



HYBRODYNAMICS

Hy-P Technology

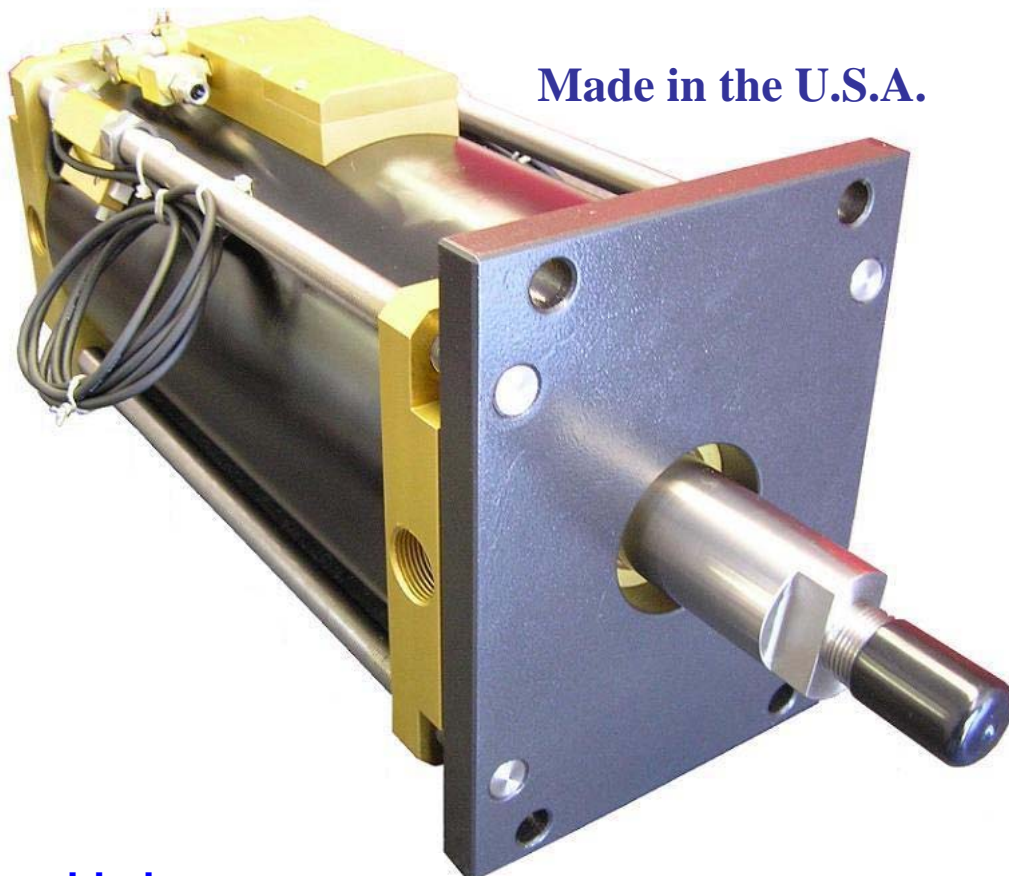
PNEUMATICALLY POWERED HYDRAULICALLY
REGULATED ACTUATION

CATALOG 8-2

Series **LIK**

Cylinders with Hydraulic Lock

THE PRODUCTS IN THIS CATALOG ARE PROTECTED UNDER ONE OR MORE OF THE
FOLLOWING PATENTS: US 6 481 335, US 6 606 936, US 6 675 698.



Made in the U.S.A.

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Effective April 2005

APPLICATIONS

We often hear the same question about our product: "What can be done with it?" Although it would be tempting to claim that this technology has no limits, this is not entirely true - for Your Imagination Is The Limit!

Frederick Nelson Brown

INTRODUCTION

Hy-P actuation is a unique hybrid form of fluid powered actuation in which air powered movement is combined with self-contained hydraulic dampening. The hydraulic dampening of Hy-P actuators (cylinders in particular) is passive and arranged internally. Due to this internal arrangement of dampening, Hy-P cylinders are compact, have the geometry of conventional cylinders and are easy to integrate into conventional systems. Hy-P cylinders can be powered by any conventional source of compressed air and controlled by standard pneumatic logic components. The dampening allows: **instant stops**; **indefinite positioning** in any desired point in-between terminal positional stops; **smooth motion** free of spontaneous spring-like displacements, creeping and chatter. Beyond that, Hy-P cylinders can **operate at up to 300PSI** of pressure.

