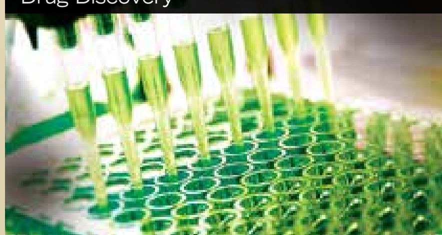
Electro-Fluidic Systems Handbook

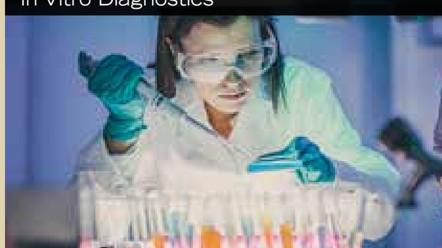
Medical Devices

Scientific Instruments

Drug Discovery



In Vitro Diagnostics



Innovation in Miniature

The Lee Company

Innovation in Miniature

The Lee Company

Electro-Fluidic Systems Handbook

9th Edition

Component catalog with engineering reference material

THE LEE COMPANY TECHNICAL CENTER

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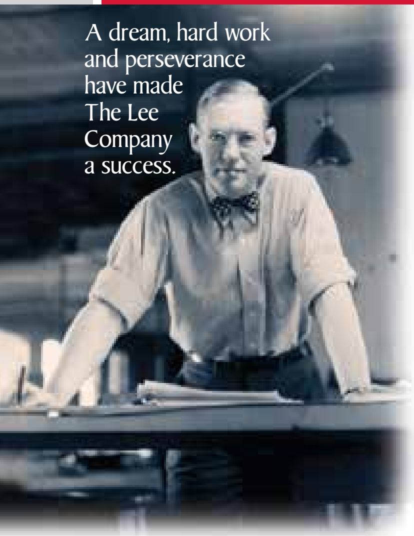
THE LEE COMPANY HISTORY



A dream, hard work and perseverance have made The Lee Company a success.

1948:
Leighton Lee II founds The Lee Company at home in Rocky Hill, CT.

Early 1950s:
The Lee Company began to expand by first purchasing a machine shop in Hartford, CT. By 1954, The Lee Company had purchased an additional 88 acres of land in Westbrook, CT which would serve as the future site for The Lee Company headquarters.

1958:
The patent for the original Lee Plug was issued. The success of this product line became the foundation for today's extensive line of aerospace and hydraulic product offerings.

Early 1960s:
The Lohm Laws were introduced.
The Lee Company continued to expand with new buildings to allow for in-house manufacturing.

Late 1960s:
Lee products were in the Lunar Excursion Module and space suits of Apollo 11 when Neil Armstrong and Buzz Aldrin Jr. took their first historic walk on the surface of the moon.

Early 1970s:
Sales offices were opened throughout the US, and foreign subsidiaries were added in Europe.

Early to Mid 1980s:
Lee introduced the LFY and LFV Series inert solenoid valves. This addressed a need for small, compact, chemically inert valves. These products would serve as part of the foundation of the Electro-Fluidic Systems (EFS) Division.

1948 | Early 1950s | 1958 | Early 1960s | Late 1960s | Early 1970s | Early to Mid 1980s

The Continuing Story

Still a family owned and operated company today, The Lee Company continues to carry out Mr. Lee's legacy. With a strong commitment to quality and performance, the company has flourished due to continuing innovation and is now a world leader in the manufacture of miniature precision fluid control products for aerospace, high performance racing, downhole oil tools, automotive, analytical and clinical chemistry, in vitro diagnostics, drug discovery, and medical/scientific instrumentation.

1989 | 1990 | 1991 | 1990 to 2000 | *2006* | *2010 – Present*

1989:
The VHS Series (Very High Speed) solenoid valve was introduced to meet the precision droplet dispensing requirements of the medical and commercial printing markets.

1990:
The HDI Series (High Density Interface) solenoid valve product line was introduced to meet the demands of the medical market for smaller, lower power, pneumatic solenoid control valves.

1991:
The LPV Series (variable volume) pumps and the LPL Series (fixed volume) pumps were released to meet the precision pumping and dispensing needs of the in vitro diagnostics market.

1990 – 2000:
The EFS Division met expansion needs by moving into a manufacturing facility in Essex, CT. The Industrial Micro Hydraulics (IMH) Division was founded to serve high volume markets, primarily automotive.

2006:
The EFS Division added 70,000 sq. feet of manufacturing space to accommodate continued growth.

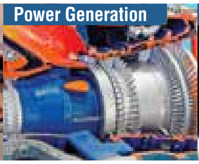
2010 – Present:
The LSP and IEP Series solenoid valves were introduced along with several derivatives to existing product series. There continues to be an ongoing focus towards developing innovative products that meet the needs of our ever changing markets.

THE CONTINUING STORY OF LEE COMPANY INNOVATION

Since its beginning in 1948, The Lee Company has pioneered the design and development of miniature fluid control components. Under the premise of economically solving 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.

The Lee Company now employs over 1000 people and occupies over 1 million square feet of modern manufacturing space at three sites in Westbrook and Essex, CT. Sales offices are located throughout the USA and the company is represented worldwide by wholly owned subsidiaries, distributors and agents.

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



PRODUCT DIVISIONS

The Lee Company is organized into three separate divisions: Electro-Fluidic Systems (EFS), Precision Hydraulics, and Industrial Microhydraulics (IMH). Within each division there are one or more product groups, each with their own dedicated engineering, manufacturing, and sales team working together to provide innovative products and first class service. This structure allows us to be very responsive to our customers, offering solutions to solve difficult fluid control problems.

The three Electro-Fluidic Systems (EFS) product groups produce high quality miniature solenoid valves (conventional 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 typically used in medical and scientific instrumentation, analytical and clinical chemistry, in vitro diagnostics, drug discovery and ink jet printing applications.

The six Precision Hydraulic product groups supply expansion 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, motorsports, etc.

The Industrial Microhydraulics (IMH) Division was established to adapt proven design concepts to meet the higher volume production, performance, and cost requirements of automotive, industrial hydraulics, and medical applications. These products include a wide variety of plugs, valves, restrictors, and safety screens designed and manufactured for ease of automated installation, which is of paramount importance to these industries.

ENGINEERING AND MANUFACTURING

The Lee Company story of innovation never ends. Ongoing research, design, and development helps us advance the technology behind our products to transform the most demanding challenges into deliverable solutions. Our Engineering departments use best practice design principles, and have extensive resources available to perform rigorous qualification testing to ensure our customers receive only fully proven products. This commitment to technology allows Lee to foster creativity and offer the best products and technical support available.

ENGINEERING AND MANUFACTURING (cont'd)

The Lee Company offers many custom solutions in addition to the standard products described in this handbook. In fact, almost half of all Lee products sold today are custom products designed to meet the requirements of specific applications. The Lee Company sales and engineering staff are eager to help you solve your fluid control problem.

The Lee Company has over 1 million square feet of modern manufacturing and office space at multiple locations in Essex and Westbrook, Connecticut USA. Our facilities are equipped with state of the art equipment used to perform various operations, such as machining, molding, assembly and testing. From prototype parts for development purposes to high volume production, we utilize controlled manufacturing practices to ensure high quality and consistent long term product performance.

QUALITY SYSTEM

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.

We strive to continually improve the effectiveness of the quality management system through our quality policy, quality objectives, audit results, analysis of data, corrective and preventative action plans, management reviews and other continuous improvement initiatives. 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 Lee Company's Electro-Fluidic Systems Division (EFS) maintains a documented quality management system, including manufacturing lot control and traceability, that is designed and implemented to fulfill ISO9001 standard requirements. This system creates a framework for clearly defining the control of materials, processes, and verification activities, thus providing our customers with the confidence that the design and manufacture of our products are performed in a well-defined and controlled environment.

Quality Control Objectives

SALES AND SERVICE

The Lee Company is committed to full professional service to our customers through a worldwide sales network of graduate engineers. 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.

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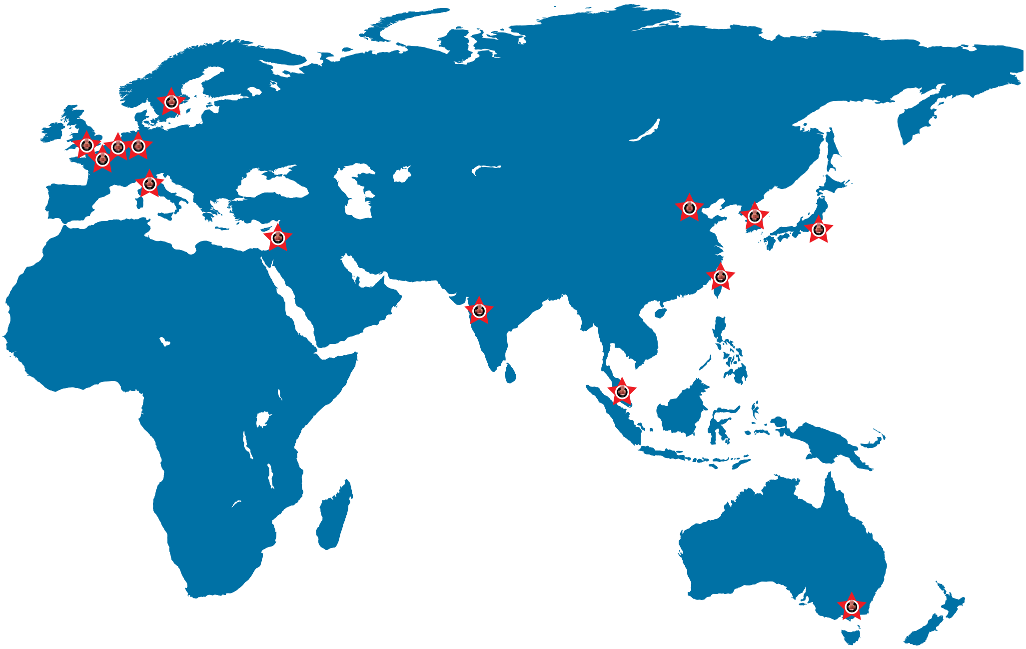

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Solenoid Valves

CONTROL VALVES

(HDI Platform)

2-way & 3-way miniature solenoid valves designed for applications flowing air, gas or mild liquids.

- 2-Way & 3-Way Designs
- Compact & Lightweight
- Conventional, Latching, Quiet Operation and Lo-Lohm Models
- Available in Multiple Styles
- Low Power Consumption & Low Leakage
- Long Life Expectancy

DISPENSING VALVES

(VHS & INK Series)

2-way solenoid valves designed for applications requiring precise dispensing and inkjet printing.

- 2-Way Designs
- Low Dispense Volumes
- Operating Frequencies up to 1200 Hz
- Response Times as Fast as 0.25 ms
- Multiple Porting Options

ISOLATION VALVES

Diaphragm Type

(LFN, LFV & LFR Series)

2-way and 3-way chemically inert solenoid valves used to flow aggressive fluids.

- 2-Way & 3-Way Designs
- Chemically Inert
- Low Internal Volume
- Multiple Seal Materials & Porting Options
- Long Life Expectancy

Pinch Tube Type

(LFY & LSP Series)

2-way & 3-way chemically inert solenoid valves with zero dead volume used to flow aggressive fluids.

- 2-Way & 3-Way Designs
- Chemically Inert
- Zero Dead Volume
- Low Internal Volume
- Internal Tube Pinch Block Design Feature
- Multiple Seal Materials & Styles Available
- Long Life Expectancy

Pumps

FIXED VOLUME PUMPS

(LPM, LPL & LPG Series)

Solenoid driven, positive displacement pumps providing accurate and repeatable dispense volumes in a small lightweight package.

- Chemically Inert
- Self-Priming
- Dispense Volumes Range from 10 to 175 µL
- High Dispense Accuracy & Repeatability
- Low Power Consumption

VARIABLE VOLUME PUMPS

(LPD & LPV Series)

Stepper motor driven, positive displacement pumps providing accurate and repeatable dispense volumes in a maintenance free design.

- Maintenance Free Design
- Wide Range of Dispense Volumes Available: 50, 250, 750, 1000 and 3000 µL
- High Dispense Accuracy and Repeatability
- Home Sensor & Motor Encoder Options Available
- Long Life Expectancy

Manifolds, Tubing and Components

MINSTAC

Miniature Inert System of Tubing and Components (MINSTAC)

- Design Flexibility
- Leak Free Performance
- Compact Size
- Wide Variety of Mounting Sizes and Options Available

NOZZLES

Atomizing and direct dispense nozzles providing highly precise performance

- Atomizing (Airless & Air Assisted) and Dispensing Designs
- Wide Range of Precision Orifice Sizes
- Different Mounting Options

MANIFOLD TECHNOLOGY

Custom designed, manufactured and 100% tested manifold assemblies

- Design Flexibility
- Wide Variety of Material Options
- Reduced Assembly & Installation Costs
- Space & Weight Savings
- Value Added Solution

CHECK AND RELIEF VALVES, ORIFICES AND SAFETY SCREENS

Wide variety of check valves, relief valves, precision flow calibrated orifices, and safety screens made from rugged materials and 100% tested to ensure long-term consistent performance.

- Compact Size
- Design Flexibility
- Multiple Configurations, Sizes and Material Options
- Valves and Orifices 100% Tested
- Accurate and Repeatable Performance
- Safety Screen Micron Ratings Available: 4 to 500 µm

Solenoid Valves

CONTROL VALVES

HDI Platform .... 2-way & 3-way miniature solenoid valves used for flowing air, gas or mild liquids. **A** 1-40

DISPENSING VALVES

VHS Series .... 2-way in-line normally closed axial flow solenoid valves used for high speed precision dispensing. **B** 1-18

INK Series .... 2-way normally closed solenoid valves used for high speed inkjet printing. **C** 1-6

ISOLATION VALVES

Diaphragm Type

LFN Series .... 2-way miniature chemically inert solenoid valves with zero dead volume used to flow aggressive fluids. **D** 1-8

LFV Series .... 2-way chemically inert solenoid valves with zero dead volume and higher flow capacity used to flow aggressive fluids. **E** 1-18

LFR Series .... 3-way chemically inert solenoid valves used to flow aggressive fluids. **F** 1-16

Pinch Tube Type

LFY Series .... 2-way & 3-way chemically inert solenoid valves with zero dead volume used to flow aggressive fluids. **G** 1-12

LSP Series .... 2-way chemically inert solenoid valves with higher flow capacity and zero dead volume used to flow aggressive fluids. **H** 1-6

Pumps

Fixed Volume Pumps .... Solenoid driven, positive displacement pumps providing accurate and repeatable dispense volumes in a small lightweight package. **I** 1-14

Variable Volume Pumps .... Stepper motor driven, positive displacement pumps providing accurate and repeatable dispense volumes in a maintenance free design. **J** 1-18

Manifolds, Tubing and Components

Manifold Technology	.... Custom designed, manufactured and 100% tested manifold assembly capabilities.	K	1-6
MINSTAC	.... Miniature Inert System of Tubing and Components	L	1-56
Nozzles	.... Atomizing and direct dispense nozzles providing precision performance	M	1-10
Check and Relief Valves, Orifices and Safety Screens	.... Screens, check valves, pressure relief valves and orifices	N	1-4

Special Products

IEP Series	.... 2-way in-line normally closed axial flow solenoid valves providing higher pressure and temperature performance.	O	1-6
120 Series	.... 2-way in-line ultra-miniature latching solenoid valve for air piloting.	P	1-2
Visco Mixers	.... Static mixers for HPLC and other high pressure applications	Q	1-4

Engineering Reference

R 1-56

General Information

Policies, Proprietary Rights, Patents, Trademarks, Copyrights, Warranty S 1-5

HDI Platform

The HDI Platform consists of compact, lightweight solenoid valves with low internal volume. Available in 2-Port or 3-Port designs, and in several mounting styles, these valves are easily manifold mounted, making them the perfect solution for applications where a large number of valves must be designed into the smallest space possible. These valves are generally used in oxygen delivery systems, gas analysis equipment, patient monitors, air calibration devices, ventilators, gas chromatography and dialysis machines. The following general performance characteristics are offered in this product platform:

- Compact Size
- Lightweight: 2.5 to 4.5 grams
- Multiple Styles: Plug-In, Face Mount and Soft Tube Ported
- Low Leakage: Less than 50 uLPM Throughout Rated Life Expectancy
- Response Time as Low as 3 ms
- Available Seal Elastomers: Silicone, FKM and FFKM (available upon request)
- Long Cycle Life

Engineered using long-lasting materials, each valve is 100% functionally tested to ensure reliable, consistent, long-term performance. The Lee Company can customize valve performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

HDI Platform

The HDI Platform consists of three different product series to cover a wide range of application needs.

LHD Series *(pages A3-8)*

The LHD Series solenoid valves are available in Conventional and Lo-Lohm models. The Conventional model offers extremely low power consumption (as low as 550 mW under continuous duty) with flow rates up to 11 SLPM at 30 psid (1100 Lohms), while the Lo-Lohm model offers even more flow capacity with certain designs reaching 39 SLPM at 50 psid (450 Lohms) without sacrificing size or weight.

LHL Series *(pages A9-14)*

The LHL Series solenoid valves are magnetically latched valves featuring ultra-low power (as low as 5.5 mJ/switch) and low heat dissipation. Ideal for battery powered portable instruments, these latching solenoid valves require only momentary (10-30 ms) pulses of current to switch to and remain in each flow state. For additional flow capacity, a Lo-Lohm Latching model is also available.

LHQ Series *(pages A15-16)*

The LHQ Series Quiet Operation solenoid valves feature Whisper Technology™ to reduce actuation noise. 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, the inherent actuation noise is reduced by 50% to a sound level measure of less than 37 dBa, ultimately making this series of solenoid valves ideal for improving patient comfort in bedside medical instruments.

For valve dimensions, mounting specifications, standard manifold offerings and general specifications for the HDI Solenoid Valve Platform, please refer to pages A17-39.

2-Port Conventional and Lo-Lohm Models

Featuring an ultra-miniature, normally closed design, the 2-Port HDI solenoid valve is exceptionally small in size, lightweight, and offers consistent performance throughout its life. Conveniently offered in both 450 and 1500 Lohm models, this small solenoid valve's wide range of performance capabilities will surpass your expectations for a product of its size.

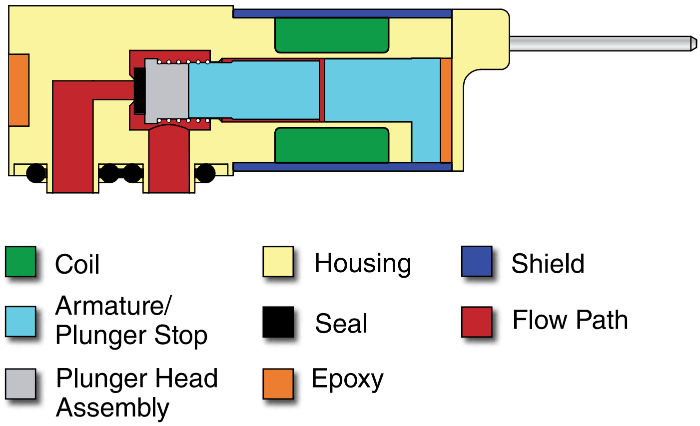
FEATURES:

- Compact size: as small as 0.28" (W) x 0.76" (L)
- Lightweight: less than 2.5 grams
- Flow capacity: 450 and 1500 Lohm models available
- Voltage flexibility: 3.3, 5, 12 and 24 Vdc standard models available
- Low internal volume: Plug-In (28 μL) and Face Mount (34 μL)
- Cycle Life: 10 million cycles (silicone or FKM). See page A37 for additional information.
- Leakage: 50 SμLPM max. at 10 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 40°F to 120°F (4°C to 49°C)
- Wetted materials: housing (PBT), armature/plunger stop (FeCr alloy), spring (316 SS) and epoxy. See table below for seal and plunger head wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1] ON AIR AT 70°F (21°C)
 Plug-In	LHDB0342115H	3.3	1500 Lohms (4.4 SLPM @ 10 psid; Ref. Cv = 0.013)
	LHDB0542115H	5	
	LHDB1242115H	12	
	LHDB0442145D[5]	Actuation: 12; Hold: 3.5	450 Lohms (14.6 SLPM @ 10 psid; Ref. Cv = 0.044)
	LHDB0442245D[5]	Actuation: 12; Hold: 3.5	
	LHDB0942145D[5]	Actuation: 24; Hold: 7	
	LHDB0942245D[5]	Actuation: 24; Hold: 7	
 Face Mount	LHDB0352115H	3.3	1500 Lohms (4.4 SLPM @ 10 psid; Ref. Cv = 0.013)
	LHDB0552115H	5	
	LHDB1252115H	12	

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) See page A38 for complete electrical characteristics.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

2-Port Conventional and Lo-Lohm Models



	OPERATING PRESSURE	POWER CONSUMPTION[2] AT 70°F (21°C) (mW)	WETTED MATERIALS[3]		CONFIGURATION[4]
			SEAL	PLUNGER HEAD	
	Supply Vac – 45 psig Differential 10 psid (max.)	850	Silicone	PPS	A
		890	Silicone	PPS	A
		850	Silicone	PPS	A
		440 (Hold Power)	Silicone	PPS	A
		440 (Hold Power)	FKM	PPA	A
		420 (Hold Power)	Silicone	PPS	A
		420 (Hold Power)	FKM	PPA	A
		850	Silicone	PPS	B
		890	Silicone	PPS	B
		850	Silicone	PPS	B

(4) See pages A17–18 for valve dimensions and mounting requirements.

(5) Spike and hold drive signal required. Refer to Engineering Reference Section, pages R35-36, for electrical circuit design recommendations, and see pages A35-36 for spike and hold driver part numbers available for purchase as accessory items.

3-Port Conventional Model

The 3-Port HDI is a compact, lightweight solenoid valve, offering consistent performance and low power consumption. This valve is ideal for applications where a large number of valves need to be designed into the smallest area possible.

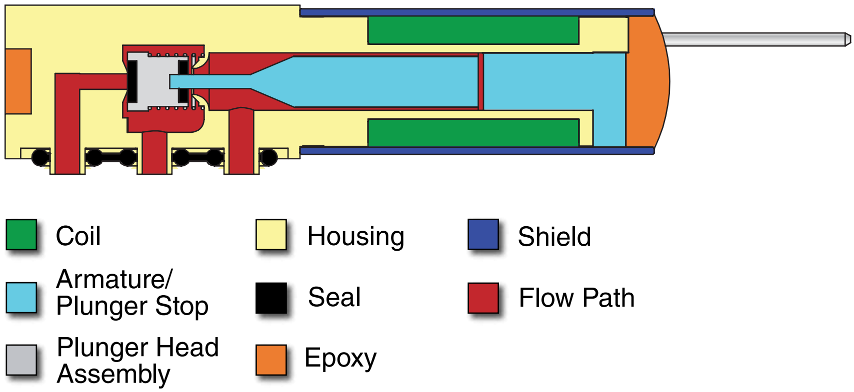
FEATURES:

- Compact size: as small as 0.28" (W) x 1.12" (L)
- Lightweight: less than 4.5 grams
- Low internal volume: Plug-In (40 µL), Face Mount (72 µL) and Ported (77 µL)
- Cycle Life: 10 million cycles (silicone), 250 million cycles (FKM). See page A37 for additional information.
- Leakage: 50 SµLPM max. at 5 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 40°F to 120°F (4°C to 49°C)
- Wetted materials: housing (PBT), spring (302 or 316 SS) and epoxy. See table below for seal, plunger head and armature/plunger stop wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER [1]	LOHM RATE [3] ON AIR AT 70°F (21°C)	OPERATING PRESSURE
 **Plug-In**	LHDA_ _11111H	1100 Lohms (7.3 SLPM @15 psid; Ref. Cv = 0.018)	Supply Vac – 45 psig Differential 15 psid (max.)
	LHDA_ _11211H		
	LHDA_ _11311H		
	LHDA_ _11411H		
 **Face Mount**	LHDA_ _21111H	1100 Lohms (7.3 SLPM @15 psid; Ref. Cv = 0.018)	Supply Vac – 45 psig Differential 15 psid (max.)
	LHDA_ _21211H		
	LHDA_ _21311H		
	LHDA_ _21411H		
	LHDA0523112H	1200 Lohms (10.1 SLPM @30 psid; Ref. Cv = 0.016)	Supply Vac – 45 psig Differential 30 psid (max.)
	LHDA0523212H		
	LHDA0523312H		
	LHDA0523412H		
	LHDA_ _23111H [2]	1100 Lohms (11 SLPM @30 psid; Ref. Cv = 0.018)	Supply Vac – 45 psig Differential 30 psid (max.)
	LHDA_ _23211H [2]		
	LHDA_ _23311H [2]		
	LHDA_ _23411H [2]		
 **Ported**	LHDA_ _31115H	1500 Lohms (5.4 SLPM @15 psid; Ref. Cv = 0.013)	Supply Vac – 45 psig Differential 15 psid (max.)
	LHDA_ _31215H		
	LHDA_ _31315H		
	LHDA_ _31415H		
	LHDA_ _33115H	1500 Lohms (8 SLPM @30 psid; Ref. Cv = 0.013)	Supply Vac – 45 psig Differential 30 psid (max.)
	LHDA_ _33215H		
	LHDA_ _33315H		
	LHDA_ _33415H		

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
(2) Available in 12 and 24 Vdc only.
(3) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

3-Port Conventional Model



POWER CONSUMPTION[4] AT 70°F (21°C) (mW)	WETTED MATERIALS[5]			CONFIGURATION[7]
	SEAL	PLUNGER HEAD	ARMATURE/PLUNGER STOP	
550	Silicone	PPS	430 SS	C
550	FKM	PPA	430 SS	C
550	Silicone	PPS	FeCr Alloy[6]	C
550	FKM	PPA	FeCr Alloy[6]	C
550	Silicone	PPS	430 SS	D
550	FKM	PPA	430 SS	D
550	Silicone	PPS	FeCr Alloy[6]	D
550	FKM	PPA	FeCr Alloy[6]	D
750	Silicone	PPS	430 SS	D
750	FKM	PPA	430 SS	D
750	Silicone	PPS	FeCr Alloy[6]	D
750	FKM	PPA	FeCr Alloy[6]	D
750	Silicone	PPS	430 SS	D
750	FKM	PPA	430 SS	D
750	Silicone	PPS	FeCr Alloy[6]	D
750	FKM	PPA	FeCr Alloy[6]	D
550	Silicone	PPS	430 SS	E
550	FKM	PPA	430 SS	E
550	Silicone	PPS	FeCr Alloy[6]	E
550	FKM	PPA	FeCr Alloy[6]	E
750	Silicone	PPS	430 SS	E
750	FKM	PPA	430 SS	E
750	Silicone	PPS	FeCr Alloy[6]	E
750	FKM	PPA	FeCr Alloy[6]	E

(4) See page A38 for additional electrical characteristics.
(5) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.
(6) Wetted materials are optimized for saline compatibility.
(7) See page A19 for valve dimensions, and page A21-22 for mounting requirements.

3-Port Lo-Lohm Model

The 3-Port Lo-Lohm HDI miniature solenoid valve is ideal for applications requiring more flow capacity when space is critical. Imagine the high flow benefits of a larger valve, together with the superior performance and compact footprint of the HDI solenoid valve platform.

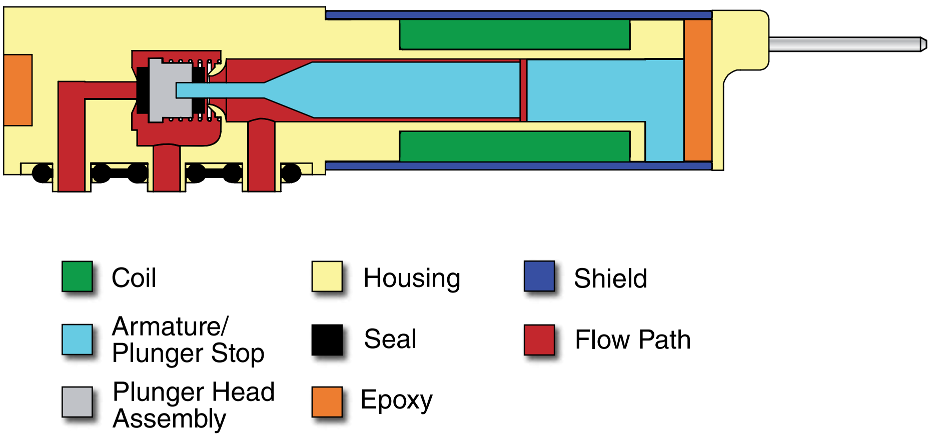
FEATURES:

- Compact size: as small as 0.28" (W) x 1.22" (L)
- High flow capacity: models available as low as 450 Lohms
- Lightweight: less than 4.5 grams
- Spike and hold voltage drive required
- Low internal volume: Plug-In (40 μL), Face Mount (72 μL) and Ported (77 μL)
- Operating temperature: 40°F to 120°F (4°C to 49°C)
- Cycle Life: 10 million cycles (silicone), 250 million cycles (FKM). See page A37 for additional information.
- Leakage: 50 SμLPM max. at 5 psid air; 70°F (21°C) throughout rated cycle life
- Wetted materials: housing (PBT), armature/plunger stop (FeCr alloy), spring (316 SS) and epoxy. See table below for seal and plunger head wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PORTING	PART NUMBER	SPIKE VOLTAGE[1] (Vdc)	HOLD VOLTAGE (Vdc)	LOHM RATE[2] ON AIR AT 70°F (21°C)
 Plug-In	2-Way N.C. (Common Inlet)	LHDA0560245D	15	5	450 Lohms (39 SLPM @ 50 psid; Ref. Cv = 0.044)
		LHDA1260245D	32	12	
	2-Way N.O. (N.O.Inlet)	LHDA0560365D	11	5	650 Lohms (27 SLPM @ 50 psid; Ref. Cv = 0.031)
		LHDA1260365D	25	12	
	3-Way (Common Inlet)	LHDB0313155D	5	2.5	550 Lohms (14.6 SLPM @15 psid; Ref. Cv = 0.036)
		LHDB0613155D	12	6	
		LHDB0313255D	5	2.5	
		LHDB0613255D	12	6	
 Face Mount	2-Way N.C. (Common Inlet)	LHDA0570290D	19	5	900 Lohms (19.5 SLPM @50 psid; Ref. Cv = 0.022)
		LHDA1270290D	45	12	
	3-Way (Common Inlet)	LHDB0323180D	5	2.5	800 Lohms (10.1 SLPM @15 psid; Ref. Cv = 0.025)
		LHDB0623180D	12	6	
		LHDB0323280D	5	2.5	
		LHDB0623280D	12	6	
 Ported		LHDB0333180D	5	2.5	
		LHDB0633180D	12	6	
		LHDB0333280D	5	2.5	
		LHDB0633280D	12	6	

NOTES: (1) Spike and hold drive signal required. Refer to Engineering Reference Section, pages R35-36 for electrical circuit design recommendations, and see pages A35-36 for spike and hold driver part numbers available for purchase as accessory items.
(2) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

3-Port Lo-Lohm Model



OPERATING PRESSURE	POWER CONSUMPTION[3] AT HOLD VOLTAGE AT 70°F (21°C) (mW)	WETTED MATERIALS[4]		CONFIGURATION[5]
		SEAL	PLUNGER HEAD	
Supply Vac – 50 psig Differential 50 psid (max.)	540	FKM	PPA	F
	550	FKM	PPA	F
	540	FKM	PPA	F
	550	FKM	PPA	F
Supply Vac – 45 psig Differential 15 psid (max.)	520	Silicone	PPS	F
	590	Silicone	PPS	F
	520	FKM	PPA	F
	590	FKM	PPA	F
Supply Vac – 50 psig Differential 50 psid (max.)	540	FKM	PPA	G
	550	FKM	PPA	G
Supply Vac – 45 psig Differential 15 psid (max.)	520	Silicone	PPS	G
	590	Silicone	PPS	G
	520	FKM	PPA	G
	590	FKM	PPA	G
	520	Silicone	PPS	H
	590	Silicone	PPS	H
	520	FKM	PPA	H
	590	FKM	PPA	H

(3) See page A38 for additional electrical characteristics.
(4) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.
(5) See page A20 for valve dimensions, and page A21-22 for mounting requirements.

