P-Series: Solenoids and Pressure Regulators

Product Bulletin 24-05 F

Type: PS4 & PA4

Purpose:

P-Series solenoids and pressure regulators valves are weld-in, reducing potential for connection leaks and the simple valve design ease for service.

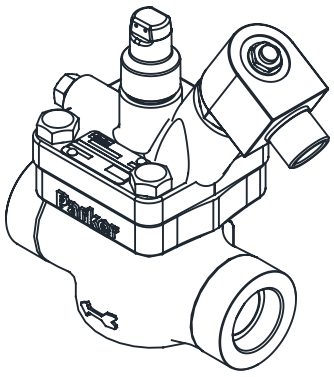
This improved design has a higher working pressure, greater working temperature range and higher flow capacities than our legacy flanged product line.

P-Series valves provide long-term performance with replaceable internal components. All moving parts are replaceable without having to remove the body from the line.

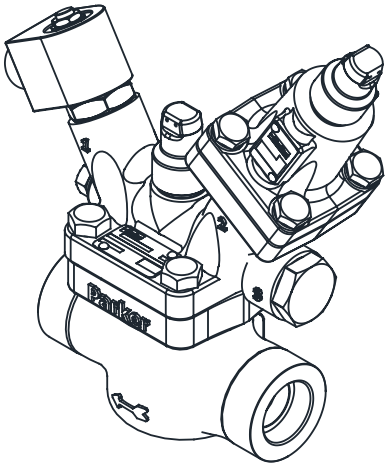
P ARKER

S4 SOLENOID VALVE

A4 PRESSURE REGULATOR



PS4



PA4

Contact Information:

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Product Features:

- Suitable for ammonia, CO_2, R-22, R-134a, R-404A, R-410A, R-507, and other common refrigerants
- Cartridge based design simplifies service and eliminates body wear
- Increased flow capacity enables smaller valve sizing
- Integral features prevent contaminants from reaching the pilot section of the valve
- Overall weight reduction up to 50% compared to traditional flanged products
- Coil options to meet various applications
- Stainless steel versions (PS4C, PA4C) are corrosion-resistant, suitable for harsh environments
- Patented design

ENGINEERING YOUR SUCCESS.

Table of Contents

Technical Data

Body Material
P_4W . . . . . Cast Steel LCC ASTM A352, Zinc Nickel/Chromated Plated
P_4C . . . . . Stainless Steel - CF3 ASTM A351

Liquid Temperature Range . . . . . -60°C to 120°C (-76°F to 248°F)

Ambient Temperature Range
AC Coils . . . . . -60°C to 60°C (-76°F to 140°F)
DC Coils . . . . . -25°C to 60°C (-13°F to 140°F)

Maximum Rated Pressure (MRP) . . . . . 52.0 bar (754 psi)

Maximum Operating Pressure Differential (M.O.P.D.)
AC Coils . . . . . 20.7 bard (300 psid)
DC Coils . . . . . 10.0 bard (145 psid)

Minimum Pressure Drop Required to Open Valve
Standard Solenoid . . . . . 0.14 bard (2 psid) min
Two Stage Solenoid . . . . . 0.69 bard (10 psid) min (1st stage)
0.28 bard (4 psid) min (2nd stage)
Regulators . . . . . 0.21 bard (3 psid) min

Port Size		Capacity Plugs	Flow Coefficient		Connections				Weight [1]	
					SW		BW ANSI BW Metric (DIN)			
mm	inch		Kv	Cv	mm	inch	mm	inch	kg	lbs
20	¾	Full 65% 30%	9.5 7.0 4.3	11.0 8.0 5.0	20 25 32	¾ 1 1¼	20 25 32 40	¾ 1 1¼ 1½	3.7 to 7.0	8.2 to 15.4
25	1	Full	12.0	14.0						
32	1¼	Full 50%	15.6 7.8	18.0 9.0	32 40 50	1¼ 1½ 2	32 40 50	1¼ 1½ 2	10.0 to 12.8	22.0 to 28.2
40	1½	Full 30%	28.0 7.8	32.0 9.0						
50	2	Full 35%	47.6 16.4	55.0 19.0	50 65	2 2½	50 65	2 2½	14.5 to 18.1	32 to 40
65	2½	Full 45%	65.0 30.3	75.0 35.0	65	2½	65 80	2½ 3	20.4 to 25.0	45 to 55
80	3	Full 35%	86.5 30.3	100.0 35.0	65	2½	65 80	2½ 3	20.4 to 25.0	45 to 55

1. The weight will vary based on the valve function.

Function and Design

P-Series valves are normally closed, requiring a minimum of pressure drop across the valve to fully open according to each series. The valves are an integrated assembly of one, two or three modules: solenoid, regulator or a combination of them.

The valves have a body that contains the cartridge assembly but is ordered to suit a particular connection size. Valve bodies are available with socket weld (SW), ANSI butt weld (BW) or metric butt weld (DIN BW) options. The port size defines the size of the body.

There is a port plate, which defines the valve function. A single port plate provides the option between a solenoid or regulator. For additional control features the multi port plate provides a variety of port plate arrangements; a regulator with pilot solenoids: either an Electric Shut-Off (S) or an Electric Wide Open Bypass (B), among others (see the application guide and variations section of this bulletin).

It is highly recommended to install an upstream strainer in all P-Series to minimize damage to or prevent malfunction of the valve and the rest of the system.

Solenoid Function (PS4)

When the solenoid coil is energized the magnetic field created pulls the plunger up. This allows flow to travel to the top of the piston and collect on the top side of the piston. When a pressure differential is met the piston pushes downward forcing the plug to a fully open position allowing flow to the valve outlet.

When the coil is de-energized the plunger returns to its normally closed seated position, by using spring force, terminating refrigerant flow to the top of the piston. A bleed hole in the piston allows for the continuous equalization, pushing the high pressure refrigerant, above the piston, through the bleed hole and out the valve. Piston seal ring ensures that this bleed hole is the sole source of equalization. The top and bottom pressure on the piston equalizes and the weight of the piston along with the closing spring forces the valve to close.

Dual Solenoid Valve or Two Stage Solenoid (PS4D)

The valve will work in the same manner previously explained for a single solenoid; the difference is that it has 2 coils to operate. The solenoid will be opened 10% only when coil in position #2 is energized, and then 100% open when coil in position #1 is energized (both coils). The valve will be closed if both coils are de-energized. See Figure 1.

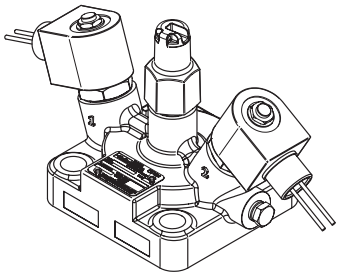


Figure 1: Dual Solenoid Coils Position

Regulators Function (PA4)

The valve will modulate to maintain a pressure set in the field using a combination of spring pressure and a diagram to seat or unseat the path to the piston. Depending on the valve variation the regulator will control upstream, downstream or differential pressure.

When pressure range of the regulator is beyond the field setting, the valve will stop modulating and the piston/plug cartridge assembly will equalize in the same manner as described in the solenoid function. For example, if an "A" range pilot 0.35 to 10.3 bar (5 to 150 psig) is selected, and the pressure in the system exceeds the range of the pilot (example 11.7 bar (170 psig)), the valve will just be wide open and not regulate pressure.

The bonnet assembly of the Pressure Regulators contains the range set spring and adjustment stem, as shown in Table 1.

Inlet pressure travels from the body to the port plate through a passage located on the inlet side of the valve. The passage is designed to minimize foreign material from entering the pressure pilot and piston area of the valve. Minimizing foreign material to these areas reduces wear and other foreign material issues.

Pressure Regulator Range	Set Point Range	Pressure Change per Turn of the Adjustment Screw	Factory Set Point [1]
V*	250mm Hg - 8.3 bar (10in Hg - 120 psig)	*Approximate* 1.5 bar (22 psig)	2.8 bar (40 psig)
A	0.35 - 10.3 bar (5 - 150 psig)	*Approximate* 1.2 bar (17 psig)	2.8 bar (40 psig)
D	5.2 - 19.3 bar (75 - 280 psig)	*Approximate* 2.9 bar (42 psig)	9.7 bar (140 psig)
E	6.9 - 51.7 bar (100 - 750 psig)	*Approximate* 3.8 bar (55 psig)	20.7 bar (300 psig)

1. The factory set point changes based on regulator type. Example "K" feature for range A is 4.8 bar (70 psig).
* Range V: Only applicable for outlet regulators.

Table 1: Pressure Pilot Range Settings

The location of the gauge port for inlet and differential pressure regulators in any variant or body type, can be on the port plate, it is shown in Figure 2.

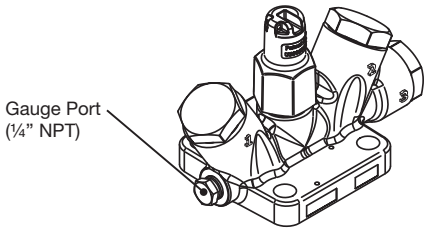


Figure 2: Gauge Port for Inlet and Differential Pressure Regulators

For outlet pressure regulators in any variant, the gauge's port is shown in Figure 3.

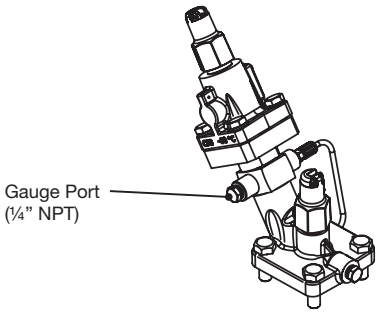


Figure 3: Gauge Port for Outlet Pressure Regulators

Some regulator variation, such as the differential ('PA4L') or outlet ('PA4O') features, require an outlet sensing tube as shown in Figure 4.

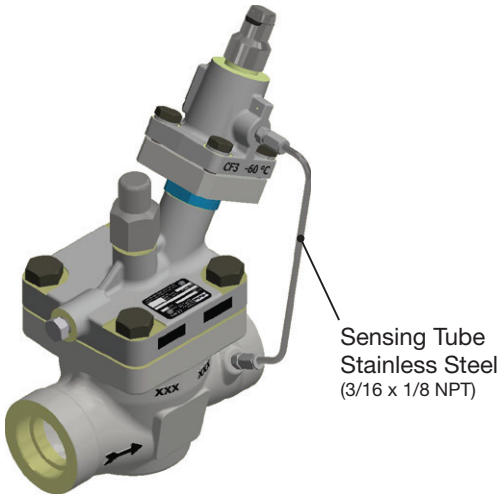
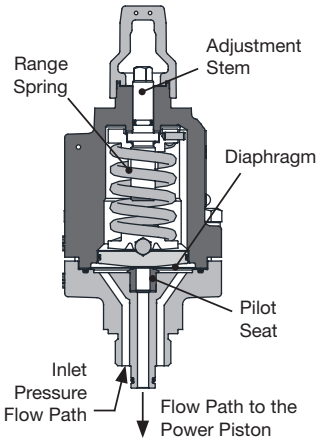
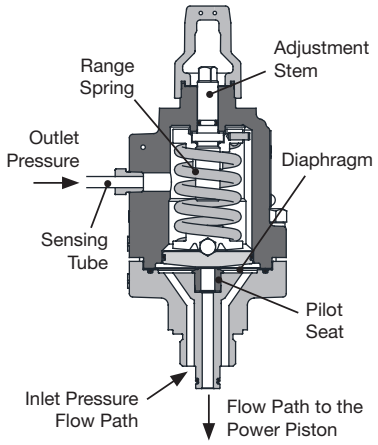
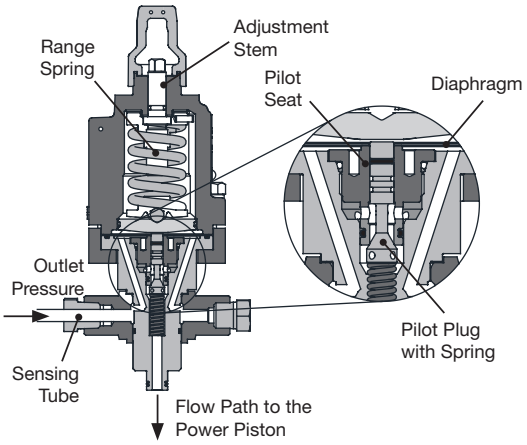


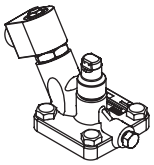
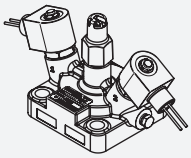
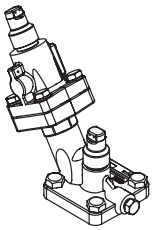
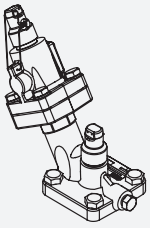
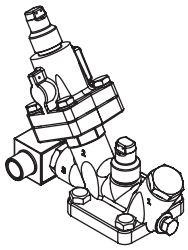
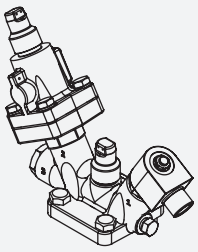
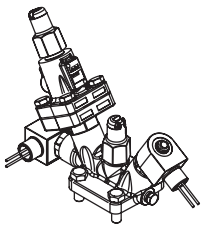
Figure 4: Differential Pressure Regulator, Sensing Tube