Hy-P Cylinders Series LIk

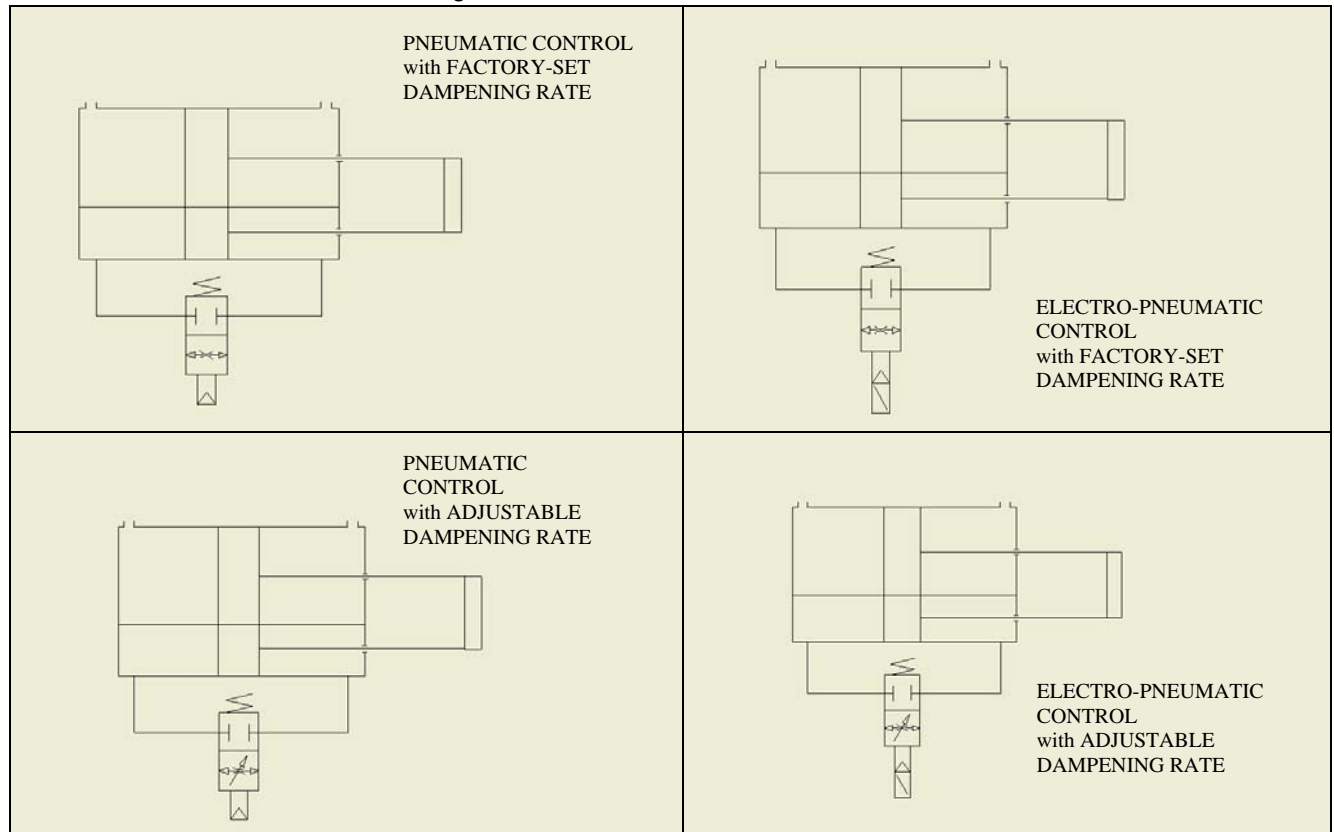
Hydraulic Lock

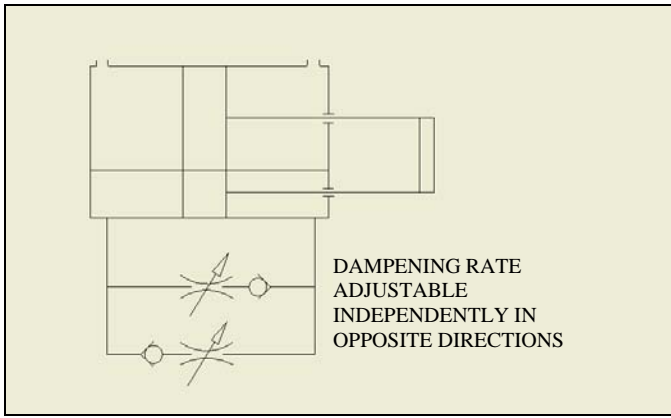
Hy-P cylinders series **LIk** are designed with normally closed hydraulic lock feature. The hydraulic lock keeps the piston/rod unit of the cylinder securely locked in any given position until a control signal to change the position is provided. When the control signal opens, the hydraulic lock airflow is simultaneously sent to power the action of displacement. When the control signal is off, the hydraulic lock returns to the closed state and the cylinder stops regardless of whether the power airflow is still being provided or not. Cylinders series **LIk** are designed for precision control of position and secure position retention. There are two standard types of hydraulic lock controls available: pneumatic control and electro-pneumatic control. Because the retention of position requires no power, **LIk** cylinders maintain position during power failures. **LIk** cylinders are also equipped with an emergency unlock feature which allows the hydraulic lock to open in case the main air supply is not available to provide the control signal.

Dampening Rates

Dampening rate is a design-attributed variable that ultimately defines the displacement velocity of the cylinders. Hy-P cylinders series **LIk** come in two modifications: with factory-set dampening rate (standard configurations) and with adjustable dampening rate (customized configurations).

