THE CONTINUING STORY OF LEE COMPANY INNOVATION

For over 60 years, The Lee Company has pioneered the design and development of miniature fluid control components. Since its beginning in 1948, The Lee Company premise has been to economically solve problems where existing hardware is either not immediately available, or is too cumbersome. The Lee Company continues to set the standards for fluid control components through innovations developed at our Technical Centers in Essex and Westbrook, Connecticut.

Electro-Fluidic Systems products are designed and manufactured at our facility in Essex, Connecticut.
PRODUCT GROUPS

Lee is organized into nine product groups or “cells”. Each product group is comprised of its own engineering, manufacturing and sales teams working together to provide better service and products. Quicker responses and deliveries, higher quality, lower costs and product innovations to better solve our customers’ problems are direct benefits of this approach.

The three Electro-Fluidic Systems (EFS) groups produce high quality miniature solenoid valves (general purpose and chemically inert models), high speed micro-dispense valves, atomizing and dispense nozzles, fixed and variable volume pumps, integrated fluidic manifolds, inert tubing and fluid control components and custom engineered designs. These products are used in medical and scientific instrumentation, analytical/clinical chemistry, in vitro diagnostics, drug discovery and ink jet printing applications.

The five “aerospace” product groups supply Lee Plugs, high pressure solenoid valves, single and multi-orifice restrictors, nozzles, safety screens, check valves, relief valves, flow controls and shuttle valves to a wide range of industries. These include hydraulic and pneumatic applications on commercial and military aircraft, spacecraft, missiles, naval vessels, machine tools, downhole oil tools, power generation equipment, race cars, etc.

The Industrial MicroHydraulics (IMH) group supplies Lee Betaplugs, Hi-Performance Cheks and other miniature fluid control components to the automotive, commercial and industrial markets. IMH products meet the requirements for quality, economy and ease of automated installation, which are of paramount importance to these industries.

ENGINEERING

The Lee story of innovation never ends. Ongoing engineering, research and development activities create new products and identify Lee as a company continually advancing the technology of miniature fluid control components.

Our engineering departments have extensive prototype shops and test laboratories. Rigorous in-house qualification test programs ensure our customers receive only fully proven products. Lee is fully committed to CAE/CAD/CAM and sophisticated computer programs enable our engineers to model many aspects of our fluid control components’ performance.

The Lee Company maintains a ratio of one engineer for every seven employees. This commitment to technology allows Lee to offer the best products and technical support available.
MANUFACTURING
The Lee Company has over 700,000 square feet of modern manufacturing and office space at four sites located in Westbrook and Essex, Connecticut. Almost all of the manufacturing of Lee products including machining, molding, assembling and testing is performed in-house at these facilities.

The Essex facility is dedicated to Electro-Fluidic Systems products and is equipped with the latest production equipment, as well as a sophisticated computerized production control system. Equipment and systems are constantly upgraded providing ever smaller and more reliable products.

SPECIAL PRODUCTS
The Lee Company offers many miniature flow control components other than the standard products described in this handbook. In fact, approximately 50% of all Lee products are special or custom items designed to meet the requirements of specific applications.

The Lee Company sales and engineering staffs are eager to help you in solving your fluid control problems with special products that meet your needs. Please contact your local Lee Company sales office or the Technical Center in Westbrook, Connecticut for assistance.

QUALITY ASSURANCE
Quality Assurance at The Lee Company is a management driven system for excellence in product quality and service. The objective of the quality management system is to ensure that our products and services exceed the customer’s quality expectations. The Lee Company’s Electro-Fluidic Systems Division maintains a documented quality management system, including lot control and traceability, designed and implemented to fulfill ISO 9001, regulatory and customer requirements. This system creates a framework for clearly defining the control of materials, processes, and verification activities, thus providing our customers with confidence that the design and manufacture of The Lee Company products are performed in a well defined and controlled environment.

QUALITY POLICY
The Lee Company Electro-Fluidic Systems Division Quality Policy demonstrates our commitment to the highest standards of product quality and reliability as well as continuous improvements of our product and Quality Management system.

Our quality ethic is deployed throughout the organization to continually improve our products, services and methods. We do this to exceed customer expectations, and to deliver a quality, on time product. Through our management system, we are committed to upholding the high standards of quality as well as the safety, education, and well being of our employees and our environment.
The Quality Assurance System is registered to ISO 9001. Our Quality Management System complies with the following specifications:

ISO 13485 ………………………….. Medical Devices: Quality Management Systems, Requirements for Regulatory Purposes
FDA’s 21 CFR Part 820 QSRs ………….. FDA Quality System Regulation; Medical Devices; Current Good Manufacturing Practice (CGMP)
ISO 19011 …………………………… Guidelines for Auditing Management Systems
ISO 10012 …………………………… Requirements for Measurement Processes and Measuring Equipment
ISO 19011 …………………………… Guidelines for Auditing Management Systems
ISO 10012 …………………………… Requirements for Measurement Processes and Measuring Equipment
IPC-610 & 620 …………………………… Acceptability of Electrical Assemblies

Zero Acceptance Number Sampling
Plan, C = 0, ASQC Quality Press ….. Sampling Plan
ANSI/ASQ Z1.4-2003 ……………….. Sampling Procedures and Tables for Inspection By Attributes

Quality Assurance surveys or audits by our customers are welcomed. Source inspection is permitted at The Lee Company in Essex, Connecticut, where most manufacturing is performed. We can also work to special QA specifications required by contract.


SALES AND SERVICE
The Lee Company is committed to full professional service to our customers through a worldwide sales network of graduate engineers. Lee has sales offices in Huntington Beach, San Francisco, Chicago, Detroit, Dallas, Tampa and at the Technical Center in Westbrook, CT. Lee also has wholly owned sales and service subsidiaries in London (Gerrards Cross), Frankfurt, Paris (Voisins-Le-Bretonneux), Milan and Stockholm and is represented in over forty countries.

If you have a fluid control problem and would like to talk to an engineer, or would like product information, please contact the Technical Center, or your local sales office (see pages T7-8).
### Solenoid Valves

**CONTROL**
- LHD Series .... 3-way miniature solenoid valves used to flow air, gas and mild liquids
  - A 1-26
- LFA Series ..... 2 and 3-way general purpose ported solenoid valves used to flow air, gas and mild liquids
  - B 1-14

**DISPENSING**
- VHS Series .... high speed 2-way valves for micro-dispensing
  - C 1-20
- INK Series ..... high speed ink jet printing valves
  - D 1-6

**ISOLATION**
- LFV Series .... 2-way chemically inert valves for aggressive fluids in scientific/analytical instruments and IVD applications
  - E 1-18
- LFR Series .... 3-way chemically inert valves for aggressive fluids in scientific/analytical instruments and IVD applications
  - F 1-16
- LFN Series .... 2-way valves for applications where space and weight are a premium
  - G 1-8
- LFY Series .... 2-way and 3-way, chemically inert valves for use when a “clean flow path” is needed. Low internal volume with zero dead volume.
  - H 1-12

### Pumps

**FIXED VOLUME**
- LPL Series .... solenoid operated fixed volume pumps
  - I 1-10

**VARIABLE VOLUME**
- LPV Series .... stepper motor-driven variable volume pumps
  - J 1-18
Manifolds, Tubing and Accessories

Manifold........... custom manifold capabilities
Technology

MINSTAC ........ miniature inert system
of tubing and components

Nozzles .......... direct dispense and atomizing

Special Products

IEP Series ...... 2-way axial flow valves for high
pressure/temperature applications

120 Series ...... 2-way inline ultra-miniature latching
solenoid valves for air piloting applications

Visco Mixers... Static mixers for HPLC and
other high pressure applications

OV'R Driver .... An electric driver used to enhance
response time or reduce power
consumption

LSP Series ..... 2-way, normally closed, high flow solenoid
valves for applications requiring a particle
tolerant flow path

Engineering Information

General Information

Policies, Proprietary Rights, Patents, Trademarks,
Copyrights, Warranty, Sales Offices
Lee's High Density Interface (LHD Series) Solenoid Valves are designed for applications where space is limited. Featuring small size and light weight without sacrificing performance and reliability, the valves are available in three different styles: plug-in, face mount, and ported. Extended performance versions (Latching, Quiet Operation, Semi-Inert and Lo-Lohm) are also available.

These valves are generally used in medical and scientific instrumentation or control applications such as oxygen delivery systems, gas analysis equipment, patient monitors, air calibration devices, ventilators/respirators, gas chromatography and other flow switching devices. Each valve is 100% functionally tested for switching voltage, flow capacity and leakage. The rugged materials used help ensure consistent long-term performance. The valves will typically operate up to 250 million cycles on air, depending on the seal material and application parameters.
Latching Design
The Latching design is optimized for applications that demand ultra-low power and low heat making it ideal for portable, battery powered instruments. The valves require only momentary (10 ms minimum) pulses of current to switch state resulting in 5.5 millijoule per switch. The polarity of the voltage on the terminal pins controls the switched position.

Quiet Operation Design
The Quiet Operation design uses “whisper technology” to achieve patient comfort. A typical solenoid valve has an inherent clicking sound when energized, which is caused by the metal-to-metal contact of the moving armature and stationary core. With “whisper technology” however, actuation noise is significantly reduced, providing a sound level measurement of less than 37 dBA when measured at a distance of 24 inches and a valve cycle frequency of 10 Hz.

Semi-Inert Design
The Semi-Inert design can handle moderately aggressive gases and liquids in a wide range of fluid handling applications. Featuring a superior perfluoro (FFKM) elastomer seal, this design is also compatible with saline.

Lo-Lohm Design
The Lo-Lohm design offers more flow capacity across an extended pressure range without sacrificing size and weight.

Projected Battery Life for Latching Designs

The Lee Company offers several standard manifolds as valuable aids to the designer during development and initial prototyping.
LHD SERIES
SOLENOID VALVES

Plug-In Style

NOTES: (1) Solenoid valves are available in 5, 12 and 24 vdc configurations.

LHDA__11111H

Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION 5 (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDA__11111H</td>
<td>3-Way</td>
<td>Vac-15 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__11211H</td>
<td>3-Way</td>
<td>Vac-15 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__11311H</td>
<td>3-Way</td>
<td>Vac-15 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__11411H</td>
<td>3-Way</td>
<td>Vac-15 psig (0-15 psid)</td>
<td>550</td>
</tr>
</tbody>
</table>

Unless otherwise specified, dimensions are in inches [mm].
## Plug-In Style

![Diagram of a solenoid valve with parts labeled]

- **Coil**
- **Armature/Plunger Stop**
- **Plunger Head Assembly**
- **Housing**
- **Seal**
- **Shield**
- **Flow Path**
- **Epoxy**

### LHD SERIES SOLENOID VALVES

<table>
<thead>
<tr>
<th>LOHM RATE</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>SI (Seal), FKM (O-ring)</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI (Seal), FKM (O-ring)</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.

(4) Wetted materials are optimized for saline compatibility.

(5) See page A20 for complete electrical characteristics.
# LHD SERIES
## SOLENOID VALVES

### Plug-In Style, Extended Performance

Uns less otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDą.11515H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>850 mW</td>
</tr>
<tr>
<td>LHDą.61215H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>750 mW</td>
</tr>
<tr>
<td>LHDą.60245D</td>
<td>2-Way NC (Common Inlet)</td>
<td>Vac-50 psig (0-50 psid)</td>
<td>550 mW (Hold Power)</td>
</tr>
<tr>
<td>LHDą.60365D</td>
<td>2-Way NO (NO Inlet)</td>
<td>Vac-50 psig (0-50 psid)</td>
<td>550 mW (Hold Power)</td>
</tr>
<tr>
<td>LHLAą.11111H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLAą.11211H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLAą.11311H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLAą.11411H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
</tbody>
</table>

NOTES:
1. Solenoid valves are available in 5, 12 and 24 vdc configurations.
2. Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc
3. Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
4. Refer to Engineering Section, pages S61-62 for material information and abbreviations.
5. Epoxy is used in the valve assembly and therefore considered a wetted material.
Plug-In Style, Extended Performance

![Diagram of LHD Series Solenoid Valves]

**LHD SERIES**

**SOLENOID VALVES**

<table>
<thead>
<tr>
<th>LOHM RATE</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>FFKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy^4</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>450</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>650</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI (Seal), FKM (O-ring)</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI (Seal), FKM (O-ring)</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy^4</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy^4</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(4) Wetted materials are optimized for saline compatibility.
(5) See page A20 for complete electrical characteristics.
(6) This design is intended for air and gas only. It contains a hydrocarbon synthetic oil in the wetted path to reduce actuation noise.
(7) Spike and hold drive required. See page A24 for drive characteristics.
(8) Only available in 5 and 12 vdc hold models.
(9) See page A23 for additional information on latching valves.
Standard Plug-In Style Manifolds

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>DIMENSION &quot;A&quot;</th>
<th>DIMENSION &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFMX0522450B</td>
<td>Manifold, HDI, Plug-In, 1x, Individual Ports</td>
<td>0.75&quot; (19.1 mm)</td>
<td>0.50&quot; (12.7 mm)</td>
</tr>
<tr>
<td>LFMX0510413B</td>
<td>Manifold, HDI, Plug-In, 3x, Individual Ports</td>
<td>1.35&quot; (34.3 mm)</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>LFMX0510418B</td>
<td>Manifold, HDI, Plug-In, 8x, Individual Ports</td>
<td>2.85&quot; (72.4 mm)</td>
<td>2.60&quot; (66.0 mm)</td>
</tr>
<tr>
<td>LFMX0510423B</td>
<td>Manifold, HDI, Plug-In, 3x, Common Header, Individual NC &amp; NO Ports</td>
<td>1.50&quot; (38.1 mm)</td>
<td>1.25&quot; (31.8 mm)</td>
</tr>
<tr>
<td>LFMX0510428B</td>
<td>Manifold, HDI, Plug-In, 8x, Common Header, Individual NC &amp; NO Ports</td>
<td>3.00&quot; (76.2 mm)</td>
<td>2.75&quot; (69.9 mm)</td>
</tr>
<tr>
<td>LFMX0510433B</td>
<td>Manifold, HDI, Plug-In, 3x, NC &amp; NO Header, Individual Common Ports</td>
<td>1.50&quot; (38.1 mm)</td>
<td>1.25&quot; (31.8 mm)</td>
</tr>
<tr>
<td>LFMX0510438B</td>
<td>Manifold, HDI, Plug-In, 8x, NC &amp; NO Header, Individual Common Ports</td>
<td>3.00&quot; (76.2 mm)</td>
<td>2.75&quot; (69.9 mm)</td>
</tr>
</tbody>
</table>

NOTES: (1) Part Numbers are for the manifold only. Secondary retention bracket included. Valves sold separately.
(2) Manifolds are anodized aluminum. A 1x acrylic manifold with individual ports is also available, Part Number LFMX0503800A. Contact The Lee Company for additional information.

Refer to Manifold Technology (Section K) for custom design capabilities.
Standard Plug-In Style Manifolds

Individual Ports

Normally Open and Normally Closed Header, Individual Common Ports

Common Header, Individual Normally Open and Normally Closed Ports

Unless otherwise specified, dimensions are in inches [mm].
LHD SERIES
SOLENOID VALVES

Face Mount Style

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION ⁵ (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDA__2111H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__2121H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__2131H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA__2141H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA0523112H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA0523212H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA0523312H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA0523412H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA__2311H⁶</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA__2321H⁶</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA__2331H⁶</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA__2341H⁶</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
</tbody>
</table>

NOTES: (1) Solenoid valves are available in 5, 12 and 24 vdc configurations.

LHDA__2111H

Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc
### Face Mount Style

**Part Number**

<table>
<thead>
<tr>
<th>LOHM RATE</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy(^4)</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy(^4)</td>
<td>316 SS</td>
</tr>
<tr>
<td>1200</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1200</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1200</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy(^4)</td>
<td>316 SS</td>
</tr>
<tr>
<td>1200</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy(^4)</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy(^4)</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.

Epoxy is used in the valve assembly and therefore considered a wetted material.

(4) Wetted materials are optimized for saline compatibility.

(5) See page A20 for complete electrical characteristics.

(6) Available in 12 and 24 vdc configurations only.
# LHD SERIES
## SOLENOID VALVES

### Face Mount Style, Extended Performance

![Diagram of Face Mount Style, Extended Performance]

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION ⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDA__21515H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>850 mW</td>
</tr>
<tr>
<td>LHDA__71215H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>750 mW</td>
</tr>
<tr>
<td>LHDA__70290D</td>
<td>2-Way NC (Common Inlet)</td>
<td>Vac-50 psig (0-50 psid)</td>
<td>550 mW (Hold Power)</td>
</tr>
<tr>
<td>LHLA__21111H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLA__21211H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLA__21311H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHLA__21411H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
</tbody>
</table>

### NOTES:
1. Solenoid valves are available in 5, 12 and 24 vdc configurations.
   - LHDA__21515H
   - Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc

2. Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
3. Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.
**Face Mount Style, Extended Performance**

![Diagram](image)

<table>
<thead>
<tr>
<th>LOHM RATE</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>FFKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>900</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(4) Wetted materials are optimized for saline compatibility.
(5) See page A20 for complete electrical characteristics.
(6) This design is intended for air and gas only. It contains a hydrocarbon synthetic oil in the wetted path to reduce actuation noise.
(7) Spike and hold drive required. See page A24 for drive characteristics. Only available in 5 and 12 vdc hold models.
(8) See page A23 for additional information on latching valves.
## Standard Face Mount Style Manifolds

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>DIMENSION &quot;A&quot;</th>
<th>DIMENSION &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFMX0507200A</td>
<td>Manifold, HDI, Face Mount, 1x, Individual Ports</td>
<td>0.44&quot; (11.2 mm)</td>
<td>0.30&quot; (7.6 mm)</td>
</tr>
<tr>
<td>LFMX0510513B</td>
<td>Manifold, HDI, Face Mount, 3x, Individual Ports</td>
<td>1.35&quot; (34.3 mm)</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>LFMX0510518B</td>
<td>Manifold, HDI, Face Mount, 8x, Individual Ports</td>
<td>2.86&quot; (72.6 mm)</td>
<td>2.59&quot; (65.8 mm)</td>
</tr>
<tr>
<td>LFMX0510523B</td>
<td>Manifold, HDI, Face Mount, 3x, Common Header, Individual NC &amp; NO Ports</td>
<td>1.51&quot; (38.4 mm)</td>
<td>1.29&quot; (32.8 mm)</td>
</tr>
<tr>
<td>LFMX0510528B</td>
<td>Manifold, HDI, Face Mount, 8x, Common Header, Individual NC &amp; NO Ports</td>
<td>3.02&quot; (76.7 mm)</td>
<td>2.79&quot; (70.9 mm)</td>
</tr>
<tr>
<td>LFMX0510533B</td>
<td>Manifold, HDI, Face Mount, 3x, NC &amp; NO Header, Individual Common Ports</td>
<td>1.55&quot; (39.4 mm)</td>
<td>1.28&quot; (32.5 mm)</td>
</tr>
<tr>
<td>LFMX0510538B</td>
<td>Manifold, HDI, Face Mount, 8x, NC &amp; NO Header, Individual Common Ports</td>
<td>3.05&quot; (77.5 mm)</td>
<td>2.78&quot; (70.6 mm)</td>
</tr>
</tbody>
</table>

NOTES: (1) Part Numbers are for the manifold only. Valves and mounting hardware sold separately. See page A25 for mounting hardware part numbers.

(2) Manifolds are anodized aluminum.

Refer to Manifold Technology (Section K) for custom design capabilities.
Standard Face Mount Style Manifolds

Individual Ports

Normally Open and Normally Closed Header, Individual Common Ports

Common Header, Individual Normally Open and Normally Closed Ports

Unless otherwise specified, dimensions are in inches [mm].
**Soft Tube Ported Style**

*Unless otherwise specified, dimensions are in inches [mm].*

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION ⁵ (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDA.__31115H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA.__31215H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA.__31315H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA.__31415H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>550</td>
</tr>
<tr>
<td>LHDA.__33115H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA.__33215H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA.__33315H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
<tr>
<td>LHDA.__33415H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-30 psid)</td>
<td>750</td>
</tr>
</tbody>
</table>

`Soft Tube Ported Valve is designed for use with soft (flexible) 1/16" ID tubing.`

**NOTES:** (1) Solenoid valves are available in 5, 12 and 24 vdc configurations.

LHDA.__31115H

Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc
LHD SERIES
SOLENOID VALVES

**Soft Tube Ported Style**

<table>
<thead>
<tr>
<th>LOHM RATE</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1500</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>302 SS</td>
</tr>
<tr>
<td>1500</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.

(4) Wetted materials are optimized for saline compatibility.

(5) See page A20 for complete electrical characteristics.
# LHD SERIES

## SOLENOID VALVES

### Soft Tube Ported Style, Extended Performance

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>MODEL</th>
<th>OPERATING PRESSURE</th>
<th>POWER CONSUMPTION 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHDA__31515H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>850 mW</td>
</tr>
<tr>
<td>LHDA__81215H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>750 mW</td>
</tr>
<tr>
<td>LHDA__31111H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHDA__31211H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHDA__31311H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
<tr>
<td>LHDA__31411H</td>
<td>3-Way</td>
<td>Vac-45 psig (0-15 psid)</td>
<td>5.5 mJ per Switch</td>
</tr>
</tbody>
</table>

**Soft Tube Ported Valve is designed for use with soft (flexible) 1/16” ID tubing.**

**NOTES:**
1. Solenoid valves are available in 5, 12 and 24 vdc configurations. LHDA__31515H
   - Coil Voltage: 05 = 5 vdc / 12 = 12 vdc / 24 = 24 vdc
2. Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
# LHD SERIES SOLENOID VALVES

## Soft Tube Ported Style, Extended Performance

![Diagram of SOLENOID VALVES](image)

<table>
<thead>
<tr>
<th>LOHM RATE ²</th>
<th>SEAL MATERIAL</th>
<th>HOUSING</th>
<th>PLUNGER HEAD</th>
<th>ARMATURE/PLUNGER STOP</th>
<th>SPRING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>FFKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1500</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>430 SS</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>FKM</td>
<td>PBT</td>
<td>PPA</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
<tr>
<td>1100</td>
<td>SI</td>
<td>PBT</td>
<td>PPS</td>
<td>FeCr Alloy⁴</td>
<td>316 SS</td>
</tr>
</tbody>
</table>

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.

(4) Wetted materials are optimized for saline compatibility.

(5) See page A20 for complete electrical characteristics.

(6) This design is intended for air and gas only. It contains a hydrocarbon synthetic oil in the wetted path to reduce actuation noise.

(7) See page A23 for additional information on latching valves.
GENERAL SPECIFICATIONS

The following specifications apply to all LHD Series valves, unless otherwise noted.

Leakage
Maximum of 50 µL/minute of air at 70°F with 5 psig applied to the common port.

Internal Volume
- Plug-In: 40 µL
- Face Mount: 72 µL
- Soft Tube Ported: 77 µL

Weight
The valves weigh only 4 grams.

Life Expectancy
The valves will typically operate up to 250 million cycles on air, depending on the seal material and application parameters.

Operating Pressure
The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%. The normally closed port seal is spring loaded, so the pressure applied to this port should not exceed the pressure on the common port or the normally open port unless otherwise indicated.

- Valve Proof Pressure: 2X Normal Rated Pressure
- Valve Burst Pressure: 3X Normal Rated Pressure

Operating Temperature
- Ambient operating temperature range is 40°F to 120°F (4°C to 49°C).

<table>
<thead>
<tr>
<th>MEAN POWER (mW)</th>
<th>INTERNAL SELF-HEATED COIL TEMPERATURE AT 100% DUTY, 72°F AMBIENT ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>550</td>
<td>165°F (74°C)</td>
</tr>
<tr>
<td>750</td>
<td>185°F (85°C)</td>
</tr>
<tr>
<td>850</td>
<td>195°F (90°C)</td>
</tr>
</tbody>
</table>

- Increasing the operating temperature tends to limit coil performance. The valve duty cycle and energized time must be evaluated for conformance with the maximum recommended operating and coil temperatures.
- Maximum internal coil temperature not to exceed 250°F (121°C).

Storage Conditions (Recommended)
- Temperature: –40°F to 175°F (–40°C to 80°C)
- Relative humidity: 85% max., non-condensing

Coil Type (DC)
- LHD Series: Electrical connection can be made without regard to polarity.
- LHL Series: Polarity must be taken into consideration to switch the valve from state to state. See page A23.
Response Time

- Typical response times in milliseconds are as follows:

<table>
<thead>
<tr>
<th>FLUID</th>
<th>MEAN POWER (mW)</th>
<th>@ RATED VOLTAGE (10 psig)</th>
<th>ENERGIZE</th>
<th>DE-ENERGIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>550</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>850</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>550</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>750</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>850</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

- Response times can be enhanced with the use of high speed drive circuits. Refer to Engineering Section, page S38.
- The Quiet Operation design will have a slightly slower response time due to the damping operation.
- Response times are dependent upon system conditions, power input, environment, etc.

Port Connections

The tube ports are designed for soft, flexible 1/16" ID tubing.

Mounting Information

Surface mount valves use #2 socket head cap screws. Refer to inspection drawings for torque specification.

Filtration

Filtration of 35 microns or finer is recommended.

Electrical Characteristics

The following chart describes the basic electrical characteristics for the LHD Series valves at room temperature. Refer to Engineering Section, pages S35-43 for special drive circuits.

<table>
<thead>
<tr>
<th>POWER AT RATED VOLTAGE (mW)</th>
<th>VOLTAGE (vdc)</th>
<th>COIL RESISTANCE (ohms)</th>
<th>INDUCTANCE (mh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>550</td>
<td>5</td>
<td>46</td>
<td>30</td>
</tr>
<tr>
<td>550</td>
<td>12</td>
<td>262</td>
<td>155</td>
</tr>
<tr>
<td>550</td>
<td>24</td>
<td>1042</td>
<td>665</td>
</tr>
<tr>
<td>750</td>
<td>5</td>
<td>33</td>
<td>20</td>
</tr>
<tr>
<td>750</td>
<td>12</td>
<td>193</td>
<td>130</td>
</tr>
<tr>
<td>750</td>
<td>24</td>
<td>766</td>
<td>460</td>
</tr>
<tr>
<td>850</td>
<td>5</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>850</td>
<td>12</td>
<td>170</td>
<td>70</td>
</tr>
<tr>
<td>850</td>
<td>24</td>
<td>675</td>
<td>340</td>
</tr>
</tbody>
</table>
VALVE MOUNTING DETAILS
(Drawings are not drawn to scale)

Plug-In
(Boss Cutting Tool, Lee Part Number TTTA0000180B)

Reference Drawing Number LCFX0300100B for Installation Hole Specification Details

Face Mount

Reference Drawing Number LFIX1001150A for Face Mount Boss Specification Details

Unless otherwise specified, dimensions are in inches [mm].
Typical Flow Characteristics
(LHD Series Valves)

Water Flow (ml/min)

Air Flow (slpm)

Differential Pressure (psid)

Differential Pressure (kPad)

0 200 400 600 800 1000

0 200 400 600 800 1000

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28

0 50 100 150 200

0 200 400 600 800 1000

0 1000 1500 2000

1500 Lohms
1300 Lohms
1100 Lohms
900 Lohms
650 Lohms
550 Lohms
450 Lohms

Differential Pressure (psid)

Differential Pressure (kPad)
Latching Valve (LHL Series)
Reference Information

The LHL Series magnetic latching valves are optimized for applications that demand ultra-low power (5.5 mJ per switch) and low heat making the valves ideal for portable, battery powered devices. The flow direction of a latching valve will switch to and remain in the direction indicated when a 10 ms pulse (min) is applied with the voltage and polarity as indicated in the table below. Refer to Engineering Section pages S41-43 for recommended driver circuit schematic. Specific pin terminal designations for each configuration are shown in the drawings below.

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>TERMINAL</th>
<th>VALVE STATE / FLOW DIRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage Return</td>
<td>1</td>
<td>Port A – Common Flow</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Rated Voltage Return</td>
<td>2</td>
<td>Port B – Common Flow</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Pin Terminal Designations

Plug-In Style

![Plug-In Style Diagram]

Face Mount Style

![Face Mount Style Diagram]

Ported Style

![Ported Style Diagram]
The Lo-Lohm design offers more flow capacity across an extended pressure range without sacrificing size and weight. A spike and hold voltage drive is required to achieve the extended flow performance with differential pressure ranges up to 50 psid. Please refer to the table below for porting specifications as well as spike actuation and hold voltage requirements at 50 psid. Spike voltage requirements for lower differential pressure operating ranges are shown in the graph below.

<table>
<thead>
<tr>
<th>STYLE</th>
<th>CONFIGURATION</th>
<th>PORTING</th>
<th>PART NUMBER</th>
<th>SPIKE ACTUATION VOLTAGE (10 to 25 ms @ 50 psid) (vdc)</th>
<th>HOLD VOLTAGE (vdc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug-In</td>
<td>2-Way NC</td>
<td>Common Inlet</td>
<td>LHDA0560245D</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2-Way NO</td>
<td>NO Inlet</td>
<td>LHDA1260245D</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>2-Way NC</td>
<td>Common Inlet</td>
<td>LHDA0560365D</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2-Way NO</td>
<td>NO Inlet</td>
<td>LHDA1260365D</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>Face Mount</td>
<td>2-Way NC</td>
<td>Common Inlet</td>
<td>LHDA0570290D</td>
<td>19</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2-Way NO</td>
<td>NO Inlet</td>
<td>LHDA1270290D</td>
<td>45</td>
<td>12</td>
</tr>
</tbody>
</table>

Spike Actuation Voltage vs. Differential Pressure

![Graph showing spike actuation voltage vs. differential pressure](image-url)
## General Accessories / Replacement Parts

<table>
<thead>
<tr>
<th>STYLE</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug-In</td>
<td>LHWX0218030A</td>
<td>Replacement O-ring (FKM)</td>
</tr>
<tr>
<td></td>
<td>LHDX0526050A</td>
<td>Boss Plug (POM with FKM O-rings)</td>
</tr>
<tr>
<td></td>
<td>TTTA0000180B</td>
<td>Boss Cutting Tool</td>
</tr>
<tr>
<td>Face Mount</td>
<td>LHWX0218000A</td>
<td>Gasket (SI)</td>
</tr>
<tr>
<td></td>
<td>LHWX0218010A</td>
<td>Gasket (FKM)</td>
</tr>
<tr>
<td></td>
<td>LLWX0218170A</td>
<td>Gasket (FFKM)</td>
</tr>
<tr>
<td></td>
<td>LHDX0307130A</td>
<td>Mounting Screw Support-2x, PBT</td>
</tr>
<tr>
<td></td>
<td>LHDX0307140A</td>
<td>Mounting Screw Support-1x, PBT</td>
</tr>
<tr>
<td></td>
<td>LHWX0503100A</td>
<td>Screw, Socket Head Cap, 0.086&quot; (#2)-56 x 0.375&quot; SS</td>
</tr>
<tr>
<td>Ported</td>
<td>LHWX0213420A¹</td>
<td>Screw, Socket Head Cap, 0.086&quot; (#2)-56 x 0.438 (7/16) SS</td>
</tr>
<tr>
<td>Universal (Plug-In, Face Mount, &amp; Ported)</td>
<td>LHWX0320090A</td>
<td>Port Plug</td>
</tr>
<tr>
<td></td>
<td>LHWX0503100A</td>
<td>Screw, Socket Head Cap, 0.086&quot; (#2)-56 x 0.375&quot; SS</td>
</tr>
<tr>
<td></td>
<td>LTTA0300000A</td>
<td>Installation/Extraction Tool</td>
</tr>
<tr>
<td></td>
<td>LHWX0605450A</td>
<td>Electrical Lead-Wire Connector</td>
</tr>
</tbody>
</table>

**NOTES:** (1) Required for use with mounting screw support (recommended).
NOTES
LFA Series
The Lee Interface Fluidic (LFA Series) Solenoid Valves offer small size and light weight, without sacrificing performance. Designed for applications where space is limited, these valves are generally used for medical and scientific applications flowing air or gas, such as blood chemistry instruments, ventilators/respirators, gas analysis equipment, blood pressure monitors and various other flow switching devices.

LFA Series valves are available as a 2-way (normally closed) or 3-way soft tube ported design with two electrical connection options; printed circuit board mount or lead-wires. The following general performance characteristics are offered in this product platform:

- Operating Pressures up to 30 psig
- Power Consumption as Low as 280 mW
- Response Times as Fast as 1.5 ms
- Low Internal Volume
- Standard Voltages Available: 5, 9, 12, 24 vdc
- Several Lohm Rates: 1000 to 1800

Each valve is 100% functionally tested for switching voltage, flow capacity, and leakage. Rugged materials are used to ensure consistent long-term performance. The valves will typically operate up to 200 million cycles on air, depending on the seal material and application parameters.
2-Way N.C. Ported Style with Lead Wires

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>PORT OUTER DIAMETER</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (mW)</th>
<th>LOHM RATE ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFAA__00218H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA__01518H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA__07018H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA__00210H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA__01510H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA__07010H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1000</td>
</tr>
</tbody>
</table>

NOTES: (1) Most solenoid valves are available in 5, 9, 12 and 24 vdc configurations.

LFAA__00218H

Coil Voltage: 05 = 5 vdc / 09 = 9 vdc
12 = 12 vdc / 24 = 24 vdc
2-Way N.C. Ported Style with Lead Wires

![Diagram showing components of a 2-way N.C. ported style solenoid valve with lead wires.]

### WETTED MATERIALS

<table>
<thead>
<tr>
<th>HOUSING</th>
<th>ARMATURE</th>
<th>CORE</th>
<th>SPRING</th>
<th>ELASTOMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>316 SS</td>
<td>EPDM</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>316 SS</td>
<td>EPDM</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.
(4) See page B12 for complete electrical characteristics.
2-Way N.C. Ported Style with Circuit Board Mounts

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>PORT OUTER DIAMETER</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (mW)</th>
<th>LOHM RATE ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFAA_03218H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_03518H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_03210H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_03510H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 7</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_09512H</td>
<td>.080&quot; (2.03 mm)</td>
<td>Vac – 30 (0-10 psid)</td>
<td>780</td>
<td>1200</td>
</tr>
</tbody>
</table>

**NOTES:** (1) Most solenoid valves are available in 5, 9, 12 and 24 vdc configurations.

LFAA_03218H

Coil Voltage: 05 = 5 vdc / 09 = 9 vdc
12 = 12 vdc / 24 = 24 vdc
2-Way N.C. Ported Style with Circuit Board Mounts

WETTED MATERIALS

<table>
<thead>
<tr>
<th>HOUSING</th>
<th>ARMATURE</th>
<th>CORE</th>
<th>SPRING</th>
<th>ELASTOMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.
(4) See page B12 for complete electrical characteristics.
# LFA SERIES
## SOLENOID VALVES

### 3-Way Ported Style with Lead Wires

```
2X .42 [10.5]
.47 [11.9]

[Diagram of a 3-way ported style solenoid valve with lead wires]
```

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>PORT OUTER DIAMETER</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (mW)</th>
<th>LOHM RATE ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFAA_00110H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1000 1300</td>
</tr>
<tr>
<td>LFAA_00310H</td>
<td>.080&quot; (2.03 mm)</td>
<td>12-18</td>
<td>490</td>
<td>1000 1300</td>
</tr>
<tr>
<td>LFAA_01410H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1000 1300</td>
</tr>
<tr>
<td>LFAA_01810H</td>
<td>.080&quot; (2.03 mm)</td>
<td>12-18</td>
<td>490</td>
<td>1000 1300</td>
</tr>
<tr>
<td>LFAA_07110H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1000 1300</td>
</tr>
<tr>
<td>LFAA_00118H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1800 1800</td>
</tr>
<tr>
<td>LFAA_00318H</td>
<td>.054&quot; (1.37 mm)</td>
<td>12-18 (Charge Vent)</td>
<td>490</td>
<td>1800 1800</td>
</tr>
<tr>
<td>LFAA_01418H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1800 1800</td>
</tr>
<tr>
<td>LFAA_01818H</td>
<td>.054&quot; (1.37 mm)</td>
<td>12-18 (Charge Vent)</td>
<td>490</td>
<td>1800 1800</td>
</tr>
<tr>
<td>LFAA_07118H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1800 1800</td>
</tr>
</tbody>
</table>

NOTES: (1) Most solenoid valves are available in 5, 9, 12 and 24 vdc configurations.