2-Port Latching Model

Optimized for applications that demand extremely low power, low heat and small size, the 2-Port Latching HDI solenoid valve is ideal for compact, battery-operated portable instruments. This magnetically latched valve requires only momentary (10 to 30 ms) pulses to switch to and remain in each state. The polarity of voltage on the terminal pins controls the switched position. With energy consumption as low as 10 mJ/switch, this small solenoid valve's wide range of performance capabilities will surpass your expectations for a product of its size.

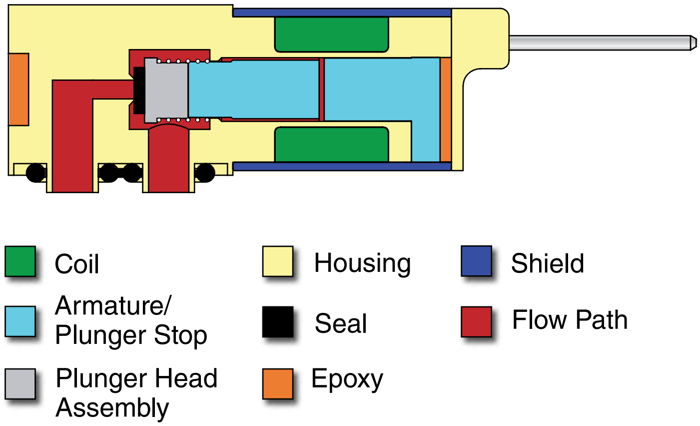
FEATURES:

- Compact size: as small as 0.28" (W) x 0.76" (L)
- Low power consumption
- Magnetically latched
- Lightweight: less than 2.5 grams
- Voltage flexibility: 3.3, 5, 12 Vdc standard models available
- Low internal volume: Plug-In (28 μL) and Face Mount (34 μL)
- Cycle Life: 10 million cycles (silicone or FKM). See page A37 for additional information.
- Leakage: 50 SμLPM max. at 10 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 40°F to 120°F (4°C to 49°C)
- Wetted materials: housing (PBT), armature/plunger stop (FeCr alloy), spring (316 SS) and epoxy. See table below for seal and plunger head wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1] ON AIR AT 70°F (21°C)
 Plug-In	LHLA0342311H	3.3	1100 Lohms (6 SLPM @ 10 psid; Ref. Cv = 0.018)
	LHLA0542311H	5	
	LHLA1242311H	12	
	LHLA0542411H	5	
	LHLA1242411H	12	
 Face Mount	LHLA0352311H	3.3	
	LHLA0552311H	5	
	LHLA1252311H	12	
	LHLA0552411H	5	
	LHLA1252411H	12	

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) See page A38 for complete electrical characteristics, and refer to Engineering Reference Section, pages R37-38, for electrical circuit design recommendations.

2-Port Latching Model



	OPERATING PRESSURE	POWER CONSUMPTION[2] AT 70°F (21°C) (mJ/SWITCH)	WETTED MATERIALS[3]		CONFIGURATION[4]
			SEAL	PLUNGER HEAD	
	Supply Vac – 45 psig Differential 10 psid (max.)	10	Silicone	PPS	A
		10	Silicone	PPS	A
		10	Silicone	PPS	A
		22	FKM	PPA	A
		22	FKM	PPA	A
		10	Silicone	PPS	B
		10	Silicone	PPS	B
		10	Silicone	PPS	B
		22	FKM	PPA	B
		22	FKM	PPA	B

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

(4) See pages A17-18 for valve dimensions and mounting requirements.

A

3-Port Latching Model

Optimized for applications that demand ultra-low power, low heat and small size, the 3-Port Latching HDI solenoid valve is ideal for compact, battery-operated portable instruments. This magnetically latched valve requires only momentary (10 to 30 ms) pulses to switch to and remain in each state, resulting in energy consumption of only 5.5 mJ per switch. The polarity of voltage on the terminal pins controls the switched position.

FEATURES:

- Magnetically latched
- Low power consumption
- Compact size: as small as 0.28" (W) x 1.22" (L)
- Lightweight: less than 4.5 grams
- Low internal volume: Plug-In (40 µL), Face Mount (72 µL) and Ported (77 µL)
- Cycle Life: 10 million cycles (silicone or FKM). See page A37 for additional information.
- Leakage: 50 SµLPM max. at 5 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 40°F to 120°F (4°C to 49°C)
- Wetted materials: housing (PBT), Spring (316 SS) and epoxy. See table below for seal, plunger head and armature/plunger stop wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER[1]	LOHM RATE[2] ON AIR AT 70°F (21°C)	OPERATING PRESSURE	
 Plug-In	LHLA_ _11111H	1100 Lohms (7.32 SLPM @ 15 psid; Ref. Cv = 0.018)	Supply Vac – 45 psig Differential 15 psid (max.)	
	LHLA_ _11211H			
	LHLA_ _11311H			
	LHLA_ _11411H			
 Face Mount	LHLA_ _21111H			
	LHLA_ _21211H			
	LHLA_ _21311H			
	LHLA_ _21411H			
 Ported	LHLA_ _31111H			
	LHLA_ _31211H			
	LHLA_ _31311H			
	LHLA_ _31411H			

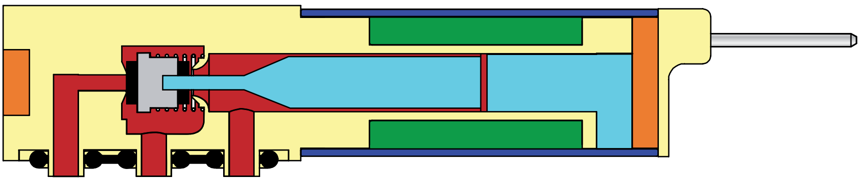
NOTES: (1) Solenoid valves are available in 5, 12 and 24 Vdc configurations.

LHLA _ _ 11111H

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

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

3-Port Latching Model



	POWER CONSUMPTION [3] AT 70°F (21°C) (mJ/SWITCH)	WETTED MATERIALS [4]			CONFIGURATION [5]
		SEAL	PLUNGER HEAD	ARMATURE/PLUNGER STOP	
	5.5	Silicone	PPS	430 SS	F
	5.5	FKM	PPA	430 SS	F
	5.5	Silicone	PPS	FeCr Alloy [6]	F
	5.5	FKM	PPA	FeCr Alloy [6]	F
	5.5	Silicone	PPS	430 SS	G
	5.5	FKM	PPA	430 SS	G
	5.5	Silicone	PPS	FeCr Alloy [6]	G
	5.5	FKM	PPA	FeCr Alloy [6]	G
	5.5	Silicone	PPS	430 SS	H
	5.5	FKM	PPA	430 SS	H
	5.5	Silicone	PPS	FeCr Alloy [6]	H
	5.5	FKM	PPA	FeCr Alloy [6]	H

(3) See page A38 for additional electrical characteristics and refer to Engineering Reference Section, pages R37-38, for electrical circuit design recommendations.
(4) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.
(5) See page A20 for valve dimensions, and page A21-22 for mounting requirements.
(6) Wetted materials are optimized for saline capability.

3-Port Lo-Lohm Latching Model

By combining the high flow capabilities of the Lo-Lohm HDI with the power savings of our Latching HDI, this 3-Port Lo-Lohm Latching HDI solenoid valve excels in applications where high flow capacity, low power and small size are critical. The ultra-low heat, low power and high flow features of this design are optimized for compact, battery powered pneumatic instruments such as portable respiratory therapy devices, molecular diagnostics instruments and environmental gas samplers. This magnetically latched valve requires only momentary (10 ms minimum) pulses to switch to and remain in each state, resulting in energy consumption as low as 28 mJ per switch. The polarity of voltage on the terminal pins controls the switched position.

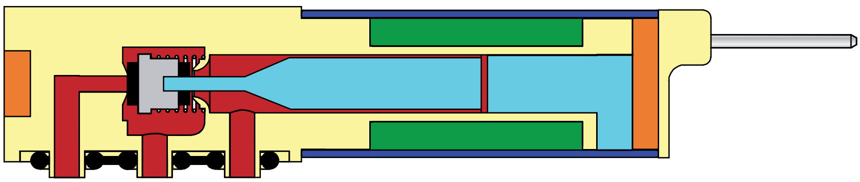
FEATURES:

- Magnetically latched
- Low power consumption
- High flow capacity: models available as low as 550 Lohms
- Compact size: as small as 0.28" (W) x 1.22" (L)
- Lightweight: less than 4.5 grams
- Low internal volume: Plug-In (40 μL), Face Mount (72 μL) and Ported (77 μL)
- Cycle Life: 10 million cycles minimum. See page A37 for additional information.
- Leakage: 50 SμLPM max. at 5 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 40°F to 120°F (4°C to 49°C)
- Wetted materials: housing (PBT), armature/plunger stop (FeCr alloy), spring (316 SS), seal (silicone) and epoxy. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER	VOLTAGE (Vdc)	LOHM RATE [1] ON AIR AT 70°F (21°C)	
 Plug-In	LHLA0511355D	5	550 Lohms (14.6 SLPM@15 psid; Ref. Cv = 0.036)	
	LHLA1211355D	12		
 Face Mount	LHLA0521380D	5	800 Lohms (10 SLPM@15 psid; Ref. Cv = 0.025)	
	LHLA1221380D	12		
 Ported	LHLA0531380D	5		
	LHLA1231380D	12		

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) See page A38 for additional electrical characteristics and refer to Engineering Reference Section, pages R37-38, for electrical circuit design recommendations.

3-Port Lo-Lohm Latching Model



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

	OPERATING PRESSURE	POWER CONSUMPTION [2] AT 70°F (21°C) (mJ/SWITCH)	CONFIGURATION [3]
	Supply Vac – 45 psig Differential 15 psid (max.)	28	F
		35	F
		28	G
		35	G
		28	H
		35	H

(3) See page A20 for valve dimensions, and page A21-22 for mounting requirements.

3-Port Quiet Operation Model

Designed to improve patient comfort, the 3-Port Quiet Operation HDI solenoid valve features Whisper Technology™ which reduces the actuation noise of a typical solenoid valve by 50%. This valve model provides a sound-level measurement of less than 37 dBA when measured at a distance of 12 inches and cycling at a frequency of 10 Hz. The Quiet Operation HDI solenoid valve is ideal for patient simulators, patient monitors and other bedside medical devices.

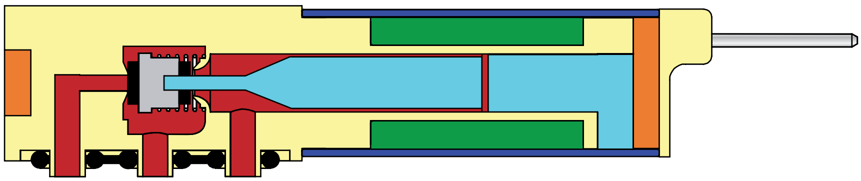
FEATURES:

- Whisper Technology™
- 50% quieter than our already best-in-class HDI design
- Lightweight: less than 4.5 grams
- Flow media: rated only for use with non-combustible gases. If oxygen-service is required, ask The Lee Company about other quiet design options.
- Compact size: as small as 0.28" (W) x 1.22" (L)
- Low internal volume: Plug-In (40 µL), Face Mount (72 µL) and Ported (77 µL)
- Cycle Life: 25 million cycles. See page A37 for additional information.
- Leakage: 50 SµLPM max. at 5 psid air; 70°F (21°C) throughout rated cycle life
- Operating temperature range: 60°F to 120°F (16°C to 49°C)
- Wetted materials: housing (PBT), armature/plunger stop (430 SS), spring (316 SS), damping fluid and epoxy. See table below for seal and plunger head wetted materials. The o-rings on all Plug-In style valves are FKM.

STYLE	PART NUMBER	VOLTAGE (Vdc)	LOHM RATE [1] ON AIR AT 70°F (21°C)	
 Plug-In	LHQA0511220H	5	2000 Lohms (4.0 SLPM @ 15 psid; Ref. Cv = 0.01)	
	LHQA1211220H	12		
	LHQA2411220H	24		
 Face Mount	LHQA0521220H	5		
	LHQA1221220H	12		
	LHQA2421220H	24		
 Ported	LHQA0531220H	5		
	LHQA1231220H	12		
	LHQA2431220H	24		

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) See page A38 for additional electrical characteristics.

3-Port Quiet Operation Model

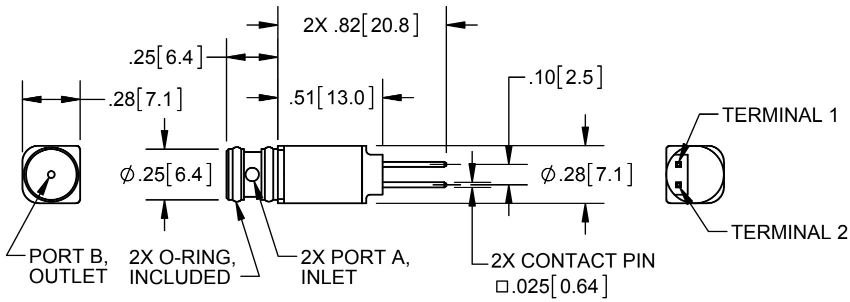


	OPERATING PRESSURE	POWER CONSUMPTION[2] AT 70°F (21°C) (mW)	WETTED MATERIALS[3]		CONFIGURATION[4]
			SEAL	PLUNGER HEAD	
	Supply 0 – 45 psig Differential 15 psid (max.)	900	FKM	PPA	F
		900	FKM	PPA	F
		900	FKM	PPA	F
		900	FKM	PPA	G
		900	FKM	PPA	G
		900	FKM	PPA	G
		900	FKM	PPA	H
		900	FKM	PPA	H
		900	FKM	PPA	H

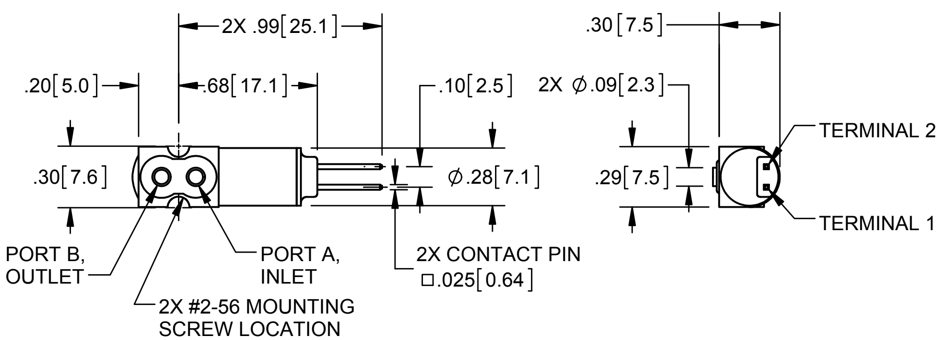
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.
(4) See page A20 for valve dimensions, and page A21-22 for mounting requirements.

A

Configuration A
2-Port Plug-In Style

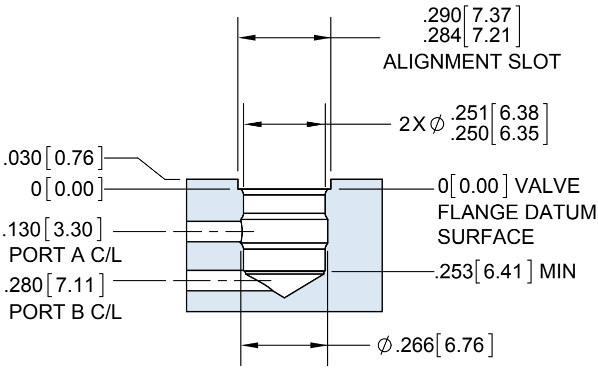


Configuration B
2-Port Face Mount Style



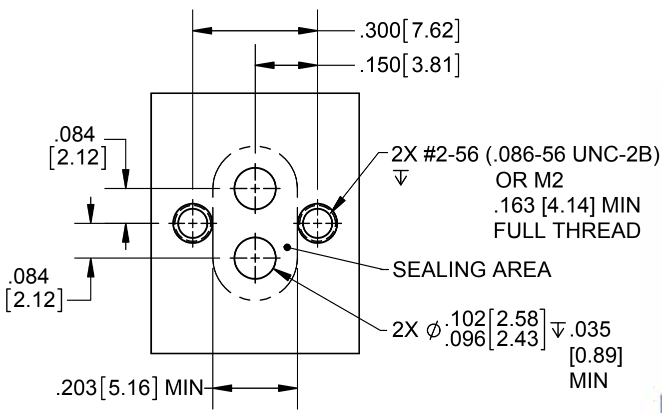
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

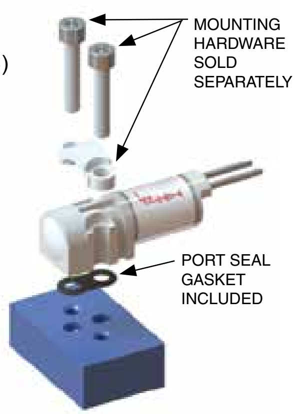
Valve Mounting Details
2-Port Plug-In Style



- Valve Boss may be created using The Lee Co. cutting tool, Part Number TTTA0000250B
- Reference Drawing Number LCFX0300250B for 2-Port Plug-In Boss Detail

Valve Mounting Details
2-Port Face Mount Style

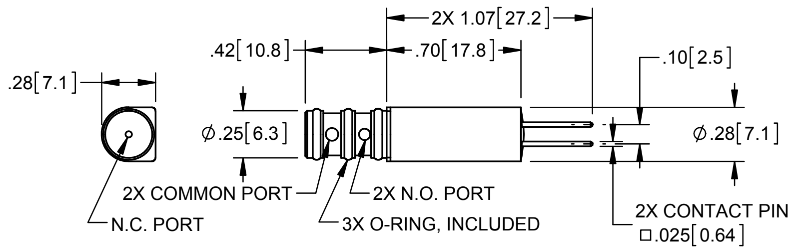




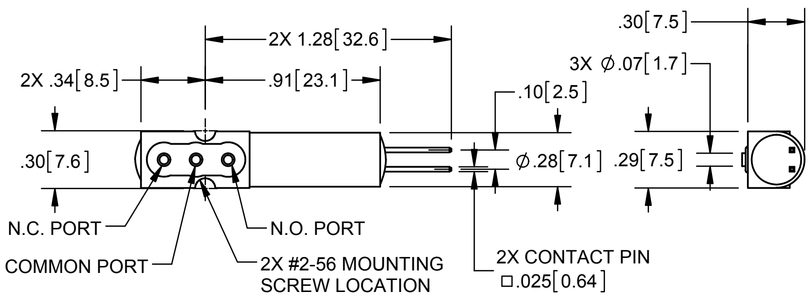
- Reference Drawing Number LFIX1002050A for 2-Port Face Mount Mounting Detail
- Mounting Hardware: Mounting Screw (LHWX0213420A); Screw Support (LHDX0307140A)

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.
Standard manifolds are available. See *pages A23-26**.*

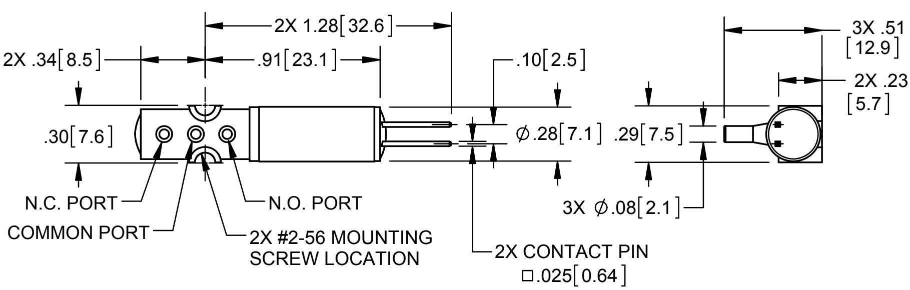
Configuration C
3-Port Plug-In Style



Configuration D
3-Port Face Mount Style

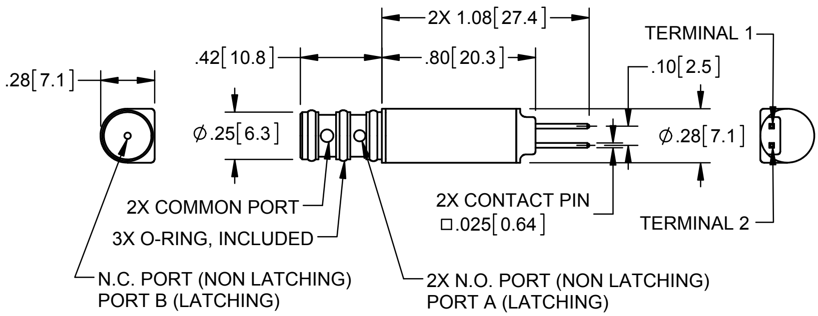


Configuration E
3-Port Ported Style

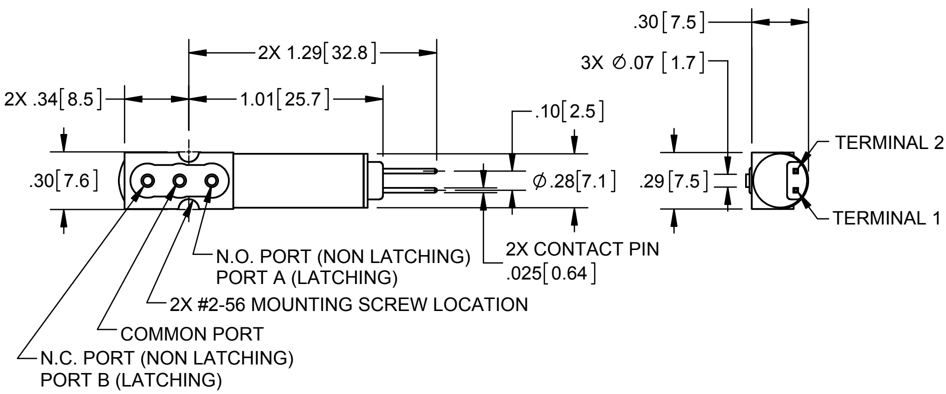


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

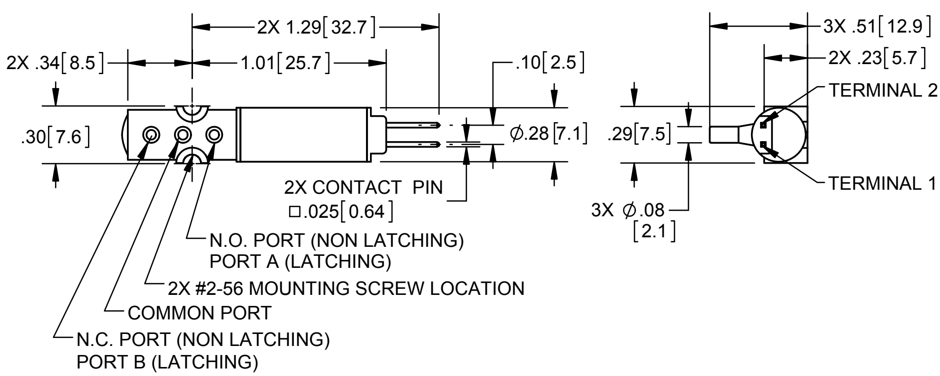
Configuration F
3-Port Plug-In Style



Configuration G
3-Port Face Mount Style



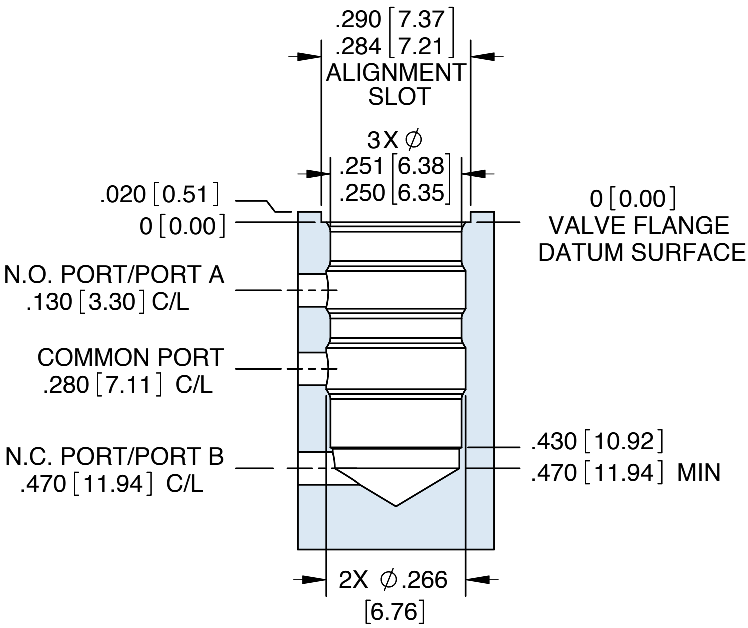
Configuration H
3-Port Ported Style



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

A

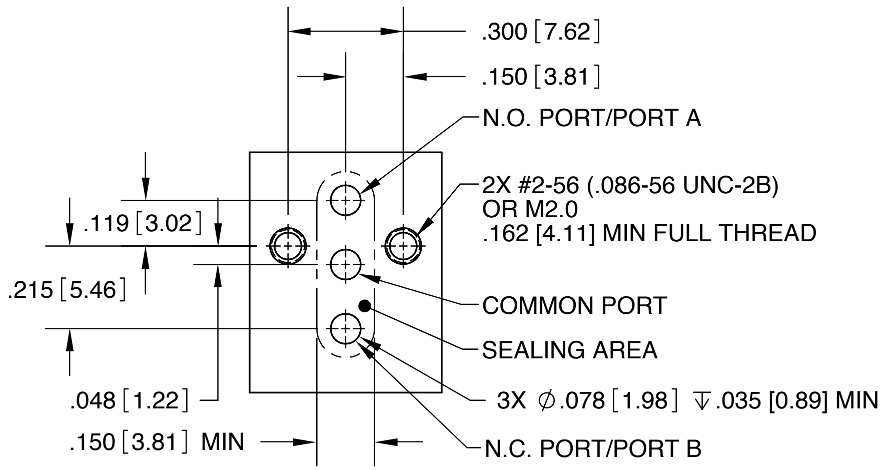
Valve Mounting Details
3-Port Plug-In Style



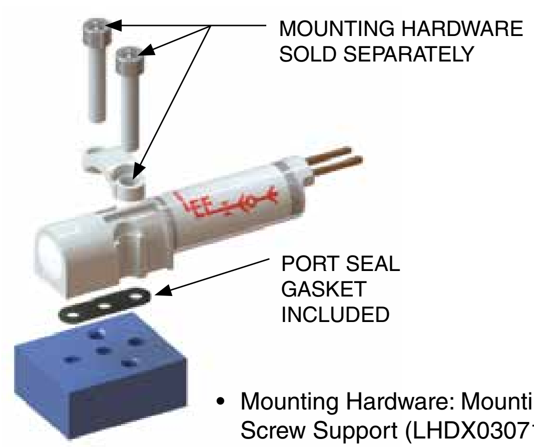
- Valve Boss may be created using Boss Cutting Tool, Lee Part Number TTTA0000180B
- Reference Drawing Number LCFX0300100B for 3-Port Plug-In Boss Detail

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.
Standard manifolds are available. See *pages A27-28.*

Valve Mounting Details
3-Port Face Mount Style



- Reference Drawing Number LFIX1001150A for 3-Port Face Mount Boss Detail



- Mounting Hardware: Mounting Screw (LHWX0213420A); Screw Support (LHDX0307140A)

Standard manifolds are available. See pages A29-30.

3-Port Ported Style

- Requires only 2x 2-56 mounting screws (LHWX0213420A). Ports are intended for connection to soft, flexible 1/16" ID tubing.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Standard, 2-Port Plug-In Style Manifolds

The Lee Company offers several standard manifold configurations to ease the setup of prototype systems. These off-the-shelf manifolds are available in mounting denominations of single valve (1x), three valves (3x) and eight valves (8x). Combine these denominations, or plug unused ports to configure the setup for your specific application.

- **Individual Ports:** This manifold configuration will allow for tubing connections to each individual valve port.
- **Port A Inlet Header, Individual Port B Outlet Ports:** This manifold configuration provides a shared inlet header line to all valve inlet ports, and also provides individual tubing connections to the outlet port of each valve.

See page A24 for a visual representation of the pneumatic schematics.

PART NUMBER	DESCRIPTION	DIMENSION "A"	DIMENSION "B"
LFMX0524000A[1]	Manifold, 1x HDI, 2-Port, Plug-In, Individual Ports, Acrylic	—	—
LFMX0528200B[1]	Manifold, 1x HDI, 2-Port, Plug-In, Individual Ports, Aluminum	—	—
LFMX0527650B[1]	Manifold, 3x HDI, 2-Port, Plug-In, Individual Ports, Aluminum	1.30" (33.0 mm)	1.05" (26.7 mm)
LFMX0527700B[1]	Manifold, 8x HDI, 2-Port, Plug-In, Individual Ports, Aluminum	2.80" (71.1 mm)	2.55" (64.8 mm)
LFMX0527750B[2]	Manifold, 3x HDI, 2-Port, Plug-In, Port A Inlet Header, Individual Port B Outlet Ports, Aluminum	1.50" (38.1 mm)	1.25" (31.8 mm)
LFMX0527800B[2]	Manifold, 8x HDI, 2-Port, Plug-In, Port A Inlet Header, Individual Port B Outlet Ports, Aluminum	3.00" (76.2 mm)	2.75" (69.9 mm)

NOTES: (1) Manifold for use with Lee Company, HDI 2-Port style solenoid valves rated to 450 Lohms or higher.
(2) Manifold for use with Lee Company, HDI 2-Port style solenoid valves, rated to 1100 Lohms or higher.

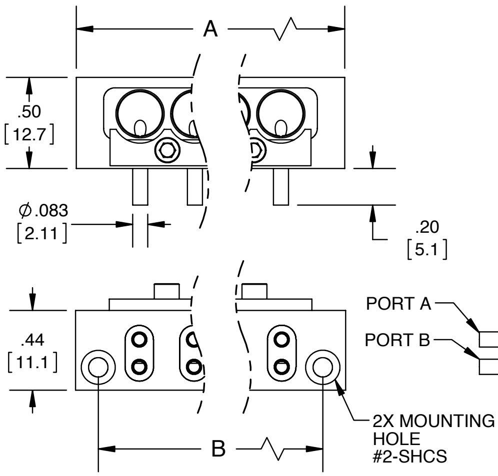
Part Numbers are for the manifold and secondary retention bracket only. Valves are sold separately.