Series LIk Modification Symbols



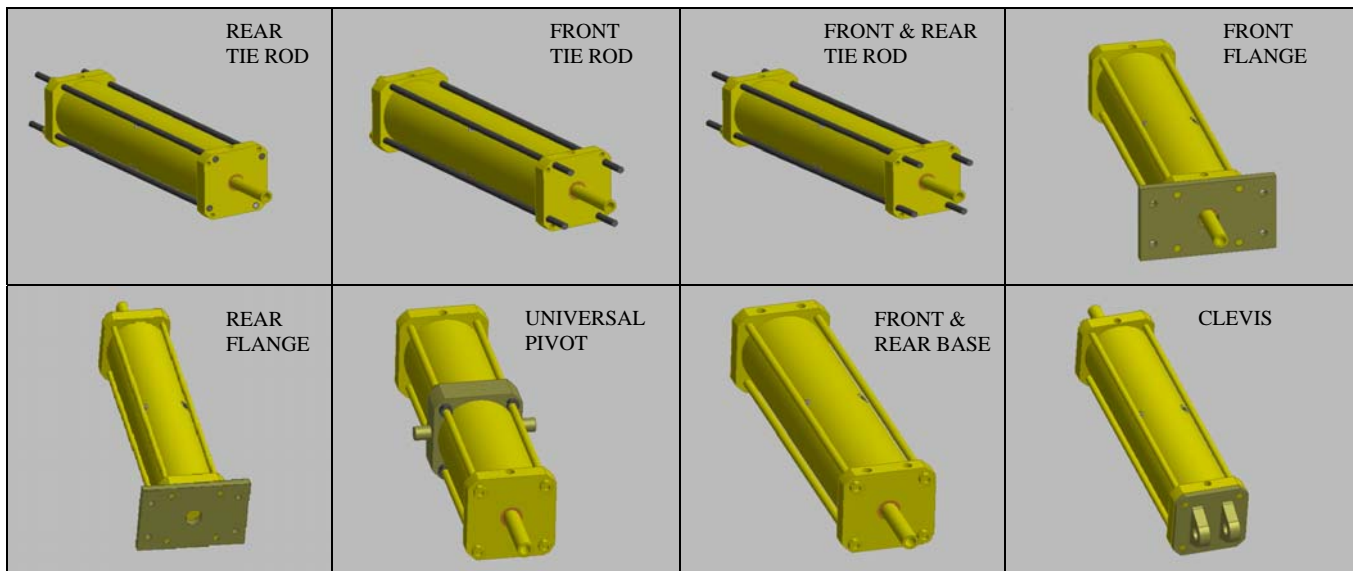


Positional Accuracy Considerations

Positional accuracy of the series **Llk** cylinders ultimately depends on the cylinder's displacement velocity at the moment the control signal is being shut off. A cylinder remains in motion from the moment of shut-off until the moment the lock is completely closed. Thus, during this period, the piston is moving away from the theoretically nominal position. The shut-off time varies depending on the bore size and other design attributed variables; however, it averages at about 5 milliseconds. As a result, at velocity 1in/sec, the anticipated positional error will be 0.005in or less, and at 10in/sec it will be 0.05in or less. For systems which are designed for stable predictable movements, the anticipated positional errors can be corrected by making control signal timing adjustment to shut the control signal off before the cylinder reaches it's theoretically nominal position.

For systems that tolerate positional error ± 0.025 in or greater, cylinders series **Llk** are largely suitable as they are, as well as for systems not subjected to random, rapidly changing external loads and having operational displacement velocities less than 3in/sec. The second type of system is most likely to produce positional accuracies better than ± 0.010 in without the use of any additional corrections.

Standard Mounting Options



Standard, Customized and Custom Mounting

Standard mounting options allow practically unlimited variety of custom modifications, including modifications to the cylinders' end-caps. Consult with the factory if customized standard or custom mounting is required.

