OUR PRODUCTS DEVELOP TOMORROW'S TECHNOLOGIES™

DELTA-P™ VALVE (DPV)

Anti-Suckback and Vacuum System Isolation Valve

USER'S MANUAL

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SAFETY

IMPORTANT SAFETY INFORMATION

Thank you for purchasing this equipment from Ideal Vacuum Products. We want you to operate it safely.

- **Read this manual before installing or operating this equipment. Failure to follow the warnings and instructions may result in serious injury or equipment damage.**
- **Keep this manual in a safe location for future reference.**
- **This equipment should only be installed and operated by trained, qualified personnel, wearing appropriate protective equipment.**
- **Follow all codes that regulate the installation and operation of this equipment.**

WARNING SYMBOLS AND DEFINITIONS

This is the universal safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER	**Indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.**
WARNING	**Indicates an imminently hazardous situation that, if not avoided, could result in death or severe injury.**
CAUTION	**Indicates a potentially hazardous situation that, if not avoided, could result in moderate or minor injury. It may also be used to alert against unsafe practices.**
NOTICE	**Indicates a potentially hazardous situation that, if not avoided, could result in equipment or property damage.**
NOTE	**Indicates helpful tips and recommendations, as well as information for efficient, trouble-free operation.**

Internationally recognized safety symbols may be used with safety warnings to specify the type of hazard or a safety protocol to follow. For example:

Indicates an electric shock hazard

Indicates safety glasses are required

1. GENERAL INFORMATION

1.1 INTRODUCTION

The Delta-P Valve (DPV) is an important component of any roughing or high vacuum system. The DPV provides anti-suckback and vacuum system isolation from the mechanical backing pump during a power outage. It prevents backstreaming and the migration of contaminants (e.g., rotary pump oil or scroll pump tip seal particles) into the vacuum system. It also protects a high vacuum pump (turbo) from damage.

The Delta-P Valve operates on the pressure difference (Delta P) between ambient atmosphere and the roughing/backing pump's vacuum level.

During a power failure, the mechanical pump is vented to atmosphere from its inlet flange which pushes debris towards the mechanical pump. This stops undesirable material from being swept into the system when the pump restarts.

The DPV is a compact, inline unit which mounts directly on the inlet side of the mechanical pump. It is available in five (5) standard KF flanged sizes (same flange on both ends), and with three (3) solenoid voltage options.

DPV closure speed is approximately 25 ms, faster than any other isolation valve available. This is due to the reduced moving mass of our advanced piston design. Flow is unrestricted with flange sizes smaller than KF-50. A slight reduction in conductance may be experienced with pumps that have a high pumping speed and KF-50 inlet flange. The DPV can be mounted in any orientation; vertical, horizontal, or inverted.

All parts that make up the DPV have been carefully selected for vacuum system compatibility and longevity. All production, assembly and testing is done in our own manufacturing facility in Albuquerque, NM, U.S.A. Every Valve is helium leak tested to ensure that it operates correctly before it ships.

Upon delivery, your Delta-P Valve is ready for immediate installation into a new or existing system.

The Delta-P Valve is intended for use with clean, dry air or inert gasses only.

1.2 QUICK START

⚠ WARNING

To prevent serious injury, read the entire manual before use. Follow all safety warnings.

1. DISCONNECT the vacuum line at the mechanical pump's inlet port.

2. CONNECT the DPV outlet flange onto the inlet flange of the pump. The DPV flow arrow points towards the pump.

3. CONNECT the vacuum line to the DPV inlet.

4. CONNECT power to the solenoid. The solenoid and pump must be powered by the same circuit breaker. AC solenoids must be properly grounded (see Section 2.2)

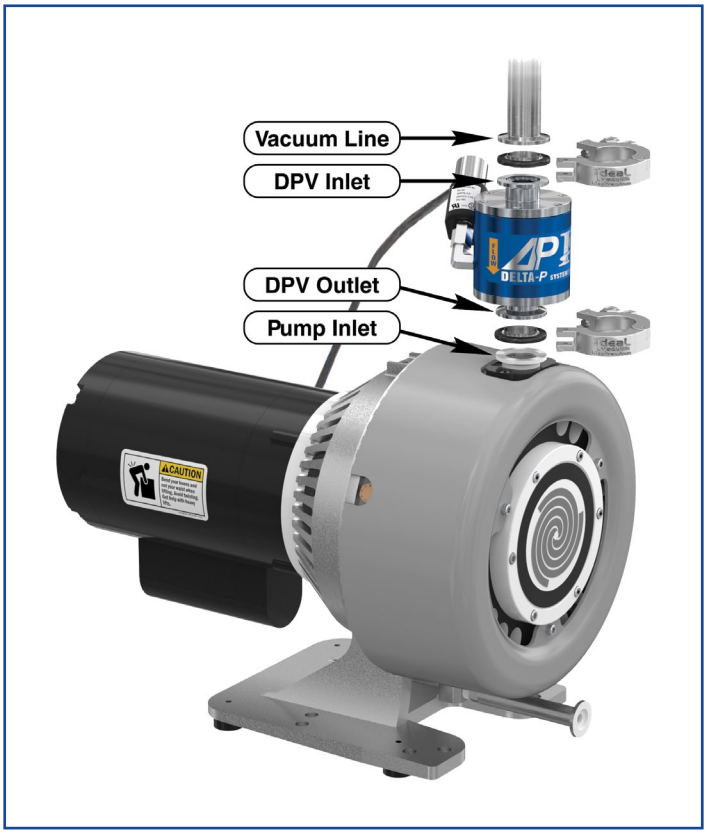


Figure 1 - Delta-P Valve Connection to the Mechanical Pump

1.3 FEATURES & FUNCTIONS

- Preserves chamber vacuum pressure during power outages
- Closes automatically upon loss of system power
- Operates on differential pressure between ambient atmosphere and roughing pump's vacuum level
- Isolates high vacuum pump and/or vacuum chamber system from mechanical pump
- Prevents backstreaming and migration of oil or particulate contaminants into the vacuum system
- Automatically re-opens when vacuum is restored
- Requires no additional power source or gasses to operate
- Very compact - mounts directly on the inlet flange of the mechanical roughing pump
- Works in any orientation: vertical, horizontal, or inverted
- Standard NW/KF flange connection sizes
- Non-restrictive flow for flange sizes smaller than KF-50
- Constructed entirely of vacuum compatible materials in the U.S.A.
- Use with clean, dry air or inert gasses only

