

Diaphragm Seals

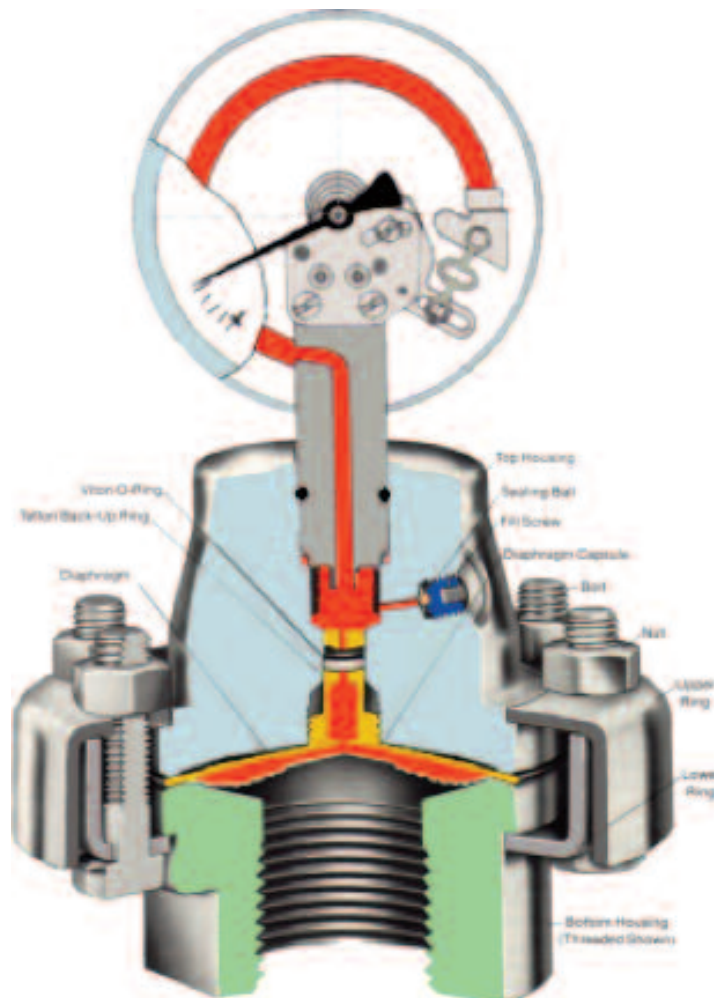
DS/PI-82E

MINIMUM/MAXIMUM PRESSURES FOR DIAPHRAGM SEALS

The comprehensive line of Ashcroft diaphragm seals will meet a variety of applications and installation requirements. To take full advantage of Ashcroft's seal technology it is important to understand the products operating principles and pressure measurement characteristics. This information provides a guideline when isolating an instrument from the process; reference Table 2 for the Minimum/Maximum operating pressure matrix.

Operating Principle

A diaphragm seal is attached to the process connection of the instrument. The hermetically sealed system is vacuum filled with liquid, or fill fluid. The pressure applied to the diaphragm is hydraulically transmitted to the pressure instrument.



Diaphragm Seal and Instrument Assembly

To ensure that the pressure is correctly transmitted from the diaphragm to the instrument the following must be considered:

1. Fluid Displacement

- a. **Volumetric Displacement:** The volume of fluid a diaphragm can displace. variables involved. However, we know it can be influence by:

DIAPHRAGM SEAL DISPLACEMENT

| DIAPHRAGM SEAL TYPE | DIAPHRAGM MATERIAL | MAXIMUM DISPLACEMENT | |
|---------------------|--------------------|----------------------|-------------------|
| | | CUBIC INCHES | CUBIC CENTIMETERS |
| 100, 200 | Metal | 0.7 | 1.14 |
| 200, 300 | Teflon | 0.14 | 2.23 |
| 200, 300 | Viton | 0.5 | 8 |
| 300 | Kalrez | 0.5 | 8 |
| 310 | Metal | 0.025 | 0.41 |
| 311, 312 | Metal | 0.032 | 0.52 |
| 320 (1½" process) | Metal | 0.025 | 0.41 |
| 320 (2" process) | Metal | 0.07 | 1.14 |
| 330 | Metal | 0.018 | 0.41 |
| 400 | Metal | 0.07 | 1.14 |
| 500 | Metal | 0.07 | 1.14 |
| 702/703 | Metal | 0.43 | 7 |
| 740/741 | Metal | 0.43 | 7 |

Table 1

- b. **Control Volume or Instrument Displacement:** The volume of fluid needed to obtain full deflection of the instrument, or 0-100% range.