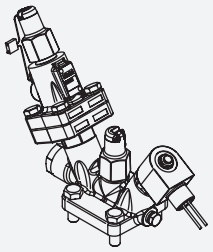
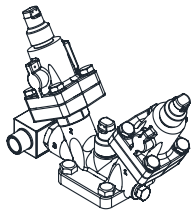
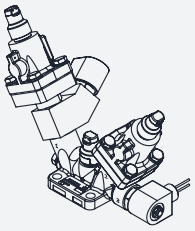
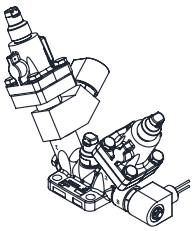
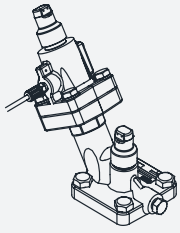
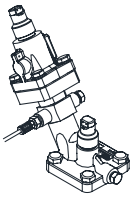
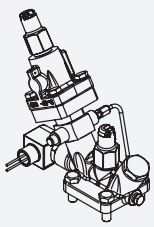
Regulator Pilot Assemblies

Pressure Pilot Regulator Assemblies - Function		
PA4, PA4_ (B, S, D), PA4K (Inlet Pressure)	**PA4L (Differential Pressure)**	**PA4O (Outlet Pressure)**
		
The inlet pressure enters the space under the diaphragm through the inlet flow path. When the force created by the pressure exceeds the force of the range spring, the diaphragm is lifted off the pilot seat allowing pressure to enter on top of the power piston. This causes the power piston to move downward forcing the modulating plug to open and modulate to maintain constant inlet pressure. An increase in inlet pressure lifts the diaphragm further, allowing more pressure on top of the power piston and opening the valve wider. A decrease in inlet pressure causes the diaphragm to move closer to the pilot seat reducing the pressure on the top of the power piston and causing the closing spring to reduce the valve opening. The pressure on top of the power piston is controlled by the flow through the pilot seat and the bleed off through the bleed hole in the power piston and through the clearance between the piston and cylinder.	This is a pilot operated regulator whose main valve is opened by a power piston in response to the inlet pressure received from below the regulator diaphragm. The outlet pressure is introduced through a sensing tube from the outlet of the valve into the bonnet and to the top of the diaphragm, thus allowing the regulator to maintain a differential pressure between the inlet and outlet equivalent to the spring pressure. After the regulator is set for the desired pressure differential, the pressure at the inlet of the regulator will rise and fall, pound for pound, with the rise and fall of pressure at the regulator outlet, always maintaining the set-for differential pressure across the regulator. If the difference between inlet pressure and outlet pressure of the regulator is less than the set-for pressure, the regulator will remain tightly closed.	The outlet pressure is sensed under the diaphragm through the sensing tube. When the force created by the outlet pressure acting under the diaphragm is less than the force of the range spring, the pilot is open, allowing pressure to enter on top of the power piston. This causes the power piston to force the modulating plug to open to maintain to constant outlet pressure. An increase in the outlet pressure will lift the diaphragm against the force of the range spring, allowing the pilot plug to start closing. The pressure on top of the power piston is decreased and the closing spring acts to reduce the opening of the modulating plug and the flow of fluid through the regulator. The pressure on top of the power piston is controlled by the flow through the pilot seat and the bleed through a bleed hole in the power piston and through the clearance between the piston and cylinder.

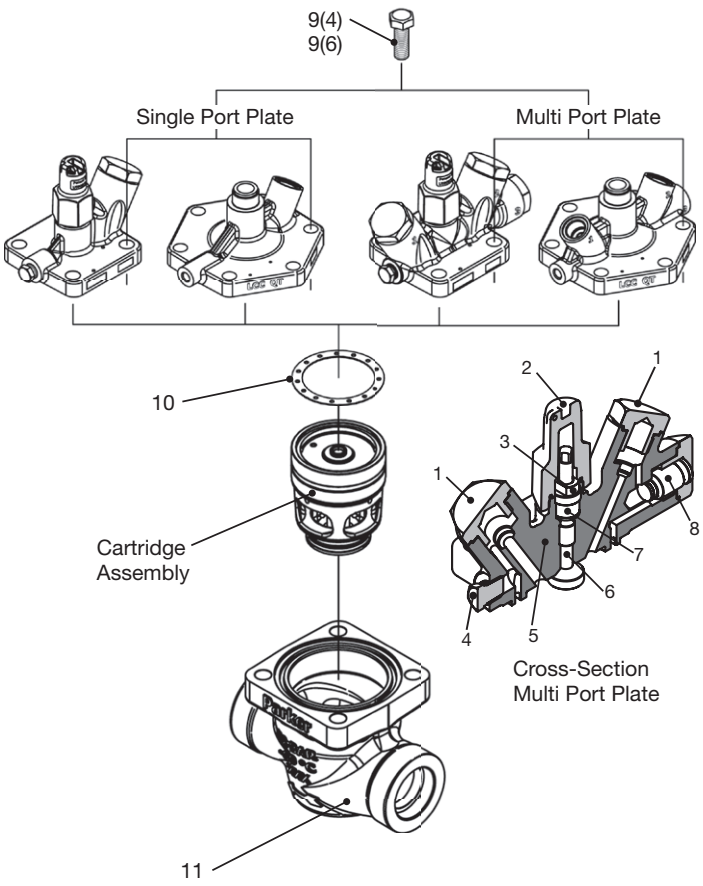
Application Guide and Variations

There are many possible options for the P-series valves. These can be used as solenoid ('PS4'), dual solenoid ('PS4D'), inlet pressure regulator ('PA4'), outlet pressure regulator ('PA4O') or differential pressure regulator ('PA4L') and these regulators may be used in combination with other variations, e.g. electric shut-off ('PA4S'), electric wide-opening ('PA4B') and dual pressure ('PA4D'), etc. Reference Schematic Flow Diagrams in **Appendix "A"** for a better understanding of each variation.

Variation	Model	Port Plate Setup	Function	Operation	Typical Applications
Solenoid	PS4		Shut-Off	Opens when coil is energized; closes when not energized.	1. Pumped liquid feed. 2. High pressure liquid (Make-Up). 3. Hot gas defrost. 4. Evaporator suction stop. 5. Equalizing lines.
Two-Stage Solenoid	PS4D		Opens or closes in two steps electrically	Opens 10% when #2 coil is energized, opens 100% when both coils are energized. Closes when both coils are de-energized. Closes 90% when coil #1 is de-energized and coil#2 is energized.	1. Combined soft gas/hot gas feed for hot gas defrost applications. 2. High pressure liquid make up line to prevent liquid hammer. 3. Suction stop with equalization.
Inlet Pressure Regulator	PA4		Controls inlet pressure	Operates at preset inlet pressure. Can be field adjusted. Opens on rising inlet pressure.	1. Evaporator pressure control. 2. Condenser pressure regulation. 3. Receiver pressure control. 4. Any inlet pressure regulation in the system.
Re-Seating Relief Inlet Pressure Regulator	PA4K		Re-seating relief regulator	Repeatedly re-seats after operation at calibrated pressure (sealed).	1. Defrost relief. 2. Relief to other parts of the system, Non-atmospheric. 3. Relief from high to low pressure side.
Inlet Pressure Regulator with Electric Shut-Off	PA4S		Controls inlet pressure or shut-off regulator	Regulates when electrically energized; closed when not energized.	1. Open for temperature control. 2. Closed for defrosting. 3. Whenever it is required to stop all flow (in the normal fluid flow direction) through the regulator.
Inlet Pressure Regulator with Electric Wide Opening	PA4B		Controls inlet pressure or wide open/bypass regulator	Regulates when not electrically energized; wide open when energized.	1. Wide open for maximum cooling. 2. Regulating for defrost. 3. Regulating for temperature control.
Inlet Pressure Regulator with Electric Wide Opening and Shut-Off	PA4BS		Controls inlet pressure or wide open/bypass regulator and shut-off	Completely closed when both coils are de-energized. Regulates when the coil in position 3 (S2) is electrically energized and the coil in position 1 (S1) is de-energized. Wide open when coil in position 1 (S1) or both coils are energized.	1. Wide open for maximum cooling. 2. Regulating for defrost. 3. Regulating for temperature control. 4. Can close suction line for defrost cycle.

Variation	Model	Port Plate Setup	Function	Operation	Typical Applications
Re-Seating Relief Inlet Pressure Regulator with Electric Wide Opening	PA4BK		Controls a re-seating inlet pressure or wide open/bypass regulator	Regulates when not electrically energized: open wide above set point (sealed calibration); repeatedly re-seats after operation. Wide open when energized.	1. Wide open for maximum cooling. 2. Regulating for defrost. 3. Regulating for temperature control.
Inlet Dual Pressure Regulator	PA4D		Dual pressure control Position 1 (P2): High pressure pilot Position 2 (P1): Low pressure pilot	Regulates at lower pressure when electrically energized; at higher pressure when not energized.	1. Control pressure for defrost. 2. Pressure regulation for temperature control. 3. Internal pressure relief.
Inlet Dual Pressure Regulator with Electric Shut-Off	PA4DS		Dual pressure control with electric shut-off Position 1: - High pressure pilot (P2) - Solenoid pilot (S2) Position 2: Low pressure pilot (P1) Position 3: Solenoid pilot for low pressure (S1)	Shut-off when both coils are de-energized. Regulates at low pressure when only solenoid in position 3 (S1) is energized. Regulates at high pressure when only solenoid in position 1 (S2) is energized.	1. Open for: a) Control pressure for defrost. b) Pressure regulation for temperature control. 2. Closed for defrosting.
Inlet Dual Pressure Regulator with Electric Wide Opening	PA4DB		Dual pressure control or wide open (bypass) Position 1: - High pressure pilot (P2) - Bypass or wide open solenoid pilot (S2) Position 2: Low pressure pilot (P1) Position 3: Solenoid pilot for low pressure (S1)	Regulates at high pressure when both solenoids are de-energized. Regulates at low pressure when only solenoid (S1) in position 3 is energized. Control valve is wide open when solenoid (S2) in position 1 is energized.	1. Wide open for maximum cooling. 2. Regulates evaporator pressure for defrost, temperature control or internal pressure relief. 3. Pressure equalization after defrost.
Differential Pressure Regulator	PA4L		Controls differential pressure between the inlet and outlet across control module.	Regulates pressure difference at or below a pre-set amount.	1. Liquid pump relief regulator. 2. Reduce liquid or vapor line pressure. 3. Condenser-receiver pressure difference regulation. 4. Differential regulation for oil control in the compressor crankcase. 5. Discharge pressure boosting for defrosting or heat recovery.
Outlet Pressure Regulator	PA4O		Controls outlet pressure	Regulates at preset outlet pressure. Can be field adjusted. Opens on a drop in outlet pressure.	1. Crankcase pressure regulation. 2. Hot gas bypass; booster loading. 3. Condenser and receiver pressure control through hot gas bypass. 4. Hot gas supply for artificial refrigeration load. 5. Compressor suction pressure limitation.
Outlet Pressure Regulator with Electric Shut-Off	PA4OS		Controls outlet pressure or shut-off regulator	Regulates when electrically energized at preset outlet pressure. Can be field adjusted. Opens on a drop in outlet pressure. Closed when not energized.	1. Crankcase pressure regulation. 2. Hot gas bypass; booster loading. 3. Hot gas feeding. 4. Pressure of hot gas header.

