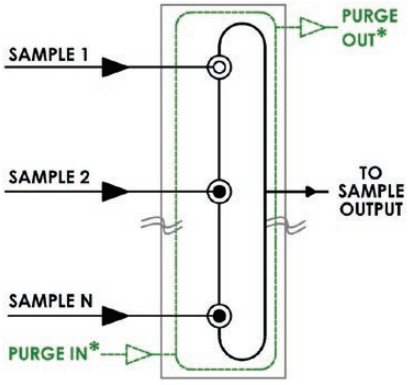
■ SINGLE STREAM
OPERATIONAL STATE #2

CLOSED POSITION

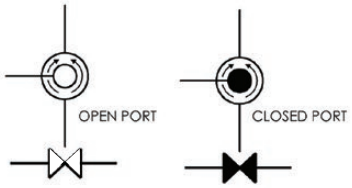
■ MULTIPLE STREAM
FLOWPATH SCHEMATIC



■ MULTIPLE STREAM
PHYSICAL FLOWPATH



- ALL CHANNELS BUILT ON THE SAME SUBSTRATE
- INTERNAL FAST LOOP INCLUDED



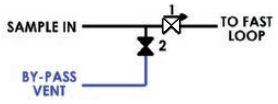
US.PAT.: 7,216,528

*** PURGE IS AVAILABLE AS AN OPTION**

Analytical Flow Products

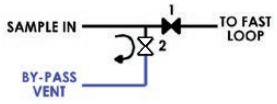
SAMPLE BY-PASS STREAM CONFIGURATION

■ SINGLE STREAM
OPERATIONAL STATE #1



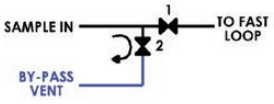
SAMPLING POSITION

■ SINGLE STREAM
OPERATIONAL STATE #2



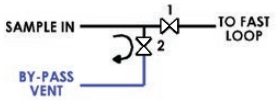
SAMPLING BY-PASS POSITION

■ SINGLE STREAM
OPERATIONAL STATE #3

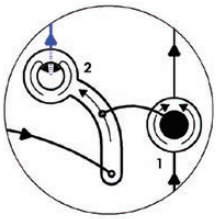


ALL-CLOSED POSITION

■ SINGLE STREAM
OPERATIONAL STATE #4



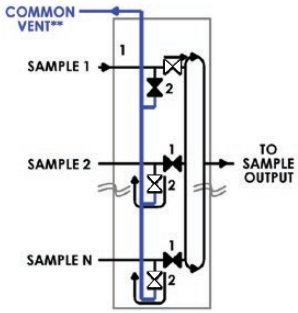
ALL-OPEN POSITION



■ MULTIPLE STREAM PHYSICAL FLOWPATH
SAMPLE BY-PASS POSITION

NOTE: VALVE PORTS 1 AND 2 CAN BE INDEPENDENTLY CONTROLLABLE

■ MULTIPLE STREAM
FLOWPATH SCHEMATIC

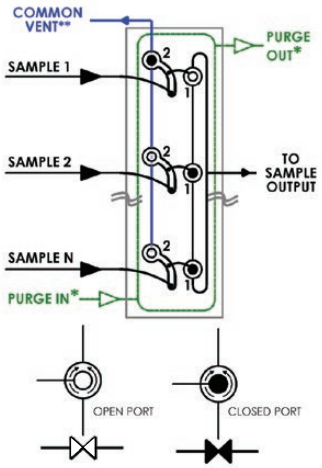


- ALL CHANNELS BUILT ON THE SAME SUBSTRATE
- INTERNAL FAST LOOP INCLUDED

US.PAT.: 7,216,528

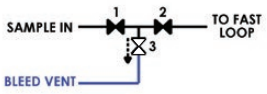
* PURGE IS AVAILABLE AS AN OPTION
** COMMON BY-PASS VENT IS AVAILABLE AS AN OPTION

■ MULTIPLE STREAM
PHYSICAL FLOWPATH



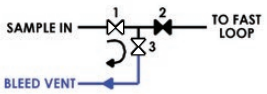
DOUBLE BLOCK & BLEED STREAM CONFIGURATION

■ SINGLE STREAM
OPERATIONAL STATE #1



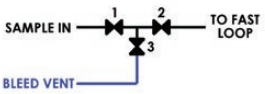
DOUBLE BLOCK & BLEED POSITION :
SAMPLE INLET CLOSED

■ SINGLE STREAM
OPERATIONAL STATE #2



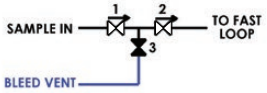
SAMPLE BY-PASS POSITION:
ACCELERATES SAMPLE REFRESH RATE BEFORE SELECTION

■ SINGLE STREAM
OPERATIONAL STATE #5



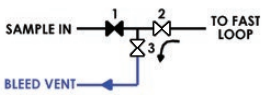
ALL-CLOSED POSITION

■ SINGLE STREAM
OPERATIONAL STATE #3



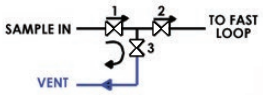
SAMPLE SELECTION POSITION

■ SINGLE STREAM
OPERATIONAL STATE #4

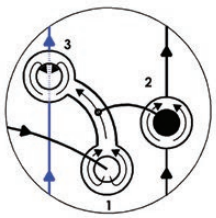


BACK PURGING POSITION: MOMENTARY
BACK PURGES THE UNSELECTED STREAMS

■ SINGLE STREAM
OPERATIONAL STATE #6



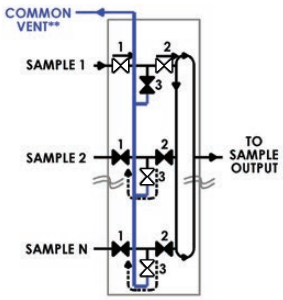
ALL-OPEN POSITION



■ MULTIPLE STREAM PHYSICAL FLOWPATH
SAMPLE BY-PASS POSITION

NOTE: VALVE PORTS 1, 2 AND 3 CAN BE INDEPENDENTLY CONTROLLABLE

■ MULTIPLE STREAM
FLOWPATH SCHEMATIC

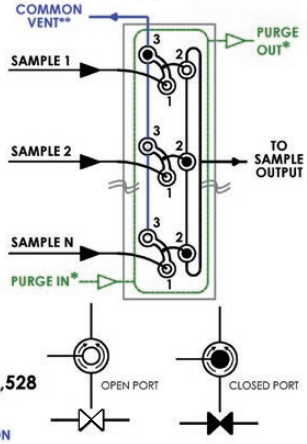


- ALL CHANNELS BUILT ON THE SAME SUBSTRATE
- INTERNAL FAST LOOP INCLUDED

US.PAT.: 7,216,528

* PURGE IS AVAILABLE AS AN OPTION
** COMMON BLEED VENT IS AVAILABLE AS AN OPTION

■ MULTIPLE STREAM
PHYSICAL FLOWPATH



DV-SERIES

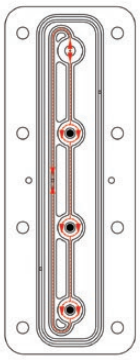
ACTUATOR CONFIGURATION

If you want a fail-safe assembly to prevent malfunction or unintentional operation of your system, you should choose only one normally open port and all the others normally closed.That way the normally open port will sweep the valve of the carrier gas while the other gases are shut off.

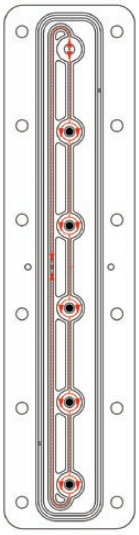
FAIL-SAFE DEFINITION: PERTAINING TO A SYSTEM OR COMPONENT THAT AUTOMATICALLY PLACES ITSELF IN A SAFE OPERATING MODE IN THE EVENT OF A FAILURE.

- Replaces standard rotary sample stream selection valve in an analytical panel.
- Drop-in valve system for easy analytical system automation.
- Easy to install and control in OEM gas analysers.
- Replaces a standard sample stream valve design with internal o-rings to provide a contamination free system.
- Used as a building block for an analyzer panel.
- Multiple columns or sample loops selection in chromatographic system.

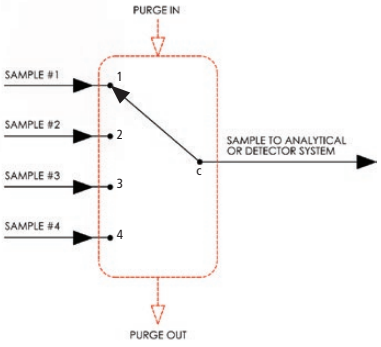
FLUID FLOW PATH EXAMPLE



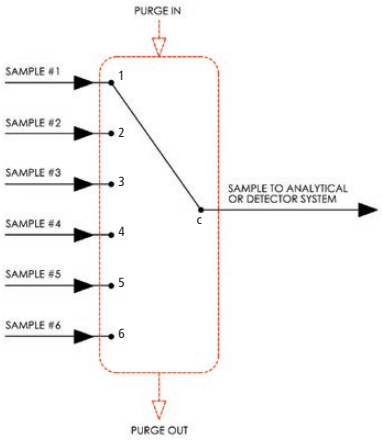
(E)DVS-4 Physical FlowPath



(E)DVS-6 Physical FlowPath



(E)DVS-4 FlowPath Schematic



(E)DVS-6 FlowPath Schematic

IN-LINE OPTION

The IN-LINE option gives you the opportunity to put few valves in series.You may increase to any value the number of sample inlet streams. It allows different sampling configuration schemes. The various DVS blocks are externally connected through an appropriate size tubing. This results in a multiple channel system with no dead volume effects and carry over (memory effect).This option is available on all DVS-Series valves.As shown on Figure 10, you can pick two DVS-8 with the in-line option and make a sixteen-port stream selection valve.