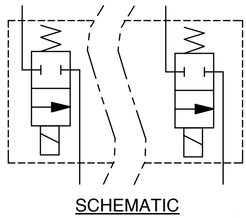
Refer to Manifold Technology (Section K) for information on customized manifold assemblies. HDI Platform valves require only 0.300" center to center spacing.

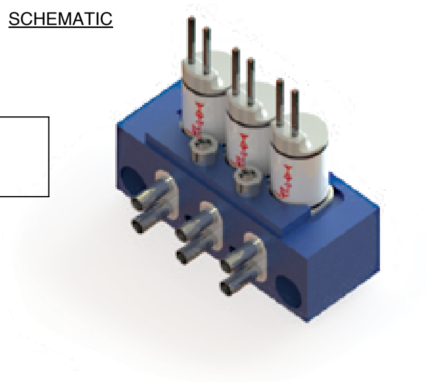
See page A31 for valve and manifold accessory items.

Standard, 2-Port Plug-In Style Manifolds

Individual Ports

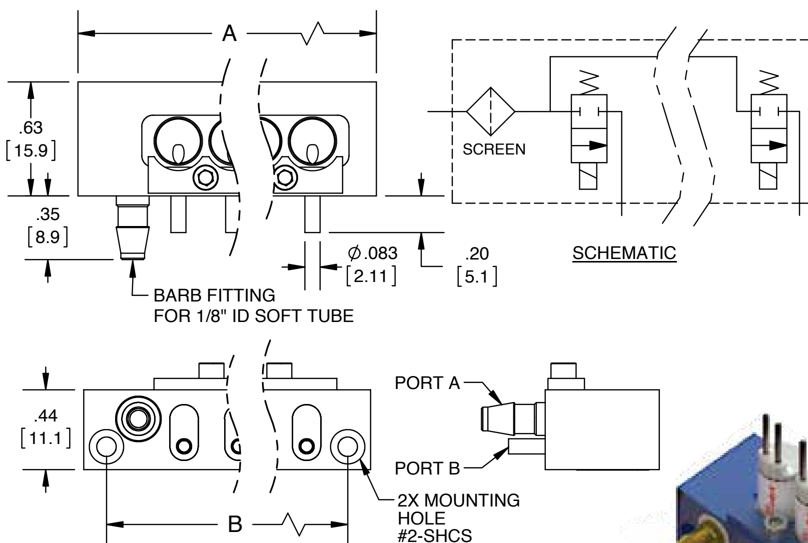


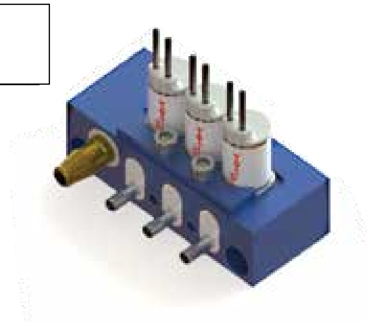




Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

Port A Inlet Header, Individual Port B Outlet Ports





Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

A

Standard, 2-Port Face Mount Style Manifolds

The Lee Company offers several standard manifold configurations to ease the setup of prototype systems. These off-the-shelf manifolds are available in mounting denominations of single valve (1x), three valves (3x) and eight valves (8x). Combine these denominations, or plug unused ports to configure the setup for your specific application.

- **Individual Ports:** This manifold configuration will allow for tubing connections to each individual valve port.
- **Port A Inlet Header, Individual Port B Ports:** This manifold configuration provides a shared inlet header line to all valve inlet ports, and also provides individual tubing connections to the outlet port of each valve.

See page A26 for a visual representation of the pneumatic schematics.

PART NUMBER	DESCRIPTION	DIMENSION "A"	DIMENSION "B"
LFMX0527400B	Manifold, 1x HDI, 2-Port, Face Mount, Individual Ports, Aluminum	0.75" (19.1 mm)	0.50" (12.7 mm)
LFMX0527450B	Manifold, 3x HDI, 2-Port, Face Mount, Individual Ports, Aluminum	1.38" (35.1 mm)	1.13" (28.7 mm)
LFMX0527500B	Manifold, 8x HDI, 2-Port, Face Mount, Individual Ports, Aluminum	2.88" (73.2 mm)	2.63" (66.8 mm)
LFMX0527550B	Manifold, 3x HDI, 2-Port, Face Mount, Port A Inlet Header, Individual Port B Ports, Aluminum	1.50" (38.1 mm)	1.25" (31.8 mm)
LFMX0527600B	Manifold, 8x HDI, 2-Port, Face Mount, Port A Inlet Header, Individual Port B Ports, Aluminum	3.00" (76.2 mm)	2.75" (69.9 mm)

Manifolds for use with Lee Company, HDI 2-Port style solenoid valves, rated to 1100 Lohms or higher.

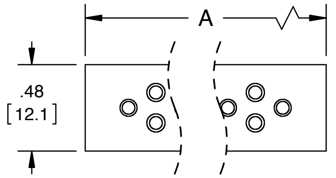
Part Numbers are for the manifold and secondary retention bracket only. Valves are sold separately.

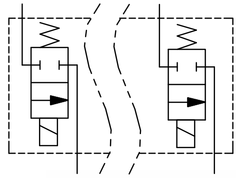
Refer to Manifold Technology (Section K) for information on customized manifold assemblies.

See page A31 for valve and manifold accessory items.

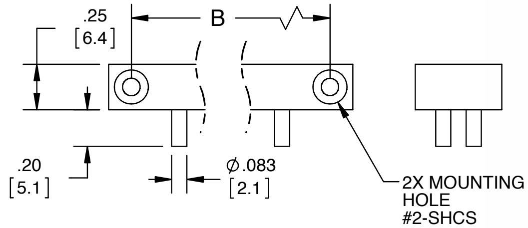
Standard, 2-Port Face Mount Style Manifolds

Individual Ports



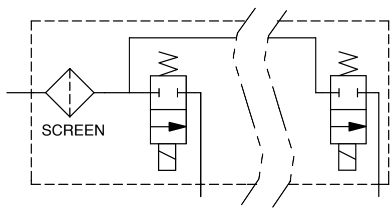


SCHEMATIC

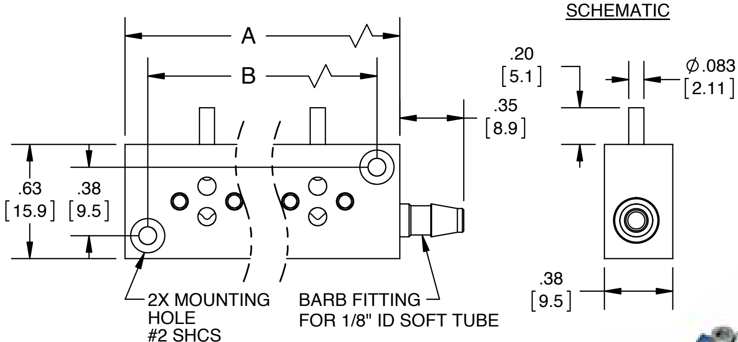


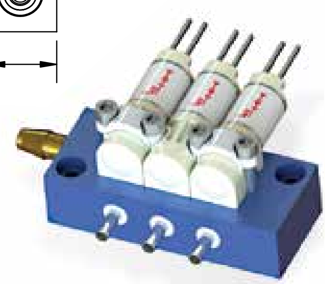
Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

Port A Inlet Header, Individual Port B Ports



SCHEMATIC





Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

A

Standard 3-Port Plug-In Style Manifolds

The Lee Company offers several standard manifold configurations to ease the setup of prototype systems. These off-the-shelf manifolds are available in mounting denominations of single valve (1x), three valves (3x) and eight valves (8x). Combine these denominations, or plug unused ports to configure the setup for your specific application.

- **Individual Ports:** This manifold configuration will allow for tubing connections to each individual valve port.
- **Normally Open and Normally Closed Header, Individual Common Ports:** This manifold configuration provides a shared inlet header line to the normally open ports of the valves, a shared inlet header line to the normally closed ports of the valves, and also provides individual tubing connections to the common port of each valve.
- **Common Header, Individual Normally Open and Normally Closed Ports:** This manifold configuration provides a shared inlet header line to the common ports of all valves, and also provides individual tubing connections to the normally closed and normally open ports of each valve.

See page A28 for a visual representation of the pneumatic schematics.

PART NUMBER	DESCRIPTION	DIMENSION "A"	DIMENSION "B"
LFMX0503800A[1]	Manifold, 1x HDI, 3-Port, Plug-In, Individual Ports, Acrylic	—	—
LFMX0522450B[1]	Manifold, 1x HDI, 3-Port, Plug-In, Individual Ports, Aluminum	0.75" (19.1 mm)	0.50" (12.7 mm)
LFMX0510413B[1]	Manifold, 3x HDI, 3-Port, Plug-In, Individual Ports, Aluminum	1.35" (34.3 mm)	1.10" (27.9 mm)
LFMX0510418B[1]	Manifold, 8x HDI, 3-Port, Plug-In, Individual Ports, Aluminum	2.85" (72.4 mm)	2.60" (66.0 mm)
LFMX0510423B[2]	Manifold, 3x HDI, 3-Port, Plug-In, Common Header, Individual NC & NO Ports, Aluminum	1.50" (38.1 mm)	1.25" (31.8 mm)
LFMX0510428B[2]	Manifold, 8x HDI, 3-Port, Plug-In, Common Header, Individual NC & NO Ports, Aluminum	3.00" (76.2 mm)	2.75" (69.9 mm)
LFMX0510433B[2]	Manifold, 3x HDI, 3-Port, Plug-In, NC & NO Header, Individual Common Ports, Aluminum	1.50" (38.1 mm)	1.25" (31.8 mm)
LFMX0510438B[2]	Manifold, 8x HDI, 3-Port, Plug-In, NC & NO Header, Individual Common Ports, Aluminum	3.00" (76.2 mm)	2.75" (69.9 mm)

NOTES: (1) Manifold for use with Lee Company HDI 3-Port style solenoid valves rated to 450 Lohms or higher.
(2) Manifold for use with Lee Company HDI 3-Port style solenoid valves rated to 1100 Lohms or higher.

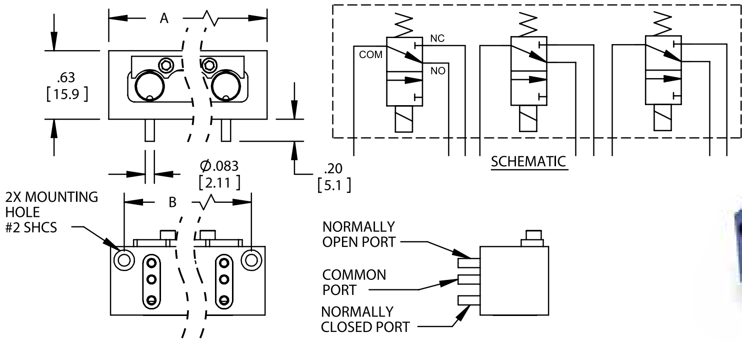
Part numbers are for the manifold and secondary retention bracket only. Valves are sold separately.

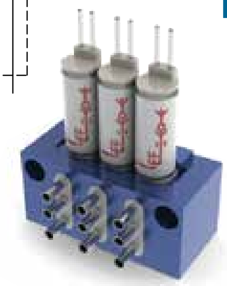
Refer to Manifold Technology (Section K) for information on customized manifold assemblies. See page A31 for valve and manifold accessory items.

Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

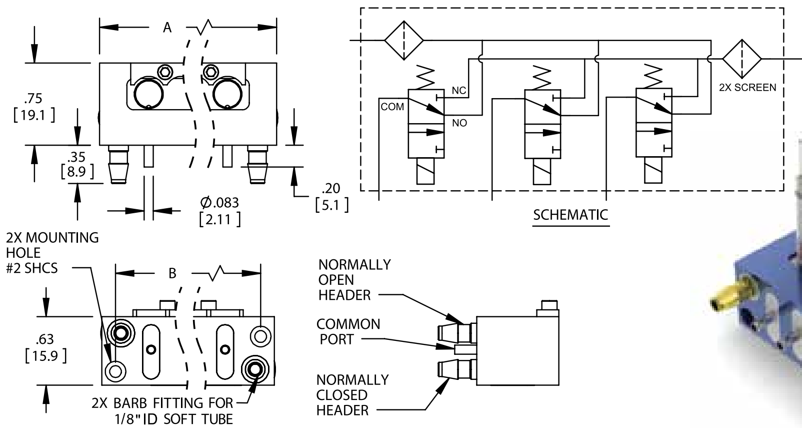
Standard 3-Port Plug-In Style Manifolds

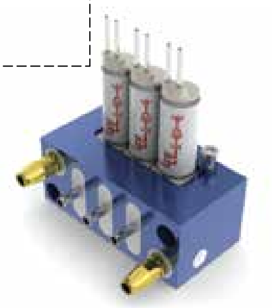
Individual Ports



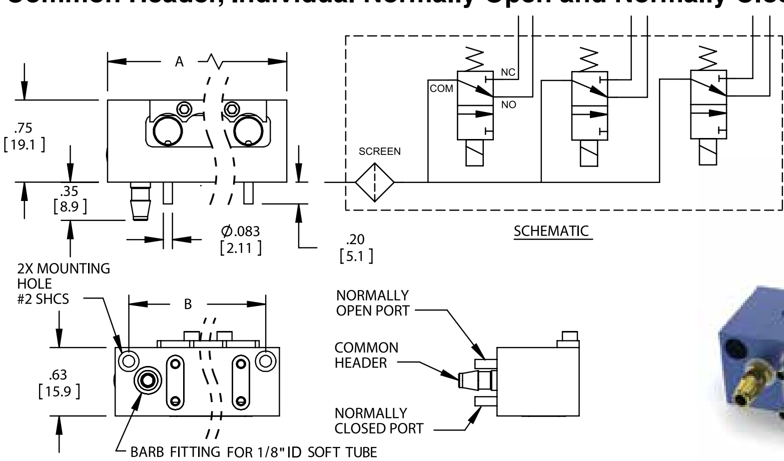


Normally Open and Normally Closed Header, Individual Common Ports





Common Header, Individual Normally Open and Normally Closed Ports



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

A

Standard 3-Port Face Mount Style Manifolds

The Lee Company offers several standard manifold configurations to ease the setup of prototype systems. These off-the-shelf manifolds are available in mounting denominations of single valve (1x), three valves (3x) and eight valves (8x). Combine these denominations, or plug unused ports to configure the setup for your specific application.

- **Individual Ports:** This manifold configuration will allow for tubing connections to each individual valve port.
- **Normally Open and Normally Closed Header, Individual Common Ports:** This manifold configuration provides a shared inlet header line to the normally open ports of the valves, a shared inlet header line to the normally closed ports of the valves, and also provides individual tubing connections to the common port of each valve.
- **Common Header, Individual Normally Open and Normally Closed Ports:** This manifold configuration provides a shared inlet header line to the common ports of all valves, and also provides individual tubing connections to the normally closed and normally open valve ports.

See page A30 for a visual representation of the pneumatic schematics.

PART NUMBER	DESCRIPTION	DIMENSION "A"	DIMENSION "B"
LFMX0507200A[1]	Manifold, 1x HDI, 3-Port, Face Mount, Individual Ports, Aluminum	0.44" (11.2 mm)	0.30" (7.6 mm)
LFMX0510513B[1]	Manifold, 3x HDI, 3-Port, Face Mount, Individual Ports, Aluminum	1.35" (34.3 mm)	1.10" (27.9 mm)
LFMX0510518B[1]	Manifold, 8x HDI, 3-Port, Face Mount, Individual Ports, Aluminum	2.86" (72.6 mm)	2.59" (65.8 mm)
LFMX0510523B[2]	Manifold, 3x HDI, 3-Port, Face Mount, Common Header, Individual NC & NO Ports, Aluminum	1.51" (38.4 mm)	1.29" (32.8 mm)
LFMX0510528B[2]	Manifold, 8x HDI, 3-Port, Face Mount, Common Header, Individual NC & NO Ports, Aluminum	3.02" (76.7 mm)	2.79" (70.9 mm)
LFMX0510533B[2]	Manifold, 3x HDI, 3-Port, Face Mount, NC & NO Header, Individual Common Ports, Aluminum	1.55" (39.4 mm)	1.28" (32.5 mm)
LFMX0510538B[2]	Manifold, 8x HDI, 3-Port, Face Mount, NC & NO Header, Individual Common Ports, Aluminum	3.05" (77.5 mm)	2.78" (70.6 mm)

NOTES: (1) Manifold for use with Lee Company HDI 3-Port style solenoid valves rated to 800 Lohms or higher.
(2) Manifold for use with Lee Company HDI 3-Port style solenoid valves rated to 1100 Lohms or higher.

Part numbers are for the manifold and secondary retention bracket only. Valves are sold separately.

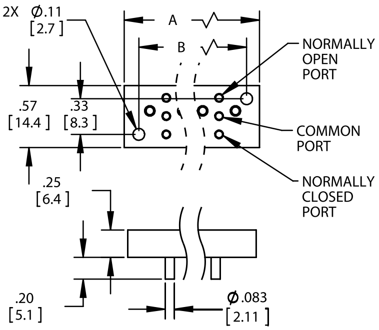
Refer to Manifold Technology (Section K) for information on customized manifold assemblies.

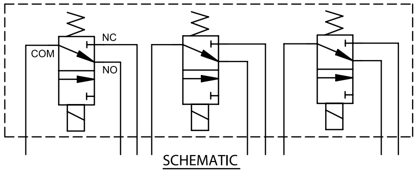
See page A31 for valve and manifold accessory items.

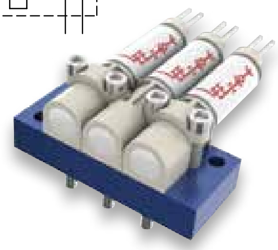
Ø 0.083" OD ports are intended for connection to 1/16" ID soft tubing.

Standard 3-Port Face Mount Style Manifolds

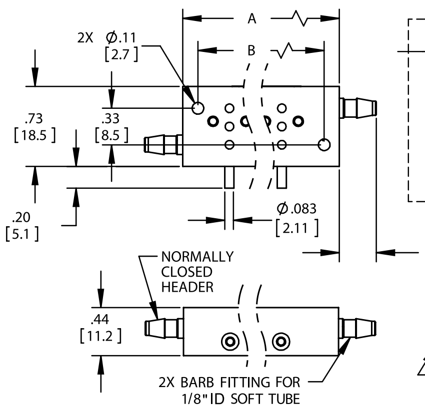
Individual Ports

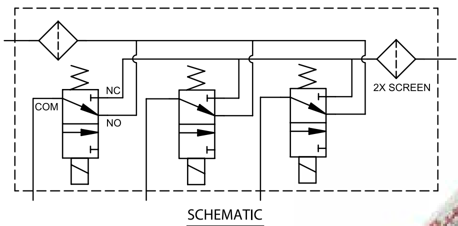


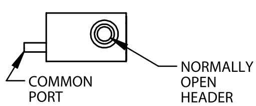


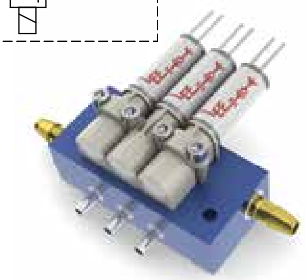


Normally Open and Normally Closed Header, Individual Common Ports

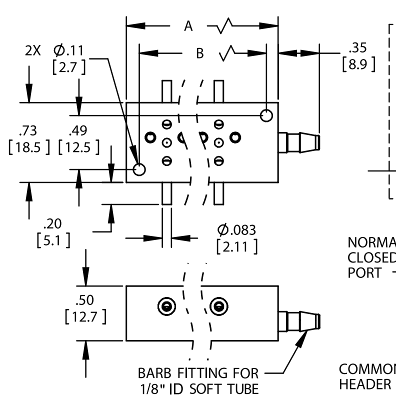


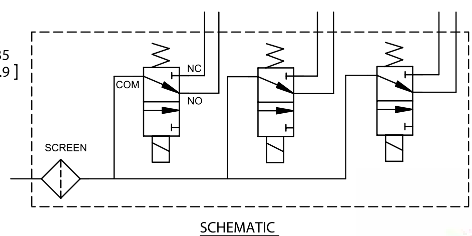


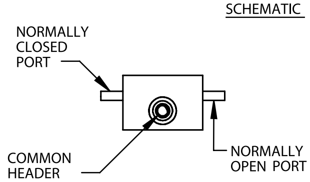




Common Header, Individual Normally Open and Normally Closed Ports







Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

General Accessories / Replacement Parts

STYLE	CONFIGURATION	PART NUMBER	DESCRIPTION
Plug-In	2-Port	TTTA0000250B	Boss Cutting Tool
		LHDX0526900A	Boss Plug (POM with FKM O-rings)
	3-Port	LHDX0526050A	Boss Plug (POM with FKM O-rings)
		TTTA0000180B	Boss Cutting Tool
	2-Port and 3-Port	LHWX0218030A	Replacement O-ring (FKM)
		LLWX0307140A	Retention Bracket, 1x
		LLWX0307130A	Retention Bracket, 3x
		LLWX0307120A	Retention Bracket, 8x
		LHWX0503010A	Screw, Socket Head Cap, 0.086" #2-56 x 0.250" SS
Face Mount	2-Port	LLWX0218230A	Gasket (SI)
		LLWX0218240A	Gasket (FKM)
	3-Port	LHWX0218000A	Gasket (SI)
		LHWX0218010A	Gasket (FKM)
	2-Port and 3-Port	LHDX0307130A	Mounting Screw Support-2x, PBT
		LHDX0307140A	Mounting Screw Support-1x, PBT
		LHWX0503100A	Screw, Socket Head Cap, 0.086" #2-56 x 0.375" SS
		LHWX0213420A[1]	Screw, Socket Head Cap, 0.086" #2-56 x 0.438" (7/16) SS
Ported	3-Port	LHWX0320090A	Port Plug
		LHWX0503100A	Screw, Socket Head Cap, 0.086" #2-56 x 0.375" SS
Universal (All Styles)		LTTA0300000A	Installation/Extraction Tool
		LHWX0605450A	Electrical Lead-Wire Connector, 6"

NOTE: (1) Required for use with mounting screw support (recommended).

Notes

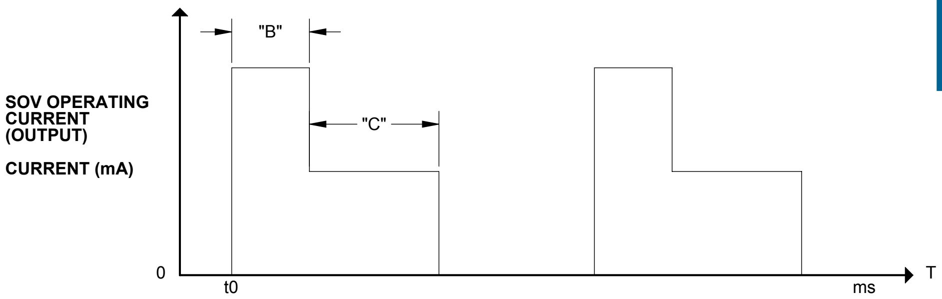
Spike and Hold Driver Accessory

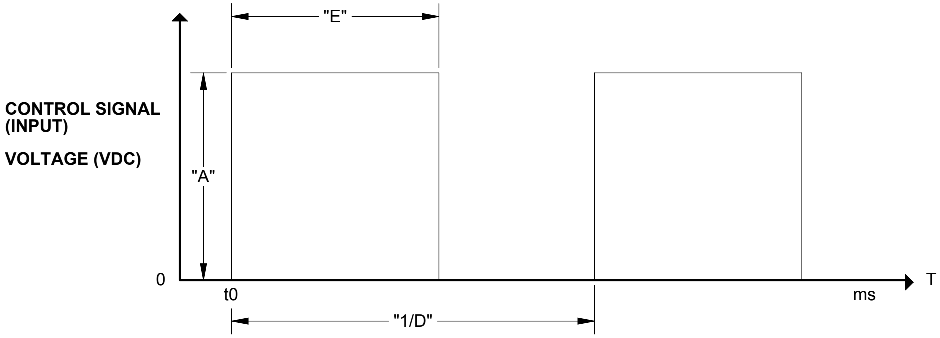
As a new accessory to the Lo-Lohm LHD Series High Density Interface (HDI) solenoid valves, the Spike and Hold Driver provides added value by allowing quick and easy prototype setup. The driver requires only a single input voltage to operate; everything else is pre-programmed and no user adjustments are required. Each driver is also equipped with an LED indicator.

- Compact size
- Simplifies the testing process
- Single voltage source
- LED indicator for operational feedback
  - Steady LED indicates correct installation and sufficient supply current to the driver.
  - Flashing LED indicates improper installation or insufficient current supply.

The Spike and Hold Drivers were tailored for use with specific 2-Port and 3-Port Lo-Lohm LHD Series valve part numbers. Select the appropriate driver part number from the table on pages A35-36 to match your Lo-Lohm LHD Series solenoid valve part number. The drivers are polarity specific, which means the required input voltage must be applied to the positive (+) terminal. Refer to the table on pages A35-36 for additional information and contact your local Lee Company Sales Engineer for technical assistance.

Spike and Hold Driver Accessory





The Spike and Hold Driver Accessory uses a current-driven PWM electrical drive to achieve the required spike and hold power levels. The required control signal (input voltage) and effective solenoid operating current (output) are shown in the signal graphs above. Refer to the individual Spike and Hold Accessory inspection drawings and the LFIX1002300B reference drawing for details. To ensure proper operation, reference parameters “A” through “E” as shown in the table on pages A35-36.

Spike and Hold Driver Accessory

SPIKE AND HOLD DRIVER PART NUMBER	LEE COMPANY SOLENOID VALVE PART NUMBER [1]	"A" REQUIRED DRIVER INPUT VOLTAGE [2] (Vdc)	"B" FIXED SPIKE DURATION (ms)
LEDX0500050B	LHDB0313_55D	24	62
	LHDB0323_80D	24	62
	LHDB0333_80D	24	62
LEDX0500100B	LHDB0613_55D	24	62
	LHDB0623_80D	24	62
	LHDB0633_80D	24	62
LEDX0500200B	LHDA1260245D	36	62
	LHDA1260365D	36	62
	LHDA1270290D	36	62
LEDX0500250B	LHDA0560245D	32	62
	LHDA0560365D	32	62
	LHDA0570290D	32	62
LEDX0501050B	LHDB0442_45D	24	62
LEDX0501100B	LHDB0942_45D	36	62

NOTES: (1) The Lo-Lohm HDI solenoid valves are available with either a silicone (1) or FKM (2) internal elastomer seal. Refer to the individual valve drawings for a complete list of wetted materials.

(2) Due to integrated circuit requirements, the required input voltage to the driver is higher than the rated spike voltage of the valve. Refer to the individual valve drawings for specific performance requirements.

Spike and Hold Driver Accessory

	"C" HOLD DURATION AT MAXIMUM FREQUENCY AND DUTY (ms)	SOLENOID VALVE COIL RESISTANCE (ohms)	POWER CONSUMPTION AT HOLD VOLTAGE (mW)	"D" MAXIMUM VALVE CYCLING FREQUENCY WITH DRIVER[3] (Hz)	"E" MAXIMUM DUTY AT CYCLE FREQUENCY[3] (%)
	9.5	12	520	3.5	25.0
	9.5	12	520	3.5	25.0
	9.5	12	520	3.5	25.0
	9.5	61	590	3.5	25.0
	9.5	61	590	3.5	25.0
	9.5	61	590	3.5	25.0
	23.0	262	550	3.3	28.0
	23.0	262	550	3.3	28.0
	23.0	262	550	3.3	28.0
	3.0	46	540	1.0	6.5
	3.0	46	540	1.0	6.5
	3.0	46	540	1.0	6.5
	18.0	28	440	1.0	8.0
	0	116	420	2.5	9.0

(3) The maximum cycling frequency and duty limits only apply when using the referenced LEDX driver part numbers together with the solenoid valve. Refer to the individual valve drawings for specific performance requirements related to using the valve without the referenced LEDX driver part numbers.

GENERAL SPECIFICATIONS

The following specifications apply to all HDI Platform solenoid valves, unless otherwise noted.

Leakage

Maximum of 50 SμLPM of air at 70°F with pressure applied to the common port. See individual product pages for specific pressure conditions.

Internal Volume

2-Port:	Plug-In:	28 μL	**3-Port:**	Plug-In:	40 μL
	Face Mount:	34 μL		Face Mount:	72 μL
				Soft Tube Ported:	77 μL

Weight

2-Port: less than 2.5 grams
3-Port: less than 4.5 grams

Cycle Life

The cycle life of the HDI Platform solenoid valves will vary depending on the seal material and application conditions. Unless otherwise specified, under standard conditions on air, valves with a silicone seal will typically operate across a minimum of 10 million cycles, while valves with an FKM seal will typically operate across a minimum of 250 million cycles.

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%. The normally closed port (Port B) 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 (Port A) 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), unless otherwise noted.
- LHQ Series ambient operating temperature range is 60°F to 120°F (16°C to 49°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.

MEAN POWER (mW)	SELF-HEATED COIL TEMPERATURE AT 100% DUTY, 72°F AMBIENT ENVIRONMENT
550	165°F (74°C)
750	185°F (85°C)
850	195°F (90°C)

- Maximum coil temperature not to exceed 250°F (121°C).

Storage Conditions

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

Response Time

- Typical response times in milliseconds are as follows:

FLUID	AT RATED VOLTAGE (10 psig)	
	ENERGIZE	DE-ENERGIZE
Air	3	4
Water	4	5

- Response times can be enhanced with the use of high speed drive circuits. Refer to Engineering Reference Section, pages R35-36. Since the Lo-Lohm and Semi Inert designs require a spike and hold drive, response times may be faster than those listed above.
- The Quiet Operation design (LHQ Series) will have a slightly slower response time due to the damping operation. Particularly after periods of inactivity, first actuation and latch-out response may be longer than the typical dynamic response. If first response is critical in your application, a warm-up cycle may be necessary after periods of inactivity. If faster response or oxygen service is required, please contact The Lee Company to discuss our alternative quiet operation design options.
- Response times are dependent upon system conditions, power, environment, etc. The response time will typically increase as the ambient temperature decreases. Extended periods of inactivity may also have an impact on the initial response time of the valve.

Compatibility

The HDI Platform solenoid valves feature various material offerings for a wide range of applications. Standard seal material offerings are silicone and FKM, while others such as FFKM, are also available upon request. For the armature and plunger stop, 430 SS is typically used for air and mild gas applications but models with FeCr alloy also allow for additional corrosion resistance, and are therefore optimized for saline or mild liquid compatibility. While The Lee Company can offer material recommendations based on your flow media, it is important and necessary to verify compatibility of our products with the fluid media and conditions of your specific application.

Filtration

Filtration of 35 microns or finer is required. Refer to Engineering Reference Section, page R30 for additional information.