1.4 SPECIFICATIONS

PARAMETER	MEASURE / TYPE
Geometry	Straight, Inline
Flanged End	KF-10, KF-16, KF-25, KF-40, or KF-50
Solenoid Voltage	110 VAC, 220 VAC, or 24 VDC
Temperature Rating	0° to 70° C (valve) 0° to 50° C (solenoid)
Close Time	≈ 25 ms
Leak Rate	<1x10-8 atm cc/sec Helium
Service Life	>10,000 cycles
Materials	
Valve Body	6061-T6 Aluminum
Flange Ends	6061-T6 Aluminum
Flange End O-Ring	Viton
Piston (Actuator Cup and Bushing)	Acetal
Piston (Actuator Cup) O-Ring	Viton
Tension Spring	302 Stainless Steel
Spring Stud Anchors	18-8 Stainless Steel
Assembly Hex Screws	18-8 Stainless Steel
Dimensions	
Body Outside Diameter	2.95 in. (75 mm)
Overall Length	4.2 in. (107 mm), KF-10 to KF-40 5.0 in. (127 mm), KF-50

Table 1 - Technical Specifications

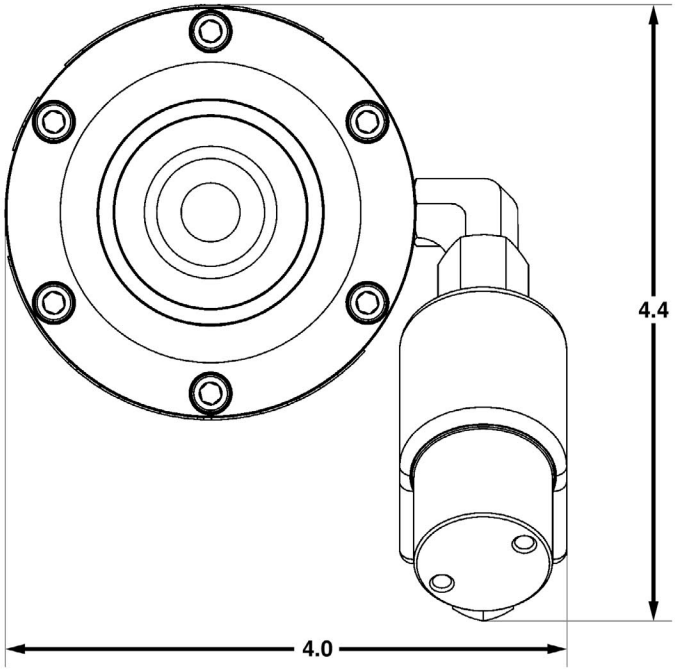
1.5 CONFIGURATIONS

The Delta-P Valve is available in five (5) standard KF flanged sizes (same flange on both ends), and with three (3) solenoid voltage options. Our part numbers for ordering standard DPV configurations are shown in Table 2 below. The Delta-P Valve may be special ordered if you require different flange ends on either side (e.g., KF-25 on the inlet and KF-40 on the outlet). Replacement flange ends and solenoids are available (see Appendix-Replacement Parts).

FLANGE	SOLENOID VOLTAGE		
SIZE	**110 VAC**	**220 VAC**	**24 VDC**
KF-10	P1010135	P1010180	P1010185
KF-16	P1010136	P1010181	P1010186
KF-25	P1010137	P1010182	P1010187
KF-40	P1010138	P1010183	P1010188
KF-50	P1010139	P1010184	P1010189

Table 2 - Part Number Selector - Flange and Solenoid Voltage Options

1.6 DIMENSIONAL DRAWINGS



FLANGE SIZE	A	B
NW/KF-10	4.2 in. (107 mm)	3.0 in. (76 mm)
NW/KF-16	4.2 in. (107 mm)	3.0 in. (76 mm)
NW/KF-25	4.2 in. (107 mm)	3.0 in. (76 mm)
NW/KF-40	4.2 in. (107 mm)	3.0 in. (76 mm)
NW/KF-50	5.0 in. (127 mm)	3.0 in. (76 mm)