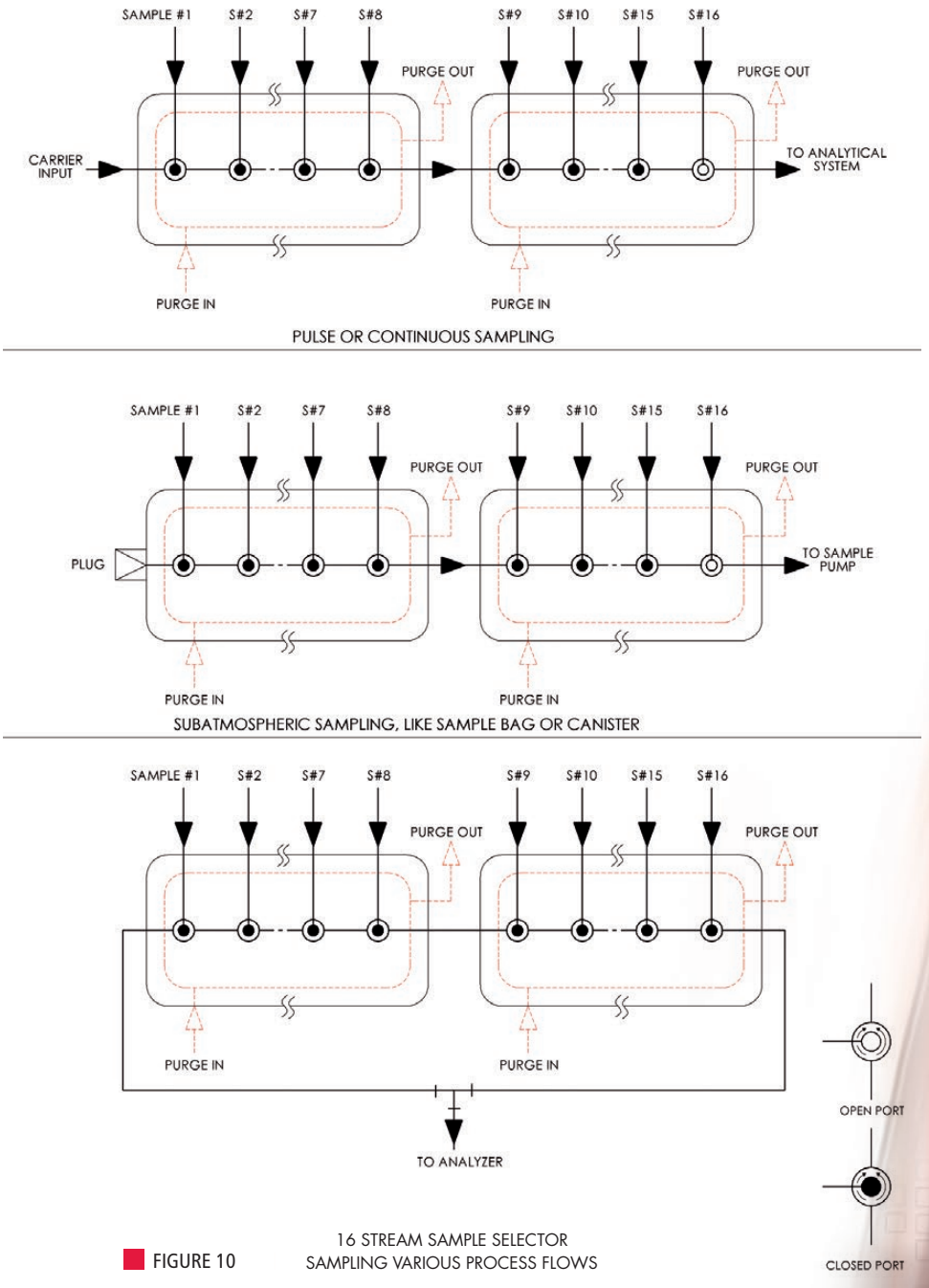
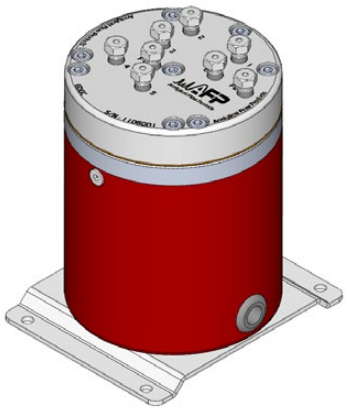


FIGURE 10 16 STREAM SAMPLE SELECTOR SAMPLING VARIOUS PROCESS FLOWS

1.3 DGC-SERIES TIGHT SHUT-OFF GC INJECTION DIAPHRAGM VALVE

Pneumatic Actuation

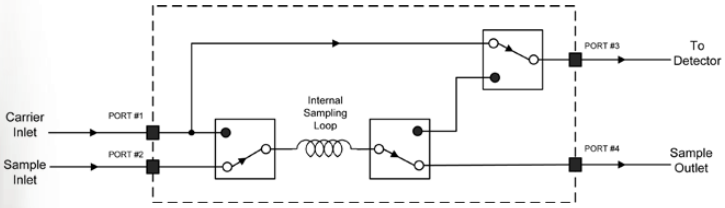


Electronic Actuation

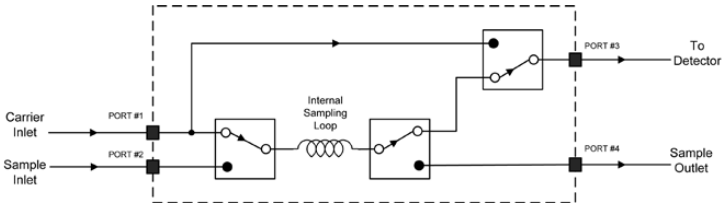
- **Unique design that leads to new GC methods.**
- **Internal sampling loop available.**

INTERNAL SAMPLING LOOP

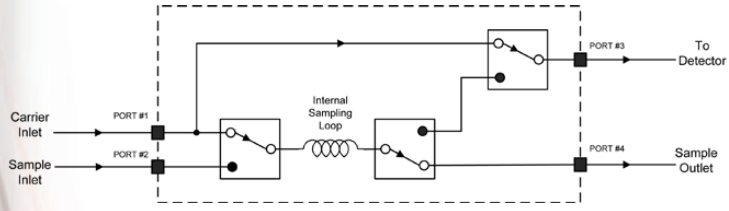
SAMPLING POSITION



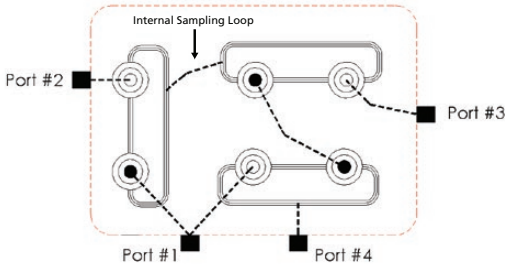
INJECTION POSITION



WASHING SAMPLE VOLUME POSITION

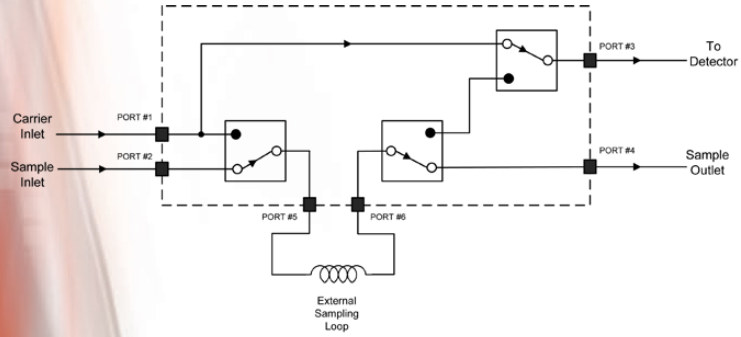


(E) DGC PHYSICAL FLOWPATH

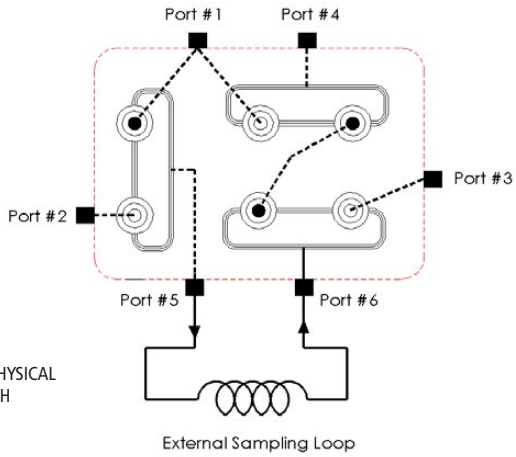


EXTERNAL SAMPLING LOOP

DGC BLOCK SCHEMATIC - CONFIGURATION



(E)DGC PHYSICAL FLOWPATH

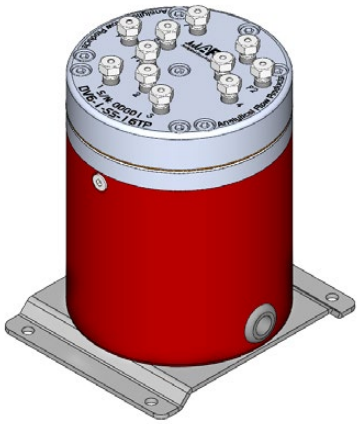


* Since all ports are independently controlled, other sequences are possible like sequencing injection, washing cycle, sample concentration, etc... See application note for more information.

Analytical Flow Products

DV6-SERIES POSITIVE PORT SHUT-OFF DIAPHRAGM VALVE

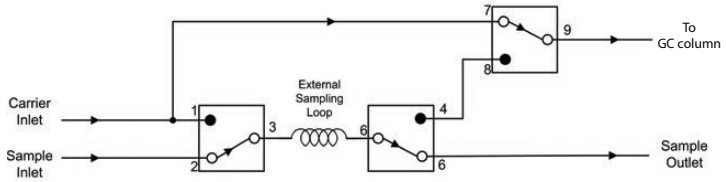
Pneumatic Actuation



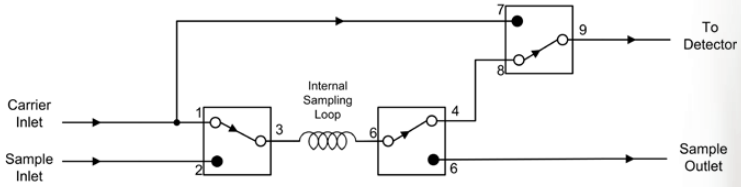
Electronic Actuation

EXTERNAL SAMPLING LOOP

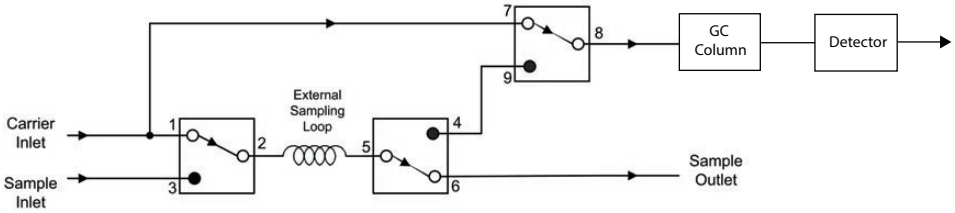
SAMPLING POSITION



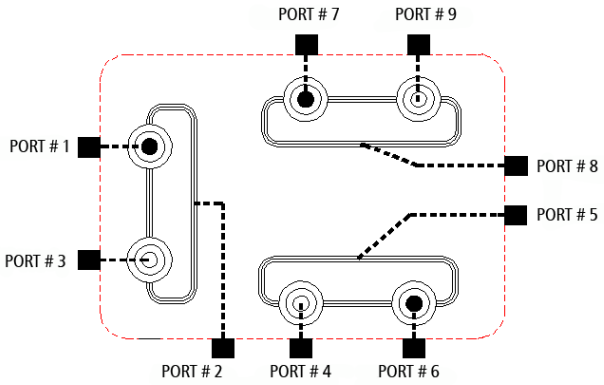
INJECTION POSITION



WASHING SAMPLE VOLUME POSITION



(E) DV6 PHYSICAL FLOWPATH



1.5 PNEUMATIC DESCRIPTION

The DV series valves are especially designed for analytical systems. All ports are independently controlled by supplying the pneumatic actuating pressure to their corresponding piston. A port is closed when its associate piston is forced against the corresponding valve's seat, interrupting the flow by directly closing the port. This is what is called positive port shut-off action. The small displacement needed to close or open the port results in a fast switching time. Figure 11 shows a standard DV3 configuration valve's head, and Figure 12 shows a low temperature independent actuator with a normally closed and a normally open configuration. Figure 13 shows a high temperature independent actuator with a double normally closed configuration.

The DV series valves could be used as a simple stand alone valve or a multiple combinations of them could be used to realize complex applications.

The problems that plague many other valve designs to be efficiently used in analytical systems have been corrected. The elimination of any dead volume effects could be achieved with the continuous flow at all time into the valve internal fluid channel, and this even if a port is closed or open. The fluid will flow through an open port or around a closed one. The inboard/outboard leak rate is extremely low, and lower than the detection limit of many leak test systems. This is achieved by the use of a flexible diaphragm that seals the internal valve volume from the exterior environment.

In critical applications an extra protection could be added by the action of purging/sealing grooves machined in the valve head and the sealing plate that could be swept by the appropriate fluid media.