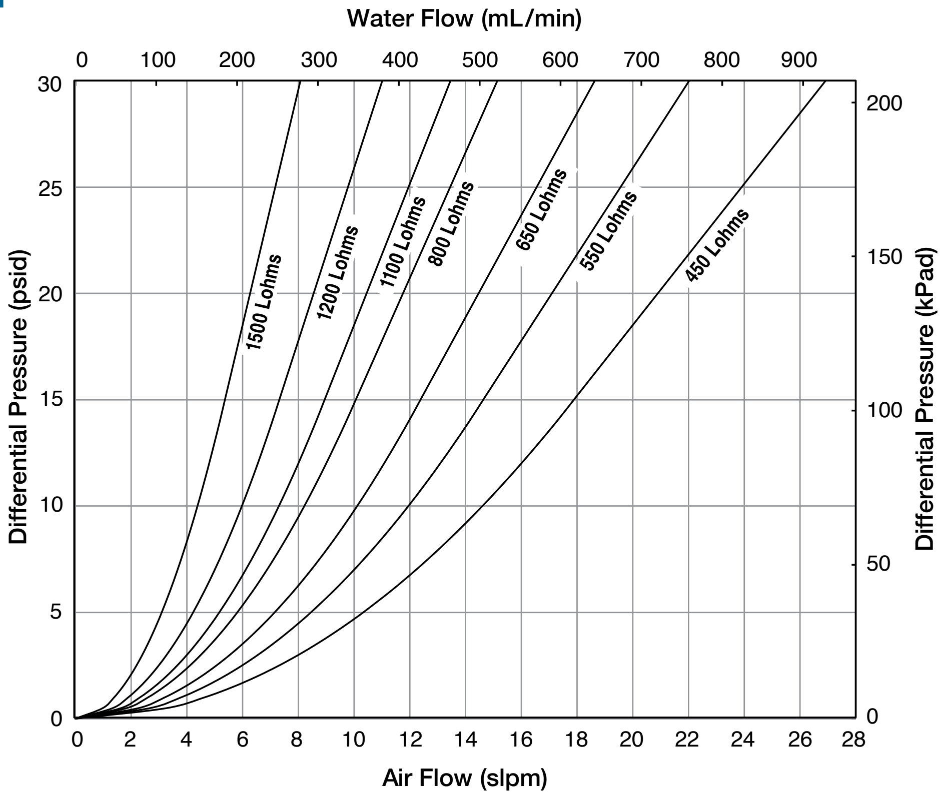
Electrical Characteristics

The following table describes the basic electrical characteristics for the HDI Platform solenoid valves at room temperature. The valves are intended for operation at the rated voltage ±5%. Refer to Engineering Reference Section, pages R33-38 for drive circuit schematic recommendations.

POWER AT RATED VOLTAGE (mW)	VOLTAGE (Vdc)	COIL RESISTANCE (ohms)	INDUCTANCE (mH)
550	5	46	30
	12	262	155
	24	1042	665
750	5	33	20
	12	193	130
	24	766	460
850	5	30	12
	12	170	70
	24	675	340

A

Typical Flow Characteristics
HDI Platform



Notes

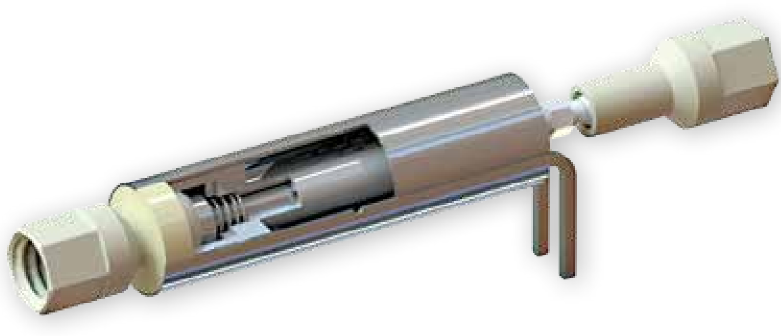
B

VHS Series

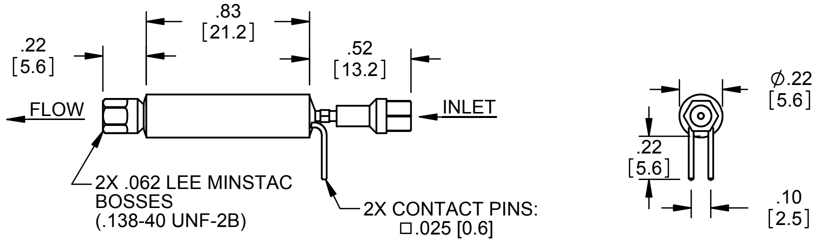
The VHS Series solenoid valves are designed for high speed applications requiring precise dispense volumes in the microliter to nanoliter range. These valves are generally used in medical and scientific applications, in markets such as high throughput screening, drug discovery, in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Low Internal Volume
- Operating Frequency up to 1200 Hz
- Operating Pressures up to 120 psig
- Fast Response Time
- Spike and Hold Drive Required
- Different Lohm Rates
- Available Seal Elastomers: Silicone, EPDM, FKM and FFKM
- Multiple Porting Options

Each valve is 100% functionally tested for performance, and is designed using materials that ensure consistent long-term performance. The Lee Company can customize valve performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.



062 MINSTAC Inlet / 062 MINSTAC Outlet (M/M)



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

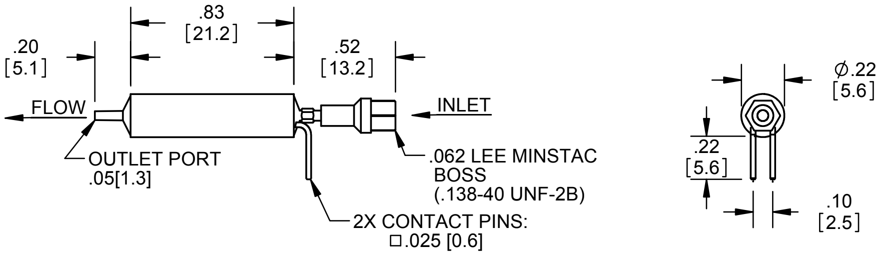
VHS M/M valves are designed for use with 062 MINSTAC fittings on the inlet port, allowing easy connections to PTFE tubing. Nozzles can be threaded directly into the outlet port. Refer to MINSTAC (Section L) or Nozzles (Section M) for additional details.

- Lohm rate: 4750 Lohms (Ref. Cv = 0.004). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 40 μL
- Wetted materials: stainless steel, PEEK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION [1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL [2]
INKX0511400A	12	1.6	2.3	0.35	0-120	EPDM
INKX0514300A	24	3.2	4.5	0.35	0-120	EPDM
INKX0511850A	12	1.6	2.3	0.50	0-120	FKM
INKX0517500A	24	3.2	4.5	0.50	0-120	FKM
INKX0516350A	12	1.6	2.3	0.50	0-120	FFKM
INKX0514100A	24	3.2	4.5	0.50	0-120	FFKM
INKX0507900A	12	1.6	2.3	0.25	0-120	SI
INKX0507950A	24	3.2	4.5	0.25	0-120	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

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



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

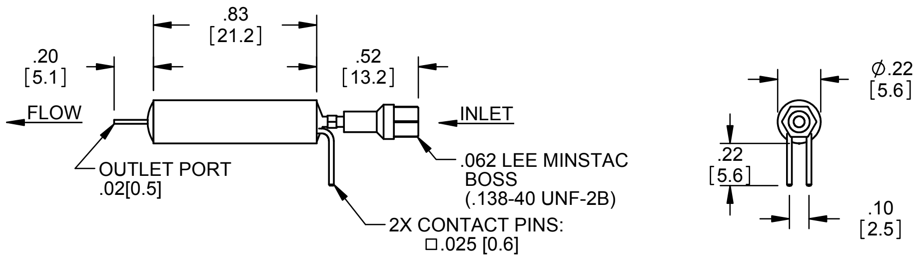
VHS M/P valves are designed for use with 062 MINSTAC fittings on the inlet port, allowing easy connections to PTFE tubing. The outlet port is designed for 1/32" ID soft (flexible) tubing which can be connected to a downstream 0.050" OD Hypo Tube nozzle. The flexible connection permits the nozzles to be placed closer than the valve center to center distance. Refer to MINSTAC (Section L) or Nozzles (Section M) for additional details.

- Lohm rate: 4750 Lohms (Ref. Cv = 0.004). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 35 µL
- Wetted materials: stainless steel, PEEK, PK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION [1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL [2]
INKX0511950A	12	1.6	2.3	0.35	0-120	EPDM
INKX0514750A	24	3.2	4.5	0.35	0-120	EPDM
INKX0519850A	12	1.6	2.3	0.50	0-120	FKM
INKX0508200A	24	3.2	4.5	0.50	0-120	FKM
INKX0512700A	12	1.6	2.3	0.50	0-120	FFKM
INKX0516450A	24	3.2	4.5	0.50	0-120	FFKM
INKX0508250A	12	1.6	2.3	0.25	0-120	SI
INKX0508300A	24	3.2	4.5	0.25	0-120	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

062 MINSTAC Inlet / Small Port Outlet (M/SP)



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

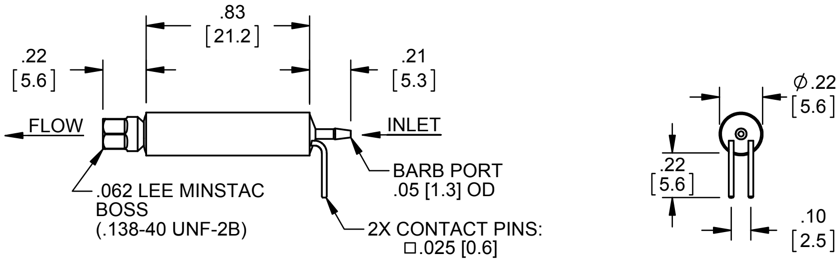
VHS M/SP valves are designed for use with 062 MINSTAC fittings on the inlet port, allowing easy connections to PTFE tubing. Refer to MINSTAC (Section L) for additional details. The outlet port can be used for direct dispensing. If smaller volumes and greater accuracy are desired, jeweled nozzles can be attached to the valve with tubing. This allows nozzles to be placed closer than the actual valve center to center distance. Refer to Nozzles (Section M) for additional details.

- Lohm rate: 11,000 Lohms (Ref. Cv = 0.001). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 35 μL
- Wetted materials: stainless steel, PEEK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION [1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL [2]
INKX0514900A	12	1.6	2.3	0.35	0-120	EPDM
INKX0514950A	24	3.2	4.5	0.35	0-120	EPDM
INKX0514650A	12	1.6	2.3	0.50	0-120	FKM
INKX0508350A	24	3.2	4.5	0.50	0-120	FKM
INKX0516200A	12	1.6	2.3	0.50	0-120	FFKM
INKX0516250A	24	3.2	4.5	0.50	0-120	FFKM
INKX0516100A	12	1.6	2.3	0.25	0-120	SI
INKX0508400A	24	3.2	4.5	0.25	0-120	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

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



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

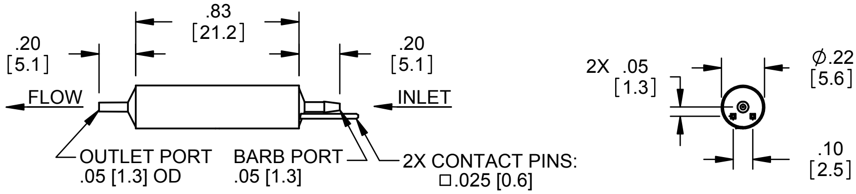
VHS P/M valves are designed for use with 1/32" ID soft (flexible) tubing on the inlet port. The 062 MINSTAC outlet boss allows for the use of threaded nozzles. Nozzles are easily interchanged to allow for different dispense ranges, or for cleaning. Refer to MINSTAC (Section L) or Nozzles (Section M) for additional details.

- Lohm rate: 4750 Lohms (Ref. Cv = 0.004). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 35 μL
- Wetted materials: stainless steel, PEEK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION[1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL[2]
INKX0514800A	12	1.6	2.3	0.35	0-30	EPDM
INKX0514850A	24	3.2	4.5	0.35	0-30	EPDM
INKX0508000A	12	1.6	2.3	0.50	0-30	FKM
INKX0508050A	24	3.2	4.5	0.50	0-30	FKM
INKX0515000A	12	1.6	2.3	0.50	0-30	FFKM
INKX0515050A	24	3.2	4.5	0.50	0-30	FFKM
INKX0508100A	12	1.6	2.3	0.25	0-30	SI
INKX0508150A	24	3.2	4.5	0.25	0-30	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Standard Port Inlet / Standard Port Outlet (P/P)



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

VHS P/P valves are designed for use with 1/32" ID soft (flexible) tubing on the inlet port. 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. Refer to Nozzles (Section M) for additional details.

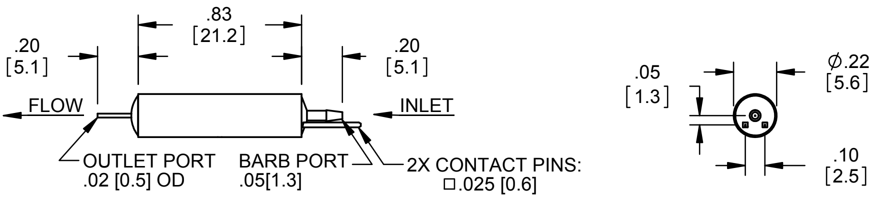
- Lohm rate: 4750 Lohms (Ref. Cv = 0.004). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 30 μL
- Wetted materials: stainless steel, PEEK, PK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION [1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL [2]
INKA1224212H	12	1.6	2.3	0.35	0 - 30	EPDM
INKA2424212H	24	3.2	4.5	0.35	0 - 30	EPDM
INKX0508450A	12	1.6	2.3	0.50	0 - 30	FKM
INKX0514550A	24	3.2	4.5	0.50	0 - 30	FKM
INKX0511900A	12	1.6	2.3	0.50	0 - 30	FFKM
INKX0516550A	24	3.2	4.5	0.50	0 - 30	FFKM
INKX0508500A	12	1.6	2.3	0.25	0 - 30	SI
INKX0508550A	24	3.2	4.5	0.25	0 - 30	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

B

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



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

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 are desired, jeweled nozzles can be attached to the valve with tubing. This allows nozzles to be placed closer than the actual valve center to center distance. Refer to Nozzles (Section M) for additional details.

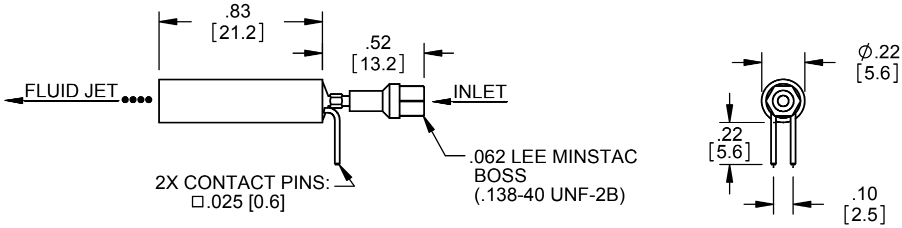
- Lohm rate: 11,000 Lohms (Ref. Cv = 0.001). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Weight: 1.8 grams
- Internal volume: 30 µL
- Wetted materials: stainless steel, PEEK, PPS, seal material and epoxy

PART NUMBER	SPIKE VOLTAGE (Vdc)	RECOMMENDED HOLD VOLTAGE (Vdc)	MAXIMUM HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION[1] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL[2]
INKA1226212H	12	1.6	2.3	0.35	0 - 30	EPDM
INKA2426212H	24	3.2	4.5	0.35	0 - 30	EPDM
INKX0508600A	12	1.6	2.3	0.50	0 - 30	FKM
INKX0508650A	24	3.2	4.5	0.50	0 - 30	FKM
INKX0507000A	12	1.6	2.3	0.50	0 - 30	FFKM
INKX0516500A	24	3.2	4.5	0.50	0 - 30	FFKM
INKX0508700A	12	1.6	2.3	0.25	0 - 30	SI
INKX0508750A	24	3.2	4.5	0.25	0 - 30	SI

NOTES: (1) Refer to page B15 for additional electrical characteristics.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

B

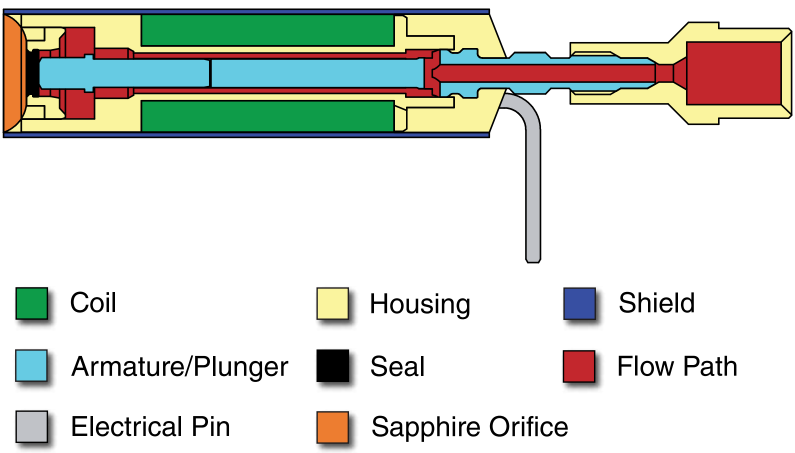
062 MINSTAC Inlet Port / Direct Dispense Outlet



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

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 PTFE tubing and the Lee 062 MINSTAC Fitting System. Refer to MINSTAC (Section L), for additional details.

- The LT style has a sapphire orifice plate and incorporates an internal pressure compensation bladder. This allows the droplet to retain its integrity longer so it can travel farther.
- 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

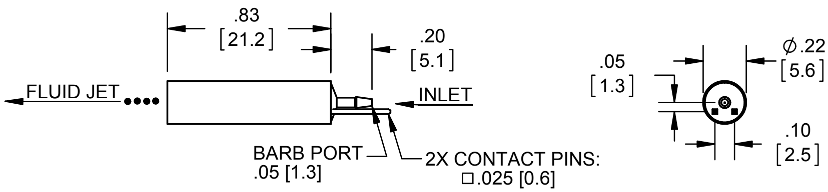
STYLE	PART NUMBER	ORIFICE DIAMETER	LOHM RATE[1]	MIN. SPIKE DURATION[2] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL[3]
LT	INKA2435010H	0.003" (0.076 mm)	110,000	0.35	0 - 30	SI
	INKA2455010H	0.005" (0.127 mm)	50,000	0.35	0 - 30	SI
	INKA2475010H	0.007" (0.178 mm)	21,000	0.35	0 - 30	SI
	INKA2435210H	0.003" (0.076 mm)	110,000	0.35	0 - 30	EPDM
	INKA2455210H	0.005" (0.127 mm)	50,000	0.35	0 - 30	EPDM
	INKA2475210H	0.007" (0.178 mm)	21,000	0.35	0 - 30	EPDM
	INKA2435110H	0.003" (0.076 mm)	110,000	0.50	0 - 30	FKM
	INKA2455110H	0.005" (0.127 mm)	50,000	0.50	0 - 30	FKM
	INKA2475110H	0.007" (0.178 mm)	21,000	0.50	0 - 30	FKM
	INKA2435510H	0.003" (0.076 mm)	110,000	0.50	0 - 30	FFKM
	INKA2455510H	0.005" (0.127 mm)	50,000	0.50	0 - 30	FFKM
	INKA2475510H	0.007" (0.178 mm)	21,000	0.50	0 - 30	FFKM
VJ	INKA2436010H	0.003" (0.076 mm)	110,000	0.35	0 - 120	SI
	INKA2456010H	0.005" (0.127 mm)	50,000	0.35	0 - 120	SI
	INKA2476010H	0.007" (0.178 mm)	21,000	0.35	0 - 120	SI
	INKA2436210H	0.003" (0.076 mm)	110,000	0.35	0 - 120	EPDM
	INKA2456210H	0.005" (0.127 mm)	50,000	0.35	0 - 120	EPDM
	INKA2476210H	0.007" (0.178 mm)	21,000	0.35	0 - 120	EPDM
	INKA2436110H	0.003" (0.076 mm)	110,000	0.50	0 - 120	FKM
	INKA2456110H	0.005" (0.127 mm)	50,000	0.50	0 - 120	FKM
	INKA2476110H	0.007" (0.178 mm)	21,000	0.50	0 - 120	FKM
	INKA2436510H	0.003" (0.076 mm)	110,000	0.50	0 - 120	FFKM
	INKA2456510H	0.005" (0.127 mm)	50,000	0.50	0 - 120	FFKM
	INKA2476510H	0.007" (0.178 mm)	21,000	0.50	0 - 120	FFKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to page B15 for additional electrical characteristics.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

- Weight: 1.8 grams
- Internal volume: LT Style: 35 µL
  VJ Style: 60 µL
- Spike voltage: 24 Vdc
- Hold voltage: 5.0 Vdc (minimum), 7.5 Vdc (maximum)
- Wetted materials: stainless steel, butyl (LT Style only), PEEK, PPS, sapphire, seal material and epoxy

B

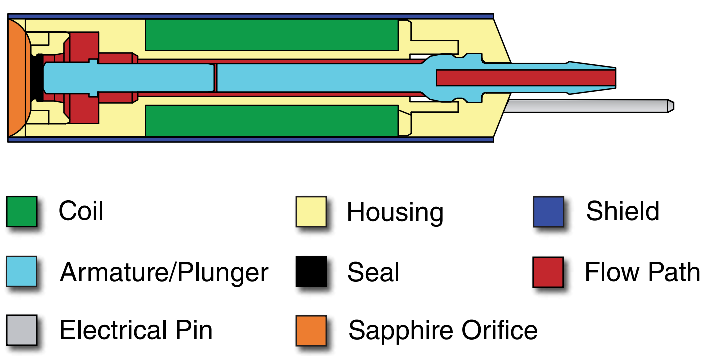
Standard Inlet Port / Direct Dispense Outlet



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

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 so it can travel farther.
- 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

STYLE	PART NUMBER	ORIFICE DIAMETER	LOHM RATE[1]	MIN. SPIKE DURATION[2] (ms)	OPERATING PRESSURE (psig)	SEAL MATERIAL[3]
LT	INKA2437010H	0.003" (0.076 mm)	110,000	0.35	0-30	SI
	INKA2457010H	0.005" (0.127 mm)	50,000	0.35	0-30	SI
	INKA2477010H	0.007" (0.178 mm)	21,000	0.35	0-30	SI
	INKA2437210H	0.003" (0.076 mm)	110,000	0.35	0-30	EPDM
	INKA2457210H	0.005" (0.127 mm)	50,000	0.35	0-30	EPDM
	INKA2477210H	0.007" (0.178 mm)	21,000	0.35	0-30	EPDM
	INKA2437110H	0.003" (0.076 mm)	110,000	0.50	0-30	FKM
	INKA2457110H	0.005" (0.127 mm)	50,000	0.50	0-30	FKM
	INKA2477110H	0.007" (0.178 mm)	21,000	0.50	0-30	FKM
	INKA2437510H	0.003" (0.076 mm)	110,000	0.50	0-30	FFKM
	INKA2457510H	0.005" (0.127 mm)	50,000	0.50	0-30	FFKM
	INKA2477510H	0.007" (0.178 mm)	21,000	0.50	0-30	FFKM
VJ	INKA2438010H	0.003" (0.076 mm)	110,000	0.35	0-30	SI
	INKA2458010H	0.005" (0.127 mm)	50,000	0.35	0-30	SI
	INKA2478010H	0.007" (0.178 mm)	21,000	0.35	0-30	SI
	INKA2438210H	0.003" (0.076 mm)	110,000	0.35	0-30	EPDM
	INKA2458210H	0.005" (0.127 mm)	50,000	0.35	0-30	EPDM
	INKA2478210H	0.007" (0.178 mm)	21,000	0.35	0-30	EPDM
	INKA2438110H	0.003" (0.076 mm)	110,000	0.50	0-30	FKM
	INKA2458110H	0.005" (0.127 mm)	50,000	0.50	0-30	FKM
	INKA2478110H	0.007" (0.178 mm)	21,000	0.50	0-30	FKM
	INKA2438510H	0.003" (0.076 mm)	110,000	0.50	0-30	FFKM
	INKA2458510H	0.005" (0.127 mm)	50,000	0.50	0-30	FFKM
	INKA2478510H	0.007" (0.178 mm)	21,000	0.50	0-30	FFKM

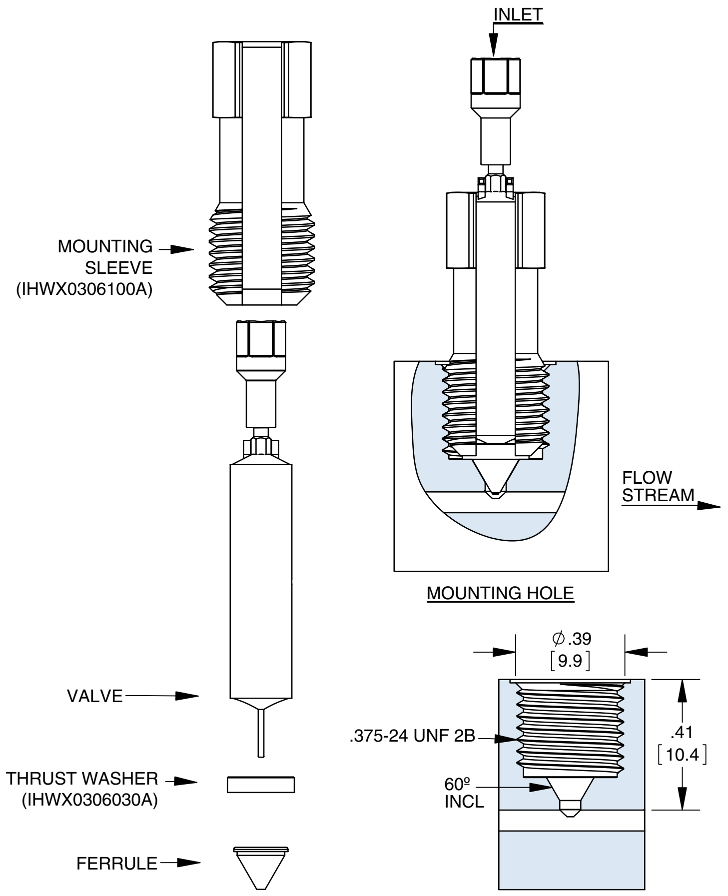
NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to page B15 for additional electrical characteristics.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

- Weight: 1.8 grams
- Internal volume: LT Style: 30 μL
  VJ Style: 55 μL
- Spike voltage: 24 Vdc
- Hold voltage: 5.0 Vdc (minimum), 7.5 Vdc (maximum)
- Wetted materials: stainless steel, butyl (LT Style only), PEEK, PPS, sapphire, seal material and epoxy

Manifold Mount VHS Valves

The 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.

The Lee Company offers single and multiple valve manifolds in PEEK or PMMA. Boss plugs are also available to allow for future system expansion.



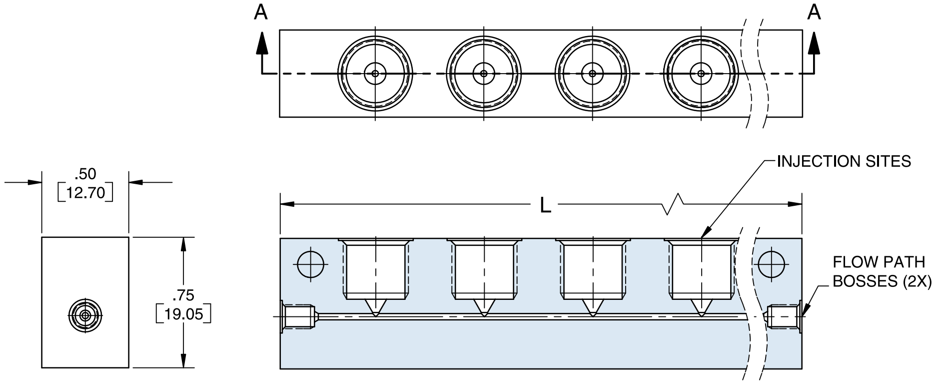
Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

Refer to Drawing Number INIX0500050A for Mounting Boss Details.

KIT PART NUMBER	DESCRIPTION	REPLACEMENT FERRULE
IKTX0322170A[1]	Mounting Sleeve Kit, Standard Port (0.050" dia.)	IHWX0306020A
IKTX0322200A[1]	Mounting Sleeve Kit, Small Port (0.020" dia.)	IHWX0306040A
IKTX0322190A[2]	Manifold Plug Sleeve Kit	IHWX0306260A

NOTES: (1) The Mounting Sleeve Kit includes a mounting sleeve, thrust washer and ferrule.
(2) The Manifold Plug Sleeve Kit includes a mounting sleeve and plug insert for blocking unused injection sites in the manifold.

Standard Manifolds



SECTION A-A

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

062 MINSTAC Connection Ports (Manifold Flow Path)

PART NUMBER[1]	MANIFOLD MATERIAL[2]	NUMBER OF VALVE POSITIONS	DIMENSION "L"
INMA0602310B	PEEK	Manifold, 1x	1.10" (27.9 mm)
INMA0602320B	PEEK	Manifold, 2x	1.73" (43.9 mm)
INMA0602330B	PEEK	Manifold, 3x	2.35" (59.7 mm)
INMA0602340B	PEEK	Manifold, 4x	2.98" (75.7 mm)
INMA0601310B	PMMA	Manifold, 1x	1.10" (27.9 mm)
INMA0601320B	PMMA	Manifold, 2x	1.73" (43.9 mm)
INMA0601330B	PMMA	Manifold, 3x	2.35" (59.7 mm)
INMA0601340B	PMMA	Manifold, 4x	2.98" (75.7 mm)

1/4-28 Flat Bottom Boss Connection Ports (Manifold Flow Path)

PART NUMBER[1]	MANIFOLD MATERIAL[2]	NUMBER OF VALVE POSITIONS	DIMENSION "L"
INMA0602410B	PEEK	Manifold, 1x	1.10" (27.9 mm)
INMA0602420B	PEEK	Manifold, 2x	1.73" (43.9 mm)
INMA0602430B	PEEK	Manifold, 3x	2.35" (59.7 mm)
INMA0602440B	PEEK	Manifold, 4x	2.98" (75.7 mm)
INMA0601410B	PMMA	Manifold, 1x	1.10" (27.9 mm)
INMA0601420B	PMMA	Manifold, 2x	1.73" (43.9 mm)
INMA0601430B	PMMA	Manifold, 3x	2.35" (59.7 mm)
INMA0601440B	PMMA	Manifold, 4x	2.98" (75.7 mm)

NOTES: (1) Part Numbers are for the manifold only. Valves are sold separately.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 250 million cycles on water, depending on application conditions.

Weight

1.8 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

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)
- Maximum coil temperature not to exceed 150°F (66°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 rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Electrical Characteristics

- The VHS Series valves require the use of a spike and hold drive to safely operate. Driving these valves any other way may result in damage to the valve. Refer to Engineering Reference Section, pages R35-36, for recommended electrical drive schematics.
- The Lee Company offers a Spike and Hold Driver (Reference Lee Company Part Number IECX0501350A) and a Starter Kit (Refer to page B18 for details) for development use.
- The valves are designed to operate at the rated voltage ±5%, unless otherwise specified.