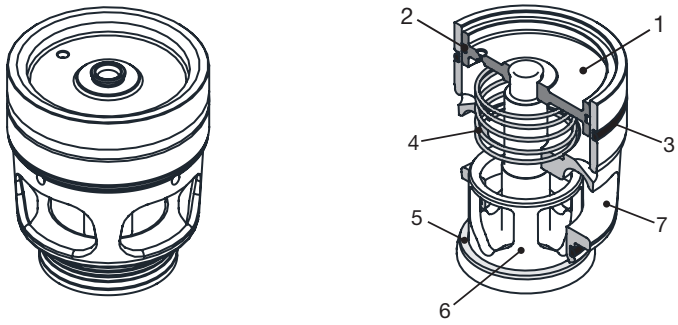
Material List: Port Plate and Body



Item	Description	Material	
		P_4C	P_4W
1	Cap, Port Plate	303 Stainless Steel	304 Stainless Steel
2	Seal Cap	304 Stainless Steel	304 Stainless Steel
3	Packing Nut	303 Stainless Steel	304 Stainless Steel
4	Plug, Gauge Port	304 Stainless Steel	304 Stainless Steel
5	Port Plate	Cast Steel - LCC ASTM A352, Zinc Nickel/Chromate Plated	Stainless Steel - CF3 ASTM A351
6	Stem, Manual Opening	303 Stainless Steel	303 Stainless Steel
7	Packing	Graphitic - ASTM F2168	Graphitic Steel, DIN- ISO 3506-1 Grade A2
8	Plug, Pilot	303 Stainless Steel	303 Stainless Steel
9	Bolts, Port Plate	Steel Grade A2, DIN-ISO 3506-1	Steel Grade A2, DIN-ISO 3506-1
10	Gasket, Port Plate	Gylon 3500	Gylon 3500
11	Body	Cast Steel - LCC ASTM A352, Zinc Nickel/Chromate Plated	Stainless Steel - CF3 ASTM A351
—	Washer, Packing	Steel	Steel
—	Gasket, Seal Cap	Wolverine MS-18020	Wolverine MS-18020
—	Gasket, Port Plate Cap	Wolverine MS-18020	Wolverine MS-18020
—	Gasket, Control Port	Wolverine MS-18020	Wolverine MS-18020

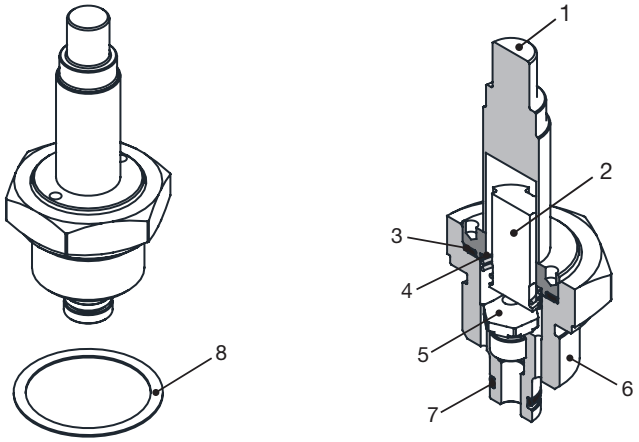
Note: The description and material information for the cartridge assembly and control port options can be found on page 8.
* 6 Bolts Port Plate is used for P-Series bodies with 50 mm (2") port or larger sizes only.

Material List: Control Module - Cartridge Assembly



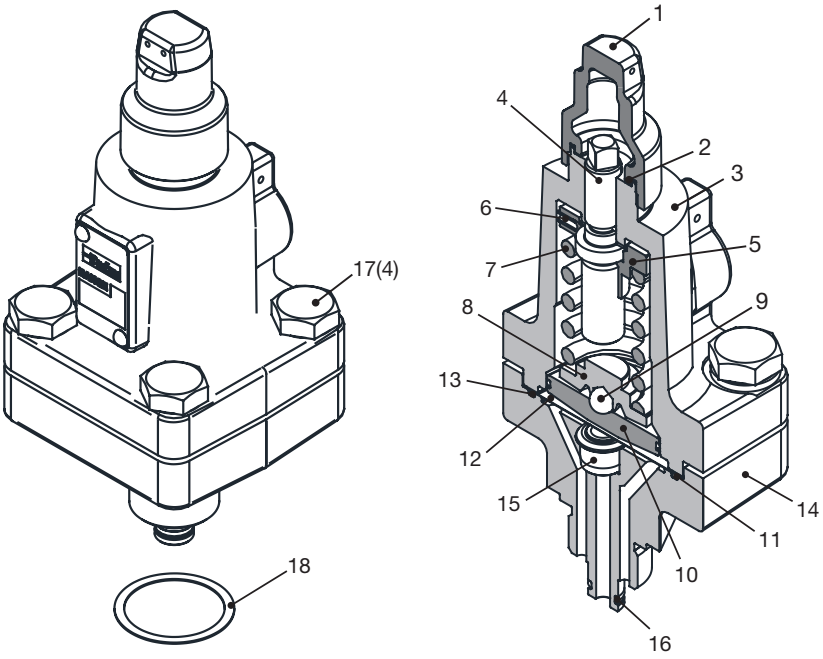
Item	Description	Material
1	Piston	303 Stainless Steel
2	Ring, Piston	Ductile Iron
3	O-Ring	Neoprene
4	Spring	Music Wire, ASTM A-228
5	Seat	PTFE
6	Plug/Stem	CF3 (ASTM A351)
7	Cartridge, Housing	CF3 (ASTM A351)

Material List: Control Module - Solenoid Pilot Assembly



Item	Description	Material
1	Sleeve	304 Stainless Steel
2	Plunger	430FR Stainless Steel
3	O-Ring	Neoprene
4	Spring, Plunger	18-8 Stainless Steel
5	Seat, Solenoid	PTFE
6	Adaptor	303 Stainless Steel
7	O-Ring, Adaptor	Neoprene
8	Gasket, Adaptor Assembly	Wolverine MS-18020

Material List: Control Module - Regulator Pilot Assembly

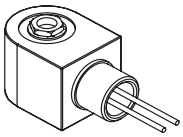
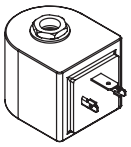
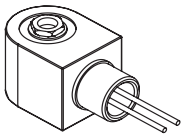


Item	Description	Material
1	Seal Cap	304 Stainless Steel
2	Gasket, Seal Cap	Wolverine MS-18020
3	Bonnet	CF3 (ASTM A351)
4	Adjustment Stem	303 Stainless Steel
5	Spring Plate, Top	Steel, AISI 1215 CD
6	Pin	420 Stainless Steel
7	Spring	Music Wire, ASTM A-228
8	Spring Plate, Bottom	Steel, AISI 1215 CD
9	Ball	440C Stainless Steel
10	Follower, Diaphragm	Steel, AISI 1215 CD
11	Gasket, Bonnet	Kingersil, C-4401
12	Diaphragm	301/302 Stainless Steel
13	O-Ring, Diaphragm	Neoprene
14	Plate, Bonnet	CF3 (ASTM A351)
15	Seat, Pilot	416 Stainless Steel
16	O-Ring, Bonnet Assembly	Neoprene
17	Bolt, Bonnet	Stainless Steel, DIN ISO 3506-1 Grade A2
18	Gasket, Bonnet Assembly	Wolverine MS-18020
—	Washer, Adjustment Stem	18-8 Stainless Steel
—	O-Ring, Adjustment Stem	Neoprene

Electrical

The Refrigerating Specialties Division molded water resistant solenoid coil is designed for long life and powerful opening force. The standard coil housing meets NEMA 4 requirements. This sealed construction can withstand direct contact with moisture and ice. Coil construction will permit coil temperatures as high as 180°C (356°F). A solenoid coil should never be energized except when mounted on its corresponding solenoid tube.

The solenoid coil must be connected to electrical lines with voltage and frequency, same as marked on coil. The supply circuits must be properly sized to give adequate voltage at the coil leads even when other electrical equipment is operating. The coil is designed to operate with line voltage from 85% to 110% of rated coil voltage. Operating with a line voltage above or below these limits may result in coil burn-out. Also, operating with line voltage below the limit will definitely result in lowering the valve's maximum opening pressure differential. Power consumption during normal operation will be 22 watts or less.

Type	Image	Terminal Diagram	Classification	Voltages/Frequencies	Wattage	Temp.	Cert.
Leaded		 Start Winding: White Wire End Winding: Black Wire	18" Leaded Wires NEMA 1, 2, 3, 4, 4x IP67	110-120 VAC/60 Hz 110-120 VAC/50 Hz 200-230 VAC/50 Hz 200-240 VAC/60 Hz 24 VAC/60 Hz 24 VAC/50 Hz 24 VDC [1] *(consult factory for other voltages/frequencies)*	22 W	180°C (356°F)	CE
DIN QD		GROUND 2 N.C.  1 COM	NEMA 1, 2, 3, 4, 4x IP65				
Leaded		 Start Winding: White Wire End Winding: Black Wire	18" Leaded Wires NEMA 1, 2, 3, 4, 4x IP67	110 VAC/50 Hz 120 VAC/60 Hz			UL Hazardous Locations [2]

1. DC coils are limited to an ambient temperature of -25°C to 60°C (-13°F to 140°F) and a M.O.P.D. of 10.0 bard (145 psid). Only available in QD connection.
2. Hazardous location coil approvals: Class II, Division 1 & 2, Groups E, F, G; Class IV, Division 1.

Table 2: General Coil Information

Installation

All valves are packed for maximum protection. Unpack carefully. Check the carton to make sure all items are unpacked. Save the enclosed instruction for the installer and eventual user.

Do not remove the protective coverings from the inlet and outlet of the regulator until the regulator is ready to be installed. Protect the inside of the regulator from dirt and chips before and during installation.

⚠ Caution

All personnel working on valves must be qualified to work on refrigeration systems. If there are any questions, contact Refrigerating Specialties before proceeding with the work.

The valve should be installed in a location where it is easily accessible for adjustment and maintenance. The location should be such that the valve cannot be easily damaged by material handling equipment. When it is necessary to insulate the valve, the insulation should be installed to provide access for adjustment and maintenance. Do not insulate solenoid coils, this applies to regulators with pilot solenoid options. Proper indicating gauges should be installed to be easily visible to the operating engineer for system checks and adjustment purposes.

The P-Series valves must be mounted in the upright horizontal position with the manual opening stem on the top. The valve must be installed with the arrow in the direction of flow for the regulator to function properly.

The valves should be disassembled before welding to prevent damage to o-rings and Teflon (PTFE) components. First remove the port plate by unbolting the bolts. Remove the gasket prior to lifting the cartridge assembly from the body. Located on the top of the cartridge are M5 threads. Screw a M5 bolt in this location and use pliers to pull the cartridge from the valve body, as shown in the Figure 5.

Prior to welding protect the inside of the valve body, cartridge and port plate from welding debris and dirt.

⚠ In the event the valve is left disassembled for any length of time, protecting the components is essential. Place the components in a polyethylene bag or apply a rust protection agent, such as refrigerant oil.

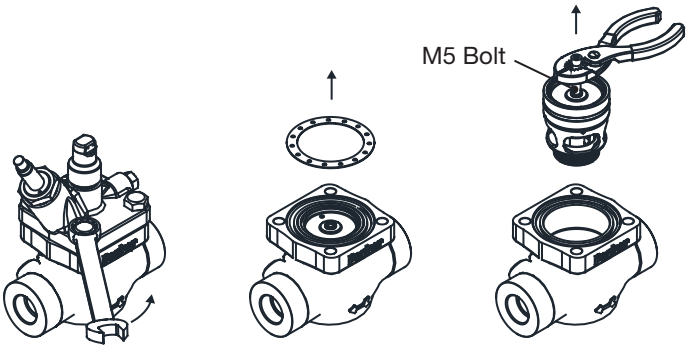


Figure 5: Installation Diagram - Removal of Cartridge

Contractors need to follow a WPS (Welding Procedure Specification) for all welding. The procedure must be qualified and welder doing the weld qualified to perform that procedure.

The codes applicable to the welding of socket weld valves require that the pipe be inserted into the socket until bottomed against the stop. The pipe is then to be backed out approximately 1/16 of an inch before welding. Use of welding rings is optional but recommended for butt weld valves. They help alignment, control gap for full penetration welding, and reduce welding debris entry.

Note: When welding carbon steel and stainless steel the welded joint should be painted to prevent galvanic corrosion.

Socket welding, where allowed, is the preferred connection. This connection helps to reduce the amount of welding debris in the piping system.

Remove welding debris and any dirt from the pipes and valve body before reassembling the valve. Check the cartridge o-rings and port plate gasket for damage. If possible, apply some silicon grease on the o-rings to ease installation and protection. After inserting the cartridge place the new port plate gasket in the same position as removed. The small hole located on the port plate gasket must line up with the inlet passage located on the body, as shown parts reference explosion views. If the port plate gasket surface has been damaged or bent, it must be replaced. If it is a multi-hole gasket, no alignment is necessary.

Tighten the port plate bolts, with a torque wrench, evenly in a X configuration to provide proper seating. Torque bolts to a torque found on Table 3.

For more detailed information on how to reassembly the valve see the cartridge maintenance procedures in the maintenance and service section of this bulletin.

Before putting valves into service, all pipe connections, valve seats, bonnet seals, and stem seals should be tested for leaks at pressure levels called for in appropriate codes.

Port Size		Bolt Size	Item Description	Torque	
mm	inch			Nm	ft. lb.
20, 25	3/4, 1	M12 x 1.5	Port Plate	61 - 68	45 - 50
32, 40	1 1/4, 1 1/2	M16 x 2.0	Port Plate	149 - 156	110 - 115
50	2	M14 x 2.0	Port Plate	102 - 109	75 - 80
65, 80	2 1/2, 3	M16 x 2.0	Port Plate	149 - 156	110 - 115
All	All	M10 x 1.5	Bonnet Assembly	41	30
All	All	1/4-18 NPT	Gauge Port Plug	14	10
All	All	1-12 UNF	Solenoid Tube Assembly	54 - 61	40 - 45
All	All	1-12 UNF	Cap, Port Plate	54 - 61	40 - 45
All	All	1-20 UNF	Seal Cap (Reg. & Man. Open Stem)	Snug	
All	All	5/8-18 UNF	Packing Nut	27	20

Table 3: Valve Torque Recommendations

Regulator Pilot Adjustment Stem Operation

The P-Series pilot adjustment stem is a non-rising stem. This design prevents foreign material from getting lodged in the threads and has less components than Refrigerating Specialties traditional A4 adjustment stem design.