Figure 11
Standard DV3
Valve's Head

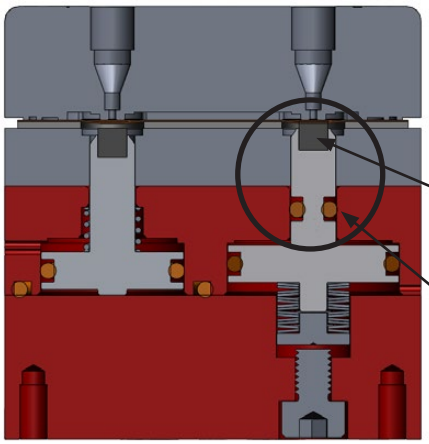


Figure 12
Independant actuation
LT model Normally
Closed/Normally Open
configuration

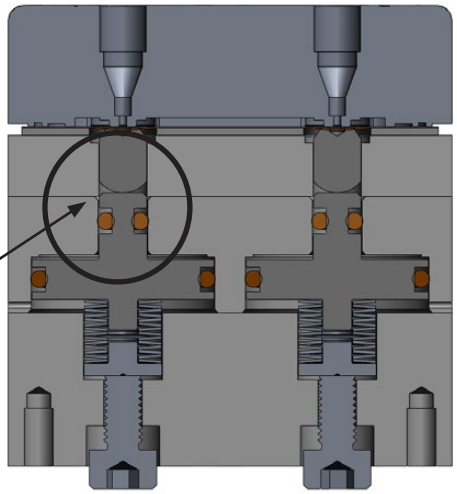


Figure 13
Independant actuation
HT model Normally
Closed/Normally Closed
configuration

Pneumatic Valve Actuation Specification

	DV SERIES
Actuation pressure (psig / kPa) (Process gas pressure of 300 psig)	**60 / 415**
Actuation pressure (psig / kPa) (Process gas pressure of 1000 psig) In Option	**125 / 860**
Gas Consumption per Actuation (in^3 / cc^3)	**.030 / .50**

This actuator has different ways to be configured. If desired, all the normally closed ports can open at the same time. But in some cases, other configurations can be made.

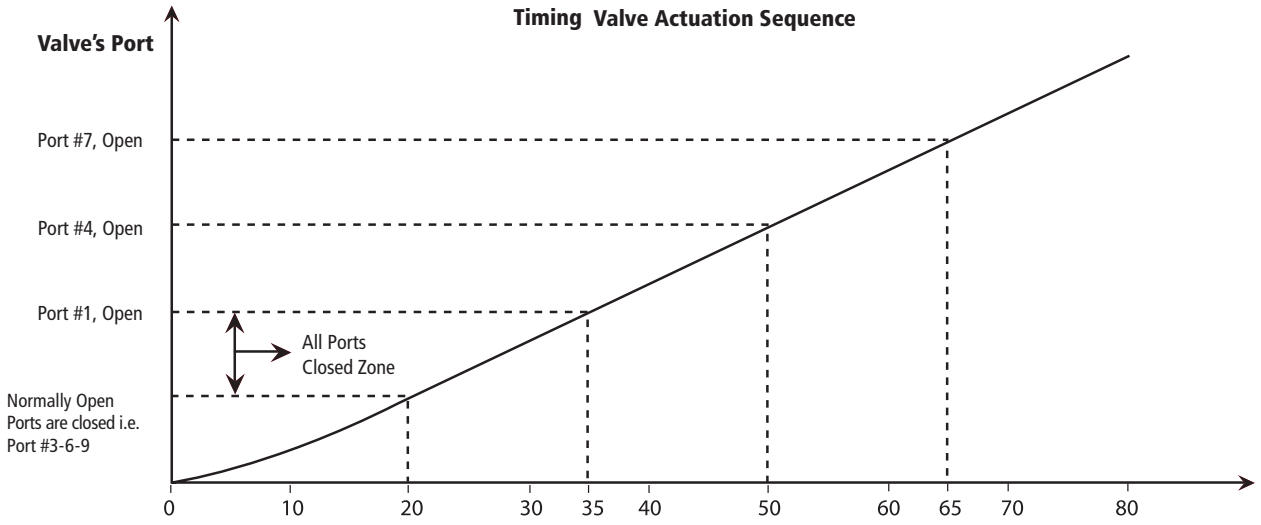


FIGURE 8 : Sequential configuration

When adjusting the set screws below of the normally closed pistons, sets a compressive force or pressure on the Belleville washer stacks, see Figure 12. Depending on how much pressure is applied on the Belleville washer stacks by the corresponding set screws, different pneumatic pressures will be required to open the corresponding ports. This feature allows the following interesting possibilities.

1) Adjusting the break before make delay

If the set screws are adjusted in order to require a high pressure to open their corresponding ports, the time that all ports are closed will be longer eliminating even more the risk of cross-port flow or the so-called «mixing». This higher pressure operation will not damage the normally open ports, since piston strokes are limited by the shim stacks.

2) Sequential injection mode

This mode allows a sample volume injection without any detector flow and column head pressure variation. Another very interesting operation mode could be done when adjusting each set screw at a different torque. Indeed, the required opening pneumatic pressure for each normally closed piston could be set at a different level, just by adjusting differently the associated set screw.

The following switching sequence is done in about 1 second.

In this case the port #1, 4, and 7 shown in figure 8 are the normally closed ports, associate to their corresponding pistons forced down by their corresponding Belleville washer stacks and associate set screws.

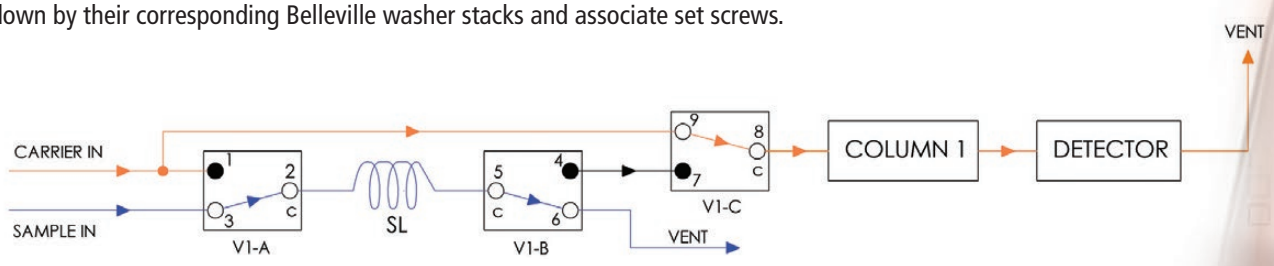


FIGURE 9A: **STEP 1: Sampling (No actuating pressure applied)**

Now, when actuating pressure reaches 137 kPa (20 psig), all normally open ports are properly closed. Then between 137 kPa to 206 kPa (20 to 30 psig), all valve ports are closed to avoid cross-port flow or «mixing.» This is the valve port position shown in Step 2.

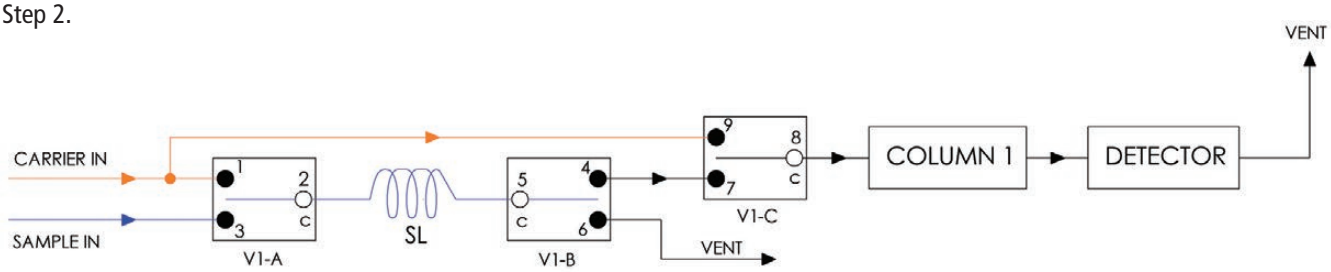


FIGURE 9B: **Step 2: Actuating pressure reach 137 kPa (20 psig)**

Now the actuating pressure is still ramping up at a predetermined rate, to eventually reach 241 kPa (35 psig). Port #1 opens, pressurizing the sampling loop volume at carrier pressure.

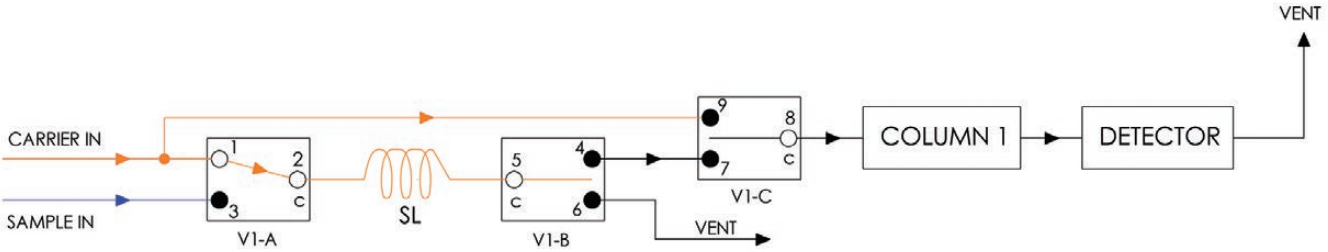


FIGURE 9C: **Step 3: Actuating pressure reaching 241 kPa (35 psig)**

The actuating pressure is still ramping at the same predetermined rate, to eventually reach 344 kPa (50 psig). At this point in time, the port #4 opens connecting the vent side of the sampling loop to port #7, that's still in it's closed position. This pressurizes the tube section to the same pressure as the carrier gas. This is what is shown by the Step 4.

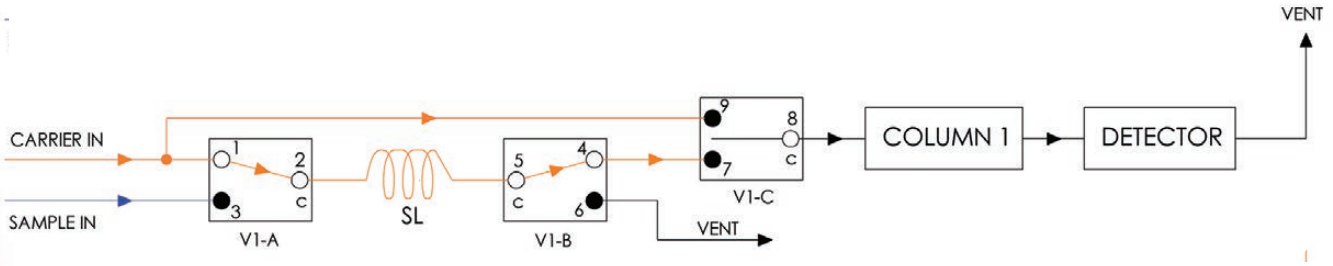


FIGURE 9D: **Step 4: Actuating pressure reach 344 kPa (50 psig)**

Then finally, the actuating pressure reaches 448 kPa (65 psig), opening port #7. This final position of the valve configuration is shown by the Step 5; the sampling loop is injected into the column.

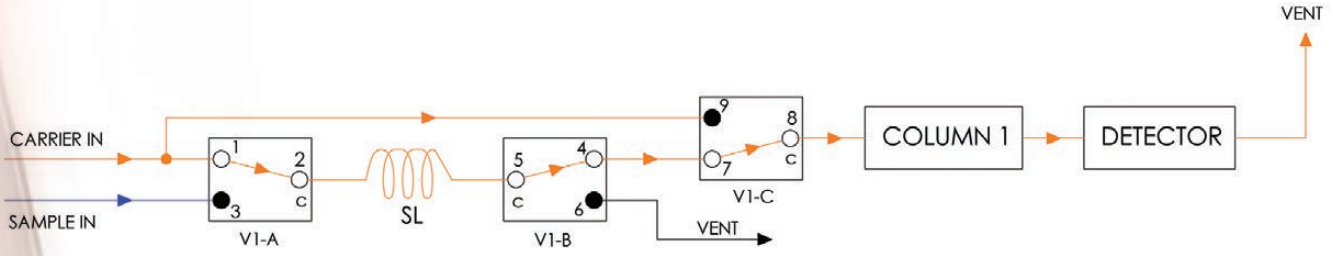


FIGURE 9E: **Step 5: Actuating pressure reach 448 kPa (65 psig)**

ELECTRONIC ACTUATION

ELECTRONIC ACTUATION IS AVAILABLE FOR ALL THE DV-SERIES VALVES.