SPIKE VOLTAGE (Vdc)	RESISTANCE (ohms)	ENERGIZED INDUCTANCE (mH)	DE-ENERGIZED INDUCTANCE (mH)
12	10.6	3.6	2.8
24	40	16	12
24 (Direct Dispense)	110	38	20

B

Electrical Connection

These valves are designed with axial 0.025" sq. pins that are spaced 0.100" center to center. The Lee Company offers a lead wire connector assembly as a separate accessory that is compatible with this pin spacing.

- Lee Company Part Number IHWX0248010A – Length, 8 inches
- Lee Company Part Number IHWX0248120A – Length, 24 inches

Response Time

- The response time is based on the spike and hold drive parameters, along with the maximum operating frequency of the specific valve design.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.

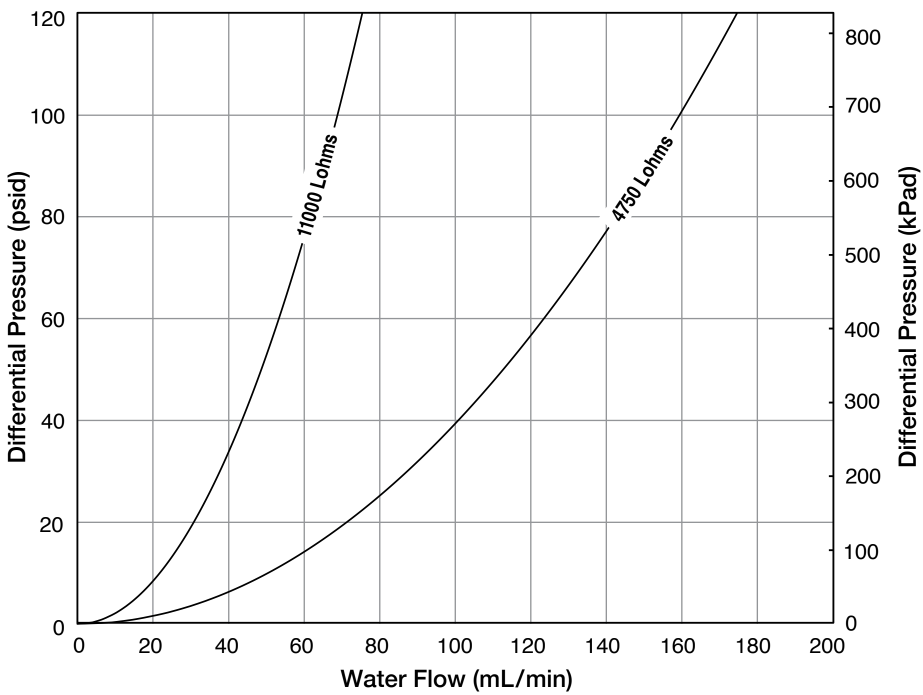
Filtration

Filtration of 12 microns or finer is recommended.

Purging

The VHS Series valves must be purged of air for optimum dispensing performance. This may require a static and/or dynamic purge. Please contact The Lee Company for technical assistance.

Typical Flow Characteristics
VHS Series Valves



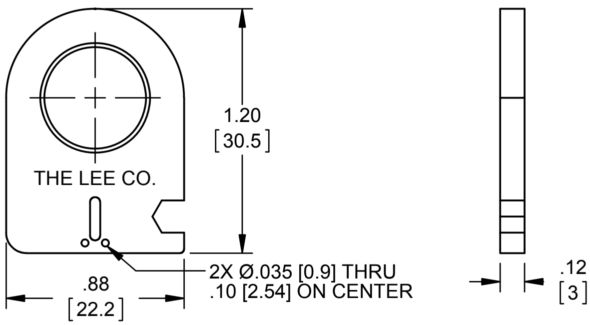
Accessories

Safety Screens

The use of proper filtration is critical to the performance of any microfluidic system, especially with the VHS Series valves. Improper filtration can result in excessive seat leakage and sometimes damage to the sealing surface. The Lee Company offers some secondary safety screens, which are not intended to replace system filtration. Refer to MINSTAC (Section L) for available options and the Engineering Reference Section, page R30, for additional information on system cleanliness.

Electrical Pin Bending Tool

The Lee Company offers a special pin bending tool (Part Number IHWX0256010A) that allows our customers to bend the electrical connection pins on the VHS Series valves. This tool is intended for development purposes and is not recommended for use in production. Please contact The Lee Company if you are interested in a custom design with bent pins.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Accessories

Nozzles

For optimum dispensing, the VHS Series valves should be used together with a nozzle. The Lee Company offers a complete line of nozzles in various styles, such as 062 MINSTAC, Straight Ported and Atomizing. Refer to Nozzles (Section M) for additional information.

VHS Series Starter Kit

The Lee Company offers a VHS Series Starter Kit (Part Number IKTX0322000A) for the easy setup and development testing of a dispense system; all that is required is a pressurized fluid source, control signal and power supply. The Starter Kit includes:

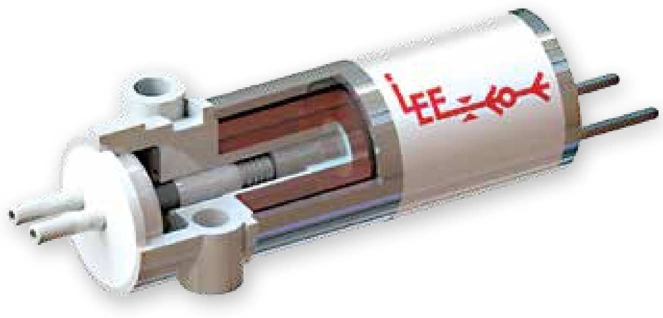
- VHS Series valve (Part Number INKX0514300B)
- Spike and Hold Electrical Driver (Part Number IECX0501350A)
- Three (3) precision dispensing nozzles (Part Numbers INZA4710975H, INZA4670915K and INZA4650935K)
- One (1) atomizing nozzle (Part Number INZX0550050A)
- MINSTAC Tubing Assembly and Components
- Safety screen (Part Number INMX0350000A)
- Lead-wire assembly (Part Number IHWX0248010A)
- Instructions

INK Series

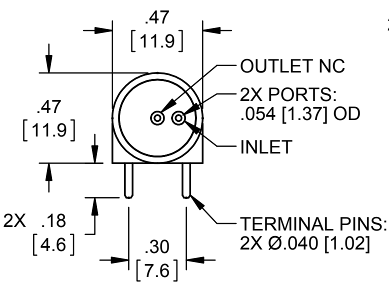
The INK Series solenoid valves are the best in class of ink jet valves for drop on demand, large character printing applications. The valves feature high switching performance which is repeatable throughout their intended life, making them ideal for ink dispensing use. The following general performance characteristics are offered in this product platform:

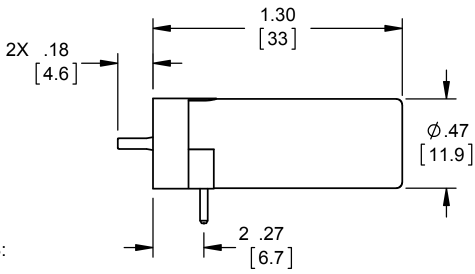
- Low Power Consumption
- Operating Frequency: 275 and 600 Hz
- Operating Pressures up to 10 psig
- Different Lohm Rates: 1800 and 4100
- Available Seal Elastomers: Silicone and FKM
- Multiple Styles: Axial Pin and PC Board Mount
- Spike and Hold Drive Required

Each valve is 100% functionally tested for performance, and designed using materials that ensure consistent long-term performance. The Lee Company can customize valves to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.



PC Board Mount





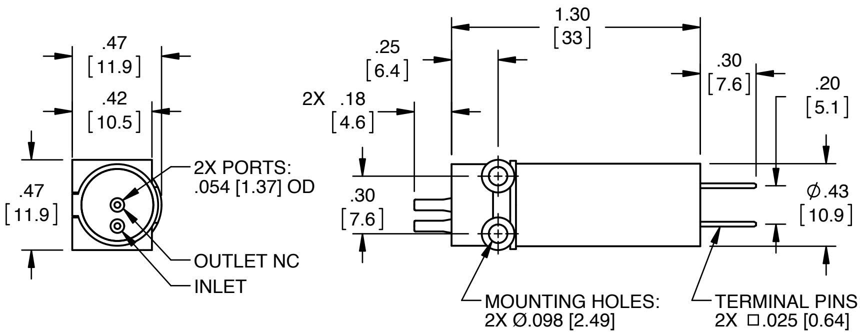
Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

- Operating pressure: 0-10 psi
- Lohm rate:
  PV275: 1800 Lohms (Ref. Cv = 0.011)
  600LT: 4100 Lohms (Ref. Cv = 0.005)
  Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Wetted materials: stainless steel, PBT, EPDM (600LT only), seal material and epoxy.

MODEL	PART NUMBER	SPIKE VOLTAGE (Vdc)	HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION (ms)	AVERAGE POWER (W)	MAX. FRE-QUENCY (Hz)	SEAL MATERIAL[1]
PV275	INKA1202028D	12	3.6	0.65	0.78	275	SI
	INKA2402028D	24	7.7	0.65	0.78	275	SI
	INKA4002028D	40	12	0.65	0.78	275	SI
600LT	INKA1202160D	12	5	0.90	1.02	600	FKM
	INKA2402160D	24	10	0.90	1.02	600	FKM
	INKA4002160D	40	16	0.90	1.02	600	FKM

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Axial Pin Mount



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

- Operating pressure: 0-10 psi
- Lohm rate: 4100 Lohms (Ref. Cv = 0.005). Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Wetted materials: stainless steel, PBT, EPDM, seal material and epoxy.

MODEL	PART NUMBER	SPIKE VOLTAGE (Vdc)	HOLD VOLTAGE (Vdc)	MIN. SPIKE DURATION (ms)	AVERAGE POWER (W)	MAX. FRE-QUENCY (Hz)	SEAL MATERIAL[1]
600LT	INKA1205160D	12	5	0.90	1.02	600	FKM
	INKA2405160D	24	10	0.90	1.02	600	FKM
	INKA4005160D	40	16	0.90	1.02	600	FKM

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 250 million cycles on water, depending on application conditions.

Weight

8 to 10 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

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)
- Maximum coil temperature not to exceed 150°F (66°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 rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Electrical Characteristics

- The INK Series valves require the use of a spike and hold drive to achieve the specified operating frequency. Refer to Engineering Reference Section, pages R35-36, for recommended electrical drive schematics.
- The Lee Company offers a Spike and Hold Driver (Lee Company Part Number IECX0501350A) for development use.
- The valves are designed to operate at the rated voltage ± 5%, unless otherwise specified.

Electrical Connections

- *PV275 Model:* These valves are designed to be mounted onto a printed circuit board.
- *600LT Model:* These valves are designed with axial 0.025" sq. pins that are spaced 0.200" center to center. The Lee Company offers a lead-wire connector assembly (Lee Company Part Number IHWX0248020A) as a separate accessory that is compatible with this pin spacing.

Response Time

- The response time is based on the spike and hold drive parameters, along with the maximum operating frequency of the specific valve design.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.

Port Connections

- The INK Series valves are designed for use with soft, flexible tubing. Refer to the individual valve drawings on pages C3-4 for size requirements.
- The dispense output is affected by the tubing length, durometer, size and material.
- Refer to MINSTAC (Section L) for various tubing and components to be used with the INK Series valves.

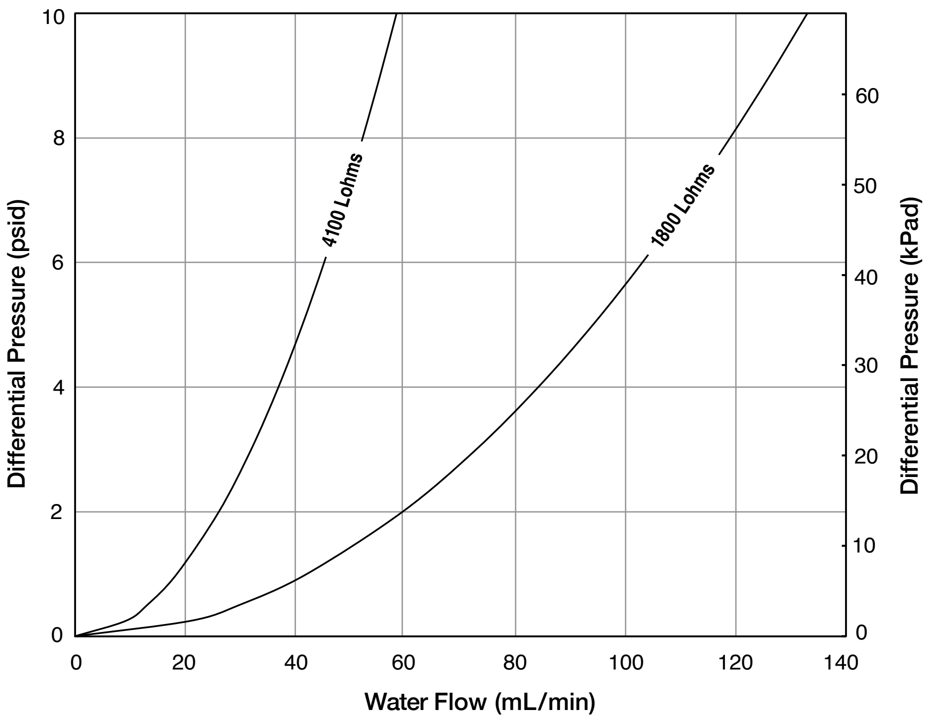
Mounting Information

Axial Pin Mount: The valves may be mounted to a flat surface using #2 (M2) screws and there must be sufficient length to allow for valve thickness and proper thread engagement into the mounting surface. The recommended mounting torque is 10 to 15 in-oz. (0.071 to 0.106 N-m). Refer to valve drawing for detailed specifications.

Filtration

Filtration of 35 microns or finer is recommended.

Typical Flow Characteristics
INK Series Valves



LFN Series

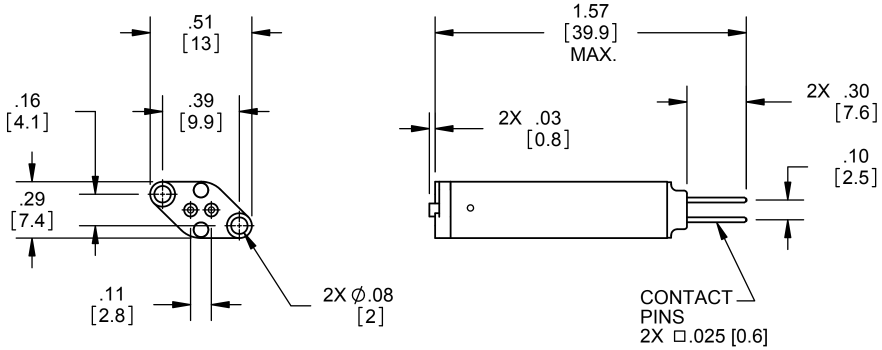
The LFN Series solenoid valves are chemically inert, isolation style valves with low internal volume. Available as a 2-way normally closed design, the valves contain a diaphragm seal that isolates the fluid from the valve's inner details, and provides consistent reliable switching performance in the smallest footprint possible.

These valves are generally used in medical and scientific applications in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Zero Dead Volume
- Low Internal Volume: 13 µL
- Operating Pressures up to 30 psig
- Standard Voltages Available: 12 and 24 Vdc
- Flow Capacity: 2500 Lohms
- Available Seal Elastomers: EPDM and FKM
- Low Power Consumption
- Flange Mount Style

Each valve is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize valve performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Flange Mount Style



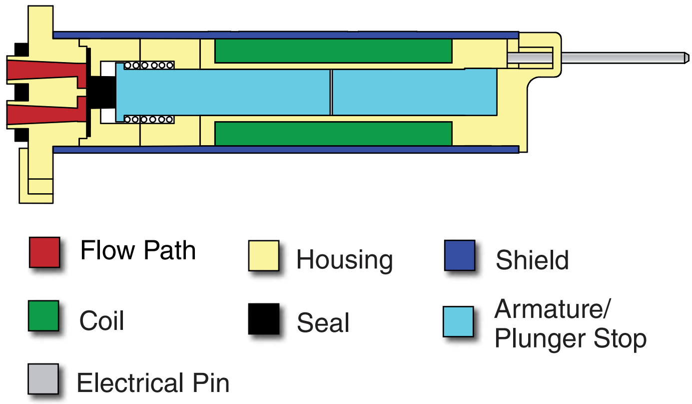
Refer to page D5 for mounting details.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	
LFNA1250125H	12	2500 (Ref. Cv = .003)	Vac - 30	
LFNA2450125H	24		Vac - 30	
LFNA1250225H	12		Vac - 30	
LFNA2450225H	24		Vac - 30	

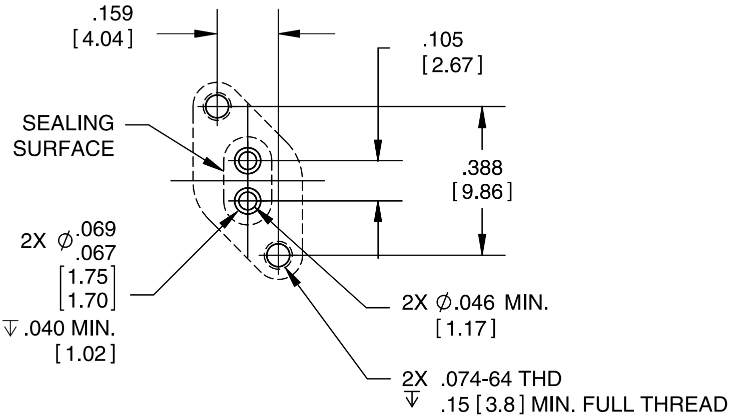
NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Flange Mount Style



	INTERNAL VOLUME (µL)	POWER CONSUMPTION (mW)	WETTED MATERIALS[2]
	13	900	FKM/PEEK
	13	900	FKM/PEEK
	13	900	EPDM/PEEK
	13	900	EPDM/PEEK

Valve Mounting Details



Reference Drawing Number LSIX1001800A for Mounting Details

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

Standard Manifolds

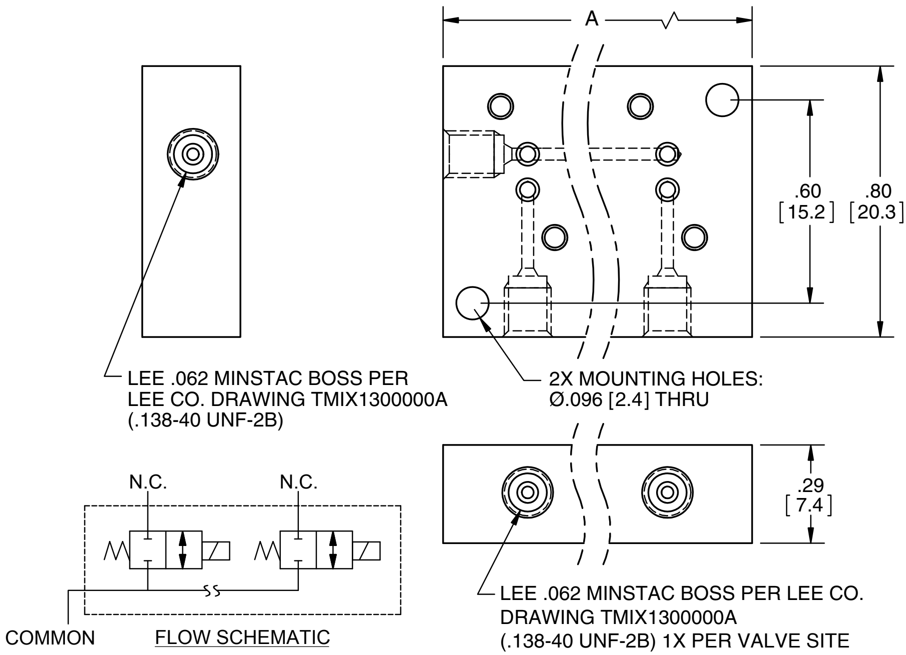
PART NUMBER[1]		NUMBER OF VALVE POSITIONS	DIMENSION "A"
PEEK	PMMA		
LSMX0509700B	N/A	Manifold, 1x	0.63" (16.0 mm)
LSMX0509520B	LSMX0509560B	Manifold, 2x	0.80" (20.3 mm)
LSMX0509530B	LSMX0509570B	Manifold, 3x	1.10" (27.9 mm)
LSMX0509540B	LSMX0509580B	Manifold, 4x	1.40" (35.6 mm)
LSMX0509550B	LSMX0509590B	Manifold, 5x	1.70" (43.2 mm)

NOTE: (1) Part Numbers are for the manifold and mounting screws only. Valves are sold separately.

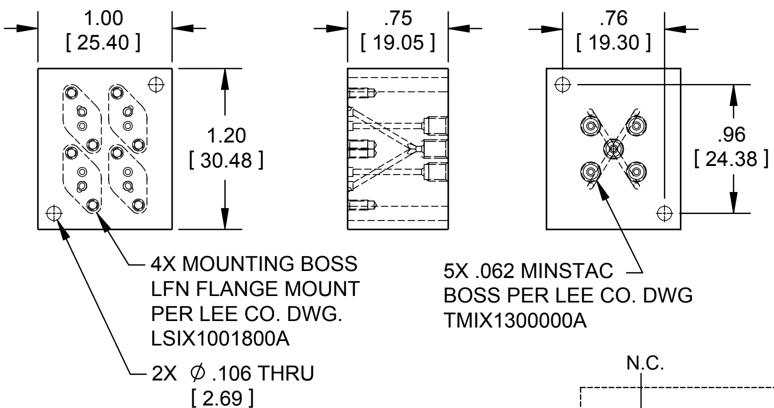
Refer to the Manifold Technology (Section K) for custom design capabilities.

Manifold Accessories

PART NUMBER	DESCRIPTION
LSWX0503110A	Mounting Screw (#1-64 x 0.1875”)
LSWX0508170A	Gasket (EPDM)
LSWX0508200A	Gasket (FKM)

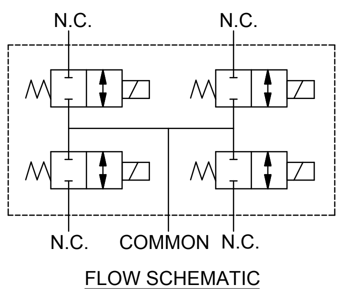


The Lee Company also offers a standard manifold design allowing for 4x valve positions arranged in a different layout, as shown below. This design allows for the 4x valves to be mounted with individual inlet ports, and a common outlet port for mixing applications.



Lee Company Part Number LSMX0512650B (Manifold, 4x Valve Positions, PMMA).

Part Number is for the manifold and mounting screws only. Valves are sold separately.



GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Weight

6 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

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)
- Maximum coil temperature not to exceed 170°F (77°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 rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Response Time

- The typical response time is 20 ms maximum at 68°F (20°C), 2Hz on air at 10 psig.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.
- Response times can be enhanced with the use of spike and hold drive circuits. Refer to the electrical characteristics on the next page.

Electrical Characteristics

- Valves are designed to operate under continuous duty at the rated voltage ±5%.
- The valves are also designed to be operated using a spike and hold drive approach to enhance response time and reduce the average power consumption. Refer to the Engineering Reference Section, pages R35-36, for information on electrical drive schematics.

NOMINAL VOLTAGE (Vdc)	RESISTANCE (ohms)	SPIKE ACTUATION VOLTAGE (Vdc)	MAXIMUM SPIKE DURATION (ms)	HOLD VOLTAGE (Vdc)	POWER CONSUMPTION @ HOLD VOLTAGE (mW)
12	158	20	25	5	160
24	630	40	25	10	160

Port Connections

Flange Mount: Refer to page D5 for mounting details.

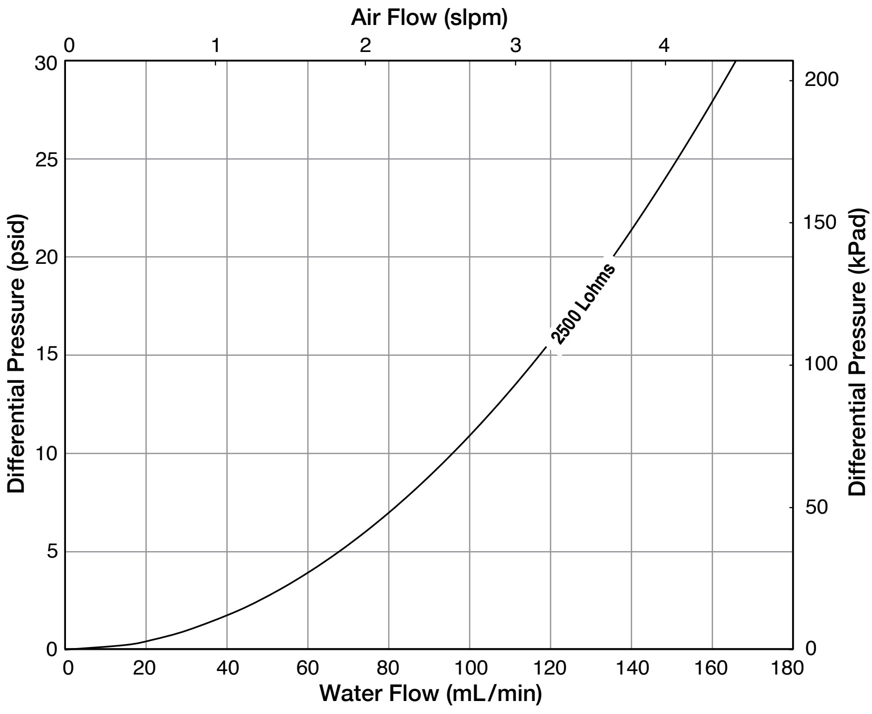
Mounting Information

Flange Mount: The valves should be mounted to a surface using #1-64 x 0.1875 (M1.6) mounting screws. The torque specification is 5 to 7 in-oz (0.035 to 0.049 N-m). See page D5 for mounting details.

Filtration

Filtration of 35 microns or finer is recommended.

Typical Flow Characteristics
LFN Series Valves



LFV Series

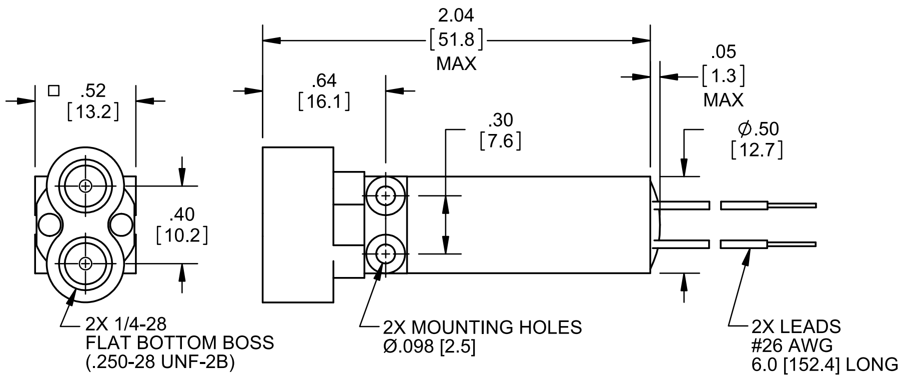
The LFV Series solenoid valves are chemically inert, isolation style valves with zero dead volume. Available in a 2-way normally closed model, the valves are rated for bi-directional flow and use a contoured internal flow path design that allows for complete flushing capability. This contoured flow path also minimizes damage to any sensitive fluids passing through the valve. The low internal volume reduces the amount of fluid required to fill the system (otherwise known as transport volume), further reducing the sample and reagent requirements.

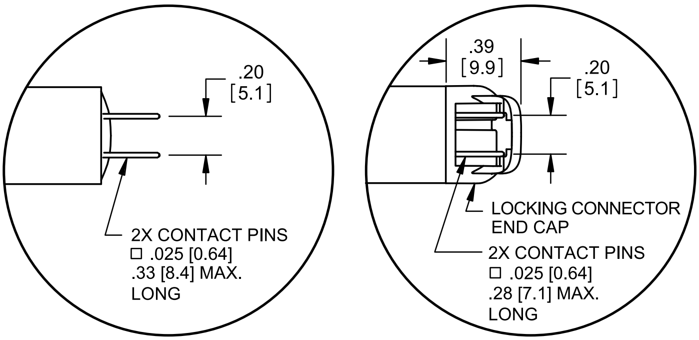
These valves are generally used in medical and scientific applications in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Zero Dead Volume
- Low Internal Volume
- Operating Pressures up to 30 psig
- Standard Voltages Available: 12 and 24 Vdc
- Different Lohm Rates: 1000, 1300 and 2000
- Available Seal Elastomers: EPDM, FKM and FFKM
- Low Power Consumption
- Multiple Styles: ¼-28 Port, 062 MINSTAC, Flange Mount, Barbed Port and Coupling Screw Mount.