Table 3 - Dimensions

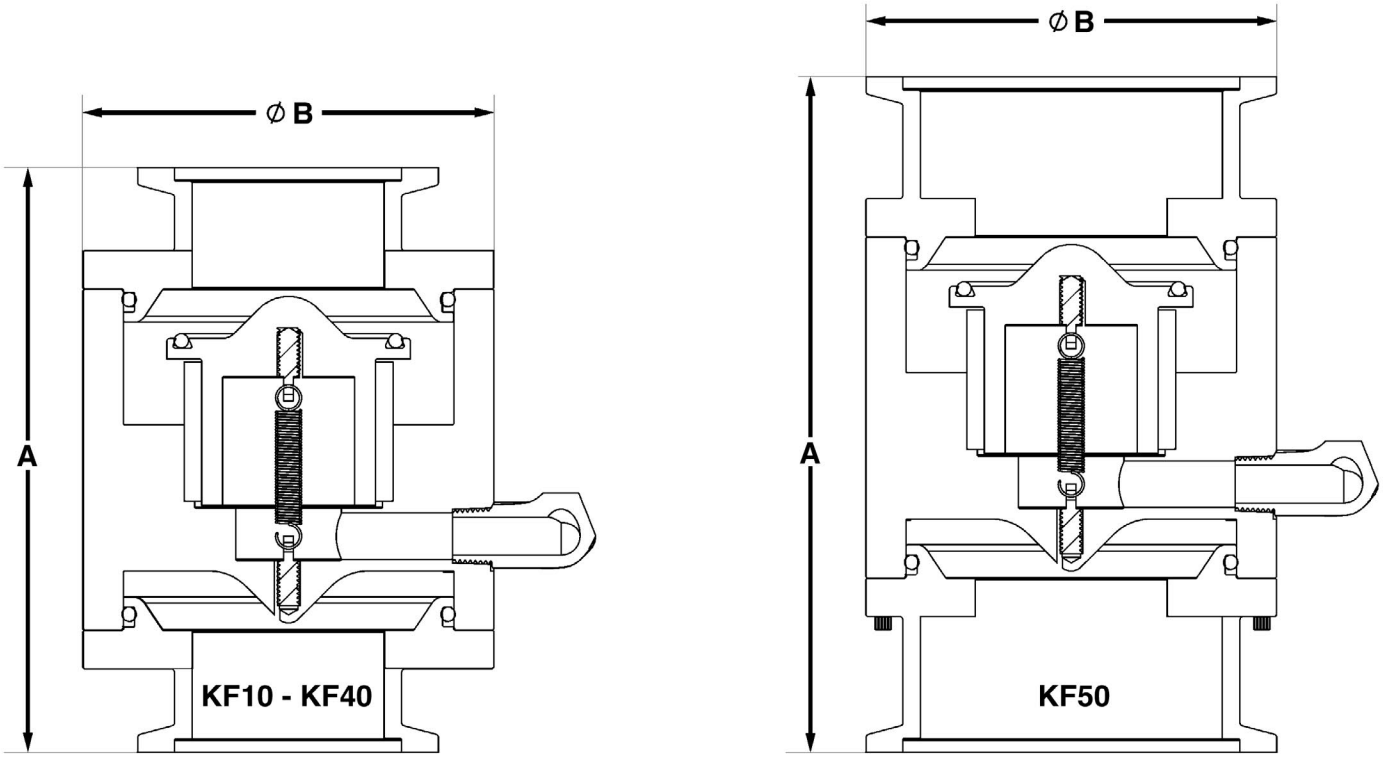


Figure 2 - Dimensional Drawings

1.7 ASSEMBLY DIAGRAM AND PARTS LIST

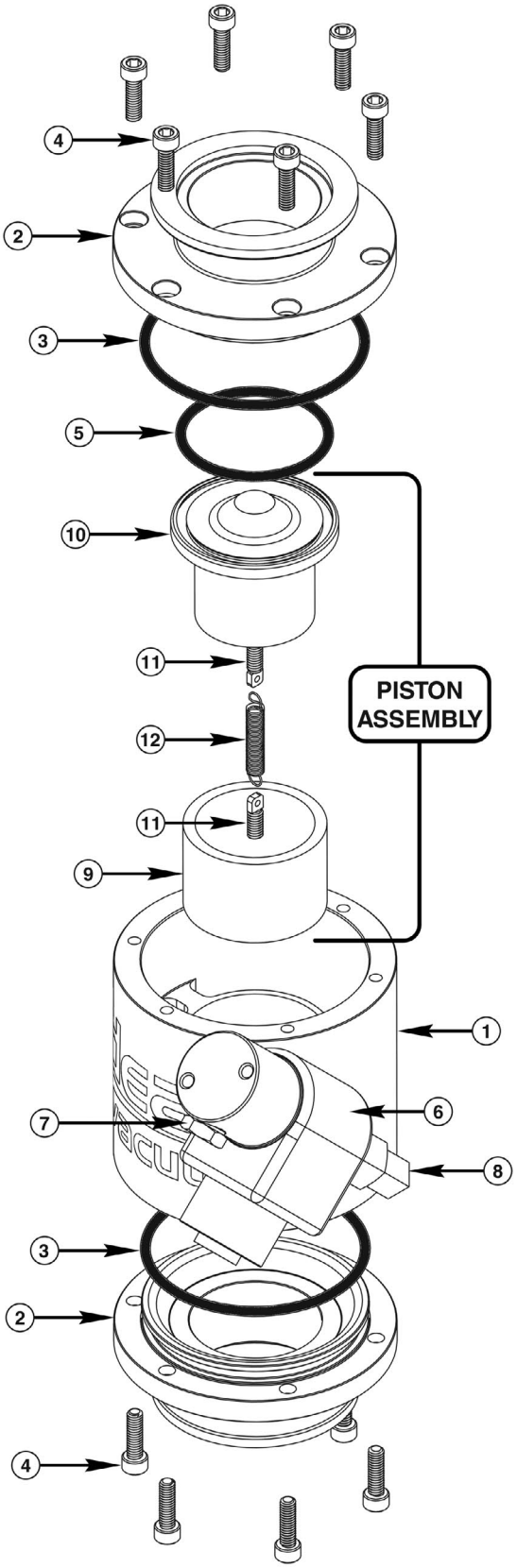


Figure 3 - Assembly Diagram

PART	DESCRIPTION	QTY.
1	Valve Body	1
2	Flange End	2
3	Flange End O-Ring	2
4	Cap Screw, 6-32 NW/KF-10 to KF40, 3/8" Long NW/KF-50, 9/16" Long	12
5	Actuator Cup O-Ring	1
6	Solenoid Valve	1
7	Atmospheric Vent	1
8	90° Elbow, 1/8" NPTF, SS	1
Piston Assembly (not user serviceable)		
9	Fixed Bearing	1
10	Acuator Cup	1
11	Spring Stud Anchor	2
12	Tension Spring	1

Table 4 - Parts List

2. INSTALLATION

DANGER

Use with clean, dry air or inert gasses only. Do not use with any process that uses explosive, pyrophoric, corrosive, or toxic gases. Evacuated vapors and gases could be vented into the personnel work area during a power outage.