LFAA_00110H

Coil Voltage: 05 = 5 vdc / 09 = 9 vdc
               12 = 12 vdc / 24 = 24 vdc
### 3-Way Ported Style with Lead Wires

![Diagram of 3-Way Ported Style with Lead Wires]

#### Wetted Materials

<table>
<thead>
<tr>
<th>Housing</th>
<th>Armature</th>
<th>Core</th>
<th>Spring</th>
<th>Elastomer</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>316 SS</td>
<td>EPDM</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>316 SS</td>
<td>EPDM</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.

(4) See page B12 for complete electrical characteristics.
LFA SERIES  
SOLENOID VALVES

3-Way Ported Style with Circuit Board Mounts

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>PORT OUTER DIAMETER</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (mW)</th>
<th>LOHM RATE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>C-N.C.</td>
</tr>
<tr>
<td>LFAA_03110H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_03310H</td>
<td>.080&quot; (2.03 mm)</td>
<td>12-18 (Charge Vent)</td>
<td>490</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_03410H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_03810H</td>
<td>.080&quot; (2.03 mm)</td>
<td>0 – 10</td>
<td>490</td>
<td>1000</td>
</tr>
<tr>
<td>LFAA_03118H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_03318H</td>
<td>.054&quot; (1.37 mm)</td>
<td>12-18 (Charge Vent)</td>
<td>490</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_03418H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>280</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_03818H</td>
<td>.054&quot; (1.37 mm)</td>
<td>0 – 10</td>
<td>490</td>
<td>1800</td>
</tr>
<tr>
<td>LFAA_09415H</td>
<td>.080&quot; (2.03 mm)</td>
<td>Vac – 30 (0 - 10 psid)</td>
<td>780</td>
<td>1200</td>
</tr>
</tbody>
</table>

NOTES: (1) Most solenoid valves are available in 5, 9, 12 and 24 vdc configurations.

Coil Voltage: 05 = 5 vdc  /  09 = 9 vdc  
12 = 12 vdc  /  24 = 24 vdc
3-Way Ported Style with Circuit Board Mounts

WETTED MATERIALS

<table>
<thead>
<tr>
<th>HOUSING</th>
<th>ARMATURE</th>
<th>CORE</th>
<th>SPRING</th>
<th>ELASTOMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>CR</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
<tr>
<td>PBT</td>
<td>430 SS</td>
<td>430 SS</td>
<td>302 SS</td>
<td>SI</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations. Epoxy is used in the valve assembly and therefore considered a wetted material.
(4) See page B12 for complete electrical characteristics.
GENERAL SPECIFICATIONS
The following specifications apply to all LFA Series valves, unless otherwise noted.

Leakage
Maximum of 50 µL/minute of air at 70°F with 5 psig applied to the common port.

Internal Volume

<table>
<thead>
<tr>
<th>2-WAY PORTED STYLE</th>
<th>3-WAY PORTED STYLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.054&quot; Port Ø</td>
<td>0.080&quot; Port Ø</td>
</tr>
<tr>
<td>82 µL</td>
<td>93 µL</td>
</tr>
<tr>
<td>0.054&quot; Port Ø</td>
<td>0.080&quot; Port Ø</td>
</tr>
<tr>
<td>99 µL</td>
<td>118 µL</td>
</tr>
</tbody>
</table>

Weight
The valves weigh only 11 grams.

Life Expectancy
The valves will typically operate up to 200 million cycles on air, depending on the seal material and application parameters.

Operating Pressure
- Normal Pressure Range: The valves will operate within the normal pressure range when supplied with the rated voltage ± 5%. The normally closed port seal is spring loaded, so the pressure applied to this port should not exceed the pressure on the common port or the normally open port (except for charge vent valves) by more than 8 psid (55 kPa).
- Extended Pressure Range: The valves can operate in the extended pressure range if higher voltage is applied. Up to 1.6 times rated voltage may be used continuously for 280 mW models. Up to 1.25 times the rated voltage may be used continuously with 490 mW models. The 780 mW valves should not be operated continuously above rated voltage.

Refer to the Operating Pressure chart below for extended pressures.
Valve Proof Pressure: 30 psig (207 kPa)
Valve Burst Pressure: 100 psig (690 kPa)

<table>
<thead>
<tr>
<th>VALVE TYPE</th>
<th>NORMAL PRESSURE RANGE</th>
<th>EXTENDED PRESSURE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Way NC</td>
<td>8 psia (vacuum) to 7 psig pressure (21.7 psia)</td>
<td>1.5 psia (vacuum) to 20 psig pressure (34.7 psia)</td>
</tr>
<tr>
<td>3-Way</td>
<td>5 psia (vacuum) to 10 psig pressure (24.7 psia)</td>
<td>1.5 psia (vacuum) to 30 psig pressure (44.7 psia)</td>
</tr>
</tbody>
</table>

Operating Temperature
- Ambient operating temperature range is 40°F to 120°F (4°C to 49°C).

<table>
<thead>
<tr>
<th>MEAN POWER (mW)</th>
<th>TEMP. RISE AT 100% DUTY 72°F AMBIENT</th>
<th>MAX. AMBIENT TEMPERATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100% DUTY</td>
<td>75% - 0% DUTY</td>
</tr>
<tr>
<td>280</td>
<td>30°F (17°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>490</td>
<td>45°F (25°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>780</td>
<td>55°F (30°C)</td>
<td>110°F (43°C)</td>
</tr>
</tbody>
</table>

- Increasing the operating temperature tends to limit coil performance. The valve duty cycle and energize time must be evaluated for conformance with the maximum recommended operating and coil temperatures. This is most important when operating in the extended range.
Response Time

- Typical response times in milliseconds are as follows:

<table>
<thead>
<tr>
<th>FLUID</th>
<th>@ RATED VOLTAGE</th>
<th>@ 3X RATED VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENERGIZE</td>
<td>DE-ENERGIZE</td>
</tr>
<tr>
<td>Air</td>
<td>4.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Water</td>
<td>10.0</td>
<td>13.5</td>
</tr>
</tbody>
</table>

- Response times can be enhanced with the use of high speed drive circuits. Refer to Engineering Section, page S38.

Port Connections

The tube ports are straight 0.054" (1.37 mm) or 0.080" (2.03 mm) in diameter, and are designed for PVC or other soft tubing.

Mounting Information

- Surface mount valves use #2 or 2 mm screws allowing 0.42" (10.7 mm) of screw length for valve thickness. Torque screws to 15 in-oz (0.11 N-m) maximum. Nylon screws, Part Number LHWX0203300A, are available to prevent valve damage from over-torquing.
- Printed circuit board mounting is available on select models per the Valve Selection Charts. See page B14 for mounting sockets.
- 0.500" (121.7 mm) minimum center to center mounting distance is recommended.

Filtration

Filtration of 35 microns or finer is recommended.

Electrical Characteristics

The following chart describes the basic electrical characteristics for the LFA Series valves. Refer to Engineering Section, pages S35-43 for special drive circuits.
Typical Flow Characteristics
(LFA Series Valves)
## General Accessories / Replacement Parts

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFFA4202035A</td>
<td>Filter, 35 Micron</td>
</tr>
<tr>
<td>LHWX0204550A</td>
<td>PC Board Socket, 0.040&quot; Dia. Pins</td>
</tr>
<tr>
<td>LHWX0203300A</td>
<td>Screw, #2 x 5/8&quot;, Nylon</td>
</tr>
<tr>
<td>LHWX0203770A</td>
<td>Screw, #2 x 1&quot;, Nylon</td>
</tr>
<tr>
<td>LHWX0503010A</td>
<td>Screw, Socket Head, #2 x 1/4&quot;, SS</td>
</tr>
<tr>
<td>LHWX0203530A</td>
<td>Plastic Coil Clip with Pressure Sensitive Adhesive</td>
</tr>
</tbody>
</table>
The Lee VHS valves are high speed, 2-way solenoid operated valves designed for applications requiring microliter and nanoliter dispense volumes. These applications include high throughput screening and drug discovery.

The VHS valves feature:

- High speed operation: up to 1200 Hz
- Long life: 250 million cycles minimum
- Fast response: some models as fast as 0.25 ms
- Operating pressures up to 120 psi
- Wide range of seal materials

The VHS Series valves are offered in numerous porting and mounting configurations:

- 062 MINSTAC for use with Teflon® tubing
- 1/32" barb for use with soft push on tubing
- Manifold mounting
- Direct dispense outlet (precision jeweled orifice)
- Small outlet ports

Lee also offers a variety of accessories such as nozzles and safety screens to further enhance the valve's operation.

Standard materials and configurations are shown on the following pages. The Lee Company can also customize valves to meet specific application requirements.
VHS M/M valves are designed for use with 062 MINSTAC fittings. Easy connections to Teflon tubing can be made on the inlet port and nozzles can be threaded directly into the outlet port (see Section M).

- Flow restriction: 4750 Lohms (Cv = 0.004)
- Weight: 1.8 grams
- Internal Volume: 40 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

### PART NUMBER SUMMARY

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKX0511400A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0514300A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0511850A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0517500A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0516350A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0514100A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0507900A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
<tr>
<td>INKX0507950A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
</tbody>
</table>

NOTES: (1) Refer to page C17 for complete electrical characteristics.
VHS M/P valves are designed for use with 062 MINSTAC fittings on the inlet port, allowing easy connections to Teflon tubing. The outlet port is designed for 1/32" ID soft (flexible) tubing which can be connected to a downstream 0.050" OD Hypo Tube nozzle. The flexible connection permits the nozzles to be placed closer than the valve center to center mounting.

- Flow restriction: 4750 Lohms \((Cv = 0.004)\)
- Weight: 1.8 grams
- Internal Volume: 35 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (^1) (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKX0511950A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0514750A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0519850A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0508200A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0512700A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0516450A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0508250A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
<tr>
<td>INKX0508300A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
</tbody>
</table>

NOTES: (1) Refer to page C17 for complete electrical characteristics.
062 MINSTAC Inlet / Small Port Outlet (M/SP)

VHS M/SP valves are designed for use with 062 MINSTAC fittings on the inlet port, allowing easy connections to Teflon tubing. The outlet port may be used for direct dispensing. For greater accuracy, a nozzle may be connected to the outlet using soft tubing (see Section M).

- Flow restriction: 11,000 Lohms (Cv = 0.001)
- Weight: 1.8 grams
- Internal Volume: 35 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

### Table: Specifications

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKX0514900A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0514950A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>120</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0514650A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0508350A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>120</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0516200A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0516250A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0516100A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
<tr>
<td>INKX0508400A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>120</td>
<td>SI</td>
</tr>
</tbody>
</table>

**NOTES:** (1) Refer to page C17 for complete electrical characteristics.
VHS P/M valves are designed for use with 1/32" ID soft (flexible) tubing on the inlet port. The 062 MINSTAC outlet boss allows for the use of threaded nozzles. Nozzles are easily interchanged to allow for different dispense ranges, or for cleaning (see Section M).

- Flow restriction: 4750 Lohms (Cv = 0.004)
- Weight: 1.8 grams
- Internal Volume: 35 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

VHS SERIES
SOLENOID VALVES

**Standard Port Inlet / 062 MINSTAC Outlet (P/M)**

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INXX0514800A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INXX0514850A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INXX0508000A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INXX0508050A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INXX0515000A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INXX0515050A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INXX0508100A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
<tr>
<td>INXX0508150A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
</tbody>
</table>

NOTES: (1) Refer to page C17 for complete electrical characteristics.
VHS P/P valves are designed for use with 1/32" ID soft (flexible) tubing. This allows nozzles to be placed closer than the actual valve center to center distance. Separate nozzles allow for fine tuning of the dispense volume range (see Section M).

- Flow restriction: 4750 Lohms (Cv = 0.004)
- Weight: 1.8 grams
- Internal Volume: 30 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION ¹ (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA1224212H</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKA2424212H</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0508450A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0514550A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0511900A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0516550A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0508500A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
<tr>
<td>INKX0508550A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
</tbody>
</table>

NOTES: (1) Refer to page C17 for complete electrical characteristics.
VHS SERIES
SOLENOID VALVES

VHS P/SP valves are designed for use with 1/32" ID soft (flexible) tubing on the inlet port. The outlet port can be used for direct dispensing. If smaller volumes and greater accuracy is desired, jeweled nozzles can be attached to the valve with tubing (see Section M). This allows nozzles to be placed closer than the actual valve center to center distance.

- Flow restriction: 11000 Lohms (Cv = 0.001)
- Weight: 1.8 grams
- Internal Volume: 30 microliters
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Epoxy

### Standard Port Inlet / Small Port Outlet (P/SP)

```
[Diagram]
```

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>MAXIMUM HOLD VOLTAGE (vdc)</th>
<th>RECOMMENDED HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE HOLD DURATION (ms)</th>
<th>PRESSURE (psig)</th>
<th>SEAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA1226212H</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKA2426212H</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.35</td>
<td>10</td>
<td>EPDM</td>
</tr>
<tr>
<td>INKX0508600A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0508650A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FKM</td>
</tr>
<tr>
<td>INKX0507000A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0516500A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.5</td>
<td>10</td>
<td>FFKM</td>
</tr>
<tr>
<td>INKX0508700A</td>
<td>12</td>
<td>2.3</td>
<td>1.6</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
<tr>
<td>INKX0508750A</td>
<td>24</td>
<td>4.5</td>
<td>3.2</td>
<td>0.25</td>
<td>10</td>
<td>SI</td>
</tr>
</tbody>
</table>

NOTES: (1) Refer to page C17 for complete electrical characteristics.
MINSTAC direct dispense valves are available in two different styles (LT and VJ), both allowing repeatable direct dispensing from the valve without the need for an additional nozzle. The 062 MINSTAC inlet port allows the valve to be used with Teflon® tubing and the Lee 062 MINSTAC Fitting System.

The LT style has a sapphire orifice plate and incorporates an internal pressure compensation bladder. This allows the droplet to retain its integrity longer and travel further. The VJ style does not have a pressure bladder. This reduces the throw distance slightly, but makes the valve easier to flush.
## 062 MINSTAC Inlet Port / Direct Dispense Outlet

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>STYLE</th>
<th>ORIFICE DIAMETER</th>
<th>SEAL MATERIAL</th>
<th>LOHMS</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA2435010H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>SI/BUTYL</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2455010H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>SI/BUTYL</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2475010H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>SI/BUTYL</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2435210H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>EPDM/BUTYL</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2455210H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>EPDM/BUTYL</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2475210H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>EPDM/BUTYL</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2435110H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>FKM/BUTYL</td>
<td>110,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2455110H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>FKM/BUTYL</td>
<td>50,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2475110H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>FKM/BUTYL</td>
<td>21,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2435510H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>FFKM/BUTYL</td>
<td>110,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2455510H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>FFKM/BUTYL</td>
<td>50,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2475510H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>FFKM/BUTYL</td>
<td>21,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2436010H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>SI</td>
<td>110,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2456010H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>SI</td>
<td>50,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2476010H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>SI</td>
<td>21,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2436210H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>EPDM</td>
<td>110,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2456210H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>EPDM</td>
<td>50,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2476210H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>EPDM</td>
<td>21,000</td>
<td>0.35</td>
<td>120</td>
</tr>
<tr>
<td>INKA2436110H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>FKM</td>
<td>110,000</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>INKA2456110H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>FKM</td>
<td>50,000</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>INKA2476110H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>FKM</td>
<td>21,000</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>INKA2436510H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>FFKM</td>
<td>110,000</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>INKA2456510H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>FFKM</td>
<td>50,000</td>
<td>0.5</td>
<td>120</td>
</tr>
<tr>
<td>INKA2476510H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>FFKM</td>
<td>21,000</td>
<td>0.5</td>
<td>120</td>
</tr>
</tbody>
</table>

- Weight: 1.8 grams
- Internal Volume: LT Style: 35 µL  
  VJ Style: 60 µL
- Pulse Voltage: 24 vdc
- Hold Voltage: 7.5 vdc (maximum), 5.0 vdc (recommended)
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Sapphire, Epoxy
Ported direct dispense valves are available in two different styles (LT and VJ), both allowing repeatable direct dispensing from the valve without the need for an additional nozzle. The 0.05" diameter inlet port is designed for use with 1/32" ID soft tubing.

The LT style has a sapphire orifice plate and incorporates an internal pressure compensation bladder. This allows the droplet to retain its integrity longer and travel further. The VJ style does not have a pressure bladder. This reduces the throw distance slightly, but makes the valve easier to flush.
Standard Inlet Port / Direct Dispense Outlet

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>STYLE</th>
<th>ORIFICE DIAMETER</th>
<th>SEAL MATERIAL</th>
<th>LOHMS</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA2437010H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>SI/BUTYL</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2457010H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>SI/BUTYL</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2477010H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>SI/BUTYL</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2437210H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>EPDM/BUTYL</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2457210H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>EPDM/BUTYL</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2477210H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>EPDM/BUTYL</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2437110H</td>
<td>LT</td>
<td>0.003” (0.076 mm)</td>
<td>FKM/BUTYL</td>
<td>110,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2457110H</td>
<td>LT</td>
<td>0.005” (0.127 mm)</td>
<td>FKM/BUTYL</td>
<td>50,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2477110H</td>
<td>LT</td>
<td>0.007” (0.178 mm)</td>
<td>FKM/BUTYL</td>
<td>21,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2438010H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>SI</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2458010H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>SI</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2478010H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>SI</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2438210H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>EPDM</td>
<td>110,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2458210H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>EPDM</td>
<td>50,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2478210H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>EPDM</td>
<td>21,000</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>INKA2438110H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>FKM</td>
<td>110,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2458110H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>FKM</td>
<td>50,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2478110H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>FKM</td>
<td>21,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2438510H</td>
<td>VJ</td>
<td>0.003” (0.076 mm)</td>
<td>FFKM</td>
<td>110,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2458510H</td>
<td>VJ</td>
<td>0.005” (0.127 mm)</td>
<td>FFKM</td>
<td>50,000</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>INKA2478510H</td>
<td>VJ</td>
<td>0.007” (0.178 mm)</td>
<td>FFKM</td>
<td>21,000</td>
<td>0.5</td>
<td>30</td>
</tr>
</tbody>
</table>

- Weight: 1.8 grams
- Internal Volume: LT Style: 30 µL  
  VJ Style: 55 µL
- Pulse Voltage: 24 vdc
- Hold Voltage: 7.5 vdc (maximum), 5.0 vdc (recommended)
- Wetted materials (in addition to seal): Stainless Steel, PEEK, PPS, Sapphire, Epoxy
Manifold Mount VHS Valves

VHS Series valves with standard or small outlet ports can be manifold mounted. This allows precise, controlled injection of fluids directly into flow streams. The outlet port is placed in close proximity to the flow stream, minimizing captive capillary volumes and increasing the accuracy of the volume of the fluid injected.

Single and multiple valve manifolds are available in PEEK and acrylic. Boss plugs are also available to allow for future system expansion.

A detailed machining drawing for the installation hole (INIX0500050A) is available to assist in the manufacturing of custom manifolds or in-house drawings.

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>KIT</th>
<th>KIT PART NUMBER</th>
<th>REPLACEMENT FERRULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Port (0.050&quot; dia)</td>
<td>IKTX03222170A</td>
<td>IHWX0306020A</td>
</tr>
<tr>
<td>Small Port (0.020&quot; dia)</td>
<td>IKTX0322200A</td>
<td>IHWX0306040A</td>
</tr>
<tr>
<td>Manifold Plug</td>
<td>IKTX0322190A</td>
<td>IHWX0306260A</td>
</tr>
</tbody>
</table>
MANIFOLD CONFIGURATIONS

Unless otherwise specified, dimensions are in inches [mm].

062 MINSTAC Connection Ports

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>MANIFOLD MATERIAL</th>
<th>NUMBER OF VALVES</th>
<th>LENGTH &quot;L&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>INMA0602310B</td>
<td>PEEK</td>
<td>1</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>INMA0602320B</td>
<td>PEEK</td>
<td>2</td>
<td>1.73&quot; (43.9 mm)</td>
</tr>
<tr>
<td>INMA0602330B</td>
<td>PEEK</td>
<td>3</td>
<td>2.35&quot; (59.7 mm)</td>
</tr>
<tr>
<td>INMA0602340B</td>
<td>PEEK</td>
<td>4</td>
<td>2.98&quot; (75.7 mm)</td>
</tr>
<tr>
<td>INMA0601310B</td>
<td>PMMA</td>
<td>1</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>INMA0601320B</td>
<td>PMMA</td>
<td>2</td>
<td>1.73&quot; (43.9 mm)</td>
</tr>
<tr>
<td>INMA0601330B</td>
<td>PMMA</td>
<td>3</td>
<td>2.35&quot; (59.7 mm)</td>
</tr>
<tr>
<td>INMA0601340B</td>
<td>PMMA</td>
<td>4</td>
<td>2.98&quot; (75.7 mm)</td>
</tr>
</tbody>
</table>

1/4-28 Flat Bottom Boss

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>MANIFOLD MATERIAL</th>
<th>NUMBER OF VALVES</th>
<th>LENGTH &quot;L&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>INMA0602410B</td>
<td>PEEK</td>
<td>1</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>INMA0602420B</td>
<td>PEEK</td>
<td>2</td>
<td>1.73&quot; (43.9 mm)</td>
</tr>
<tr>
<td>INMA0602430B</td>
<td>PEEK</td>
<td>3</td>
<td>2.35&quot; (59.7 mm)</td>
</tr>
<tr>
<td>INMA0602440B</td>
<td>PEEK</td>
<td>4</td>
<td>2.98&quot; (75.7 mm)</td>
</tr>
<tr>
<td>INMA0601410B</td>
<td>PMMA</td>
<td>1</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>INMA0601420B</td>
<td>PMMA</td>
<td>2</td>
<td>1.73&quot; (43.9 mm)</td>
</tr>
<tr>
<td>INMA0601430B</td>
<td>PMMA</td>
<td>3</td>
<td>2.35&quot; (59.7 mm)</td>
</tr>
<tr>
<td>INMA0601440B</td>
<td>PMMA</td>
<td>4</td>
<td>2.98&quot; (75.7 mm)</td>
</tr>
</tbody>
</table>
VHS Hard Seat Valves

VHS Hard Seat Valves replace the elastomeric seals with a precision zirconia ball and seat. These valves offer precise, repeatable, non-contact dispensing in the nanoliter and microliter range. They are well suited for DMSO and other fluids that negatively react with elastomers.

- High Speed Operation
- Fluid Applications Only
- Wetted Materials
  - Configuration A and B: Stainless Steel, PEEK, TZP
  - Configuration C: Stainless Steel, PEEK, TZP, Sapphire
- 2 way, Normally Closed Operation
- Available in 12 and 24 vdc models (spike and hold circuit required)
- Inlet ports: 062 MINSTAC
- Outlet ports
  - 062 MINSTAC for connection of nozzles or tubing (Configuration A)
  - 0.05" O.D. port for use with flexible tubing or direct dispensing (Configuration B)
  - Jeweled orifice for direct dispensing (Configuration C)
- Weight: 1.8 grams

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>CONFIGURATION</th>
<th>OUTLET PORT</th>
<th>LOHM RATE</th>
<th>INTERNAL VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA__83410H</td>
<td>A</td>
<td>062 MINSTAC</td>
<td>6250</td>
<td>40 µL</td>
</tr>
<tr>
<td>INKA__03410H</td>
<td>B</td>
<td>0.05&quot; O.D. port</td>
<td>5000</td>
<td>37 µL</td>
</tr>
<tr>
<td>INKA__43410H</td>
<td>C</td>
<td>0.004&quot; I.D. jewel</td>
<td>60,000</td>
<td>35 µL</td>
</tr>
<tr>
<td>INKA__53410H</td>
<td>C</td>
<td>0.005&quot; I.D. jewel</td>
<td>35,000</td>
<td>35 µL</td>
</tr>
<tr>
<td>INKA__73410H</td>
<td>C</td>
<td>0.0075&quot; I.D. jewel</td>
<td>15,400</td>
<td>35 µL</td>
</tr>
</tbody>
</table>

NOTES:
1. Solenoid valves available in 12 and 24 vdc configurations.
2. Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
Configuration A

Configuration B

Configuration C

Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS
The following specifications apply to all VHS Series solenoid valves, unless otherwise noted.

**Cycle Life**
VHS valves will operate for a minimum of 250 million cycles on water. Flow media and system conditions may affect performance.

Standard VHS valves are designed for operation on liquids. For air or gas operations, contact The Lee Company for special models.

**Electrical Characteristics**
The VHS valves require a spike and hold signal for proper operation. This will prevent damage to the coil.

Spike and hold drive circuit modules are available (IECX0501350A) for use with VHS valves. See page C20 for complete starter kit.

A schematic for a "typical" spike and hold drive circuit (H-wave) can be found in the Engineering Section, page S37.

There is no polarity associated with the valve pins.

<table>
<thead>
<tr>
<th></th>
<th>STANDARD 12 VOLT COIL</th>
<th>STANDARD 24 VOLT COIL</th>
<th>DIRECT DISPENSE 24 VOLT COIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (ohms)</td>
<td>10.6</td>
<td>40</td>
<td>110</td>
</tr>
<tr>
<td>Inductance: energized (mH)</td>
<td>3.6</td>
<td>16</td>
<td>38</td>
</tr>
<tr>
<td>Inductance: de-energized (mH)</td>
<td>2.8</td>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

**Operating Pressure**
- Valves are designed to operate within the normal ranges listed in this handbook.
  - Proof Pressure ...... 2 x normal operating pressure
  - Burst Pressure ...... 3 x normal operating pressure
- Special higher pressure valves can be designed. Contact The Lee Company for specifications.
Operating Temperature
- Ambient operating temperature range is 40°F - 120°F (4°C - 49°C)
- Maximum outside coil temperature not to exceed 150°F (66°C)
- Increasing the operating temperature tends to limit coil performance. Coil temperature is influenced by current and environmental factors such as self-heating, ambient temperature and heat dissipation (heat sinks, active cooling, fluid flow, etc.)
- Special high temperature valves are available

Response Time
- VHS Series valves require a spike and hold drive circuit (H-wave) to operate properly. Failure to reduce the spike voltage will result in damage to the valve. Schematics for these circuits can be found in the Engineering section, page S37.

Purging
- Valves must be free of air (purged) for optimum dispensing performance. This may require a static and/or dynamic purge. Please contact The Lee Company if assistance is needed.

Filtration
System filtration of 12 microns is recommended. In addition, last chance safety screens are available that thread directly into valves with MINSTAC inlet ports. These are last chance screens and are not intended to replace system filters. Improper filtration can result in damage to the valve (leakage) due to contamination of the sealing surface. Refer to MINSTAC Section, pages L52-53.
Accessories

Electrical Connectors
The VHS Series valves use 0.025" electrical pins on 0.100" centers. Standard electrical connectors that fit these dimensions can be used. Lee also offers pre-made lead assemblies.

8": IHWX0248010A
24": IHWX0248120A

Electrical Pin Bending Tool
The Pin Bending Tool (IHWX0256010A) allows the end user to, as the name suggests, bend the electrical pins on VHS Series valves. The tool is intended for prototype work and limited initial production. The Lee Company can provide special part numbers for OEM applications requiring bent pins.

Safety Screens
Proper system filtration is critical for the operation of any valve. Lee offers “last chance safety screens” which can be placed directly inline with the valve to prevent stray particles from damaging the valve. They are not meant to act as system filters or replace proper filtration. The screens are available in male to male and male to female configurations. Refer to Engineering Section, pages L52-53 for details.
Nozzles
For optimum dispensing, VHS valves should be used with separate nozzles. Lee offers a full line of threaded 062 MINSTAC nozzles, straight ported nozzles and atomizing nozzles. See Section M for details.

Starter Kits
Lee offers a VHS Starter Kit for micro dispensing (Part Number IKTX0322000A). This kit provides all of the specialized hardware to set up and run a small dispensing system. The user needs to provide a pressurized fluid source, control signal and power supply. The kit includes:

- High speed dispensing valve (Part Number INXX0514300A)
- Spike / hold electrical driver (Part Number IECX0501350A)
- 3 precision dispensing nozzles
- Atomizing nozzle (Part Number INZX0550050A)
- MINSTAC tubing assembly and components
- Safety screen
- Lead wire assembly (Part Number IHWX0248010A)
- Instructional CD
The Lee Company is the world leader in providing ink jet valves for drop on demand, large character printing. Featuring high speed, repeatability and long life, the INK Series valves are ideal for a replacement to existing printers or in new drop on demand and dispensing applications.

- Two mounting styles: Axial Pin and PC Board
- 275 Hz and 600 Hz models
- Low power consumption
- Long life, 250 million cycles minimum
PC Board Mount

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>AVERAGE POWER (W)</th>
<th>MAX. FREQUENCY (Hz)</th>
<th>SEAL MATERIAL¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA1202028D</td>
<td>12</td>
<td>3.6</td>
<td>0.65</td>
<td>0.78</td>
<td>275</td>
<td>SI</td>
</tr>
<tr>
<td>INKA2402028D</td>
<td>24</td>
<td>7.7</td>
<td>0.65</td>
<td>0.78</td>
<td>275</td>
<td>SI</td>
</tr>
<tr>
<td>INKA4002028D</td>
<td>40</td>
<td>12</td>
<td>0.65</td>
<td>0.78</td>
<td>275</td>
<td>SI</td>
</tr>
<tr>
<td>INKA1202160D</td>
<td>12</td>
<td>5</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
<tr>
<td>INKA2402160D</td>
<td>24</td>
<td>10</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
<tr>
<td>INKA4002160D</td>
<td>40</td>
<td>16</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
</tbody>
</table>

NOTE: (1) Wetted materials (in addition to seal): stainless steel, PBT and epoxy
Axial Pin Mount

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>HOLD VOLTAGE (vdc)</th>
<th>MIN. SPIKE DURATION (ms)</th>
<th>AVERAGE POWER (W)</th>
<th>MAX. FREQUENCY (Hz)</th>
<th>SEAL MATERIAL¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>INKA1205160D</td>
<td>12</td>
<td>5</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
<tr>
<td>INKA2405160D</td>
<td>24</td>
<td>10</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
<tr>
<td>INKA4005160D</td>
<td>40</td>
<td>16</td>
<td>0.9</td>
<td>1.02</td>
<td>600</td>
<td>FKM</td>
</tr>
</tbody>
</table>

NOTE: (1) Wetted materials (in addition to seal): stainless steel, PBT and epoxy
GENERAL SPECIFICATIONS

The following specifications apply to all INK Series valves, unless otherwise noted.

Life Expectancy
The valves will typically operate for a minimum of 250 million cycles on water. Typical life exceeds 500 million on water.

Operating pressure
- Pressure range: vac-10 psig. Pressure exceeding 10 psi will reduce the valve operating speed.
- Valve proof pressure: 20 psi
- Valve burst pressure: 30 psi

Operating Temperature
- Ambient operating temperature range: 40°F to 120°F (4°C to 49°C)
- Maximum coil temperature: 150°F (66°C)
- Increasing operating temperature tends to limit coil performance.
- Valve duty cycle and energized time must be evaluated for conformance with the maximum recommended operating temperature and coil temperature.

Response Time
INK Series valves require a spike and hold drive circuit (refer to Engineering Section, page S37) to attain rated speeds. Maximum frequency for INK valves is based on the “voltage spike duration” and the use of high speed drive circuits.

Filtration
Filtration of 35 microns or finer is recommended. Contact The Lee Company for additional technical assistance and application information.
**Port connections**

- INK Series valves are designed for use with soft, flexible tubing. The dispensed droplet is affected by the length of tubing used in the system. Tubing stiffness, I.D., O.D. and chemical compatibility must be considered during system design.

- Lee offers 0.042” I.D., PVC tubing for use with INK Series valves (Part Number TUVA4220900A).

**Electrical Characteristics**

“Spike voltage” is the voltage required to actuate the valve. Spike voltage can be applied for a limited time (several milliseconds) depending on conditions. Longer on-times require the voltage to be reduced to the “holding voltage”. Failure to do so will cause permanent damage to the valve.

High speed drive circuits are necessary to achieve the maximum operating frequency (refer to Engineering Section, pages S37-S38).

A spike and hold driver (Part Number IECX0501350A) is also available.

**Electrical Connections**

- PV275 valves are designed for PC board mounting.

- 600LT valves are provided with .025” sq. pins that are .200” apart (lead wire adapter: Part Number IHWX0248020A). PC board mounting is also available.
LFV Series

LFV SERIES
SOLENOID VALVES
The LFV Series is a family of 2-way isolation valves, featuring bi-directional flow and a contoured flow path which allows complete flushing. This contoured flow path also minimizes damage to “delicate” fluids. The small internal volume reduces the amount of fluid needed to fill the system (transport volume) further reducing sample and reagent requirements. LFV valves are optimized for applications in analytical instruments, biotechnology and IVD devices.

- Standard and Low Pressure Models Available
- 30 ms Response Time
- Operating Life of 10 Million Cycles Minimum
- Standard Operating Pressures up to 30 psid (Higher Pressures Available as Custom Designs)
- Low Power Consumption
- 12 and 24 vdc Models
- Low Internal Volume
- Zero Dead Volume
- Multiple Porting Options
- Manifold Mountable
## LFV SERIES
### SOLENOID VALVES

### 1/4-28 Port Style

![Diagram of 1/4-28 Port Style](image)

### Table of Specifications

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFVA __ 30213H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 31213H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 32213H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 30113H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 31113H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 32113H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 30313H</td>
<td>Lead Wire</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 31313H</td>
<td>Pin</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 32313H</td>
<td>Pin with locking end cap</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 30413H</td>
<td>Lead Wire</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 31413H</td>
<td>Pin</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 32413H</td>
<td>Pin with locking end cap</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### Notes:
1. Solenoid valves are available in 12 and 24 vdc configurations.

### Coil Voltage:
- 12 = 12 volts
- 24 = 24 volts
**LFV SERIES**
**SOLENOID VALVES**

**1/4-28 Port Style**

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>LOHM RATE² (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS ³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,300 (0.015)</td>
<td>43</td>
<td>25</td>
<td>FFKM / PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
062 MINSTAC Port Style

PART NUMBER ¹ | ELECTRICAL CONNECTION | OPERATING PRESSURE (psig) | POWER CONSUMPTION (W)
--- | --- | --- | ---
LFVA _ _ 10220H | Lead Wire | Vac - 30 | 1.5
LFVA _ _ 11220H | Pin | Vac - 30 | 1.5
LFVA _ _ 12220H | Pin with locking end cap | Vac - 30 | 1.5
LFVA _ _ 10120H | Lead Wire | Vac - 30 | 1.5
LFVA _ _ 11120H | Pin | Vac - 30 | 1.5
LFVA _ _ 12120H | Pin with locking end cap | Vac -30 | 1.5
LFVA _ _ 10320H | Lead Wire | 1 - 30 | 1.5
LFVA _ _ 11320H | Pin | 1 - 30 | 1.5
LFVA _ _ 12320H | Pin with locking end cap | 1 - 30 | 1.5
LFVA _ _ 10420H | Lead Wire | Vac - 20 | 1.5
LFVA _ _ 11420H | Pin | Vac - 20 | 1.5
LFVA _ _ 12420H | Pin with locking end cap | Vac - 20 | 1.5

NOTES: (1) Solenoid valves are available in 12 and 24 vdc configurations.

LFVA _ _ 10220H

Coil Voltage: 12 = 12 volts
24 = 24 volts
Lohm Rate (Cv) | Internal Volume (µL) | Weight (g) | Wetted Materials
--- | --- | --- | ---
2,000 (0.010) | 11 | 24 | EPDM / PEEK
2,000 (0.010) | 11 | 24 | EPDM / PEEK
2,000 (0.010) | 11 | 24 | EPDM / PEEK
2,000 (0.010) | 11 | 24 | FKM / PEEK
2,000 (0.010) | 11 | 24 | FKM / PEEK
2,000 (0.010) | 11 | 24 | FKM / PEEK
2,000 (0.010) | 11 | 24 | FFKM / PEEK
2,000 (0.010) | 11 | 24 | FFKM / PEEK
2,000 (0.010) | 11 | 24 | FFKM / PEEK
2,000 (0.010) | 11 | 24 | FFKM / PEEK

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.