Rod End Options

Standard rod end

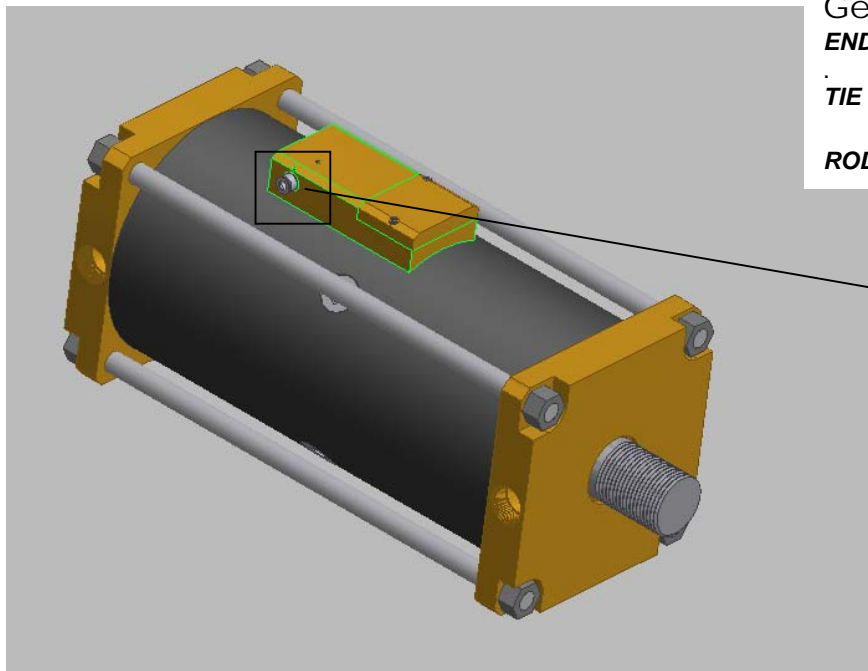


Customized rod end options



Consult with the factory about custom rod end design and geometry

SERIES L1k, STANDARD CONFIGURATIONS



General Construction

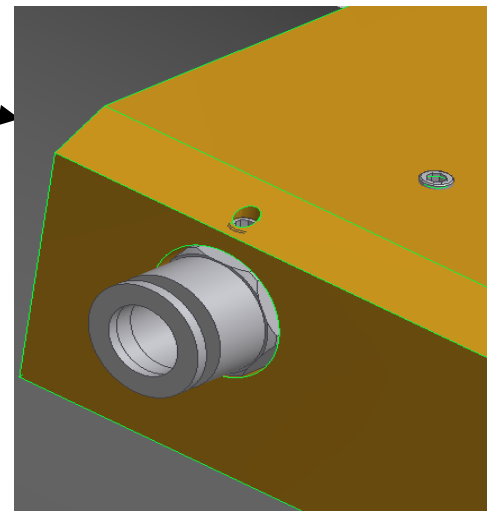
END CAPS & CYLINDER Anodized aluminum

TIE RODS

Stainless steel 18-8

ROD

Stainless steel 303



General Specification

OPERATION

Double-acting

OPERATING PRESSURE

30 – 300psi (non-shock operation)

Definition: Non-shock operation is defined as operation in which all stops and movements occur via pneumatic or internal hydraulic control and not via mechanical limits at terminal positions or external forces.

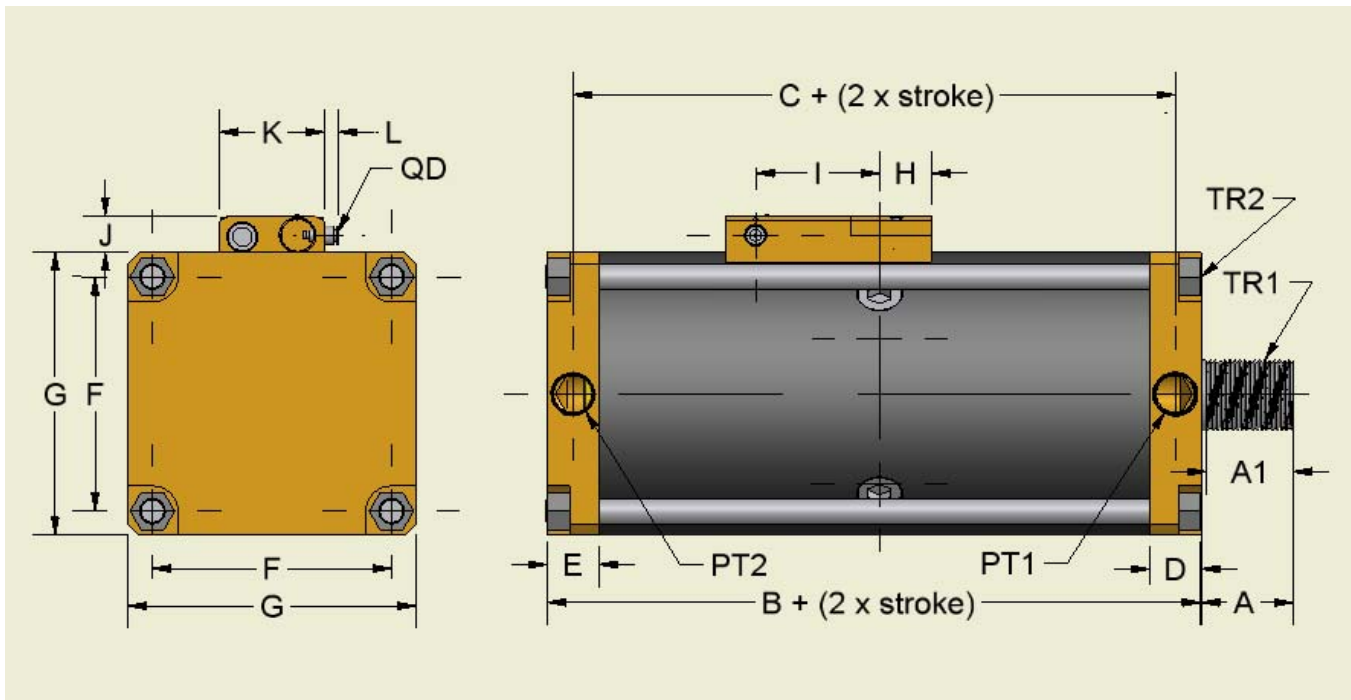
OPERATING TEMPERATURE

20 – 180°F

DISPLACEMENT VELOCITY at ZERO LOAD

0.1–10in/sec@100psi

CONTINUOUS NON-STOP CYCLING AT MAXIMUM VELOCITY WITHOUT OVERHEATING



| BORE | MAX STANDARD STROKE | A | A1 | B | C | D | E | F | G | H | I | J | K | L | QD CONTROL SIGNAL PORT | TR1 | TR2 | PT1 & PT2 |
|------|---------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|---------------------------------|-----------|-----------|-----------|
| 6 | 20 | 2.13 | 2.00 | 7.88 | 6.64 | 1.76 | 1.76 | 5.80 | 7.00 | 1.26 | 3.01 | 0.91 | 2.53 | 0.34 | QUICK DISCON. FOR TUBE OD 1/4IN | 13/4-12UN | 5/8-18UNF | 3/4NPT |