CAUTION

Always wear protective equipment, including safety glasses and gloves. Exercise care when working with vacuum equipment.

Figure 4 below illustrates the Delta-P Valve installed in a typical (simplified) high vacuum system. The system is comprised of a backing pump, the Delta-P Valve, a bellows hose, a turbo pump and a vacuum chamber (one of our modular Ideal Vacuum Cubes). In this example, both the turbo pump and chamber are protected during a power failure.

The DPV can also be used to safeguard a vacuum chamber in a roughing system (no turbo). Ideal Vacuum stocks everything shown in this example.

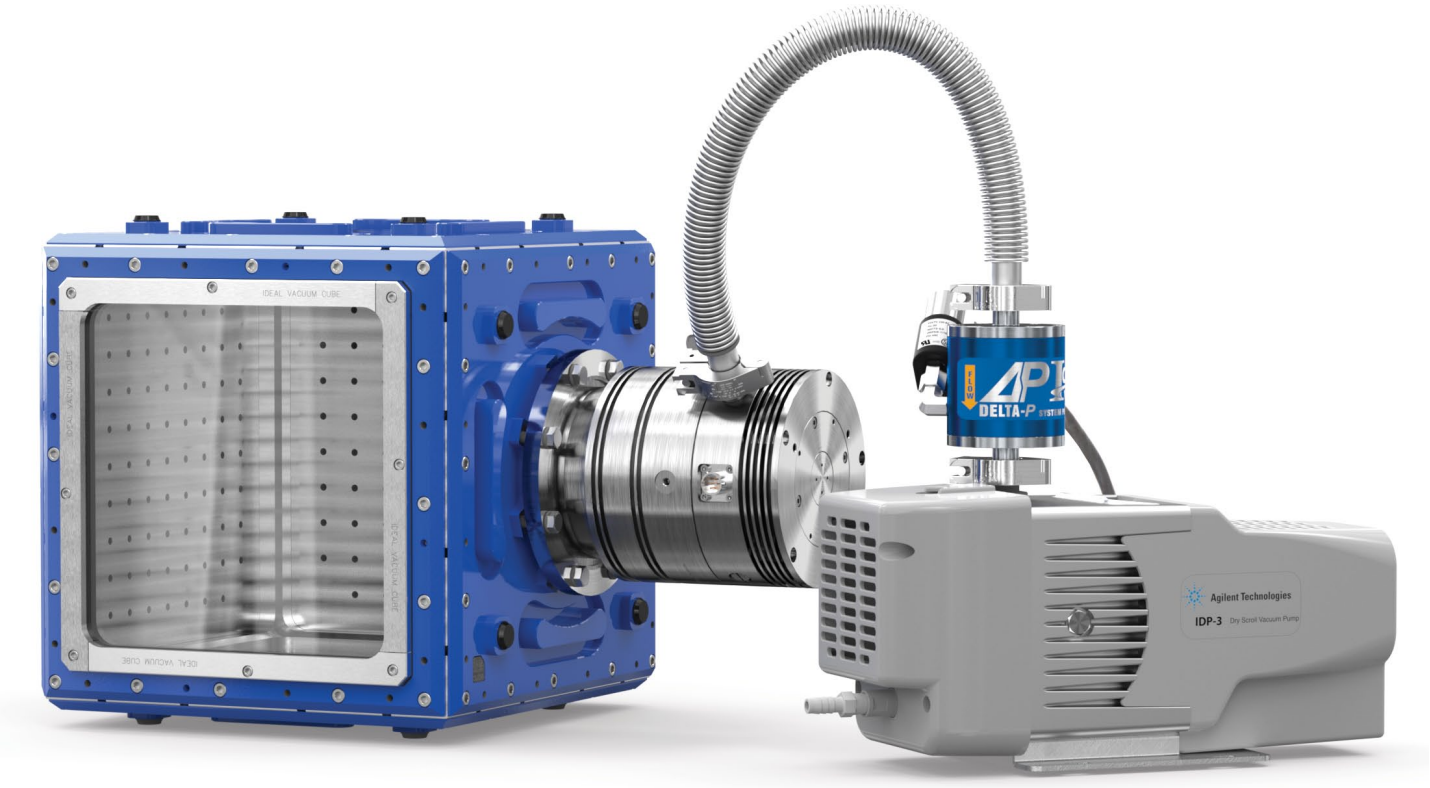


Figure 4 - High Vacuum Simplified System Example

2.1 MECHANICAL

NOTICE

Delta-P Valve must be installed with the correct flow direction. The DPV outlet connects to the inlet of the mechanical pump (flow arrow points towards mechanical pump). Never install the Delta-P valve on the inlet of a high vacuum pump. Risk of pump damage if installed incorrectly.

To plumb the Delta-P Valve:

1. Disconnect the roughing or backing line (foreline) at the mechanical pump.
2. Examine the DPV to determine flow direction. The flow arrow points towards the mechanical pump's inlet.
3. Connect the DPV to the mechanical pump using an appropriately sized quick clamp and properly sized centering ring.
4. Connect the vacuum line to the inlet of the DPV.

2.2 ELECTRICAL

WARNING

Disconnect from Power Source and Lockout/Tagout BEFORE connecting equipment. Trained Service Personnel Only! Follow all applicable electrical codes for installation. AC solenoids must be properly grounded.

The DPV solenoid must be wired on the same circuit which powers the pump.

AC solenoids have 3 wires: Black (hot), White (neutral) and Green/Yellow (ground).

DC solenoids have 2 wires: Black (hot) and white (negative).