To obtain a successful transfer of pressure from the diaphragm to the pressure instrument the volumetric *displacement of the diaphragm must be greater than the control volume of the instrument.*

2. Instrument Pressure Range

Instruments offering **low pressure** ranges (i.e. series 1188 gauges, inches of water range switches and low differential pressure gauges, such as 5503), typically have a high control volume. Consequentially, these instruments require a high volumetric displacement diaphragm seal. As noted on **Table 1**, the 700 series seals and the Viton/Kalrez diaphragms offer the highest volumetric displacement. In fact, low pressure instruments such as 1188, 5503 and inches of water switches **must be** mounted to the 700 series or a seal with Viton or Kalrez. Please reference Table 2 Min/Max.

In addition, the diaphragm seal must be **rated for pressure greater than the full scale of the instrument.** For threaded seals, please refer to the datasheet. For flanged seals, please refer to DS/PI- 83 Diaphragm Seal Flange Ratings, found on ashcroft.com

3. Fill Fluid

Ashcroft offers a variety of fill fluids to meet customer requirements. When selecting the appropriate fill fluid for the application please consider the following:

a. Safety: In the unlikely event of a diaphragm rupture, the fill fluid will come into contact with the process media. Applications where oxidizing agents are present, (i.e. chlorine, bromine, oxygen etc.) require Halocarbon fill, as they may cause fires or violent reactions in the event that glycerin, silicone or oil are utilized. For a complete list of oxidizing agents please use our guide at ashcroft.com

In the case of food/beverage and pharmaceutical applications, a non-toxic food grade fluid may be required. Ashcroft offers food grade glycerin, silicone and mineral oil.

b. Pressure Ranges: Applications in vacuum, compound or low pressure require low viscosity fluid; 1188 series gauges must be filled with low viscosity fluids as silicone. Glycerin is high viscosity (1,300cSt) and not recommended for such applications.

c. Temperature: The fill fluid must be able to withstand the min./max. of the process temperature. The following table provides a list of common fluids and their temperature ratings.

| FILLING | SERVICE | CONNECTION TO INSTRUMENT | TEMPERATURE LIMITS RANGE | | CODE |
|-------------------------|---|--------------------------|--------------------------|---------|------|
| | | | °F | °C | |
| Glycerin | Pressure | Direct Only | 0/400 | 0/204 | CG |
| Silicone | Pressure/Vacuum | Direct or Remote Line | -40/600 | -40/315 | CK |
| Halocarbon | Pressure/Vacuum in Presence of Strong Oxidizing Agent | Direct or Remote Line | -80/392 | -62/200 | CF |
| Syltherm | Pressure/Vacuum | Direct or Remote Line | -40/750 | -40/399 | HA |
| Food Grade Silicone | Pressure/Vacuum | Direct or Remote Line | -40/500 | -40/260 | CZ |
| Distilled Water | Pressure/Vacuum | Direct or Remote Line | 40/185 | 4/85 | FJ |
| Ethylene Glycol & Water | Pressure/Vacuum | Direct or Remote Line | 20/325 | -7/163 | CT |
| Propylene Glycol | Pressure/Vacuum | Direct or Remote Line | 20/325 | -7/163 | CV |
| Mineral Oil | Pressure/Vacuum | Direct or Remote Line | 10/400 | -12/204 | HY |
| Silicone 10 cST | Pressure/Vacuum | Direct or Remote Line | -40/500 | -40/260 | DJ |

In extreme high or low temperature applications, the fill fluid may experience thermal expansion. This could result in added pressure to the closed system, thereby creating an error in accuracy. The DS/PI-14 Product Information page (found at ashcroft.com) provides a detailed explanation of the temperature impact as well as how to calculate increase in pressure;

<http://www.ashcroft.com/products/upload/DS-PI-14-2.pdf>

4. Mounting

a. Pressure Instruments: Gauges, transducers and pressure switches can be direct or remote mounted.

b. The fill fluid must be coded on both seals and instruments.

c. The seal instrument connection must match the instrument process connection.

i. Switches: X06 or O6 connection (½ NPT) will match O4T seal connection.

d. Differential Pressure Instruments: Differential gauges, switches and transmitters must be mounted to seals using a capillary. A low viscosity fluid is required for remote mount systems. Each instrument requires two seals and two capillaries.

e. Multiple Instrument Assemblies: Only available with low viscosity fill fluid. Not available with Glycerin.