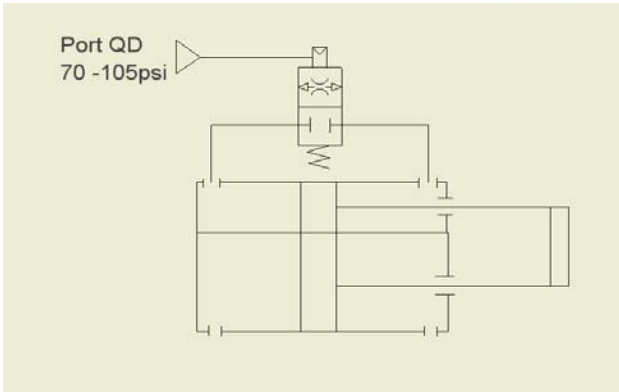
NOTE: ALL LINEAR DIMENSIONS ARE IN INCHES

FOR EXTENDED STROKE MODELS SEE Pg.7

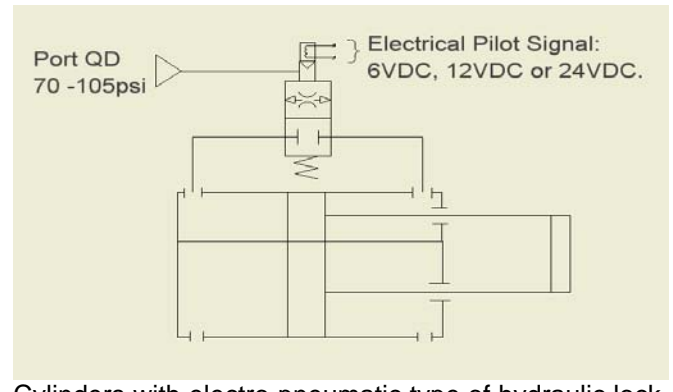
| BORE | FORCE FACTOR | | STATIC FORCE [LB] | | | | | | | | | | VOLUMETRIC DISPLACEMENT [FT ³ /IN STROKE] | |
|------|--------------|---------|-------------------|------|--------|------|---------|------|---------|------|---------|------|--|---------|
| | FORWARD | REVERSE | @60psi | | @80psi | | @100psi | | @200psi | | @300psi | | FORWARD | REVERSE |
| | | | R/W | V/R | R/W | V/R | R/W | V/R | R/W | V/R | R/W | V/R | | |
| 6 | 28.3 | 25.9 | 1698 | 1554 | 2264 | 2072 | 2830 | 2590 | 5660 | 5180 | 8490 | 7770 | 0.0164 | 0.0150 |

Standard Types of Hydraulic Lock Control

| BORE | ** HYDRAULIC LOCK CONTROL TYPE | CONTROL SIGNAL PILOT | CONTROL SIGNAL | TIME TO OPEN HYDRAULIC LOCK | TIME TO CLOSE HYDRAULIC LOCK |
|------|--------------------------------|--------------------------|------------------------------|-----------------------------|------------------------------|
| 6 | PNEUMATIC | 70+200psi compressed air | Same as CONTROL SIGNAL PILOT | 7ms | 5ms |
| | ELECTROPNEUMATIC | 6VDC, 112mA | 70+105psi compressed air | 10ms | 5ms |
| | ELECTROPNEUMATIC | 12VDC, 56mA | 70+105psi compressed air | 10ms | 5ms |
| | ELECTROPNEUMATIC | 24VDC, 28mA | 70+105psi compressed air | 10ms | 5ms |



Cylinders with pneumatic type of hydraulic lock control have the hydraulic lock open with pneumatic pilot signal provided thru port QD.



Cylinders with electro-pneumatic type of hydraulic lock control have the hydraulic lock open with electrical pilot signal provided to hydraulic lock solenoid and the presence of air pressure thru port QD.

SERIES LIK, CUSTOMIZED CONFIGURATIONS

Stainless Steel Construction

Hy-P cylinders series **LIK** listed in standard configurations but made for environments typical for **chemical, petrochemical** and other specific industries can be constructed with:

| | |
|------------------------|--|
| Cylinder | - 304 stainless steel. |
| Rod | - 303 stainless steel. |
| Tie Rods | - 18-8 stainless steel. |
| Nuts | - 18-8 stainless steel. |
| Bushings | - chemically inert polymer (FDA approved if required). |
| Seals | - chemically inert polymer (FDA approved if required). |
| Dampening fluid | - chemically inert synthetic oil (FDA approved if required). |

Cylinders for **extremely aggressive environments, aggressive environments** with **operating temperature above 200°F, seawater applications**, and for **food, pharmaceutical and medical industries** can be constructed with:

| | |
|------------------------|--|
| Cylinder | - 316 stainless steel. |
| Rod | - 316 stainless steel. |
| Tie Rods | - 316 stainless steel. |
| Nuts | - 316 stainless steel. |
| Bushings | - chemically inert FDA approved polymer. |
| Seals | - chemically inert FDA approved polymer. |
| Dampening fluid | - chemically inert FDA approved synthetic oil. |

Other Types of Construction

Hy-P cylinders series **LIK** can be constructed of different carbon steel alloys or other unconventional materials and their combinations to best accommodate specific applications. Metal parts can be electrochemically plated. External parts can be painted. Consult with the factory about details related to specific applications.