To wire the Delta-P Valve:

1. Disconnect power before making any electrical connections.
2. Install an appropriate plug on the solenoid's power cord (if necessary).
3. Make sure an AC solenoid is properly grounded.
4. Connect the solenoid. The solenoid might be wired directly to the pump motor, to an AC outlet, or for DC solenoids, through a 24VDC power supply.
5. Wait until all connections are made before restoring power.

3. OPERATION

3.1 PRINCIPLE OF OPERATION

The Delta-P Valve operates on the differential pressure between ambient atmosphere and the roughing pump's vacuum level.

A normally open (NO) electric solenoid valve with an attached atmospheric solenoid vent is affixed to the DPV. When system power is on, the solenoid valve is held closed. Loss of system power causes the solenoid valve to open. Atmospheric air travels through the vent and enters the Delta-P Valve's body on the mechanical pump side of the Valve. The pressure difference (Delta P) between atmosphere at the mechanical pump side and vacuum on the chamber side, causes the DPV to actuate and close very quickly (≈ 25 ms). This isolates the vacuum system from the mechanical pump and provides the force needed to keep the DPV closed.

When power is restored, the solenoid is re-energized and the atmospheric solenoid vent closes. The backing (mechanical) pump starts to pump down the roughing side of the Valve. When the backing pump's pressure approaches that of the static isolated vacuum chamber's pressure, the holding force on the DPV is significantly decreased, such that the DPV re-opens. Once open, vacuum pressure throughout the system equalizes and the system quickly returns to its normal operating pressure.

3.2 SEQUENCE OF OPERATION

Figure 5, on the following page, illustrates the four stages of DPV operation during a power loss and recovery cycle. The illustrations show how the internal mechanism of the Delta-P Valve functions and how the flow route changes at each of these stages.

