



Integrated Piston™ Assembly

for Hydraulic Cylinders

ISO 9001, QS 9000
Registered

Catalog EPS-5220/USA



Integrated Piston™ Assembly for Hydraulic Cylinders



WARNING:

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

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The products described herein, including without limitation, product features, specifications, designs, availability and pricing, are subject to change by Parker Hannifin Corporation and its subsidiaries at any time without notice.

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Product Overview



Parker Seal Engineered Polymer System (EPS) Division's *Integrated Piston™ Assembly for Hydraulic Cylinders* adds value to manufacturers of hydraulic systems through enabling productivity improvements and increased capacity utilization. The *Integrated Piston* is a self-contained, completely integrated piston, bearing and seal, all in one assembly. Contained in this catalog is all the information required to select the *Integrated Piston* assembly to meet each exacting application need.

The *Integrated Piston's* design flexibility accommodates various Parker piston sealing options. Additionally, the *Integrated Piston* assembly features:

- An increased molded bearing surface area
- Tightly controlled dimensions which reduce extrusion gap and extend seal life
- Parker engineered state-of-the-science materials
- Good, Better & BEST piston seal profiles -- adaptable to your system and its life requirements.

Molded Bearing Surface Area:

An increased molded bearing surface area provides improved stability and smaller extrusion gaps, resulting in extended piston seal life. The *Integrated Piston* features Parker's new **WearGard™** (4734) compound. WearGard, with proprietary internal lubrication, has successfully endured hundreds of thousands of cycles of harsh field and laboratory performance testing (see Bulletin PPD-5213-B1/USA).

Piston Core:

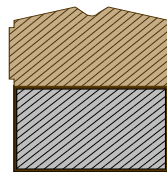
The standard piston core is machined from carbon steel rod. Piston cores of different metallurgy are available based on the application requirements.

Tolerances:

The outer diameter of the *Integrated Piston* is the one key dimensional characteristic versus two or more in conventional piston sealing systems. Therefore, the number of critical tolerance variables is reduced by at least 50% with the *Integrated Piston*. The advantage is minimized diametrical clearances, resulting in extended seal life and increased system performance.

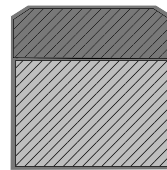
Piston Seal Selection

The *Integrated Piston* assembly is engineered to accommodate various Parker piston seals. Piston seals may be selected from one of many options. Parker engineered piston seal options for the *Integrated Piston* are as follows: (Refer to Table 1 as a selection guide.)



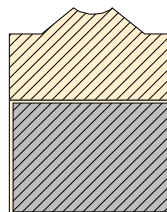
BP Piston Seal. The BP piston seal is another example of sealing excellence developed by Parker Hannifin. Parker developed the Bi-directional Piston (BP) seal utilizing its diverse resources, including Finite Element Analysis engineering, state of the science

materials development, and a functional on-site test laboratory. Parker's BP seal offers superior performance in safety critical medium- to heavy-duty fluid power cylinders. Unique features of the BP seal design include its fluid reservoir mechanism which maintains lubricity against the cylinder wall, and its pressure relief pedestals (see Bulletin PPD-5212-B1/USA).



OK Piston Seal. The OK piston seal, designed for higher temperatures and pressures, is recommended for heavy-duty hydraulic applications, and suitable for working pressures up to 7,250 psi (above in some specific situations). The OK is an effective and less expensive

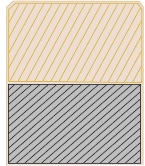
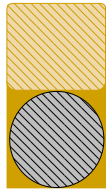
alternative to costly capped T-Seals and PTFE loaded cap seals (see Bulletin PPD-5206-B1/USA).