Unless otherwise specified, dimensions are in inches [mm].
## LFV SERIES
### SOLENOID VALVES

#### Flange Style

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFVA ____ 50210H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 51210H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 52210H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 50110H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 51110H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 52110H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 50310H</td>
<td>Lead Wire</td>
<td>1 - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 51310H</td>
<td>Pin</td>
<td>1 - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 52310H</td>
<td>Pin with locking end cap</td>
<td>1 - 30</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 50410H</td>
<td>Lead Wire</td>
<td>Vac - 20</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 51410H</td>
<td>Pin</td>
<td>Vac - 20</td>
<td>1.4</td>
</tr>
<tr>
<td>LFVA ____ 52410H</td>
<td>Pin with locking end cap</td>
<td>Vac - 20</td>
<td>1.4</td>
</tr>
</tbody>
</table>

NOTES: (1) Solenoid valves are available in 12 and 24 vdc configurations.

---

Coil Voltage: 12 = 12 volts
24 = 24 volts
Flange Style

![Diagram of Flange Style Valve Components]

- Coil
- Housing
- Shield
- Armature/Plunger Stop
- Seal
- Flow Path

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>LOHM RATE(^2) (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>21</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
(4) See page E17 for mounting boss details.
**LFV SERIES SOLENOID VALVES**

**Barbed Port Style**

2X BARBED PORT Ø .093 [2.4] FOR USE WITH .062 [1.6] I.D. SOFT TUBING

2X MOUNTING HOLES Ø .098 [2.5]

2X LEADS #26 AWG 6.0 [152.4] LONG

2X CONTACT PINS Ø .025 [0.64] .33 [8.4] MAX. LONG

**NOTE:** (1) Solenoid valves are available in 12 and 24 vdc configurations.

**PART NUMBER 1**

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFVA ___ 20210H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 21210H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 22210H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 20110H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 21110H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 22110H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 20310H</td>
<td>Lead Wire</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 21310H</td>
<td>Pin</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 22310H</td>
<td>Pin with locking end cap</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 20410H</td>
<td>Lead Wire</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 21410H</td>
<td>Pin</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA ___ 22410H</td>
<td>Pin with locking end cap</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
</tbody>
</table>

NOTES: (1) Solenoid valves are available in 12 and 24 vdc configurations.

LFVA ___ 20210H

Coil Voltage: 12 = 12 volts
24 = 24 volts
**Barbed Port Style**

Unless otherwise specified, dimensions are in inches \( [\text{mm}] \).

<table>
<thead>
<tr>
<th>LOHM RATE(^2) (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1,000 (0.020)</td>
<td>43</td>
<td>24</td>
<td>FFKM / PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
## LFV SERIES
### SOLENOID VALVES

**Coupling Screw Style**

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFVA __ 40120H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 41220H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 42220H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 40120H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 41120H</td>
<td>Pin</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 42120H</td>
<td>Pin with locking end cap</td>
<td>Vac - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 40320H</td>
<td>Lead Wire</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 41320H</td>
<td>Pin</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 42320H</td>
<td>Pin with locking end cap</td>
<td>1 - 30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 40420H</td>
<td>Lead Wire</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 41420H</td>
<td>Pin</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
<tr>
<td>LFVA __ 42420H</td>
<td>Pin with locking end cap</td>
<td>Vac - 20</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**NOTES:**
1. Solenoid valves are available in 12 and 24 vdc configurations.

   **LFVA __ 40120H**
   
   **Coil Voltage:**
   - 12 = 12 volts
   - 24 = 24 volts
### Coupling Screw Style

![Diagram of Coupling Screw Style]

*Unless otherwise specified, dimensions are in inches [mm].*

<table>
<thead>
<tr>
<th>LOHM RATE&lt;sup&gt;2&lt;/sup&gt;</th>
<th>INTERNAL VOLUME</th>
<th>WEIGHT</th>
<th>WETTED MATERIALS&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Cv)</td>
<td>(µL)</td>
<td>(g)</td>
<td></td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>2,000 (0.010)</td>
<td>21</td>
<td>26</td>
<td>FFKM / PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.

(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.

(4) See page E17 for mounting boss details.
## Standard Manifolds

<table>
<thead>
<tr>
<th>STYLE</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
<th>LENGTH &quot;A&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PEEK</td>
<td>PMMA</td>
<td></td>
</tr>
<tr>
<td>Coupling Screw</td>
<td>LSMX0517010B</td>
<td>LSMX0517020B</td>
<td>1 valve</td>
</tr>
<tr>
<td></td>
<td>LFMX0514100B</td>
<td>LFMX0514300B</td>
<td>3 valve</td>
</tr>
<tr>
<td></td>
<td>LFMX0514200B</td>
<td>LFMX0514400B</td>
<td>8 valve</td>
</tr>
<tr>
<td>Flange</td>
<td>N/A</td>
<td>LSMX0502400B</td>
<td>1 valve</td>
</tr>
<tr>
<td></td>
<td>LSMX0503600B</td>
<td>LSMX0502360B</td>
<td>2 valve</td>
</tr>
<tr>
<td></td>
<td>LSMX0503610B</td>
<td>LSMX0502370B</td>
<td>3 valve</td>
</tr>
<tr>
<td></td>
<td>LSMX0503620B</td>
<td>LSMX0502380B</td>
<td>4 valve</td>
</tr>
<tr>
<td></td>
<td>LSMX0503630B</td>
<td>LSMX0502390B</td>
<td>5 valve</td>
</tr>
</tbody>
</table>

**NOTES:** (1) Part Numbers are for the manifold only. Valves sold separately. Refer to Manifold Technology *(Section K)* for custom design capabilities.

## Manifold Accessories

<table>
<thead>
<tr>
<th>STYLE</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange Mount</td>
<td>LSWX0208050A</td>
<td>Standard Gasket (FFKM)</td>
</tr>
<tr>
<td>Coupling Screw</td>
<td>LHWX0208750A</td>
<td>Standard Gasket (FFKM)</td>
</tr>
</tbody>
</table>
Coupling Screw Style

- Dimensions: .75 [19.1] MAX
- 2X MOUNTING HOLES: Ø.146 [3.7] THRU
- LEE FLAT BOTTOM PLUG (.250-28 UNF)

Flange Style

- Dimensions: .35 [8.9]
- 2X MOUNTING HOLES: Ø.11 [2.8] THRU
- FLAT BOTTOM BOSS (.250-28 UNF-2B)

FLOW SCHEMATIC

Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS

The following specifications apply to all LFV Series valves, unless otherwise noted.

Life Expectancy

The valves will typically operate for a minimum of 10 million cycles on water.

Operating Pressure

- The valves will operate within the normal pressure range when supplied with the rated voltage +/- 5%.

  Valve Proof Pressure: 2x normal operating pressure
  Valve Burst Pressure: 3x normal operating pressure

Operating Temperature

- As the ambient temperature decreases, the valve’s response time will increase. Contact The Lee Company for lower temperature applications.

- Maximum solenoid coil temperature is 220°F (104°C)

- Increasing the operating temperature tends to limit coil performance. The valve duty cycle and energized time must be evaluated for conformance with the maximum recommended operating and coil temperatures.

- Minimum and maximum ambient operating temperatures are dependent on the elastomer selection. Lower temperatures will increase the response time needed. If the temperature is too low, the valves may fail to open (ref. chart below for temperature ranges of the 3 elastomers). For applications with temperatures below those listed, please contact The Lee Company.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>MINIMUM</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPDM</td>
<td>30°F (1°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>FKM</td>
<td>40°F (4°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>FFKM</td>
<td>70°F (21°C)</td>
<td>120°F (49°C)</td>
</tr>
</tbody>
</table>

Response Time

- Typical response time is 30 ms maximum at 68°F (20°C), 2 Hz, air at 10 psig.

- Response times can be enhanced with the use of high speed drive circuits. Refer to Engineering Section, page S38.
Filtration

Filtration of 35 microns or finer is recommended.

Electrical Connections

The LFV coils are not polarized and therefore can be connected to the power in either direction. There are three different styles of electrical connections:

- **Lead wires**: Valves are supplied with 6", #26 AWG lead wires. The ends are stripped and tinned. Electrical connectors can be added as specials.

- **Pins**: Valves are supplied with two 0.025" square electrical pins. The pins are spaced 0.20" apart and will work with standard electrical connectors designed for 0.10" spacing.

- **Pins with Locking End Caps**: These are similar to pins, but a secondary retention clip has been added. These will work with AMP 104257-2 style connectors. The Lee Company offers compatible lead wire sets in two different lengths:
  - 6" lead wire set: Part Number LSWX0504300A
  - 24" lead wire set: Part Number LSWX0606700A

Electrical Characteristics

- Standard operating voltages are 12 and 24 vdc ±5%.

- For power consumption, see valve selection charts on pages E3-12.

- Holding voltage is 50% of operating voltage.

- Refer to Engineering Section, pages S36-43 for special drive circuits.

Port Connections

Several different port (fluid) connections are available.

- **Tubed Valves**: Mount valves using #2 (2 mm) mounting screws. 0.052" of screw length is required in addition to the length of the thread on the mounting plate. Screws should be torqued to a maximum of 15 in-oz.

- **Manifold Mounted Valves (flange mount style)**: Mount valves using two #2 (2 mm) mounting screws. Screws should be evenly torqued to 15 in-oz max. See page E17 for manifold mounting details.

- **Manifold Mounted Valves (coupling screw style)**: The coupling screw should be tightened to 60-120 in-oz. See page E17 for manifold mounting details.
VALVE MANIFOLD MOUNTING DETAILS

Flange Mount Boss

Reference Drawing Number LSIX1001100A

Coupling Screw Boss

Reference Drawing Number LSIX1000850A

Unless otherwise specified, dimensions are in inches [mm].
FLOW vs PRESSURE

Typical Water Flow Characteristics (LFV Series Valves)

Differential Pressure (psi) vs Flow Rate (mL/min)

- 2000 Ohms
- 1300 Ohms
- 1000 Ohms

Differential Pressure (kPa)
LFR Series
The LFR Series Micro Inert Valves (MIV) are 3-way inert solenoid valves designed for applications demanding high flow and small size. The different mounting combinations and porting options allow the designer the highest degree of freedom available.

- As Low as 700 Lohms
- Pressure Range: 28 in. Hg Vac - 30 psig
- 30 ms Response Time
- 10 Million Cycles Minimum
- Power Consumption: 1.6 Watts
- 12 and 24 Volt Models
- Available with EPDM, FKM, or FFKM Diaphragm
- PEEK Porthead on all Models
- Manifold Mount, Barbed, and 1/4-28 Flat Bottom Boss Available
Barbed Port Style

NOTES: (1) Solenoid valves are available in 12 and 24 vdc configurations.

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFRA__20270D</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__22270D</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__20170D</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__22170D</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__20370D</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__22370D</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
</tbody>
</table>

NOTES: (1) Solenoid valves are available in 12 and 24 vdc configurations.

LFRA__20270D

Coil Voltage: 12 = 12 volts
24 = 24 volts
### Barbed Port Style

![Diagram of Barbed Port Style](image)

- **Coil**
- **Armature/Plunger Stop**
- **Housing**
- **Seal**
- **Shield**
- **Flow Path**

Unless otherwise specified, dimensions are in inches [mm].

| LOHM RATE \(^2\)  
\( (Cv) \) | INTERNAL VOLUME \( (\mu L) \) | WEIGHT \( (g) \) | WETTED MATERIALS \(^3\) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>FFKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>150</td>
<td>27</td>
<td>FFKM/PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
(4) See page F14 for complete electrical characteristics.
**LFR SERIES**

**SOLENOID VALVES**

### 1/4-28 Port Style

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFRA__30210H</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__32210H</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__30110H</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__32110H</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__30310H</td>
<td>Lead Wire</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA__32310H</td>
<td>Pin w/ Locking End Cap</td>
<td>28 in. Hg Vac - 30</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**NOTES:** (1) Solenoid valves are available in 12 and 24 vdc configurations. LFRA__30210H

Coil Voltage:  
12 = 12 volts  
24 = 24 volts
**1/4-28 Port Style**

![Diagram of 1/4-28 Port Style solenoid valve](image)

- **Coil**
- **Armature/Plunger Stop**
- **Housing**
- **Seal**
- **Shield**
- **Flow Path**

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>LOHM RATE (^2) (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>FFKM/PEEK</td>
</tr>
<tr>
<td>1000 (0.020)</td>
<td>180</td>
<td>31</td>
<td>FFKM/PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
(4) See page F14 for complete electrical characteristics.
**LFR SERIES**
**SOLENOID VALVES**

### 062 MINSTAC Style

**Electrical Connection**

<table>
<thead>
<tr>
<th>PART NUMBER ¹</th>
<th>ELECTRICAL CONNECTION</th>
<th>OPERATING PRESSURE (psig)</th>
<th>POWER CONSUMPTION ⁴ (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFRA _ _ 10110H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA _ _ 12110H</td>
<td>Pin w/ Locking End Cap</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA _ _ 10210H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA _ _ 12210H</td>
<td>Pin w/ Locking End Cap</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA _ _ 10310H</td>
<td>Lead Wire</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
<tr>
<td>LFRA _ _ 12310H</td>
<td>Pin w/ Locking End Cap</td>
<td>Vac - 30</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**Notes:**

1. Solenoid valves are available in 12 and 24 vdc configurations.

---

² Coils: 12VDC: 12 ± 20%, 24VDC: 24 ± 20%

³ Wetted Materials:
   - EPDM / PEEK
   - FKM / PEEK
   - FFKM / PEEK

⁴ Single Phase 60Hz, 115VAC

---

**Coil Voltage:**

- **LFRA _ _ 10110H**: 12V DC
- **LFRA _ _ 12110H**: 24V DC
- **LFRA _ _ 10210H**: 12V DC
- **LFRA _ _ 12210H**: 24V DC
- **LFRA _ _ 10310H**: 12V DC
- **LFRA _ _ 12310H**: 24V DC
062 MINSTAC Style

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>LOHM RATE (^2) (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>FKM / PEEK</td>
</tr>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>EPDM / PEEK</td>
</tr>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>FFKM / PEEK</td>
</tr>
<tr>
<td>1100 (0.018)</td>
<td>151</td>
<td>31</td>
<td>FFKM / PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
(4) See page F14 for complete electrical characteristics.
**Manifold Mount Style**

**PART NUMBER** ¹ | **ELECTRICAL CONNECTION** | **OPERATING PRESSURE** (psig) | **POWER CONSUMPTION** ⁴ (W)
---|---|---|---
LFRA _ _ 50270D | Lead Wire | 28 in. Hg Vac - 30 | 1.6
LFRA _ _ 52270D | Pin w/ Locking End Cap | 28 in. Hg Vac - 30 | 1.6
LFRA _ _ 50170D | Lead Wire | 28 in. Hg Vac - 30 | 1.6
LFRA _ _ 52170D | Pin w/ Locking End Cap | 28 in. Hg Vac - 30 | 1.6
LFRA _ _ 50370D | Lead Wire | 28 in. Hg Vac - 30 | 1.6
LFRA _ _ 52370D | Pin w/ Locking End Cap | 28 in. Hg Vac - 30 | 1.6

**NOTES:** (1) Solenoid valves are available in 12 and 24 vdc configurations.

---

LFRA _ _ 50270D

Coil Voltage: 12 = 12 volts
24 = 24 volts
### Manifold Mount Style

![Solenoid Valve Diagram](image)

- **Coil**
- **Housing**
- **Shield**
- **Armature/Plunger Stop**
- **Seal**
- **Flow Path**

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>LOHM RATE (^2) (Cv)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>WEIGHT (g)</th>
<th>WETTED MATERIALS (^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>EPDM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>FKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>FFKM/PEEK</td>
</tr>
<tr>
<td>700 (0.029)</td>
<td>130</td>
<td>27</td>
<td>FFKM/PEEK</td>
</tr>
</tbody>
</table>

(2) Refer to Engineering Section, page S3 for a full description of the Lohm Laws.
(3) Refer to Engineering Section, pages S61-62 for material information and abbreviations.
(4) See page F14 for complete electrical characteristics.
## Standard Manifolds

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>PART NUMBER¹ (PMMA)</th>
<th>PART NUMBER¹ (PEEK)</th>
<th>LENGTH &quot;A&quot;</th>
<th>LENGTH &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 valve</td>
<td>LSMX0501402C</td>
<td>LSMX0501412C</td>
<td>1.9&quot; (48.26 mm)</td>
<td>1.66&quot; (42.16 mm)</td>
</tr>
<tr>
<td>3 valve</td>
<td>LSMX0501403C</td>
<td>LSMX0501413C</td>
<td>2.45&quot; (62.23 mm)</td>
<td>2.210&quot; (56.13 mm)</td>
</tr>
<tr>
<td>4 valve</td>
<td>LSMX0501404C</td>
<td>LSMX0501414C</td>
<td>3.00&quot; (76.20 mm)</td>
<td>2.760&quot; (70.10 mm)</td>
</tr>
<tr>
<td>5 valve</td>
<td>LSMX0501405C</td>
<td>LSMX0501415C</td>
<td>3.55&quot; (84.07 mm)</td>
<td>3.31&quot; (84.07 mm)</td>
</tr>
<tr>
<td>6 valve</td>
<td>LSMX0501406C</td>
<td>LSMX0501416C</td>
<td>4.1&quot; (104.10 mm)</td>
<td>3.86&quot; (98.04 mm)</td>
</tr>
</tbody>
</table>

NOTES: (1) Part Numbers are for the manifold only. Valves sold separately. Standard manifolds are available in PEEK & PMMA. These contain 1/4-28 flat bottom connections and incorporate a common header and individual N.C. and N.O. ports for each valve.

Refer to Manifold Technology (Section K) for custom design capabilities.

FLOW SCHEMATIC

COMMON

NORMALLY OPEN

NORMALLY CLOSED

FLOW SCHEMATIC
Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS

The following specifications apply to all LFR Series valves, unless otherwise noted.

**Life Expectancy**
The valves will typically operate for a minimum of 10 million cycles on water.

**Operating Pressure**
The valves will operate within the normal pressure range when supplied with the rated voltage (+/- 5%).

- Valve Proof Pressure: 2x normal operating pressure
- Valve Burst Pressure: 3x normal operating pressure

**Operating Temperature**
- Maximum allowable solenoid temperature is 200°F (90°C)
- Increasing the operating temperature tends to limit the coil performance.
- The valve duty cycle must be evaluated to prevent the coil temperature from exceeding 200°F (90°C).
- Storage temperature is -20°F to 180°F (-28° to 80°C)
- Minimum and maximum ambient operating temperatures are dependent on the elastomer selection. Lower temperatures will increase the response time needed. If the temperature is too low, the valves may fail to open (ref. chart below for temperatures ranges of the 3 elastomers). For applications with temperatures below those listed, please contact The Lee Company.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>MINIMUM</th>
<th>MAXIMUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPDM</td>
<td>30°F (1°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>FKM</td>
<td>45°F (7°C)</td>
<td>120°F (49°C)</td>
</tr>
<tr>
<td>FFKM</td>
<td>70°F (21°C)</td>
<td>120°F (49°C)</td>
</tr>
</tbody>
</table>

**Response Time**
- Typical response time is 30 ms maximum at 68°F (20°C), 2Hz air at 10 psig.
- Response times can be enhanced with the use of high speed drive circuits. Refer to Engineering Section, page S37.
- Lower temperatures will decrease response time (dependent on type of elastomer used in diaphragm).

**Filtration**
Filtration of 35 microns or finer is recommended.
Port Connections
Several different port (fluid) connections are available.
- **Barbed**: Ports designed for use with 1/16" I.D. flexible tubing
- **1/4-28**: Ports designed for standard 1/4-28 flat bottom fittings
- **Manifold Mount**: See page F15 for manifold mounting details.

Valve Mounting
1/4-28 and Barbed Port Valves: Mount valves using #2 (2 mm) screws allowing 0.52" (12.7 mm) of screw length for valve thickness. Torque screws to 15 in-oz max.

Manifold Mount Valves
Minimum center to center spacing is 0.5" (12.7 mm). One gasket per valve is required for mounting (Part Number LHWX0218130A for FKM, LHWX0218140A for EPDM and LSWX0508210A for FFKM.) Each valve requires four #2 (M2) screws for mounting. Screws should be torqued to 13.5-16.5 in-oz (0.095-0.117 N-m).

Electrical Connections
The LFR coils are not polarized and therefore can be connected to the power in either direction. There are three different styles of electrical connections.
- **Lead wires**: Valves are supplied with 6", #26 AWG lead wires. The ends are stripped and tinned. Electrical connectors can be added as specials.
- **Pins**: Valves are supplied with two 0.025" square electrical pins. These pins are spaced 0.20" apart and will work with standard electrical connectors designed for 0.10" spacing.
- **Pins with Locking End Caps**: These are similar to pins, but a secondary retention clip has been added. These will work with AMP 104257-2 style connectors. The Lee Company offers compatible lead wire sets in two different lengths:
  - 6" lead wire set: Part Number LSWX0504300A
  - 24" lead wire set: Part Number LSWX0606700A

Electrical Characteristics

<table>
<thead>
<tr>
<th>RATED VOLTAGE (vdc)</th>
<th>RESISTANCE (ohms)</th>
<th>INDUCTANCE CLOSED (mH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>91</td>
<td>930</td>
</tr>
<tr>
<td>24</td>
<td>360</td>
<td>217</td>
</tr>
</tbody>
</table>

- Holding voltage is 50% of operating voltage.
LFR SERIES
SOLENOID VALVES

VALVE MOUNTING DETAILS

Part Number Description
LHWX0213420A Mounting Screws, #2 (or 2 mm), 0.438" long
LHWX0218130A Standard Gasket, FKM
LHWX0218140A Standard Gasket, EPDM
LSWX0508210A Standard Gasket, FFKM

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES (MM).
GRAPH OF FLOW VS PRESSURE FOR LFR VALVES

Typical Water Flow Characteristics (LFR Series Valves)

Differential Pressure (psi)

Differential Pressure (kPa)

Flow Rate (mL/min)
LFN SERIES
SOLENOID VALVES

LFN Series
The LFN Series Solenoid Valves are 2-way normally closed, diaphragm valves, designed to provide consistent reliable switching in the smallest footprint possible. The small footprint allows a high valve packing density on manifolds. Combining this with the valves’ low internal volume greatly reduces the overall system fluid volume and manifold size. The isolation diaphragm on an inert housing makes these valves suitable for the control of critical and aggressive fluids.

LFN valves feature:

- Small size: 0.3” center to center mounting
- Low internal volume: 13 microliters
- Fast response time: 20 ms (faster with a spike and hold circuit)
- Operating pressure: 30 psig
- Low Power: 900 mW
LFN SERIES
SOLENOID VALVES

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLTAGE (vdc)</th>
<th>SEAL/HOUSING</th>
<th>OPERATING PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFNA1250125H</td>
<td>12</td>
<td>FKM/PEEK</td>
<td>Vac - 30</td>
</tr>
<tr>
<td>LFNA2450125H</td>
<td>24</td>
<td>FKM/PEEK</td>
<td>Vac - 30</td>
</tr>
<tr>
<td>LFNA1250225H</td>
<td>12</td>
<td>EPDM/PEEK</td>
<td>Vac - 30</td>
</tr>
<tr>
<td>LFNA2450225H</td>
<td>24</td>
<td>EPDM/PEEK</td>
<td>Vac - 30</td>
</tr>
</tbody>
</table>

- Flow Restriction: 2500 Lohms (Cv = .008)
- Weight: 6 grams
- Internal volume: 13 microliters
- Power Consumption: 900 mW
Fluid
Coil
Electrical Pin
Housing
Seal
Shield
Armature/Plunger Stop
An adaptor manifold (Part Number LSMX0509700B) is available for design prototyping. This allows the fluidic system to be designed, built up and tested, all prior to manifold construction. The same LFNX valve can later be used on the manifold system.

A special Lee 4 place manifold (Part Number LSMX0512650B) allows 4 valves to be mounted with a single common outlet port and 4 individually controlled inlet ports. This allows mixing of 4 streams into one outlet.
## LFN Manifolds

<table>
<thead>
<tr>
<th>NUMBER OF VALVES</th>
<th>MATERIAL</th>
<th>PART NUMBER</th>
<th>LENGTH &quot;A&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PEEK</td>
<td>LSMX0509700B</td>
<td>0.63&quot; (16.0 mm)</td>
</tr>
<tr>
<td>2</td>
<td>PEEK</td>
<td>LSMX0509520B</td>
<td>0.80&quot; (20.3 mm)</td>
</tr>
<tr>
<td>3</td>
<td>PEEK</td>
<td>LSMX0509530B</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>4</td>
<td>PEEK</td>
<td>LSMX0509540B</td>
<td>1.40&quot; (35.6 mm)</td>
</tr>
<tr>
<td>5</td>
<td>PEEK</td>
<td>LSMX0509550B</td>
<td>1.70&quot; (43.2 mm)</td>
</tr>
<tr>
<td>2</td>
<td>PMMA</td>
<td>LSMX0509560B</td>
<td>0.80&quot; (20.3 mm)</td>
</tr>
<tr>
<td>3</td>
<td>PMMA</td>
<td>LSMX0509570B</td>
<td>1.10&quot; (27.9 mm)</td>
</tr>
<tr>
<td>4</td>
<td>PMMA</td>
<td>LSMX0509580B</td>
<td>1.40&quot; (35.6 mm)</td>
</tr>
<tr>
<td>5</td>
<td>PMMA</td>
<td>LSMX0509590B</td>
<td>1.70&quot; (43.2 mm)</td>
</tr>
</tbody>
</table>

Replacement gaskets can be purchased using Part Number LSWX0508170A for EPDM, and LSWX0508200A for FKM. Valves should be mounted using #1-64 X 0.1875" mounting screws (Part Number LSWX0503110A).

**FLOW SCHEMATIC**

Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS

The following specifications apply to all LFN Series valves, unless otherwise noted.

**Cycle Life**
LFN Series solenoid valves will operate for a minimum of 10 million cycles (clean water at 68°F and 10 psi). System fluid and operating conditions may affect performance.

**Response Time**
Typical response time is 20 ms or less at 68°F (20°C), 2 Hz air @ 10 psig. Response times can be enhanced by using a spike and hold circuit. Refer to Engineering Section, page S37.

**Electrical**
- LFN valves are designed to operate continuously using the nominal rated voltage (+/-5%). Response times can be enhanced by using a spike and hold circuit.

<table>
<thead>
<tr>
<th>RATED VOLTAGE (vdc)</th>
<th>RESISTANCE (ohms)</th>
<th>MAXIMUM SPIKE VOLTAGE (vdc)</th>
<th>RECOMMENDED SPIKE DURATION (ms)</th>
<th>ENHANCED RESPONSE TIME (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>158</td>
<td>20</td>
<td>25</td>
<td>&lt;10</td>
</tr>
<tr>
<td>24</td>
<td>630</td>
<td>40</td>
<td>25</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

- Power consumption and temperature rise of the coil can be minimized using a hold voltage (50% of rated voltage).

<table>
<thead>
<tr>
<th>RATED VOLTAGE (vdc)</th>
<th>HOLD VOLTAGE (vdc)</th>
<th>POWER CONSUMPTION AT HOLD VOLTAGE (W)</th>
<th>COIL TEMPERATURE AT HOLD VOLTAGE (70°F Ambient) °F (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>5</td>
<td>0.16</td>
<td>&lt;100 (38)</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
<td>0.16</td>
<td>&lt;100 (38)</td>
</tr>
</tbody>
</table>
Operating Pressure
LFN valves are designed to operate in the range listed on page G3.

- Valve Proof pressure: 60 psig
- Valve Burst pressure: 90 psig

Operating Temperature
LFN valves are designed to operate in the range shown below.

- Ambient operating temperature is 40-120°F (4-49°C)
- Max coil temperature: 150°F (66°C)

Filtration
Filtration of 35 microns or finer is recommended.
LFY Series

LFY Series Inert Valves
The LFY Series are chemically inert solenoid valves which provide precise dispensing and control of aggressive and sensitive fluids.

The LFY Series valves feature a unique internal configuration which minimizes damage to sensitive materials.

- Zero Dead Volume
- Standard (3,200 Lohm) and High Flow (1,000 Lohm) Models
- 2-way and 3-way models available
- Operating Pressures up to 30 psig
- Standard 12 and 24 vdc models available
- Low Internal Volume (as low as 18 microliters)
- Several mounting options for tube connections and manifold applications
- FKM and FFKM elastomers available
- 5 Million Cycles (minimum) service life
3-Way .054 Ports

3-Way 062 MINSTAC

3-Way 156 MINSTAC

Unless otherwise specified, dimensions are in inches [mm].
### 3-Way .054 Ports

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME 1 (µL)</th>
<th>PRESSURE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1226032H</td>
<td>LCP/FKM</td>
<td>12</td>
<td>22</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA2426032H</td>
<td>LCP/FKM</td>
<td>24</td>
<td>22</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA1228032H</td>
<td>LCP/FFKM</td>
<td>12</td>
<td>22</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA2428032H</td>
<td>LCP/FFKM</td>
<td>24</td>
<td>22</td>
<td>0-15</td>
<td>1.0</td>
</tr>
</tbody>
</table>

NOTES: (1) Internal volume per leg
Lohm Rate: 3,200 Lohms (Cv = .006)

### 3-Way 062 MINSTAC

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME 1 (µL)</th>
<th>PRESSURE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1218032H</td>
<td>PPS/FFKM</td>
<td>12</td>
<td>18</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA2418032H</td>
<td>PPS/FFKM</td>
<td>24</td>
<td>18</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA1216032H</td>
<td>PPS/FKM</td>
<td>12</td>
<td>18</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA2416032H</td>
<td>PPS/FKM</td>
<td>24</td>
<td>18</td>
<td>0-30</td>
<td>1.5</td>
</tr>
</tbody>
</table>

NOTES: (1) Internal volume per leg
Lohm Rate: 3,200 Lohms (Cv = .006)

### 3-Way 156 MINSTAC²

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME 1 (µL)</th>
<th>PRESSURE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1215010H</td>
<td>PEEK/FFKM</td>
<td>12</td>
<td>72</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2415010H</td>
<td>PEEK/FFKM</td>
<td>24</td>
<td>72</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA1219010H</td>
<td>PEEK/FKM</td>
<td>12</td>
<td>72</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2419010H</td>
<td>PEEK/FKM</td>
<td>24</td>
<td>72</td>
<td>0-15</td>
<td>2.0</td>
</tr>
</tbody>
</table>

NOTES: (1) Internal volume per leg
(2) 156 MINSTAC is compatible with many 1/4-28 systems
Lohm Rate: 1,000 Lohms (Cv = .02)
2-Way 062 MINSTAC

NORMALLY CLOSED PORT
2X .062 MINSTAC BOSS (.138-40 UNF-2B)
COMMON PORT

2X LEADS
28 AWG
6.0 [152.4]

2X MOUNTING HOLES
Ø.10 [2.5]

(.750-28 UN-2A)

2-Way 156 MINSTAC

NORMALLY CLOSED PORT
2X .156 MINSTAC BOSS (.250-28 UNF-2B)
COMMON PORT

2X MOUNTING HOLES
Ø.10 [2.5]

(.8125-20 UNEF-2A)

2X LEADS
28 AWG
6.0 [152.4]

Unless otherwise specified, dimensions are in inches [mm].
**2-Way 062 MINSTAC**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>TYPE</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>PRESSURE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1218232H</td>
<td>N.O.</td>
<td>PPS/FFKM</td>
<td>12</td>
<td>14</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA2418232H</td>
<td>N.O.</td>
<td>PPS/FFKM</td>
<td>24</td>
<td>14</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA1218132H</td>
<td>N.C.</td>
<td>PPS/FFKM</td>
<td>12</td>
<td>11</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA2418132H</td>
<td>N.C.</td>
<td>PPS/FFKM</td>
<td>24</td>
<td>11</td>
<td>0-15</td>
<td>1.0</td>
</tr>
<tr>
<td>LFYA1212232H</td>
<td>N.O.</td>
<td>PPS/FKM</td>
<td>12</td>
<td>14</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA2412232H</td>
<td>N.O.</td>
<td>PPS/FKM</td>
<td>24</td>
<td>14</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA1212132H</td>
<td>N.C.</td>
<td>PPS/FKM</td>
<td>12</td>
<td>11</td>
<td>0-30</td>
<td>1.5</td>
</tr>
<tr>
<td>LFYA2412132H</td>
<td>N.C.</td>
<td>PPS/FKM</td>
<td>24</td>
<td>11</td>
<td>0-30</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Lohm Rate: 3,200 Lohms (Cv = .006)

**2-Way 156 MINSTAC¹**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>TYPE</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME (µL)</th>
<th>PRESSURE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1215210H</td>
<td>N.O.</td>
<td>PEEK/FFKM</td>
<td>12</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2415210H</td>
<td>N.O.</td>
<td>PEEK/FFKM</td>
<td>24</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA1215110H</td>
<td>N.C.</td>
<td>PEEK/FFKM</td>
<td>12</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2415110H</td>
<td>N.C.</td>
<td>PEEK/FFKM</td>
<td>24</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA1219210H</td>
<td>N.O.</td>
<td>PEEK/FKM</td>
<td>12</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2419210H</td>
<td>N.O.</td>
<td>PEEK/FKM</td>
<td>24</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA1219110H</td>
<td>N.C.</td>
<td>PEEK/FKM</td>
<td>12</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
<tr>
<td>LFYA2419110H</td>
<td>N.C.</td>
<td>PEEK/FKM</td>
<td>24</td>
<td>54</td>
<td>0-15</td>
<td>2.0</td>
</tr>
</tbody>
</table>

NOTES: (1) 156 MINSTAC is compatible with many 1/4-28 systems.

Lohm Rate: 1,000 Lohms (Cv = .02)
**3-Way Manifold Mount**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>WETTED MATERIAL</th>
<th>VOLTAGE (vdc)</th>
<th>INTERNAL VOLUME (^1) (µL)</th>
<th>PRESSURE RANGE (psig)</th>
<th>POWER (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFYA1236032H</td>
<td>PPS/FKM</td>
<td>12</td>
<td>22</td>
<td>0-30</td>
<td>1.5</td>
</tr>
</tbody>
</table>

NOTES: (1) Volume is per leg

Lohm Rate: 3,200 Lohms (Cv = .006)

Use Lee gasket Part Number LHWX0218040A (3x)

(Boss Drawing LFIX1001350A)
3-Way Flange Mount

NORMALLY OPEN PORT
3X 1/4-28 FLAT BOTTOM BOSS (.250-28 UNF-2B)
NORMALLY CLOSED PORT
2X MOUNTING HOLES Ø.11 [2.8]
COMMON PORT

NOTES:
(1) Volume is per leg
(2) Max. pressure differential (between ports) is 17 psid.

Lohm Rate: 1,000 Lohms (Cv = .02)

Panel Mounting
This valve requires a 0.95" (25 mm) diameter clearance hole with a mounting hole for #2 or 2 mm screws.

Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS
The following specifications apply to all LFY Series valves unless otherwise noted.

Cycle Life
The LFY valves will operate for a minimum of 5 million cycles on water at standard temperature and pressure conditions. Specific application conditions and fluids may affect the life of the valve.

Operating Pressure
The LFY valves will operate properly within the range specified. Excess pressure may adversely affect the cycle life.

Valve Proof Pressure .......... 2 x normal rated pressure
Valve Burst Pressure .......... 3 x normal rated pressure

Operating Temperature
- Ambient operating range is 60°F to 118°F (16°C - 48°C)
- Maximum allowable solenoid coil temperature is 250°F (121°C).
- Increasing coil temperature tends to limit performance. Valve duty cycle and energized time must be evaluated so coil temperature does not exceed 250°F (121°C).
**Response Time**

Typical response time for the LFY valve is 50 ms at 65°F (18°C). Lower operating temperatures can dramatically increase response time. Extended periods of inactivity may also increase the initial response time.

**Port Connections**

Several different port connections are available:

- 054 ports: these are designed for use with 0.040” (1.0 mm) I.D. flexible tubing
- 062 MINSTAC: for use with Lee 062 MINSTAC Teflon® tubing system
- 156 MINSTAC: for use with 156 MINSTAC Teflon tubing systems (also compatible with many 1/4-28 flat bottom fitting systems).
- Manifold mount for use with custom manifolds.

**Filtration**

Fluid used in LFY Series valves should be filtered to 35 microns or finer.

**Wetted Materials**

Wetted materials used in the LFY series are:

- PPS: polyphenelene sulfide
- LCP: liquid crystal polymer
- PEEK: polyetheretherkeytone
- FKM: fluoroelastomer
- FFKM: perfluoroelastomer
Valve Mounting
LFY valves may be mounted using #2 (2 mm) screws to a flat surface. Sufficient length must be provided to allow for the valve thickness and still allow proper engagement into the mounting surface. Screws should be torqued to 15 in-oz (0.11 N-m). Nylon screws can be used to prevent over torquing.