Adjustment of a set regulators' point requires that the pressure being controlled be monitored by an accurate pressure gauge. Before making any adjustments, the seal cap must be removed. In all cases where the regulator is administering a pressure condition and a solenoid feature is not overriding that function, and the flow is in the normal direction, turning the adjusting stem in the (i.e. clockwise) direction will raise the set point, and turning it (i.e. counterclockwise) direction will lower the set point. See Table 3 for set point range, pressure change per turn of the adjustment stem and the factory set point.

Depending on system responses, the gauge may reflect some delay before change in set point actually results in a change in the pressure being maintained. This can also sometimes be observed following the energization or de-energization of the solenoid features. Regulators with 'B' feature can only be adjusted with the pilot solenoid de-energized. Regulators with the 'S' feature can only be adjusted with the solenoid energized.

For all inlet valve variations the pressure gauge can be connected to the gauge port on the inlet side of the regulator.

Always re-tighten the seal cap once adjustments are complete. See Table 3 for torque specifications.

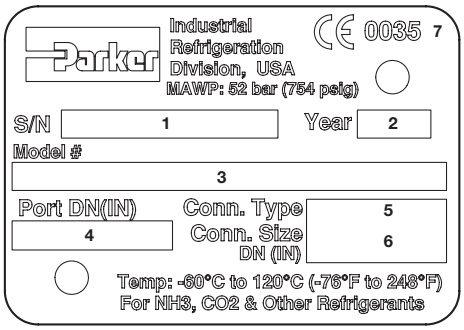
⚠ Caution

When unscrewing the pilot regulator seal cap, check to ensure the entire assembly is not coming off the port plate.

Manual Opening Stem Operation

These valves are equipped with a manual driven opening stem located in the center on the top side of the port plate. To manually bypass or open the pressure regulator turn the stem in (clockwise) until it stops. To put the pressure regulator back in automatic operation, turn the stem out (counterclockwise) until it back seats.

Nameplate Information

Port Size	Name Plate Image	Name Plate
20 mm - 80 mm (¾" - 3")		1. Serial Number (S/N) 2. Year 3. Valve Model Number 4. Port Size 5. Connection Size 6. Connection Type 7. CE Mark (1¼" thru 3" only)

Maintenance

⚠ Caution

Before doing any service work, always be sure to disconnect the power and isolate the valve. Failure to do so will result in venting of refrigerant.

All P-series regulators can be serviced without disturbing the piping or the removal of the valve body. The internal components are designed so that they do not cause wear to the welded-in body.

Prior to performing any maintenance on the valve, read the information in this bulletin, safety procedures for refrigeration control valves (bulletin RSBCV) and safety guide on selecting and using Refrigerating Specialties division products and related accessories (bulletin RSBSG)

Before the regulator is disassembled in the line, make sure the valve has been isolated, manually opened and all the refrigerant pumped out.

For instruction on how to operate the manual opening stem, read the manual opening stem operation instructions on the previous page of this document.

Before re-assembly, all parts must be cleaned with a suitable solvent and permitted to dry. For gaskets that are stuck to the surface use a brass scraper or pick to remove the gasket. Using a brass scraper to remove the gasket from the gasket surface prevents from damaging the surface. Do not polish the gasket contact surfaces.

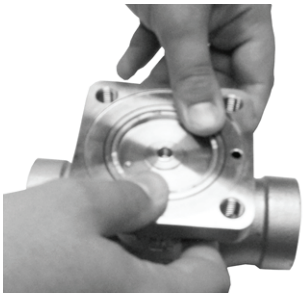
Cartridge Maintenance Procedures

To replace the cartridge assembly, unbolt the port plate from the body. After the port plate has been removed, screw a M5 bolt into the center of the cartridge and pull upwards using pliers to remove the cartridge assembly.

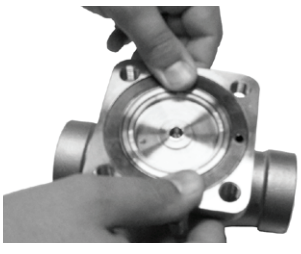
Follow the instructions below to reassemble the new cartridge and valve:

1. Apply silicon grease to the two cartridge o-rings and install the o-rings into the appropriate groove located on the top and bottom of the cartridge assembly. The larger of the two o-rings goes in the top groove.

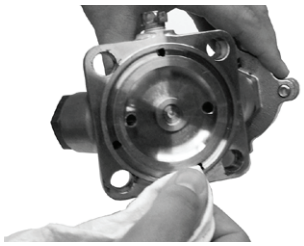
2. Insert the cartridge assembly into the body bore and press down until the cartridge o-rings snap into their seating position.

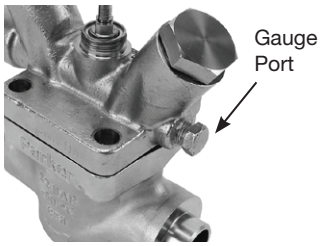


3. Position the port plate gasket into groove aligning the gasket hole with the valve body bleed hole. If it is a multi-hole gasket, alignment is not necessary.



4. Use a paper towel to clean the bottom of the port plate before positioning over the body. Be careful not to misalign the port plate gasket when positioning the port plate. Do not polish the gasket contact surfaces.





5. Apply Never·Seez to the port plate bolt threads and hand thread until snug. Tighten all bolts equally, using the X-pattern sequence, to draw the assembly together evenly, to ensure properly sealing of all joints. Use the same tightening pattern sequence to fully tighten the bolts to the recommended torque specs located in Table 3.

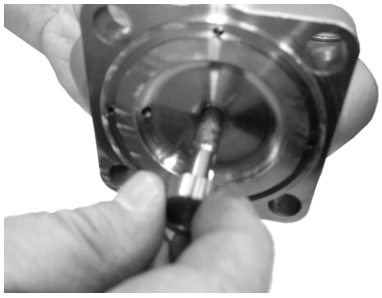
Manual Opening Stem Maintenance Procedures

To replace the manual opening stem the P-Series port plate must be removed. Remove the manual opening stem seal cap and gasket. Unbolt the packing nut prior to removing the port plate from the body. After the port plate has been removed, turn the manual opening stem clockwise until it disengages itself from the threads. From the underside of the port plate, pull the manual open stem to remove it from the port plate. The manual opening stem washer and packing may have to be picked out with a brass pick, so not to damage any surfaces.

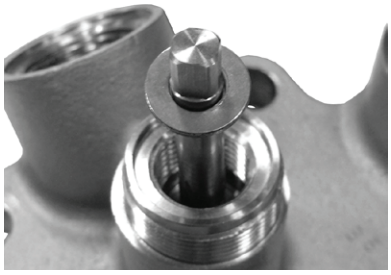
Follow the instructions below to reassemble the new manual opening stem and valve:

1. Apply Never·Seez to the new manual opening stem threads, upper stem and thread located on the underside of the port plate.

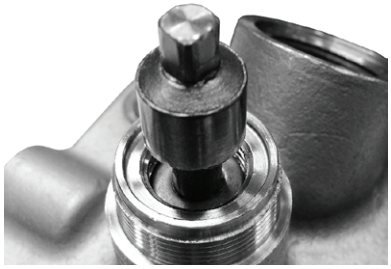
2. Insert the thread into the bottom of the port plate and turn clockwise to engage the threads. The manual opening stem needs to be back seated prior to installing the washer, packing and packing nut.



3. Install the washer onto the manual opening stem.



4. Install packing onto the manual opening stem with the tapered side end up. Tamp the packing gently using a steel pipe with a outer diameter (OD) of no greater than 13 mm (1/2") and inner diameter (ID) no smaller than 6 mm (1/4").



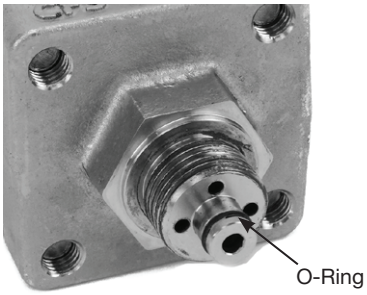
5. Apply Never·Seez to the packing nut threads. Place the packing nut over the stem and thread into the port plate. Tighten the packing nut to the recommended torque specs located in Table 3.

6. For the port plate to body assembly instructions follow steps 3 thru 5 in the cartridge maintenance procedures discussed earlier in this bulletin.

Pressure Regulator Pilot Maintenance Procedures

When replacing the entire pressure pilot, i.e. bonnet assembly, removing the spring tension is not required. Simply unbolt the current bonnet assembly from the port plate, remove the gasket and o-ring.

Before installing the replacement regulator pilot assembly, lubricate the o-ring with silicon grease and install it in the o-ring groove located on the shaft of the regulator pilot base plate. Apply Never·Seez to the mounting plate bottom threads and appropriate port location on the port plate. Torque the bonnet assembly to the port plate using the torque recommendation in Table 3.



When replacing individual components, the spring force on the diaphragm caused by the pressure adjustment stem will need to be reduced. This will prevent the bonnet from projecting off the regulator pilot base plate. To reduce the pilot pressure, remove the regulator seal cap and back out (counterclockwise) the adjustment stem until no further spring compression is felt or when the adjustment stem stops. Now the bonnet bolts can be removed, and the internal components replaced.

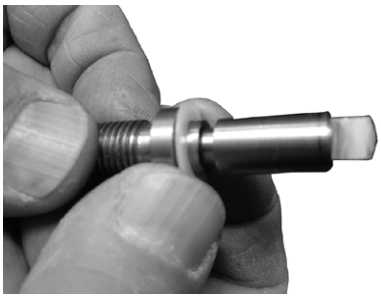
The removal of the bonnet will expose the diaphragm, diaphragm follower, bottom spring plate and range spring. To remove the adjustment stem rotate the bonnet upside down where the flat of the adjustment stem rests on a hard flat surface. Push down and the adjustment stem assembly will slide out the bottom of the bonnet. The top spring plate, adjustment stem washer and o-ring will remain intact. To remove the o-ring, washer and top spring plate simply unscrew the spring plate from the bottom of the adjustment stem and pull the o-ring and washer up through the top of the adjustment stem.

If the diagram follower, bottom spring plate and range spring do not fall out from the removal of the bonnet then use the same technique to remove the adjustment stem as described above.

Located on the regulator pilot mounting plate is the diaphragm gasket, diaphragm and diaphragm o-ring. If replacing these components, they will have to be removed. The diaphragm o-ring is located in a groove underneath the diaphragm.

Follow the instructions below to reassemble the new pressure pilot components and pilot assembly:

1. Slide the adjustment stem washer onto the adjustment stem from the top.

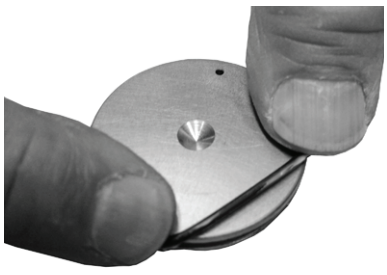


2. Apply silicon grease to the adjustment stem o-ring and slide onto the adjustment stem from the top. Make sure the o-ring slides into the groove located on the stem.

3. Apply Never·Seez to the adjustment stem threads and thread top spring plate onto stem. After threading spring plate onto stem re-apply Never·Seez to the exposed stem threads.

4. Place the adjustment stem assembly over the range spring. Make sure the top spring plate is threaded to the full length of the adjustment stem.

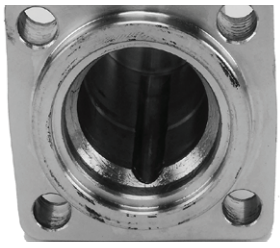
5. Lubricate the diaphragm follower o-ring with silicon grease and install it in the o-ring groove located on the diaphragm follower.



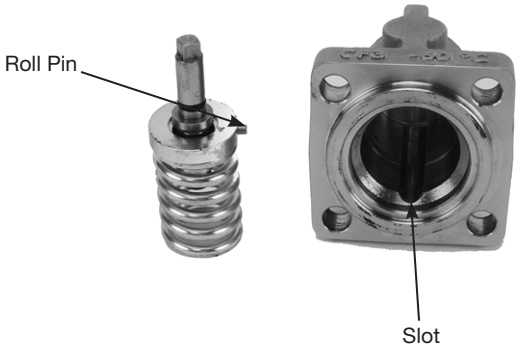
6. Apply bearing grease to the bearing on the lower spring plate and receiving dimple in the diaphragm follower.

7. Place the lower spring plate over the diaphragm follower so that the ball is engaged in the dimple of the diaphragm follower. Place the adjustment stem assembly and range spring onto the lower spring plate.

8. Apply bearing grease to the diaphragm follower seat area of the bonnet and to the top of the adjustment stem assembly.



9. Place bonnet over the assembly, shown in step 7, making sure the upper spring plate roll pin aligns with the slot relief on the inside of the bonnet.