Common features:

- Microprocessor controlled motors
- Green Power: Consumes power only during actuation. Sleep mode between actuation.
- User selectable default position; normally closed (NC), normally open (NO). Position selected on power up.
- Servoloop torque controlled, compensating for long term wearing; maintaining sealing level over time.
- Various interface for control:
  - Motor Direct Drive.
  - Digital input; Interface with PLC, dry contact, digital electronic.
  - Serial interface, allows daisy chain of multiple valve modules through RS-485.
  - Allows system status report and user's programmable timing sequence and control from PC or microcontroller.
- CE, RoHS

Applications:

- Electrically controlled sample stream selection systems.
- Analyzer auto-calibration systems.
- Built-in analyzer sample and calibration gas selection.
- Complex GC configurations.
- Liquid autosamplers.
- Sample panel automation.
- Purge and trap systems.
- GC front end sample processing (Concentration/Purication)
- Syringe pump / dispenser / diluter systems.

ACTUATION MECHANISM

In general, port closing or opening is done by controlling a miniature DC motor. Depending on applied voltage polarity to the motor, the output shaft rotates in one direction (clockwise) or the other (counter-clockwise). Speed control is important. This allows the valve to be efficient in different pressure systems by controlling opening and closing parameters (speed, time and priority).

Mechanically, the shaft has a flat side, that is inserted into the motor drive adapter. It transfers the torque from the motor assembly to the threaded coupling through its flat end, which is inserted in the slot at the threaded coupling. The threaded coupling and the motor drive adapter are free to move up and down on the shaft when they rotate. The threaded coupling transfers the rotational torque into a vertical displacement. Then it pushes on a self-aligned plunger. The plunger does not rotate, thanks to the anti-rotation dowel pin. The side of the plunger facing the threaded coupling is treated to reduce friction and wearing while other side is fitted with a compressible cushion, which transfers the vertical force onto the sealing diaphragm. The other side of the diaphragm is facing the valve's seat. Pressing the diaphragm against the valve's seat shuts off fluid flow. Lifting it restores the flow. The plunger is self-aligned and free to move. When the threaded coupling is going up, the plunger will be lifted by the return spring, removing any force on the sealing diaphragm. This makes sure that there is no flow restriction when the valve port is fully open. See Figure 1.

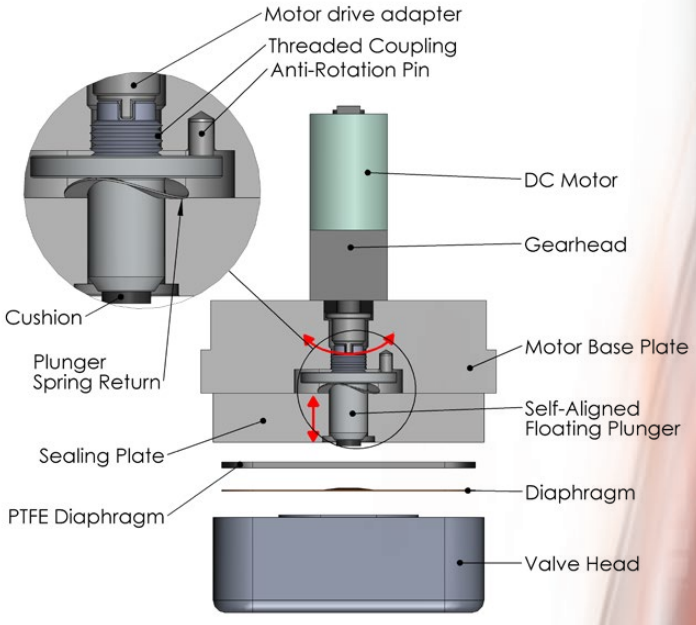


FIGURE 1: Mechanical assembly

ELECTRONIC INTERFACE

Figure 2 shows the valve electronic actuation aspects. Each motor is controlled through an H bridge driver. The H bridge allows direction, speed and torque control over the motor. A pulse width modulation technique (PWM) and other parameters are used to reliably control valve operations regarding its specifications (pressure, speed, multiple actuation, diaphragm type).

Diaphragm valve LOW POWER consumption is a good AFP innovation. The mechanical design makes sure that there is no plunger movement when the power is shut off (or H bridge in idle mode) resulting in very low standby power compared to solenoid valve. Safety and application issues can be solved with this feature.

The valve operation could be controlled in three different ways. First, by simply using the corresponding digital input lines; this mimics the traditional way to control closing or opening of a valve port. Applying voltage to a digital input line opens the associate valve port, and vice-versa. The digital input lines are electrically isolated from the electronic control circuit. These inputs are low power inputs and can be connected to PLC, microcontroller digital outputs or dry contact relay.

The second method uses a predefined BCD (binary coded decimal) instruction format.

The third method is through the use of serial interface. Simple command could be sent to open or close a port. This is not doing more than using the discrete digital inputs for controlling the valve. The only difference is the serial interface is used, typically RS-485. Multiple valve modules could be daisy chained and controlled through serial interface freeing system digital outputs. The serial interface allows also the use of the valve internal microcontroller to control various valve operation sequences, in a user programmed timing sequence.

The Figure 2 shows a simplified block diagram of the electronic actuation system.

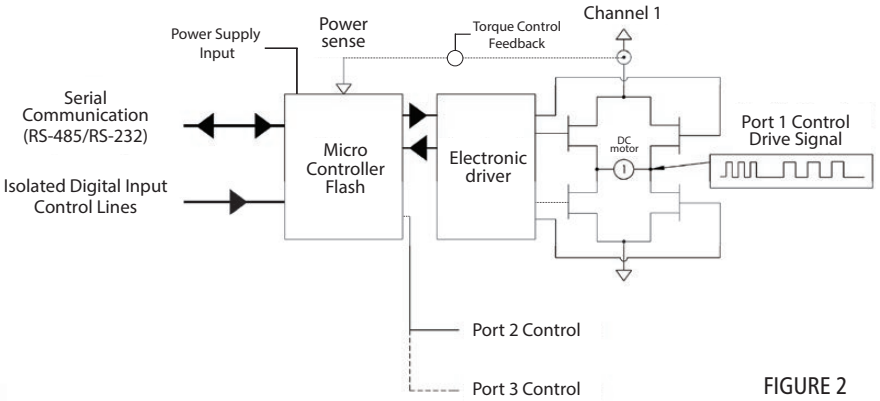


FIGURE 2

ELECTRONIC SPECIFICATION

TYPICAL FOR AN EDVS4 : 4-INLET SAMPLE STREAM SELECTION VALVE

FEATURES:

- For any valve configuration, each port is independently controllable.
- No solenoid valve and tubing are required for actuation. This saves space, cost and setup time.
- Green actuation. Indeed, power is consumed only when the valve is actuated. Once the valve reaches its final position (open or closed), no more power is consumed. The valve switches to Standby power mode. For an ON/OFF configuration, the equivalent solenoid valve consumes between 7 and 10W to keep a port open. The EDV Standby is consuming less than 140 mW.
- Direct interface to PLC digital I/O, or any digital controller.
- Serial control interface: Control multiple inlets with a pair of wires.
- Real time wearing compensation: Constant torque.
- RS-485 AFP Command Interpreter
- Software tools available
- Electric and environnement self-diagnostic
- CE, RoHS

GENERAL SPECIFICATION

8 BITS MICROCONTROLLER WITH (RTC) REAL TIME CLOCK, FOR PRECISE EVENT TIMING		
LOG AND CONFIGURATION MEMORY	FLASH	1 MEG BYTE
RS-232	SPEED	9600 BAUDS
RS-485 (2 WIRES)	SPEED	9600 BAUDS
SUPPLY VOLTAGE MONITORING	ANALOG CONVERTER	10 BITS
INTERNAL TEMPERATURE MONITORING	ANALOG CONVERTER	10 BITS
MOTOR CURRENT MONITORING	ANALOG CONVERTER	10 BITS
OPERATING TEMPERATURE (ELECTRONIC MODULE)	FAHREHEIT (°F) CELSIUS (°C)	32°F TO 140°F [1] 0°C TO 60°C
CE CONFORM , ROHS		

Note 1 : From the temperature specification. It is important to note that the " valve body" maximum temperature could be much higher and does not affect the electronic module.

ELECTRICAL SPECIFICATION

SUPPLY VOLTAGE INPUT RANGE (TRANSIENT AND REVERSEPOLARITY PROTECTOR)	MIN MAX	5 Volts DC 24 Volts DC
STANDBY POWER CONSUMPTION	TYPICAL	140 mW [2]

Note 2 : Configurable upon application and pressure

DIGITAL AND CONTROL INPUT

INPUT PROTECTION	ALL INPUT	DIGITAL ISOLATED
INPUT VOLTAGE AND CURRENT RANGE TO OPEN A PORT	5 Volts DC 12 Volts DC 24 Volts DC	1.6 mA 2.5 mA 5.1 mA
PORT ACTUATION CAN BE CONTROLLED BY SERIAL PORT		
IN NORMAL MODE, PORT CONTROL IS "COMPATIBLE" TO A NORMALY CLOSE PNEUMATIC VALVE PORT OPEN = 5 TO 24 VOLTS PORT CLOSE = GND OR NOT CONNECTED		

ELECTRICAL POWER CONSUMPTION DURING PORT ACTUATION @ 500 PSI

OPENING POWER	MAX AVERAGE	2000 mW [2] 1500 mW [2]
CLOSING POWER	MAX AVERAGE	2400 mW [2] 2000 mW [2]
CLOSING OR OPENING TIME (ACTUATION TIME)	TYPICAL	300 msec. [3]

Note 2 : Configurable upon application and pressure

Note 3 : This power is consumed only when port is actuated. Between actuation maximum power consumption is less then 140 mW .

CONTROL MODE TABLE

ON - OFF CONFIGURATION HAS ONE CONTROLLABLE PORT.

Operation description	Serial mode	Standard Mode	*BCD mode digital inputs	Valve port State
	AFP Commands	Digital Input	Digital Input	
		1	1	1
Port closed	closed	0	0	C
Port open	open	1	1	O

1 = Digital input supplied 0 = Digital input to ground O = Open C = Closed

THE SAMPLE BY-PASS CONFIGURATION HAS TWO CONTROLLABLE PORTS.

Operation description	Serial mode	Standard Mode		*BCD mode digital inputs		Valve port State	
	AFP Commands	Digital Input		Digital Input			
		2	1	2	1	2	1
Sample selected	Sample	0	1	0	1	O	C
Sample by-pass	By-pass	1	0	1	0	C	O
All ports closed	All closed	0	0	0	0	C	C
All ports open	All open	1	1	1	1	O	O

1 = Digital input supplied 0 = Digital input to ground O = Open C = Closed

THE DOUBLE BLOCK & BLEED HAS THREE CONTROLLABLE PORTS.

Operation description	Serial mode	Standard Mode			*BCD mode digital inputs			Valve port State		
	AFP Commands	Digital Input			Digital Input					
		3	2	1	3	2	1	3	2	1
Sample selected	Sample	0	1	1	0	0	1	C	O	O
Sample by-pass	By-pass	1	0	1	0	1	0	O	C	O
Back purging unselected streams	Back Purge	1	1	0	0	1	1	O	O	C
Sample isolated, bleed port open	DBB	1	0	0	1	0	0	O	C	C
All ports closed	All closed	0	0	0	0	0	0	C	C	C
All ports open	All open	1	1	1	1	1	1	O	O	O

1 = Digital input supplied 0 = Digital input to ground O = Open C = Closed

* BCD control mode is selected with the help of the internal dip switchs. Please see user's instructions for detail.