Nylon mounting Screws (#2)
- LHWX0203770A: 1" long
- LHWX0203990A: 1.25" long

Panel Mounting
- 3200 Lohm valves require a 0.79" (20 mm) clearance hole with a maximum panel thickness of 0.44" (11 mm). Use panel nut LHWX0203250A to mount the valve.
- 1000 Lohm valves require a 0.83" (21 mm) clearance hole with a maximum panel thickness of .44" (11 mm). Use panel nut LHWX0203760A to mount valve.

Electrical Characteristics
LFY valves are designed to run at the rated voltage +/- 5%
Typical Flow Characteristics
3,200 and 1,000 Lohm LFY Series Valves
LPL Series
Lee LPL Series solenoid pumps provide accurate, repeatable, fixed volume dispensing in a small lightweight package. A normally closed seat prevents siphoning when the pump is de-energized.

LPL solenoid pumps are ideally suited for applications that require a precise, fixed volume dispense. The pump's accuracy and repeatability eliminate the need for calibration and adjustment.

- LPL pumps provide the designer with greater flexibility
- Inert wetted materials (PEEK body)
  Choice of FKM and EPDM as standard elastomers
- 12 and 24 volt coil
- Low power consumption: 2 and 2.5 W models
- Fast: 2 Hz operation
- Standard 50 μL dispense, special sizes also available
- Self priming
- Long life: 10 million cycles
**062 MINSTAC Ports**

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ACCURACY (%)</th>
<th>POWER (W)</th>
<th>ELASTOMER</th>
<th>VOLUME (µL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPLA _ _ 10350L</td>
<td>3</td>
<td>2</td>
<td>FKM</td>
<td>50</td>
</tr>
<tr>
<td>LPLA _ _ 11350L</td>
<td>3</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 10550L</td>
<td>5</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 11550L</td>
<td>5</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 10050L</td>
<td>10</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 11050L</td>
<td>10</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: (1) Pumps are available in 12 and 24 vdc configurations.

LPLA _ _ 10350L

Coil Voltage:  
12 = 12 vdc  
24 = 24 vdc
NOTES:

Pumps are available in 12 and 24 vdc configurations.

LPLA _ __20350L

Coil Voltage: 12 = 12 vdc
24 = 24 vdc

Unless otherwise specified, dimensions are in inches [mm].
1/4-28 Flat Bottom Boss

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>ACCURACY (%)</th>
<th>POWER (W)</th>
<th>ELASTOMER</th>
<th>VOLUME (µL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPLA_ _30350L</td>
<td>3</td>
<td>2</td>
<td>FKM</td>
<td>50</td>
</tr>
<tr>
<td>LPLA_ _31350L</td>
<td>3</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA_ _30550L</td>
<td>5</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA_ _31550L</td>
<td>5</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA_ _30050L</td>
<td>10</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA_ _31050L</td>
<td>10</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: (1) Pumps are available in 12 and 24 vdc configurations.

LPLA_ _30350L

Coil Voltage:  
12 = 12 vdc  
24 = 24 vdc
Standard Manifold Mount

See page I10 for mounting boss drawing LSIX01001110A.

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER 1</th>
<th>ACCURACY (%)</th>
<th>POWER (W)</th>
<th>ELASTOMER</th>
<th>VOLUME (µL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPLA _ _ 40350L</td>
<td>3</td>
<td>2</td>
<td>FKM</td>
<td>50</td>
</tr>
<tr>
<td>LPLA _ _ 41350L</td>
<td>3</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 40550L</td>
<td>5</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 41550L</td>
<td>5</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 40050L</td>
<td>10</td>
<td>2</td>
<td>FKM</td>
<td></td>
</tr>
<tr>
<td>LPLA _ _ 41050L</td>
<td>10</td>
<td>2</td>
<td>EPDM</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: (1) Pumps are available in 12 and 24 vdc configurations.

LPLA _ _ 40350L

Coil Voltage: 12 = 12 vdc
24 = 24 vdc
LPL2 – Combination Manifold/Soft Tube Port

The LPL2 pump features a port head design that allows tubing connections (push on ports) and manifold mounting. A special end cap design simplifies electrical connections and wiring harnesses.

Unless otherwise specified, dimensions are in inches [mm].

See page 110 for mounting boss drawing LSIX01001440A.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>ACCURACY (%)</th>
<th>POWER (W)</th>
<th>WEIGHT (g)</th>
<th>ELASTOMER</th>
<th>VOLUME (µL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPLA_ _50650L</td>
<td>6</td>
<td>2.5</td>
<td>53</td>
<td>FKM</td>
<td>50</td>
</tr>
<tr>
<td>LPLA_ _50625L</td>
<td>12</td>
<td></td>
<td></td>
<td>FKM</td>
<td>25</td>
</tr>
<tr>
<td>LPLA_ _51650L</td>
<td>6</td>
<td></td>
<td></td>
<td>EPDM</td>
<td>50</td>
</tr>
<tr>
<td>LPLA_ _51625L</td>
<td>12</td>
<td></td>
<td></td>
<td>EPDM</td>
<td>25</td>
</tr>
</tbody>
</table>

NOTES: (1) Pumps are available in 12 and 24 vdc configurations.

LPLA_ _50650L

Coil Voltage: 12 = 12 vdc
24 = 24 vdc
Unless otherwise specified, dimensions are in inches [mm].
GENERAL SPECIFICATIONS

The following specifications apply to all LPL Series pumps, unless otherwise noted.

Life Expectancy
The LPL Series pumps will operate for a minimum of 10 million cycles on clean water. Fluids may affect actual life.

Operating Pressure
- Maximum case pressure is 5 psig
- Total head range is -30 to +30 inches water
- Inlet/Outlet pressure will affect dispense volume
- Inlet/Outlet restrictions may affect pumped volume

Pumped Volume
- The standard dispensed volume is 50 µL. 25 µL available for combo port style.
- Special volumes are also available
- Repeatability of pumped volume is 2%
- Coefficient of Variation (CV) = +/- 0.3%

Response Time
Maximum operating frequency is 2 Hz. Cycling pump faster will adversely affect dispense accuracy. Fluid properties (i.e. viscosity) and flow restrictions may reduce maximum operating speed.

Filtration
Filtration of 35 microns or finer is recommended.

Electrical Characteristics
- Lead wires are #28 PTFE insulated wire
- Leads are white (no coil polarity)

LPL2 Only
- End Cap connector is compatible with AMP part number: 104257-2
- Lead wire assemblies available
  - 6" assembly: LSWX0504300A
  - 24" assembly: LSWX0606700A

Operating Temperature
- Ambient operating temperature is 60 - 150°F (16 - 66°C)
- Max. coil temperature is 180°F (85°C)
- Lower operating temperatures may require special elastomers to ensure proper dispensing.
Port Connections

All ported pumps (non manifold) can be mounted using #2 or 2 mm screws. Adequate length must be allowed for pump housing (0.75") and proper engagement into mounting plate. Mounting screws should be torqued to 10-15 in-oz (0.071 - 0.106 N-m). Manifold mounted pumps require a properly prepared boss. #2 or 2 mm screws should be used for attachment.

### Standard Manifold Mount

Lee Drawing LSIX1001110A

### LPL2

Lee Drawing LSIX1001440A

Unless otherwise specified, dimensions are in inches [mm].
LPV Series
LPV Series pumps are variable volume, positive displacement pumps that feature unparalleled reliability and consistent performance. Their small size, light weight and maintenance free design permit the pumps to be located where the fluidic requirements dictate, regardless of maintenance accessibility. This makes them ideal for replacing conventional syringe and peristaltic pumps. This also allows the pumps to be located on or near the sample arm, further reducing the required transport volume of the system.

Standard LPV Pumps incorporate a stacked can motor, which creates a smaller, lighter package. A home sensor is available as an option.

High Performance LPV Pumps use a hybrid stepper motor, which allows smaller dispense increments and higher pressures. Encoders and home sensors are included with these pumps, allowing positive feedback.

High Performance pumps are also available with dual seals. The second seal creates a “flushing” chamber which allows the use of a barrier fluid. Flushing of the piston to prevent build up is also possible.

All LPV Series Pumps Offer:
- Compact Size, Light Weight
- Low Power Consumption
- Maintenance Free Design
- Self Priming Operation
**LPV Series**

**CONFIGURATION A**

![Diagram of Configuration A]

**CONFIGURATION B**

![Diagram of Configuration B]

*Unless otherwise specified, dimensions are in inches [mm].*

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PISTON MATERIAL</th>
<th>PORT HEAD MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1020050L</td>
<td>50</td>
<td>TZP</td>
<td>PMMA</td>
<td>0.1</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1050050L</td>
<td></td>
<td>TZP</td>
<td>PEEK</td>
<td>0.1</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sapphire</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1520025D</td>
<td>250</td>
<td>TZP</td>
<td>PMMA</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1550025D</td>
<td></td>
<td>TZP</td>
<td>PEEK</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sapphire</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1520075D</td>
<td>750</td>
<td>TZP</td>
<td>PMMA</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>LPVA1550075D</td>
<td></td>
<td>TZP</td>
<td>PEEK</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sapphire</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### LPV Series

**Wetted Materials:** Piston and Port Head (see chart below), UHMW-PE, EPDM

- External valving required
- Motor: Bipolar
- Power: 260-290 mA / phase (250 and 750 µL)
  - 210-240 mA / phase (50 µL)

<table>
<thead>
<tr>
<th>CV% (10% Dispensed Volume)</th>
<th>CV% (Full Dispensed Volume)</th>
<th>MAX. SPEED HALF STEPS (pps)</th>
<th>LENGTH &quot;L&quot;</th>
<th>WIDTH &quot;W&quot;</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4% (@5 µL)</td>
<td>0.04% (@50 µL)</td>
<td>1000</td>
<td>3.90&quot; (99.1 mm)</td>
<td>1.25&quot; (31.7 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.4% (@25 µL)</td>
<td>0.04% (@250 µL)</td>
<td>1000</td>
<td>4.58&quot; (116.3 mm)</td>
<td>1.5&quot; (38.1 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.4% (@75 µL)</td>
<td>0.04% (@750 µL)</td>
<td>1000</td>
<td>4.61&quot; (117.1 mm)</td>
<td>1.5&quot; (38.1 mm)</td>
<td>B</td>
</tr>
</tbody>
</table>
LPV Series with Home Sensor

**CONFIGURATION A**

- 2X 1/4-28 FLAT BOTTOM BOSS
- 2X MOUNTING HOLES .14 [3.6] THRU
- 4X LEADS #28 AWG 11.0-12.5 LONG [279.4-317.5]

**CONFIGURATION B**

- 2X 1/4-28 FLAT BOTTOM BOSS
- 2X MOUNTING HOLES .14 [3.6] THRU
- 4X LEADS #28 AWG 11.0-12.5 LONG [279.4-317.5]

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PISTON MATERIAL</th>
<th>PORT HEAD MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1520125D</td>
<td>250</td>
<td>TZP</td>
<td>PMMA</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1550125D</td>
<td></td>
<td>TZP</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1551125D</td>
<td></td>
<td>sapphire</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1520175D</td>
<td>750</td>
<td>TZP</td>
<td>PMMA</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>LPVA1550175D</td>
<td></td>
<td>TZP</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1551175D</td>
<td></td>
<td>sapphire</td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LPV Series with Home Sensor

- Wetted Materials: Piston and Port Head (see chart below), UHMW-PE, EPDM
- External valving required
- Home Sensor: Honeywell Micro Switch Part Number: 2005-001
- Motor: Bipolar
- Power: 260-290 mA / phase (250 and 750 µL)

<table>
<thead>
<tr>
<th>CV% (10% Dispensed Volume)</th>
<th>CV% (Full Dispensed Volume)</th>
<th>MAX. SPEED HALF STEPS (pps)</th>
<th>LENGTH &quot;L&quot;</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4% (@25 µL)</td>
<td>0.04% (@250 µL)</td>
<td>1000</td>
<td>4.74&quot; (120.4 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.4% (@75 µL)</td>
<td>0.04% (@750 µL)</td>
<td>1000</td>
<td>4.74&quot; (120.4 mm)</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.8&quot; (121.9 mm)</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.8&quot; (121.9 mm)</td>
<td>B</td>
</tr>
</tbody>
</table>
LPV Series Manifold Mount

CONFIGURATION A

Unless otherwise specified, dimensions are in inches [mm].

For manifold boss, use Lee Drawing
50 µL: LSIX1001350A
250 µL: LSIX1001140A
750 µL: LSIX1001120A

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PISTON MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
<th>CV% (10% Dispensed Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1000050L</td>
<td>50</td>
<td>TZP</td>
<td>0.1</td>
<td>30</td>
<td>0.4% (@5 µL)</td>
</tr>
<tr>
<td>LPVA1001050L</td>
<td>50</td>
<td>sapphire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1500025D</td>
<td>250</td>
<td>TZP</td>
<td>0.5</td>
<td>30</td>
<td>0.4% (@25 µL)</td>
</tr>
<tr>
<td>LPVA1501025D</td>
<td>250</td>
<td>sapphire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1500075D</td>
<td>750</td>
<td>TZP</td>
<td>1.5</td>
<td>15</td>
<td>0.4% (@75 µL)</td>
</tr>
<tr>
<td>LPVA1501075D</td>
<td>750</td>
<td>sapphire</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### LPV Series Manifold Mount

![Diagram of LPV Series Manifold Mount]

- Wetted Materials: Piston (see chart below), UHMW-PE, EPDM, 316 SS
- External valving required
- Motor: Bipolar
- Power: 260-290 mA / phase (250 and 750 µL)
  210-240mA / phase (50 µL)

<table>
<thead>
<tr>
<th>CV% (Full Dispensed Volume)</th>
<th>MAX. SPEED HALF STEPS (pps)</th>
<th>MOUNTING BOSS DRAWING</th>
<th>LENGTH &quot;L&quot;</th>
<th>PISTON LENGTH &quot;LP&quot;</th>
<th>PISTON DIAMETER &quot;PD&quot;</th>
<th>WIDTH &quot;W&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04% (@50 µL)</td>
<td>1000</td>
<td>LSIX1001350A</td>
<td>2.96&quot; (68.3 mm)</td>
<td>0.51&quot; (13.0 mm)</td>
<td>0.088&quot; (1.68 mm)</td>
<td>1.25&quot; (31.75 mm)</td>
</tr>
<tr>
<td>0.04% (@250 µL)</td>
<td>1000</td>
<td>LSIX1001400A</td>
<td>3.42&quot; (86.9 mm)</td>
<td>0.72&quot; (18.3 mm)</td>
<td>0.197&quot; (5.00 mm)</td>
<td>1.5&quot; (38.1 mm)</td>
</tr>
<tr>
<td>0.04% (@750 µL)</td>
<td>1000</td>
<td>LSIX100120A</td>
<td>3.42&quot; (86.9 mm)</td>
<td>0.57&quot; (14.5 mm)</td>
<td>0.341&quot; (8.66 mm)</td>
<td>1.5&quot; (38.1 mm)</td>
</tr>
</tbody>
</table>
LPV Series Manifold Mount with Home Sensor

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PISTON MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1500125D</td>
<td>250</td>
<td>TZP</td>
<td>0.5</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1501125D</td>
<td>250</td>
<td>sapphire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1500175D</td>
<td>750</td>
<td>TZP</td>
<td>1.5</td>
<td>15</td>
</tr>
<tr>
<td>LPVA1501175D</td>
<td>750</td>
<td>sapphire</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LPV Series Manifold Mount with Home Sensor

- Wetted Materials: Piston (see chart below), UHMW-PE, EPDM, 316 SS
- External valving required
- Home Sensor: Honeywell Micro Switch Part Number: HOA2005-001
- Motor: Bipolar
- Power: 260-290 mA / phase

| CV% (10% Dispensed Volume) | CV% (Full Dispensed Volume) | MAX. SPEED HALF STEPS (pps) | MOUNTING BOSS DRAWING | PISTON LENGTH "LP" | PISTON DIAMETER "PD"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4% (@25 µL)</td>
<td>0.04% (@250 µL)</td>
<td>1000</td>
<td>LSIX1001140A</td>
<td>0.72&quot; (18.3 mm)</td>
<td>0.197&quot; (5.00 mm)</td>
</tr>
<tr>
<td>0.4% (@75 µL)</td>
<td>0.04% (@750 µL)</td>
<td>1000</td>
<td>LSIX1001120A</td>
<td>0.57&quot; (14.5 mm)</td>
<td>0.341&quot; (8.66 mm)</td>
</tr>
</tbody>
</table>
LPV Series High Performance

**CONFIGURATION A**

- 5X LEADS #26 AWG 10.25 [260.4] MAX LONG
- 4X LEADS #22 AWG 10.25 [260.4] MAX LONG

**CONFIGURATION B**

- 5X LEADS #26 AWG 10.00 [254] MAX LONG

**Home Encoder**
- 5X LEADS #26 AWG 10.00 [254] MAX LONG
- 4X LEADS #22 AWG 10.25 [260.4] MAX LONG

**Surface Mount Adapter**
- "L"

**NOTE:**
1. Wetted material includes 316 Stainless Steel.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PORT HEAD MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1720350L</td>
<td>50</td>
<td>PMMA</td>
<td>0.04</td>
<td>60</td>
</tr>
<tr>
<td>LPVA1750350L</td>
<td>50</td>
<td>PEEK</td>
<td>0.03% (@5 µL)</td>
<td>0.03% (@50 µL)</td>
</tr>
<tr>
<td>LPVA1720325D</td>
<td>250</td>
<td>PMMA</td>
<td>0.3% (@25 µL)</td>
<td>0.2% (@250 µL)</td>
</tr>
<tr>
<td>LPVA1750325D</td>
<td>250</td>
<td>PEEK</td>
<td>0.2% (@25 µL)</td>
<td>0.3% (@250 µL)</td>
</tr>
<tr>
<td>LPVA1720375D</td>
<td>750</td>
<td>PMMA</td>
<td>0.3% (@75 µL)</td>
<td>0.2% (@750 µL)</td>
</tr>
<tr>
<td>LPVA1750375D</td>
<td>750</td>
<td>PEEK</td>
<td>0.2% (@75 µL)</td>
<td>0.3% (@750 µL)</td>
</tr>
<tr>
<td>LPVA1720310H</td>
<td>1000</td>
<td>PMMA</td>
<td>0.3% (@100 µL)</td>
<td>0.2% (@1000 µL)</td>
</tr>
<tr>
<td>LPVA1750310H</td>
<td>1000</td>
<td>PEEK</td>
<td>0.2% (@100 µL)</td>
<td>0.3% (@1000 µL)</td>
</tr>
<tr>
<td>LPVA1720330H</td>
<td>3000</td>
<td>PMMA</td>
<td>0.3% (@300 µL)</td>
<td>0.2% (@3000 µL)</td>
</tr>
<tr>
<td>LPVA1750330H</td>
<td>3000</td>
<td>PEEK</td>
<td>0.2% (@300 µL)</td>
<td>0.3% (@3000 µL)</td>
</tr>
</tbody>
</table>

Unless otherwise specified, dimensions are in inches [mm].


**LPV Series High Performance**

![Image of LPV Series Pump](image)

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Pump Housing</th>
<th>Piston</th>
<th>Motor</th>
<th>Seal</th>
<th>Port Head</th>
<th>Encoder</th>
<th>Home Sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Blue</td>
<td>Green</td>
<td>Gray</td>
<td>Black</td>
<td>Yellow</td>
<td>Gray</td>
<td>Green</td>
</tr>
</tbody>
</table>

- Wetted Materials: Port Head (see chart below), TZP, UHMW PE
- External valving required
- Encoder and home sensor equipped
- Motor: Bipolar
- Power: 400-420 mA / phase

<table>
<thead>
<tr>
<th>CV% (10% Dispensed Volume)</th>
<th>CV% (Full Dispensed Volume)</th>
<th>MAX. SPEED HALF STEPS (pps)</th>
<th>LENGTH &quot;L”</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3% (@5 µL)</td>
<td>0.03% (@50 µL)</td>
<td>5000</td>
<td>4.84” (122.9 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.3% (@25 µL)</td>
<td>0.03% (@250 µL)</td>
<td>4000</td>
<td>4.84” (122.9 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.3% (@75 µL)</td>
<td>0.03% (@750 µL)</td>
<td>4000</td>
<td>5.25” (133.3 mm)</td>
<td>A</td>
</tr>
<tr>
<td>0.3% (@100 µL)</td>
<td>0.03% (@1000 µL)</td>
<td>4000</td>
<td>6.21” (157.7 mm)</td>
<td>B</td>
</tr>
<tr>
<td>0.3% (@300 µL)</td>
<td>0.03% (@3000 µL)</td>
<td>4000</td>
<td>6.32” (160.5 mm)</td>
<td>A</td>
</tr>
</tbody>
</table>
LPV Series High Performance Manifold Mount

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
<th>CV% (10% Dispensed Volume)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1700350L</td>
<td>50</td>
<td>0.04</td>
<td>60</td>
<td>0.3% (@5 µL)</td>
</tr>
<tr>
<td>LPVA1700325D</td>
<td>250</td>
<td>0.2</td>
<td>60</td>
<td>0.3% (@25 µL)</td>
</tr>
<tr>
<td>LPVA1700375D</td>
<td>750</td>
<td>0.47</td>
<td>30</td>
<td>0.3% (@75 µL)</td>
</tr>
<tr>
<td>LPVA1700310H</td>
<td>1000</td>
<td>0.4</td>
<td>30</td>
<td>0.3% (@100 µL)</td>
</tr>
<tr>
<td>LPVA1700330H</td>
<td>3000</td>
<td>1</td>
<td>95</td>
<td>0.3% (@300 µL)</td>
</tr>
</tbody>
</table>
LPV Series High Performance Manifold Mount

- Wetted Materials: TZP, UHMW PE, 316 SS
- External valving required
- Encoder and home sensor equipped
- Motor: Bipolar
- Power: 400-420 mA / phase

| CV% (Full Dispensed Volume) | MAX. SPEED HALF STEPS (pps) | MOUNTING BOSS DRAWING | LENGTH "L" | PISTON LENGTH "LP" | PISTON DIAMETER "PD"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03% (@50 µL)</td>
<td>5000</td>
<td>LSIX1001420A</td>
<td>3.78* (96.0 mm)</td>
<td>0.6&quot; (15.2 mm)</td>
<td>0.1&quot; (2.5 mm)</td>
</tr>
<tr>
<td>0.03% (@250 µL)</td>
<td>4000</td>
<td>LSIX1001140A</td>
<td>3.78* (96.1 mm)</td>
<td>0.6&quot; (15.2 mm)</td>
<td>0.22&quot; (5.6 mm)</td>
</tr>
<tr>
<td>0.03% (@750 µL)</td>
<td>4000</td>
<td>LSIX1001120A</td>
<td>3.89* (98.8 mm)</td>
<td>0.65&quot; (16.5 mm)</td>
<td>0.34&quot; (8.6 mm)</td>
</tr>
<tr>
<td>0.03% (@1000 µL)</td>
<td>4000</td>
<td>LSIX1001460A</td>
<td>4.58* (116.3 mm)</td>
<td>0.95&quot; (24.1 mm)</td>
<td>0.32&quot; (8.1 mm)</td>
</tr>
<tr>
<td>0.03% (@3000 µL)</td>
<td>4000</td>
<td>LSIX1001150A</td>
<td>4.70* (119.4 mm)</td>
<td>0.8&quot; (20.3 mm)</td>
<td>0.45&quot; (11.4 mm)</td>
</tr>
</tbody>
</table>
# LPV Series High Performance - Dual Seal

![Diagram of LPV Series Pump](image)

## Specifications
- **LPV Series High Performance - Dual Seal**
- **Part Numbers:** LPVA1725325D, LPVA1755325D, LPVA1725350D, LPVA1755350D, LPVA1725310H, LPVA1755310H, LPVA1725330H, LPVA1755330H

## Table of Specifications

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>VOLUME (µL)</th>
<th>PORT HEAD MATERIAL</th>
<th>FULL STEP DISPENSE (µL)</th>
<th>MAXIMUM DISCHARGE PRESSURE (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1725325D</td>
<td>250</td>
<td>PMMA</td>
<td>0.2</td>
<td>45</td>
</tr>
<tr>
<td>LPVA1755325D</td>
<td></td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725350D</td>
<td>500</td>
<td>PMMA</td>
<td>0.47</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1755350D</td>
<td></td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725310H</td>
<td>1000</td>
<td>PMMA</td>
<td>0.4</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1755310H</td>
<td></td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725330H</td>
<td>3000</td>
<td>PMMA</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td>LPVA1755330H</td>
<td></td>
<td>PEEK</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Unless otherwise specified, dimensions are in inches [mm].*
### LPV Series High Performance – Dual Seal

![LPV Series Pump Diagram](image)

- **Wetted Materials:**
  - Pump chamber: Port Head (see chart below), TZP, UHMW PE
  - Flush chamber: TZP, UHMW PE, PEEK, 316 SS

- External valving required
- Encoder and home sensor equipped
- Motor: Bipolar
- Power: 400-420 mA / phase

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Volume (µL)</th>
<th>Material</th>
<th>Port Head Material</th>
<th>Full Dispensed Volume %</th>
<th>Max. Speed (pps)</th>
<th>Length &quot;L&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPVA1725325D</td>
<td>250</td>
<td>PMMA</td>
<td></td>
<td>0.5% (@25 µL)</td>
<td>4000</td>
<td>5.54&quot; (140.7 mm)</td>
</tr>
<tr>
<td>LPVA1755325D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725350D</td>
<td>500</td>
<td>PMMA</td>
<td></td>
<td>0.5% (@50 µL)</td>
<td>4000</td>
<td>5.87&quot; (149.1 mm)</td>
</tr>
<tr>
<td>LPVA1755350D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725310H</td>
<td>1000</td>
<td>PMMA</td>
<td></td>
<td>0.5% (@100 µL)</td>
<td>4000</td>
<td>7.24&quot; (183.9 mm)</td>
</tr>
<tr>
<td>LPVA1755310H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPVA1725330H</td>
<td>3000</td>
<td>PMMA</td>
<td></td>
<td>0.5% (@300 µL)</td>
<td>4000</td>
<td>7.86&quot; (199.6 mm)</td>
</tr>
<tr>
<td>LPVA1755330H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GENERAL SPECIFICATIONS

The following specifications apply to all LPV Series pumps, unless otherwise noted.

Cycle Life
The LPV pumps will operate for a minimum of 5 million cycles on clean water. Chemical content of the fluid and other factors such as particulate matter and dissolved salts will affect the life.

Operating Pressure
LPV pumps are self priming. Typically, the pumps will operate as low as -10 psi on the inlet. This lower limit will be affected by the fluid being pumped. Discharge pressures for specific models are listed with the specific part number.

Operating Temperature
Maximum operating temperature is 150°F (66°C).

Operating Speed
■ Refer to the Pump Selection Charts for the maximum operating speed (listed in half steps) for specific models.
■ For maximum acceleration rates, ramp rates and harmonic ranges, contact The Lee Company for individual drawings.
■ Pumps may be operated in full step, half step and micro step mode, depending on the capability of the drive electronics and the application requirements.

Port Connections
■ All pumps use 1/4-28 flat bottom ports (inlet and outlet).
■ Custom port head options are available for OEM applications.

Valving
LPV pumps require inlet and outlet valving.

Pump Mounting
LPVA15 and LPVA17 Series surface mount pumps (port head style) require #4 (3 mm) screws. LPVA10 Series utilize #4 (2.5 mm) screws. The screw length must be sufficient to allow proper engagement in the mounting surface. Manifold mount pumps require a properly machined boss. A detailed machining drawing is available for all of the manifold mounted models (see Pump Selection Charts).

Electrical Characteristics
■ All motors are 2 phase bipolar.
■ Pumps supplied with encoders use 2 channel, quadrature encoders. These are 1 step per pulse (no index pulse supplied).
**Drive Electronics**

Lee offers a pump driver kit for application development, Part Number LSKX0502150C. This includes the electronics to drive any of the LPV series pumps and the required valving (one 3-way valve or two 2-way valves)*. The unit is based on an AllMotion Inc. stepper drive, which can later be incorporated into production hardware if needed.

* Pump and valves are not included in kit.

---

**Diagram:**

- **A** – Stepper Pump Driver
- **B** – Power Supply
- **C** – USB Cable
- **D** – Three Button Switch Box
- **E** – Extension Cable
- **F** – Installation CD
- **G** – Quick Start Guide
- **H** – Home Sensor Adapter Cable
Manifold Technology

The Lee Company Electro-Fluidic Systems Group has been an industry leader in electro-mechanical valve and pump technology for over three decades. Manifolds offer several advantages compared to just tubing together discrete components, such as fewer leakage points, lower internal volumes, easier assembly into the instrument, and higher reliability. Our expertise in fluidics is drawn from a solid understanding of the application and the components involved. We can incorporate solenoid valves, pumps, passive components (i.e. restrictors) and active components (i.e. transducers) into a complete assembly that has been functionally tested per the application requirements. The different manufacturing techniques used to create such manifolds include conventional, multi-layered and ant farm.
Conventional Manifold Technique
The conventional approach to machining a manifold is typically used when the valve count is minimal and the flow paths are straightforward. The design pattern of drilled passages enables you to locate valves as desired, with some limitations because the drilled passages must be straight and it requires the plugging of superfluous construction passageways. Integrating miniature valves into a common fluid manifold using conventional cross-drilled machining is a major step in the direction of simplifying otherwise complex valve and fluid passage configurations that once required numerous tubes from point to point.

Multi-Layered Manifold Technique
A multi-layered manifold is typically used when the functional requirements are more complex, which usually involves a higher valve count. This type of manifold design involves stacking together multiple layers of plates containing different machined or milled passages. The different plates are then bonded (epoxy, diffusion or solvent weld) together which allows the valves, pumps, and other fluidic sub-components to be located where appropriate for a specific application.
**Ant Farm Manifold Technique**

The Ant Farm Technique involves machining a series of intricate flow paths or channels into the face of the manifold. After the machining operation, a plate is bonded over the flow passages to complete the circuit. In complex applications, the channels can be milled into more than one face of the manifold block. This manifold machining technique further reduces the overall manifold size compared to the other technologies.

This technology also lends itself towards building a modular design. The modular design includes provisions in the near fluid passage for O-rings to provide a seal between different sections of the manifold when mounted together. This erector-set approach to manifold construction gives the designer more flexibility, especially if the application requires a distribution plate to redirect or prevent flow from one passage to another between sections. It also allows the designer to use a spacer plate to increase dimensions between sections when an oversized component or obstruction must be accommodated on the mounting surface.

This manifold design capitalizes on the use of our Ant Farm Technique integrating multiple styles of LHD Series valves (plug-in and face mount) in order to accommodate a system’s specific space constraints and flow schematic requirements. The intricate flow paths that complete the internal circuit are showcased in the image on the right, where the bond plate has been partially cut away.

This manifold design exemplifies a higher degree of capability using our Ant Farm Technique together with several LHD Series solenoid valves and other critical components (pressure transducer and regulator).

This complex manifold design demonstrates taking a modular approach while also employing our Ant Farm Technique. Four valve modules are mounted onto a distribution plate and o-rings with integrated screens are used to ensure a proper seal between the different manifold sections.
Combination Manifold Technique
Combination manifolds are used to incorporate discrete components into a single unit. The Lee LPV Series pumps have a large machined port head. Customization of this port head can incorporate solenoid valves, connections and sensors into a single package. This technique reduces the number of connections, the need for a second manifold and the overall package size. Combining several discrete components into a single one also reduces assembly time during instrument production.

Injection Manifold Technique
Lee injection valves minimize the fluid between the valve seat and the flow stream. This in turn minimizes carry over volumes. Staggering the valves on a multi-face manifold allows closer spacing and further reduces the length (thus volume) of the main flow passage.
**Manifold Materials**

The following is a list of typical materials used for each technology. Other materials may also be available.

- **Conventional:**
  - Stainless Steel
  - Aluminum (Anodized)
  - PMMA
  - PEEK
  - Ultem

- **Multi-Layered:**
  - Aluminum (Anodized)
  - PMMA

- **Ant Farm:**
  - Aluminum (anodized for increased corrosion resistance)

- **3-D Printing STL:** This allows quick turnaround of proof of principle parts without having to commit to the cost of hard tooling.

- Other materials are available. Contact The Lee Company for technical assistance.

**Manifold Assembly**

Manifolds are typically outfitted with inlet and outlet ports. These ports can be brass barbs, stainless steel hypo tubes, 1/4-28, M6 or any other port that is needed. To prevent contamination from rogue particles, it is standard Lee Company practice to screen all ports when space permits. The finished manifold is then populated with subcomponents. Once the manifold is fully assembled, it is tested to comply with specific application parameters to reduce installation time and eliminate start-up problems. After successfully passing all tests and certified clean, the ports are sealed to prevent any contamination during subsequent transit or handling.

**Manifold Advantages**

There are many advantages for using a manifold system, such as:

- Custom designed, manufactured, and 100% tested from a single source
- Reduced assembly & installation costs
- Space & weight savings
- Manifold mountable components:
  - Solenoid valves
  - Pumps
  - Components (restrictors, filters, check valves)
  - Single fluid fittings and gang interface connections
- Integrated electrical components (pressure sensors, connectors, circuit boards)
- Warranted as a single part number
- Maintenance and repair service available

Contact The Lee Company for additional technical assistance and application information.
MINSTAC, The Lee Company's Miniature Inert System of Tubing and Components, offers the ability to precisely control flow rate, pressure, filtration and other performance factors of aggressive fluids.

**Tube Fittings**
- 062 MINSTAC .................................................................L5-12
- 125 MINSTAC ...............................................................L13-20
- 156 MINSTAC ...............................................................L21-30
- 1/4-28 Flat Bottom .......................................................L31-32
- Line Seal Caps .............................................................L33
- Boss Plugs ....................................................................L34
- Manifolds – 3 Boss .......................................................L35
- Manifolds – 5 Boss ........................................................L36
- Adapters ......................................................................L37-44
- Unions .........................................................................L45-46

**Fluid Control Components**
- Check Valves ..............................................................L48
- Filters ..........................................................................L49-51
- Safety Screens ............................................................L52-53
- Stock Tubing .................................................................L54
- Starter / Tool Kits ........................................................L55-56
Lee MINSTAC Tubing End Connections

The basis of the Lee MINSTAC System is the unique Collet-Lock system, which allows the chamfering of Teflon® tubing, and threading a specially designed Collet onto its end. This assembly provides a leak-proof connection from Teflon® tubing to the wide range of MINSTAC components and fittings, all without the problems associated with Teflon’s® cold flow characteristics.

Standard tubing assemblies are available from stock with one or two fitting ends installed. Special lengths and fitting assembly tool kits are also available. Please request T.R. 062 for complete assembly instructions and tool kit part numbers.

The standard tubing connection sizes described below are available with a variety of inner diameters, and are capable of satisfying most fluid handling requirements.

062 MINSTAC

The 062 MINSTAC fitting system is for use with 0.062” (1.57 mm) O.D. Teflon® tubing and uses a 0.138-40 UNF fitting end. This system utilizes an internally threaded Collet that grips the outer diameter of the Teflon® tubing end, preventing cold flow. The Coupling Screw acts like a compression fitting and presses the chamfered end of the tubing against one end of the KEL-F® Ferrule. The other end of the Ferrule is pressed against the sealing surface in the boss by the Coupling Screw. This self-aligning fitting provides the smallest most reliable leak proof system on the market today.

Unless otherwise specified, dimensions are in inches [mm].
**125 MINSTAC**

The 125 MINSTAC fitting system uses 0.125” (3.18 mm) O.D. Teflon® tubing and a 0.25-28 UNF fitting end. The MINSTAC system utilizes an internally threaded Collet sleeve that grips the outer diameter of the Teflon® tubing end, preventing cold flow. The chamfered end of the tubing is pressed against one end of the Ferrule by the Collet. The other end is pressed against the sealing surface in the boss by the Coupling Screw.

**156 MINSTAC**

The 156 MINSTAC fitting system is for use with 0.156” (3.96 mm) O.D. Teflon® tubing and uses a 0.25-28 UNF fitting end. This system utilizes an internally threaded Collet that grips the outer diameter of the Teflon® tubing end, preventing cold flow. The chamfered end of the tubing is pressed against one end of the Ferrule by the Collet. The other end is pressed against the sealing surface in the boss by the Coupling Screw.