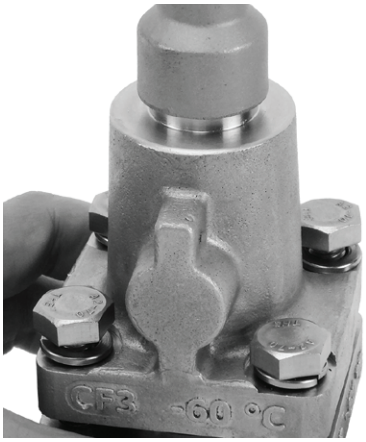
10. Press the bonnet over the assembly until the diaphragm follower is seated flush with a bottom of the bonnet. Use a hard flat surface for this step.

11. Lubricate the bonnet mounting plate o-ring with silicon grease and install it in the mounting plate groove. If the seat is damaged, the entire bonnet will need to be replaced.

12. Clean the diaphragm and place in the bonnet mounting plate pocket. Make sure there are no scratches or dents in the center area of the diaphragm and the side stamped with “this side up” is legible (concave up).

13. Install the gasket over the diaphragm and apply a small amount of refrigeration oil on the center of the diaphragm.

14. Place bonnet assembly over mounting plate, aligning the bolt holes to the bonnet mounting plate. Apply Never·Seez to the bolt threads and hand thread until snug. Tighten all bolts equally, using the X-pattern sequence, to draw the assembly together evenly, to ensure properly sealing of all joints. Use the same tightening pattern sequence to fully tighten the bolts to the recommended torque specs located in Table 3.



15. Apply the seal cap gasket and screw the seal cap on using the recommended torque specs located in Table 3.

16. Apply Never·Seez to the mounting plate bottom threads and appropriate port location on the port plate. Torque the bonnet assembly to the port plate using the torque recommendation in Table 3.

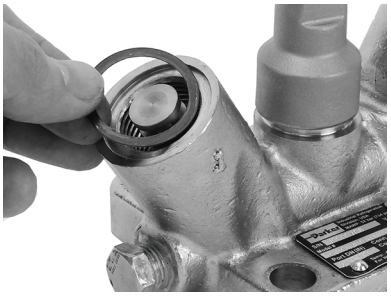
Solenoid Pilot Maintenance Procedures

To replace the solenoid pilot assembly, first remove the coil and unbolt the solenoid pilot assembly from the port plate assembly and remove the gasket.

Follow the instructions below to reassemble the new solenoid pilot assembly:

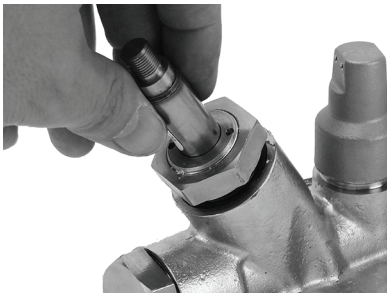
1. Lubricate the o-ring with silicon grease and install it in the o-ring groove located on the bottom end of the solenoid pilot assembly.

2. Install the new gasket into the correct port on the port plate assembly.



3. Apply Never·Seez to the pilot solenoid assembly threads and appropriate port location on the port plate.

4. Insert the new pilot solenoid assembly into same port as the gasket and make sure it is correctly aligned. Screw the assembly with hand until snug and then torque the assembly to the port plate using the torque recommendation in Table 3.



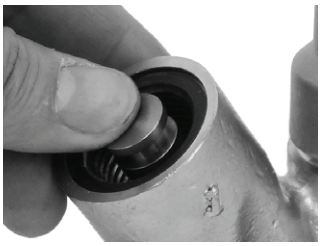
Port Plate Plug Maintenance Procedures

To replace the port plate plug/plugs, unbolt it from the port plate and remove the plug and gasket.

Follow the instructions below to reassemble the new pilot plug and cap:

1. Lubricate the o-ring with silicon grease and install it in the o-ring groove located on the bottom end of the port plate plug.

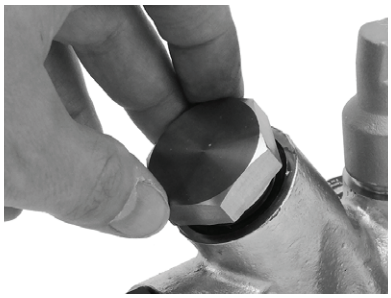
2. Insert the new plug with o-ring into the correct port on the port plate and press down until it snaps into place. Make sure the o-ring end of the plug is inserted first and properly aligned to the orifice located at the bottom of the port.



3. Install the new gasket into the same port as the plug.

4. Apply Never·Seez to the port plate plug cap threads and the appropriate port location on the port plate.

5. Screw the plug cap with hand until snug and then torque to the port plate using the torque recommendation in Table 3.



Service Pointers

P-Series Service Pointers		
Symptom	**Probable Cause**	**Correction**
Failure to open or close	Piston jammed due to excessive dirt	Flush clearance space between piston and cartridge bore with refrigeration oil solvent
	Valve Manually Open	Close manual bypass stem by turning counterclockwise
	Solenoid seat dirty or eroded	Clean and smooth pilot seat
	Installed backwards	Re-install regulator in proper position
System Control cannot be maintained - unstable valve operation	Improper solenoid selection: a. Actual load is lower than regulator capacity b. Actual pressure drop across valve is higher than originally intended c. Combination of a and b	Replace cartridge with one of suitable size

To properly install and/or remove solenoid coil over the solenoid operator on Parker P-Series products:

- Identify the parts, see Figure 5.
- Place the solenoid coil over the solenoid operator.
- Install the wave spring (included with the coil) over the Solenoid Operator on top of the coil.
- Inspect the Solenoid Operator threads for damage. If the threads are damaged, the Solenoid Operator Assembly must be replaced.
- Thread the coil retaining nut (included with the coil) or optional LED knob onto the Solenoid Operator until it contacts the wave spring. Take caution to avoid cross threading.
- Rotate the nut or knob an additional ¼ to ½ turn, compressing the wave spring.
- To remove the coil, unthread the coil retaining nut or the LED knob. Torque must not exceed 6.8 Nm (5 ft. lb.).

If cross threading occurred or the threads were damaged, excess torque may be required for removal. This higher torque could unthread the Solenoid Operator from the valve leading to a refrigerant leak. **If the unthreading torque exceeds 6.8 Nm (5 ft. lb.), the refrigerant in the valve must be evacuated before proceeding.**

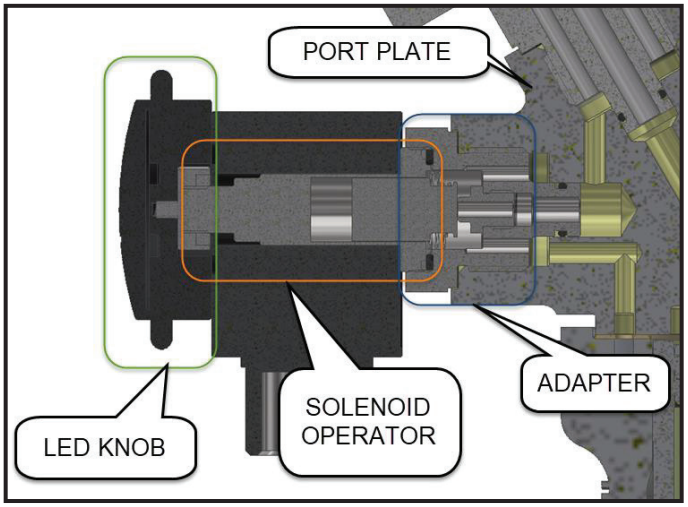
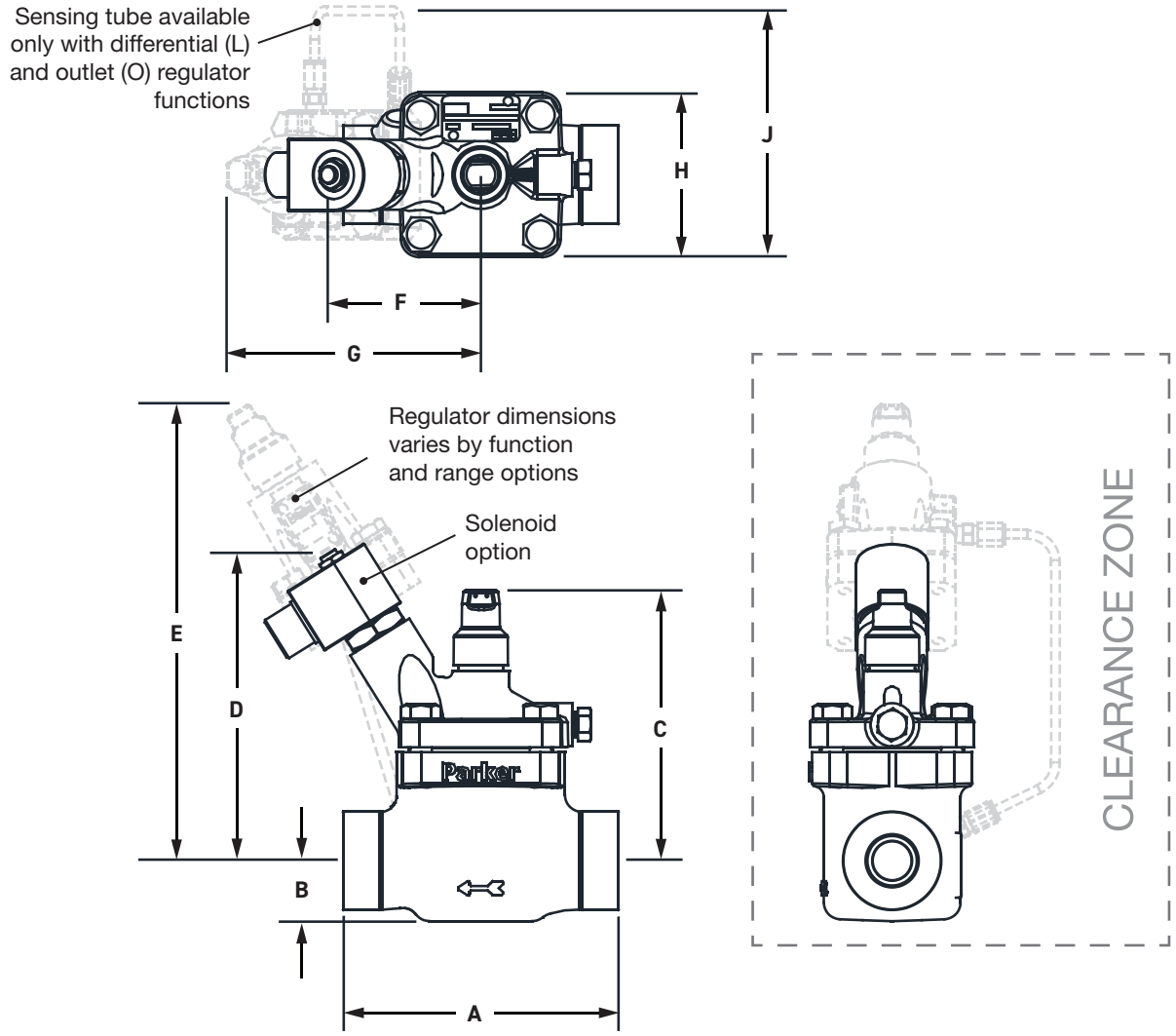


Figure 5: Install and Remove Solenoid Coil over the Solenoid Operator.