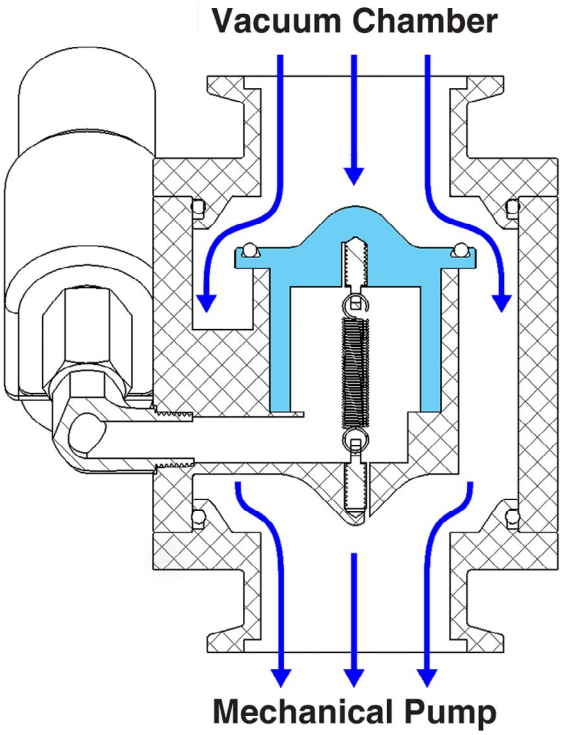


Figure 5a- Normal Operation

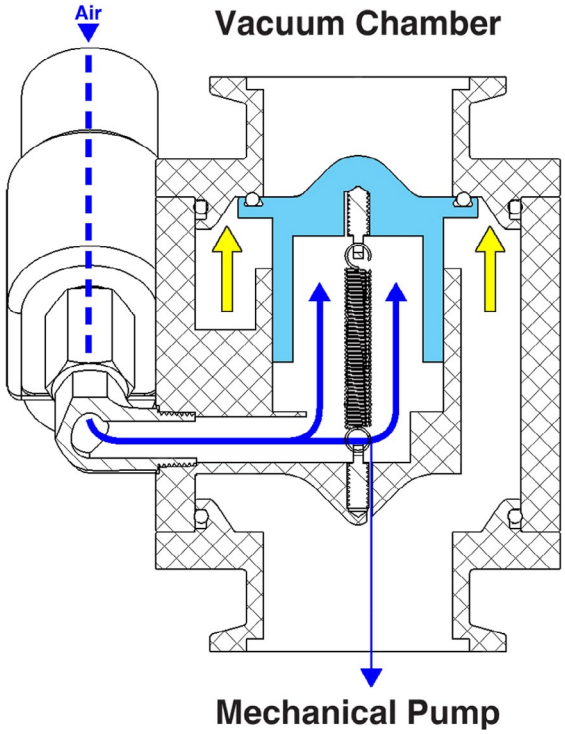


Figure 5b - Power Loss

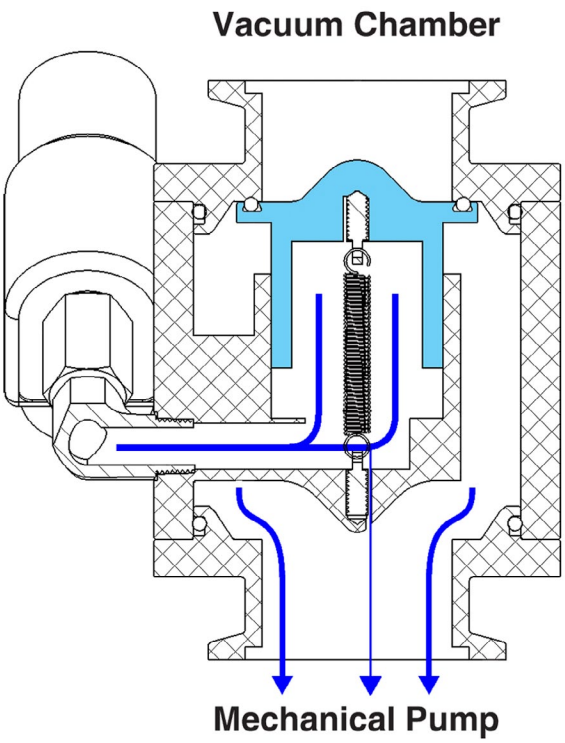


Figure 5c - Power Restored

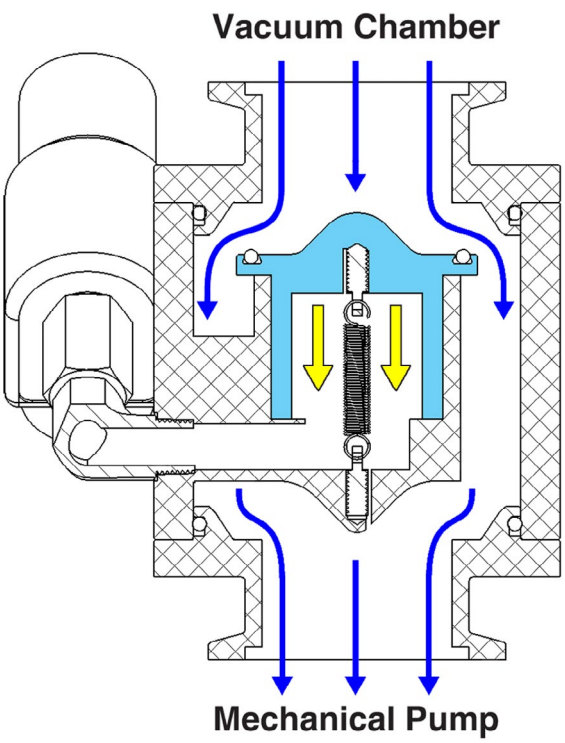


Figure 5d - Return to Normal Operation

Figure 5 - Four Stages of DPV Operation

3.2.1 NORMAL OPERATION (Power On, DPV Open)

Figure 5a shows the DPV in its normal operating condition. System power is on and the primary (mechanical/backing) pump is producing vacuum. The Delta-P Valve is open allowing flow from the vacuum system into and through the pump. The Delta-P solenoid (vent) is closed. The mechanical pump, the roughing/backing line, and the Delta-P Valve are all at the same vacuum pressure.

3.2.2 POWER LOSS (Solenoid vents to Atmosphere, DPV Closes)

Figure 5b shows the action of the DPV when there is a power loss. If a power interruption occurs, the mechanical pump motor loses power and starts to spin down. The solenoid is de-energized and opens to atmosphere through its vent. Atmospheric air rushes through the solenoid vent, filling the Delta-P Valve's body on the mechanical vacuum pump's side of the valve, and into the piston chamber.

The pressure difference (Delta P) created between the higher ambient atmospheric pressure at the backing pump side and the lower pressure (vacuum) on the vacuum system side, provides the force necessary to overcome the spring tension holding the piston actuator cup in the open position (Figure 5b, yellow arrows). The piston actuator cup is forced rapidly towards the vacuum system (chamber) side, and it closes against the flange end. As the DPV closes, only the interior of the piston chamber is filled with air. Air cannot enter the vacuum system side.

Once closed, vacuum chamber pressure is preserved and the vacuum side is isolated from the backing pump side, safe from migrating contaminants. The backing pump side ultimately reaches atmospheric pressure and remains there until system power resumes.

3.2.3 POWER RESTORED (Power On, Air Evacuated from Piston Chamber)

Figure 5c shows the DPV when power is restored. The solenoid is re-energized which closes its atmospheric vent. The backing pump begins to remove the atmospheric air contained between it and the closed Delta-P Valve. Air trapped in the piston chamber is evacuated through a small orifice in the DPV body as the backing pump generates more vacuum on its return to normal operation.

3.2.4 RETURN TO NORMAL OPERATION (Power On, DPV Opens)

Figure 5d shows the DPV as it returns to normal operation. While air is extracted from the DPV piston chamber, the backing pump's pressure rapidly decreases and begins to approach that of the static, isolated, vacuum chamber's pressure. The Differential Pressure force, which held the Delta-P Valve tightly closed (Figure 5b), is now significantly lessened.

When the differential holding force is reduced sufficiently, the piston tension spring pulls the actuator cup towards the backing pump side. The DPV opens. Flow from the vacuum system, through the DPV, is re-established. The vacuum and backing pressures equalize, then pressure quickly reaches normal (pre-power loss) operating conditions.