Each valve is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize valves to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

1/4-28 Port Style





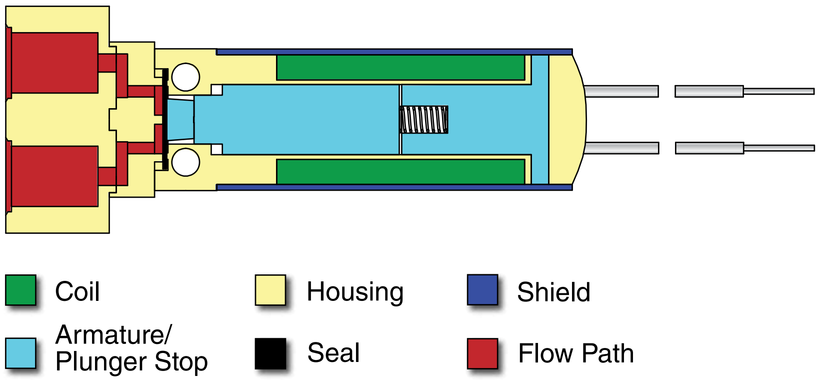
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFVA _ _ 30213H	1300 (Ref. Cv = 0.015)	Vac - 30	1.5
LFVA _ _ 31213H		Vac - 30	1.5
LFVA _ _ 32213H		Vac - 30	1.5
LFVA _ _ 30113H		Vac - 30	1.5
LFVA _ _ 31113H		Vac - 30	1.5
LFVA _ _ 32113H		Vac - 30	1.5
LFVA _ _ 30313H		1 - 30	1.5
LFVA _ _ 31313H		1 - 30	1.5
LFVA _ _ 32313H		1 - 30	1.5
LFVA _ _ 30413H		Vac - 30	1.5
LFVA _ _ 31413H		Vac - 30	1.5
LFVA _ _ 32413H		Vac - 30	1.5

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

LFVA_ _30213H

Coil Voltage: 12 = 12 volts
24 = 24 volts

1/4-28 Port Style



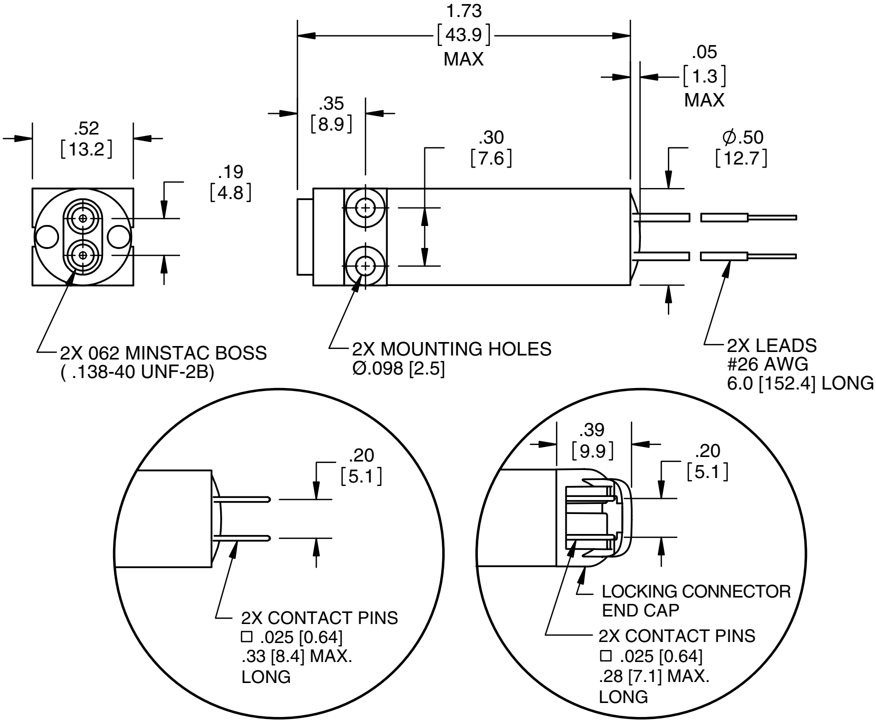
Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

	INTERNAL VOLUME (µL)	WETTED MATERIALS[3]	ELECTRICAL CONNECTION
	43	EPDM/PEEK	Lead Wire
	43	EPDM/PEEK	Pin
	43	EPDM/PEEK	Pin with locking end cap
	43	FKM/PEEK	Lead Wire
	43	FKM/PEEK	Pin
	43	FKM/PEEK	Pin with locking end cap
	43	FFKM/PEEK	Lead Wire
	43	FFKM/PEEK	Pin
	43	FFKM/PEEK	Pin with locking end cap
	43	FFKM/PEEK	Lead Wire
	43	FFKM/PEEK	Pin
	43	FFKM/PEEK	Pin with locking end cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

062 MINSTAC Port Style



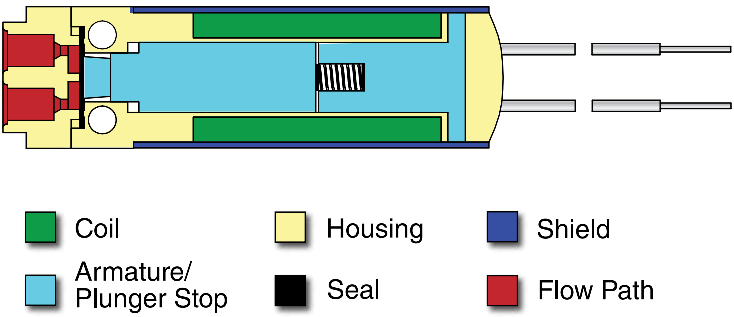
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFVA _ _ 10220H	2000 (Ref. Cv = 0.010)	Vac - 30	1.5
LFVA _ _ 11220H		Vac - 30	1.5
LFVA _ _ 12220H		Vac - 30	1.5
LFVA _ _ 10120H		Vac - 30	1.5
LFVA _ _ 11120H		Vac - 30	1.5
LFVA _ _ 12120H		Vac - 30	1.5
LFVA _ _ 10320H		1 - 30	1.5
LFVA _ _ 11320H		1 - 30	1.5
LFVA _ _ 12320H		1 - 30	1.5
LFVA _ _ 10420H		Vac - 30	1.5
LFVA _ _ 11420H		Vac - 30	1.5
LFVA _ _ 12420H		Vac - 30	1.5

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

LFVA_ _10220H

Coil Voltage: 12 = 12 volts
24 = 24 volts

062 MINSTAC Port Style



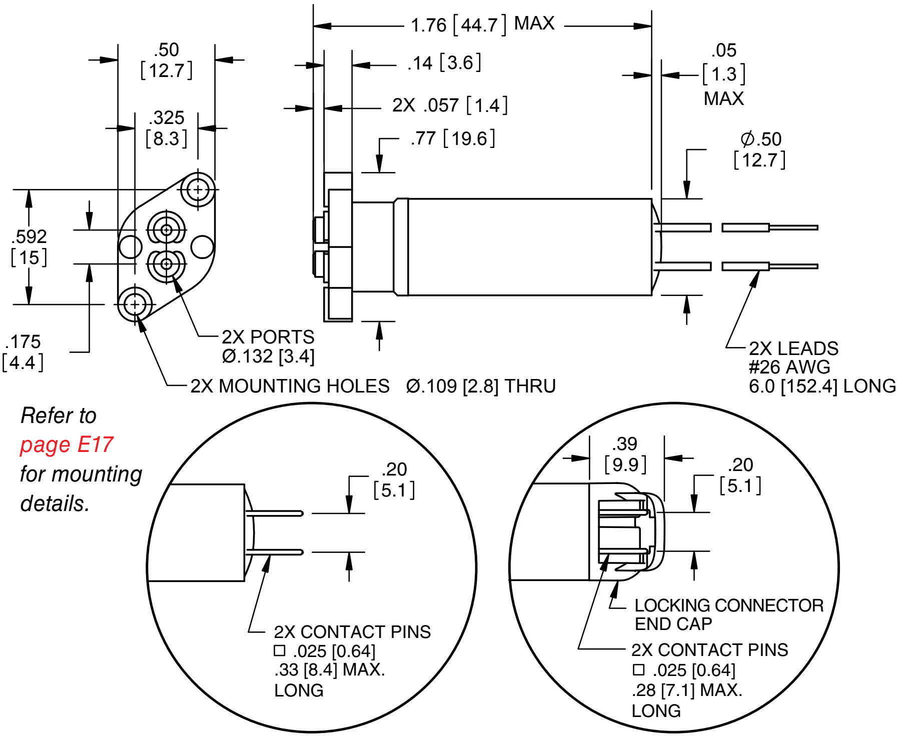
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

	INTERNAL VOLUME (µL)	WETTED MATERIALS[3]	ELECTRICAL CONNECTION
	11	EPDM/PEEK	Lead Wire
	11	EPDM/PEEK	Pin
	11	EPDM/PEEK	Pin with locking end cap
	11	FKM/PEEK	Lead Wire
	11	FKM/PEEK	Pin
	11	FKM/PEEK	Pin with locking end cap
	11	FFKM/PEEK	Lead Wire
	11	FFKM/PEEK	Pin
	11	FFKM/PEEK	Pin with locking end cap
	11	FFKM/PEEK	Lead Wire
	11	FFKM/PEEK	Pin
	11	FFKM/PEEK	Pin with locking end cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Flange Mount Style



Refer to *page E17* *for mounting details.*

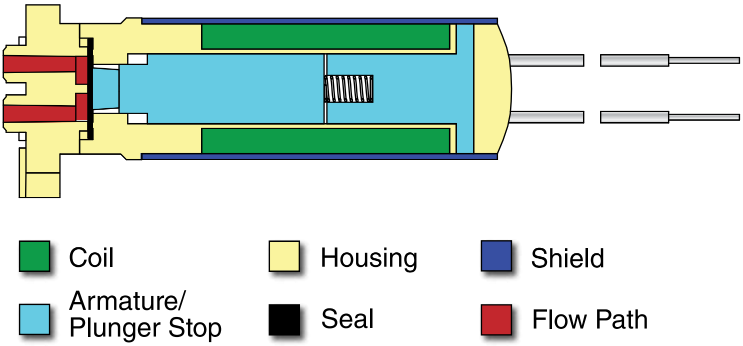
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFVA _ _ 50210H	1000 (Ref. Cv = 0.020)	Vac - 30	1.4
LFVA _ _ 51210H		Vac - 30	1.4
LFVA _ _ 52210H		Vac - 30	1.4
LFVA _ _ 50110H		Vac - 30	1.4
LFVA _ _ 51110H		Vac - 30	1.4
LFVA _ _ 52110H		Vac - 30	1.4
LFVA _ _ 50310H		1 - 30	1.4
LFVA _ _ 51310H		1 - 30	1.4
LFVA _ _ 52310H		1 - 30	1.4
LFVA _ _ 50410H		Vac - 30	1.4
LFVA _ _ 51410H		Vac - 30	1.4
LFVA _ _ 52410H		Vac - 30	1.4

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

LFVA_ _50210H

Coil Voltage: 12 = 12 volts
24 = 24 volts

Flange Mount Style



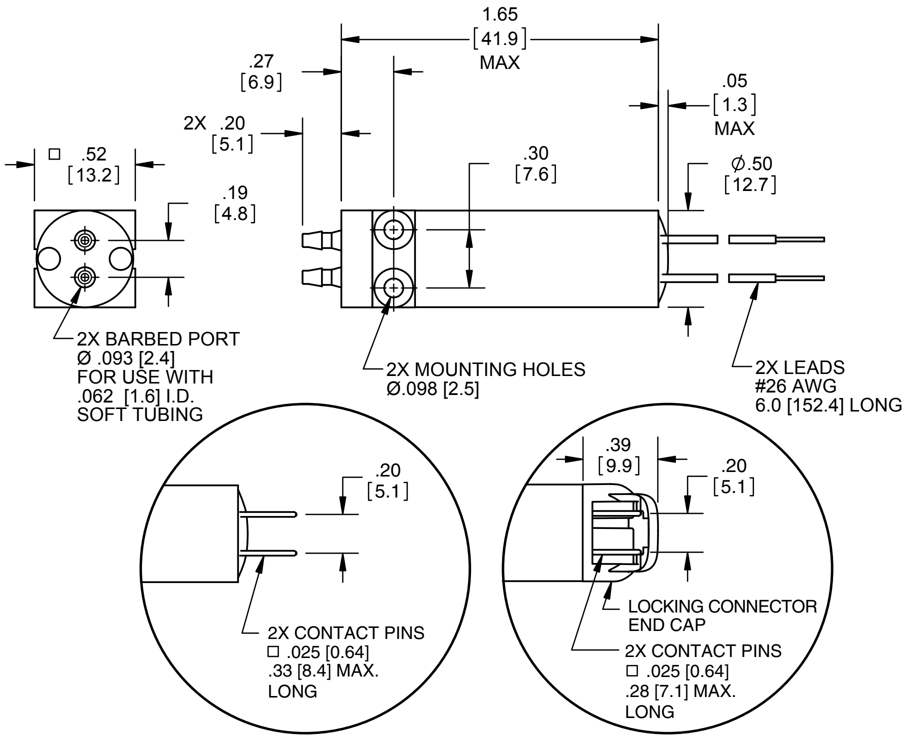
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

INTERNAL VOLUME (µL)	WETTED MATERIALS[3]	ELECTRICAL CONNECTION
21	EPDM/PEEK	Lead Wire
21	EPDM/PEEK	Pin
21	EPDM/PEEK	Pin with locking end cap
21	FKM/PEEK	Lead Wire
21	FKM/PEEK	Pin
21	FKM/PEEK	Pin with locking end cap
21	FFKM/PEEK	Lead Wire
21	FFKM/PEEK	Pin
21	FFKM/PEEK	Pin with locking end cap
21	FFKM/PEEK	Lead Wire
21	FFKM/PEEK	Pin
21	FFKM/PEEK	Pin with locking end cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Barbed Port Style



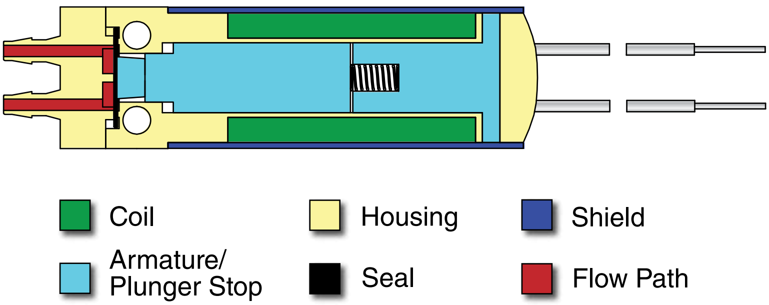
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFVA _ _ 20210H	1000 (Ref. Cv = 0.020)	Vac - 30	1.5
LFVA _ _ 21210H		Vac - 30	1.5
LFVA _ _ 22210H		Vac - 30	1.5
LFVA _ _ 20110H		Vac - 30	1.5
LFVA _ _ 21110H		Vac - 30	1.5
LFVA _ _ 22110H		Vac - 30	1.5
LFVA _ _ 20310H		1 - 30	1.5
LFVA _ _ 21310H		1 - 30	1.5
LFVA _ _ 22310H		1 - 30	1.5
LFVA _ _ 20410H		Vac - 30	1.5
LFVA _ _ 21410H		Vac - 30	1.5
LFVA _ _ 22410H		Vac - 30	1.5

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



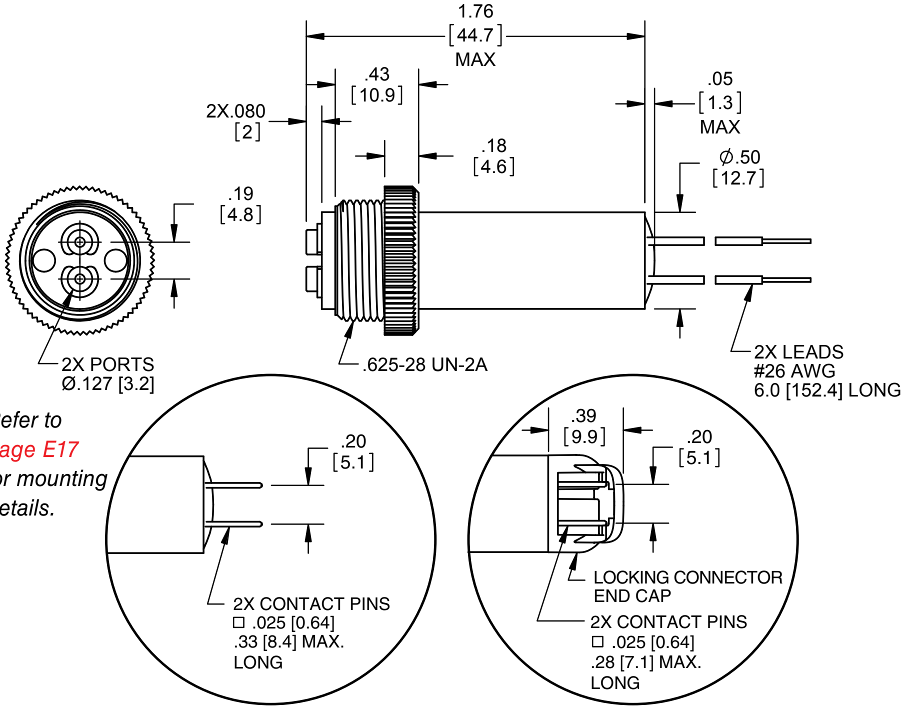
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

	INTERNAL VOLUME (µL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	43	EPDM/PEEK	Lead Wire
	43	EPDM/PEEK	Pin
	43	EPDM/PEEK	Pin with locking end cap
	43	FKM/PEEK	Lead Wire
	43	FKM/PEEK	Pin
	43	FKM/PEEK	Pin with locking end cap
	43	FFKM/PEEK	Lead Wire
	43	FFKM/PEEK	Pin
	43	FFKM/PEEK	Pin with locking end cap
	43	FFKM/PEEK	Lead Wire
	43	FFKM/PEEK	Pin
	43	FFKM/PEEK	Pin with locking end cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Coupling Screw Mount Style



Refer to *page E17* *for mounting details.*

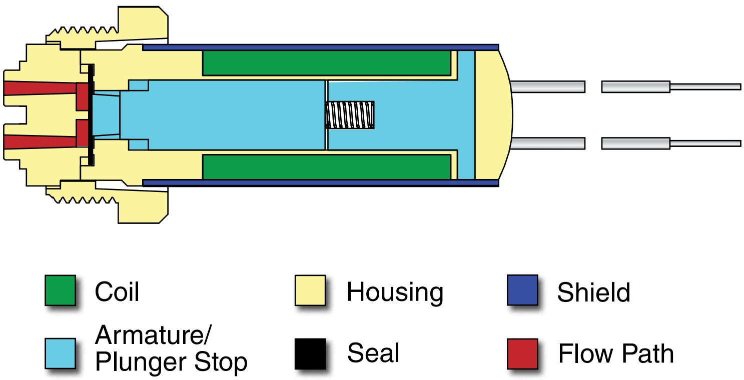
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFVA _ _ 40220H	2000 (Ref. Cv = 0.010)	Vac - 30	1.5
LFVA _ _ 41220H		Vac - 30	1.5
LFVA _ _ 42220H		Vac - 30	1.5
LFVA _ _ 40120H		Vac - 30	1.5
LFVA _ _ 41120H		Vac - 30	1.5
LFVA _ _ 42120H		Vac - 30	1.5
LFVA _ _ 40320H		1 - 30	1.5
LFVA _ _ 41320H		1 - 30	1.5
LFVA _ _ 42320H		1 - 30	1.5
LFVA _ _ 40420H		Vac - 30	1.5
LFVA _ _ 41420H		Vac - 30	1.5
LFVA _ _ 42420H		Vac - 30	1.5

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

LFVA_ _40220H

Coil Voltage: 12 = 12 volts
24 = 24 volts

Coupling Screw Mount Style



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

	INTERNAL VOLUME (µL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	21	EPDM/PEEK	Lead Wire
	21	EPDM/PEEK	Pin
	21	EPDM/PEEK	Pin with locking end cap
	21	FKM/PEEK	Lead Wire
	21	FKM/PEEK	Pin
	21	FKM/PEEK	Pin with locking end cap
	21	FFKM/PEEK	Lead Wire
	21	FFKM/PEEK	Pin
	21	FFKM/PEEK	Pin with locking end cap
	21	FFKM/PEEK	Lead Wire
	21	FFKM/PEEK	Pin
	21	FFKM/PEEK	Pin with locking end cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Standard Manifolds

STYLE	PART NUMBER [1]		NUMBER OF VALVE POSITIONS	DIMENSION "A"
	PEEK	PMMA		
Flange Mount (Linear)	N/A	LSMX0502400B	Manifold, 1x, Flange Mount	1.00" (25.4 mm)
	LSMX0503600B	LSMX0502360B	Manifold, 2x, Flange Mount	1.22" (31.0 mm)
	LSMX0503610B	LSMX0502370B	Manifold, 3x, Flange Mount	1.73" (43.9 mm)
	LSMX0503620B	LSMX0502380B	Manifold, 4x, Flange Mount	2.24" (56.9 mm)
	LSMX0503630B	LSMX0502390B	Manifold, 5x, Flange Mount	2.75" (69.9 mm)
Flange Mount (Radial)	LSMX0502800B	LSMX0502750B	Manifold, 6x, Flange Mount	1.03" (26.2 mm)[2]
	LSMX0502850B	LSMX0502900B	Manifold, 8x, Flange Mount	1.41" (35.8 mm)[2]
Coupling Screw Mount	LSMX0517010B	LSMX0517020B	Manifold, 1x, Coupling Screw Mount	1.00" (25.4 mm)
	LFMX0514100B	LFMX0514300B	Manifold, 3x, Coupling Screw Mount	3.25" (82.6 mm)
	LFMX0514200B	LFMX0514400B	Manifold, 8x, Coupling Screw Mount	8.25" (209.6 mm)

NOTES: (1) Part Numbers are for the manifold and mounting screws only. Valves are sold separately.
(2) Length measured across flats of manifolds.

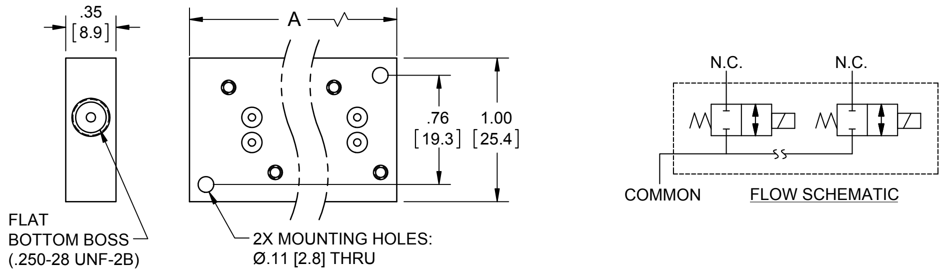
Refer to Manifold Technology (Section K) for custom design capabilities.

General Accessories/Replacement Parts

STYLE	PART NUMBER	DESCRIPTION
Flange Mount	LSWX0208050A	Gasket (FFKM)
Coupling Screw Mount	LHWX0208750A	Gasket (FFKM)
	LSWX0610000A	Splined Installation Wrench[1]

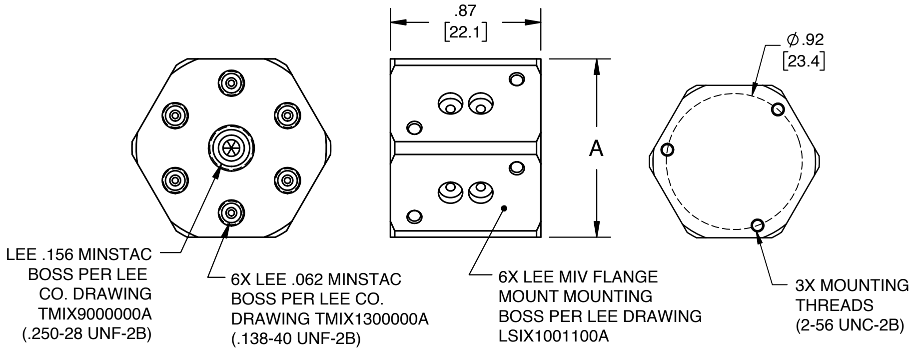
NOTE: (1) Splined installation wrench is only needed for torque measurements. Coupling screw LFV Series valves can be installed by hand.

Flange Mount (Linear) Style

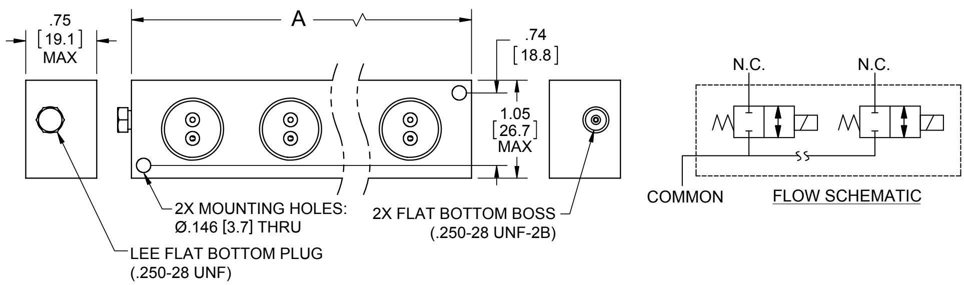


Flange Mount (Radial) Style

6 place shown



Coupling Screw Mount Style



Flange Mount Style

Coupling Screw Mount Style

Unless otherwise specified, dimensions are in inches [mm]. *Drawings are not to scale.*

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Weight

24 to 26 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

Valve Proof Pressure: 2x Normal Rated Pressure
Valve Burst Pressure: 3x Normal Rated Pressure

Operating Temperature

- Ambient operating temperature range is dependent on the elastomer; refer to table below for details.
- Maximum coil temperature not to exceed 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 rated operating and coil temperatures.

ELASTOMER	AMBIENT OPERATING TEMPERATURE RANGE
EPDM	30°F to 120°F (-1°C to 49°C)
FKM	40°F to 120°F (4°C to 49°C)
FFKM	70°F to 120°F (21°C to 49°C)

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Response Time

- The typical response time is 30 ms maximum at 65°F (18°C), 2Hz on air at 10 psig.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.
- Response times can be enhanced with the use of spike and hold drive circuits. Refer to Engineering Reference Section, pages R35-36.

Electrical Connections

There are three different connection designs available:

- *Lead-Wires:* Valves are supplied with 6", #26 AWG lead-wires with the ends of the wires stripped and tinned. An electrical connector can be added as part of a custom design.
- *Pins:* Valves are supplied with two 0.025" square electrical pins spaced 0.20" center to center. This design should be compatible for use with standard electrical connectors designed for 0.10" spacing.
- *Pins with Locking End Caps:* This is similar to pins, but with an added secondary retention clip that is compatible with AMP Part Number 104257-2 style connectors. The Lee Company also offers compatible lead-wire assemblies in two different lengths:
  - Lee Company Part Number LSWX0504300A – Length, 6 inches
  - Lee Company Part Number LSWX0606700A – Length, 24 inches

Electrical Characteristics

- Standard operating voltages available: 12 and 24 Vdc (±5%)
- Refer to individual valve tables on pages E3-12 for power consumption.
- The valves are designed for continuous duty operation. Following actuation at nominal voltage, the voltage can be lowered to a hold voltage that is 50% of the rated nominal voltage. This will reduce power consumption and heat. Refer to Engineering Reference Section, pages R35-36, for information on electrical drive schematics.

Port Connections

- Barbed Port: Designed for use with soft, flexible 1/16" (1.6 mm) I.D. tubing.
- ¼ - 28 Port: Designed for use with standard ¼-28 flat bottom fittings.
- 062 MINSTAC Ports: Designed for use with The Lee Company's 062 MINSTAC PTFE tubing system.
- Flange Mount and Coupling Screw: Refer to page E17 for mounting details.

Mounting Information

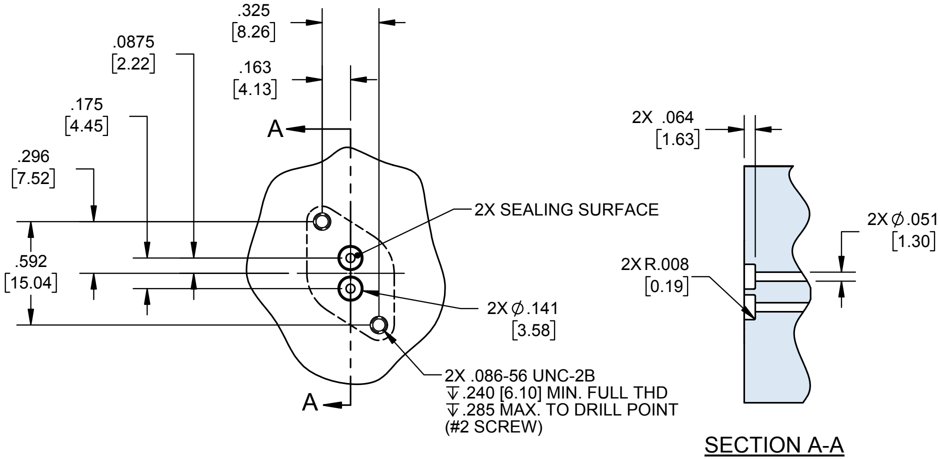
- Barbed Port: The valves should be mounted to a surface using #2 (M2) mounting screws.
- Flange Mount: The valves should be mounted to a surface using #2 (M2) mounting screws. The torque specification is 15 in-oz maximum. See page E17 for mounting details.
- Coupling Screw Mount: The coupling screw should be tightened within 60 to 120 in-oz of torque. See page E17 for mounting details.

Filtration

Filtration of 35 microns or finer is recommended.