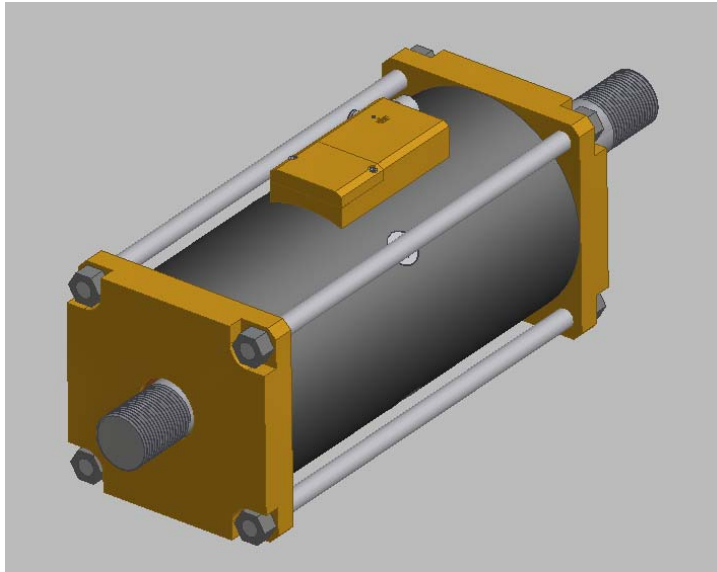
Custom Specification Cylinders

a. Models with Adjustable Displacement Velocity

The range of displacement velocity outlined in the **General Specification** is given for zero load and 100psi conditions. Displacement velocity is generally proportional to the cylinder's operating pressure within 30 – 300psi of range, provided that the operating temperature is constant. In standard Hy-P cylinders series **LIK**, the displacement velocity is determined by permanent factory settings. Customized cylinders modifications series **LIK** are available with an adjustable displacement velocity feature. This feature comes in two sub-modifications: unified adjustment

for both strokes (extension and retraction) and independent adjustments for extension and retraction. The sub-modification with independent adjustments allows different settings of displacement velocity for extension and retraction. Both sub-modifications allow displacement velocity adjustment within the range of 0 – 10in/sec.

b. Double Rod Cylinders



Hy-P cylinders series **L1k** listed in standard configurations are available in sub-standard **Double Rod** version. **Double Rod** cylinders are not considered as standard. The main functional differences between standard **Single Rod** and sub-standard **Double Rod** cylinders are force factors and linear dimensions.

| BORE | FORCE FACTOR | STATIC FORCE [LB] | | | | | VOLUMETRIC DISPLACEMENT [FT ³ /IN STROKE] |
|----------|--------------|-------------------|--------|--------|--------|--------|--|
| | | @60psi | @80psi | ±100ps | ±200ps | ±300ps | |
| 6 | 25.9 | 1554 | 2072 | 2590 | 5180 | 7770 | 0.0150 |

b. High and Special Performance Cylinders

Custom configurations also include cylinders with special performance features or with specifications that exceed specifications of standard models. High and special performance include:

- High Operating Pressure** (600psi and higher)
- Broad Operating Temperature Range** (-30°F to +250°F with possibility for expansion)
- High Displacement Velocity** (12in/sec and higher)
- Magnetic Position Detection Feature**
- Non-Rotating Feature**
- Submerged Deep Sea Operation**
- Vacuum Operation**

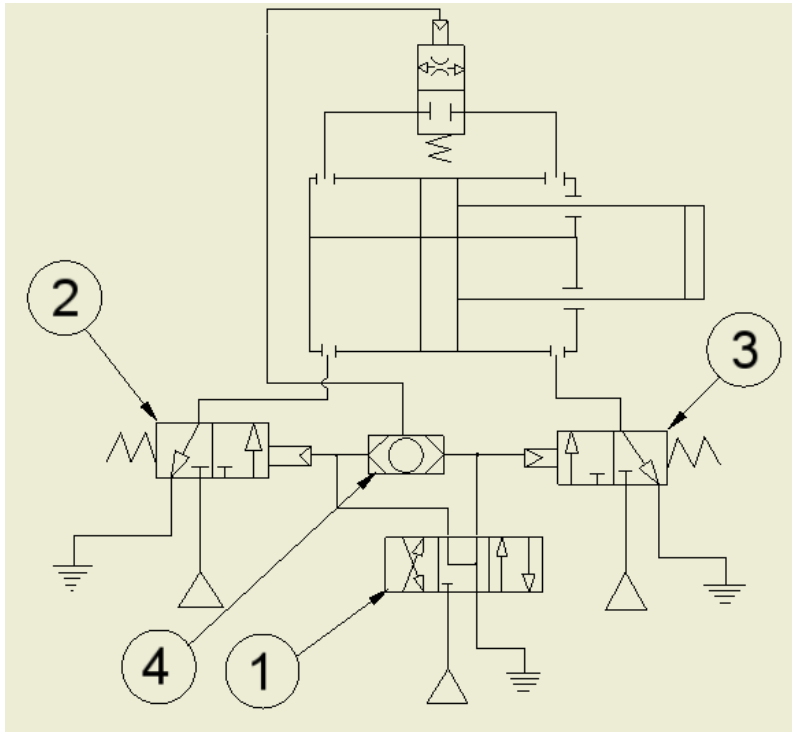
c. Extended Stroke Cylinders

Custom cylinders are available with strokes exceeding the stroke of standard cylinders up to two times. Extended stroke cylinders might have side load and axial load capacity lower than the standard models. Consult with the factory about the possible load limitations or if longer stroke increase is required.

d. Custom-Shaped Models

Cylinders with custom-shaped exteriors, locations and types of ports, etc. are also available by special order.