3.3 CLOSURE TEST

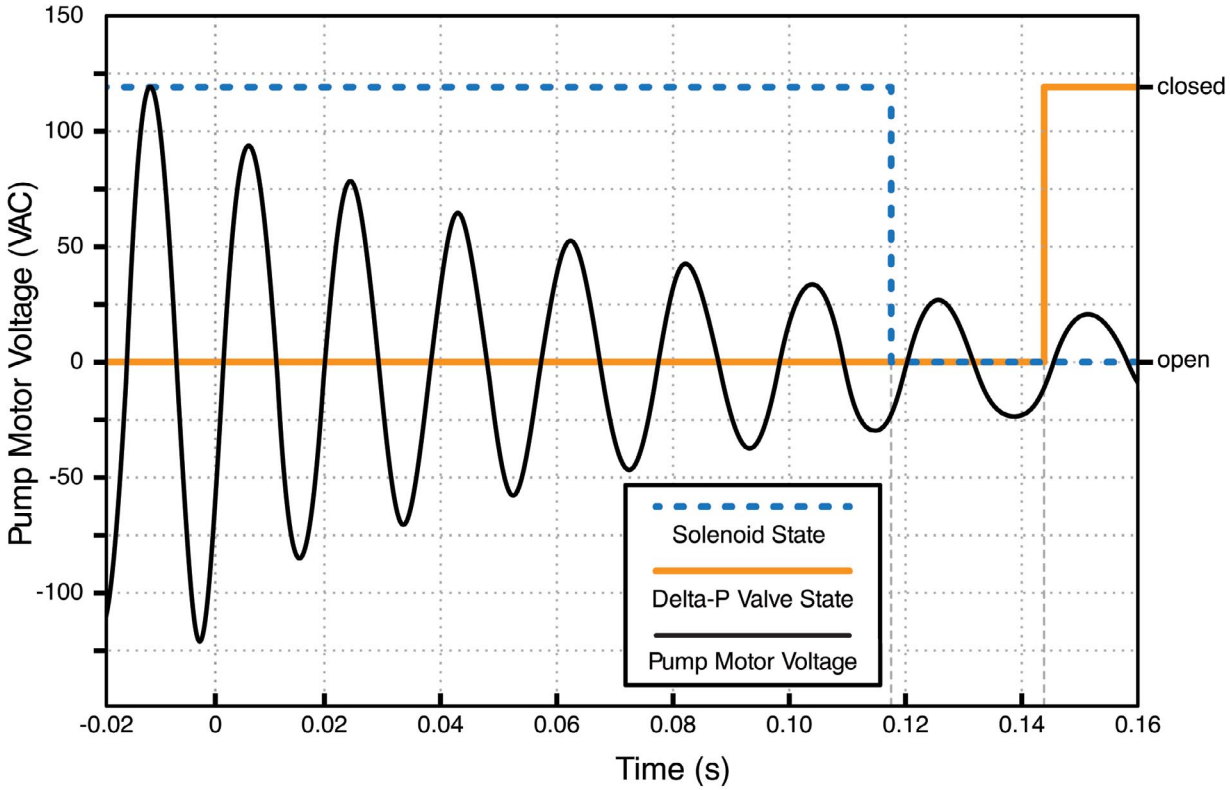


Figure 6 - Closure Test with Agilent Varian SH 110 Vacuum Pump

Isolation valve closure is not instantaneous upon a power loss. A delay will always occur. Actual closure time will vary depending on the pump and the time required for it to stop.

Figure 6 shows the results of an actual test using an Agilent Varian SH 110 dry scroll vacuum pump and the Delta-P Valve operating on standard 120 VAC power. The vacuum pump and solenoid are wired in parallel, powered from the same electrical circuit breaker. The pump motor's AC voltage is plotted as a function of time. The power is switched off at (0) seconds. The blue dashed line shows the state of the solenoid valve. The solid orange line represents the Delta-P Valve state.

This test result shows that the solenoid does not open, and the Delta-P Valve does not close, immediately upon power loss. Here, the DPV closes at approximately 143 ms.

When power is removed, the momentum of the pump's spinning rotor causes it to spin down, rather than to stop abruptly. The black sinusoidal curve shows that after power is removed, the pump's motor generates AC voltage, decaying as it slows. The AC voltage (and current) generated is fed back through the pump's electrical circuit.

Since it is on the same electrical circuit as the pump, the solenoid valve remains energized by the AC voltage being generated back through the circuit by the spinning pump motor. The solenoid opens when the AC voltage feedback drops below where it can no longer be held closed. In this test, the solenoid opens at approximately 118 ms.

Once the solenoid opens and atmospheric air is vented into the DPV, it requires only about 25 ms for the DPV to close.

4. MAINTENANCE AND SERVICE

⚠ CAUTION


Always wear protective equipment, including safety glasses and gloves. Exercise care when working with any vacuum component.

NOTICE

Before working on any vacuum system component, prepare a clean work area. Use only clean tools and recommended cleaning agents to perform maintenance, cleaning and service.

NOTE

If the DPV begins to close slowly, or does not seal completely, it is an indication that the Valve actuator cup seal requires cleaning.

The Delta-P Valve is designed to require very little maintenance. However, occasional cleaning of the DPV is beneficial to maintain good operation. Particulates and other contaminants can begin to accumulate inside the Valve, resulting in poor sealing or conductance reduction. Service the DPV as part of scheduled, system preventive maintenance. Most importantly, the O-rings should be checked, cleaned and replaced if necessary. After service, test the DPV for correct operation.

4.1 CLEANING VALVE EXTERIOR

The Valve's exterior may be wiped down with IPA (isopropyl alcohol), soap and water, or another mild cleaning solution.

4.2 DISASSEMBLY

NOTICE

The piston chamber, made up of the acetal bearing, actuator cup (piston) and the internal spring mechanism, is not user serviceable. DO NOT DISASSEMBLE THE PISTON CHAMBER. Disassembly of the Valve's internal components may make it inoperable and will void the warranty.

Access the Valve's interior and actuator cup (piston) seal for cleaning:

1. Remove the Valve's inlet flange end (the flange end opposite the flow arrow).
2. Use a 7/64" hex key wrench to remove the six (6) hex screws that secure the flange end onto the Valve body.
3. Hold the Valve body firmly in one hand and the flange in the other.
4. Slowly twist, rock and pull the flange end away from the Valve body. It will be tight due to the sealing O-ring.
5. The O-ring can be reused if it is still smooth, flexible and undamaged.

4.3 CLEANING O-RINGS

To clean the actuator cup and flange end O-rings:

1. Dip a clean, lint-free cloth in IPA.
2. Wrap the IPA dampened cloth around one finger and gently wipe the O-ring.
3. Repeat as necessary to remove all dirt. Use a clean spot on the cloth for each pass.
4. Similarly, wipe down the flange end O-ring and its interior sealing surface.

Figure 7 - Cleaning the Actuator Cup O-Ring

4.4 CLEANING VALVE BODY

NOTICE

Use only Isopropyl Alcohol on the Valve's interior. Other cleaning agents or solvents are not recommended. Do not insert any tool inside the Valve body. Do not use compressed air to blow out the Valve after cleaning.

To clean the entire Valve body, remove both flange ends according to the disassembly instructions, and immerse the body in IPA.

4.5 REPLACING O-RINGS

Should the actuator cup O-ring become too dirty to clean successfully, or if either of the flange end O-rings become damaged, replacement is required. We recommend you replace all three (3) O-rings at once. See Replacement Parts in the Appendix for our O-ring Replacement Kit.