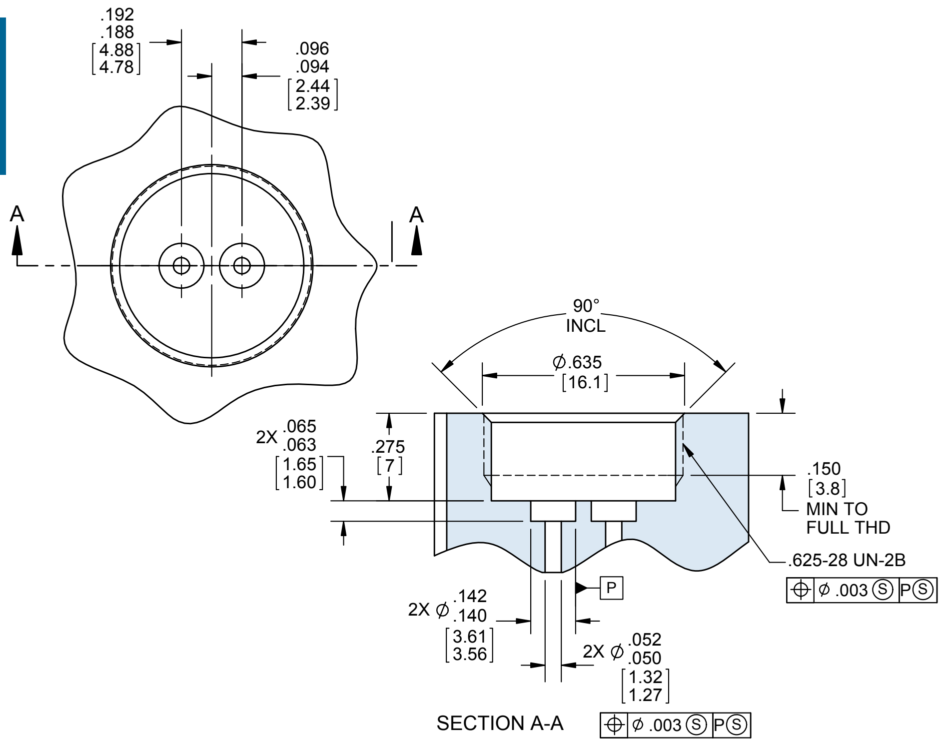
Valve Mounting Details

Flange Mount Boss



Reference Drawing Number LSIX1001100A for Mounting Details

Coupling Screw Boss

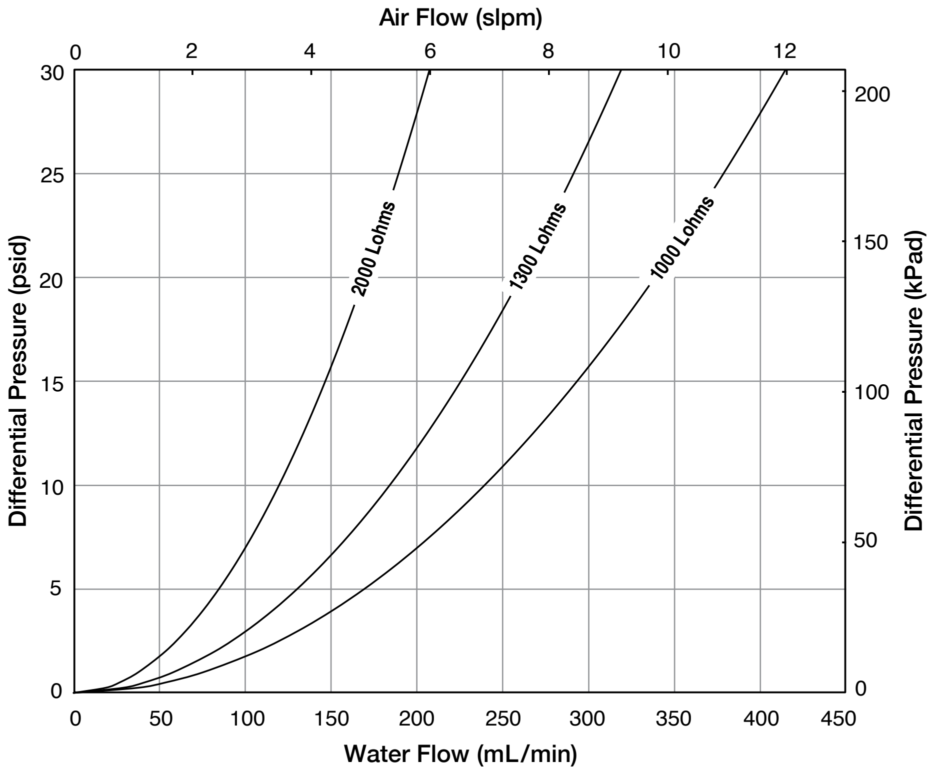


Reference Drawing Number LFIX1000850A for Mounting Details

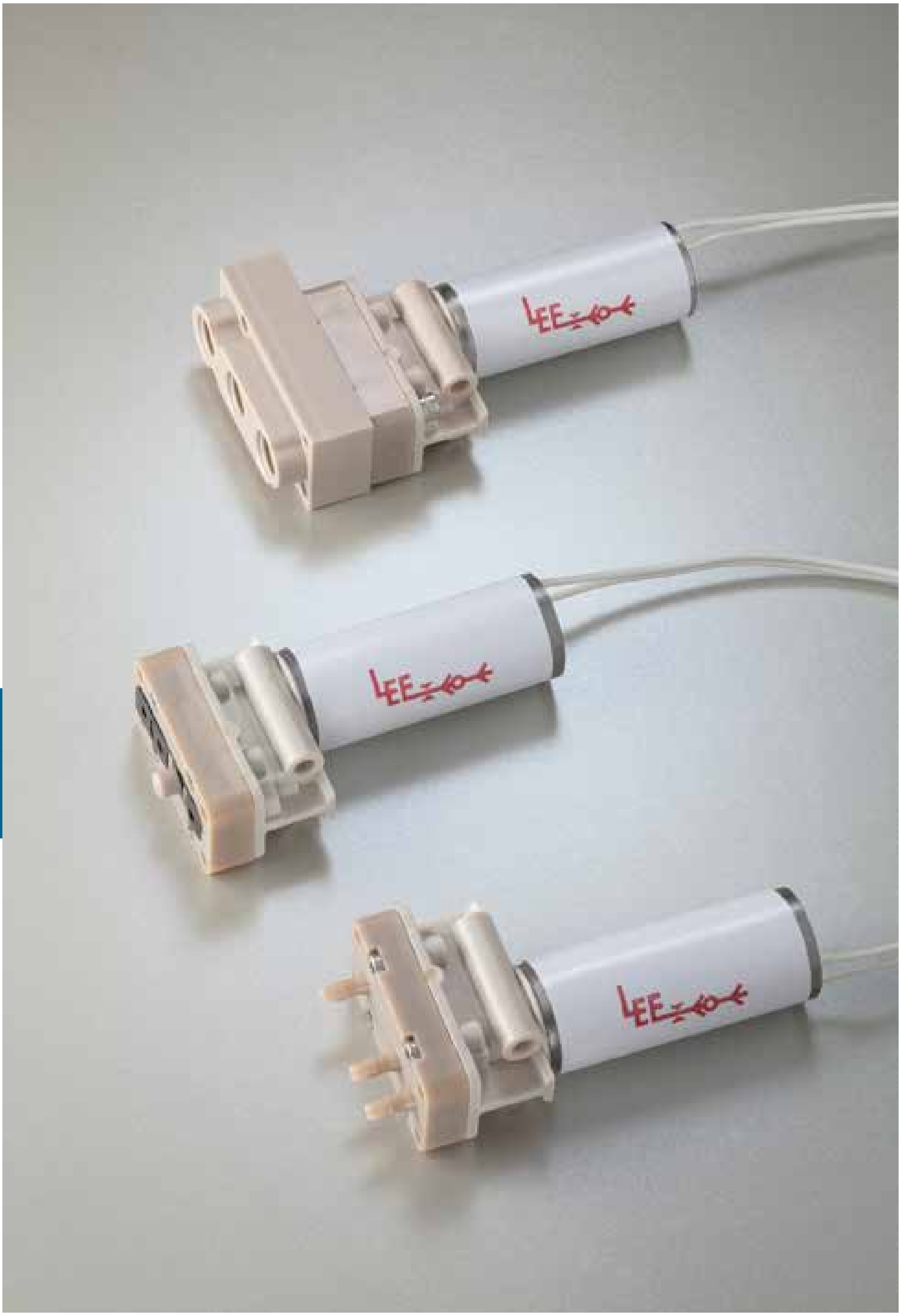
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

E

Typical Flow Characteristics
LFV Series Valves



LFR Series

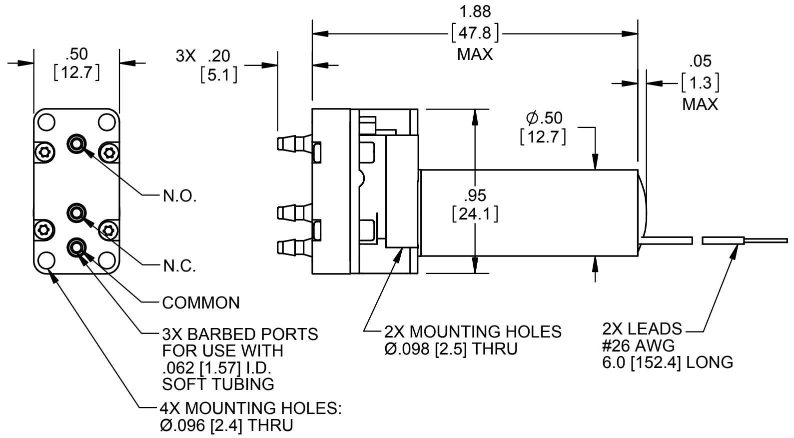


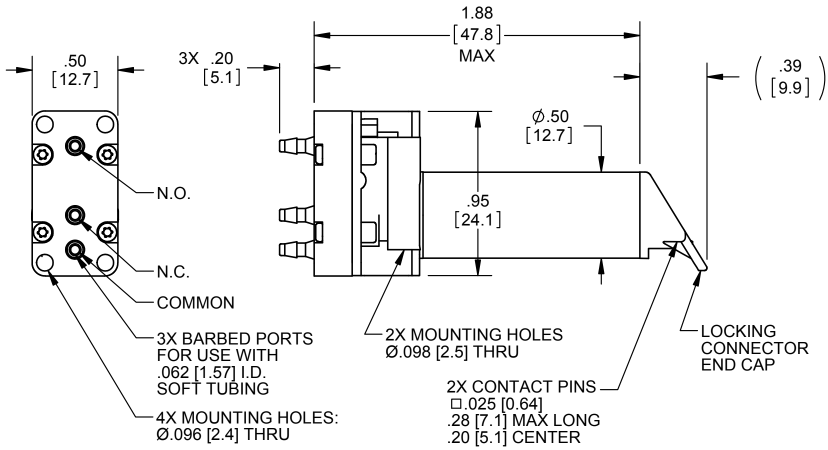
The LFR Series solenoid valves are 3-way, chemically inert, isolation style valves, optimized for high flow performance without sacrificing size or weight. These valves are generally used in medical and scientific applications, in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Operating Pressures up to 30 psig
- Standard Voltages Available: 12 and 24 Vdc
- Different Lohm Rates: 700, 1000 and 1100
- Available Seal Elastomers: EPDM, FKM and FFKM
- Low Power Consumption
- Multiple Styles: Barbed Port, ¼-28 Port, 062 MINSTAC and Manifold Mount.

Each valve is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize valves to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Barbed Port Style





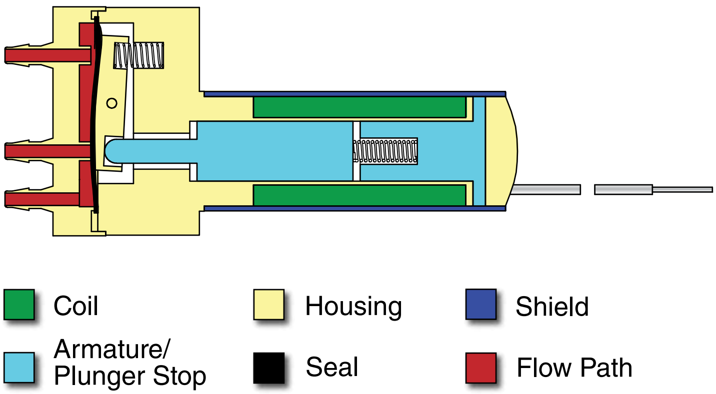
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFRA_ _20270D	700 (Ref. Cv = 0.029)	Vac - 30	1.6
LFRA_ _22270D		Vac - 30	1.6
LFRA_ _20170D		Vac - 30	1.6
LFRA_ _22170D		Vac - 30	1.6
LFRA_ _20370D		Vac - 30	1.6
LFRA_ _22370D		Vac - 30	1.6

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



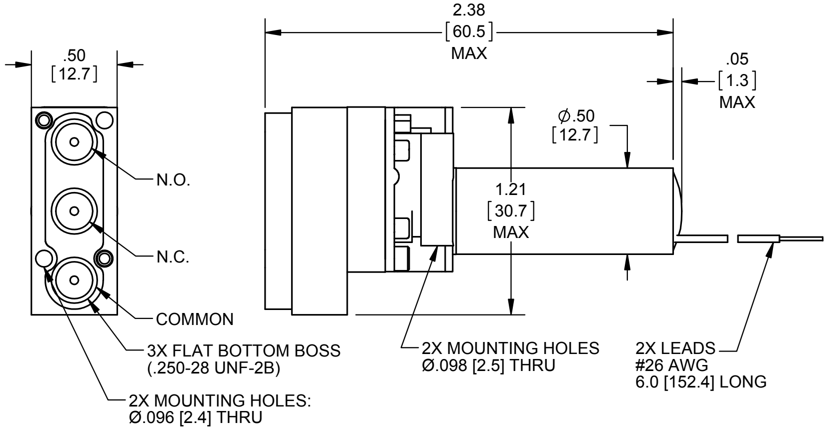
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

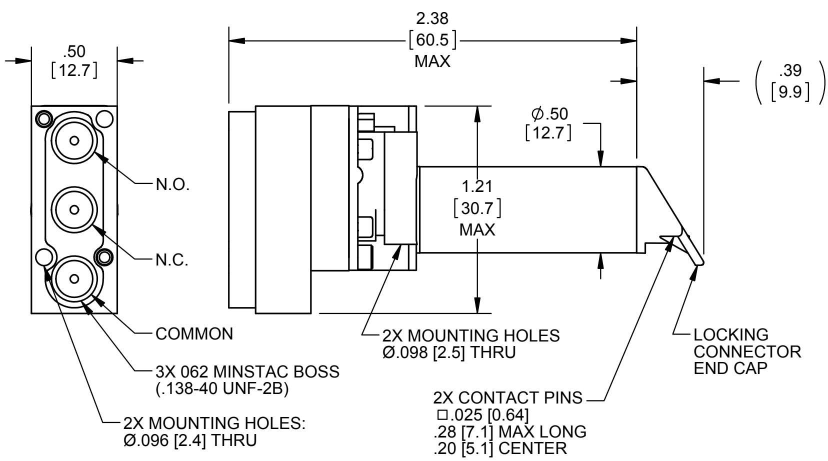
	INTERNAL VOLUME (μL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	150	EPDM/PEEK	Lead Wire
	150	EPDM/PEEK	Pin with Locking End Cap
	150	FKM/PEEK	Lead Wire
	150	FKM/PEEK	Pin with Locking End Cap
	150	FFKM/PEEK	Lead Wire
	150	FFKM/PEEK	Pin with Locking End Cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

1/4-28 Port Style





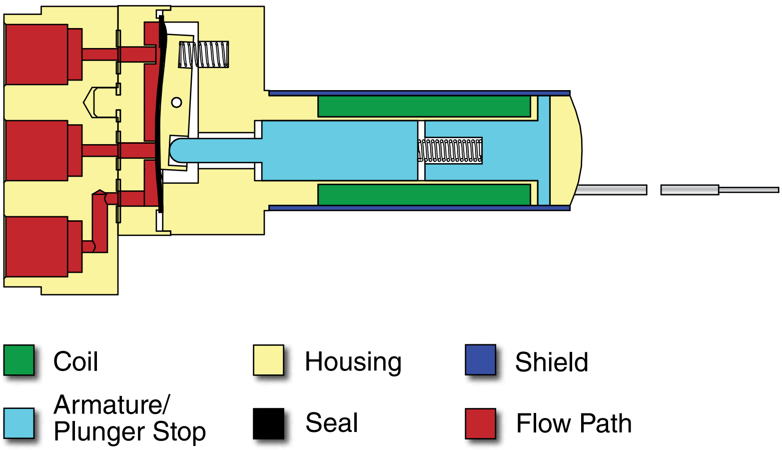
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFRA_ _30210H	1000 (Ref. Cv = 0.020)	Vac - 30	1.6
LFRA_ _32210H		Vac - 30	1.6
LFRA_ _30110H		Vac - 30	1.6
LFRA_ _32110H		Vac - 30	1.6
LFRA_ _30310H		Vac - 30	1.6
LFRA_ _32310H		Vac - 30	1.6

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



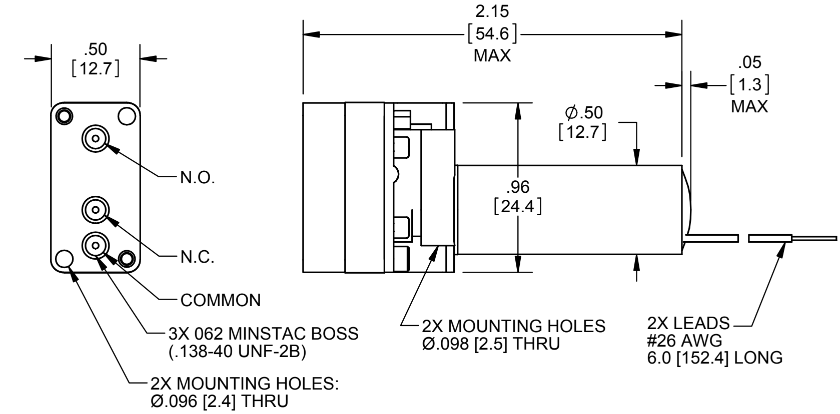
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

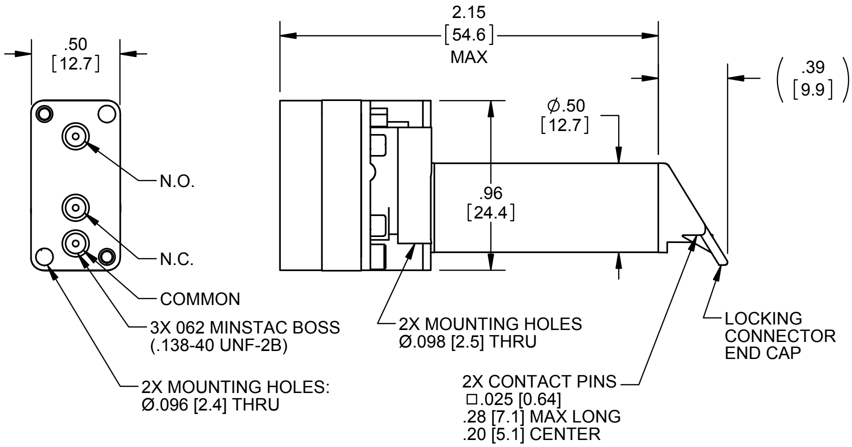
	INTERNAL VOLUME (μL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	180	EPDM/PEEK	Lead Wire
	180	EPDM/PEEK	Pin with Locking End Cap
	180	FKM/PEEK	Lead Wire
	180	FKM/PEEK	Pin with Locking End Cap
	180	FFKM/PEEK	Lead Wire
	180	FFKM/PEEK	Pin with Locking End Cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

062 MINSTAC Style





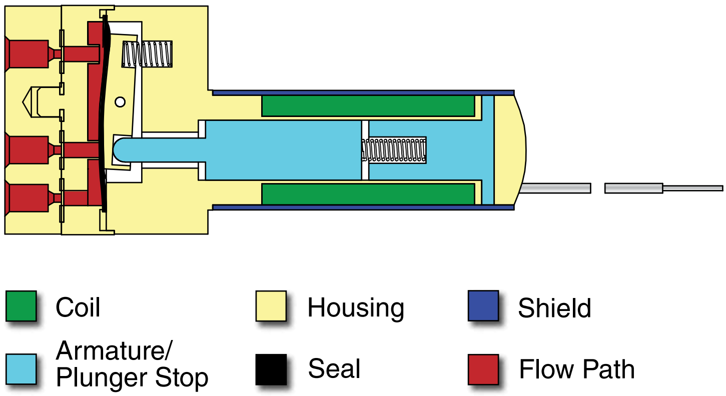
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)	
LFRA _ _ 10110H	1100 (Ref. Cv = 0.018)	Vac - 30	1.6	
LFRA _ _ 12110H		Vac - 30	1.6	
LFRA _ _ 10210H		Vac - 30	1.6	
LFRA _ _ 12210H		Vac - 30	1.6	
LFRA _ _ 10310H		Vac - 30	1.6	
LFRA _ _ 12310H		Vac - 30	1.6	

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

LFRA_ _10110H

Coil Voltage: 12 = 12 volts
24 = 24 volts

062 MINSTAC Style

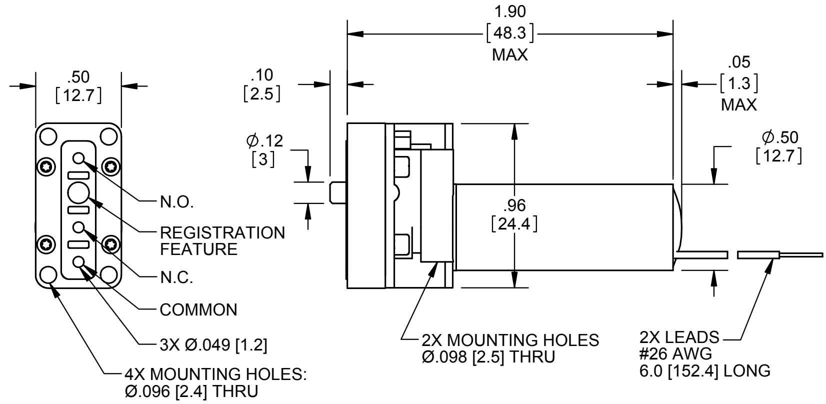


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

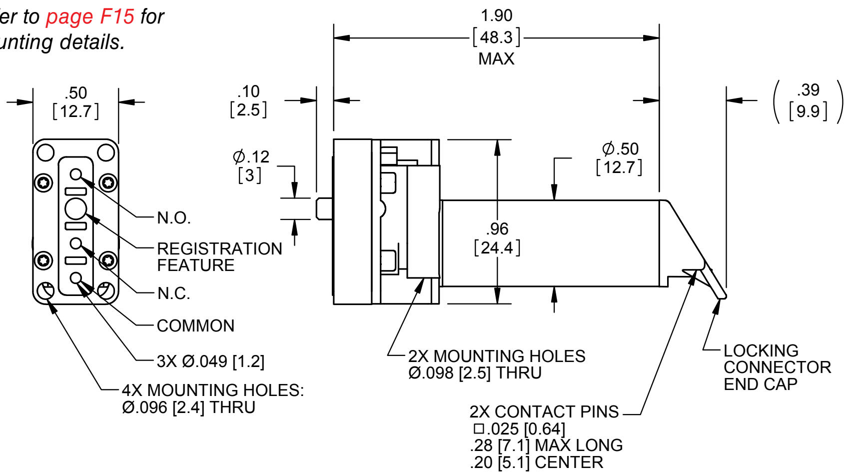
	INTERNAL VOLUME (µL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	151	FKM/PEEK	Lead Wire
	151	FKM/PEEK	Pin with Locking End Cap
	151	EPDM/PEEK	Lead Wire
	151	EPDM/PEEK	Pin with Locking End Cap
	151	FFKM/PEEK	Lead Wire
	151	FFKM/PEEK	Pin with Locking End Cap

(2) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Manifold Mount Style



Refer to page F15 for mounting details.



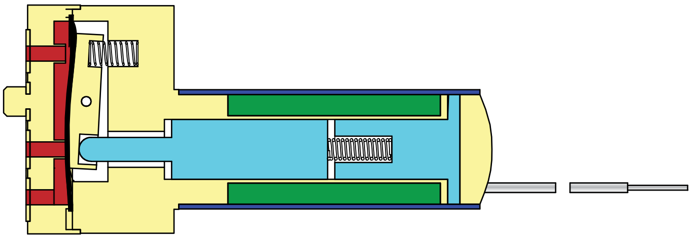
PART NUMBER [1]	LOHM RATE [2]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (W)
LFRA _ _ 50270D	700 (Ref. Cv = 0.029)	Vac - 30	1.6
LFRA _ _ 52270D		Vac - 30	1.6
LFRA _ _ 50170D		Vac - 30	1.6
LFRA _ _ 52170D		Vac - 30	1.6
LFRA _ _ 50370D		Vac - 30	1.6
LFRA _ _ 52370D		Vac - 30	1.6

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



Coil	Housing	Shield
Armature/ Plunger Stop	Seal	Flow Path

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

	INTERNAL VOLUME (μL)	WETTED MATERIALS [3]	ELECTRICAL CONNECTION
	130	EPDM/PEEK	Lead Wire
	130	EPDM/PEEK	Pin with Locking End Cap
	130	FKM/PEEK	Lead Wire
	130	FKM/PEEK	Pin with Locking End Cap
	130	FFKM/PEEK	Lead Wire
	130	FFKM/PEEK	Pin with Locking End Cap

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

(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Standard Manifolds for Manifold Mount Style Valves

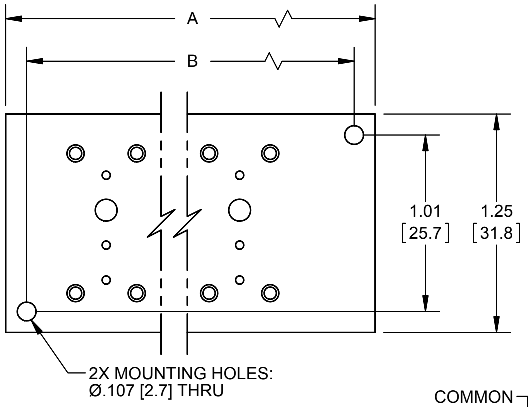
PART NUMBER[1]		NUMBER OF VALVE POSITIONS	DIMENSION "A"	DIMENSION "B"
PMMA	PEEK			
LSMX0501402C	LSMX0501412C	Manifold, 2x	1.90" (48.26 mm)	1.66" (42.16 mm)
LSMX0501403C	LSMX0501413C	Manifold, 3x	2.45" (62.23 mm)	2.21" (56.13 mm)
LSMX0501404C	LSMX0501414C	Manifold, 4x	3.00" (76.20 mm)	2.76" (70.10 mm)
LSMX0501405C	LSMX0501415C	Manifold, 5x	3.55" (84.07 mm)	3.31" (84.07 mm)
LSMX0501406C	LSMX0501416C	Manifold, 6x	4.10" (104.10 mm)	3.86" (98.04 mm)

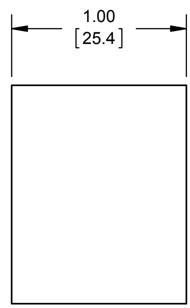
NOTE: (1) Part Numbers are for the manifold and mounting screws only. Valves are sold separately.
Standard manifolds are available in PEEK and PMMA. These contain 1/4-28 flat bottom connections and incorporate a common header and individual N.C. and N.O. ports for each valve.

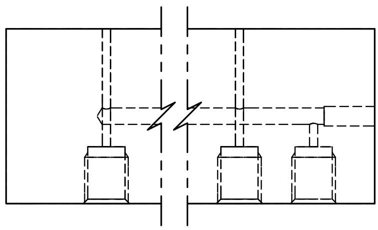
Refer to Manifold Technology (Section K) for custom design capabilities.

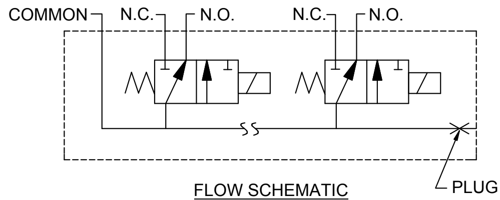
General Accessories/Replacement Parts

PART NUMBER	DESCRIPTION
LHWX0213420A	Mounting Screws, #2 (or 2 mm), 0.438" long
LHWX0218130A	Gasket (FKM)
LHWX0218140A	Gasket (EPDM)
LSWX0508210A	Gasket (FFKM)

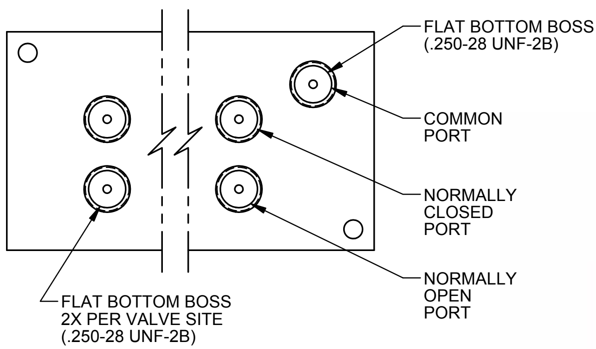








FLOW SCHEMATIC



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Weight

27 to 31 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

Valve Proof Pressure: 2x Normal Rated Pressure

Valve Burst Pressure: 3x Normal Rated Pressure

Operating Temperature

- Ambient operating temperature range is dependent on the elastomer. Refer to table below for details.
- Maximum coil temperature not to exceed 200°F (90°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 rated operating and coil temperatures.

ELASTOMER	AMBIENT OPERATING TEMPERATURE RANGE
EPDM	30°F to 120°F (-1°C to 49°C)
FKM	45°F to 120°F (7°C to 49°C)
FFKM	80°F to 120°F (27°C to 49°C)

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Response Time

- The typical response time is:
  - EPDM/FKM: 30 ms at 68°F (20°C), 2 Hz on air at 10 psig
  - FFKM: 75 ms at 80°F (27°C), 2 Hz on air at 10 psig
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.

Electrical Connections

There are three different connection designs available:

- *Lead-Wires:* Valves are supplied with 6", #26 AWG lead-wires with the ends of the wires stripped and tinned. An electrical connector can be added as part of a custom design.
- *Pins with Locking End Caps:* Valves are supplied with two 0.025" square electrical pins spaced 0.20" center to center. This design should be compatible for use with standard electrical connectors designed for 0.10" spacing. There is an added secondary retention clip that is compatible with AMP Part Number 104257-2 style connectors. The Lee Company also offers compatible lead-wire assemblies in two different lengths:
  - Lee Company Part Number LSWX0504300A – Length, 6 inches
  - Lee Company Part Number LSWX0606700A – Length, 24 inches

Electrical Characteristics

- Standard operating voltages available: 12 and 24 Vdc (±5%)
- Refer to individual valve tables on pages F3-10 for power consumption.
- The valves are designed for continuous duty operation. Following actuation at nominal voltage, the voltage can be lowered to a hold voltage that is 50% of the rated nominal voltage. This will reduce power consumption and heat. Refer to Engineering Reference Section, pages R35-36, for information on electrical drive schematics.

NOMINAL VOLTAGE (Vdc)	RESISTANCE (ohms)	INDUCTANCE (mH)
12	91	930
24	360	217

Port Connections

- Barbed Port: Designed for use with soft, flexible 1/16" (1.6 mm) I.D. tubing.
- ¼ - 28 Port: Designed for use with standard ¼-28 flat bottom fittings.
- 062 MINSTAC Ports: Designed for use with The Lee Company's 062 MINSTAC PTFE tubing system.
- Manifold Mount: See page F15 for mounting details.

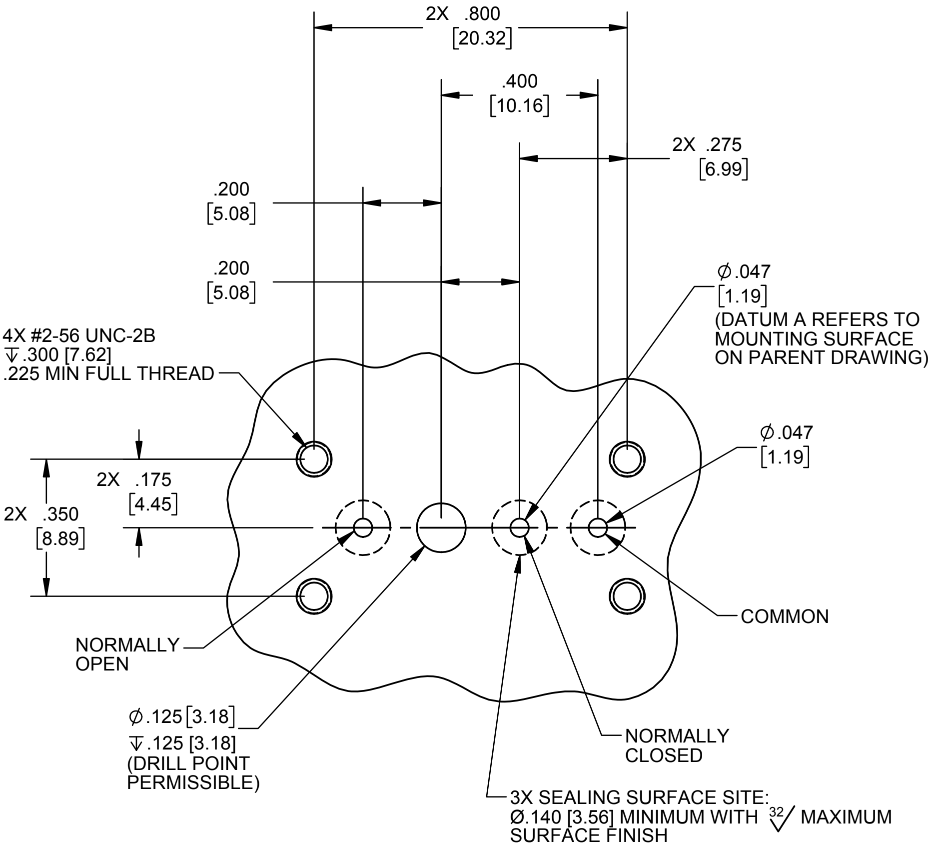
Mounting Information

- Barbed Port: The valves should be mounted to a surface using #2 (M2) mounting screws.
- ¼-28 Port: The valves should be mounted to a surface using #2 (M2) mounting screws.
- Manifold Mount: Minimum center to center spacing of 0.5" between valves is required. The valves use four #2 (M2) screws for mounting and the torque specification is 13.5 to 16.5 in-oz (0.095 to 0.117 N-m).