PSP Piston Seal. The PSP seal is a bi-directional squeeze type seal used exclusively in low- to medium-duty fluid power cylinders. The unique geometry of the PSP Seal design creates a fluid reservoir between the beveled dual-lip sealing surfaces. This important feature provides extra lubrication, resulting in

reduced breakaway and running friction. The "square-

natured” cross section improves stability, and provides greater resistance to rolling and twisting in the groove (see Bulletin PPD-5238-B1/USA).

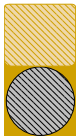

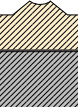




PTFE Series S5000 & R5100 Piston Seals. Features of the Parker PTFE S5000 and R5100 Series piston seals include a simplified piston design and an interference piston seal fit that assures positive sealing. Additionally, PTFE piston seals conform to out-of-round bore conditions, require no lubrication, eliminate breakaway stick/slip and reduce seal system damage from particulate contamination. Series S5000 piston seals feature o-ring expanders (see Bulletin PPD-5301-B1/USA). Series R5100 piston seals

feature lathe-cut expanders (see Bulletin PPD-5302-B1/USA).



Table 1

Parker Piston Seal	Friction Rating	Working Pressure* Max (psi)	Seal Element Material Options	Seal Energizer	
				Type	Material
 S5000 Series PTFE seal	Low	3,000	• P808	O-ring	N0674
 R5100 Series PTFE seal	Low	3000	• P808	Lathe Cut	N0674
 PSP A-Style	Med-High	5,000	• 4300 (RESILON™ HT) • 4622 (Ultrathane™)	Lathe Cut	N0674
 BP Profile	Low-Med	7,000	• 4304 (RESILON™ ER)	Lathe Cut	N0674
 OK Profile	High	7,250	• W4650 (MolyGard™)	Lathe Cut	N0674

*Pressure ratings reflect .005" maximum extrusion gap. Validated on Integrated Piston™ assembly.

Materials

Integrated Piston™ assembly materials are selected based on temperature, pressure and fluid compatibility. This section briefly describes the standard bearing, seal and expander materials available for the **Integrated Piston** assembly.

Table 2






Material Number	Compound Type/Description	Hardness	Temp Range	Color
4734	WearGard™ WearGard™ is Parker's newest family of bearing and wear ring materials. This heat-stabilized compound will provide its superior physical properties for prolonged periods of time at elevated temperatures.	109-R Rockwell	-40°F to +275°F	green 
P808	15% Fiberglass filled PTFE Parker's P808 is 15% fiberglass-filled PTFE. Recommended for low to medium pressure piston and rod seals and rotary seals. Typically used in lubricating hydraulic medium. Requires hardness of 55/65 RC on dynamic rubbing surfaces. P808 offers lowest friction, good wear resistance, and good creep resistance.	55 Shore D	-100°F to +150°F	gold 
4622	Ultrathane™ Parker's Ultrathane™ offers reduced friction over conventional urethane materials. Because of this reduced friction and the resulting lowering of frictional heat build-up at the seal interface, the operating temperature of this material is -65°F to +225°F. Ultrathane fluid compatibility is the same as Parker's other high-tensile urethane materials and is good for service to 5000 psi at recommended dimensions and tolerances.	90 Shore A	-65°F to +225°F	yellow 
W4650	MolyGard™ Parker's MolyGard™ is corrosion resistant, wear resistant and has higher strength/weight ratio than most metals. Minimal effects of weathering. Good hydrolysis resistance. Compatible with most organic and inorganic reagents, lubricating oils, greases, aliphatic and aromatic hydrocarbons, ketones, amides, ethers, common esters, phosphate esters, and most inorganic acids and bases. Characteristics of this material include excellent compressive strength and the ability to capture and contain system contaminants such as metal fragments.	121-R Rockwell	-40°F to +275°F	black 
4300	RESILON™ HT High-performance PPDI Parker's RESILON™ family of high-performance PPDI-based urethanes are developed with greatly improved physical properties. With a tensile strength of over 8000 psi, RESILON™ HT will resist extrusion over a broad pressure range. Excellent abrasion resistance and low wear provide extended seal life. Resilience makes for a very responsive piston seal as sealing surfaces will remain in contact with cylinder walls while reacting to rapid changes in load. Excellent fluid compatibility with most petroleum base fluids, acetic and alkaline solutions under 10% concentration.	90 Shore A	-40°F to +275°F	tan 