*Unless otherwise specified, dimensions are in inches [mm]*.
062 Boss Configuration

062 Fitting Assembly

<table>
<thead>
<tr>
<th>Anodized Aluminum</th>
<th>Coupling Screw: TMAA320207 Z</th>
<th>*color code</th>
</tr>
</thead>
<tbody>
<tr>
<td>303 Stainless</td>
<td>Collet Sleeve: TMCA3202030Z</td>
<td></td>
</tr>
<tr>
<td>PCTFE</td>
<td>Ferrule: TMBA3202910Z</td>
<td></td>
</tr>
</tbody>
</table>

* Color Code: 0 - Black; 1 - Brown; 2 - Red; 3 - Orange; 4 - Yellow; 5 - Green; 6 - Blue; 7 - Violet; 8 - Gray; 9 - Clear

Unless otherwise specified, dimensions are in inches [mm].
# TEFLON® TUBING
## PART NUMBER INFORMATION

<table>
<thead>
<tr>
<th>TU</th>
<th>T</th>
<th>C</th>
<th>32</th>
<th>16</th>
<th>6</th>
<th>05</th>
<th>L</th>
</tr>
</thead>
</table>

**Length Multiplier:**
- \( L = \text{CM} \times 1 \)
- \( D = \text{CM} \times 10 \)
- \( H = \text{CM} \times 100 \)

First two significant digits of tubing length.\(^1\)
Available in 5 cm increments (05,10,15 etc.)**

### Tubing and Coupling Screw Color Code*
- Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear

### Nominal Tubing Wall Thickness
- 12 for 0.042" I.D.
- 16 for 0.032" I.D.
- 26 for 0.012" I.D.

### Nominal Tubing I.D.
- 12 = .012"; 32 = .032"; 40 = .040"

### Number of preassembled fittings (per ordered length)
- A = None (bulk tubing)
- B = 1
- C = 2

**Material – T = TFE**

### Code – Tube Assembly
- TU = Standard MINSTAC\(^2\)
- TL = MIN-LOK (coupling screw with lock wire holes)\(^2\)
- TS = MIN-Spline (coupling screw with spline for finger tightening)\(^2\)

---

(1.) See page L54 for available stock lengths.
(2.) See page L7 for styles.

* Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear

** Bulk tubing is only available in 300 cm (30D) and 3,000 cm (30H) lengths.
062 MINSTAC Tubing Assembly Styles

Standard MINSTAC – smallest package

“MIN-Spline” – larger coupling screw for hand tightened installations

“MIN-LOK” – MINSTAC coupling screw with lock wire holes for high vibration applications

062 MINSTAC Tubing Assembly

MINSTAC Tubing Assemblies are available in pre-made assemblies (see page L54 for standard lengths). Special lengths and configurations are available for OEM applications.

Fittings are also available in tubing and tool kits for prototype and lab work.
062 MINSTAC Boss Preparation

The fitting boss required for the 062 MINSTAC coupling may be produced with the Lee Combination Drill Part Number TTTA3200643A. The drill was designed for use in plastics and soft metals. It produces a boss (excluding the threads) with the proper configuration and dimensions. The boss may be produced as follows:

**Boss Preparation Tools**

- Combination Boss Drill: TTTA3200643A
- Plug Tap: TTTA3200743A
- Bottoming Tap: TTTA3200843A

**Procedure:**

1. Drill a 0.035" (0.89 mm) diameter pilot hole in the desired boss location.
2. Insert the front of the Lee Combination Boss Drill Part Number TTTA3200643A into the pilot hole and drill down until the 0.187" (4.75 mm) diameter spotface cleans up the surface of the boss. All diameters should be concentric within 0.006" (0.15 mm) T.I.R. The sealing surface should be smooth with no burrs or tool marks.
3. Tap the 0.138-40 unfinished threads using the Lee Plug Tap Part Number TTTA3200743A first and the Lee Bottoming Tap Part Number TTTA3200843A second. These taps incorporate stops to avoid damaging the sealing surface. The boss is now complete.

**NOTE:** Care must be taken to ensure that the taps will follow true in hole produced by the Combination Drill.

*Unless otherwise specified, dimensions are in inches [mm].*
062 MINSTAC Tubing Preparation and Coupling Assembly

Coupling Assembly Tools

- Chamfer Tool
  TTTA3201543A

- Collet Tool*
  TTTA3201443A

Procedure:

1. Cut the tubing to the desired length. The cut should be reasonably square.
2. Slide the Coupling Screw (Part Number TMAA320207_Z) over the end of the tubing, with the threaded end facing the tubing end. Place the collet into Tool* (Part Number TTTA3201443A) counterbore end first.

* The Lee Collet Tool (Part Number TTTA3201443A) is for use with 0.032" (0.81 mm) I.D. tubing. The following tools should be substituted for use with their respective sized tubing:

  - TTTA3201743A: 0.012" (0.30 mm) I.D. tubing
  - TTTA4000143A: 0.040" (1.02 mm) I.D. tubing
Procedure continued:

3. While holding the tubing with the rubber Tubing Grip (Part Number TTTX0500900A), screw the Collet onto the tubing end. This should require about 15-20 turns of the Collet Tool. Remove the tool from the coupling end and check that the tubing extends at least to the end of the collet.

4. Using the Lee Chamfering Tool* (Part Number TTTA3201543A), place the pilot pin into the tubing assembly. Rotate the tool while applying a small axial force in a clockwise direction until it bottoms out against the Collet (already installed on the tubing).

* The Chamfer Tool (Part Number TTTA3201543A) is for use with 0.032” (0.81 mm) I.D. tubing. The following tools should be substituted for use with their respective sized tubing:

5. Slide the Coupling Screw over the Collet.

Unless otherwise specified, dimensions are in inches [mm].
Procedure continued:

6. Push the Ferrule (Part Number TMBA3202910Z) onto the Ferrule installation end of the Lee Chamfer Tool (Part Number TTTA3201543A).

7. While holding the Coupling Screw, insert the Ferrule into the Coupling Screw (approx. 4 lbs. (1.8 kg.) force is required). The Ferrule will "snap" in place. The coupling assembly is now complete.

062 MINSTAC Coupling Installation

Coupling Installation Tools

Torque Wrench TTTA3201243A

Wrench TTTA3200543C

Unless otherwise specified, dimensions are in inches [mm].
**Procedure:**

1. Start threading coupling assembly into the 062 MINSTAC fitting boss by hand.

2. Tighten the fitting between 5 to 10 ozf-in (0.035 to 0.07 N-m) by slipping the Lee Torque Wrench (Part Number TTTA3201243A) onto the knurled Coupling Screw. The minimum torque is achieved by pressing the shorter torque arm clockwise until it just contacts the longer arm. To check that maximum recommended torque is not exceeded, invert the Torque Wrench and press the longer torque arm clockwise until the Coupling Screw begins to move. This should occur before the torque arms make contact. After gaining a feel for the proper torque, use of the Torque Wrench may be discontinued.

**Note:** Minimum recommended torque: 5 ozf-in (0.035 N-m)

Maximum recommended torque: 10 ozf-in (0.07 N-m)

*Unless otherwise specified, dimensions are in inches [mm].*
**125 Boss Configuration**

Unless otherwise specified, dimensions are in inches [mm].

**125 Fitting Assembly**

<table>
<thead>
<tr>
<th>Material</th>
<th>Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valox®</td>
<td>Coupling Screw: TMAA6201929Z</td>
</tr>
<tr>
<td>Valox®</td>
<td>Collet Sleeve: TMCA6201920Z</td>
</tr>
<tr>
<td>PCTFE</td>
<td>Ferrule: TMBA6201910Z</td>
</tr>
</tbody>
</table>
## TEFLO® TUBING
### PART NUMBERING INFORMATION

<table>
<thead>
<tr>
<th>TM</th>
<th>T</th>
<th>C</th>
<th>62</th>
<th>30</th>
<th>6</th>
<th>05</th>
<th>L</th>
</tr>
</thead>
</table>

- **Length Multiplier:**
  - \( L = \text{CM} \times 1 \)
  - \( D = \text{CM} \times 10 \)
  - \( H = \text{CM} \times 100 \)

- **First two significant digits tubing length.**
  - \(^1\) Available in 5 cm increments (05, 10, 15, etc.). **

- **Color Code:**
  - Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear

- **Nominal tubing wall thickness**
  - 30 for .062" I.D., 47 for .032" I.D.

- **Nominal tubing I.D.**
  - 32 = .032", 62 = .062"

- **Number of preassembled fittings (per ordered length)**
  - A = None (bulk tubing)
  - B = 1 with ferrule
  - C = 2 with ferrule

- **Material**
  - T = TFE

- **Product Code**
  - 125 MINSTAC Tube Assembly

---

1. See page L54 for available stock lengths.

* Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear

** Bulk tubing (TUTA) is only available in 300 cm (30D) and 3,000 cm (30H) lengths.
125 MINSTAC Boss Preparation

Boss Preparation Tools

- Combination Boss Drill
  TTTA6201927A

- Plug Tap
  TTTA6201627A

- Bottoming Tap
  TTTA6201727A

Procedure:

1. Drill a 0.062” (1.67 mm) diameter pilot hole in the desired boss location.
2. Insert the front of the Lee Combination Boss Drill (Part Number TTTA6201927A) into the pilot hole and drill down until the 0.312” (7.90 mm) diameter spotface cleans up the surface of the boss. All diameters should be concentric within .006" (0.15 mm) T.I.R. The sealing face should be smooth with no burrs or tool marks.
3. Tap the 0.250-28 unfinished threads using the Lee Plug Tap (Part Number TTTA6201627A) first and the Lee Bottoming Tap (Part Number TTTA6201727A) second. These taps incorporate stops to avoid damaging the sealing surface.

*NOTE:* Care must be taken to ensure that the taps will follow true in hole produced by the Combination Drill.

Unless otherwise specified, dimensions are in inches [mm].
125 MINSTAC Tubing Preparation and Coupling Assembly

Coupling Assembly Tools

125 MINSTAC TTTA6200143A *

125 MINSTAC TTTA6200343 (no ferrule) *

Procedure:

1. Assembly instructions for use with 125 MINSTAC Bosses.
   a. Cut the tubing reasonably square to the desired length.
   b. Hold tubing with Tubing Grip. Slide the center drill end of Lee Coupling Assembly Tool* (Part Number TTTA6200143A) onto tubing. Hand twist the tool clockwise to form a chamfered lip seal. The resulting chamfer should leave a 0.002" to 0.004" (0.05 mm to 0.10 mm) flat on the end of the tube.

* Use the Lee Coupling Assembly Tool (Part Number TTTA6200143A) for use with 0.062" (1.57 mm) I.D. tubing. Substitute the Lee Coupling Assembly Tool (Part Number TTTA6200243A) for use with 0.032" (0.81 mm) I.D. tubing.
Procedure continued:

c. Slip the Ferrule (Part Number TMB6201910Z) onto pin of the Coupling Assembly Tool. (See page L40 for 1/4-28 Flat Bottom Ferrule).

d. Slide the flanged end of Collet Sleeve (Part Number TMCA6201920Z) over the Ferrule until it snaps in place.

e. Thread the Coupling Screw (Part Number TMAA6201929Z) over the Collet Sleeve until it bottoms.

f. Thread the tool/coupling assembly counterclockwise onto the chamfered tubing using the Tubing Grip, applying slight force until resistance is felt after approximately 5 turns.

g. Unscrew the coupling from tool. The assembly is now ready for installation into a 125 MINSTAC boss.
125 MINSTAC Coupling Installation

Coupling Installation Tools

Procedure:

1. Start threading the coupling assembly into a 125 MINSTAC boss using Lee Wrench (Part Number TTTA6200227C).

2. Tighten the fitting between 7 to 21 ozf•in (0.05 to 0.15 N-m) by slipping the Lee Torque Wrench (Part Number TTTA6202227A) onto the Coupling Screw hex. The minimum torque is achieved by pressing the shorter torque arm clockwise until it just contacts the longer arm. To check that maximum recommended torque is not exceeded, invert the Torque Wrench and press the longer torque arm clockwise until the Coupling Screw begins to move. This should occur before the torque arms make contact. After gaining a feel for the proper torque, use of the Torque Wrench may be discontinued.

Unless otherwise specified, dimensions are in inches [mm].
**Procedure continued:**

TO ACHIEVE MINIMUM TORQUE APPLY PRESSURE AT THIS POINT UNTIL BOTH ARMS MAKE CONTACT

TO ACHIEVE MAXIMUM TORQUE, TURN WRENCH OVER AND APPLY PRESSURE AT THIS POINT UNTIL BOTH ARMS MAKE CONTACT

**NOTE:** Minimum recommended torque: 7 ozf•in (0.05 N-m)
Maximum recommended torque: 21 ozf•in (0.15 N-m)

Unless otherwise specified, dimensions are in inches [mm].
156 Boss Configuration

Anodized Aluminum: Coupling Screw: TMAA950107 Z

*color code

PEEK: Collet Sleeve: TMCA9501950Z

PCTFE: Ferrule: TMBA9501910Z

* Color Code: 0 - Black; 1 - Brown; 2 - Red; 3 - Orange; 4 - Yellow; 5 - Green; 6 - Blue; 7 - Violet; 8 - Gray; 9 - Clear
TEFLON® TUBING
PART NUMBERING INFORMATION

<table>
<thead>
<tr>
<th>TU</th>
<th>T</th>
<th>C</th>
<th>95</th>
<th>31</th>
<th>6</th>
<th>05</th>
<th>L</th>
</tr>
</thead>
</table>

Length Multiplier:
L = CM x 1
D = CM x 10
H = CM x 100

First two significant digits tubing length.¹
Available in 5 cm increments (05, 10, 15, etc.) ²

Tubing and Coupling Screw Color Code* 

Nominal tubing wall thickness
31 for .095" I.D.

Nominal tubing I.D.
95 = .095*

Number of preassembled fittings (per ordered length)
A = None (bulk tubing)
B = 1
C = 2

Material – T = TFE

Product Code – Tube Assembly

(1.) See page L54 for available stock lengths.

* Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear

** Bulk tubing is only available in 300 cm (30D) and 3,000 cm (30H) lengths.
156 MINSTAC Boss Preparation

Boss Preparation Tools

- Combination Boss Drill
  TTTA9500227A

- Plug Tap
  TTTA6201627A

- Bottoming Tap
  TTTA6201727A

Procedure:

1. Drill a 0.096" (2.44 mm) diameter pilot hole in the desired boss location.

Unless otherwise specified, dimensions are in inches [mm].
Procedure continued:

2. Insert the front of the Lee Combination Boss Drill (Part Number TTTA9500227A) into the pilot hole and drill down until the 0.311" (7.90 mm) diameter spotface cleans up the surface of the boss. All diameters should be concentric within 0.006" (0.15 mm) T.I.R. The sealing surface should be smooth with no burrs or tool marks.

3. Tap the 0.250-28 unfinished threads using the Lee Plug Tap (Part Number TTTA6201627A) first and the Lee Bottoming Tap (Part Number TTTA6201727A) second. These taps incorporate stops to avoid damaging the sealing surface.

NOTE: Care must be taken to ensure that the Taps will follow true in the hole produced by the Combination Drill.

Unless otherwise specified, dimensions are in inches [mm].
156 MINSTAC Tubing Preparation and Coupling Assembly

Tubing Preparation and Coupling Assembly Tools

Procedure:

1. Cut the tubing reasonably square to the desired length.

2. Hold the tubing with the Tubing Grip. Slide the center drill end of Lee Coupling Assembly Tool (Part Number TTTA9500127A) onto the tubing. Hand twist the tool clockwise to form a chamfered lip seal. The resulting chamfer should extend to the O.D. of the tubing.
Procedure continued:

3. Slip the Ferrule (Part Number TMBA9501910Z) onto pin of the Coupling Assembly Tool. (See page L40 for 1/4-28 Flat Bottom Ferrule).

4. Slide internally unthreaded end of the Collet Sleeve (Part Number TMCA9501950Z) over the Ferrule until it snaps in place.

NOTE: Collet should protrude approximately 0.10" (2.5 mm from tool end).

5. Thread the Coupling Screw (Part Number TMAA9501079Z) over the Collet Sleeve until it bottoms on the Collet Sleeve.

Unless otherwise specified, dimensions are in inches [mm].
**Procedure continued:**

NOTE: The Coupling Screw should protrude approximately 0.21" (5.3 mm from the end of tool).

6. Thread the tool/coupling assembly counterclockwise onto the chamfered tubing with the Tubing Grip, applying slight force until resistance is felt after approximately 5 turns.

7. Unscrew the coupling from tool.

*Unless otherwise specified, dimensions are in inches [mm].*
156 MINSTAC Coupling Installation

Coupling Installation Tools

- Torque Wrench
  - TTTA9500343A
- Wrench
  - TTTA9500427C

Procedure:

1. Start threading the coupling assembly into a 156 MINSTAC boss using Spline Wrench (Part Number TTTA9500427C).

Unless otherwise specified, dimensions are in inches [mm].
Procedure continued:

2. Tighten the fitting between 7 to 21 ozf•in (0.05 to 0.15 N-m) by slipping the Lee Torque Wrench (Part Number TTTA9500343A) onto the knurled Coupling Screw. The minimum torque is achieved by pressing the shorter torque arm clockwise until it just contacts the longer arm. To check that maximum recommended torque is not exceeded, invert the Torque Wrench and press the longer torque arm clockwise until the Coupling Screw begins to move. This should occur before the torque arms make contact. After gaining a feel for the proper torque, use of the Torque Wrench may be discontinued.

NOTE: Minimum recommended torque: 7 ozf•in (0.05 N-m)
Maximum recommended torque: 21 ozf•in (0.15 N-m)
Torque values based on fittings threaded into PEEK bosses.
1/4-28 Boss Configuration

Unless otherwise specified, dimensions are in inches [mm].

1/4-28 Fitting Assembly

<table>
<thead>
<tr>
<th>Material</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anodized Aluminum</td>
<td>Coupling Screw: TMAA950307</td>
</tr>
<tr>
<td></td>
<td>*color code</td>
</tr>
<tr>
<td>PEEK</td>
<td>Collet Sleeve: TMCA9501950Z</td>
</tr>
<tr>
<td>PCTFE</td>
<td>Ferrule: TMBA9503910Z</td>
</tr>
</tbody>
</table>

* Color Code: 0 - Black; 1 - Brown; 2 - Red; 3 - Orange; 4 - Yellow; 5 - Green; 6 - Blue; 7 - Violet; 8 - Gray; 9 - Clear
TEFLON® TUBING
PART NUMBERING INFORMATION

<table>
<thead>
<tr>
<th>TQ</th>
<th>T</th>
<th>C</th>
<th>95</th>
<th>31</th>
<th>6</th>
<th>05</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Length Multiplier:
L = CM x 1
D = CM x 10
H = CM x 100

First two significant digits tubing length.¹
Available in 5 cm increments (05, 10, 15, etc.)

Color Code*

Nominal tubing wall thickness
31 for .095" I.D. tubing

Nominal tubing
95 for .095" I.D.

Number of preassembled fittings (per ordered length)
B = 1 with ferrule
C = 2 with ferrule

Material – T = TFE

Product Code – TQ = 1/4-28 Flat Bottom

TQT Part Numbers sold as complete tubing assemblies only.

(1.) See page L54 for available stock lengths.

* Color Code: 0-Black; 1-Brown; 2-Red; 3-Orange; 4-Yellow; 5-Green; 6-Blue; 7-Violet; 8-Gray; 9-Clear
MINSTAC®
LINE SEAL CAPS

062 MINSTAC
TMLA3201950Z – PEEK

0.25
[6.4]  

0.25
[6.4]
HEX

.062 MINSTAC BOSS
(.138-40 UNF-2B)

156 MINSTAC
TMLA9501950Z – PEEK

0.40
[10.2]  

0.34
[8.6]
HEX

.156 MINSTAC BOSS
(.250-28 UNF-2B)

1/4-28 Flat Bottom
TMLA9502950Z – PEEK

0.40
[10.2]  

0.34
[8.6]
HEX

FLAT BOTTOM BOSS
(.250-28 UNF-2B)

Unless otherwise specified, dimensions are in inches [mm].
062 MINSTAC
TMPA3201919Z – PCTFE

.43
[10.9]

.05
[1.3] MIN

KNURL

FITTING END FOR USE WITH
.062 MINSTAC BOSS

125/156 MINSTAC
TMPA9501959Z – PEEK

.57
[14.5]

.25
[6.4] HEX

(.250-28 UNF-2A)

.125/.156 MINSTAC
BOSS PLUG

1/4-28 Flat Bottom
TMPA9502909ZA – PEEK-PTFE

.25
[6.4] HEX

.64
[16.3]

φ .13
[3.3]

FITTING END FOR USE
WITH FLAT BOTTOM BOSS
(.250-28 UNF-2A)

Unless otherwise specified, dimensions are in inches [mm].
062 MINSTAC
TMMA3203950Z – PEEK

2X MOUNTING HOLES
Ø.10 [2.5]
Ø.20 [5.1]

3X .062 MINSTAC BOSS
(.138-40 UNF-2B)

125/156 MINSTAC
TMMA9503950Z – PEEK

2X MOUNTING HOLES
Ø.15 [3.8]

3X .156 MINSTAC BOSS
(.250-28 UNF-2B)

1/4-28 Flat Bottom
TMMA9504950Z – PEEK

2X MOUNTING HOLES
Ø.15 [3.8]

3X FLAT BOTTOM BOSS
(.250-28 UNF-2B)

Unless otherwise specified, dimensions are in inches [mm].
MINSTAC®
MANIFOLDS – 5 BOSS

062 MINSTAC
TMMA3201950Z – PEEK

125/156 MINSTAC
TMMA9501950Z – PEEK

1/4-28 Flat Bottom
TMMA9502950Z – PEEK

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC 1/8" Pipe Bushing
TMGA9502950Z – PEEK

1.56 MINSTAC BOSS (.250-28 UNF-2B)

1/8-27 NPT

1/4-28 Flat Bottom 1/8" Pipe Bushing
TMGA9504950Z – PEEK

FLAT BOTTOM BOSS (.250-28 UNF-2B)

1/8-27 NPT

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC 1/16" Pipe Bushing
TMGA9501950Z – PEEK

1/16-27 NPT

.156 MINSTAC BOSS
(.250-28 UNF-2B)

.28 [7.2]

.67 [16.9]

.095 [2.4]

.37 [9.4] HEX

Unless otherwise specified, dimensions are in inches [mm].

1/4-28 Flat Bottom 1/16" Pipe Bushing
TMGA9503950Z – PEEK

1/16-27 NPT

FLAT BOTTOM BOSS
(.250-28 UNF-2B)
062 MINSTAC – LFA Tubing Adapter

Size: 0.05" (1.3 mm) A dia. (0.042" tube I.D.)
TMDA3207920Z Valox®
TMDA3207950Z PEEK

Size: 0.07" (1.8 mm) A dia. (0.060" tube I.D.)
TMDA3201930Z POM
TMDA3201950Z PEEK

125/156 MINSTAC Boss – LFA Tubing Adapter

TMDA9501950Z (.060" tube I.D.) – PEEK – A = 0.07" (1.8 mm) Dia.
TMDA9507950Z (.042" tube I.D.) – PEEK – A = 0.05" (1.3 mm) Dia.

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC Soft Tubing Adapter
TMDA9501920Z – Valox®

BARBED FITTING END FOR USE WITH .125/.156 MINSTAC BOSS (.250-28 UNF-2A)

Image not drawn to scale.

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC – Male Tube – Luer Adapter

TMRA9503950Z – PEEK

125/156 MINSTAC – Female Tube – Luer Adapter

TMRA9502950Z – PEEK

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC – Female Boss – Female Tube Luer Adapter

TMRA9501950Z – PEEK

0.10 [2.5]

0.90 [22.9]

0.06 [1.6]

Fitting end for use with 0.125/0.156 MINSTAC boss (.250-28 UNF-2A)

LUER TAPER (ANSI/HIMA MD70.1)

0.26 [6.7]

0.31 [7.9] HEX

062 MINSTAC – 1/4-28 Flat Bottom Adapter

TMDA3204950Z – PEEK – PTFE

0.25 [6.4] HEX

0.031 [0.8]

0.64 [16.3]

0.13 [3.3]

Fitting end for use with 0.125/.156 MINSTAC boss style C (.250-28 UNF-2A)

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES [MM].
1/4-28 Flat Bottom – 062 MINSTAC
TMDA3212950Z – PEEK

062 MINSTAC Adapter – 125/156 MINSTAC
TMDA3203950Z – PEEK

Unless otherwise specified, dimensions are in inches [mm].
125/156 MINSTAC – 062 MINSTAC Adapter

TMDA9502950Z – PEEK

062 MINSTAC Male – 062 MINSTAC Male

TMUA3205950Z – PEEK

Image not drawn to scale.

Unless otherwise specified, dimensions are in inches [mm].
**062 MINSTAC Tubing Union**

TMUA3201950Z – PEEK

- $\phi_{0.031} [0.8]$
- $0.50 [12.7]$
- $0.25 [6.4]$
- $0.25$ [HEX]
- $0.50$ [HEX]
- $2 \times 0.062$ MINSTAC BOSS (.138-40 UNF-2B)

**1/4-28 Flat Bottom Tubing Union**

TMUA9503950Z – PEEK

- $\phi_{0.06} [1.5]$
- $0.74 [18.8]$
- $0.34 [8.6]$
- $0.34$ [HEX]
- $0.74$ [HEX]
- $2 \times$ FLAT BOTTOM BOSS (.250-28 UNF-2B)

**125/156 MINSTAC Tubing Union**

TMUA9501950Z – PEEK

- $\phi_{0.095} [2.4]$
- $0.74 [18.8]$
- $0.34 [8.6]$
- $0.34$ [HEX]
- $0.74$ [HEX]
- $2 \times 0.125/0.156$ MINSTAC BOSS (.250-28 UNF-2B)

*Unless otherwise specified, dimensions are in inches [mm].*
062 MINSTAC Bulkhead Union
TMUA3202950A – PEEK – Nut: Nylon

1/4-28 Flat Bottom Bulkhead Union
TMUA9504950Z – PEEK – Nut: Nylon

125/156 MINSTAC Bulkhead Union
TMUA9502950Z – PEEK – Nut: Nylon

Unless otherwise specified, dimensions are in inches [mm].
Lee MINSTAC Components

The MINSTAC components were developed to expand the total scope and range of the MINSTAC system. A complete line of components is available including check valves, filters and safety screens.
Check Valves

Chemically Inert
- Materials: PEEK Body, FFKM Diaphragm
- Cracking Pressure: 4 in. H2O (1.0 kPa)
- Leakage: 10 µL/min. at 28 in. H2O in Checked Direction
- Maximum Pressure in Checked Direction
  - 75 psig (517 kPa) (062 MINSTAC)
  - 40 psig (276 kPa) (125/156 MINSTAC, 1/4-28 Flat Bottom Boss)
- Lohm Rate
  - 1,000 Lohms (062 MINSTAC)
  - 300 Lohms (125/156 MINSTAC, 1/4-28 Flat Bottom Boss)
- 35 micron (minimum) filtration recommended

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>CONNECTION</th>
<th>LOHM RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TKLA3201112H</td>
<td>062 MINSTAC (.138-40)</td>
<td>1000</td>
</tr>
<tr>
<td>TKLA9501130D</td>
<td>156 MINSTAC (1/4-28)</td>
<td>300</td>
</tr>
<tr>
<td>TKLA9502130D</td>
<td>1/4-28 Flat Bottom Boss</td>
<td>300</td>
</tr>
</tbody>
</table>
Lee LFA Filter *
LFFA4202035A: 35 micron

- Micron rating: 35 micron nominal
- Lohm rating: 1,500 Lohms
- Operating pressure: 30 psig (207 kPa) maximum
- Panel mounted φ .350" (8.89 mm) diameter hole, 0.054" (1.37 mm) maximum plate thickness
- Material:
  Filter: UHMW Polyethylene
  Housing: Valox® and PC
- Optional retaining ring available, LFFS0300420A
- Use with 0.040" ID Soft Tubing (TUVA4220900A)

* Suitable for LFA Series solenoid valves with .054" ports (See Section B).

Unless otherwise specified, dimensions are in inches [mm].
In-Line Filter
TCFA1201035A: 35 micron
TCFA6202035A: 35 micron

Tube I.D.
TCFA1201035A: .125” (3.2 mm)
TCFA6202035A: .062” (1.6 mm)

- Materials
  - Body: PC
  - Filter Element: UHMW Polyethylene
- Replacement Filter Element: 35 micron TCFS0300210A
- Max. Operating Pressure: 30 psig (207 kPa)

Unless otherwise specified, dimensions are in inches [mm].
062 MINSTAC In-Line Filter

TKFA3202135A: 35 micron (1300 Lohm)

TKFA9502135A: 35 micron (300 Lohm)

TKFA9502110A: 10 micron (300 Lohm)

Materials
- Body: PEEK
- Filter Element: UHMW PE
- Seal: PTFE

■ Replacement Filter Element: 35 micron TCFS0300560A
■ Operating Pressure: 100 psig (690 kPa)

125/156 MINSTAC In-Line Filter

TKFA9502135A: 35 micron (300 Lohm)

TKFA9502110A: 10 micron (300 Lohm)

Materials
- Body: PEEK
- Filter Element: UHMW PE
- Seal: PTFE

■ Replacement Filter Element: 35 micron TCFS0300560A
■ Operating Pressure: 100 psig (690 kPa)

Unless otherwise specified, dimensions are in inches [mm].
062 MINSTAC Safety Screen
INMX0350000A: 12 micron

1/4-28 Flat Bottom Safety Screen
INMX0350250A: 35 micron

- Materials: PEEK, PTFE (1/4-28 only)
- Maximum Operating Pressure: 120 psig (827 kPa)
- Lohm Rate
  - INMX0350000A: 2100 Lohms
  - INMX0350520A: 250 Lohms
- Internal screen is not replaceable

Unless otherwise specified, dimensions are in inches [mm].
062 MINSTAC – Safety Screen
INMX0502300A: 12 micron

1/4-28 Flat Bottom – Safety Screen
INMX0503300A: 35 micron

- Materials: PEEK
- Maximum Operating Pressure
  INMX0502300A: 150 psig
  INMX0503300A: 120 psig
- Lohm Rate
  INMX0502300A: 1450 Lohms
  INMX0503300A: 280 Lohms

Unless otherwise specified, dimensions are in inches [mm].
MINSTAC tubing assemblies are available in standard lengths and configurations (specials are available for OEM applications).

<table>
<thead>
<tr>
<th>TUTA (cm)</th>
<th>TUTB/TQTB (cm)</th>
<th>TUTC/TQTC (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>—</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>—</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>—</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>—</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>—</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>30</td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>—</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>—</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>300</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3000</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
MINSTAC®
STARTER KITS

MINSTAC Starter Kits
Lee offers four starter kits to familiarize the new user with the versatility of the MINSTAC system and assist in organizing preproduction bread boards.

### 062 MINSTAC Fitting End Kit
**Lee Part Number TMZA3202010Z**

<table>
<thead>
<tr>
<th>Kit Includes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – TTTA3201443A</td>
<td>Collet Tool</td>
</tr>
<tr>
<td>1 – TTTA3201543A</td>
<td>Chamfer Tool</td>
</tr>
<tr>
<td>1 – TTTA3201243A</td>
<td>Torque Wrench</td>
</tr>
<tr>
<td>1 – TTTA6202027A</td>
<td>Knife</td>
</tr>
<tr>
<td>25 – TMAA3202079Z</td>
<td>Coupling Screws</td>
</tr>
<tr>
<td>25 – TMBA3202910Z</td>
<td>Ferrules</td>
</tr>
<tr>
<td>25 – TMCA3202030Z</td>
<td>Collet Sleeves</td>
</tr>
<tr>
<td>1 – TUTA3216930D</td>
<td>10 feet of Tubing</td>
</tr>
<tr>
<td>1 – TTTX0500900A</td>
<td>Rubber Tubing Grip</td>
</tr>
</tbody>
</table>

### 062 MINSTAC Tool Kit
**Lee Part Number TTTA3201043C**

<table>
<thead>
<tr>
<th>Kit Includes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – TTTA3201543A</td>
<td>Chamfer Tool</td>
</tr>
<tr>
<td>1 – TTTA3201443A</td>
<td>Collet Installation Tool</td>
</tr>
<tr>
<td>1 – TTTA3200643A</td>
<td>Combination Spade Drill</td>
</tr>
<tr>
<td>1 – TTTA3200743A</td>
<td>Plug Tap with Stop</td>
</tr>
<tr>
<td>1 – TTTA3200843A</td>
<td>Bottoming Tap with Stop</td>
</tr>
<tr>
<td>1 – TTTA3200543C</td>
<td>Spline Wrench</td>
</tr>
<tr>
<td>1 – TTTA3201243A</td>
<td>Torque Wrench</td>
</tr>
</tbody>
</table>

### 125 MINSTAC Fitting End Kit
**Lee Part Number TMZA6201010Z**

<table>
<thead>
<tr>
<th>Kit Includes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – TTTA6200143A</td>
<td>Coupling Assembly Tool</td>
</tr>
<tr>
<td>1 – TTTA6200343A</td>
<td>Coupling Assembly Tool (ferruleless)</td>
</tr>
<tr>
<td>1 – TTTA6202027A</td>
<td>Knife</td>
</tr>
<tr>
<td>1 – TTTA6202227A</td>
<td>Torque Wrench</td>
</tr>
<tr>
<td>25 – TMAA6201929Z</td>
<td>Coupling Screws</td>
</tr>
<tr>
<td>25 – TMBA6201910Z</td>
<td>Ferrules</td>
</tr>
<tr>
<td>25 – TMCA6201920Z</td>
<td>Collets</td>
</tr>
<tr>
<td>1 – TUTA6230930D</td>
<td>10 feet of Tubing (TFE)</td>
</tr>
<tr>
<td>1 – TTTX0500900A</td>
<td>Rubber Tubing Grip</td>
</tr>
</tbody>
</table>
125 MINSTAC Tool Kit  
Lee Part Number TTTA6201827C  
Kit Includes:  
1 – TTTA6200143A  
1 – TTTA6200343A  
1 – TTTA6201927A  
1 – TTTA6200227C  
1 – TTTA6200227C  
1 – TTTA6201727A  
1 – TTTA6202227A  
- Coupling Assembly Tool  
- Coupling Assembly Tool (ferruleless)  
- Combination Spade Drill  
- Combination Wrench – .25 in.  
- Plug Tap with Stop  
- Bottoming Tap with Stop  
- Torque Wrench  

156 MINSTAC Fitting End Kit  
Lee Part Number TMZA9501110Z  
Kit Includes:  
1 – TT TA9500127A  
1 – TTA9500343A  
1 – TT TA6202027A  
25 – TMAA9501079Z  
25 – TMBA9501910Z  
25 – TMCA9501950Z  
1 – TUTA9531930D  
1 – TTTX0500900A  
- Coupling Assembly Tool  
- Torque Wrench  
- Knife  
- Coupling Screws  
- Ferrules  
- Collet Sleeves  
- 10 feet of Tubing  
- Rubber Tubing Grip  

156 MINSTAC Tool Kit  
Lee Part Number TTTA9500443C  
Kit Includes:  
1 – TTA9500127A  
1 – TTA9500227A  
1 – TTA9500343A  
1 – TTA9500427C  
1 – TTTA6201627A  
1 – TTTA6201727A  
- Coupling Assembly Tool  
- Combination Boss Drill  
- Torque Wrench  
- Wrench  
- Plug Tap with Stop  
- Bottoming Tap with Stop
Lee offers a wide range of nozzles capable of providing either a precise droplet or atomized fluid. Several mounting styles allow these nozzles to be incorporated directly onto our VHS dispensing valves, or to be connected to valves using soft flexible tubing.

Dispense nozzles are available in straight tubes or with jeweled orifices (allowing tighter droplet control).

- Mounting styles include:
  - 062 MINSTAC
  - 062 MINSTAC w/ HEX nut
  - Straight tube for use with soft tubing

Atomizing nozzles are available in airless and air assisted models.
Dispensing Nozzles
Lee dispensing nozzles with 062 threads mount into any Lee 062 MINSTAC boss. This allows the nozzle to be mounted directly onto our VHS micro-dispensing valves. Direct mounting reduces the overall package size and the fluid volume between the nozzle and valve sealing point. This reduced volume decreases the fluid reaction time (time from when the valve opens until the fluid exits the nozzle). This will also allow flow control using PWM (pulse width modulation).

The hypo port design can be pressed into flexible tubing allowing remote mounting of the nozzle. This can be used to decrease the center to center spacing or to place the nozzle away from the valving.