Dimensional Information: Single Port Plate



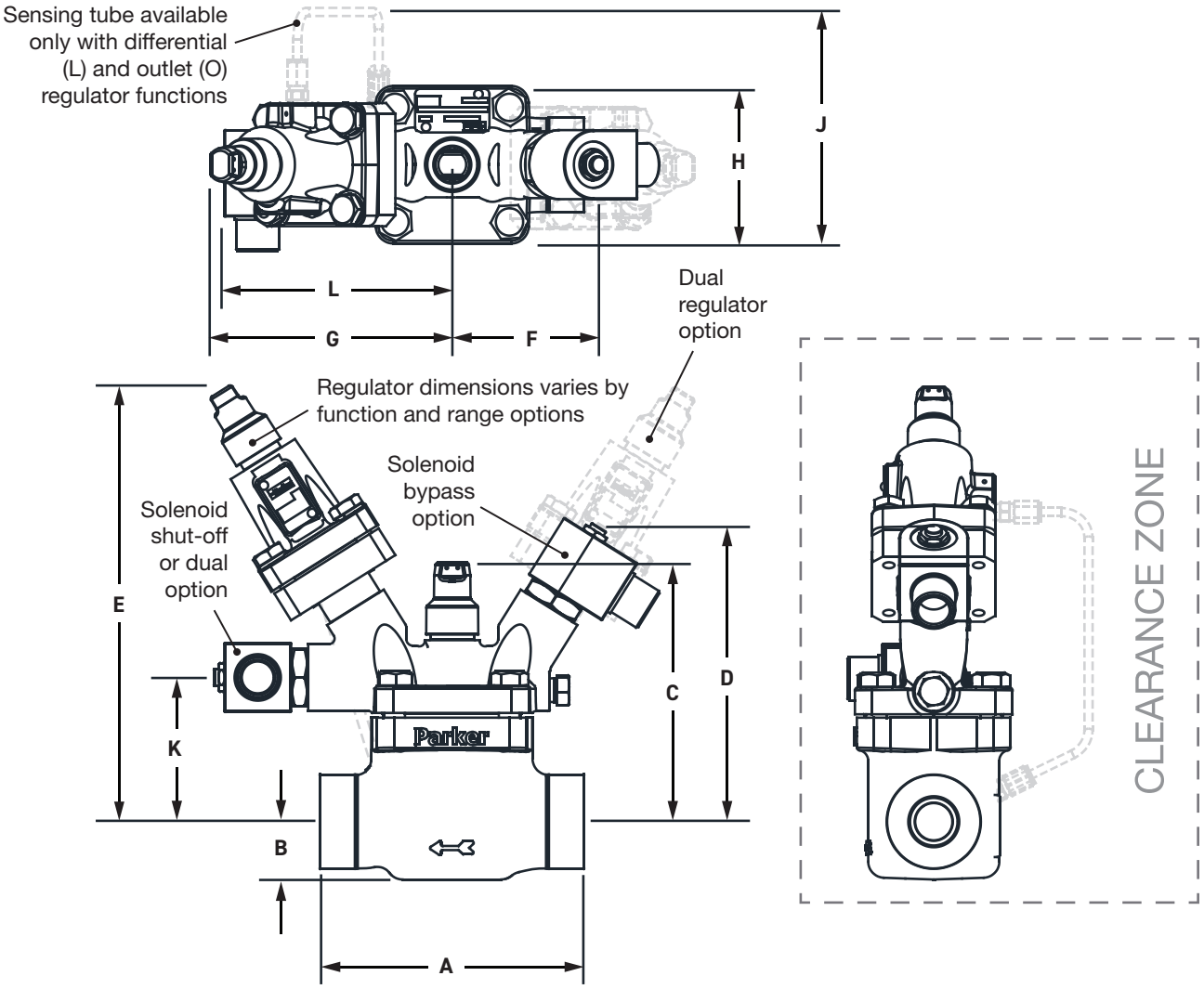
Port Size		A		B		C		D		F		H		J	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
20, 25	¾, 1	153	6.0	34	1.3	150	5.9	171	6.7	85	3.4	91	3.6	94	3.7
32, 40	1¼, 1½	188	7.4	48	1.9	187	7.4	191	7.6	83	3.3	121	4.8	139	5.5
50	2	227	8.9	75	2.9	187	7.4	187	7.4	89	3.5	170	6.7	183	7.2
65, 80	2½, 3	254	10.0	89	3.5	300	11.8	210	8.3	99	3.9	189	7.5	195	7.7

Port Size		E						G					
		Inlet Regulators				Outlet Regulators		Inlet Regulators				Outlet Regulators	
		Range A, D		Range E		Range V, D		Range A, D		Range E		Range V, D	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
20, 25	¾, 1	254	10.0	281	11.1	276	10.8	142	5.6	156	6.1	160	6.3
32, 40	1¼, 1½	274	10.8	306	12.0	297	11.7	137	5.4	162	6.4	156	6.1
50	2	268	10.5	300	11.8	291	11.5	136	5.3	154	6.0	149	5.9
65, 80	2½, 3	294	11.6	326	12.8	319	12.5	151	6.0	170	6.7	167	6.6

Clearance Zone:

1. The top of the P-series valves requires a clearance of 50 mm (2") for the removal of the solenoid or regulator.
2. The bottom of the P-series valves requires a clearance of 13 mm (½").
3. Both the left and right side of the P-series, widest valve setup as shown above, requires a minimum of 25 mm (1") on each side. If the valve has a sensing line add 25 mm (1") to the overall width.

Dimensional Information: Multi Port Plate



Port Size		A		B		C		D		F		H		J		K		L	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
20, 25	¾, 1	153	6.0	34	1.3	150	5.9	171	6.7	85	3.4	91	3.6	94	3.7	84	3.3	138	5.4
32, 40	1¼, 1½	188	7.4	48	1.9	187	7.4	191	7.6	83	3.3	121	4.8	139	5.5	101	4.0	138	5.4
50	2	227	8.9	75	2.9	187	7.4	187	7.4	89	3.5	170	6.7	183	7.2	99	3.9	148	5.8
65, 80	2½, 3	254	10.0	89	3.5	300	11.8	210	8.3	99	3.9	189	7.5	195	7.7	119	4.7	151	6.0

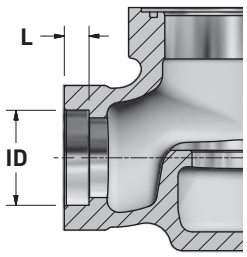
Port Size		E						G					
		Inlet Regulators				Outlet Regulators		Inlet Regulators				Outlet Regulators	
		Range A, D		Range E		Range V, D		Range A, D		Range E		Range V, D	
mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch
20, 25	¾, 1	254	10.0	281	11.1	276	10.8	142	5.6	156	6.1	160	6.3
32, 40	1¼, 1½	274	10.8	306	12.0	297	11.7	137	5.4	162	6.4	156	6.1
50	2	268	10.5	300	11.8	291	11.5	136	5.3	154	6.0	149	5.9
65, 80	2½, 3	294	11.6	326	12.8	319	12.5	151	6.0	170	6.7	167	6.6

Clearance Zone:

1. The top of the P-series valves requires a clearance of 50 mm (2") for the removal of the solenoid or regulator.
2. The bottom of the P-series valves requires a clearance of 13 mm (½").
3. Both the left and right side of the P-series, widest valve setup as shown above, requires a minimum of 25 mm (1") on each side. If the valve has a sensing line add 25 mm (1") to the overall width.

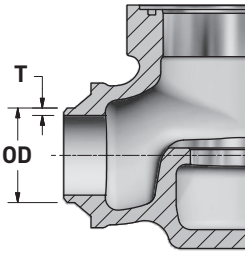
Connection Type - Dimensions

Socket Weld (SW) ANSI



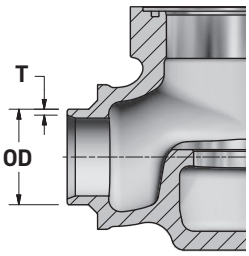
Port Size		Connection	L		ID	
mm	inch		mm	inch	mm	inch
20 25	¾ 1	¾"	12.7	0.50	27.3	1.075
		1"			34.0	1.340
		1¼"			42.8	1.685
32 40	1¼ 1½	1¼"	12.7	0.50	42.8	1.685
		1½"			48.9	1.925
		2	16.0	0.63	61.4	2.416
50	2	2"	15.9	0.63	61.4	2.416
		2½"			74.1	2.919
65 80	2½ 3	2½"	15.9	0.63	74.1	2.919

Butt-Weld (BW) ANSI



Port Size		Connection	Valve Body Material	T		OD	
mm	inch			mm	inch	mm	inch
20 25	¾ 1	¾"	Steel (PA4W)	4.06	0.160	26.9	1.06
			Stainless Steel (PA4C)	3.05	0.120		
		1"	Steel (PA4W)	4.57	0.180	33.7	1.32
			Stainless Steel (PA4C)	3.56	0.140		
		1¼"	Steel (PA4W)	5.08	0.200	42.4	1.67
			Stainless Steel (PA4C)	3.81	0.150		
32 40	1¼ 1½	1¼"	Steel (PA4W)	5.08	0.200	42.4	1.67
			Stainless Steel (PA4C)	3.81	0.150		
		1½"	Steel (PA4W)	5.33	0.210	48.5	1.91
			Stainless Steel (PA4C)	3.81	0.150		
		2"	All	4.06	0.160	60.7	2.39
50	2	2"	All	4.06	0.160	60.7	2.39
		2½"	All	5.33	0.210	73.4	2.89
65 80	2½ 3	2½"	All	5.33	0.210	73.4	2.89
		3"		5.61	0.221	89.2	3.51

Butt-Weld (BW DN) Metric



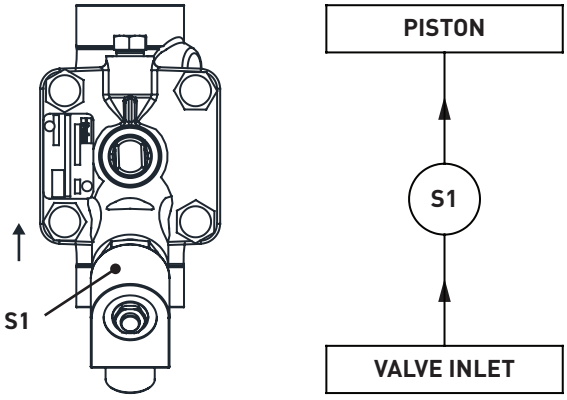
Port Size		Connection	Valve Body Material	T		OD	
mm	inch			mm	inch	mm	inch
20 25	¾ 1	DN20	All	2.30	0.091	26.9	1.06
		DN25	All	2.60	0.102	33.7	1.33
		DN32	All	2.60	0.102	42.4	1.67
32 40	1¼ 1½	DN32	All	2.60	0.102	42.4	1.67
		DN40	All	2.60	0.102	48.3	1.90
		DN50	All	2.90	0.114	60.3	2.37
50	2	DN50	All	2.90	0.114	60.3	2.37
		DN65	All	2.90	0.114	76.1	3.00
65 80	2½ 3	DN65	All	2.90	0.114	76.1	3.00
		DN90	All	3.20	0.126	88.9	3.50

APPENDIX A

Schematic Flow Diagrams

Schematic Flow Diagrams

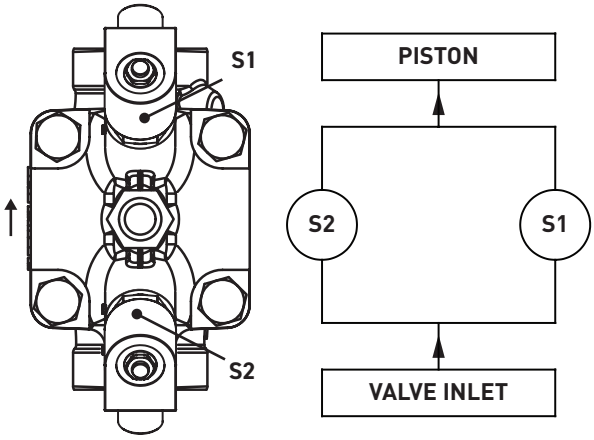
PS4_
Solenoid



Control Function	Operation
	S1
Open	Energized
Shut-Off	De-Energized

Patent Pending

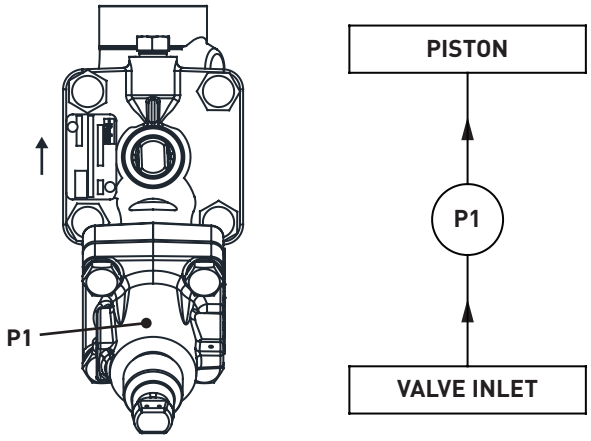
PS4D
Two-Stage Solenoid



Control Function	Operation	
	S1	S2
10% Open	De-Energized	Energized
100% Open	Energized	Energized
Shut-off	De-Energized	De-Energized

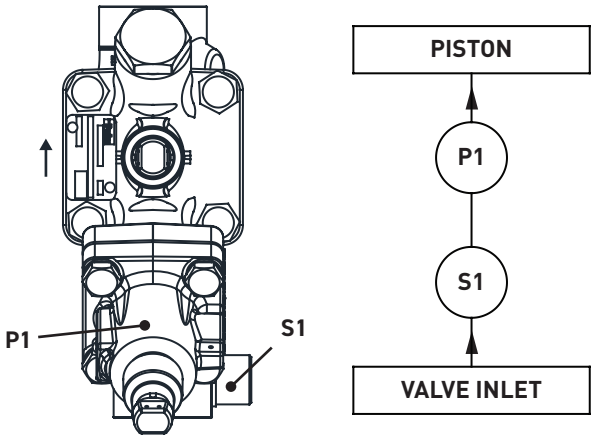
Proper sequencing (energizing and de-energizing) of the solenoid coils is essential for proper operation of the PS4D valve.