CYLINDER CONTROL CIRCUIT DIAGRAM

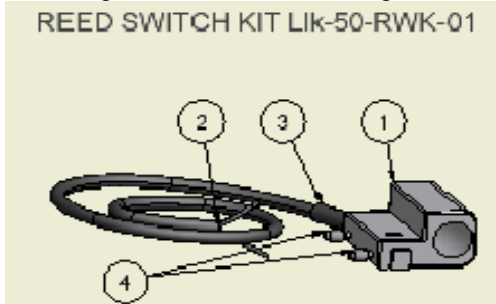


This circuit is an example to illustrate basic principles of controlling a standard Hy-P cylinder with hydraulic lock. When 5-way 3-position valve 1 is in the middle position, hydraulic lock is closed and 3-way 2-position valves 2 and 3 are closed and vented, thus the Hy-P cylinder is locked in position and the ports of the cylinder are vented to the atmosphere. When 5-way 3-position valve 1 is in the right (left) position it sends a signal to open 3-way 2-position valve 3 (valve 2), which provides pressure to the right (left) chamber of the cylinder and simultaneously, thru shuttle valve 4, opens the hydraulic lock and sets the cylinder in motion.

MAGNETIC SENSORS AND ACCESSORIES

RBHydrodynamics, Inc. offers Hy-P cylinders with magnetic position detection feature. Models equipped with this feature have magnets mounted on the cylinder piston. Magnetic sensors mounted on the cylinder surface detect magnetic signature of the magnets as the piston moving inside the cylinder passes the sensors. The sensors can be multiple and can be installed anywhere along the stroke of the piston.

RBHydrodynamics, Inc. offers the reed switch as a part of the standard reed switch kit. The kit is designed for mounting magnetic sensors on **Standard** and **Double Rod** cylinders with 6in bore (ref. pg.5 and pg.7) by attaching the reed switch holding bracket to the cylinder tie rod.



| Part Name | Part Number | QTY | Part Description |
|----------------------------|---------------|-----|---|
| 1. Reed Switch Bracket | Llk-50-RSB-01 | 1 | Anodized Aluminum |
| 2. Reed Switch | 00045-01 | 1 | Input: 10 - 30VDC, Load: 200mA max with LED indicator |
| 3. Reed Switch Tubing | Llk-50-RST-01 | 1 | Polymer Sleeve |
| 4. Slotted Nylon Set Screw | | 2 | 10-32x1/4 |
| 5. Hex Nut | 00003-20 | 2 | 5/8-18 (not shown) |

NOTE: Reed Switch kits for other standard bore sizes are available by special order

NOTE: Reed Switch Brackets adjustably slide on tie rods with Hex Nuts used to secure them in position. The Reed Switch Brackets and Hex Nuts are not detachable parts and are installed at the factory. Specify the number of Reed Switch Brackets and the tie rods on which they shall be installed at the time of order.

SERVICES

RBHydrodynamics, Inc. offers the following services:

- Application Engineering Consultations
- Custom Design and Material Selection

- Custom Hardware and Accessories Design
- Documented Design Proposals
- Finite Analysis and Testing
- Troubleshooting and Technical Support
- Quality Assurance
- Expedited Delivery

SPECIAL ORDERS vs. STANDARD CONFIGURATIONS

Hy-P cylinder configurations that deviate from the standards are defined as special order items. Depending on the degree of deviations, special order items can be qualified as either customized or custom. For instance, double rod cylinders require minimum modification of materials and manufacturing processes compared to standard single rod cylinders. They also need zero R&D and thus qualify as customized products. Production of extended stroke and custom-shaped cylinders, on the other hand, demands special engineering and manufacturing efforts, and is associated with additional material expenses, and qualifies as custom. Customized and custom cylinders have longer lead-times and are more expensive proportionally to the level of uniqueness, novelty, and manufacturing and R&D efforts.

RBHydrodynamics, Inc. has a goal of expanding the number of standard products in order to make its products more affordable and to minimize the lead-time. To achieve this goal, the company encourages the customers to consider the use of custom configuration cylinders in their products having continuous reoccurring and/or growing demand. In such cases, RBHydrodynamics, Inc. can often offer custom cylinder models at the price of standard models and reduce the lead-time to the level typical for standard units. In practical terms, the company offers “Standard Configurations” status to the models with sufficient reoccurring demand.

RBHydrodynamics, Inc. constantly conducts new product development in the direction of promising fields where the R&D efforts have the highest justifiable probability to yield new products that can be qualified as standard configurations.