5. Response Time

This is the period of time required for the pressure instrument to indicate 90% of the value of a sudden pressure variation. Unfortunately, response time cannot be quantified due to the many variables involved yet it is understood to be influenced by:

a. Configuration of the System:

- i. Direct or Remote Mounted:** Direct mounted assemblies provide faster response times.
- ii. Pressure or Differential Pressure.**
- iii. Length of Capillary:** Limiting the length of capillary will improve response time.
- iv. Multiple Instrument Assemblies.**

b. Fill Fluid: Low viscosity fill fluids will have reduced response time.

c. Diaphragm Size: Larger diaphragms, ie. type 700, will respond faster to changes in pressure.

6. Diaphragm Materials

Ashcroft offers a diversity of diaphragm materials to withstand a variety of processes. The mechanical properties of each material might impact the sensitivity of the diaphragm. Figure 2 shows a qualitative representation of diaphragm sensitivity based on material.



Figure 2

Ashcroft has compiled the above information on this Easy and Simple to read table. This is a guide, please contact inside sales if you have any questions.

Table 2: MIN/MAX OPERATING PRESSURES FOR DIAPHRAGM SEALS

| Process Connection Type | Diaphragm Seal Type | Duragauge & 4 1/2" & Larger Gauges ⁽²⁾ | Unigaugue, 2 1/2" & 3 1/2", Type 1009 ⁽¹⁾ | 1259, 5500/6500 ⁽⁶⁾ | Low Pressure Bellows Gauges (1188 Series) ^(3,4) | 5503 DP Gauge ⁽⁴⁾ | Digital Gauges ^(5,6) | Transducers ⁽⁶⁾ | Switches |
|-------------------------|---|---|---|---|--|------------------------------|---|---|---|
| THREADED | 100/101/200/201 METAL DIAPH. | 15psi & Vac (compound), 30psi to 2500psi (XHP to 5000#) | Vac to 2500psi (XHP to 5000#) | 15psi & Vac (compound), 30psi to 2500psi (XHP to 5000#) | N/A | N/A | Vac to 2500psi (XHP to 5000#) | Vac to 2500psi (XHP to 5000#) | 6psi & Above Setpoint |
| | 200/201/300/301 TEFLON DIAPH. | Vac to 2500psi | Vac to 2500psi | Vac to 2500psi | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to 2500psi | Vac to 2500psi (XHP to 5000#) | 6psi & Above Setpoint |
| | 200/201/300/301 VITON, OR KALREZ DIAPH. | Vac to 500psi | Vac to 500psi | Vac to 500psi | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to 500psi | Vac to 500psi | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | 310/315 ("MINI") | N/A | Vac to 2500psi | N/A | N/A | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 311/312 ("MINI") | 15psi & Vac (compound), 30psi to 1000psi | Vac 15psi to 1000psi 6psi to 3000psi | 15psi & Vac (compound), 30psi to 1000psi | N/A | N/A | Vac 15psi to 1000psi | Vac (compound) Vac to 1000psi | 6psi & Above Setpoint |
| | 330 (FLUSH) | N/A | 45psi & Vac (compound), 6psi to 3000psi | N/A | N/A | N/A | Vac | Vac (compound) Vac to 1000psi | 6psi & Above Setpoint |
| | 400/401 (WELDED) | 15psi & Vac (comp), 30psi to 4400psi (400 XHP to 9000psi) (401 XHP to 5000psi) | Vac to 4400psi (400 XHP to 9000psi) (401 XHP to 5000psi) | 15psi & Vac (comp), 30psi to 4400psi (400 XHP to 9000psi) (401 XHP to 5000psi) | N/A | N/A | Vac to 4400psi | Vac to 4400psi (XHP to 9000psi) | 6psi & Above Setpoint |
| | 500/501 (WELDED) | 15psi & Vac (compound), 30psi to 500psi | Vac to 500psi | 15psi & Vac (compound), 30psi to 500psi | N/A | N/A | Vac to 500psi | Vac to 500psi | 6psi & Above Setpoint |
| | 500/511 | 30psi to 1500psi (XHP to 5000psi) | 30psi to 1500psi (XHP to 5000psi) | 30psi to 1500psi (XHP to 5000psi) | N/A | N/A | 100psi to 1500psi (XHP to 5000psi) | 100psi to 1500psi (XHP to 5000psi) | 6psi & Above Setpoint |
| | 740/741 (LP) | Vac to 750psi | Vac to 750psi | Vac to 750psi | 15MW & 15WC, 30WC to 10psi | 10psid to 40psid | Vac to 750psi | Vac to 750psi | 30" H ₂ O & Above Setpoint |
| IN-LINE THREADED | 104/204 METAL DIAPH. | 15psi & Vac (compound), 30psi to 2500psi | Vac to 2500psi | 15psi & Vac (compound), 30psi to 2500psi | N/A | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 204 TEFLON DIAPH. | Vac to 2500psi | Vac to 2500psi | Vac to 2500psi | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to 2500psi | Vac to 2500psi (XHP to 5000#) | 6psi & Above Setpoint |