In BCD and serial control modes, the driver makes sure that valve ports are operated in the appropriate sequence, i.e., for example, break before make.

GUIDELINES FOR VALVE CONFIGURATION

Valve's head configuration

Since there is no one size fit all application valve, the system designer must select the appropriate valve configuration that will fulfill the needs of the application. To achieve this, the following parameters for any particular design must be considered :

- Valve head material, i.e. metal, polymer or ceramic
- Diaphragm type
- Operating pressure and temperature
- Valve process fitting type; compression, AFP Lip Seal Fitting*or VCR
- Purged sealing plate
- Hard or soft seat

*Patent pending

As rule of thumb, one must take into consideration the effects that may have on a particular application, the adsorption, the absorption, the out gassing, the permeation and the chemical inertness of the various valve materials in contact (i.e. the so called "wetted parts") with the fluid to be controlled. The following will help the system designer to understand various DV series possible configurations. It may be used as a general guide line. For example, if the system where the valve would be installed is working with an ECD (i.e. electron capture detector) any material releasing electron absorbing compounds will kill the detector sensitivity. This is the case with some fluoropolymer that may release halogen compounds. In this case a Teflon® type diaphragm would not be a right choice. However in some other applications, Teflon® type diaphragm could be an excellent choice. Another example of this fact is if the valve is to be installed in a system measuring low level of moisture or oxygen, surface adsorption and diaphragm permeation, absorption and out gassing are of prime importance. Not only the valve itself must be considerated, but also its operating environment. In such case, operating the valve at higher temperature will have a major impact on system performance. Working with corrosive gases, for example chlorine or acid (like HCL), will also call for specific valve materials.

In brief, the final configuration of a DV valve is application driven.

STANDARD CONFIGURATION

The DV basic standard version has a valve head made of 316L grade stainless steel. The diaphragm is made of a multilayer polymer, i.e. Teflon®/ Polyimide. The maximum operating temperature defined as standard range is 180°C. The standard operating and test pressure is 500 psig (3345 kPa). Minimum operating pressure is vacuum. The diaphragm and other parts of the valve are easily replaceable. All the port connections are 1/16¨ single ferrule type with AFP® high quality finish.

EXTRA PURGE CONNECTION

The DV is also available with an extra purge connection. These purge connections allow the select purge fluid to purge the back side of the diaphragm, depending on a particular system requirements.
This allows :

- Working at higher pressure by equilibrating the pressure on both side of a diaphragm
- Eliminating permeation problem through the diaphragm. (Gas application)
- Reducing hazard risk when working with dangerous media.
- Real time diagnostic for critical operation. This is done by monitoring the purge fluid on the purge vent.

DV3 WITH 1/8" VCR AND/OR OTHER FITTING CONNECTIONS

DV3 could be also fit with 1/8¨ VCR brazed fittings for process port connection. nections. This configuration could be required for semiconductor and vacuum applications. It also works better for extended time columns, traps or sample isolation due to high level of sealing integrity.

Other kind of fitting connections may also be used to respond to your needs, like 1/4-28, NPT, compression fittings, etc...

All DV series valves are available for the NeSSI™ surface mounting standard platform.

OPTIONNAL VALVE HEAD MATERIALS FOR CHEMICALLY INERT AND CORROSIVE APPLICATION

For application requiring chemically inert material in regard to the process fluid, for example, corrosive or some organic compound, the DV valve head could be made of polymer, such as PEEK™, ceramic or other appropriate materials. This is often required in the field of liquid chromatography or mass spectrometry. In such configurations, all wetted parts would be made in materials compatible with your applications.

1.7 DIAPHRAGM AND SEAT DESIGN

SEAT OPTION

HARD SEAT

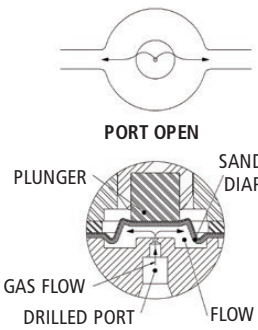


FIGURE 1A - Hard seat

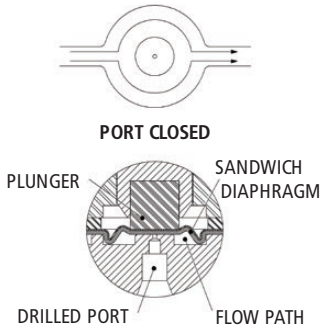


FIGURE 1B - Hard seat

SOFT SEAT

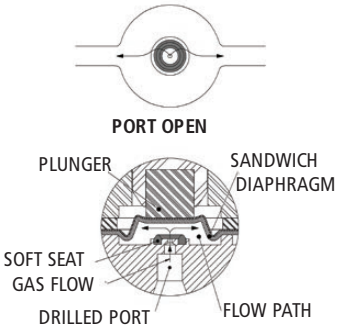


FIGURE 1C - Soft seat

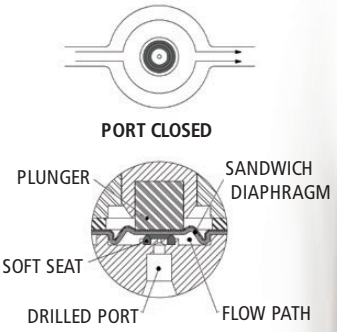
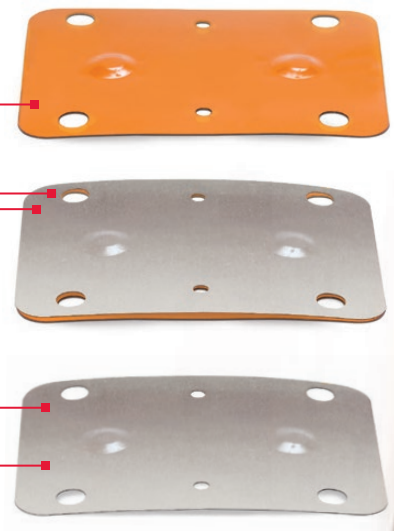


FIGURE 1D - Soft seat

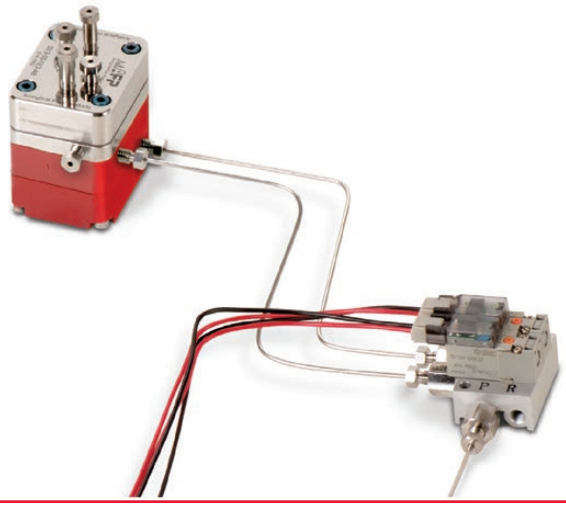
DIAPHRAGM MODEL, TYPICAL FOR DV3 SERIES

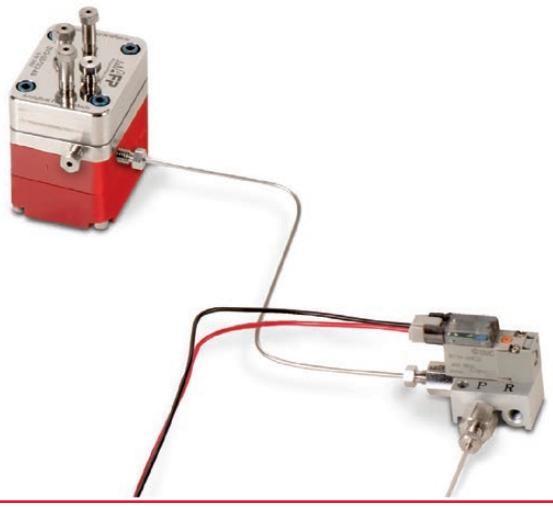
- Single layer of selected polymer (Polyimide/Teflon®/PEEK™)
- Multilayer Teflon®/Polyimide (general purpose, longer lifetime)
- Multilayer, very low absorption and permeation
- Metalized, i.e. selected polymer with metal deposition on it.
- Metal only (require valve head soft seat configuration) or coated valve's head
- Stacked layer
- Custom (example: Teflon®/Gold/Polyimide)



ACTUATOR CONFIGURATION

DV series valve pneumatic actuator could be driven by only one solenoid, i.e. all ports actuated at the same time with a break before make action, or by one solenoid valve for each port, so they would be independently controlled.





CUSTOM REQUEST

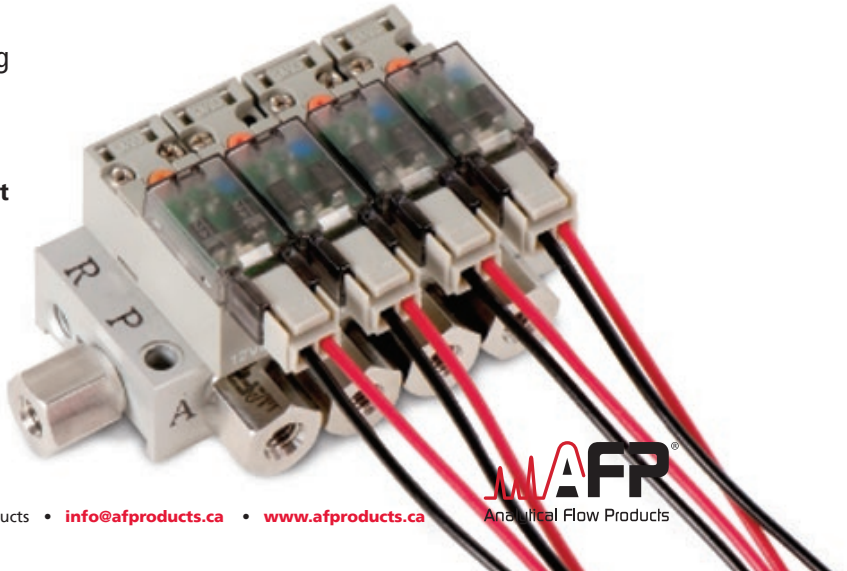
Please consider AFP as a partner in your projects. If you have any special needs, we will be glad to help you in customizing our products fitting your specific applications. For example DV3 has been made with a longer fitting pilot detail to drop in disc frit to be used as particle filter. Longer pilot detail allows tubing to be fit in other standard fittings without the need to cut it and replacing ferrules.

N.B. : AFP® is also manufactu ring filtering unions with the same characteristic.

ACCESSORIES

- ☐ Electronic timer / sequencer / and driver board, with software. Allow easy interface between third party software/hardware system and multiple DV series valves USB interfaces and software.
- ☐ 3-way solenoid valves and manifolds including electrical connector.

For more information, please ask for specific product information sheet.