1. Carefully remove the O-ring from its groove. Use only a plastic O-ring/seal removal tool like the one shown in Figure 11. Avoid the use of metal tools which could scar the actuator cup or damage the O-ring groove.

2. Wipe the O-ring grooves with IPA before installing new O-rings.

3. Apply a thin layer of vacuum grease on the two (2) flange end O-rings before reassembling the Valve. DO NOT use vacuum grease on the actuator cup O-ring.

4. Reassemble the Valve.

Figure 8 - Replacing the Actuator Cup O-Ring

4.6 REASSEMBLY

Before replacing the flange end, lightly lubricate its O-ring with vacuum grease.

1. Replace the flange end by slowly twisting, rocking and pushing the flange end into the Valve body.

2. Use care not to catch or trap the O-ring between the flange end and Valve body, as the O-ring could be damaged.

3. Do not over-tighten the flange end cap screws. A quarter or half turn past finger tight is sufficient.

4.7 TESTING

After performing any maintenance or service on the DPV and prior to reinstalling it in your system, we recommend you test it for proper functionality. The hardware setup and procedure described below will verify proper Valve function.

The test setup includes a mechanical pump, the Delta-P Valve, and a pressure sensor with controller, arranged as shown below in Figure 12.

1. Disconnect all power cables.

2. Connect the pump, DPV and pressure gauge with quick clamps and centering rings (as shown). Connect the sensor cable to the controller.

3. Connect power cables to the pump, Valve solenoid and controller.

4. Turn on power.

5. The pump will start evacuating the air trapped between it and the pressure gauge. After the vacuum pressure is pumped down (less than about a minute), cut power.

6. The controller should show an immediate, slight pressure increase. Pressure should quickly stabilize and remain constant for at least 10 minutes.

Figure 9 – Simple Test Apparatus

If the pressure remains constant, the Valve is working. If the pressure increases, either the Valve is not closing properly, or there may be a leak in another area of the test apparatus. See Troubleshooting on the following page.

4.8 TROUBLESHOOTING

ISSUE	POSSIBLE CAUSES	POSSIBLE SOLUTIONS
Solenoid gets hot	Normal operation	No action required
No flow	DPV installed in wrong direction	Reinstall DPV with flow arrow towards mechanical pump
Closes slowly	Dirty actuator cup O-ring	Clean O-ring
	Dirty Valve body	Clean valve body
	Solenoid vent clogged	Remove and clean solenoid vent with IPA
Leaks when closed	Dirty actuator cup O-ring	Clean O-ring
Leaks When Closed (after cleaning)	Damaged actuator Cup or flange end O-ring	Replace O-rings
	Bad solenoid valve seal	
Leaks after O-ring replacement	Bad centering ring seal	Replace centering ring
	Delta-P Valve damaged	Return to Ideal for repair service
Solenoid does not close	Solenoid not powered	Check power to solenoid
	Solenoid coil damaged	Replace solenoid valve

Table 5 - Troubleshooting

4.9 FACTORY REPAIR

If you have exhausted all troubleshooting suggestions, and the Valve is still not functioning properly, it may need factory service or repair.

Please contact us prior to returning a malfunctioning Valve, whether under warranty or outside the warranty period. Contact us by phone, M-F, 8 am - 5 pm, Mountain Time, at (505) 872-0037, or by email at: techsupport@idealvac.com. A technical support representative will try to resolve the problem. If we cannot resolve the issue quickly, we will issue an RMA number and provide product return instructions.

APPENDIX

A.1 REPLACEMENT PARTS

We offer a replacement O-ring kit, flange ends and solenoids for the Delta-P Valve. The O-ring kit consists of all three (3) O-rings in the Delta-P Valve. This includes two (2) flange end O-rings and one (1) actuator cup O-ring. Always replace all O-rings at once. Flange end replacement kits are available in five (5) NW/KF sizes and include a flange end O-ring and 6 cap screws. Use this kit to replace a damaged flange end, to match flange sizes between the DPV and a mechanical pump, or to avoid the use of a flange adapter between the DPV and the vacuum system line. We offer solenoids as replacement spares in three voltages (110-120 VAC, 200-240 VAC, and 24 VDC).

PART NUMBER	DESCRIPTION
P1010156	O-Ring Replacement Kit
P1010192	NW/KF-10 Flange End Kit
P1010193	NW/KF-16 Flange End Kit
P1010194	NW/KF-25 Flange End Kit
P1010195	NW/KF-40 Flange End Kit
P1010196	NW/KF-50 Flange End Kit
P108430	Solenoid Valve, 110VAC
P108431	Solenoid Valve, 220VAC
P1010132	Solenoid Valve, 24VDC

Table 6 - Replacement Parts

A.2 ACCESSORIES

To help speed the construction of your vacuum system, we suggest the accessories listed below. Visit idealvac.com for all your system needs.

PART NUMBER	DESCRIPTION
P1010547	O-Ring Removal Tool, Non Scratch Polycarbonate
P102545	Apiezon AP101 Anti Seize Vacuum Grease, 50 g Tube
P101198	NW/KF-10/16 Quick Clamp
P101199	NW/KF-25 Quick Clamp
P101200	NW/KF-40 Quick Clamp
P101201	NW/KF-50 Quick Clamp
P101958	NW/KF-10 Centering Ring w/Viton O-ring
P101242	NW/KF-16 Centering Ring w/Viton O-ring
P101243	NW/KF-25 Centering Ring w/Viton O-ring
P101244	NW/KF-40 Centering Ring w/Viton O-ring
P101245	NW/KF-50 Centering Ring w/Viton O-ring
P101246	NW/KF10 to KF16 Adaptive Centering Ring w/Viton O-ring

Table 7 - Recommended Accessories

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