| | 204 VITON, OR KALREZ DIAPH. | Vac to 500psi | Vac to 500psi | Vac to 500psi | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to 500psi | Vac to 500psi | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | 102/103/202/203/402/403 METAL DIAPH. | 15psi & Vac (compound), 30psi to Class 2500# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 15psi & Vac (compound), 30psi to Class 2500# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 15psi & Vac (compound), 30psi to Class 2500# (Per Group 1.1 Materials, Per ASME B16.5-2003) | N/A | N/A | Vac to Class 2500# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 2500# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| | 202/203/302/303 TEFLON DIAPH. | Vac to Class 900# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 900# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 900# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to Class 900# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 900# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| | 202/203/302/303 VITON, OR KALREZ DIAPH. | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | 702/703 | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 15MW & 15WC (compound), 10WC to 10psi | 10psid to Class 300# | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 30" H ₂ O & Above Setpoint |
| | 106/206 METAL DIAPH. | 15psi & Vac (compound), 30psi to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 15psi & Vac (compound), 30psi to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 15psi & Vac (compound), 30psi to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | N/A | N/A | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| | 206 TEFLON DIAPH. | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| | 206 VITON, OR KALREZ DIAPH. | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 150# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| IN-LINE SOCKET WELD | 107/207 METAL DIAPH. | 15psi & Vac (compound), 30psi to 2500psi | 15psi & Vac (compound), 30psi to 2500psi | 15psi & Vac (compound), 30psi to 2500psi | N/A | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 207 TEFLON DIAPH. | Vac to 2500psi | Vac to 2500psi | Vac to 2500psi | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 207 VITON, OR KALREZ DIAPH. | Vac to 500psi | Vac to 500psi | Vac to 500psi | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to 500psi | Vac to 500psi | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | 108/208 METAL DIAPH. | 15psi & Vac (compound), 30psi to 2500psi | Vac to 2500psi | 15psi & Vac (compound), 30psi to 2500psi | N/A | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 208 TEFLON DIAPH. | Vac to 2500psi | Vac to 2500psi | Vac to 2500psi | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 208 VITON, OR KALREZ DIAPH. | Vac to 500psi | Vac to 500psi | Vac to 500psi | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to 500psi | Vac to 500psi | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | 105/205 METAL DIAPH. | 15psi & Vac (compound), 30psi to 2500psi | Vac to 2500psi | 15psi & Vac (compound), 30psi to 2500psi | N/A | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 205 TEFLON DIAPH. | Vac to 2500psi | Vac to 2500psi | Vac to 2500psi | 30MW & 30WC (compound), 60WC to 10psi | N/A | Vac to 2500psi | Vac to 2500psi | 6psi & Above Setpoint |
| | 205 VITON, OR KALREZ DIAPH. | Vac to 500psi | Vac to 500psi | Vac to 500psi | 5MW & 5WC (compound), 10WC to 10psi | 10psid to 40psid | Vac to 500psi | Vac to 500psi | 10" H ₂ O & Above (B-Series only) 20" H ₂ O & Above All Others |
| | TYPE 80 | | | | | | | | |
| ISO RING | TYPE 81 | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | N/A | N/A | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | Vac to Class 300# (Per Group 1.1 Materials, Per ASME B16.5-2003) | 6psi & Above Setpoint |
| | TYPE 85 | | | | | | | | |
| | TYPE 86 | | | | | | | | |
| | 320 | Vac to 1000psi (with High Pressure Clamps) (2" Tri-Clamp Only) | Vac to 1000psi (with High Pressure Clamps) (2" Tri-Clamp Only) | Vac to 1000psi (with High Pressure Clamps) (2" Tri-Clamp Only) | N/A | N/A | Vac to 1000psi | Vac to 1000psi | 6psi & Above Setpoint |

NOTES: 1. 1008 not available with seals.
 2. 1125/1127/1128 same system as Duragauge, use static pressure of the system to define compatibility.
 3. 1188 gauges/seal assemblies NOT available with glycerine.
 4. 5503 must be assembled with capillaries.
 5. Glycerine NOT available per Vac and compound ranges.
 6. Lower limits are guidelines for direct mount only. For remote mount consult factory.