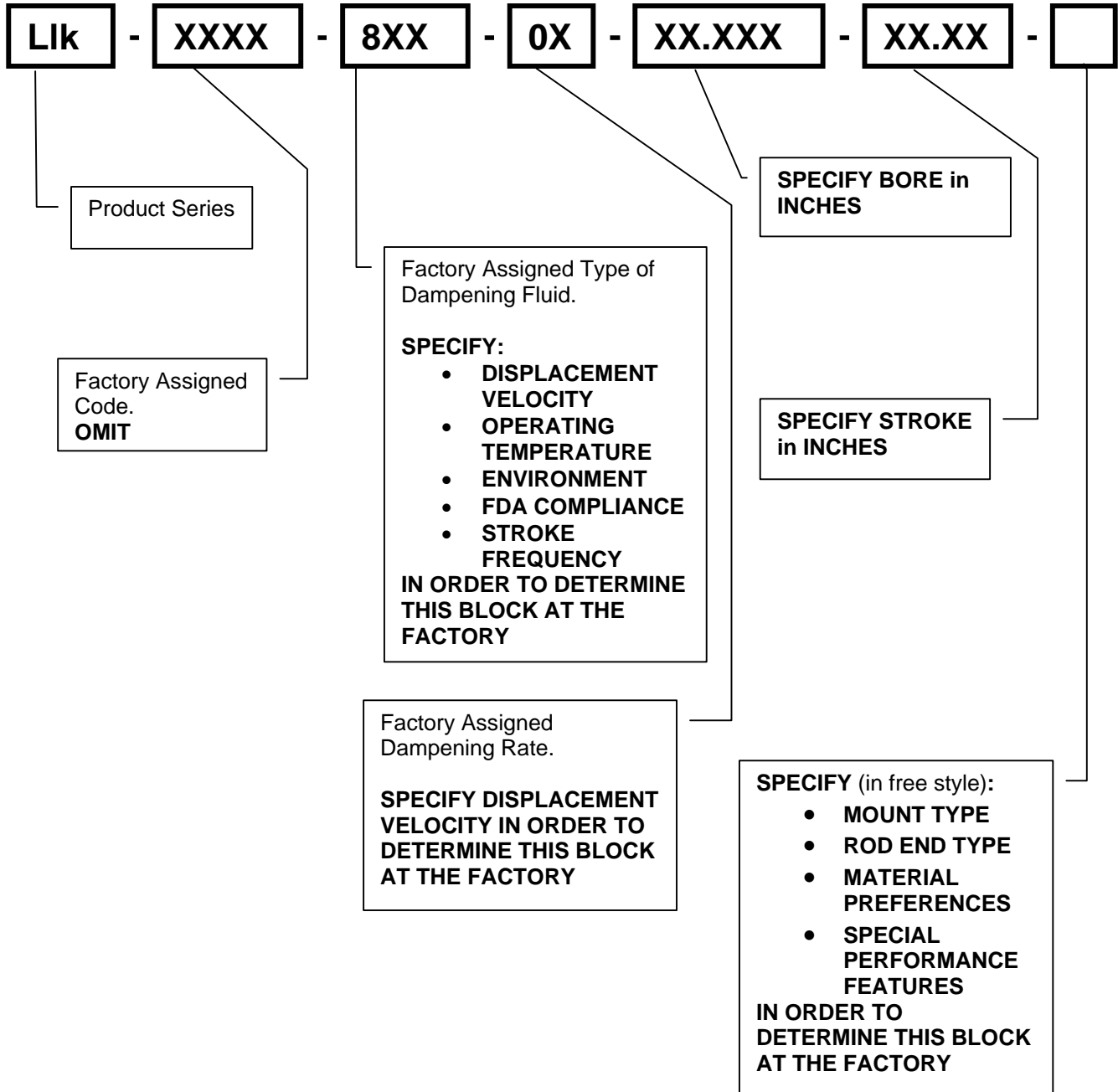
ORDERING INSTRUCTIONS

When ordering, define basic specification parameters including:

- **Bore**
- **Stroke**
- **Operating Pressure**
- **Displacement Velocity**
- **Operating Temperature**
- **Mount Type**
- **Rod End Type**
- **Material Preferences**
- **Special Performance Features**, such as:
 - ✓ **Magnetic Position Detection**
 - ✓ **Non-Rotating**
 - ✓ **Aggressive Environment**
 - ✓ **Submerged Deep Sea Operation**
 - ✓ **Vacuum Operation**
 - ✓ **FDA Compliance**
 - ✓ **Extended Stroke**
 - ✓ **Custom-Shaped**
 - ✓ **Etc.**
- **Quantity**

Consult with the factory to select the model of correct nomenclature or select the correct model using basic principles of nomenclature.

BASIC PRINCIPLES of NOMENCLATURE



WARRANTY

All products are warranted against defects in workmanship and material under normal conditions and usage for a total of 1×10^6 inches of linear displacement or for a period of 2 years from the date of shipment, whichever is earlier in time. The exclusive remedy in the event of such defect is repair, replacement, or refund, at RBHydrodynamics, Inc.'s option. This warranty does not cover products that have been subject to misuse, negligence, accidents, misapplication or tampering in a way so as to affect normal performance. ALL WARRANTIES, EXPRESS OR IMPLIED OTHER THAN THE WARRANTY SPECIFIED ABOVE, ARE EXCLUDED INCLUDING BUT NOT LIMITED TO ANY WARRANTY AS TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AS SOLD, DESCRIPTION, AND QUALITY. RBHydrodynamics, Inc. shall not be liable for special, indirect or consequential damages. RBHydrodynamics, Inc. does not assume, nor authorize anyone else to assume for it, any other obligation or liability in connection with the sale or use of its products. EXCEPT FOR THE EXPRESS WARRANTY SET FORTH ABOVE, RBHYBRODYNAMICS, INC. GRANTS NO OTHER WARRANTIES, EXPRESS OR IMPLIED, BY STATUTE OR OTHERWISE, REGARDING THE PRODUCTS, THEIR FITNESS FOR ANY PURPOSE, THEIR QUALITY, THEIR MERCHANTABILITY, OR OTHERWISE.

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