Table 2 (cont'd)

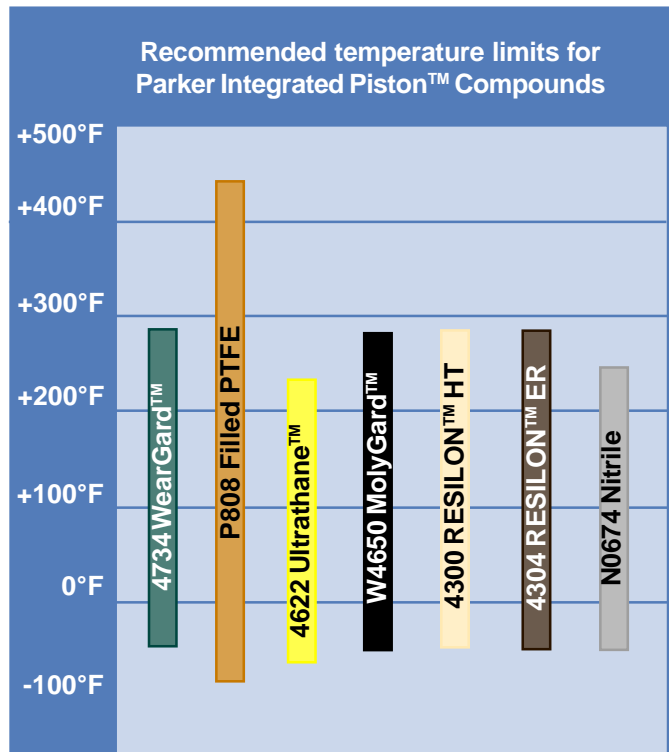
Material Number	Compound Type/Description	Hardness	Temp Range	Color
4734	RESILON™ ER High-performance PPDl Higher modulus RESILON™ for improved extrusion resistance over a broader pressure range. May be used as auxilliary devices, such as backups, anti-extrusion devices, etc. Exhibits all characteristics of RESILON™ family of high-performance materials.	60 Shore D	-40°F to +275°F	brown ●
N0674	Nitrile General purpose 70 durometer Nitrile, used as piston seal expanders (lathe-cut or o-ring). Nitrile is one of the oldest and most popular seal compounds. Nitriles have good resistance, to extrusion and compression set and are generally suitable for service in petroleum, water-oil emulsions and water-glycol fluids.	70 Shore A	-40°F to +250°F	black ●

NOTE: Material combinations for the *Integrated Piston* assembly are confined by the capabilities of the least capable component from all components of the *Integrated Piston* assembly. Parker EPS Applications Engineers are pleased to suggest alternate compounds for custom applications where standard materials fall short of requirements. Many additional materials are already available as options to the standards, and still more may be qualified to custom requirements.

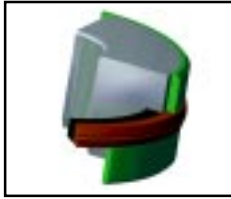
Table 3.0



Table 3.1



Part Numbering



The Parker *Integrated Piston*™ assembly may be completely described and ordered by a 9-part composite part number (see below). Alpha-numeric codes define all standard seal dimensions, materials and configurations. Special materials or sizes should be ordered only after consultation with Parker's Applications Engineers who will help you construct the proper part number. For special design assistance and custom part design and numbering, photocopy pages 10 and 11 of this catalog, fill in the required information and fax (801) 972-4777, or mail the same to Parker's Applications Engineers. Or visit us online at www.integratedpiston.com

and fill in and submit the online RFQ form.