1.8 PART NUMBERING

DV3-SERIES CONFIGURATION / PNEUMATIC ACTUATION

DV3 - [ ] - [ ] - [ ] - [ ] - [ ] - [ ]

Connection	Temperature	Manifold	Actuation Port #	Configuration	Option
16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	T = 180°C HT = 250°C	RM = Remote solenoid manifold BM = Bolt-on solenoid manifold	1 = 1 port 2 = 2 ports	1 = NO, NO 2 = NC, NC 3 = NC, NO NO = Normally Open NC = Normally Closed	P = Backside of the diaphragm purged M = Metalized diaphragm S = SilcoNert 2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

EDV-3 SERIES CONFIGURATION / ELECTRONIC ACTUATION

EDV-3 - [ ] - [ ] - [ ]

Connection	Controller	Option
16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	D = Digital input B = BCD S = Serial command	P = Backside of the diaphragm purged M = Metalized diaphragm S = SilcoNert 2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

DVS-SERIES CONFIGURATION / PNEUMATIC ACTUATION

DVS - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ] - [ ]

#Of inlets	Connection	Configuration	Temperature	Manifold	#Of N.C. ports	By Pass Port***	Option
3= 3 inlets 4= 4 inlets 6= 6 inlets 8= 8 inlets	16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	OO = ON/OFF SBP = Sample By-Pass DBB = Double Block and Bleed	T = 180°C H = 250°C	RM = Remote solenoid manifold BM = Bolt-on solenoid manifold	0 to 8	0 = ON/OFF 1 = Common 2 = Individual	P = Backside of the diaphragm purged M = Metalized diaphragm S = SilcoNert2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

*** 0= ON/OFF = When used with ON/OFF configuration
1= Common = One common port for all channels
2= Individual = One port for each channel

EDVS SERIES CONFIGURATION / ELECTRONIC ACTUATION

EDVS - ____ - ____ - ____ - ____ - ____ - ____

#Of inlets	Connection	Configuration	Controller	By Pass Port***	Option
3 = 3inlets 4 = 4inlets 6 = 6inlets 8 = 8inlets	16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	OO = ON/OFF SBP = Sample By-Pass DBB = Double Block and Bleed	D = Digital input B = BCD S = Serial command	0 = ON/OFF 1 = Common 2 = Individual	P = Backside of the diaphragm purged M = Metalized diaphragm I = Inline S = SilcoNert2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

*** 0= ON/OFF = When used with ON/OFF configuration
1= Common = One common port for all channels
2= Individual = One port for each channel

DGC SERIES CONFIGURATION / PNEUMATIC ACTUATION

DGC - 6 - ____ - ____ - ____ - ____ - ____

Connection	Temperature	Sampling	ISL size	Option
16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	T = 180°C HT = 250°C	ISL = Internal Sampling Loop ESL = External Sampling Loop	0 = N/A 50 = 50 µl 100 = 100 µl 150 = 150 µl 200 = 200 µl 250 = 250 µl Other dimensions on demand	P = Backside of the diaphragm purged S = SilcoNert 2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

EDGC SERIES CONFIGURATION / ELECTRONIC ACTUATION

EDGC - 6- ____ - ____ - ____ - ____ - ____

Connection	Controller	Sampling	ISL size	Option
16 = Fitting 1/16'' LS16 = Lip Seal 1/16''* 08 = Fitting 1/8'' LS08 = Lip Seal 1/8''* V8 = VCR 1/8''	D = Digital input B = BCD S = Serial command	ISL = Internal Sampling Loop ESL = External Sampling Loop	0 = N/A 50 = 50 µl 100 = 100 µl 150 = 150 µl 200 = 200 µl 250 = 250 µl Other dimensions on demand	P = Backside of the diaphragm purged S = SilcoNert 2000™ D = Dursan™ HC = Hastelloy® TI = Titanium XX = Custom C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

DV6-SERIES CONFIGURATION / PNEUMATIC ACTUATION

DV6 - ____ - ____ - ____ - ____

Configuration	Connection	Temperature	Option
1 = 1 actuation ports	16 = Fitting 1/16''	T = 180°C	P = Backside of the diaphragm purged
2 = 2 actuation ports	LS16 = Lip Seal 1/16''*	HT = 250°C	M = Metalized diaphragm
6 = 6 actuation ports	08 = Fitting 1/8''		S = SilcoNert2000™
1S = Sequential tuning	LS08 = Lip Seal 1/8''*		D = Dursan™
	V8 = VCR 1/8''		HC = Hastelloy®
			TI = Titanium
			XX = Custom
			C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

EDV6-SERIES CONFIGURATION / ELECTRONIC ACTUATION

EDV6 - ____ - ____ - ____

Connection	Controller	Option
16 = Fitting 1/16''	D = Digital input	P = Backside of the diaphragm purged
LS16 = Lip Seal 1/16''*	B = BCD	M = Metalized diaphragm
08 = Fitting 1/8''	S = Serial command	S = SilcoNert2000™
LS08 = Lip Seal 1/8''*		D = Dursan™
V8 = VCR 1/8''		HC = Hastelloy®
		TI = Titanium
		XX = Custom
		C = Pre-conditioning

***Lip Seal:** Lip Seal fitting is our new patent pending AFP fitting detail. This reduces the dead volume, eliminates the rotation of the ferrule and improves the sealing resulting in an improved connection for valve and fitting. This is very beneficial for any analytical high sensitivity instrumentation. Sealing integrity of a VCR fitting with the flexibility of a compression fitting. Please refer to Design Report 3 (DR-3) in the Analytical Flow Product Cookbook.

*Patent Pending

Option

- **P** = Backside of the diaphragm purged with extra purge ports on the sealing plate.
- **M** = Metalized diaphragm.
- **I** = Inline; this allows the possibility to put few valves in series.
- **S** = SilcoNert 2000™ The ultimate passivation of treated surfaces. A required treatment for metal components when analyzing for parts-per-billion levels of organo-sulfur compounds & mercury. Greatly reduce moisture contamination, improve system performance and eliminates surface adsorption of active compounds on steel.
- **D** = Dursan™ is a coating designed to improve the inertness, hardness, and corrosion resistance of stainless steel. Ideal for sulfur, H2S, mercaptan, ammonia and mercury sampling.
- **C** = Pre-conditioning; this allows the elimination of atmospheric contaminants from the wetted internal surface.
- **HC** = Valve Cap made of Hastelloy ®.
- **TI** = Valve Cap made of Titanium.
- **XX** = Custom request.

DIMENSION : Refer to website www.afproducts.ca

CLEANING PROCESS

Please refer to our web site for AFPC-2 i.e. AFP cleaning procedure for O2 compatibility.

LEAK TESTING

Leak rates are verified at maximum operation conditions. See engineering note EN-01 for more information, available on our website. Verified on a VARIAN™ helium leak mass spectrometer detector and on AFP® proprietary online leak detection system.

WARNING: NOT TO BE USED IN LIFE SUPPORT EQUIPMENT WITHOUT FORMAL AGREEMENT OF AFP®.

Based on a specific valve configuration and working condition, warranty period and valve maintenance procedure (i.e. part replacement) are different. Please refer to Analytical Flow Products® specific valve documentation for more information.

It is still the responsibility of the user to make sure that the selected valve configuration is safe and reliable for his application.

Analytical Flow Products engineering team will do their best to help customers for any application that may require custom modification. Analytical Flow Products will be please to supply demonstration parts to qualified OEMs.

*SEE WEBSITE FOR WARRANTY AND DISCLAIMER NOTICE. PRODUCT SPECIFICATION MAY CHANGE WITHOUT NOTICE, ASK FOR UPTODATE NOTIFICATION.

APPLICATION EXAMPLES

EXAMPLE WITH THREE DV3.

LEGEND:

C: INDICATE THE COMMON PORT
● VALVE PLUNGER DOWN, CLOSING THE PORT
○ VALVE PLUNGER UP, OPENING THE PORT

FIGURE 2A

Step 1 - Sample isolated

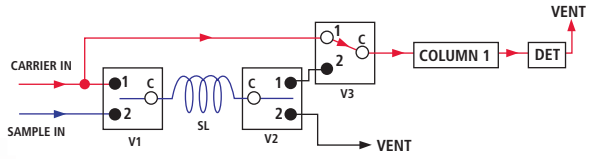


FIGURE 2B

Step 2 - Sample injection into a simple column configuration with sample loop pressurization to carrier pressure

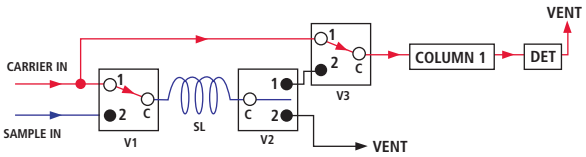
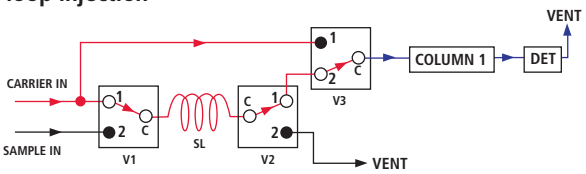


FIGURE 2C

Step 3 - Sample injection into a simple column configuration with pressurized sampling loop injection



Analytical Flow Products

APPLICATION EXAMPLE

EXAMPLE WITH TWO DV6.

Here's one of many configurations that we are able to do with our DV6 valve. It's a Heartcut configuration, popular in GC systems. The Figures 10 show this configuration. First, here is a standard DV6 valve used as V1 to do the sample injection into column 1. Valve V2 has been added to allow the heartcutting from an impurity from column 1 into column 2. As a first step, the sample volume is injected into column 1 as shown in Figure 10a, then V2 is actuated at the appropriate time to allow peak of interest to come out of column 1 and being transferred in column 2. This is shown in Figure 10b and 10c. When the peak of interest has been transferred in column 2, as shown in Figure 10c, V2 is set back to the position shown in Figure 10b.

This allows background balance to be vented away. The flow restrictor R1 is adjusted at the same pressure drop as column 2. This results in a system constant flow whatever the valve positions are. However, if one is worried about carrier flow consumption, the carrier flow path created by V2-B could be eliminated and port 7 of V2-C connected to carrier network.

SEE AN-01/AN-02 NOTES FOR APPLICATION IDEAS, AVAILABLE FROM OUR WEBSITE.

FIGURE 10A **Heartcut Configuration** (Sample injection)

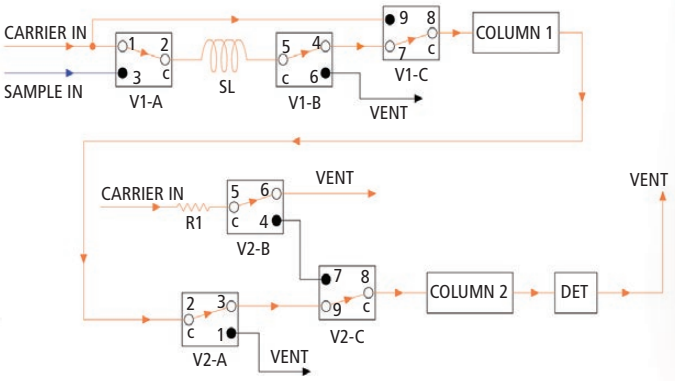


FIGURE 10B **Heartcut Configuration** (Column 1 to vent / column 2 to detector)

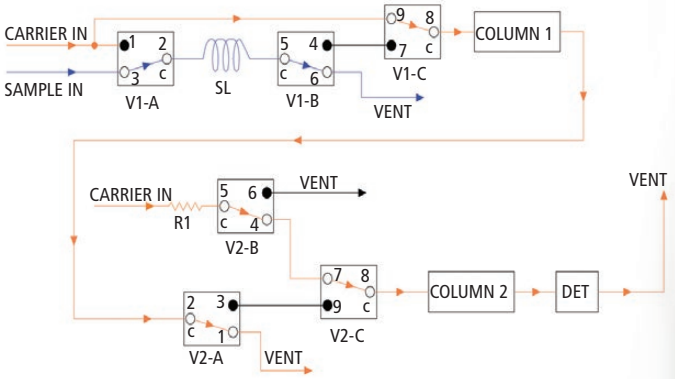
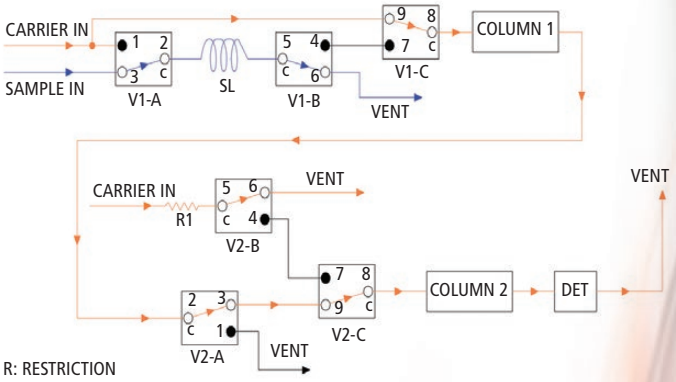