Lee offers Nitinol® dispensing nozzles. These flexible nozzles can be side loaded and still return to their original shape. This prevents permanent damage when they are accidentally struck.

Atomizing Nozzles
Lee atomizing nozzles are offered in both air assisted and airless designs. The airless design provides atomization at relatively low pressure (15 psi) without the need for an external air source. These are offered in a 062 MINSTAC mounting style.

Air assisted nozzles provide atomization with as little as 5 psi fluid and atomizing air pressures. These are designed for use with soft tubing.

Special nozzles can be engineered for insertion into manifolds, and with coatings to reduce droplet adhesion.
Dispensing Nozzles

CONFIGURATION A

(.138-40 UNF-2A)
USE WITH .062 [1.57] MINSTAC BOSS PER LEE CO.
DWG NO. TMI1X1300000A

CONFIGURATION B

(.138-40 UNF-2A)
USE WITH .062 [1.57] MINSTAC BOSS PER LEE CO.
DWG NO. TMI1X1300000A

CONFIGURATION C

Tube is stainless steel. Mounted orifice is sapphire.

Unless otherwise specified, dimensions are in inches [mm].
### 062 MINSTAC Straight Tube

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>TUBE I.D.</th>
<th>TUBE O.D.</th>
<th>TUBE LENGTH</th>
<th>LOHMS</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>INZA3070940K</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.02&quot; (0.51 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>40,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA31025414K</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.02&quot; (0.51 mm)</td>
<td>1.00&quot; (25.4 mm)</td>
<td>14,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA5102514K</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.02&quot; (0.51 mm)</td>
<td>1.00&quot; (25.4 mm)</td>
<td>14,000</td>
<td>B*</td>
</tr>
<tr>
<td>INZA5109914K</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.02&quot; (0.51 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>14,000</td>
<td>B*</td>
</tr>
<tr>
<td>INZA3100914K</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.02&quot; (0.51 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>14,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA3330997D</td>
<td>0.030&quot; (0.76 mm)</td>
<td>0.05&quot; (1.27 mm)</td>
<td>0.37&quot; (9.4 mm)</td>
<td>975</td>
<td>A</td>
</tr>
<tr>
<td>INZA3362597D</td>
<td>0.030&quot; (0.76 mm)</td>
<td>0.07&quot; (1.65 mm)</td>
<td>1.00&quot; (25.4 mm)</td>
<td>975</td>
<td>A</td>
</tr>
</tbody>
</table>

Wetted Material: Stainless Steel, Epoxy
* PTFE coated.

### 062 MINSTAC with Jeweled Orifice

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>ORIFICE I.D.</th>
<th>TUBE O.D.</th>
<th>TUBE LENGTH</th>
<th>LOHMS</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>INZA4620928T</td>
<td>0.002&quot; (0.05 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>280,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4630912T</td>
<td>0.003&quot; (0.08 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>125,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4542560K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>0.020&quot; (0.5 mm)</td>
<td>1.00&quot; (25.4 mm)</td>
<td>60,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4640960K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>60,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA6542460K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>0.020&quot; (0.5 mm)</td>
<td>0.96&quot; (24.4 mm)</td>
<td>60,000</td>
<td>B*</td>
</tr>
<tr>
<td>INZA4650935K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>35,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4652535K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.97&quot; (24.6 mm)</td>
<td>35,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4655035K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>1.97&quot; (50.0 mm)</td>
<td>35,000</td>
<td>A</td>
</tr>
<tr>
<td>INZA4670915K</td>
<td>0.0075&quot; (0.19 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>15,400</td>
<td>A</td>
</tr>
<tr>
<td>INZA6670915K</td>
<td>0.0075&quot; (0.19 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>15,400</td>
<td>A*</td>
</tr>
<tr>
<td>INZA4710975H</td>
<td>0.010&quot; (0.25 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.35&quot; (8.9 mm)</td>
<td>7,500</td>
<td>A</td>
</tr>
</tbody>
</table>

Wetted Materials: Stainless Steel, Sapphire, Epoxy
* PTFE coated.

### Straight Tube with Jeweled Orifice

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>ORIFICE I.D.</th>
<th>TUBE O.D.</th>
<th>TUBE LENGTH</th>
<th>LOHMS</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>INZA2631412T</td>
<td>0.003&quot; (0.08 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.57&quot; (14.5 mm)</td>
<td>125,000</td>
<td>C</td>
</tr>
<tr>
<td>INZA2543460K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>0.020&quot; (0.51 mm)</td>
<td>1.33&quot; (33.8 mm)</td>
<td>60,000</td>
<td>C</td>
</tr>
<tr>
<td>INZA2540660K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>0.020&quot; (0.51 mm)</td>
<td>0.25&quot; (6.4 mm)</td>
<td>60,000</td>
<td>C</td>
</tr>
<tr>
<td>INZA2651435K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.57&quot; (14.5 mm)</td>
<td>35,000</td>
<td>C</td>
</tr>
<tr>
<td>INZA2653035K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>1.17&quot; (29.7 mm)</td>
<td>35,000</td>
<td>C</td>
</tr>
<tr>
<td>INZA2671415K</td>
<td>0.0075&quot; (0.19 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.57&quot; (14.5 mm)</td>
<td>15,400</td>
<td>C</td>
</tr>
<tr>
<td>INZA2961331H</td>
<td>0.016&quot; (0.41 mm)</td>
<td>0.043&quot; (1.09 mm)</td>
<td>0.50&quot; (12.7 mm)</td>
<td>3,100</td>
<td>C</td>
</tr>
<tr>
<td>INZA2621428T</td>
<td>0.002&quot; (0.05 mm)</td>
<td>0.050&quot; (1.3 mm)</td>
<td>0.57&quot; (14.5 mm)</td>
<td>280,000</td>
<td>C</td>
</tr>
</tbody>
</table>

Wetted Materials: Stainless Steel, Sapphire
Hex Dispensing Nozzles

- Nozzles are 062 MINSTAC thread and sealing surface
- MINSTAC spline has been replaced with 0.156" HEX
- Compatible with all LEE 062 MINSTAC components and valves
- Wetted Materials: Stainless Steel, Sapphire

### HEX MINSTAC with Jeweled Orifice

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>JEWEL I.D.</th>
<th>LOHMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INZA7710975H</td>
<td>0.010&quot; (0.25 mm)</td>
<td>7,500</td>
</tr>
<tr>
<td>INZA7670915K</td>
<td>0.008&quot; (0.20 mm)</td>
<td>15,400</td>
</tr>
<tr>
<td>INZA7650935K</td>
<td>0.005&quot; (0.13 mm)</td>
<td>35,000</td>
</tr>
<tr>
<td>INZA7640960K</td>
<td>0.004&quot; (0.10 mm)</td>
<td>60,000</td>
</tr>
<tr>
<td>INZA7630912T</td>
<td>0.003&quot; (0.08 mm)</td>
<td>125,000</td>
</tr>
<tr>
<td>INZA7620928T</td>
<td>0.002&quot; (0.05 mm)</td>
<td>280,000</td>
</tr>
</tbody>
</table>

Unless otherwise specified, dimensions are in inches [mm].
Nitinol® Dispensing Nozzles

Nitinol nozzles allow precise dispensing and flexibility. The Nitinol material is resistant to permanent deformation. This allows the nozzle to be bent and still return to its original shape. The nozzle can also be passed into twisted or restrictive passageways.

- Wetted material: Nitinol, Stainless Steel, Epoxy
- Compatible with 062 MINSTAC bosses

**062 MINSTAC with Straight Nitinol® Tube**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>LENGTH &quot;L&quot;</th>
<th>LOHMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INZA9102520K</td>
<td>1.0&quot; (25.4 mm)</td>
<td>20,000</td>
</tr>
<tr>
<td>INZA9105132K</td>
<td>2.0&quot; (50.8 mm)</td>
<td>32,000</td>
</tr>
<tr>
<td>INZA9107642K</td>
<td>3.0&quot; (76.2 mm)</td>
<td>42,000</td>
</tr>
</tbody>
</table>

Unless otherwise specified, dimensions are in inches [mm].
Atomizing Nozzles

**CONFIGURATION A**

- NOZZLE OUTLET
- INLET
- FLUID
- GAS
- BARB PORT Ø.06 [1.6] SOFT TUBING
- .65 [16.5]
- .20 [5]
- .40 [10.1]

**CONFIGURATION B**

- NOZZLE OUTLET
- GAS INLET
- STRAIGHT PORT Ø.03 [0.8] SOFT TUBING
- FLUID INLET
- .65 [16.5]
- .20 [5]
- .40 [10.1]

**CONFIGURATION C**

- NOZZLE OUTLET
- GAS INLET
- BARB PORT Ø.06 [1.6] SOFT TUBING
- FLUID INLET
- .65 [16.5]
- .20 [5]
- .40 [10.1]

*Unless otherwise specified, dimensions are in inches [mm].*
Airless Atomizing Nozzles

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>LOHMS</th>
<th>OPERATING PRESSURE (psig)</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAZA1200167K</td>
<td>67,000</td>
<td>10-1000</td>
<td></td>
</tr>
<tr>
<td>IAZA1200163K</td>
<td>63,000</td>
<td>10-1000</td>
<td></td>
</tr>
<tr>
<td>IAZA1200147K</td>
<td>47,000</td>
<td>20-1000</td>
<td>A</td>
</tr>
<tr>
<td>IAZA1200134K</td>
<td>34,000</td>
<td>20-1000</td>
<td></td>
</tr>
<tr>
<td>IAZA1200122K</td>
<td>22,000</td>
<td>20-1000</td>
<td></td>
</tr>
<tr>
<td>IAZA1200110K</td>
<td>10,000</td>
<td>20-1000</td>
<td></td>
</tr>
</tbody>
</table>

Spray Cone: 50° hollow
Wetted Material: Stainless Steel

Air Assisted Nozzle

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>LOHMS</th>
<th>OPERATING PRESSURE (psig)</th>
<th>CONFIGURATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAZA5200315K</td>
<td>15,000</td>
<td>5-60</td>
<td>B</td>
</tr>
<tr>
<td>IAZA5200415K</td>
<td>15,000</td>
<td>5-60</td>
<td>C</td>
</tr>
</tbody>
</table>

Spray Cone: 50° solid
External air pressure of 5 psig min. is required for atomization.
Wetted Materials: Stainless Steel, Epoxy
This chart illustrates steady state flow through the nozzles. Flow rates can be further modified by using pulse width modulation through a VHS valve.

- PTFE coating is surface treatment for wetting only
- Airless nozzles designed for use with 062 MINSTAC system
Special Nozzles

Special nozzle designs are available for OEM applications.

- Sharp Tip
- Long Length
- Wash Nozzles
- Multi-Lumen
- Bent Nozzle
- Nozzle Integrated into Valve
- Barb Connection
The Lee IEP Series valves are 2-way, extended performance, axial-flow solenoid operated valves. These are designed for high pressure and high temperature applications where small size and lightweight are critical factors.

The IEP Series valves are supplied with 1/16" inlet and outlet stainless steel tubing. This allows the valve to be connected using standard high pressure chromatography fittings or welded directly in place.

- Two temperatures ranges
  - Standard: 120°F (49°C)
  - High: 275°F (135°C)

- Two pressure ranges
  - Standard: 300 psi (21 bar)
  - High: 800 psi (55 bar)

- All Stainless Steel housing

- Range of seal options
  - FFKM
  - FKM
  - EPDM

- 12 and 24 volt coils available

- Light weight (less than 6 grams)

- Fast (operating speed up to 500 Hz)

Standard materials and configurations are shown on the following pages. The Lee Company can also customize valves to meet specific application requirements. These include custom port configurations.
### IEP SERIES

**SPECIAL PRODUCTS**

**NOTES:**  (1) Wetted materials (in addition to seal): 316 stainless steel, Chrome Core® 18.

(2) Extreme environmental conditions may require higher power.

(3) Spike time is based on max. operating pressure at 70°F (21°C). Lower pressures will allow shorter spike durations. Higher temperatures will require longer spike durations.

(4) Other Lohm rates are available. Contact The Lee Company.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>SEAL MATERIAL 1</th>
<th>SPIKE VOLTAGE (vdc)</th>
<th>HOLD VOLTAGE (vdc)</th>
<th>POWER @ HOLDING VOLTAGE 2 (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEPA1211141H</td>
<td>FKM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2411141H</td>
<td>FKM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA1221141H</td>
<td>FKM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2421141H</td>
<td>FKM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA1211541H</td>
<td>FFKM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2411541H</td>
<td>FFKM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA1221541H</td>
<td>FFKM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2421541H</td>
<td>FFKM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA1211241H</td>
<td>EPDM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2411241H</td>
<td>EPDM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA1221241H</td>
<td>EPDM</td>
<td>12</td>
<td>1.6</td>
<td>0.25</td>
</tr>
<tr>
<td>IEPA2421241H</td>
<td>EPDM</td>
<td>24</td>
<td>3</td>
<td>0.25</td>
</tr>
</tbody>
</table>

*Unless otherwise specified, dimensions are in inches [mm].*
### MAX. SPIKE DURATION (ms)

<table>
<thead>
<tr>
<th>MAX. SPIKE DURATION (ms)</th>
<th>MAX. OPERATING PRESSURE</th>
<th>MAX. AMBIENT TEMPERATURE</th>
<th>FLOW 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psig (bar)</td>
<td>°F (°C)</td>
<td>Lohms (Cv)</td>
</tr>
<tr>
<td>3.8</td>
<td>800 (55)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>3.8</td>
<td>800 (55)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>800 (55)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>800 (55)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>300 (21)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>300 (21)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>3.8</td>
<td>300 (21)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>3.8</td>
<td>300 (21)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>3.8</td>
<td>800 (55)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>3.8</td>
<td>800 (55)</td>
<td>120 (49)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>800 (55)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
<tr>
<td>2</td>
<td>800 (55)</td>
<td>275 (135)</td>
<td>4100 (.005)</td>
</tr>
</tbody>
</table>

Chrome Core 18 is a registered trade name of Carpenter Technology Corp.
GENERAL SPECIFICATIONS
The following specifications apply to all IEP Series solenoid valves, unless otherwise noted.

**Dry Weight:** 4.7 g

**Internal Volume:** 62 µL

**Electrical Characteristics**
The IEP valves will actuate at the rated voltage at low pressures (below 60 psi). Higher pressure applications may need a spike and hold driver.

Spike and hold drive circuit modules are available for use with IEP valves (Part Numbers: IECX0501350A, IECX0501500A).

<table>
<thead>
<tr>
<th></th>
<th>12 VOLT COIL</th>
<th>24 VOLT COIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (ohms)</td>
<td>10.6</td>
<td>37</td>
</tr>
<tr>
<td>Inductance: energized (mH)</td>
<td>22.2</td>
<td>5</td>
</tr>
<tr>
<td>Inductance: de-energized (mH)</td>
<td>16.5</td>
<td>4.2</td>
</tr>
</tbody>
</table>

**Operating Pressure**
- Valves are designed to operate within the normal ranges listed on page N4.
  - Proof Pressure: .......... 2x normal operating pressure
  - Burst Pressure: .......... 3x normal operating pressure

**Operating Temperature**
- Ambient operating temperature range is listed in the Valve Selection Chart pages N3-4.
- Maximum coil temperature not to exceed:
  - 250°F (121°C) for standard model
  - 400°F (204°C) for high temperature model
- Higher temperatures limit coil performance. Coil temperature must take into account ambient conditions and self heating of the valve.

**Response Time**
- Typical response time at 10 psig (air): 0.5 ms

**Filtration**
System filtration of 10 microns is recommended. Improper filtration can result in damage to the valve (leakage) due to contamination of the sealing surface.
ACCESSORIES

Electrical Connectors
The IEP Series valves use 0.025” electrical pins, on 0.100” centers. Standard electrical connectors that fit these dimensions can be used. Lee also offers pre-made lead assemblies (Part Number IHWX0248010).

Special Applications
Special configurations are available for OEM applications. These include stainless 062 MINSTAC connections (male and female), bent ports, and special flow rates.

Integral nozzles and safety screens can also be supplied as special parts.

Standard IEPA Valve Flowing Nitrogen

![Graph showing flow in standard IEPA valve flowing nitrogen]

- **Flow (slpm)**
- **Differential Pressure (psid)**
The Lee Series 120 Solenoid Valve is a 2-way, ultra-miniature, magnetically latched solenoid valve ideal for compact battery-powered pneumatic applications such as air piloting, lab automation (lab-on-a-chip), and other miniature, power-sensitive markets such as fuel cells or for R&D proof of concept projects.

The Series 120 valve sets a new industry standard in reducing space, weight and power consumption. Measuring just 0.4" long, the valve weighs 300 mg and requires only 1.8 mJ/switch. It also features high performance flow switching characteristics, reliable bi-stable performance and quiet operation.
Cross Section View

Unless otherwise specified, dimensions are in inches [mm].

<table>
<thead>
<tr>
<th>GENERAL SPECIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Media</td>
</tr>
<tr>
<td>Operating Voltage</td>
</tr>
<tr>
<td>Flow Capacity (air)</td>
</tr>
<tr>
<td>Operating Pressure</td>
</tr>
<tr>
<td>Coil Resistance</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Leakage</td>
</tr>
<tr>
<td>Max Frequency</td>
</tr>
<tr>
<td>Interface</td>
</tr>
<tr>
<td>Wetted Materials</td>
</tr>
</tbody>
</table>
The Lee Visco-Jet® Micro-Mixer

The Lee Visco-Jet Micro-Mixer uses aerospace technology to provide the ultimate in static mixing efficiency. A series of 36 critically controlled spin chambers subject the incoming liquids to a vigorously repeated mixing process. No electrical or mechanical input is required – the mixing energy is drawn from the liquids themselves.

Two sizes are currently offered, differing primarily in their internal volume, to provide the user a selection to optimize system performance.

- Low Internal Volume – 10 µL and 250 µL Models
- Special Sizes as Small as 3 µL Available
- Material – 316 Stainless Steel
- Maximum Flow – 45 mL/min. at 70°F 6,000 psid Water
- Screen Protected Passages
- Zero Dead Volume
- Proof-tested to 10,000 psi
Each mixing chamber induces tangentially spinning fluids to reduce their radius of rotation to allow passage into the next chamber, thus increasing angular velocity. This rapidly spinning column of liquid must then reverse its own direction of rotation in order to progress to subsequent spin chambers. The result is a vigorously repeated mixing process.

The mixing in a Lee Visco Mixer is a relatively brief process. As shown in the table below, the throughput time of the mixer is directly related to the flow rate. The more flow, the briefer the throughput time. It is during this throughput time that the two input flows are combined together for mixing.

<table>
<thead>
<tr>
<th>FLOW (µL/min.)</th>
<th>THROUGHPUT TIME (SEC.)</th>
<th>PRESSURE DROP (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 µL MIXER</td>
<td>250 µL MIXER</td>
</tr>
<tr>
<td>50</td>
<td>12.0</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>6.0</td>
<td>150</td>
</tr>
<tr>
<td>200</td>
<td>3.0</td>
<td>75</td>
</tr>
<tr>
<td>500</td>
<td>1.2</td>
<td>30</td>
</tr>
<tr>
<td>1000</td>
<td>.6</td>
<td>15</td>
</tr>
<tr>
<td>2000</td>
<td>.3</td>
<td>7</td>
</tr>
<tr>
<td>4000</td>
<td>.15</td>
<td>3</td>
</tr>
</tbody>
</table>

Any irregularities in either of the input flows will tend to be time averaged during the throughput time of the mixer.
- Wetted Materials: 316 Stainless Steel Au/Ni Braze per AMS 4787
- Proof Pressure: Tested to 10,000 psi
- Passage Size: 130 micron nominal
- Internal Protective Filtration: 17 µ nominal, 45 µ absolute
- Lohm Rate: 130,000 Lohms ±15%
- Internal Volume: 10 µL and 250 µL
- Fittings: Compatible with Swagelok® chromatography fittings (tubing and couplings are customer supplied)

Unless otherwise specified, dimensions are in inches [mm].
**In-Line 10 µL Model**
Part Number TCMA0110113T

**In-Line 250 µL Model**
Part Number TCMA2510113T

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>INTERNAL VOLUME</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCMA0120113T</td>
<td>10 µL</td>
<td>316 Stainless Steel</td>
</tr>
<tr>
<td>TCMA2520113T</td>
<td>250 µL</td>
<td>316 Stainless Steel</td>
</tr>
<tr>
<td>TCMA0110113T</td>
<td>10 µL</td>
<td>316 Stainless Steel</td>
</tr>
<tr>
<td>TCMA2510113T</td>
<td>250 µL</td>
<td>316 Stainless Steel</td>
</tr>
</tbody>
</table>

Unless otherwise specified, dimensions are in inches [mm].
Operating Voltage Regulating Driver (OV'R Driver)

The OV'R Driver is a miniature electronic device which can be used to enhance the versatility and operating characteristics of solenoid valves. This circuit has a self-contained 'spike & hold' voltage controller, which allows the valve to be run at various voltages to compensate for fluctuations in power sources. This circuit can also be used to enhance a solenoid valve's response time or to reduce power consumption.

- Solenoid valves operated at nominal voltages are automatically dropped to a lower 'holding' voltage resulting in lower power consumption.
- Fluctuations in input voltage levels are compensated, resulting in more consistent valve performance.
- Allows standard valves to be energized with a high voltage, reducing response time, and then held at a lower voltage thereby reducing heating.
Operation

The OV'R Driver is a simple three terminal device placed between the voltage source and the solenoid valve. Applying the input voltage to the circuit allows the solenoid to be energized by the OV'R Driver with approximately the full input voltage for a short time period. The circuit then reduces the voltage across the solenoid valve to the holding voltage level. The voltage across the valve will remain at this holding level until power is removed from the circuit. No additional control signals are necessary.

Both the spike duration and the holding voltage can be factory set to meet a variety of applications. The holding voltage, once set, is independent of the input voltage. The OV'R Driver can drive any solenoid valve up to 30 vdc and 15 Watts.

Pulse Width vs. Input Voltage

A key advantage of the OV'R Driver circuit is its ability to self-adjust the pulse width of the output spike voltage based on the input voltage level. As input voltage increases, the spike duration needed decreases. The holding voltage is unaffected by the input voltage level and since solenoid valves respond quicker at higher input voltages, the spike duration can be shortened, minimizing energy consumption, without affecting valve operation.
Models

The OV’R Driver is available in two standard configurations which are optimized for 12 vdc solenoid valves.

- Part Number DRVA0000010A – Designed to drive a single valve (less than 1 Watt)
- Part Number DRVA0000020A – Designed to drive multiple valves (15 Watt max total power). This design does not allow valves to be energized independently.

\[\text{Unless otherwise specified, dimensions are in inches [mm].}\]
OV'R Driver Operating Ranges

70° F, 100% duty cycle

* A 15 volt minimum input voltage is recommended to make up for the small voltage drop across the O'VR Driver when using a 12 volt valve.
LSP Series Solenoid Valves
The LSP Series valve is a 2-way, manifold mounted, normally closed design featuring a full bore flow path. The full bore allows unimpeded high flow and is very tolerant of fluids that have particles and solids. The design minimizes clogging and leakage in applications such as waste and drain lines.

The flow path is a single wetted material incorporating flanged ports, thus eliminating the need for gaskets during mounting.

- Flow: 300 Lohms nominal
- Zero dead (unswept) volume
- Working pressure: 15 psig
- Response time: 30 ms
- Cycle life: 10 million cycles on clean water (minimum)
- Power consumption: 1.6 W
- Wetted material: FKM

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>OPERATING VOLTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSPA1242130D</td>
<td>12 vdc</td>
</tr>
<tr>
<td>LSPA2442130D</td>
<td>24 vdc</td>
</tr>
</tbody>
</table>

![Diagram of LSP Series Valve]
For manifold boss, use Lee Drawing LSIX1001450A

Unless otherwise specified, dimensions are in inches [mm].
Typical Water Flow Characteristics

Flow Rate (mL/min)

Differential Pressure (psi)

Differential Pressure (kPa)

- 300 Ohms
Lohm Laws
Definition............................................................................................... S3
Liquid Flow ............................................................... S4-5
Liquid Flow – Units Constant K..................................................... S6
Viscosity “V” Factor............................................................. S7
Liquid Lohm Rate vs. Hole Diameter ........................................... S8
Liquid Flow Formulas ................................................. S9-10
Fluid Power Dissipation ..................................................... S11-12
Gas vs. Liquid Calibration..................................................... S13
Gas Lohm Laws............................................................. S14-20
Gas Flow Rate of Various Air at Room Temperature ................ S15
Units Constant K – Volumetric / Gravimetric.......................... S18-20
Absolute Pressure Measurement........................................ S21
Gas Flow Characteristics / Momentum Forces...................... S22-24
Pneumatic Power Dissipation ........................................... S25
Gas Properties............................................................................ S26
Transient Gas Flow............................................................. S27-28

Tubing Flow
Resistance to Flow in Tubing..................................................... S29
Tubing Flow Curves ............................................................. S30-31
Tubing Volume vs. Length..................................................... S32

Contamination............................................................................ S33

Electrical Engineering
Ohm’s Law................................................................................. S34
Lee Solenoid Coil Electrical Characteristics.......................... S35
Basic Drive Circuit ............................................................. S36
Spike and Hold Driver Schematic........................................ S37
Fast Response Drive Circuit................................................ S38
Low Power Consumption Circuit........................................ S39-40
Latching Valve Driver Schematic......................................... S41-43

Reference Information
Primary Standards........................................................................ S44
Conversion Factors............................................................. S45-50
Pressure Conversion Chart ................................................ S48
Viscosity............................................................................. S51-56
Specific Gravity........................................................................ S57-58
Torque Conversion..................................................................... S59
Temperature Conversion..................................................... S60
Materials.............................................................................. S61-62

Glossary..................................................................................... S63-64

References................................................................................... S64
A Simplified System of Defining Fluid Resistance

Over the years, The Lee Company has developed the Lohm system for defining and measuring resistance to fluid flow. Just as the “ohm” defines electrical resistance, the “Lohm” or “liquid ohm” can be used as a measure of fluid resistance.

The Lohm is defined such that 1 Lohm will flow 100 gallons per minute of water with a pressure drop of 25 psi at a temperature of 80°F. Since resistance is inversely proportional to flow, by definition:

$$\text{Lohms} = \frac{100}{\text{flow (gal/min H}_2\text{O @ 25 psid)}}$$

1,000 Lohms will flow 0.1 GPM (378.5 mL/min.)
378,500 Lohms will flow 1 mL/min.

By using Lohms, one can specify performance without concern for coefficients of discharge, passageway geometries, physical dimensions or tolerances. The resistance of any flow configuration can be expressed in Lohms and confirmed by actual flow tests.

Lohm Laws generalize the Lohm definition for calculating the resistance required to flow any liquid or gas. Lohm Laws allow the system designer to determine Lohm requirements for a particular fluid with the desired pressures and flow rates. The graph on page S8 will be helpful in relating Lohms to hole diameter and flow coefficient, CV, during the introduction of the Lohm system.
LIQUID FLOW

The Lohm Laws predict the actual performance of fluidic devices beyond the definition conditions of water at 25 psid and 80°F. The Liquid Flow Lohm Law is shown below and the Gas Flow Lohm Law can be found on page S16.

In Liquid Flow several variables must be related, including:

- \( I \) = Flow rate
- \( H \) = Differential pressure
- \( V \) = Viscosity correction factor. \( V \) factors compensate for the interaction of viscosity and device geometry and are unique to each class of device. See page S7 for a graph of “\( V \)” factors for typical Lee orifices.
- \( S \) = Specific gravity
- \( K \) = A constant to take care of units of measure. See page S6 for table of values

The Lohm Law for Liquid Flow is:

\[
Lohms = \frac{KV}{I} \sqrt{\frac{H}{S}}
\]

When testing with water at 25 psid (\( \sqrt{H} = 5 \)), 80°F and flow rate in gallons per minute,

\[
Lohms = \frac{100}{I} \quad \quad \quad \quad I = \frac{100}{Lohms}
\]

Notes:
1. \( V \) and \( S \) are equal to 1 for water at 80°F
2. \( \text{Lohms} = \frac{20}{C_v} = \frac{.67}{C_d d^2} \) and \( C_v = 30 C_d d^2 \)

\( d \) = orifice diameter (inches)
\( C_d \) = coefficient of discharge
\( C_v \) = flow coefficient

For special flow requirements, The Lee Company can determine the required Lohm rating.
LIQUID FLOW – EXAMPLES

Problem 1. A restrictor is required to flow 0.1 GPM of 50/50 ethylene glycol/water blend (specific gravity = 1.07) at 45°F and 6 psid. How many Lohms are required?

Solution:
1. Read kinematic viscosity; \( \nu = 5.0 \) cs from curve on pages S53-54.
2. Use \( \nu \) and \( \Delta P \) to determine viscosity correction factor, \( V = .87 \), from curve on page S7.
3. Select unit constant \( K \) from table on page S6.
4. Compute Lohms required.

\[
L = \frac{20 \nu}{H} \sqrt{\frac{H}{S}} = 20 \cdot \frac{.87}{.1} \sqrt{\frac{6}{1.07}} = 412 \text{ Lohms}
\]

Problem 2. What pressure drop will result from a flow of 57 mL/min. of 50/50 ethylene glycol/water mixture (specific gravity = 1.07) at 45°F, flowing through a 1000 Lohm restrictor?

Solution:
1. Find viscosity from pages S53-54. \( \nu = 5 \) cs
2. Use \( \nu \) and \( \Delta P \) to determine viscosity correction factor, \( V = .75 \), from curve on page S7.
3. Select unit constant \( K \) from table on page S6.
4. Compute Lohms required.
5. Compute trial \( \Delta P \)

\[
H = S \frac{I L^2}{K^2 V^2} = 1.07 \cdot \left( \frac{57 \cdot 1000}{75700 \cdot .75} \right)^2 = 1.08 \text{ psid}
\]

6. Make trials as required to find correct solution.

\( H = 2 \) psid \( V = .55 \)
LIQUID FLOW – UNITS CONSTANT K

To eliminate the need to convert pressure and flow parameters to specific units such as PSI and GPM, the units constant K may be used in the Lohm formula:

\[ L = \frac{KV}{I} \sqrt{\frac{H}{S}} \]

<table>
<thead>
<tr>
<th>FLOW UNITS</th>
<th>PRESSURE UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>psi</td>
</tr>
<tr>
<td>gpm</td>
<td>20</td>
</tr>
<tr>
<td>L/min.</td>
<td>75.7</td>
</tr>
<tr>
<td>mL/min.</td>
<td>75,700</td>
</tr>
<tr>
<td>in³/min.</td>
<td>4,620</td>
</tr>
<tr>
<td>ft³/min.</td>
<td>2.67</td>
</tr>
</tbody>
</table>

Example: Problem: An orifice must flow 43 in.³/min. of water at a head of 300 kPa. What Lohm rate is required?

Solution: First, the appropriate K is selected from the table: K = 1,760.
Second, the Lohm Formula is solved using the K value:

\[ L = \frac{1760 \sqrt{300}}{43} = 709 \text{ Lohms} \quad (S = V = 1.0) \]
Note: “V” Factor Curve may vary depending on specific geometry of the device.
LIQUID LOHM RATE VERSUS HOLE DIAMETER
(Single Orifice Restrictor)

FLOW COEFFICIENT, \( C_v \)

\[
L = \frac{.67}{C_d \ d^2}
\]
and
\[
L = \frac{20}{C_v}
\]

APPROXIMATE HOLE DIAMETER (INCHES)

GRAPHICAL EXTENSION
.500 DIA. = 3 LOHMS, .250 DIA. = 12 LOHMS, .025 DIA. = 1200 LOHMS
LIQUID FLOW – TWO FORMULAS FOR COMBINATIONS OF RESTRICTORS

For parallel flow, the total Lohm rating is:

\[
\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots + \frac{1}{L_N}
\]

Please note that this relationship is identical to the electrical equation.

Example:

\[
\frac{1}{L_T} = \frac{1}{2000} + \frac{1}{3000} + \frac{1}{5000} = 0.00103 \text{ and therefore } L_T = 970 \text{ Lohms}
\]

For series flow, the total Lohm rating is:

\[
L_T = \sqrt{L_1^2 + L_2^2 + L_3^2 + \ldots + L_N^2}
\]

Please note that this relationship is not the same as in electrical problems. The difference is due to the non-linearity of

\[
H = \frac{I^2 L^2 S}{K^2 V^2}
\]

Example:

\[
L_T = \sqrt{2000^2 + 3000^2 + 5000^2} = 6164 \text{ Lohms}
\]

When \(L_1 = L_2 = L_3\), then \(L_T = L\sqrt{N}\)

\(N = \text{Number of equal resistors in series}\)

For passageway size: \(D_T = \frac{D}{N^{1/4}}\)

\(D = \text{Diameter of the actual orifices, each with a Lohm rate } = L_1\)
\(D_T = \text{Diameter of a single equivalent orifice, with a Lohm rate } = L_T\)
MOMENTUM FORCES – LIQUID FLOW

The momentum Lohm Laws give the designer simple formulas to determine the forces caused by changes in velocity (either speed or direction) of a liquid.

\[ F = \frac{SI^2L}{400} \quad F = \frac{H}{L} \quad F = \frac{I \sqrt{HS}}{20} \]

F = Force in lbs. \quad H = \text{psid} \quad I = \text{GPM} \quad S = \text{Spec. gravity}

These forces are produced by locally high (or low) pressure gradients, and should be added to the forces produced by the static pressure. It is often useful to sketch these pressure gradients to determine the direction of the momentum forces.

EXAMPLE: Where a liquid changes direction.

\[ F_{\text{momentum}} = \frac{H}{L} = \frac{990}{600} = 1.7 \text{ lbf} \]

The momentum force of 1.6 lbs. in this example must be added to the force produced by static pressure on the plate (of .1 in.\(^2\) x 10 psi = 1 lb.) to give the total force on the plate.

EXAMPLE: Where a liquid changes speed.

\[ F_{\text{momentum}} = \frac{SI^2L}{400} = \frac{1 \times 2^2 \times 100}{400} = 1 \text{ lbf} \]

The momentum force of 1lb. in this example must be subtracted from the force produced by static pressure on the plate (of 0.1 \times [3000-2900] = 10 lb.) to give the total force on the piston.
FLUID POWER DISSIPATION

Whenever there is flow through an orifice, there is a power consumption (or loss) which is a function of the pressure drop and the flow rate. The following data is useful in calculating the hydraulic power requirements of a system.

\[
H.P. = \frac{H \times I}{1714} \quad \text{When } H = \text{ psi } \Delta P, \quad I = \text{ GPM flow rate}
\]

The hydraulic power can also be expressed in another convenient form.

\[
H.P. = \frac{0.0117 H^{3/2}}{L} \quad \text{or} \quad \frac{0.0117 H^{1/2}}{L}
\]

Since 1 H.P. = 746 watts, the above formula can be:

\[
\text{Watts} = \frac{8.70 H^{3/2}}{L} \quad \text{or} \quad \frac{8.70 H^{1/2}}{L}
\]

The nomogram on the next page shows this relationship.

EXAMPLE:

A Lee Valve rated at 400 Lohms will flow 0.35 GPM at 50 psid. At those conditions, what horsepower is lost?

\[
H.P. = \frac{H \times I}{1714} = \frac{50 \times 0.35}{1714}
\]

\[
H.P. = 0.010
\]
NOMOGRAM for FLUID POWER DISSIPATION

\[ W = 8.70 \frac{H^3}{L} \]

\[ HP = 0.017 \frac{H^3}{L} \]

Example:

- \( H \) (PSID)
- \( HP \) (HORSEPOWER)
- \( W \) (WATTS)
- \( L \) (LOHMS)
**GAS vs. LIQUID CALIBRATION**

Most EFS products are calibrated on gas for both gas and liquid service. Should it be necessary to use a gas calibrated component for liquid service, or a liquid calibrated component for gas service, the following factors should be considered.

Allowance should be made for variations in liquid/gas correlation of up to ±15%. This is caused by the response of different fluids to the orifice geometry.

Single-orifice restrictors will correlate directly from gas to liquid service, subject to the ±15% normal variation.

Multi-orifice restrictors will correlate directly only when the pneumatic pressure ratio is very low (P₁ / P₂ < 1.2).

When Multi-orifice restrictors are used at higher pressure ratios, the gas flow will be up to 30% higher than expected from a liquid calibration. This is caused by gas compressibility which results in a non-uniform distribution of pressure drops through the restrictor.