Parker *Integrated Piston* assembly part numbers may be constructed as follows:

EXAMPLE: An *Integrated Piston* assembly is required for a cylinder bore of 2.500 inches, operating in petroleum-base fluid at 4,000 psi and 185°F. The best seal for the application is the BP profile. This part number would be written in these nine steps:

Bearing Material	Molded Piston	Nominal Bore Diameter	Minimum Piston Through-hole	Piston Nominal Width	Piston Core Material	Piston Core Detail	Seal Profile	Assembly
4734	MP	2500	1001	1000	A	00	B1	A
1	2	3	4	5	6	7	8	9

4734 MP 2500 1001 1000 A 00 B1 A

- Step 1:** Bearing Material
- Step 2:** MP - Product Line Call-out
- Step 3:** Nominal Bore Diameter (with typical tolerance of +0.002/ -0.000)
- Step 4:** Minimum Piston Through-hole Dia. (example dia 1.001 = 1001)
- Step 5:** Nominal Piston Width
- Step 6:** Piston Core Metallurgy
A = Machined cold-drawn carbon steel
- Step 7:** Piston Design
00 = Standard design and through-hole with two 25° x 0.080" chamfers
00 - 99 = Custom design
- Step 8:** Seal Profile Selected:
A1 = Series S5000 PTFE Seal
A2 = Series R5100 PTFE Seal
B1 = RESILON™ ER (4304) BP Seal
G1 = RESILON™ HT (4300) PSP Seal (A-Style)
G2 = Ultrathane™ 4622 PSP Seal (A-Style)
N1 = MolyGard™ OK Seal
- Step 9:** Assembled/finished product



Selection Guide

Standard Parker *Integrated Piston™* assemblies are available in the following dimensions. Custom configurations are available. Consult Parker Application Engineers at (801) 972-3000 for custom configuration options.

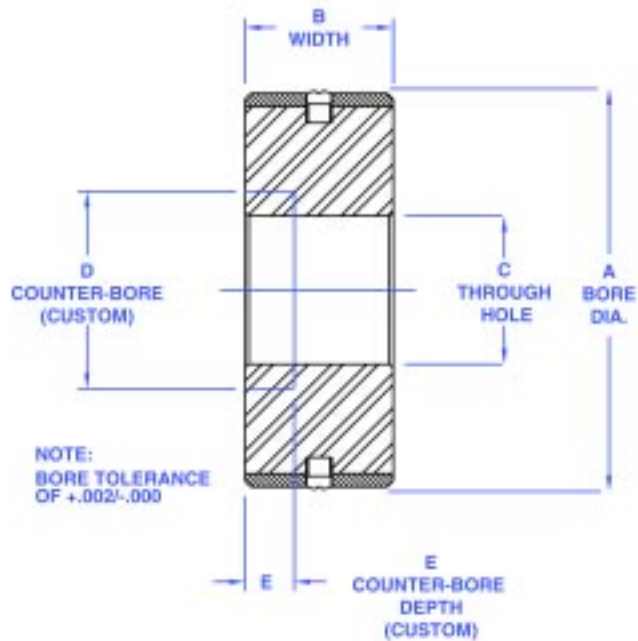


Table 4

A Nominal Bore Diameter	B Nominal Width	C Core through hole	D Counter Bore Dia. (Custom)	E Counter Bore Depth (Custom)
1.500	1.000	0.500	0.750	0.250
1.750	1.000	0.750	1.000	0.250
2.000	1.000	0.750	1.000	0.250
2.250	1.000	1.000	1.250	0.250
2.500	1.000	1.000	1.500	0.250
2.750	1.000	1.000	1.500	0.250
3.000	1.000	1.000	1.500	0.250
3.250	1.250	1.000	1.500	0.250
3.500	1.250	1.000	1.500	0.375
3.750	1.500	1.000	1.500	0.375
4.000	1.500	1.250	1.750	0.375

Note: Modification available for engineered core through-holes to fit specification. Contact Parker Applications Engineers for design assistance.