FIGURE 10C **Heartcut Configuration** (Column 1 & 2 to detector)



R: RESTRICTION
C: INDICATES THE COMMON PORT
● VALVE PLUNGER DOWN, CLOSING THE PORT
○ VALVE PLUNGER UP, OPENING THE PORT
VALVE TYPE: **DV6-SERIES**

Analytical Flow Products

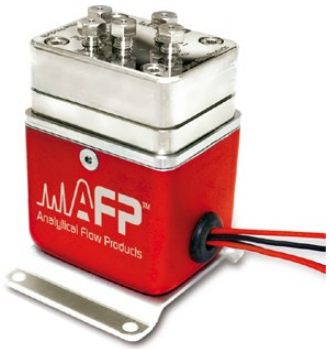
SHORT TUTORIAL AND TECHNICAL NOTE ON THE DV-SERIES

DV3-SERIES

A DEEPER STEP INTO INNOVATION

VCR 1/8''

Standard



Electronic actuation

Purge sealing plate

Peek head

Instrumentation and sampling:

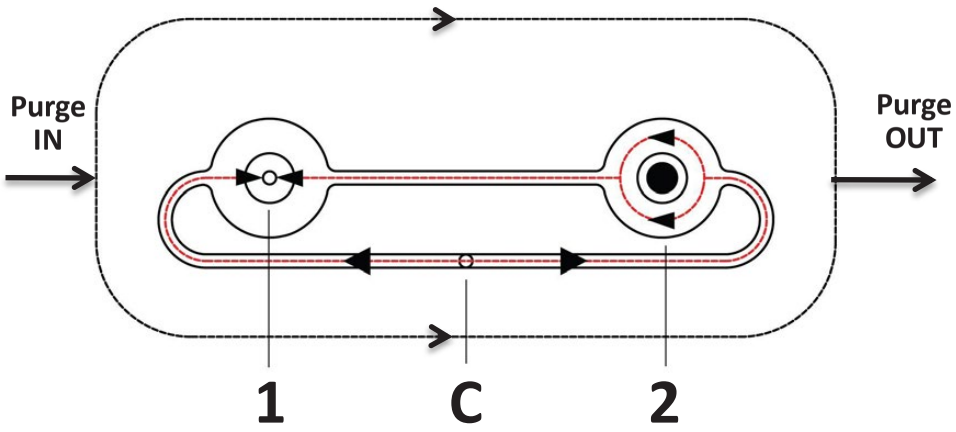
- ✓ Makes easier the task of designing complex system configurations

Analytical / Chromatographic:

- ✓ Allows higher pressure operation for sample and carrier gas
- ✓ Allows unique sample injection method that eliminates column head pressure and flow upset
- ✓ Common conventional configuration like heartcut, backflush, column or sampling loop selection
- ✓ Pneumatic and intelligent electronic actuator

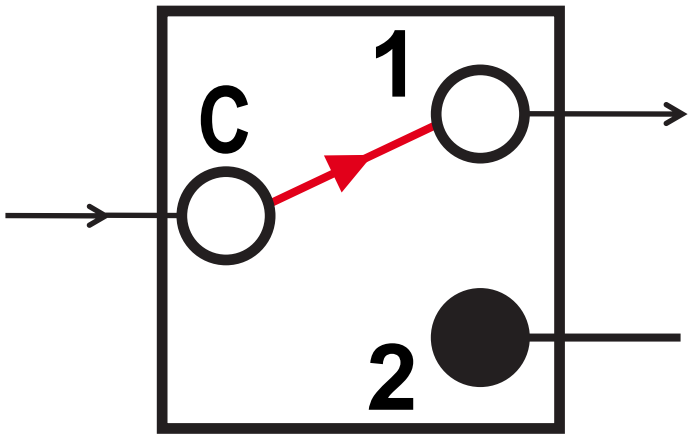
BASIC CONCEPT

Flow Path



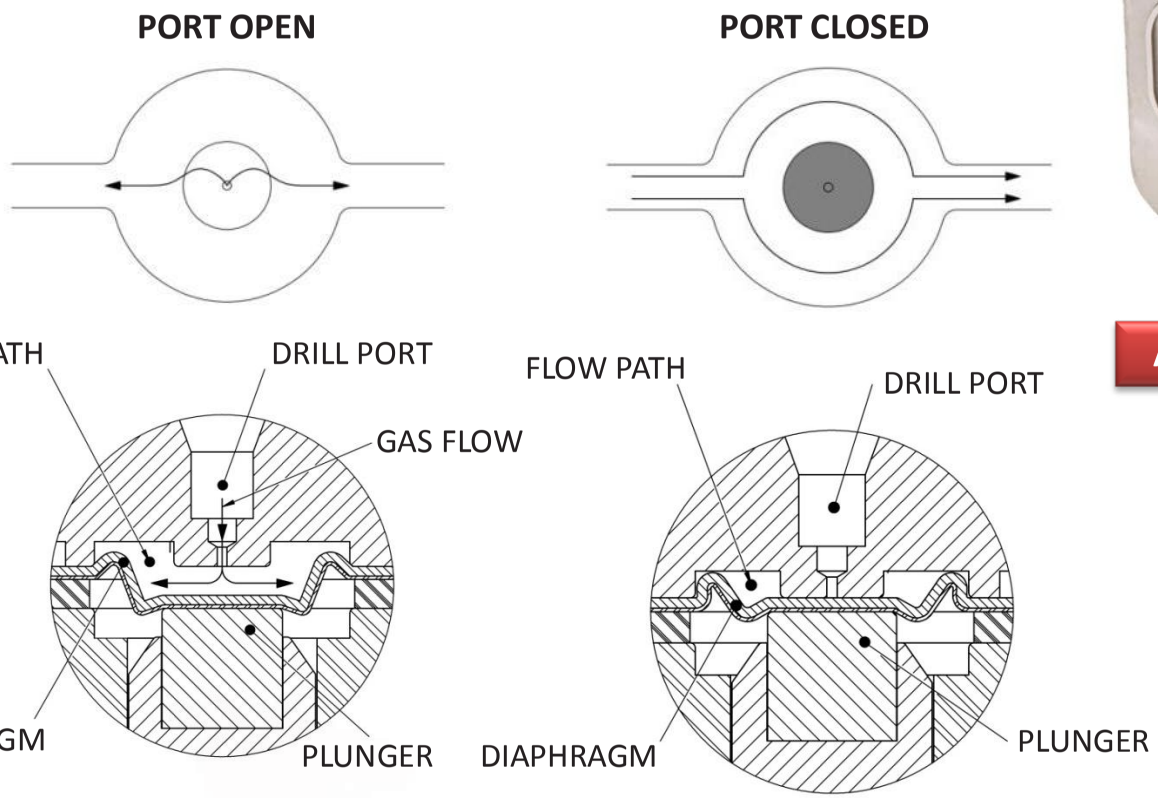
- ✓ No dead volume effect, continuous sweeping action
- ✓ Purging/Sealing groove design, eliminates inboard/outboard leakage.

Equivalent schematic



- ✓ Positive port shut off
- ✓ Independent port control
- ✓ Multiple configurations

POSITIVE PORT SHUT-OFF



Acts like a standard 1/16'' union

EXAMPLE OF DIAPHRAGM CONFIGURATION

Diaphragm:

Polyimide + Metal deposition

Polyimide

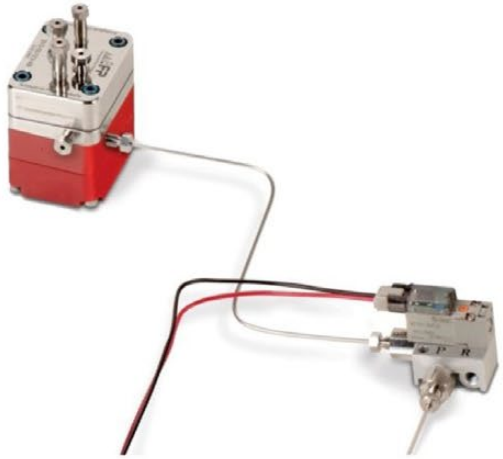
Metal

Use with

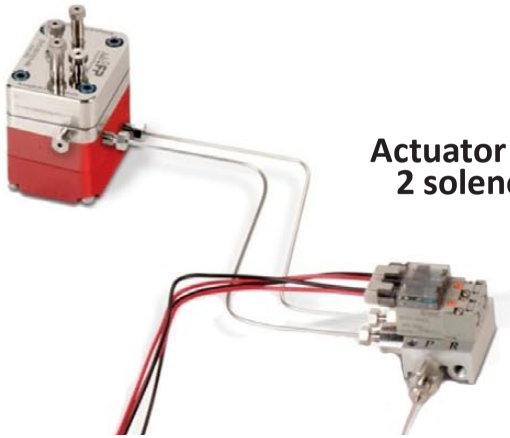
Soft seat configuration

EXAMPLE OF ACTUATOR CONFIGURATION

Actuation:



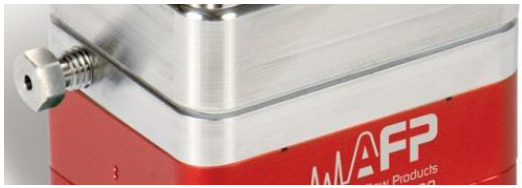
Actuator using 1 solenoid
(Break before make switching mode)