**WARNING:** Do not substitute hydraulic restrictors in gas applications, or vice versa, without first considering the application and correlation accuracy.

**STANDARD CONDITIONS**

U.S. Standard Conditions at sea level are per ICAO STD ATMOSPHERE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>14.70 psia (29.92 in. Hg)</td>
</tr>
<tr>
<td>Temperature</td>
<td>59°F (518.7°R)</td>
</tr>
</tbody>
</table>

Other References may use somewhat different conditions.

**GAS FLOW ACFM TO SCFM CONVERSION**

It is frequently convenient to express gas flow in terms of flow at standard conditions. This is useful for calculation purposes, or for application to flow measuring instruments.

\[
\text{SCFM} = \text{ACFM} \left( \frac{P}{14.7} \right) \left( \frac{519}{T} \right)
\]

**UNITS:**

- T = Gas temperature, °R = 460 + °F
- P = Gas pressure, psia
- ACFM = Gas flow, actual cubic feet/minute
- SCFM = Gas flow, standard cubic feet/minute

**EXAMPLE:** What is SCFM corresponding to 0.032 ACFM at 300 psia and at 240°F?

**SOLUTION:**

\[
\text{SCFM} = 0.032 \left( \frac{300}{14.7} \right) \left( \frac{519}{700} \right) = 0.48
\]
LOHM LAWS (GAS)

Every engineer will be interested in our simple system of defining the fluid resistance of Lee components. Just as the OHM is used in the electrical industry, we find that we can use the Liquid OHM or “Lohm” to quantify the restriction of hydraulic or pneumatic components.

When using the Lohm system for pneumatics, the effect of flow in the subsonic region and the compressibility of gases is corrected for in the Lohm calculations. The resistance to flow of any component can be expressed in Lohms.

The Lohm has been selected so that a 100 Lohm restriction will permit a flow of 250 standard liters per minute of nitrogen at a temperature of 59°F, and an upstream pressure of 90 psia discharging to atmosphere.

The graph on the following page relates Lohms to hole diameter for a single orifice restrictor.
GAS FLOW RATE OF VARIOUS RESTRICTION AIR AT ROOM TEMPERATURE

AIR FLOW – SCFM

AIR SUPPLY PRESSURE – psig
The Lohm Laws extend the definition of Lohms for gas flow at any pressure and temperature, and with any gas. The formulas work well for all gases because they are corrected for the specific gas, and for the flow region and incompressibility of low pressure gases.

The Lohm Law for Gas Flow is:

\[
\text{Lohms} = \frac{K_f T P_1}{Q} \quad \text{(Sonic region)}
\]

i.e. \( P_1 / P_2 \geq 1.9 \)

\[
\text{Lohms} = \frac{2 K f_T \sqrt{\Delta P} P_2}{Q} \quad \text{(Subsonic region)}
\]

i.e. \( P_1 / P_2 < 1.9 \)

NOMENCLATURE

\( K = \) Gas units constant (see pages S18-19)

\( f_T = \) Temperature correction factor (see page S17)

\( P_1 = \) Upstream absolute pressure (psia)

\( P_2 = \) Downstream absolute pressure (psia)

\( Q = \) Gas flow (std L/min.)

\( \Delta P = P_1 - P_2 \) (psid)

All you have to do is:

- Compute the \( P_1 / P_2 \) pressure ratio.
- Select the correct formula for the flow region.
- Look up the value of “K” for the gas.
- Look up the temperature correction factor, “\( f_T \).”
- Use the formula to solve for the unknown.
EXAMPLE: What restriction will permit a flow of 1.00 std L/min. of nitrogen at 90°F, with supply pressure at 5 psig, discharging to atmosphere?

\[ K = 276 \text{ (see pages S18-19)} \]
\[ T_1 = 90 f_T = 0.98 \]
\[ P_1 = 5.0 + 14.7 = 19.7 \text{ psia, } P_2 = 14.7 \text{ psia} \]
\[ P_1/P_2 = 19.7/14.7 = 1.34 \text{ (subsonic)} \]
\[ \Delta P = 5.0 \text{ psid} \]
\[ Q = 1.00 \text{ std L/min.} \]

\[ L = \frac{2 \times 276 \times 0.98 \times \sqrt{5.0 \times 14.7}}{1.00} = 4,640 \text{ Lohms} \]
UNITS CONSTANT “K” – VOLUMETRIC

To eliminate the need to convert pressure and flow parameters into specific units such as “psia” and “std L/min.,” the table below lists values of the Units Constant “K,” which is used in the Gas Flow Lohm Formula:

\[
\text{Lohms} = \frac{K f_T P_1}{Q} \quad \text{(Sonic)}
\]

<table>
<thead>
<tr>
<th>VOLUMETRIC FLOW UNITS</th>
<th>Abs. Pres</th>
<th>psia</th>
<th>In³/min</th>
<th>bar</th>
<th>kPa</th>
<th>mm/Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLOW</td>
<td>SLPM</td>
<td>SCFM</td>
<td>SLPM</td>
<td>SCFM</td>
<td>SLPM</td>
<td>mL/min</td>
</tr>
<tr>
<td>H₂</td>
<td>1030</td>
<td>36.3</td>
<td>62,700</td>
<td>14,900</td>
<td>149</td>
<td>19,900</td>
</tr>
<tr>
<td>He</td>
<td>771</td>
<td>27.2</td>
<td>47,100</td>
<td>11,200</td>
<td>112</td>
<td>14,900</td>
</tr>
<tr>
<td>Neon</td>
<td>343</td>
<td>12.1</td>
<td>20,900</td>
<td>4,980</td>
<td>176</td>
<td>49.8</td>
</tr>
<tr>
<td>Nat. Gas</td>
<td>319</td>
<td>11.3</td>
<td>19,400</td>
<td>4,620</td>
<td>163</td>
<td>46.2</td>
</tr>
<tr>
<td>N₂</td>
<td>276</td>
<td>9.730</td>
<td>16,800</td>
<td>4,000</td>
<td>141</td>
<td>40.0</td>
</tr>
<tr>
<td>CO</td>
<td>274</td>
<td>9.69</td>
<td>16,700</td>
<td>3,980</td>
<td>141</td>
<td>39.8</td>
</tr>
<tr>
<td>Air</td>
<td>271</td>
<td>9.56</td>
<td>16,500</td>
<td>3,930</td>
<td>139</td>
<td>39.3</td>
</tr>
<tr>
<td>Ethane</td>
<td>251</td>
<td>8.86</td>
<td>15,300</td>
<td>3,640</td>
<td>129</td>
<td>36.4</td>
</tr>
<tr>
<td>O₂</td>
<td>257</td>
<td>9.08</td>
<td>15,700</td>
<td>3,730</td>
<td>132</td>
<td>37.3</td>
</tr>
<tr>
<td>Argon</td>
<td>245</td>
<td>8.65</td>
<td>14,900</td>
<td>3,550</td>
<td>125</td>
<td>35.5</td>
</tr>
<tr>
<td>CO₂</td>
<td>213</td>
<td>7.52</td>
<td>13,000</td>
<td>3,090</td>
<td>109</td>
<td>30.9</td>
</tr>
<tr>
<td>N₂O</td>
<td>214</td>
<td>7.56</td>
<td>13,100</td>
<td>3,100</td>
<td>110</td>
<td>31.0</td>
</tr>
<tr>
<td>SO₂</td>
<td>176</td>
<td>6.21</td>
<td>10,700</td>
<td>2,550</td>
<td>90.1</td>
<td>25.5</td>
</tr>
<tr>
<td>Freon-12</td>
<td>123</td>
<td>4.34</td>
<td>7,510</td>
<td>1,780</td>
<td>63.0</td>
<td>17.8</td>
</tr>
</tbody>
</table>
UNITS CONSTANT “K” – GRAVIMETRIC

See examples on page S20 of using the Units Constant “K” with flow specified in either volume or weight units.

\[
\text{Lohms} = \frac{K f_T P_1}{w} \quad \text{(Sonic)}
\]

<table>
<thead>
<tr>
<th>GRAVIMETRIC FLOW UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abs. Pres</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td><strong>FLOW</strong></td>
</tr>
<tr>
<td>H₂</td>
</tr>
<tr>
<td>He</td>
</tr>
<tr>
<td>Neon</td>
</tr>
<tr>
<td>Nat. Gas</td>
</tr>
<tr>
<td>N₂</td>
</tr>
<tr>
<td>CO</td>
</tr>
<tr>
<td>Air</td>
</tr>
<tr>
<td>Ethane</td>
</tr>
<tr>
<td>O₂</td>
</tr>
<tr>
<td>Argon</td>
</tr>
<tr>
<td>CO₂</td>
</tr>
<tr>
<td>N₂O</td>
</tr>
<tr>
<td>SO₂</td>
</tr>
<tr>
<td>Freon-12</td>
</tr>
</tbody>
</table>
UNITS CONSTANT “\(K\)"

**EXAMPLE:** A restrictor must flow 8.20 std L/min. of helium at room temperature (70°F), with an inlet pressure of 1,500 kPa, discharging to atmosphere. What Lohm rate is required?

\[
K = 112 \quad \text{(see pages S18-19)} \\
T_1 = 70°F, \quad f_T = 1.00 \quad \text{(see page S17)} \\
P_1 = 1,500 \text{ kPa}, \quad P_2 = 101 \text{ kPa} \\
P_1/P_2 = 14.9 \quad \text{(sonic)} \\
Q = 8.20 \text{ std L/min.}
\]

\[
L = \frac{112 \times 1,500 \times 1.00}{8.20} = 20,500 \text{ Lohms}
\]

**EXAMPLE:** A restrictor must flow 0.0015 lbm/s of oxygen at room temperature (70°F), with an inlet pressure of 1,200 psia, discharging to 850 psia. What Lohm rate is required?

\[
K = 0.0128 \quad \text{(see pages S18-19)} \\
T_1 = 70°F, \quad f_T = 1.00 \\
P_1 = 1,200 \text{ psia}, \quad P_2 = 850 \text{ psia.} \\
P_1/P_2 = 1.41 \quad \text{(subsonic)} \\
\Delta P = 350 \text{ psid.} \\
w = 0.0015 \text{ lbm/s} \\

L = \frac{2 \times 0.0128 \times 1.00 \times \sqrt{350 \times 850}}{0.0015} = 9,300 \text{ Lohms}
\]
**ABSOLUTE PRESSURE MEASUREMENT**

Gas flow is a function of upstream absolute pressure, and of the ratio of upstream to downstream pressures. Lohm testing done at The Lee Company is performed at an upstream pressure which is high enough so that downstream pressure does not affect the flow rate. To accurately determine the upstream absolute pressure, it is necessary to measure atmospheric pressure with a suitable barometer. This measurement will normally be in units of in. Hg, while the gauge pressure reading is in units of psig. Thus, the barometer reading must be converted to psia, and added to the gauge reading to get the value of pressure in psia.

\[
\text{Pres. (psia)} = \text{Pres. (psig)} + 0.4912 \times \text{Pres. (in. Hg @ 32°F)}.
\]

**EXAMPLE:** What single-orifice restriction will permit a flow of 2.00 std L/min. of nitrogen at 70°F, with supply pressure at 10 psig, discharging to an atmospheric pressure of 29.5 in. Hg.

\[
K = 276 \text{ (see pages S18-19)}
\]

\[
T_1 = 70°F, \quad f_T = 1.00 \text{ (see page S17)}
\]

\[
P_2 = 0.4912 \times 29.5 = 14.5 \text{ psia.}
\]

\[
P_1 = 10.0 + 14.5 = 24.5 \text{ psia.}
\]

\[
P_1/P_2 = 24.5/14.5 = 1.69 \text{ (subsonic)}
\]

\[
\Delta P = 24.5-14.5 = 10.0 \text{ psid.}
\]

\[
Q = 2.00 \text{ std L/min}
\]

\[
L = \frac{2 \times 276 \times 1.0 \times \sqrt{10.0 \times 14.5}}{2.00} = 3,320 \text{ Lohms}
\]
GAS FLOW CHARACTERISTICS

When selecting components for use in a gas system, certain factors must be considered which arise only because of the compressibility of the gaseous medium. The nature of gas compressibility is defined by the following two rules:

**Boyle's Law** – The pressure and specific volume of a gas are inversely proportional to each other under conditions of constant temperature.

**Charles’ Law** – The pressure and temperature of a gas are directly proportional to each other when the volume is held constant, and the volume and temperature are directly proportional when the pressure is held constant.

Thus, a gas will expand to fill any container, and pressure and temperature will adjust to values consistent with the above rules. Gas flowing through valves and restrictors will be subject to an increasing specific volume as pressure drops take place, and temperatures will change as determined by the Joule-Thomson effect.

The combination of the above rules forms the basis for the “Equation of State” for perfect gases. This allows either pressure, temperature, or volume to be calculated for a known quantity of gas when the other two variables are known.

\[ p \ V = m \ R \ T \] (see page S26 for values of gas constant, R)

In general, the following comments apply to gas flow:

1. Gas flow at high pressure ratios \( (P_1/P_2 > 1.9) \) is directly proportional to the upstream absolute pressure.

2. Gas flow at moderate pressure ratios \( (1.1 < P_1/P_2 < 1.9) \) is proportional to the downstream absolute pressure, and to the pressure differential (see page S16).

Continued on next page.
GAS FLOW CHARACTERISTICS (continued)

3. Gas flow at low pressure ratios ($P_1/P_2 < 1.1$) is proportional to the pressure differential, similar to hydraulic flow.

4. When restrictions appear in series, the most downstream restrictor dominates in the determination of flow rate.

5. When the absolute pressure ratio across a restrictor is above $1.9$, the gas velocity will reach the speed of sound (sonic flow) in the restrictor throat. When restrictors appear in series the overall pressure ratio must be even higher.

6. When equal restrictors appear in series, sonic flow can only occur in the most downstream restrictor.

7. Velocity of the gas stream cannot exceed the speed of sound in either a constant area duct, or a converging section.

The Rule of Forbidden Signals: *

“The effect of pressure changes produced by a body moving at a speed faster than the speed of sound cannot reach points ahead of the body.”

This rule can be applied to pneumatic flow restrictors where the body is not moving, but the flow velocity relative to the body can reach, or exceed, the speed of sound. Whenever the downstream pressure is low enough to produce Mach 1 at the restrictor throat, any effect of changes in the downstream pressure cannot reach points upstream of the throat. Thus, flow rate will be independent of downstream pressure. This situation applies to a single orifice restrictor flowing air when the overall pressure ratio exceeds $1.89/1$

MOMENTUM FORCES – GAS FLOW

When a flowing stream of gas is subject to a change in velocity (either speed or direction), forces arise which are the reaction to the change in momentum of the stream. This is particularly important in valve design where the position of a moving element may be affected.

The direction in which the momentum force acts is always opposite to the acceleration which is imparted to the flow stream. The magnitude of the force may be calculated by using the momentum Lohm Laws which apply to air at near room temperature.

\[ F = \frac{0.4 \times P_1}{L} \quad F = \frac{\text{SLPM}}{700} \]  

(sonic flow)

**EXAMPLE:** Where a gas changes direction.

\[ F = \frac{0.4 \times P_1}{L} = \frac{0.4 \times 1000}{2000} = 0.2 \text{ lbf.} \]

The momentum force of 0.2 lbs. in this example must be added to the force produced by static pressure on the plate (0.1 in.\(^2\) x 10 psi = 1 lb.) to give the total force on the plate.

**EXAMPLE:** Where a gas changes speed.

\[ F = \frac{\text{SLPM}}{700} = \frac{35}{700} = 0.05 \text{ lbf.} \]

The momentum force of 0.05 lb. in this example must be subtracted from the force produced by static pressure on the plate (0.1 in.\(^2\) x [100-50] = 5 lb.) to give the total force on the piston.
For more precise calculations, or to extend the range of the pneumatic power dissipation graph, the following formula may be used for air.

\[
\text{Watts} = \frac{1,641 \ P_1}{L} \left( \frac{P_1}{P_2} \right)^{1/4} - 1
\]

- \( P_1 \) = Supply Pressure (psia)
- \( P_2 \) = Exhaust Pressure (psia)
- \( L \) = Lohm Rate

Note that due to compressor inefficiencies, more energy will be needed to compress the air than will be expended when it flows through an orifice.
### GAS PROPERTIES

<table>
<thead>
<tr>
<th>GAS</th>
<th>k</th>
<th>R</th>
<th>DENSITY</th>
<th>cdP*</th>
<th>cdV*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ft lb/lb°R</td>
<td>lbₘ/ft³</td>
<td>lbₘ/std L</td>
<td>Btu/lb°R</td>
</tr>
<tr>
<td>H₂</td>
<td>1.40</td>
<td>766.6</td>
<td>0.00532</td>
<td>0.000188</td>
<td>3.420</td>
</tr>
<tr>
<td>He</td>
<td>1.66</td>
<td>386.1</td>
<td>0.01056</td>
<td>0.000373</td>
<td>1.250</td>
</tr>
<tr>
<td>Neon</td>
<td>1.66</td>
<td>76.6</td>
<td>0.0533</td>
<td>0.00188</td>
<td>0.248</td>
</tr>
<tr>
<td>Nat. Gas</td>
<td>1.22</td>
<td>79.2</td>
<td>0.0516</td>
<td>0.00182</td>
<td>0.560</td>
</tr>
<tr>
<td>N₂</td>
<td>1.40</td>
<td>55.2</td>
<td>0.0739</td>
<td>0.00261</td>
<td>0.247</td>
</tr>
<tr>
<td>CO</td>
<td>1.41</td>
<td>55.2</td>
<td>0.0739</td>
<td>0.00261</td>
<td>0.243</td>
</tr>
<tr>
<td>Air</td>
<td>1.40</td>
<td>53.3</td>
<td>0.0764</td>
<td>0.00270</td>
<td>0.241</td>
</tr>
<tr>
<td>Ethane</td>
<td>1.21</td>
<td>51.4</td>
<td>0.0793</td>
<td>0.00280</td>
<td>0.386</td>
</tr>
<tr>
<td>O₂</td>
<td>1.40</td>
<td>48.3</td>
<td>0.0845</td>
<td>0.00298</td>
<td>0.217</td>
</tr>
<tr>
<td>Argon</td>
<td>1.67</td>
<td>38.7</td>
<td>0.1053</td>
<td>0.00372</td>
<td>0.124</td>
</tr>
<tr>
<td>CO₂</td>
<td>1.28</td>
<td>35.1</td>
<td>0.1162</td>
<td>0.00410</td>
<td>0.205</td>
</tr>
<tr>
<td>N₂O</td>
<td>1.26</td>
<td>35.1</td>
<td>0.1162</td>
<td>0.00410</td>
<td>0.221</td>
</tr>
<tr>
<td>SO₂</td>
<td>1.25</td>
<td>24.1</td>
<td>0.1691</td>
<td>0.00597</td>
<td>0.154</td>
</tr>
<tr>
<td>Freon-12</td>
<td>1.13</td>
<td>12.8</td>
<td>0.319</td>
<td>0.01127</td>
<td>0.145</td>
</tr>
</tbody>
</table>

*values at 68°F and 14.7 psia

\[
c_P = \text{Specific heat at constant pressure}
\]

\[
c_V = \text{Specific heat at constant volume}
\]

\[
k = \text{Ratio of specific heats,} \quad \frac{c_P}{c_V}
\]

\[
R = \text{Gas Constant,} \quad \frac{R}{\text{Molecular. Wt.}}
\]
TRANSIENT GAS FLOW

This type of flow normally concerns the charging of a volume through a fixed resistance such as an orifice. Use of the Lohm system simplifies the calculation of the time required to blow down or charge up a vessel.

The first step is to calculate system time constant, $\tau$, which takes into consideration the type of gas, pressure–vessel volume, absolute temperature, and flow resistance. The time constant is given by:

$$\tau = \frac{4 f_T V L}{K}$$

**Note:** Select $K$ from the appropriate “psia” column of the Volumetric Flow Table on page S18. Keep the units of pressure vessel volume ($V$) consistent with the volumetric flow units.

The larger the value of $\tau$, the more sluggish the system.

Once $\tau$ has been calculated, the ratio of upstream pressure to downstream pressure for both the initial and final conditions must be computed. Then, from the pressure–ratio graph, initial and final values for $N$ can be found. $N$ is the number of system time constants required for the system to reach equilibrium.

If the final condition is equilibrium, where upstream and downstream pressures are equal, the final pressure ratio is 1 and the final value of $N$ is 0. With these values, the time for the system to blow down or charge up can be calculated from:

$$t = \tau (N_i - N_f) \quad t = \text{Time (sec.)}$$
TRANSIENT GAS FLOW

NOMENCLATURE

K = Units correction factor
L = Flow resistance, (Lohms)
N_i = Initial number of system time constants
N_f = Final number of system time constants
P_1 = Upstream gas pressure
P_2 = Downstream gas pressure
f_T = Temperature factor
t = Time to charge up or blow down a pressure vessel (sec.)
V = Pressure vessel volume
τ = System time constant (sec.)
RESISTANCE TO FLOW IN TUBING

The Lohm Laws, described in the preceding pages, accurately relate flow, pressure drop, and Lohm rating for individual components. For tubing, however, these variables are best related in graph form. The following graphs show pressure drop and flow rate for four different standard sizes of tubing offered by The Lee Company. A 10 cm length of tubing is used in the graphs. If your flow problem involves longer tubing length, increase the pressure drop proportionately.

Example:
To find the pressure drop for a 30 cm length of Lee Company standard 0.032” I.D. tubing flowing 100 mL/min. of water, begin by consulting the water flow graph. From the graph, you determine that the pressure drop is 4 psia for a 100 mL/min. flow rate. Adjust this to your length of 30 cm by ratio:

\[
\frac{30 \text{ cm}}{10 \text{ cm}} \times 4 \text{ psid} = 12 \text{ psid}
\]

Due to slight variations that normally occur in the tubing I.D., these flow calculations for tubing are not exact, but are useful for most design work.
TUBING FLOW CURVES – WATER FLOW
For 10 cm Tube Length

EFFECTS OF TUBE DIAMETER

ML/MIN

Differential Pressure (PSI)
TUBING FLOW CURVES – AIR FLOW
For 10 cm Tube Length

EFFECTS OF TUBE DIAMETER

STANDARD LITERS / MINUTE

DIFFERENTIAL PRESSURE (PSI)
TUBING VOLUME vs. LENGTH

TUBE VOLUME, µL

TUBE LENGTH, cm

0.1 1 10 100

0.12 (0.3 mm) I.D.

0.32 (0.8 mm) I.D.

0.52 (1.5 mm) I.D.

0.93 (2.4 mm) I.D.
CONTAMINATION – Fluidic System Cleanliness

The number one cause of hydraulic and fluidic system failure is contamination. Every fluidic system is sensitive to this. The degree of sensitivity is usually determined by the smallest passage in the system. This may be an orifice, a valve seat or clearance between two components.

Contaminants enter the system in one of several ways:

- Dirty or contaminated fluid
- Debris introduced when the system is “opened” (i.e. maintenance, tubing changes, fluid replenishment etc.)
- Debris “built into” the system

The simplest problem is the fluid. This must be filtered to the proper micron level. Any new fluid added to the system must also be properly filtered.

Introduction of contamination during maintenance is a design issue. Any point in the system that needs to be opened should have a safety screen downstream, prior to sensitive components.

The third scenario, building in contamination is usually an assembly and housekeeping issue. All components, including filters, contain debris. These are from the manufacturing process, packaging, shipping, storage and even handling prior to final assembly. Sintered filters may have small loose particles while machined manifolds may contain loose metal shavings or burrs. All components should be flushed prior to assembly. This removes loose particles and prevents them from entering the fluidic system. In critical systems it may be necessary to flush the system as it is assembled, starting from the reservoir moving out to the final dispense tip.
OHM'S LAW
Electrical energy is governed by several basic laws. The first, Ohm's law, is similar to the Lohm law and defines the resistance of a device to the flow of electrons.

\[ V = I \times R \]
\[ I = \text{current (amperes)} \]
\[ R = \text{resistance (ohms)} \]

When current passes through a resistance, power is dissipated in the form of heat, as in an oven. Power is calculated by the following:

\[ P = V \times I \]
\[ P = \text{power (watts)} \]

These equations allow any one of the four electrical parameters to be expressed in terms of any other two. A reference table of derived expressions is given below.

<table>
<thead>
<tr>
<th>DC ELECTRICAL EQUATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VOLTAGE</strong></td>
</tr>
<tr>
<td>( I \times R )</td>
</tr>
<tr>
<td>( \frac{P}{I} )</td>
</tr>
<tr>
<td>( \sqrt{(P \times R)} )</td>
</tr>
</tbody>
</table>
ELECTRICAL ENGINEERING DATA

In a DC solenoid valve there is a magnetic coil that actuates the valve mechanism. The coil can be electrically modeled as an inductance and a resistance in series. The typical room temperature coil resistance and operating voltage determine the steady state current and power consumption, as shown in the table below.

### Lee Solenoid Coil Electrical Characteristics

<table>
<thead>
<tr>
<th>VALVE TYPE</th>
<th>RATED VOLTAGE (vdc)</th>
<th>POWER (mWatt) @ RATED VOLTAGE</th>
<th>MAX. CONTINUOUS</th>
<th>RESISTANCE (ohms)</th>
<th>INDUCTANCE (mHenrys)</th>
<th>TIME CONSTANT (Sec) (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFA</td>
<td>24</td>
<td>280 780</td>
<td>2080</td>
<td>2600</td>
<td>.00125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>280 780</td>
<td>500 850</td>
<td>660 90</td>
<td>.00132</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>280 780</td>
<td>85 90</td>
<td>50 60</td>
<td>.00110</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>490 780</td>
<td>1180 1200</td>
<td>.00101</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>490 780</td>
<td>295 310</td>
<td>.00105</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>490 780</td>
<td>51 50</td>
<td>.00098</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>780 780</td>
<td>738 900</td>
<td>.00123</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>780 780</td>
<td>185 220</td>
<td>.00119</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>780 780</td>
<td>32 30</td>
<td>.00094</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>550 850</td>
<td>1042 665</td>
<td>.00064</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>550 850</td>
<td>262 155</td>
<td>.00059</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>550 850</td>
<td>46 30</td>
<td>.00065</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>750 850</td>
<td>766 460</td>
<td>.00060</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>750 850</td>
<td>193 130</td>
<td>.00067</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>750 850</td>
<td>33 20</td>
<td>.00061</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>850 850</td>
<td>675 340</td>
<td>.00050</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>850 850</td>
<td>170 70</td>
<td>.00041</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>850 850</td>
<td>30 12</td>
<td>.00040</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LHD</td>
<td>24</td>
<td>1000 1000</td>
<td>576 —</td>
<td>— —</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1000 1000</td>
<td>144 —</td>
<td>— —</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>1500 1500</td>
<td>384 —</td>
<td>— —</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1500 1500</td>
<td>96 —</td>
<td>— —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFY</td>
<td>24</td>
<td>1600 1600</td>
<td>353 1080</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1600 1600</td>
<td>90 280</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFR</td>
<td>24</td>
<td>1600 1600</td>
<td>353 1080</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1600 1600</td>
<td>90 280</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LEE SOLENOID VALVE DRIVE CIRCUIT SCHEMATICS

The coil inductance and the resistance affect the valve’s response time by opposing changes in the coil current. The time constant shown in the preceding table is the time required for the current in a valve coil to reach 63% of its steady state value, when subjected to a step voltage input. When the solenoid valve is turned off, the energy stored in the coil’s magnetic field will be dissipated by some means, usually through a diode to keep the circuit operation within predictable, safe limits. Several proven circuit designs to optimize response time or power consumption are presented on the following pages. These designs are ‘typical’ circuits and components listed are typical for Lee solenoid valves. For additional circuits (for specific valves or pumps), contact The Lee Company for assistance.

Basic Transistor Driver Schematic
(Lee Drawing LFIX1001850A)

All Lee solenoid valves can be operated with a variety of circuits, the simplest being a transistor and diode with varying additional complexity depending upon the performance demands of the application.

Note: Vcc = Required Lee Co Solenoid Valve Operating Voltage
Spike and Hold Driver Schematic
(Lee Drawing LFIX1001750A)

This circuit can be used as either an enhanced response time driver or as a low power consumption driver. As an enhanced response time driver, select V1 (usually 2-4 times the rated voltage of the valve being driven) as required to obtain the desired valve response. V2 is the nominal rated valve voltage. Choose values for R1 and C1 to determine V1 pulse duration.

As a low power consumption driver, V1 is the rated valve voltage and V2 is one half the value of V1. This serves to provide full actuation voltage to the valve, which reduces the applied voltage by 50%, thus reducing the valve's power consumption by 75%.

Notes:
1. Do not exceed the valve’s maximum power rating.
2. V1 Pulse Duration = 1.1 x R1 x C1. Adjust values as required to obtain desired pulse duration. For C1 = 0.047 μF, R1 = 100k pot, spike time range is 0.05 – 5.0 ms.
3. Vcc range recommended = 4.5 V to 16 V
4. V1 = Required valve spike voltage. V2 = Required valve nominal hold voltage.
**Fast Response Driver Schematic**  
*(Lee Drawing LFIX1001800A)*

The response time of most Lee solenoid valves can be reduced by operating the valve at a higher than normal supply voltage in conjunction with a properly selected zener diode. When used in this manner, care must be taken that the power rating of the valve is not exceeded. Excessive heat may cause damage. Calculate the power \( P = \frac{V^2}{R} \) and multiply this by the percent on time in the duty cycle. The result is the mean power dissipation, which should be less than the valve's maximum power rating.

Shown below is a typical circuit designed to enhance the response time of a Lee solenoid valve.

![Fast Response Driver Schematic](image)

Note: \( V_{cc} \) = Required Lee Co Solenoid Valve Operating Voltage
Low Power Consumption Driver Schematic (Lee Drawing LFIX1000650A)

This circuit provides a 70% reduction in valve power consumption. The valve is actuated with the full design voltage and then held at a holding voltage of approximately one half of the design voltage. The additional voltage required to actuate the valve is stored in the capacitor C2. When the control voltage signals the valve on, the transistors are switched such that C2 doubles the supply voltage and discharges through the valve coil. Recommended values for various valves are given in the table on the following page. Resistor R3 determines the peak current and rate of recharge and should be sized according to the particular application.

Notes:
1. Do not exceed the valve's maximum power rating.
2. V1 Pulse Duration = 1.1 x R3 x C2. Adjust values as required to obtain desired pulse duration, spike time range varies between 2.6 – 26 ms depending on valve design and R3 value chosen.
3. Vcc range recommended = 4.5 V to 16 V
4. V1 = Required valve input voltage. V2 = Required valve hold voltage.
# Low Power Drive Circuit Resistor (R3) Selection

<table>
<thead>
<tr>
<th>VALVE TYPE</th>
<th>V1 ACTUATION VOLTAGE (COIL DESIGN)</th>
<th>COIL DESIGN POWER (mW)</th>
<th>V2 HOLD VOLTAGE</th>
<th>HOLD POWER (mW)</th>
<th>C2 CAPACITOR (µF)</th>
<th>R3 RESISTOR (KΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LHD</td>
<td>5</td>
<td>550</td>
<td>3</td>
<td>198</td>
<td>0.047</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>550</td>
<td>6</td>
<td>137</td>
<td>0.047</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>550</td>
<td>12</td>
<td>138</td>
<td>0.047</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>750</td>
<td>3</td>
<td>273</td>
<td>0.047</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>750</td>
<td>6</td>
<td>187</td>
<td>0.047</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>750</td>
<td>12</td>
<td>188</td>
<td>0.047</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>280</td>
<td>3</td>
<td>105</td>
<td>0.047</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>280</td>
<td>6</td>
<td>72</td>
<td>0.047</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>280</td>
<td>12</td>
<td>69</td>
<td>0.047</td>
<td>100</td>
</tr>
<tr>
<td>LFA</td>
<td>5</td>
<td>490</td>
<td>3</td>
<td>176</td>
<td>0.047</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>490</td>
<td>6</td>
<td>217</td>
<td>0.047</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>490</td>
<td>12</td>
<td>122</td>
<td>0.047</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>780</td>
<td>3</td>
<td>281</td>
<td>0.047</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>780</td>
<td>6</td>
<td>195</td>
<td>0.047</td>
<td>510</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>780</td>
<td>12</td>
<td>195</td>
<td>0.047</td>
<td>110</td>
</tr>
</tbody>
</table>
Latching Valve Driver Schematic (H-Bridge Design)

The Lee Company’s LHL Series latching valves are designed to operate on 10 ms (min), bi-directional pulses. When integrating these latching valves into a system, only a single driving supply is needed. An H-Bridge circuit can be used to switch current direction (an additional logic supply may also be needed depending on the individual application). Most H-Bridge drivers such as Freescale’s 17529 or 33886 would be suitable for the task, depending on how many valves are to be driven, the valve’s specified voltage, PCB space constraints, etc. Regardless of the H-Bridge used, the following tips should lead to success when designing an electrical circuit to drive such a valve.

1. Connect the logic supply and driving supply. These are normally separate power supplies (one to drive the logic circuitry in the application, such as microprocessors, and another to drive the valves themselves), though they can be the same supply under certain circumstances.

2. Connect any enable/disable inputs of the H-Bridge to the appropriate logic. If the H-Bridge is to remain on, connect the enable/disable input(s) to HIGH or LOW (depending on which level asserts the input).

3. Ensure that any charge pump capacitors are attached. Refer to the H-Bridge manufacturer’s data sheet and use the recommended values.

4. Design adequate power supply decoupling. This can often be achieved by connecting capacitors across the supply terminals. The H-Bridge manufacturer’s data sheet may have device-specific tips.

5. Design the logic which will control the H-Bridge. This can be done easily with a microprocessor or with combinational logic. The basic logic is described below:

   a. To switch the valve for Common to Port-A flow...
      i. Enable the H-Bridge if it is not already enabled. Refer to the H-Bridge’s data sheet to determine whether or not the disable-enable delay is short enough to enable/disable on the fly.
      ii. Drive the H-Bridge in its forward operation mode. The exact logic to do this will be in the H-Bridge manufacturer’s data sheet, though it typically involves setting one input HIGH and another LOW. This will apply current in the forward direction through the valve.
      iii. Wait 10 ms (min). This will allow the valve to shuttle and become magnetically latched.
      iv. Stop current to the valve. This can be done by either disabling the H-Bridge (in which case the enable-disable delay of the device should be investigated) or by setting both H-Bridge inputs to either HIGH or LOW.

   b. To switch the valve for Common to Port-B flow...
      i. Enable the H-Bridge if it is not already enabled. Refer to the H-Bridge’s data sheet to determine whether or not the disable-enable delay is short enough to enable/disable on the fly.
Latch

An example utilizing Freescale's 17529 as an H-Bridge drive with two LHLA0521111H valves is shown below. This sample implements two, 5 volt valves, cycling at 10 Hz. The valves are cycled at different times to reduce peak power supply current. Refer to the waveform in the graph on the following page.

Dual, 5vdc, Latching Valve Driver Schematic
(Lee Drawing LFIX1001900A)
Quad, 5vdc, Latching Valve Driver Schematic
(Lee Drawing LFIX1001950A)
PRIMARY STANDARDS*

Meter  Length equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels 2 p_{10} and 5 d_{5} of the Krypton-86 atom.

Kilogram  Mass equal to the mass of the international prototype of the kilogram. This is a particular cylinder of platinum-iridium alloy which is preserved in a vault at Sèvres, France by the International Bureau of Weights and Measures.

Second  Time duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.

DERIVED STANDARD

Newton  Force which gives to a mass of 1 kilogram an acceleration of 1 meter per second per second.