Test Data

In an effort to simulate effects of field conditions, Parker conducted laboratory tests to determine friction, piston seal blow-by and endurance life on the **Integrated Piston™** assembly. Test descriptions and results are as follows:

Integrated Piston assemblies with the following four seals installed were tested:

Part Number	Seal Material	Size	Description
4300PSP330A	4300 Resilon™ HT	2.500" dia	Type A PSP Seal
P808 S-5000-40	P808	2.500" dia	PTFE S5000 Piston Seal
4304 BP2500-175A	4304 Resilon™ ER	2.500" dia	BP Piston Seal
4650 OK 269002500-312A	4650 MolyGard™	2.500" dia	OK Piston Seal

Friction Test

Objective: Obtain statistically significant data on breakaway and running friction for various piston seal profiles and materials.

Test Procedure:

Equipment: 2 1/2" bore hydraulic cylinder, lubricated and vented

Measurement Apparatus: Instron load cell

Parameters:

Stroke	2"
Temperature	73°F
Speed	20 in/min

Procedure:

- Cylinder assembled with **Integrated Piston** and new seal profiles
- Cylinder lubricated and vented (no pressure)
- Actuate Instron to determine breakaway and running friction.

Data:

Table 5

Piston Seal Profile	Ave. Breakaway Friction (lb _f)	Ave. Running Friction (lb _f)
S-5000	8.0	6.7
BP	17.3	13.7
PSP	21.7	17.6
OK	43.7	36.7

Conclusion: PTFE S5000 Series piston seals offer the lowest breakaway and running friction, as expected. The RESILON™ ER BP piston seal exhibited excellent breakaway and running friction properties. The combined attributes of the RESILON™ ER, the 60 Shore D hardness, and the contact seal design result in a urethane piston seal with minimal frictional drag.

Piston Seal Blow-By Test

Objective: Obtain statistically significant data on the movement under load of a piston/rod assembly within a hydraulic cylinder, correlating movement to piston seal leakage.

Test Procedure:

Equipment:

- 2 1/2" bore hydraulic cylinder, lubricated and vented
- 3.5" bore hydraulic "slave" cylinder
- 5000 psi hydraulic test stand

Measurement Apparatus: Dial indicator

Parameters:

Pressure	Per each seal rating (Table 1)
Temperature	73°F

Procedure:

- Cylinder assembled with **Integrated Piston** and new seal profiles that have not been endurance tested. (Pre-Endurance)
- Cylinder filled with fluid
- Test cylinder vented at retraction port
- Pressurize slave cylinder, applying load to test cylinder until test pressure reached
- Measure and record indicator movement every 3 minutes for 15 minutes
- Assemble cylinder with **Integrated Piston** and seal profiles that have completed endurance test of 100,000 cycles at maximum rated Integrated Piston/seal pressure (Post Endurance).
- Repeat above test.

Data: Test pressures based on 100%, 50% and 5% of rated seal pressure per SAE J214 test procedure. See Tables 6 and 7, Graphs 1 and 2, next page.

Conclusion: Post test measurements are less than 0.001" (except for PTFE), indicating that a break-in period for the seal and bore sealing surface make the seals "zero leakage."

Endurance Test

Objective: Obtain objective evidence that the *Integrated Piston™* assembly, of premium design and materials, successfully endures loaded cycle testing at maximum rated seal pressure.

Test Procedure:

- Equipment:**
- 2 1/2" bore hydraulic cylinder, lubricated and vented
 - 3.5" bore hydraulic "slave" cylinder
 - 5000 psi hydraulic test stand

Measurement Apparatus:

Computer Data Acquisition (PLC)

Parameters:

- Stroke: 6" (3000 psi); 2" (6000 psi)
- Media: Standard hydraulic fluid
- Temperature: 160°F
- Pressure: Per each seal rating (Table 1)
- Speed: 3"/sec; 1"/sec. per seal spec.