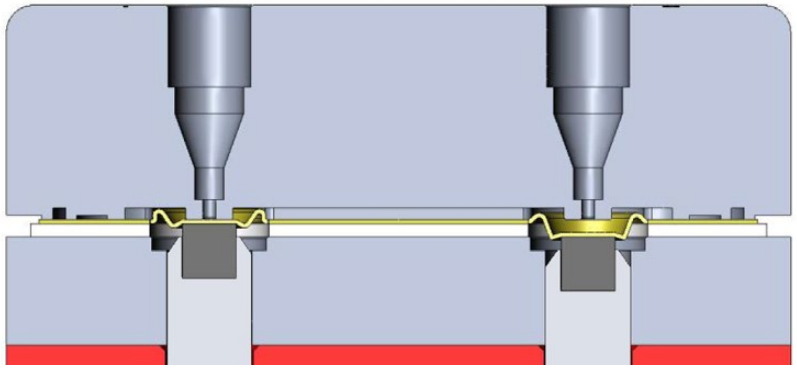


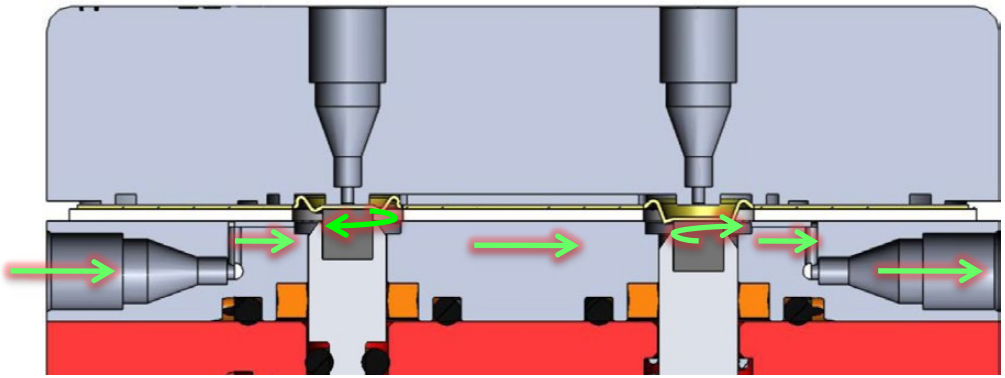
Actuator using 2 solenoids

OPTIONAL PURGING CONFIGURATION

Sealing Plate







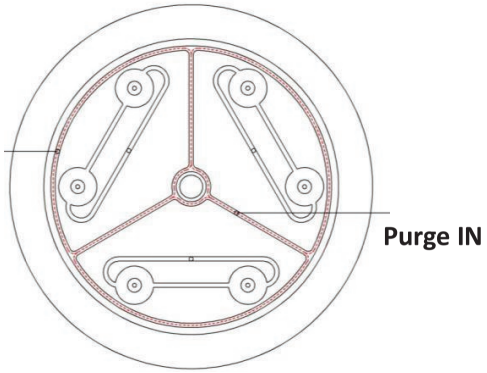
Standard sealing plate

Purging / Pressurized sealing plate

DV6-SERIES

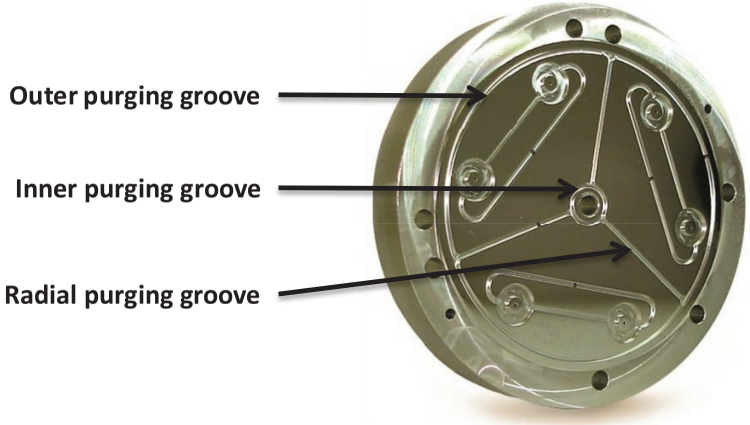
DV6-1-16-T

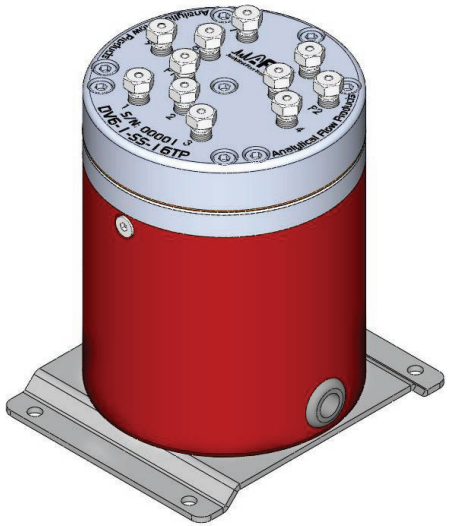
Purging Flow Path



- ✓ Simply three DV-3 cells, embedded on the same substrate to provide a 6 port valve that mimics a standard 6 port GC valve.
- ✓ All DV3 configurations are available with the DV6

Purging/Sealing groove



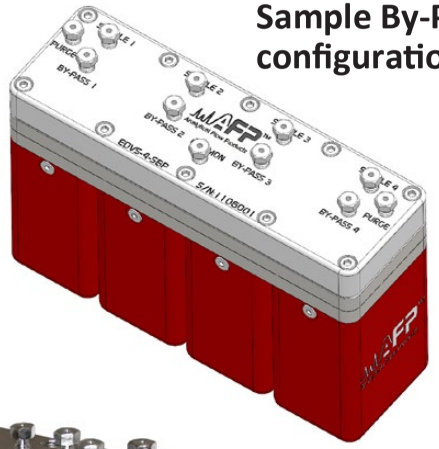


EDV6-16-S

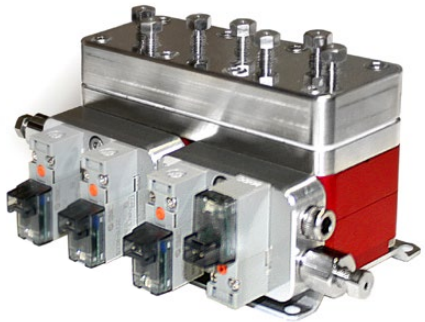
DVS-SERIES

DVS-4 with 1/8'' VCR fittings

DVS-4, ON/OFF configuration



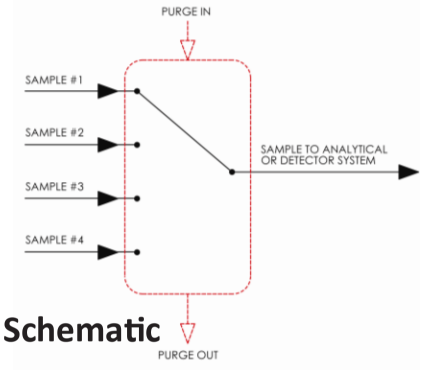
EDVS-4,
Sample By-Pass
configuration



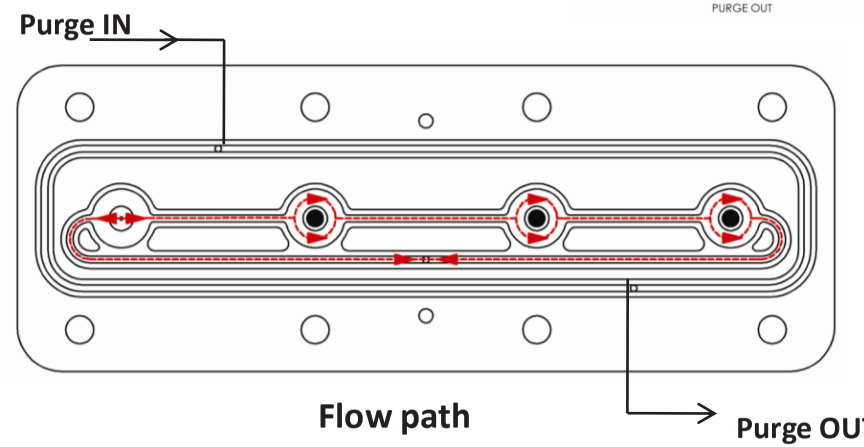
DVS-4 with Bolt-on solenoid manifold

DVS-SERIES

Valve body

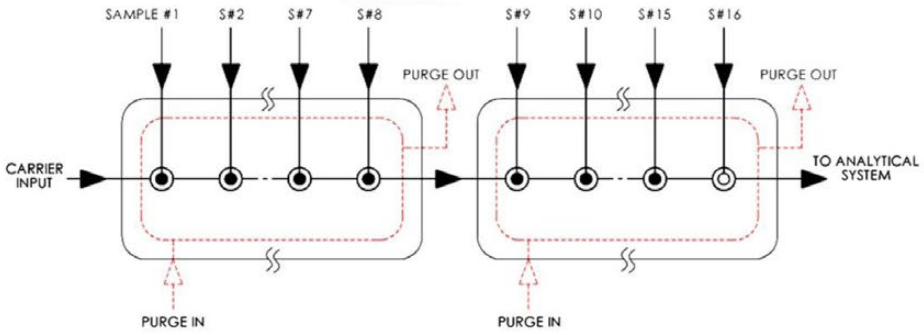


Schematic

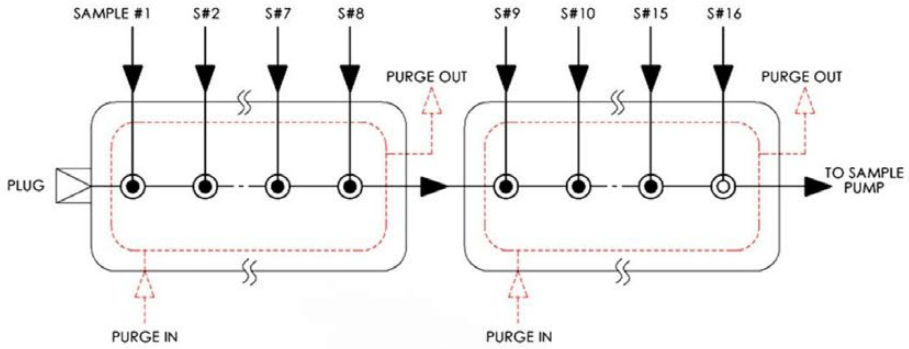


- Sample stream selection system made easy
- Could be used in GC for various components selection
- No dead volume effects due to continuous sweeping action. Allows fast system recovery.
- Purge design
- Available in 3,4,6,8 ports.
- Multiple configurations
- Fail/Safe mode selection

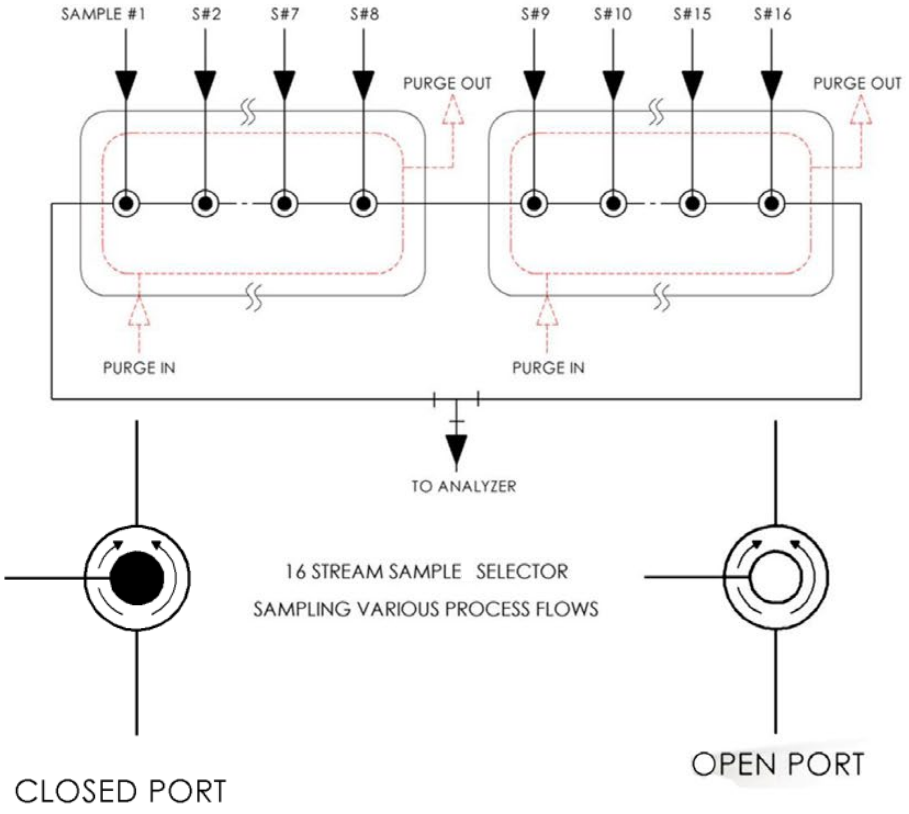
IN-LINE OPTION, POSSIBLE CONFIGURATIONS



PULSE OR CONTINUOUS SAMPLING



SUBATMOSPHERIC SAMPLING, LIKE SAMPLE BAG OR CANISTER



Analytical Flow Products

233, Jalbert St. W., Thetford Mines, QC, Canada G6G 7W1
Phone: 418.338.0004 Fax: 418.338.2500
Email: info@afproducts.ca

www.afproducts.ca