EXACT CONVERSIONS*

1 pascal  = 1 newton/meter^{2}
1 atmosphere  = 101,325 pascals
1 bar  = 100,000 pascals
1 centipoise  = 0.001 newton-second/meter^{2}
1 centistoke  = 1 \times 10^{-6} meter^{2}/second
1 fluid ounce (U.S.)  = 2.95735295625 \times 10^{-5} meter^{3}
1 foot  = 0.3048 meter
1 gallon (U.S.)  = 3.785411784 \times 10^{-3} meter^{3}
1 gram  = 0.001 kilogram
1 inch  = 0.0254 meter
1 kilogram force  = 9.80665 newtons
1 liter  = 0.001 meter^{3}
1 micron  = 1 \times 10^{-6} meter
1 milliliter  = 1 \times 10^{-6} meter^{3}
1 ounce mass (avdp)  = 0.028349523125 kilogram
1 pound force (avdp)  = 4.4482216152605 newtons
1 pound mass (avdp)  = 0.45359237 kilogram

*Exact by National Institute of Standards and Technology
### DERIVED CONVERSIONS:

1. 1 foot of H\(_2\)O at 4\(^\circ\)C = 2,988.98 pascals
2. 1 gram/centimeter\(^3\) = 1,000 kilograms/meter\(^3\)
3. 1 inch of H\(_2\)O at 4\(^\circ\)C = 249.082 pascals
4. 1 inch of Hg at 0\(^\circ\)C = 3,386.389 pascals
5. 1 pound\(_F\) / inch\(^2\) = 6,894.7572 pascals
6. 1 pound\(_M\) / inch\(^3\) = 27,679.905 kilograms/meter\(^3\)
7. 1 quart (U.S.) = 9.4635295 x 10\(^4\) meter\(^3\)
8. 1 drop = 50 microliters
9. 1 bar = 14.503774 pound\(_F\) / inch\(^2\)

### CONVERSION FACTORS:

#### MASS

<table>
<thead>
<tr>
<th>To Convert</th>
<th>LB(_M) (avdp)</th>
<th>OZ(_M) (avdp)</th>
<th>SLUG</th>
<th>gram</th>
<th>kg(_M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB(_M) (avdp)</td>
<td>—</td>
<td>16.00</td>
<td>3.108 x 10(^{-2})</td>
<td>453.6</td>
<td>0.4536</td>
</tr>
<tr>
<td>OZ(_M) (avdp)</td>
<td>6.250 x 10(^{-2})</td>
<td>—</td>
<td>1.943 x 10(^{-3})</td>
<td>28.35</td>
<td>2.835 x 10(^{-2})</td>
</tr>
<tr>
<td>SLUG</td>
<td>32.17</td>
<td>514.8</td>
<td>—</td>
<td>1.459 x 10(^4)</td>
<td>14.59</td>
</tr>
<tr>
<td>gram</td>
<td>32.17</td>
<td>514.8</td>
<td>6.852 x 10(^{-5})</td>
<td>—</td>
<td>14.59</td>
</tr>
<tr>
<td>kg(_M)</td>
<td>2.205</td>
<td>35.27</td>
<td>6.852 x 10(^{-2})</td>
<td>1,000</td>
<td>—</td>
</tr>
</tbody>
</table>

Multiply by —
### Conversion Factors

#### Volume

<table>
<thead>
<tr>
<th>To Convert</th>
<th>FT.³</th>
<th>IN.³</th>
<th>GAL. (U.S.)</th>
<th>QUART (U.S.)</th>
<th>FL. OZ. (U.S.)</th>
<th>liter</th>
<th>mL</th>
<th>m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT.³</td>
<td>—</td>
<td>1,728</td>
<td>7.481</td>
<td>29.92</td>
<td>957.5</td>
<td>28.32</td>
<td>2.832 x 10⁴</td>
<td>2.832 x 10⁻²</td>
</tr>
<tr>
<td>IN.³</td>
<td>5.787 x 10⁻⁴</td>
<td>—</td>
<td>4.329 x 10⁻³</td>
<td>1.732 x 10⁻²</td>
<td>0.5541</td>
<td>1.639 x 10⁻²</td>
<td>16.39</td>
<td>1.639 x 10⁻⁵</td>
</tr>
<tr>
<td>GAL. (U.S.)</td>
<td>0.1337</td>
<td>231.0</td>
<td>—</td>
<td>4.000</td>
<td>128.0</td>
<td>3.785</td>
<td>3,785</td>
<td>3.785 x 10⁻³</td>
</tr>
<tr>
<td>QUART (U.S.)</td>
<td>3.342 x 10⁻²</td>
<td>57.75</td>
<td>0.2500</td>
<td>—</td>
<td>32.00</td>
<td>0.9464</td>
<td>946.4</td>
<td>9.464 x 10⁻⁴</td>
</tr>
<tr>
<td>FL. OZ. (U.S.)</td>
<td>1.044 x 10⁻³</td>
<td>1.805</td>
<td>7.813 x 10⁻³</td>
<td>3.125 x 10⁻²</td>
<td>—</td>
<td>2.957 x 10⁻²</td>
<td>29.57</td>
<td>2.957 x 10⁻⁵</td>
</tr>
<tr>
<td>liter</td>
<td>3.531 x 10⁻²</td>
<td>61.02</td>
<td>0.2642</td>
<td>1.057</td>
<td>33.81</td>
<td>—</td>
<td>1,000</td>
<td>1.000 x 10⁻³</td>
</tr>
<tr>
<td>mL</td>
<td>3.531 x 10⁻⁵</td>
<td>6.102 x 10⁻²</td>
<td>2.642 x 10⁻⁴</td>
<td>1.057 x 10⁻³</td>
<td>3.381 x 10⁻²</td>
<td>1,000</td>
<td>—</td>
<td>1.000 x 10⁻⁶</td>
</tr>
<tr>
<td>m³</td>
<td>35.31</td>
<td>6.102 x 10⁴</td>
<td>264.2</td>
<td>1,057</td>
<td>3,381 x 10⁴</td>
<td>1,000</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Multiply by ▲
### CONVERSION FACTORS

#### PRESSURE

<table>
<thead>
<tr>
<th>To Convert</th>
<th>LB. IN.²</th>
<th>IN. Hg at 0°C</th>
<th>IN. H₂O at 4°C</th>
<th>FT. H₂O at 4°C</th>
<th>ATM</th>
<th>kgF cm²</th>
<th>kgF m²</th>
<th>kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB. IN.²</td>
<td>—</td>
<td>2.036</td>
<td>27.68</td>
<td>2.307</td>
<td>6.805 x 10⁻²</td>
<td>7.031 x 10⁻²</td>
<td>703.1</td>
<td>6.895</td>
</tr>
<tr>
<td>IN. Hg at 0°C</td>
<td>0.4912</td>
<td>—</td>
<td>13.60</td>
<td>1.133</td>
<td>3.342 x 10⁻²</td>
<td>3.453 x 10⁻²</td>
<td>345.3</td>
<td>3.386</td>
</tr>
<tr>
<td>IN. H₂O at 4°C</td>
<td>3.613 x 10⁻²</td>
<td>7.355 x 10⁻²</td>
<td>—</td>
<td>8.333 x 10⁻²</td>
<td>2.458 x 10⁻³</td>
<td>2.540 x 10⁻³</td>
<td>25.40</td>
<td>0.2491</td>
</tr>
<tr>
<td>FT. H₂O at 4°C</td>
<td>0.4335</td>
<td>0.4335</td>
<td>0.4335</td>
<td>12.00</td>
<td>—</td>
<td>2.950 x 10⁻²</td>
<td>3.048</td>
<td>2.989</td>
</tr>
<tr>
<td>ATM</td>
<td>14.70</td>
<td>29.92</td>
<td>406.8</td>
<td>33.90</td>
<td>—</td>
<td>1.033 x 10⁴</td>
<td>101.3</td>
<td>—</td>
</tr>
<tr>
<td>kgF cm²</td>
<td>14.22</td>
<td>28.96</td>
<td>393.7</td>
<td>32.81</td>
<td>0.9678</td>
<td>—</td>
<td>1.000 x 10⁴</td>
<td>98.07</td>
</tr>
<tr>
<td>kgF m²</td>
<td>1.422 x 10⁻³</td>
<td>2.896 x 10⁻³</td>
<td>3.937 x 10⁻²</td>
<td>3.281 x 10⁻³</td>
<td>9.678 x 10⁻⁵</td>
<td>1.000 x 10⁻⁴</td>
<td>—</td>
<td>9.807 x 10⁻³</td>
</tr>
<tr>
<td>kPa</td>
<td>0.1450</td>
<td>0.2953</td>
<td>4.015</td>
<td>0.3346</td>
<td>9.869 x 10⁻³</td>
<td>1.020 x 10⁻²</td>
<td>102.0</td>
<td>—</td>
</tr>
</tbody>
</table>

Multiply by —
NOTE: For application of these factors to fluids with specific gravity other than 1.0, these factors must be multiplied by the actual specific gravity.

EXAMPLE:

*Problem:* Determine flow rate in lb./hr. of acetone at 40°F and 2 mL/min.

*Solution:* Specific Gravity $S$ of acetone at 40°F = 0.80

\[
I \text{ lbs/hr} = \left[ I \text{ mL/min.} \right] \left[ \text{ conversion factor mL — lbs} \right] \left[ \text{ conversion factor min.— hrs} \right] \left[ S \right] \\
= \left[ 2 \text{ mL/min.} \right] \left[ 2.205 \times 10^{-3} \text{ lbs/mL} \right] \left[ 60 \text{ min/1 hr} \right] \left[ 0.80 \right] \\
= .21 \text{ lb/hr}
\]
**CONVERSION FACTORS – MASS TO VOLUME**

**WATER AT 39.2°F (4°C)**

### Table: Conversion Factors – Mass to Volume

<table>
<thead>
<tr>
<th>Volume Unit</th>
<th>LB(_m) (avdp)</th>
<th>OZ(_m) (avdp)</th>
<th>SLUG</th>
<th>gram</th>
<th>kg(_m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FT(^3)</td>
<td>1.001 x 10(^{-3})</td>
<td>1.001 x 10(^{-3})</td>
<td>0.5154</td>
<td>3.532 x 10(^{-5})</td>
<td>3.532 x 10(^{-2})</td>
</tr>
<tr>
<td>IN(^3)</td>
<td>27.68</td>
<td>1.730</td>
<td>890.6</td>
<td>6.103 x 10(^{-2})</td>
<td>61.03</td>
</tr>
<tr>
<td>GAL. (U.S.)</td>
<td>0.1198</td>
<td>7.489 x 10(^{-3})</td>
<td>3.855</td>
<td>2.642 x 10(^{-4})</td>
<td>0.2642</td>
</tr>
<tr>
<td>QUART (U.S.)</td>
<td>0.4793</td>
<td>2.996 x 10(^{-2})</td>
<td>15.42</td>
<td>9.464 x 10(^{-4})</td>
<td>0.9464</td>
</tr>
<tr>
<td>FL. OZ. (U.S.)</td>
<td>15.34</td>
<td>0.9586</td>
<td>493.5</td>
<td>3.381 x 10(^{-2})</td>
<td>33.81</td>
</tr>
<tr>
<td>Liter</td>
<td>0.4536</td>
<td>2.835 x 10(^{-2})</td>
<td>14.59</td>
<td>1.000 x 10(^{-3})</td>
<td>1.000</td>
</tr>
<tr>
<td>mL</td>
<td>453.6</td>
<td>28.35</td>
<td>1.459 x 10(^4)</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>m(^3)</td>
<td>4.536 x 10(^{-4})</td>
<td>2.835 x 10(^{-5})</td>
<td>1.459 x 10(^{-2})</td>
<td>1.000 x 10(^{-6})</td>
<td>1.000 x 10(^{-3})</td>
</tr>
</tbody>
</table>

### NOTE:

For application of these factors to fluids with specific gravity other than 1.0, these factors must be divided by the actual specific gravity.

### EXAMPLE:

**Problem:** Determine volume in gallons which would be occupied by 3.0 kg of sea water, specific gravity is 1.02.

**Solution:**

\[
\text{GAL.} = \frac{3.0 \text{ kg}}{1.02} \times \frac{2642 \text{ GAL}}{\text{kg}} = 0.777 \text{ GAL.}
\]
VISCOSITY DEFINITIONS

Absolute Viscosity: the force required to move a unit plane surface over another plane surface at unit velocity when surfaces are separated by a layer of fluid of unit thickness.

Unit of Absolute Viscosity in the metric system:
poise and centipoise
1 poise = 1 gram / (cm) (sec) and
1 centipoise = 1/100 poise

Unit of Absolute Viscosity in the English system:
slugs / (ft.) (sec.);
1 slug / (ft.) (sec.) = 1 / 0.002089 poise

Kinematic Viscosity: the absolute viscosity divided by density.

Unit of Kinematic Viscosity in the metric system and commonly used in the countries using the English system:
stoke and centistoke;
1 stoke = 1 poise / density (gm / mL)
1 centistoke = 1/100 stoke

Other units of Kinematic Viscosity in the English system, the most practical unit for making calculations is ft.² / sec.; 1 ft.² / sec. = 92903 centistoke and 1 centistoke = 1.076 x 10⁻⁵ ft.² / sec.
VISCOSITY CONVERSION CHART

NOTE: Centistokes = 

CONNECT HORIZONTALLY

Density
VISCOSITY OF TYPICAL FLUIDS vs. TEMPERATURE
VISCOsITY OF TYPICAL FLUIDS vs. TEMPERATURE
VISCOSITY vs. CONCENTRATION

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

KINEMATIC VISCOSITY, CENTISTOKES

SUCROSE
FRUCTOSE
H₂SO₄
ETHANOL
ACETONITRILE
METHANOL
SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C
SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C

SPECIFIC GRAVITY vs. CONCENTRATION

SPECIFIC GRAVITY

AQUEOUS CONCENTRATION, WEIGHT PERCENT AT 20°C
TORQUE CONVERSION CHART

<table>
<thead>
<tr>
<th>INCH OUNCE</th>
<th>NEWTON METER</th>
<th>GRAM CENTIMETER</th>
<th>INCH POUND</th>
<th>FOOT POUND</th>
<th>INCH OUNCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>-200</td>
<td>1.5</td>
<td>15,000</td>
<td>10</td>
<td>1.0</td>
<td>-200</td>
</tr>
<tr>
<td>-150</td>
<td>1.0</td>
<td>10,000</td>
<td>8</td>
<td>1.0</td>
<td>-150</td>
</tr>
<tr>
<td>-100</td>
<td>0.8</td>
<td>8,000</td>
<td>7</td>
<td>0.7</td>
<td>-100</td>
</tr>
<tr>
<td>-80</td>
<td>0.6</td>
<td>6,000</td>
<td>6.5</td>
<td>0.6</td>
<td>-80</td>
</tr>
<tr>
<td>-70</td>
<td>0.5</td>
<td>5,000</td>
<td>4</td>
<td>0.4</td>
<td>-70</td>
</tr>
<tr>
<td>-60</td>
<td>0.4</td>
<td>4,000</td>
<td>3</td>
<td>0.3</td>
<td>-60</td>
</tr>
<tr>
<td>-50</td>
<td>0.3</td>
<td>3,000</td>
<td>2</td>
<td>0.2</td>
<td>-50</td>
</tr>
<tr>
<td>-40</td>
<td>0.2</td>
<td>2,000</td>
<td>1.5</td>
<td>0.15</td>
<td>-40</td>
</tr>
<tr>
<td>-30</td>
<td>0.15</td>
<td>1,500</td>
<td>1.0</td>
<td>0.10</td>
<td>-30</td>
</tr>
<tr>
<td>-20</td>
<td>0.10</td>
<td>1,000</td>
<td>0.8</td>
<td>0.08</td>
<td>-20</td>
</tr>
<tr>
<td>-15</td>
<td>0.08</td>
<td>800</td>
<td>0.7</td>
<td>0.07</td>
<td>-15</td>
</tr>
<tr>
<td>-10</td>
<td>0.07</td>
<td>700</td>
<td>0.6</td>
<td>0.05</td>
<td>-10</td>
</tr>
<tr>
<td>-8</td>
<td>0.05</td>
<td>500</td>
<td>0.5</td>
<td>0.04</td>
<td>-8</td>
</tr>
<tr>
<td>-6</td>
<td>0.04</td>
<td>400</td>
<td>0.4</td>
<td>0.03</td>
<td>-6</td>
</tr>
<tr>
<td>-5</td>
<td>0.03</td>
<td>300</td>
<td>0.3</td>
<td>0.02</td>
<td>-5</td>
</tr>
<tr>
<td>-4</td>
<td>0.02</td>
<td>200</td>
<td>0.2</td>
<td>0.015</td>
<td>-4</td>
</tr>
<tr>
<td>-3</td>
<td>0.015</td>
<td>150</td>
<td>0.15</td>
<td>0.010</td>
<td>-3</td>
</tr>
<tr>
<td>-1.5</td>
<td>0.01</td>
<td>100</td>
<td>0.1</td>
<td>0.008</td>
<td>-1.5</td>
</tr>
<tr>
<td>-1</td>
<td>0.008</td>
<td>80</td>
<td>0.08</td>
<td>0.007</td>
<td>-1</td>
</tr>
<tr>
<td>1</td>
<td>0.007</td>
<td>70</td>
<td>0.08</td>
<td>0.005</td>
<td>1</td>
</tr>
</tbody>
</table>

CONNECT HORIZONTALLY

MINSTAC

FITTING TORQUE RANGE

FINGER TIGHT
TEMPERATURE CONVERSION

\[ ^\circ K = ^\circ C \left( \frac{5}{9} \right) + 32 \]
\[ ^\circ C = \left( ^\circ F - 32 \right) \frac{5}{9} \]
\[ ^\circ R = ^\circ F + 460 \]
\[ ^\circ K = ^\circ C + 273 \]
\[ ^\circ K = ^\circ R \left( \frac{5}{9} \right) \]
MATERIALS – The chemical compatibilities listed are meant as guidelines only. Material samples for immersion testing can be requested from The Lee Company. This is the most accurate method of determining the chemical compatibility of our materials and our customers’ specific fluids.

<table>
<thead>
<tr>
<th>PLASTIC</th>
<th>MECHANICAL STRENGTH</th>
<th>GENERAL CHEMICAL RESISTANCE</th>
<th>THERMAL RESISTANCE</th>
<th>FEATURED PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVA (Micro-Line™ - TSI) Ethylene-vinyl acetate</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>Physically conformable</td>
</tr>
<tr>
<td>LCP (Vectra® - Celanese) Liquid crystal polymer</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>Superior balance of all properties</td>
</tr>
<tr>
<td>PBT (Valox® - GE) Polybutylene terephthalate</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Good balance of all properties</td>
</tr>
<tr>
<td>PC (Lexan® - GE) Polycarbonate</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Optical clarity</td>
</tr>
<tr>
<td>PCTFE (Kel-F® 81 - 3M) Polychlorotrifluoroethylene</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>Resists most chemicals, zero water absorption</td>
</tr>
<tr>
<td>PES (Vicrrex® - ICI) Polyethersulfone</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>Dimensionally stable</td>
</tr>
<tr>
<td>PEEK (Vicrrex® - ICI) Polyetheretherketone</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>Thermal stability &amp; good solvent resistance</td>
</tr>
<tr>
<td>PFA (Teflon® - DuPont Dow) Perfluoroalkoxy resin</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>Chemical &amp; solvent resistant</td>
</tr>
<tr>
<td>PMMA (Acrylic) Polymethyl Methacrylate</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Transparent, good general properties</td>
</tr>
<tr>
<td>PTFE (Teflon® - DuPont Dow) Polytetrafluoroethylene</td>
<td>2</td>
<td>5</td>
<td>2</td>
<td>Unsurpassed chemical resistance</td>
</tr>
<tr>
<td>POM (Delrin® - DuPont Dow) Polyoxymethylene</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>Wear resistance</td>
</tr>
<tr>
<td>PPA (Amodel®) Polyphthalimide</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>Thermal and dimensional stability</td>
</tr>
<tr>
<td>PPS (Fortron® - Phillips Pet- ro.) Polyphenylene sulfide</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>Very good mechanical strength</td>
</tr>
<tr>
<td>PVC (Polyvinylchloride)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>High flexibility</td>
</tr>
<tr>
<td>PVDF (Kynar® - Pennwalt) Polyvinylidene fluoride</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>Chemical &amp; solvent resistant, porous form</td>
</tr>
<tr>
<td>UHMWPE Ultra-high molecular weight polyethylene</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Porous form, solvent resistant</td>
</tr>
</tbody>
</table>

KEY: 5....... Superior 4....... Excellent 3 ..... Good 2 ...... Fair
### MATERIALS (continued)

<table>
<thead>
<tr>
<th>ELASTOMER</th>
<th>WEAR RESISTANCE</th>
<th>GENERAL CHEMICAL RESISTANCE</th>
<th>THERMAL RESISTANCE</th>
<th>FEATURED PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPDM Ethylene/propylene rubber</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>Very good solvent resistance</td>
</tr>
<tr>
<td>FKM (Viton® Fluoroelastomer - DuPont Dow)</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>Superior balance of properties</td>
</tr>
<tr>
<td>CR (Neoprene® Polychloroprene - DuPont Dow)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>Good balance of properties</td>
</tr>
<tr>
<td>FFKM (Kalrez® Perfluoroelastomer - DuPont Dow)</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>Unsurpassed chemical resistance</td>
</tr>
<tr>
<td>Silicone (Silastic E® - DuPont Dow)</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>Good balance of properties</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER MATERIALS</th>
<th>MECHANICAL STRENGTH</th>
<th>GENERAL CHEMICAL RESISTANCE</th>
<th>THERMAL RESISTANCE</th>
<th>FEATURED PROPERTIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>TZP (Ceramic)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Superior surface finish and excellent dimensional stability</td>
</tr>
<tr>
<td>Sapphire (Aluminum Oxide)</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>Superior surface finish and excellent dimensional stability</td>
</tr>
</tbody>
</table>

**KEY:** 5....... Superior  4....... Excellent  3 ...... Good  2 ...... Fair

### ADHESIVES FEATURED PROPERTIES
- Epoxy ................... Good adhesive strength to many materials; good chemical resistance
- Cyanoacrylate..... Quick set; high strength
- Anaerobic ........... Very high strength; very good chemical resistance

### METALS FEATURED PROPERTIES
- 316 CRES.............. Superior corrosion resistance
- 430 CRES............. Good magnetic properties, good corrosion resistance
- 303,304 CRES..... Good machinability, good corrosion resistance
- 17-4, 17-7 CRES .. High modulus, good corrosion resistance
- FeCr Alloy ................ Excellent corrosion resistance, good magnetic properties
- Aluminum............... Colorability, low cost

*Trade names are for reference only.*
GLOSSARY

This glossary serves to introduce the user to the terminology used throughout this handbook. These descriptions are proposed to serve as a reference point in product discussions to eliminate problems of definition. While these terms are subject to different interpretation throughout various technologies, it is proposed that these definitions be adhered to throughout industry, to unify their usage.

**Accuracy:** The degree of error between the intended, specified, or nominal property value and actual value. Typically used to define the performance envelope of a production lot of parts about the specified nominal. Normally used to relate single-event performance of multiple parts. Compare to PRECISION.

**Ambient Temperature:** Temperature of the media surrounding external surfaces of a valve.

**Axial Mixing:** See FLUSHABILITY.

**Burst Pressure:** The maximum pressure a valve can endure before it will break.

**Carry-over Volume:** See CROSSOVER VOLUME

**Coefficient of Variation (CV):** Defined as the standard deviation of a distribution divided by the mean value. This value, expressed in percent, reflects the degree of spread of data and is used to define the consistency of the performance or of dispensed volumes, etc.

**Coil Voltage:** Voltage at the electrical connector pins in which the coil must energize if the valve is to perform as stated in the specifications.

**Continuous Duty:** Coils rated for continuous duty are designed to be energized continuously without overheating to failure.

**Crossover Volume:** (Dead-leg Volume, Carry-over Volume) Any internal-geometry-dependent volumetric error introduced by the valve internal volume between the valving point and the common flow point. Most commonly used in discussions of three-way valves, it refers to the unwashed slug of material between the flowing passage and the closed port seal.

**Crosstalk:** (Intra-port Flow) Any response-time-dependent flow or pressure variation between any two valves or two ports of a three-way valve. For example, this term refers to the flow that takes place between the NC and NO ports of the three-way valve in the time between the beginning of actuation and the end of actuation, when both ports are partially open.

**Dead-leg Volume:** See CROSSOVER VOLUME

**Dead Volume:** The actual non-flushable volumes of any component or system flow passages, where a dead-end passageway or cavity could retain materials to contaminate subsequent sample or flow media. This value is highly subjective, as many factors come into play to determine the actual dead volume such as miscibility, viscosity, binding energy, etc. The quantity of the former sample still retained inside the component after flushing with some specified volume is defined as dead volume.

**De-energized:** No power applied to the coil. A normally closed valve is closed when the coil is de-energized.

**Differential Pressure (∆P):** Pressure difference between the inlet and outlet of a valve.
**Duty Cycle:** The ratio of "on" time to "total cycle" time. If a valve is on for 2 seconds and off for 8 seconds, the total cycle time is 10 seconds and the duty cycle is 20%.

**Energized:** Power applied to the solenoid valve coil causing the valve to change state. A normally closed valve will open when energized.

**Flushability:** (Axial Mixing) The degree of dispersion or band-broadening introduced by a component into a flowing stream. Sometimes referred to as axial mixing, it defines the stretching of a slug of sample as it passes through a component. Usually discussed in relative or qualitative terms, as the specific definition of this characteristic is somewhat complex.

**Intra-port Flow:** See CROSSTALK

**Normally Closed:** A normally closed valve is closed when de-energized, preventing flow. When energized, the valve opens allowing flow.

**Normally Open:** A normally open valve is open when de-energized, allowing flow. When energized, the valve closes preventing flow.

**Operating Pressure:** The pressure at which the valve is operating.

**Proof Pressure:** The level of pressure which may be applied to the valve without causing permanent damage.

**Repeatability (Precision):** The repeatability of any function. Used in reference to valve response times or dispensed volumes. Usually specified in terms of the percent tolerance about the nominal, specified, or mean value. Used to express the total variability of a single component over multiple events. Repeatability means consistency of performance even if the performance is not accurate.

**Response Time:** This term defines the lag time between the input of a control signal and the resulting response of the system or component being monitored. Typical use of the response time with a passive component could define the time lag between a pressure pulse input to a check valve, and the time to close or open the valve seat in response to that pulse. The more common usage is in reference to active components, such as solenoid valves. This term then typically defines the time from beginning of a normal voltage step-input drive signal, and the pneumatic output from the valve port that is opening or closing as a result of that signal. For further discussion of response times, contact The Lee Company.

**ENGINEERING REFERENCES:**


The dimensions and configurations in this handbook are for reference purposes only, and may be updated at any time. Contact The Lee Company for current inspection drawings.

**POLICY FOR SPECIALLY FABRICATED PARTS**

The Lee Company offers a wide range of off-the-shelf catalog components to help designers find the solutions to their problems. Should you need a non-standard component, The Lee Company will be pleased to design products not listed in this handbook. We have the capability to design and manufacture variations to the components listed in this handbook on a prototype basis and for future production.

A unique part number would be assigned to the design. The subsequent purchase of this part number would be in accordance with the originator’s requirements.

Our policy for specially fabricated parts is as follows:

1. At the time an order is placed, a Production Preparation Charge (PPC) will be billed to the customer. This charge is usually non-recurring and includes partial cost of design, manufacturing, testing and special tooling.

2. The design of this special part will be the property of The Lee Company.

3. Changes in the original part specification could result in extra charges.

**PROPRIETARY RIGHTS**

The Lee Company retains all proprietary rights and the exclusive right to manufacture the products shown in this Electro-Fluidic Systems Technical Handbook, as well as any specially designed products. Unlimited rights, as described in DAR 7-104.9(b), are *not* transferred to the buyer.
U.S. EXPORT COMPLIANCE

Buyer and (The Lee Company) shall comply with the laws and regulations of the United States of America (USA) relating to exports and foreign transactions, including, but not limited to, the International Traffic in Arms Regulations (ITAR) (22 C.F.R. Parts 120-130), the Arms Export Control Act (22 U.S.C. 2778), the Export Administration Regulation (EAR) (15 C.F.R. Parts 730-774) and the Export Administration Act of 1979, as amended (50 U.S.C. 2401 et seq). Buyer hereby agrees to hold The Lee Company harmless due to buyer's breach of such obligation.

PATENTS • TRADEMARKS • COPYRIGHTS

1. Throughout the text of this handbook, The Lee Company has referred to components by their trade names and trade marks. Many of these are covered by U.S. and foreign Patents — issued, pending, or applied for.

2. Permission is hereby granted to use, copy and reproduce the general engineering material, including nomograms, tables and formulas, with the only restriction being to give credit to The Lee Company if the material is published or republished.

3. It is the clear intent of The Lee Company to encourage all members of the engineering profession to use the Lohm System, whether they are customers or competitors or others who could benefit from its use.
## TRADEMARKS OF THE LEE COMPANY

<table>
<thead>
<tr>
<th>TRADE NAME</th>
<th>TRADE MARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>THE LEE COMPANY</td>
<td>![Lee Logo](Lee Logo.png)</td>
</tr>
<tr>
<td>LIF</td>
<td>![LIF Logo](LIF Logo.png)</td>
</tr>
<tr>
<td>MINSTAC</td>
<td>![Lee Minstac Logo](Lee Minstac Logo.png)</td>
</tr>
<tr>
<td>TRADE NAME</td>
<td>TRADE MARK</td>
</tr>
<tr>
<td>------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Lee Plug</td>
<td>©</td>
</tr>
<tr>
<td>Lee Plug RFO</td>
<td>©</td>
</tr>
<tr>
<td>Lee Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee Hi Watt Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee kW Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee Micro Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee Bender Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee Axial Visco Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee JEVA</td>
<td>©</td>
</tr>
<tr>
<td>Lee Visco Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee Cro</td>
<td>©</td>
</tr>
<tr>
<td>Lee Restrictor Chek</td>
<td>©</td>
</tr>
<tr>
<td>Lee Flow Control</td>
<td>©</td>
</tr>
<tr>
<td>Lee Flosert</td>
<td>©</td>
</tr>
<tr>
<td>Lee Spin Jet</td>
<td>©</td>
</tr>
<tr>
<td>Lee JELA</td>
<td>©</td>
</tr>
<tr>
<td>Lee Chek</td>
<td>©</td>
</tr>
<tr>
<td>Lee Pri</td>
<td>©</td>
</tr>
<tr>
<td>Lee Tri</td>
<td>©</td>
</tr>
<tr>
<td>Lee Shuttle Valve</td>
<td>©</td>
</tr>
<tr>
<td>Lee Safety Screens</td>
<td>©</td>
</tr>
<tr>
<td>Lee HI-BAR Screens</td>
<td>©</td>
</tr>
<tr>
<td>Lee Micro Damp</td>
<td>©</td>
</tr>
<tr>
<td>Lee Kipster</td>
<td>©</td>
</tr>
</tbody>
</table>
Other Registered Trademarks

Throughout this handbook, The Lee Company has referred to suppliers’ products by their trade names. A complete list is provided below.

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>TRADE NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crawford Fitting Company</td>
<td>Swagelok®</td>
</tr>
<tr>
<td>CRS Holding, Inc. (Subsidiary of Carpenter Technology Corporation)</td>
<td>Chrome Core 18®</td>
</tr>
<tr>
<td>DuPont Dow</td>
<td>Delrin®, Kalrez®, Neoprene®, Silastic E®, Teflon®, Viton®</td>
</tr>
<tr>
<td>General Electric Company</td>
<td>Lexan®, Valox®</td>
</tr>
<tr>
<td>Green, Tweed and Company</td>
<td>Chemraz®</td>
</tr>
<tr>
<td>Hoechst Celanese</td>
<td>Vectra®</td>
</tr>
<tr>
<td>Imperial Chemical Industries</td>
<td>Victrex®</td>
</tr>
<tr>
<td>Pennwalt Corporation</td>
<td>Kynar®</td>
</tr>
<tr>
<td>Phillips Chemical Company</td>
<td>Ryton®</td>
</tr>
<tr>
<td>Thermoplastic Scientifics, Inc.</td>
<td>Micro-Line™</td>
</tr>
<tr>
<td>The 3M Company</td>
<td>KEL-F®</td>
</tr>
</tbody>
</table>
WARRANTY

The Lee Company is proud to warrant that all items described in this handbook are free from defect in design, workmanship and materials and that they conform to any applicable specifications, drawings, or approved samples.

Our products will only operate as well as the systems in which they are installed. We therefore expect the buyers of our products to be responsible for the proper design and fabrication of the systems in which our products are used. To assist our customers, we maintain a staff of sales engineers that can recommend the proper Lee Company products to satisfy a particular system requirement. However, the buyer assumes the risk of incompatibility between Lee Company products and the fluid media.

Should any Lee Company product not satisfy this warranty, we will promptly repair or replace it within a four (4) year period or the product’s published cycle life, whichever is less, without responsibility for indirect or consequential damages, provided the product was used for its intended purpose, and in its intended environment.

Should any Lee product fail to perform to its specifications as stated in this handbook, a Returned Material Authorization, “RMA”, number is required prior to returning the product. Please contact The Lee Company for the RMA number. Products returned without an RMA number may not be accepted.
The Lee Company

Technical Center
2 Pettipaug Road, P.O. Box 424
Westbrook, CT  06498-0424   USA

Tel: 860  399-6281
     800  533-7584 (LEE PLUG)
Fax: 860  399-7058 (Order Entry)
     860  399-7037 (Technical Information)
Web: www.theleeeco.com
E-Mail: ct-sales@theleeeco.com

U.S. Sales Offices

Chicago, Illinois
Tel:  773  693-0880
     il-sales@theleeeco.com

Detroit, Michigan
Tel:  248  827-0981
     mi-sales@theleeeco.com

Tampa, Florida
Tel:  813  287-9293
     fl-sales@theleeeco.com

Huntington Beach, California
Tel:  714  899-2177
     ca-sales@theleeeco.com

San Bruno, California
Tel:  650  616-4066
     ca-sales@theleeeco.com

Dallas/Ft. Worth, Texas
Tel:  972  791-1010
     tx-sales@theleeeco.com
International Sales Offices

Lee Products Limited – London
Tel: + 44 1753 886664
sales@leeproducts.co.uk
Subsidiary / United Kingdom & Ireland

LEE COMPANY S.A. – Paris
Tel: + 33 1 30 64 99 44
info@leecompany.fr
Subsidiary / France, Spain & French speaking Switzerland

Lee Hydraulische Miniaturkomponenten GmbH – Frankfurt
Tel: + 49 6196-77369-0
info@lee.de
Subsidiary / Germany, Austria, Eastern Europe & German speaking Switzerland

Lee SRL – Milan
Tel: + 39 02 43981750
sales@leesrl.it
Subsidiary / Italy

The Lee Company
Scandinavia AB – Stockholm
Tel: + 46 8 579 701 70
sales@theleeco.se
Subsidiary / Denmark, Sweden, Norway, Finland & Russia

Distributor for Belgium, Netherlands and Luxemburg
Denis de Ploeg BV
Tel: + 31 43 820 0250
bs.deploeg@ddp.nl

Distributor for People's Republic of China, and Hong Kong
Eastern Bridge Service, Ltd.
Tel: + 86 10 84721266
info@ebshk.com.cn

Distributor for Australia and New Zealand
Aviaquip Pty. Ltd.
Tel: + 61 3 9585 1211
sales@aviaquip.com.au

Distributor for Japan
Jupiter Corporation
Tel: + 81 33 403 1313
t_suzuyama@jupiter.co.jp

Distributor for Korea
Min Sung HT Corporation
Tel: + 82 2 964 5242 - 4
minsunght@hanafos.com

Distributor for Taiwan
Loop Link Enterprise, Inc.
Tel: + 886 2 2762 9614
looplink@ms9.hinet.net

Agent for South America
Trusty Comércio e Representações Ltda.
Tel: + 55 12 3132-3418
rui@tcr-brazil.com.br

Agent for Israel
ENL Engineering & Logistics Ltd.
Tel: + 972 3 549 3644
enleng@netvision.net.il

Agent for India
Hind Industrial & Mercantile Corp. Pvt. Ltd.
Tel: + 91 22 2493 3545
info@hindco.net

Agent for Singapore, Indonesia, Thailand and Malaysia
Winova Pte. Ltd.
Tel: + 65 6425 2116
Mobile: + 65 9655 9910
sales@winova.com.sg
The Lee Company
Electro-Fluidic Systems Group

2 Pettipaug Road, P.O. Box 424
Westbrook, Connecticut 06498-0424 USA

Tel: 860 399-6281
Fax: 860 399-7058 (Order Entry)
     860 399-7037 (Technical Information)
www.theleeco.com

Technical Services and Sales Information also available through Lee Sales Offices in:

Chicago, IL..................773-693-0880
Tampa, FL ..................813-287-9293
Dallas/Ft. Worth, TX.......972-791-1010
Detroit, MI..................248-827-0981
Huntington Beach, CA.....714-899-2177
San Bruno, CA..............650-616-4066

London, England..........44 1 753-886664
Paris, France .............33 1 30 64 99 44
Frankfurt, Germany.......49 6196-77369-0
Milan, Italy ...............39 02 43981750
Stockholm, Sweden .......46 8 579 701 70