Procedure:

- Assemble cylinder onto test stand with slave cylinder
- Set pressure, stroke, temperature with PLC
- Set slave cylinder pressure to resist movement of test cylinder
- 100,000 minimum cycles = complete test

Data: All *Integrated Piston* assemblies reached or exceeded the minimum 100,000 cycles.

Conclusion: The conditions of the endurance test represented average side loading and linear resistance. With this, the WearGard™ showed minute wear. All seal components were found to be in excellent condition and fully functional.

Table 6 (Piston total movement [in]) (See also Graph 1)

Min	1500 psi S5000		3000 psi S5000		1500 psi 4300 PSP		1500 psi 4300 PSP	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
3	0.001	0.000	0.001	0.001	0	0	0.001	0
6	0.002	0.000	0.001	0.002	0.000	0	0.002	0
9	0.003	0.001	0.002	0.002	0.000	0	0.002	0
12	0.004	0.001	0.002	0.003	0.001	0	0.002	0
15	0.004	0.001	0.002	0.003	0.001	0	0.003	0

***NOTE:** Consult factory for Post Endurance test data on OK Profile seal at 5,000 and 10,000 psi.

Graph 1 (Piston total movement [in])

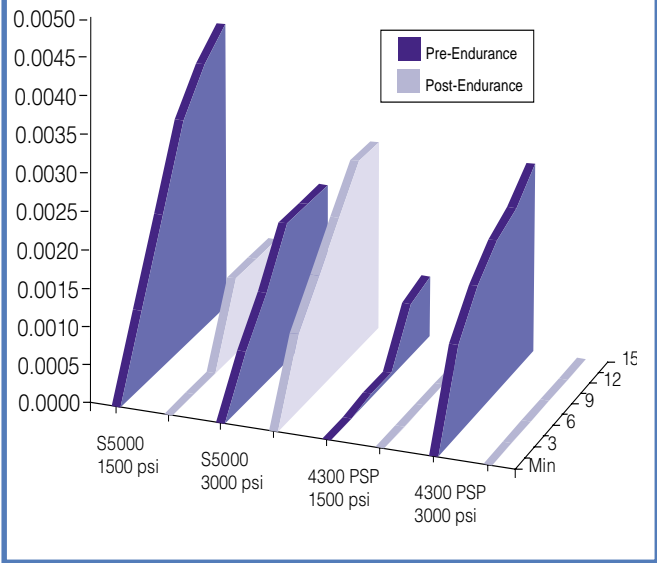
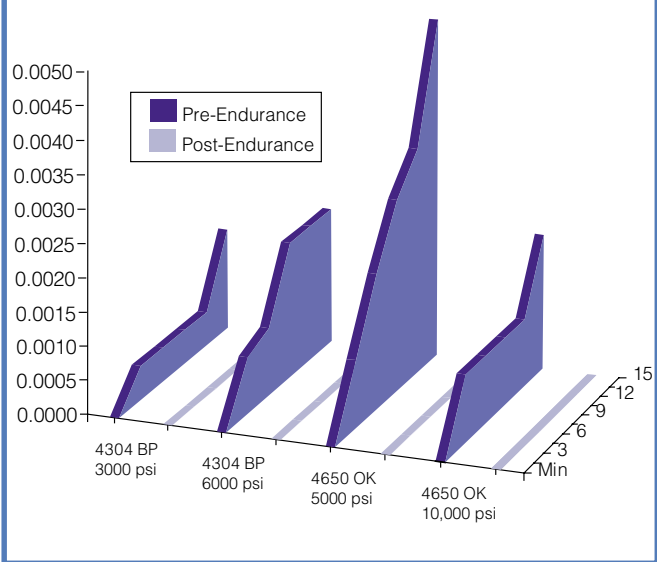


Table 7 (Piston total movement [in]) (See also Graph 2)