PA4_ / PA4_K
Inlet Pressure Regulator



Control Function	Operation
	P1
Pressure Pilot (P1)	Modulating

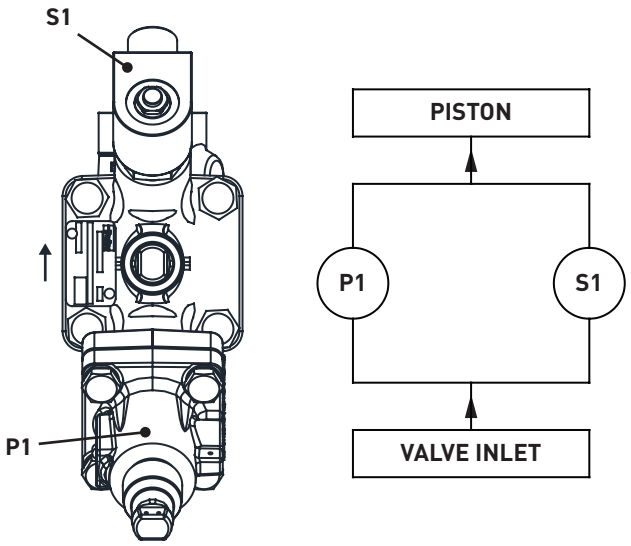
PA4_S
Inlet Pressure Regulator with Electric Shut-Off



Control Function	Operation
	S1
Pressure Pilot (P1)	Energized
Shut-Off	De-Energized

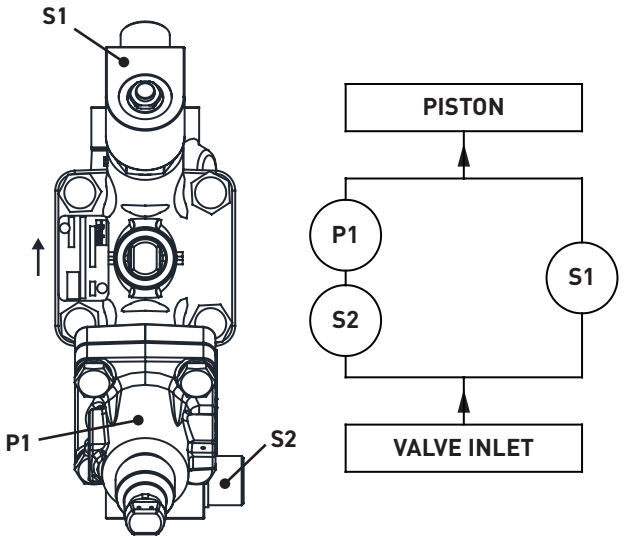
Schematic Flow Diagrams

PA4_B
Inlet Pressure Regulator w/ Electric Wide Open



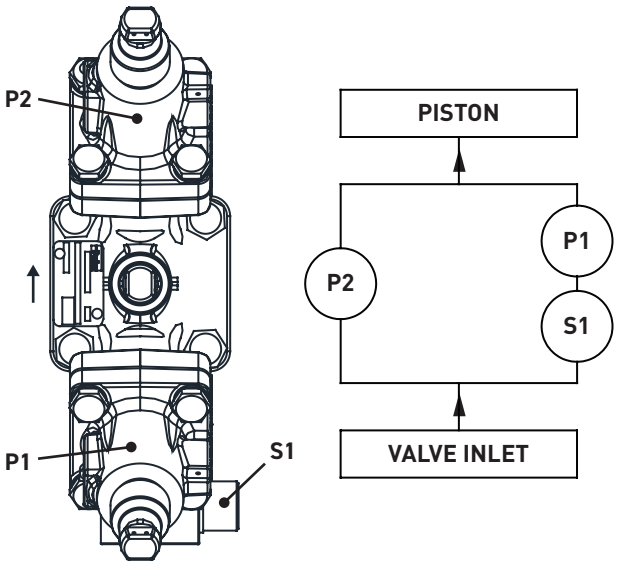
Control Function	Operation
	S1
Pressure Pilot (P1)	De-Energized
Wide Open	Energized

PA4_BS
Inlet Pressure Regulator with Electric Shut-Off and Electric Wide Open



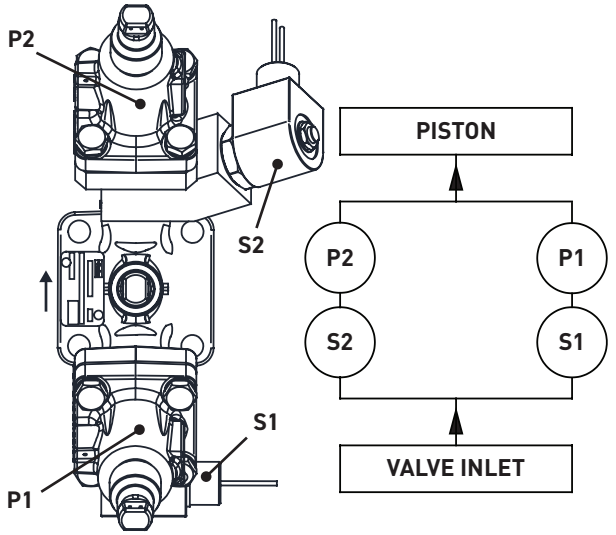
Control Function	Operation	
	S1	S2
Pressure Pilot (P1)	De-Energized	Energized
Shut-Off	De-Energized	De-Energized
Wide Open	Energized	De-Energized

PA4_D
Dual Inlet Pressure Regulator



Control Function	Operation
	S1
Low Pressure Pilot (P1)	Energized
High Pressure Pilot (P2)	De-Energized

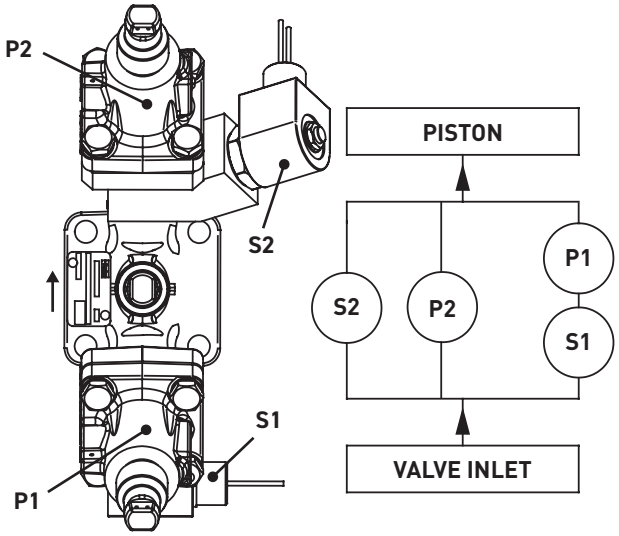
PA4_DS
Inlet Dual Pressure Regulator with Electric Shut-Off



Control Function	Operation	
	S1	S2
Low Pressure Pilot (P1)	Energized	De-Energized
High Pressure Pilot (P2)	De-Energized	Energized
Shut-Off	De-Energized	De-Energized

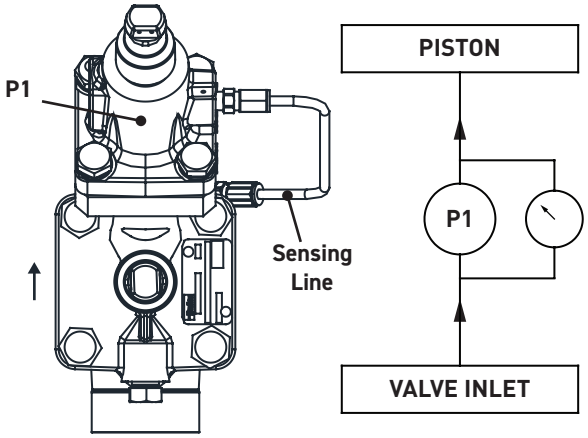
Schematic Flow Diagrams

PA4_DB
Inlet Dual Pressure Regulator with Electric Wide Open



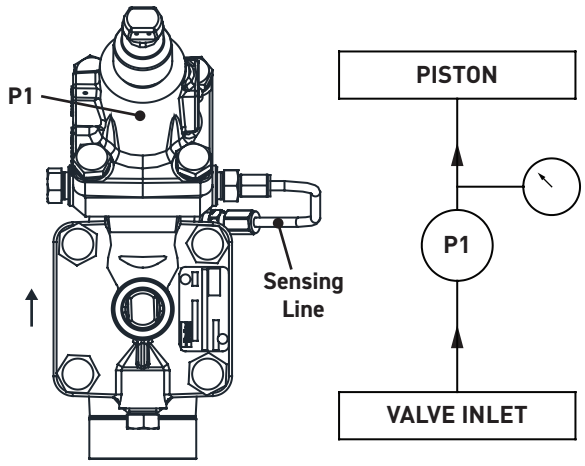
Control Function	Operation	
	S1 (Position 3)	S2 (Position 1)
Low Pressure Pilot (P1) (Position 2)	Energized	De-Energized
High Pressure Pilot (P2) (Position 1)	De-Energized	De-Energized
Wide Open	De-Energized/ Energized	Energized

PA4_ L
Differential Pressure Regulator



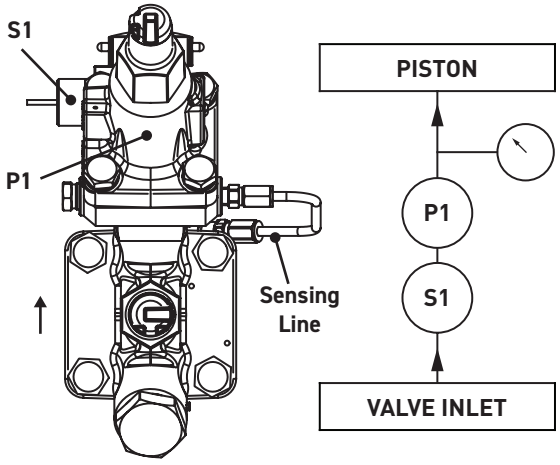
Control Function	Operation
	P1
Pressure Pilot (P1)	Differential

PA4_ O
Outlet Pressure Regulator



Control Function	Operation
	P1
Pressure Pilot (P1)	Modulating

PA4_ OS
Outlet Pressure Regulator with Electric Shut-Off



Control Function	Operation
	S1
Pressure Pilot (P1)	Energized
Shut-Off	De-Energized

PARKER-HANNIFIN CORPORATION

OFFER OF SALE

1. Definitions. As used herein, the following terms have the meanings indicated.

Buyer: means any customer receiving a Quote for Products.

Goods: means any tangible part, system or component to be supplied by Seller.

Products: means the Goods, Services and/or Software as described in a Quote.

Quote: means the offer or proposal made by Seller to Buyer for the supply of Products.

Seller: means Parker-Hannifin Corporation, including all divisions and businesses thereof.

Services: means any services to be provided by Seller.

Software: means any software related to the Goods, whether embedded or separately downloaded.

Terms: means the terms and conditions of this Offer of Sale.

2. Terms. All sales of Products by Seller are expressly conditioned upon, and will be governed by the acceptance of, these Terms. These Terms are incorporated into any Quote provided by Seller to Buyer. Buyer's order for any Products whether communicated to Seller verbally, in writing, by electronic data interface or other electronic commerce, shall constitute acceptance of these Terms. Seller objects to any contrary or additional terms or conditions of Buyer. Reference in Seller's order acknowledgement to Buyer's purchase order or purchase order number shall in no way constitute an acceptance of any of Buyer's terms or conditions of purchase. No modification to these Terms will be binding on Seller unless agreed to in writing and signed by an authorized representative of Seller.

3. Price; Payment. The Products set forth in the Quote are offered for sale at the prices indicated in the Quote. Unless otherwise specifically stated in the Quote, prices are valid for thirty (30) days and do not include any sales, use, or other taxes or duties. Seller reserves the right to modify prices at any time to adjust for any raw material price fluctuations. Unless otherwise specified by Seller, all prices are EXW Seller's facility (INCOTERMS 2020). All sales are contingent upon credit approval and full payment for all purchases is due thirty (30) days from the date of invoice (or such date as may be specified in the Quote). Unpaid invoices beyond the specified payment date incur interest at the rate of 1.5% per month or the maximum allowable rate under applicable law.

4. Shipment; Delivery; Title and Risk of Loss. All delivery dates are approximate, and Seller is not responsible for damages resulting from any delay. Regardless of the manner of shipment, delivery occurs and title and risk of loss or damage pass to Buyer, upon placement of the Products with the carrier at Seller's facility. Unless otherwise agreed prior to shipment and for domestic delivery locations only, Seller will select and arrange, at Buyer's sole expense, the carrier and means of delivery. When Seller selects and arranges the carrier and means of delivery, freight and insurance costs for shipment to the designated delivery location will be prepaid by Seller and added as a separate line item to the invoice. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions. Buyer shall not return or repackage any Products without the prior written authorization from Seller, and any return shall be at the sole cost and expense of Buyer.