Min	3000 psi 4304 BP		6000 psi 4304 BP		5000 psi 4650 OK		10000 psi 4650 OK	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
3	0.001	0.000	0.001	0.000	0.001		0.001	
6	0.001	0.000	0.001	0.000	0.002	*	0.001	*
9	0.001	0.000	0.002	0.000	0.003		0.001	
12	0.001	0.000	0.002	0.000	0.003		0.001	
15	0.002	0.000	0.002	0.000	0.005		0.002	

Graph 2 (Piston total movement [in])



Need Help? If you need assistance, please photocopy this page and the facing page. Fill out the required information, and fax it to Parker EPS Division at (801) 972-4777. Utilize the information below and other information in this guide to determine the dimensions needed. We will contact you to discuss your specific application and make recommendations. If you need help filling out the form, please call EPS Division Applications Engineers at (801) 972-3000.

**ENGINEERED POLYMER SYSTEM DIVISION
DATA REQUEST**

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FAX (801) 972-4777

CHICAGO OPERATIONS
2565 NORTHWEST PARKWAY
ELGIN, IL 60123
PHONE (847) 783-4300
FAX (847) 783-4301

DISTRIBUTOR _____	END-USER _____
ADDRESS _____	ADDRESS _____
CITY _____ STATE _____ ZIP _____	CITY _____ STATE _____ ZIP _____
CONTACT _____ TITLE _____	CONTACT _____ TITLE _____
PHONE _____ FAX _____	PHONE _____ FAX _____
E-MAIL _____	E-MAIL _____
ALT. CONTACT _____ TITLE _____	ALT. CONTACT _____ TITLE _____
PHONE _____ FAX _____	PHONE _____ FAX _____
E-MAIL _____	E-MAIL _____

EQUIPMENT _____	MODEL: _____
COMPONENTS _____	PROBLEM: _____
EXISTING SEAL/PART NUMBER: _____ <input type="checkbox"/> N/A	_____
PRICE \$ _____ @ _____ PCS USAGE/YEAR: _____	_____
TARGET \$ _____ @ _____ PCS QUOTE QTY: _____	_____
PRODUCT POTENTIAL _____	PROBLEM PARTS INCLUDED <input type="checkbox"/> YES <input type="checkbox"/> NO
ISSUE: <input type="checkbox"/> PRICING <input type="checkbox"/> SEAL PROBLEM (Explain) _____	CUSTOMER P/N: _____
PROTO QTY: _____ DATE PROTO REQ'D: _____	

SPECIAL INSPECTION REQUIREMENTS? YES NO SPECIAL PACKAGING REQUIREMENTS? YES NO

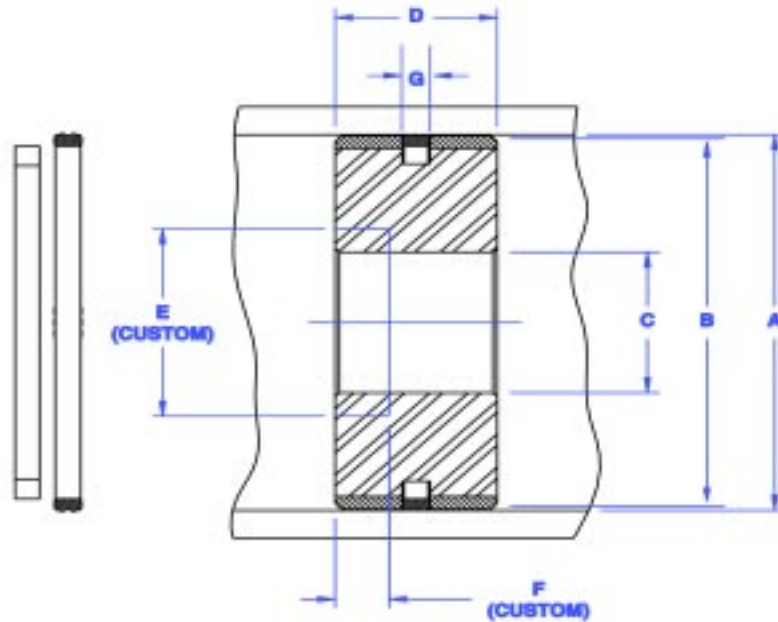
OPERATING	UNIT				
PARAMETERS	(CIRCLE ONE)	MINIMUM	OPERATING	MAXIMUM	MOTION
TEMPERATURE	°K °F °C	_____	_____	_____	<input type="checkbox"/> STATIC
PRESSURE	PSI BAR MPA	_____	_____	_____	<input type="checkbox"/> RECIPROCATING
STROKE LENGTH	INCH MM	_____	_____	_____	
CYCLE RATE	/MIN. /HR HZ	_____	_____	_____	
VELOCITY/		_____	_____	_____	PRESSURE DIRECTION
SURFACE SPEED	FT/MIN. MM/MIN.	_____	_____	_____	<input type="checkbox"/> UNIDIRECTIONAL
VACUUM	IN. HG TORR	_____	_____	_____	<input type="checkbox"/> BI-DIRECTIONAL

MEDIA TO BE SEALED _____



HARDWARE

INTEGRATED PISTON™ ASSEMBLY AND PISTON SEAL



HARDWARE DRAWINGS INCLUDED WITH DATA REQUEST

YES NO

A DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____
B DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____
C DIAMETER	MIN. _____	MAX. _____	HARDNESS _____	FINISH _____	MAT'L _____
D WIDTH	MIN. _____	MAX. _____			
E COUNTERBORE (optional)	MIN. _____	MAX. _____			
F COUNTERBORE (depth)	MIN. _____	MAX. _____			
G GROOVE	MIN. _____	MAX. _____			

DESIRED PISTON SEAL: BP PROFILE PSP PROFILE OK PROFILE PTFE S5000 Series PTFE R5100 Series
 OTHER _____

METRIC YES NO

SIDE LOAD (LBS NEWTONS): _____

PERFORMANCE REQUIREMENTS
 (CIRCLE ONE)

FRICTION _____ LBS OZ GMS BREAKOUT DYNAMIC
 EXPECTED LIFE: _____ CYC HRS YRS
 MAX LEAKAGE: _____ DROPS CC/MIN _____

MOST CRITICAL ASPECT (check only one) SEAL LIFE PRICE LEAKAGE FRICTION OTHER (EXPLAIN)

CONTAMINATION: _____



11
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 fax: (801) 972-4777
 www.parkerseals.com

As part of the **Integrated Piston™** product line, please refer to the following bulletins for further information. Parker EPS Division is your Total Sealing System supplier.

**BP Profile Piston Seal
 Bulletin 5212B1-USA**



**WearGard™ Bearing Material
 Bulletin 5213B1-USA**



**OK Profile Piston Seal
 Bulletin 5206B1-USA**



**PSP Piston Seal
 Bulletin 5238B1-USA**



**PTFE S5000 Piston Ring
 Bulletin 5301B1-USA**



**PTFE R5100 Piston Ring
 Bulletin 5302B1-USA**



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4. Warranty. Seller warrants that the items sold hereunder shall be free from defects in material or workmanship at the time of delivery. THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING, BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.

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6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. 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 apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity for infringement of intellectual property rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereunder "Intellectual Property Rights"). 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 an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after the Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, place or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights. If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgements resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter "Events of Force Majeure"). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Any special requirements for items to be provided by Seller hereunder including without limitation; compliance with military specifications, special documentation, or testing requirements, must be communicated to Seller in writing at the time the items are first requested. Any such requests that are communicated to Seller after preparation to manufacture an item has commenced may result in additional charges for rework or remanufacture of the item.

13. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either more than two (2) years after the cause of action accrues.



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