5. Warranty. The warranty for the Products is as follows: (i) Goods are warranted against defects in material or workmanship for a period of twelve (12) months from the date of delivery or 2,000 hours of use, whichever occurs first; (ii) Services shall be performed in accordance with generally accepted practices and using the degree of care and skill that is ordinarily exercised and customary in the field to which the Services pertain and are warranted for a period of six (6) months from the date of completion of the Services; and (iii) Software is only warranted to perform in accordance with applicable specifications provided by Seller to Buyer for ninety (90) days from the date of delivery or, when downloaded by a Buyer or end-user, from the date of the initial download. All prices are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **EXEMPTION CLAUSE; DISCLAIMER OF WARRANTY, CONDITIONS, REPRESENTATIONS: THIS WARRANTY IS THE SOLE AND ENTIRE WARRANTY, CONDITION, AND REPRESENTATION, PERTAINING TO PRODUCTS. SELLER DISCLAIMS ALL OTHER WARRANTIES, CONDITIONS, AND REPRESENTATIONS, WHETHER STATUTORY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THOSE RELATING TO DESIGN, NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE SOFTWARE IS ERROR-FREE OR FAULT-TOLERANT, OR THAT BUYER'S USE THEREOF WILL BE SECURE OR UNINTERRUPTED. UNLESS OTHERWISE AUTHORIZED IN WRITING BY SELLER, THE SOFTWARE SHALL NOT BE USED IN CONNECTION WITH HAZARDOUS OR HIGH RISK ACTIVITIES OR ENVIRONMENTS. EXCEPT AS EXPRESSLY STATED HEREIN, ALL PRODUCTS ARE PROVIDED "AS IS".**

6. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon receipt. No claims for shortages will be allowed unless reported to Seller within ten (10) days of delivery. Buyer shall notify Seller of any alleged breach of warranty within thirty (30) days after the date the non-conformance is or should have been discovered by Buyer. Any claim or action against Seller based upon breach of contract or any other theory, including tort, negligence, or otherwise must be commenced within twelve (12) months from the date of the alleged breach or other alleged event, without regard to the date of discovery.

7. LIMITATION OF LIABILITY. IN THE EVENT OF A BREACH OF WARRANTY, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE THE NON-CONFORMING PRODUCT, RE-PERFORM THE SERVICES, OR REFUND THE PURCHASE PRICE PAID WITHIN A REASONABLE PERIOD OF TIME. **IN NO EVENT IS SELLER LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING ANY LOSS OF REVENUE OR PROFITS, WHETHER BASED IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE PAID FOR THE PRODUCTS.**

8. Confidential Information. Buyer acknowledges and agrees that any technical, commercial, or other confidential information of Seller, including, without limitation, pricing, technical drawings or prints and/or part lists, which has been or will be disclosed, delivered or made available, whether directly or indirectly, to Buyer ("Confidential Information"), has been and will be received in confidence and will remain the property of Seller. Buyer further agrees that it will not use Seller's Confidential Information for any purpose other than for the benefit of Seller.

9. Loss to Buyer's Property. Any tools, patterns, materials, equipment or information furnished by Buyer or which are or become Buyer's property ("Buyer's Property"), will be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer ordering the Products manufactured using Buyer's Property. Furthermore, Seller shall not be responsible for any loss or damage to Buyer's Property while it is in Seller's possession or control.

10. Special Tooling. "Special Tooling" includes but is not limited to tools, jigs, fixtures and associated manufacturing equipment acquired or necessary to manufacture Goods. Seller may impose a tooling charge for any Special Tooling. Such Special Tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in the Special Tooling, even if such Special Tooling has been specially converted or adapted for manufacture of Goods for Buyer and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller has the right to alter, discard or otherwise dispose of any Special Tooling or other property owned by Seller in its sole discretion at any time.

11. Security Interest. To secure payment of all sums due from Buyer, Seller retains a security interest in all Products delivered to Buyer and, Buyer's acceptance of these Terms is deemed to be a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect Seller's security interest.

12. User Responsibility. Buyer, through its own analysis and testing, is solely responsible for making the final selection of the Products and assuring that all performance, endurance, maintenance, safety and warning requirements of the application of the Products are met. Buyer must analyze all aspects of the application and follow applicable industry standards, specifications, and any technical information provided with the Quote or the Products, such as Seller's instructions, guides and specifications. If Seller provides options of or for Products based upon data or specifications provided by Buyer, Buyer is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products. In the event Buyer is not the end-user of the Products, Buyer will ensure such end-user complies with this paragraph.

13. Use of Products, Indemnity by Buyer. Buyer shall comply with all instructions, guides and specifications provided by Seller with the Quote or the Products. **Unauthorized Uses.** If Buyer uses or resells the Products in any way prohibited by Seller's instructions, guides or specifications, or Buyer otherwise fails to comply with Seller's instructions, guides and specifications, Buyer acknowledges that any such use, resale, or non-compliance is at Buyer's sole risk. Further, Buyer shall indemnify, defend, and hold Seller harmless from any losses, claims, liabilities, damages, lawsuits, judgments and costs (including attorney fees and defense costs), whether for personal injury, property damage, intellectual property infringement or any other claim, arising out of or in connection with: (a) improper selection, design, specification, application, or any misuse of Products; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, tools, equipment, plans, drawings, designs, specifications or other information or things furnished by Buyer; (d) damage to the Products from an external cause, repair or attempted repair by anyone other than Seller, failure to follow instructions, guides and specifications provided by Seller, use with goods not provided by Seller, or opening, modifying, deconstructing, tampering with

or repackaging the Products; or (e) Buyer's failure to comply with these Terms. Seller shall not indemnify Buyer under any circumstance except as otherwise provided in these Terms.

14. Cancellations and Changes. Buyer may not cancel or modify, including but not limited to movement of delivery dates for the Products, any order for any reason except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage and any additional expense. Seller, at any time, may change features, specifications, designs and availability of Products.

15. Limitation on Assignment. Buyer may not assign its rights or obligations without the prior written consent of Seller. **16. Force Majeure.** Seller is not liable for delay or failure to perform any of its obligations by reason of events or circumstances beyond its reasonable control. Such circumstances include without limitation: accidents, labor disputes or stoppages, government acts or orders, acts of nature, pandemics, epidemics, other widespread illness, or public health emergency, delays or failures in delivery from carriers or suppliers, shortages of materials, war (whether declared or not) or the serious threat of same, riots, rebellions, acts of terrorism, fire or any reason whether similar to the foregoing or otherwise. Seller will resume performance as soon as practicable after the event of force majeure has been removed. All delivery dates affected by force majeure shall be tolled for the duration of such force majeure and rescheduled for mutually agreed dates as soon as practicable after the force majeure condition ceases to exist. Force majeure shall not include financial distress, insolvency, bankruptcy, or other similar conditions affecting one of the parties, affiliates and/or sub-contractors.

17. Waiver and Severability. Failure to enforce any provision of these Terms will not invalidate that provision; nor will any such failure prejudice either party's right to enforce that provision in the future. Invalidation of any provision of these Terms shall not invalidate any other provision herein and, the remaining provisions will remain in full force and effect.

18. Termination. Seller may terminate any agreement governed by or arising from these Terms for any reason and at any time by giving Buyer thirty (30) days prior written notice. Seller may immediately terminate, in writing, if Buyer: (a) breaches any provision of these Terms, (b) becomes or is deemed insolvent, (c) appoints or has appointed a trustee, receiver or custodian for all or any part of Buyer's property, (d) files a petition for relief in bankruptcy on its own behalf, or one is filed against Buyer by a third party, (e) makes an assignment for the benefit of creditors; or (f) dissolves its business or liquidates all or a majority of its assets.

19. Ownership of Software. Seller retains ownership of all Software supplied to Buyer hereunder. In no event shall Buyer obtain any greater right in and to the Software than a right in the nature of a license limited to the use thereof and subject to compliance with any other terms provided with the Software.

20. Indemnity for Infringement of Intellectual Property Rights. Seller is not liable for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights ("Intellectual Property Rights") except as provided in this Section. Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on a third party claim that one or more of the Products sold hereunder infringes the Intellectual Property Rights of a third party in the country of delivery of the Products by Seller to Buyer. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of any such claim, and Seller having sole control over the defense of the claim including all negotiations for settlement or compromise. If one or more Products sold hereunder is subject to such a claim, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Products, replace or modify the Products so as to render them non-infringing, or offer to accept return of the Products and refund the purchase price less a reasonable allowance for depreciation. Seller has no obligation or liability for any claim of infringement: (i) arising from information provided by Buyer; or (ii) directed to any Products provided hereunder for which the designs are specified in whole or part by Buyer; or (iii) resulting from the modification, combination or use in a system of any Products provided hereunder. The foregoing provisions of this Section constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for claims of infringement of Intellectual Property Rights.

21. Governing Law. These Terms and the sale and delivery of all Products are deemed to have taken place in, and shall be governed and construed in accordance with, the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to the sale and delivery of the Products.

22. Entire Agreement. These Terms, along with the terms set forth in the main body of any Quote, forms the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale and purchase. In the event of a conflict between any term set forth in the main body of a Quote and these Terms, the terms set forth in the main body of the Quote shall prevail. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter shall have no effect. These Terms may not be modified unless in writing and signed by an authorized representative of Seller.

23. Compliance with Laws. Buyer agrees to comply with all applicable laws, regulations, and industry and professional standards, including those of the United States of America, and the country or countries in which Buyer may operate, including without limitation the U.S. Foreign Corrupt Practices Act ("FCPA"), the U.S. Anti-Kickback Act ("Anti-Kickback Act"), U.S. and E.U. export control and sanctions laws ("Export Laws"), the U.S. Food Drug and Cosmetic Act ("FDCA"), and the rules and regulations promulgated by the U.S. Food and Drug Administration ("FDA"), each as currently amended. Buyer agrees to indemnify, defend, and hold harmless Seller from the consequences of any violation of such laws, regulations and standards by Buyer, its employees or agents. Buyer acknowledges that it is familiar with all applicable provisions of the FCPA, the Anti-Kickback Act, Export Laws, the FDCA and the FDA and certifies that Buyer will adhere to the requirements thereof and not take any action that would make Seller violate such requirements. Buyer represents and agrees that Buyer will not make any payment or give anything of value, directly or indirectly, to any governmental official, foreign political party or official thereof, candidate for foreign political office, or commercial entity or person, for any improper purpose, including the purpose of influencing such person to purchase Products or otherwise benefit the business of Seller. Buyer further represents and agrees that it will not receive, use, service, transfer or ship any Products from Seller in a manner or for a purpose that violates Export Laws or would cause Seller to be in violation of Export Laws. Buyer agrees to promptly and reliably provide Seller all requested information or documents, including end-user statements and other written assurances, concerning Buyer's ongoing compliance with Export Laws.

Safe Operation (See Bulletin RSBCV)
People doing any work on a refrigeration system must be qualified and completely familiar with the system and the Refrigerating Specialties Division valves involved, or all other precautions will be meaningless. This includes reading and understanding pertinent Refrigerating Specialties Division Product Bulletins and Safety Bulletin RSB prior to installation or servicing work.

Where cold refrigerant liquid lines are used, it is necessary that certain precautions be taken to avoid damage which could result from liquid expansion. Temperature increase in a piping section full of solid liquid will cause high pressure due to the expanding liquid which can possibly rupture a gasket, pipe or valve. All hand valves isolating such sections should be marked, warning against accidental closing, and must not be closed until the liquid is removed. Check valves must never be installed upstream of solenoid valves, or regulators with electric shut-off, nor should hand valves upstream of solenoid valves or downstream of check valves be closed until the liquid has been removed.

It is advisable to properly install relief devices in any section where liquid expansion could take place. Avoid all piping or control arrangements which might produce thermal or pressure shock.

For the protection of people and products, all refrigerant must be removed from the section to be worked on before a valve, strainer, or other device is opened or removed. Flanges with ODS connections are not suitable for ammonia service.

Warranty
All Refrigerating Specialties products are under warranty against defects in workmanship and materials for a period of one year from date of shipment from factory. This warranty is in force only when products are properly installed, field assembled, maintained, and operated in use and service as specifically stated in Refrigerating Specialties Catalogs or Bulletins for normal refrigeration applications, unless otherwise approved in writing by the Refrigerating Specialties Division. Defective products, or parts thereof returned to the factory with transportation charges prepaid and found to be defective by factory inspection, will be replaced or repaired at Refrigerating Specialties option, free of charge, F.O.B. factory. Warranty does not cover products which have been altered, or repaired in the field, damaged in transit, or have suffered accidents, misuse, or abuse. Products disabled by dirt or other foreign substances will not be considered defective.

The express warranty set forth above constitutes the only warranty applicable to Refrigerating Specialties products, and is in lieu of all other warranties, expressed or implied, written including any warranty of merchantability, or fitness for a particular purpose. In no event is Refrigerating Specialties responsible for any consequential damages of any nature whatsoever. No employee, agent, dealer or other person is authorized to give any warranties on behalf of Refrigerating Specialties, nor to assume, for Refrigerating Specialties, any other liability in connection with any of its products.

⚠WARNING – USER RESPONSIBILITY

Failure or improper selection or improper use of the products described herein or related items can cause death, personal injury and property damage.

This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provide product or system options for further investigation by users having technical expertise.

The user, through its own analysis and testing, is solely responsible for making the final selection of the system and components and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application, follow applicable industry standards, and follow the information concerning the product in the current product catalog and in any other materials provided from Parker or its subsidiaries or authorized distributors.

To the extent that Parker or its subsidiaries or authorized distributors provide component or system options based upon data or specifications provided by the user, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the components or systems.

For safety information see the Safety Guide at www.parker.com/safety or call 1-800-CParker.

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