Filtration

Filtration of 35 microns or finer is recommended.

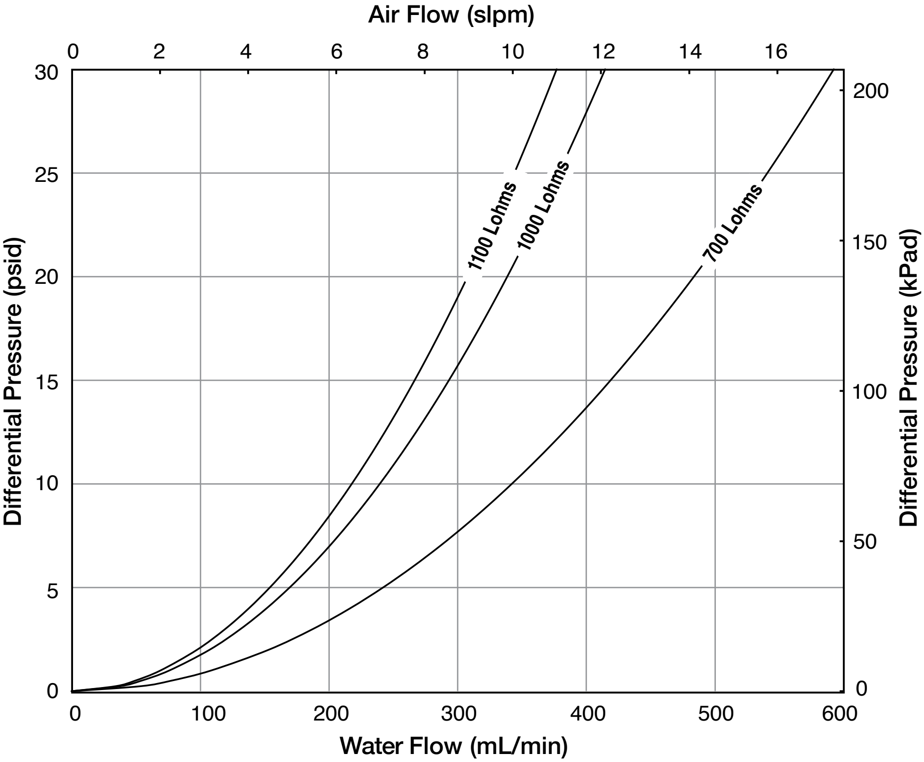
Valve Mounting Details



Reference Drawing Number LSIX1001600A for Mounting Details

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Typical Flow Characteristics
LFR Series Valves



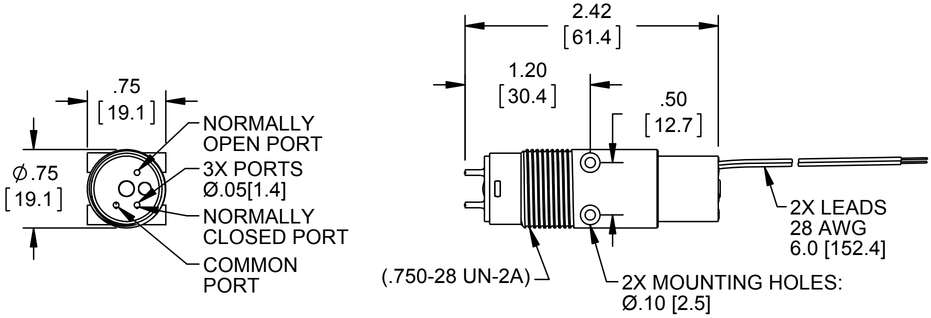
LFY Series

The LFY Series solenoid valves are chemically inert valves with zero dead volume. Available in a 2-way or 3-way model, the valves feature a unique internal pinch block design to isolate the fluid while providing precise microfluidic control. These valves are generally used in medical and scientific applications in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

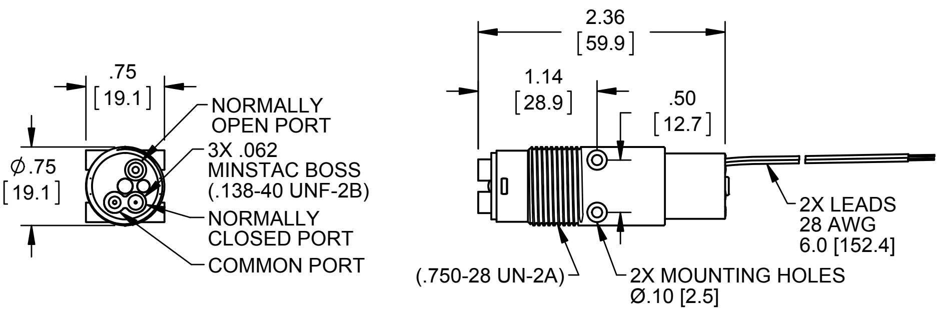
- Zero Dead Volume
- Low Internal Volume
- Operating Pressures up to 30 psig
- Standard Voltages Available: 12 and 24 Vdc
- Different Lohm Rates: 1000 and 3200
- Available Elastomers: FKM and FFKM
- Multiple Styles: 0.054" Port, 062 MINSTAC, 156 MINSTAC, Manifold Mount and Flange Mount.

Each valve is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize valves to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

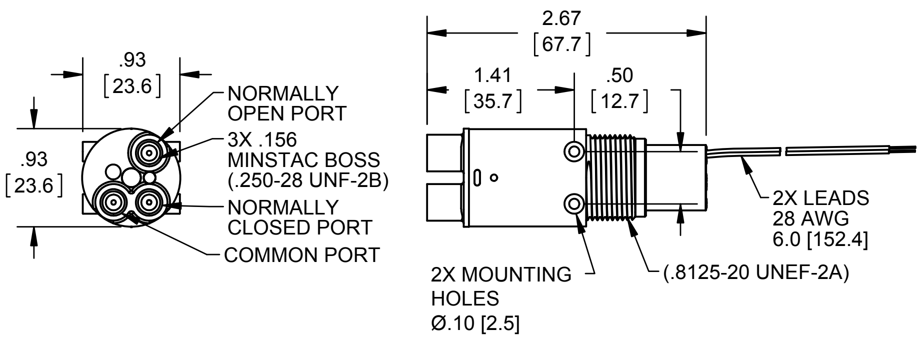
3-Way 0.054" Port Style



3-Way 062 MINSTAC Port Style



3-Way 156 MINSTAC Port Style



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

3-Way 0.054" Port Style

PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME[2] (µL)	WETTED MATERIALS[3]
LFYA1228032H	12	3200 (Ref. Cv = 0.006)	0-15	1.0	22	LCP/FFKM
LFYA2428032H	24		0-15	1.0	22	LCP/FFKM
LFYA1226032H	12		0-30	1.5	22	LCP/FKM
LFYA2426032H	24		0-30	1.5	22	LCP/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Internal volume per channel.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

3-Way 062 MINSTAC Port Style

PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME[2] (µL)	WETTED MATERIALS[3]
LFYA1218032H	12	3200 (Ref. Cv = 0.006)	0-15	1.0	18	PPS/FFKM
LFYA2418032H	24		0-15	1.0	18	PPS/FFKM
LFYA1216032H	12		0-30	1.5	18	PPS/FKM
LFYA2416032H	24		0-30	1.5	18	PPS/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Internal volume per channel.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

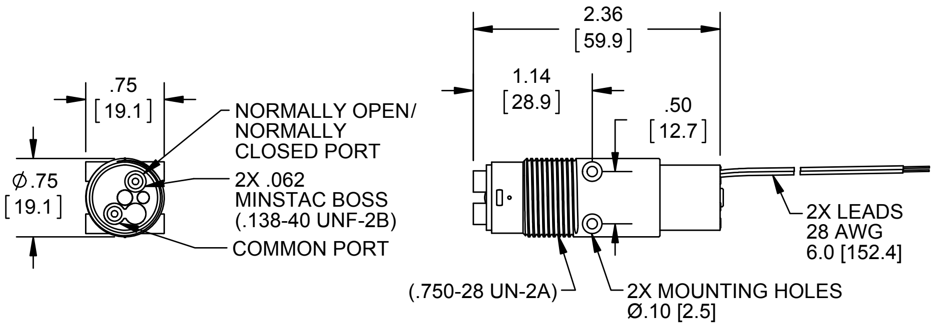
3-Way 156 MINSTAC Port Style

Compatible with many 1/4-28 Systems

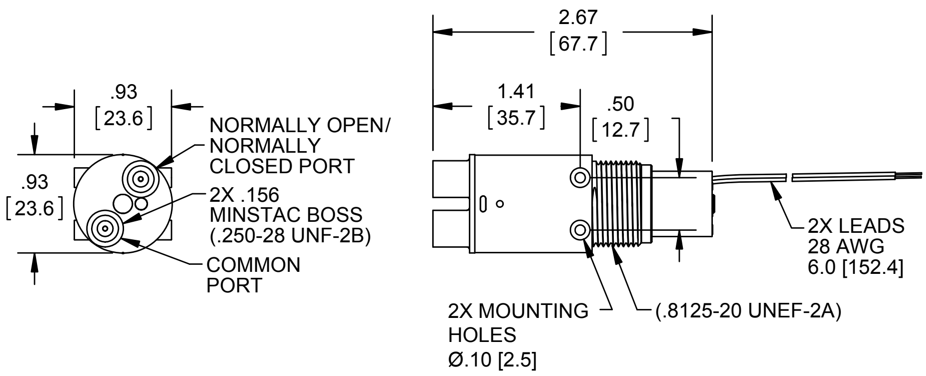
PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME[2] (µL)	WETTED MATERIALS[3]
LFYA1215010H	12	1000 (Ref. Cv = 0.02)	0-15	2.0	72	PEEK/FFKM
LFYA2415010H	24		0-15	2.0	72	PEEK/FFKM
LFYA1219010H	12		0-15	2.0	72	PEEK/FKM
LFYA2419010H	24		0-15	2.0	72	PEEK/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Internal volume per channel.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

2-Way 062 MINSTAC Port Style



2-Way 156 MINSTAC Port Style



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

2-Way 062 MINSTAC Port Style

PART NUMBER	TYPE	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME (µL)	WETTED MATERIALS[2]
LFYA1218232H	N.O.	12	3200 (Ref. Cv = 0.006)	0-15	1.0	14	PPS/FFKM
LFYA2418232H	N.O.	24		0-15	1.0	14	PPS/FFKM
LFYA1218132H	N.C.	12		0-15	1.0	11	PPS/FFKM
LFYA2418132H	N.C.	24		0-15	1.0	11	PPS/FFKM
LFYA1212232H	N.O.	12		0-30	1.5	14	PPS/FKM
LFYA2412232H	N.O.	24		0-30	1.5	14	PPS/FKM
LFYA1212132H	N.C.	12		0-30	1.5	11	PPS/FKM
LFYA2412132H	N.C.	24		0-30	1.5	11	PPS/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

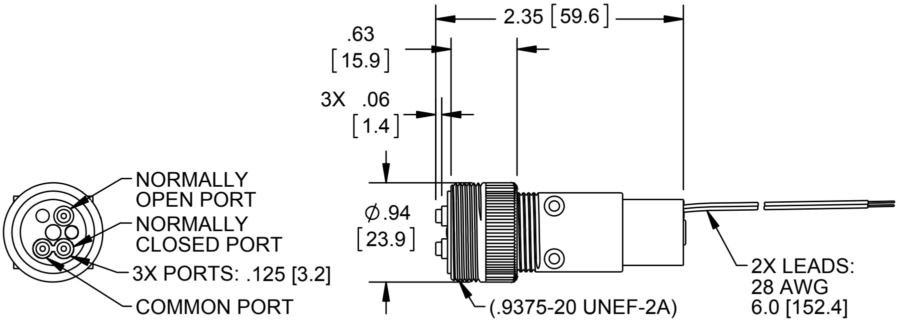
2-Way 156 MINSTAC Port Style

Compatible with many ¼-28 Systems

PART NUMBER	TYPE	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME (µL)	WETTED MATERIALS[2]
LFYA1215210H	N.O.	12	1000 (Ref. Cv = 0.006)	0-15	2.0	54	PEEK/FFKM
LFYA2415210H	N.O.	24		0-15	2.0	54	PEEK/FFKM
LFYA1215110H	N.C.	12		0-15	2.0	54	PEEK/FFKM
LFYA2415110H	N.C.	24		0-15	2.0	54	PEEK/FFKM
LFYA1219210H	N.O.	12		0-15	2.0	54	PEEK/FKM
LFYA2419210H	N.O.	24		0-15	2.0	54	PEEK/FKM
LFYA1219110H	N.C.	12		0-15	2.0	54	PEEK/FKM
LFYA2419110H	N.C.	24		0-15	2.0	54	PEEK/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

3-Way Manifold Mount Style



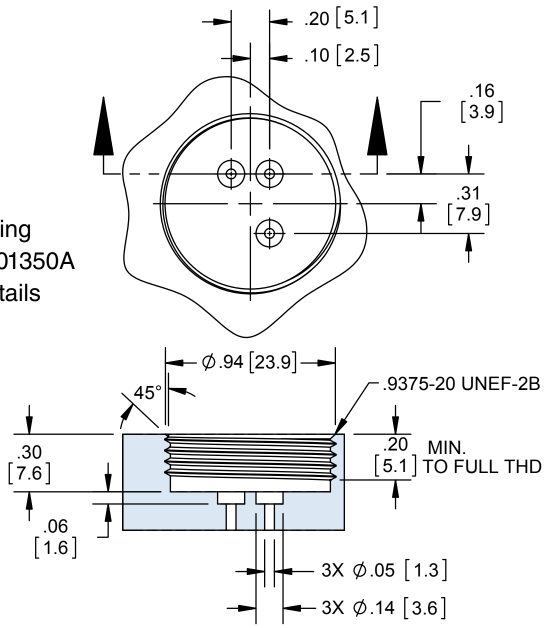
PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME[2] (μL)	WETTED MATERIALS[3]
LFYA1236032H	12	3200 (Ref. Cv = 0.006)	0-30	1.5	22	PPS/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Internal volume per channel.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Use Lee gasket Part Number LHWX0218040A (3x)

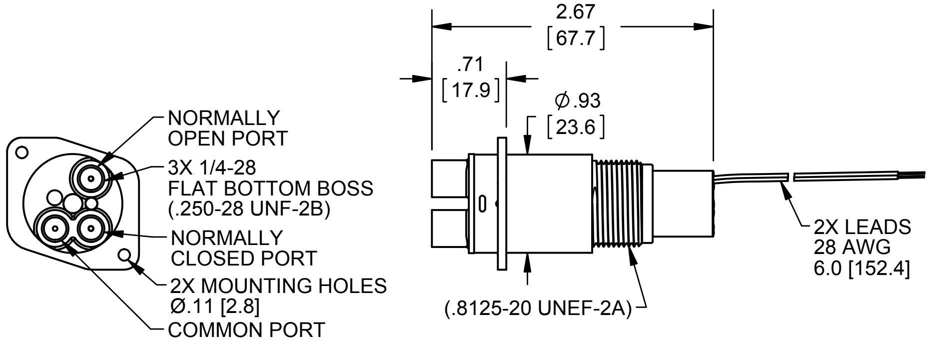
Manifold Mounting Details

Reference Drawing Number LFIX1001350A for Mounting Details



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

3-Way Flange Mount Style

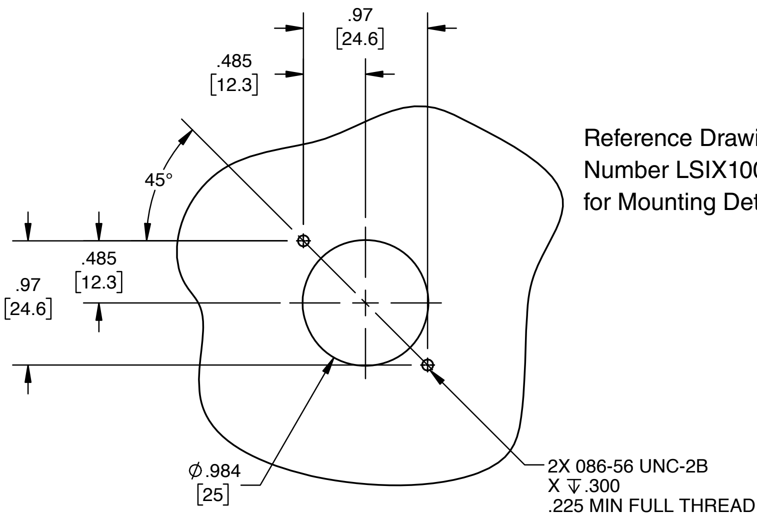


PART NUMBER	VOLTAGE (Vdc)	LOHM RATE[1]	OPERATING PRESSURE (psig)	POWER (W)	INTERNAL VOLUME[2] (μL)	WETTED MATERIALS[3]
LFYX0509700B	24	1000 (Ref. Cv = 0.02)	0-15	2.0	54	PEEK/FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Internal volume per channel.
(3) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Flange Mounting Details

This valve requires a 0.98" (25 mm) diameter clearance hole with mounting holes for #2 or 2 mm screws.



Reference Drawing Number LSIX1001000A for Mounting Details

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 5 million cycles on water, depending on application conditions.

Weight

40 to 43 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

Valve Proof Pressure: 2x Normal Rated Pressure

Valve Burst Pressure: 3x Normal Rated Pressure

Operating Temperature

- Ambient operating temperature range is 60°F to 118°F (16°C to 48°C)
- Maximum coil temperature not to exceed 250°F (121°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 rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Response Time

- The typical response time is 50 ms at 65°F (18°C).
- Response times are dependent upon system conditions, power, environment, etc. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.

Port Connections

- 0.054" Ports: These ports are designed for use with soft, flexible 0.040" (1.0 mm) I.D. tubing.
- 062 MINSTAC Ports: These ports are designed for use with The Lee Company's 062 MINSTAC PTFE tubing system.
- 156 MINSTAC Ports: These ports are designed for use with The Lee Company's 156 MINSTAC PTFE tubing system. This system is also compatible with many ¼-28 flat bottom fitting systems.

Electrical Characteristics

Valves are designed to operate under continuous duty at the rated voltage ± 5%.

Mounting Information

Surface Mount: The valves may be mounted to a flat surface using #2 (M2) screws and there must be sufficient length to allow for valve thickness and proper thread engagement into the mounting surface. The recommended mounting torque is 10 to 15 in-oz. (0.071 to 0.106 N-m).

Panel Mount: The valves may also be mounted using a panel screw.

- The 3200 Lohm valve design will require a 0.79" (20 mm) clearance hole with a maximum 0.44" (11 mm) panel thickness. Use Lee Part Number LHWX0203250A (Panel Nut) to mount the valve.
- The 1000 Lohm valve design will require a 0.83" (21 mm) clearance hole with a maximum 0.44" (11 mm) panel thickness. Use Lee Part Number LHWX0203760A (Panel Nut) to mount the valve.

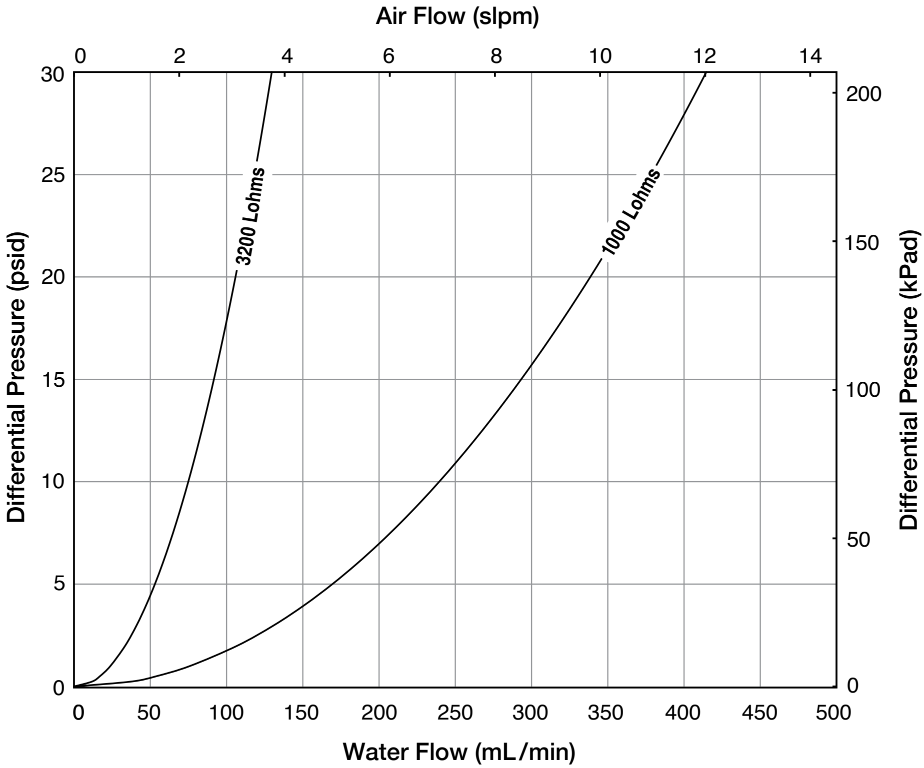
Manifold Mount: See page G7 for specifications.

Flange Mount: The valves may be mounted to a flat surface using #2 (M2) screws. See page G8 for specifications.

Filtration

Filtration of 35 microns or finer is recommended.

Typical Flow Characteristics
LFY Series Valves



Notes

LSP Series Solenoid Valves

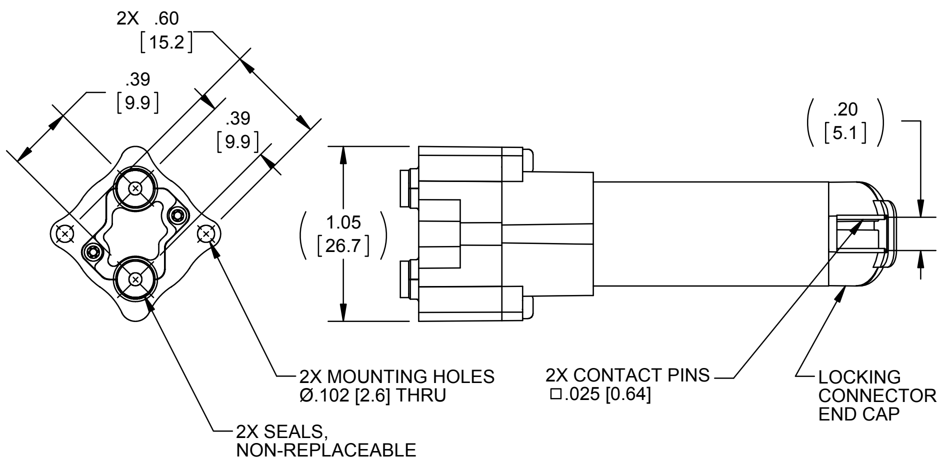
The LSP Series solenoid valves are chemically inert valves with zero dead volume. Available as a 2-way, normally closed model, the valves contain a unique internal full bore tubed design path that yields high bi-directional flow performance while minimizing damage to any sensitive fluids flowing through the valve. This tubed design is integrated into the flow ports, thus eliminating the need for a secondary sealing gasket between the valve and a mounting surface.

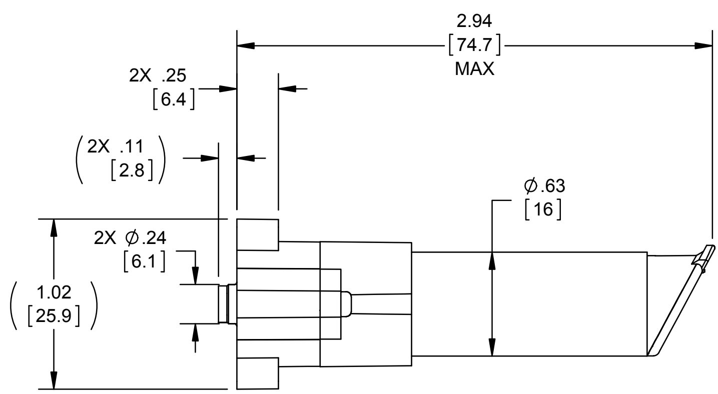
These valves are generally used in medical and scientific applications such as waste and drain lines, in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Zero Dead Volume
- Operating Pressure: 15 psig
- Standard Voltages Available: 12 and 24 Vdc
- Flow Capacity: 330 Lohms
- Elastomer: FKM
- Manifold Mount Style

Each valve is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize valve performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Manifold Mount Style



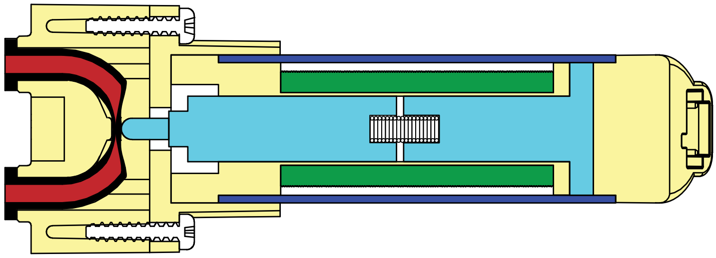


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

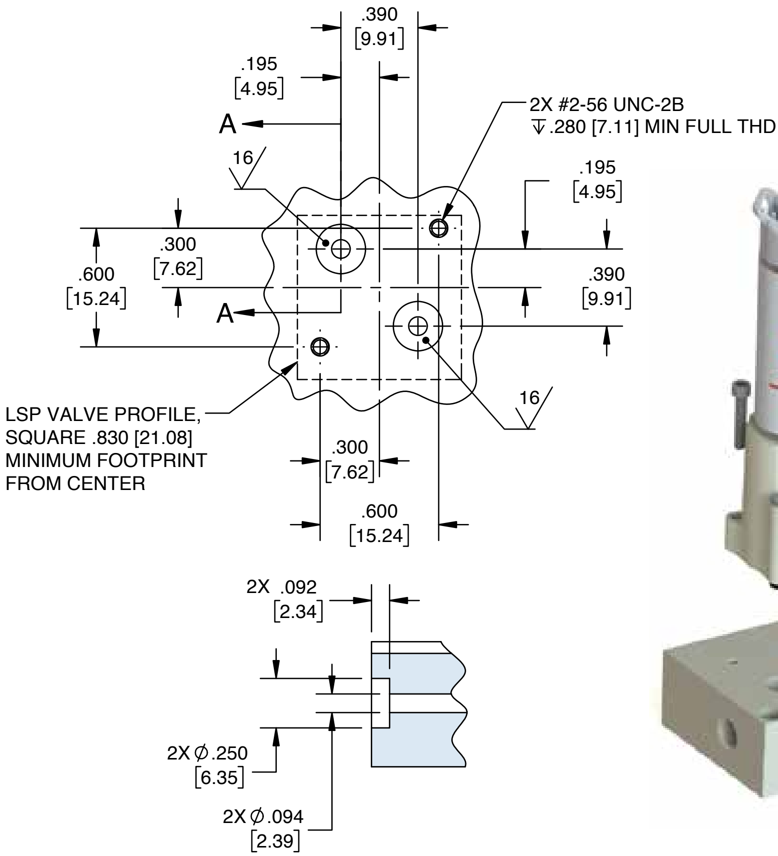
PART NUMBER	LOHM RATE [1]	OPERATING PRESSURE (psig)	POWER CONSUMPTION (w)	INTERNAL VOLUME (µL)	WETTED MATERIALS [2]
LSPA1242130D	330 (Ref. Cv = 0.06)	0-15	3	100	FKM
LSPA2442130D		0-15	3	100	FKM

NOTES: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Manifold Mount Style



Flow Path | Housing | Armature/Plunger Stop
Coil | Shield | Seal (elastomer tube)



Reference Drawing Number LSIX1001450A for Mounting Details

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

GENERAL SPECIFICATIONS

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

Cycle Life

The valves will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Weight

57 grams

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

Operating Temperature

- Ambient operating temperature range is 40°F to 150°F (4°C to 65°C)
- Maximum coil temperature not to exceed 180°F (82°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 rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Response Time

- The typical response time is 30 ms maximum at 70°F (21°C), on air at 5 psig.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.
- Response times can be enhanced with the use of spike and hold drive circuits. Refer to Engineering Reference Section, pages R35-36.

Electrical Characteristics

- Valves are designed to operate under continuous duty at the rated voltage ±5%.

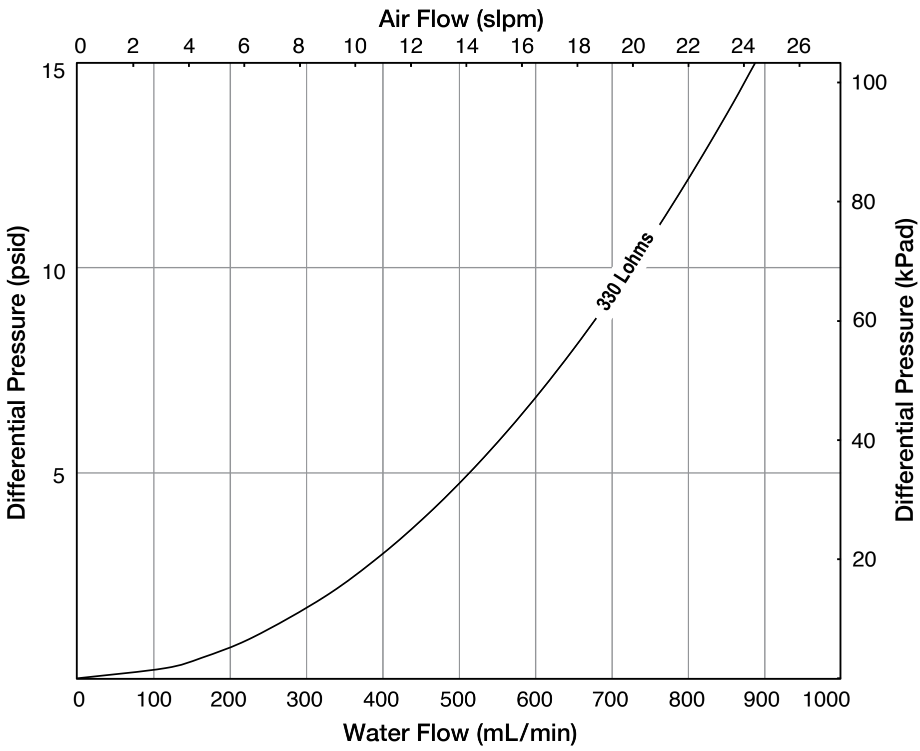
Mounting Information

Flange Mount: The valves should be mounted to a surface using #2 (M2) mounting screws. The torque specification is 10 to 15 in-oz (0.071 to 0.106 N-m). See page H4 for mounting details.

Filtration

Filtration of 100 microns or finer is recommended.

Typical Flow Characteristics
LSP Series Valves



Fixed Volume Dispense Pumps

The Lee Company's Fixed Volume Dispense Pumps are solenoid driven, chemically inert, positive displacement pumps, which provide accurate and repeatable dispense volumes in a small lightweight package. Requiring a simple square wave electrical signal for operation, the pumps aspirate fluid when energized and dispense fluid when de-energized. The normally closed design with integrated check valves prevents siphoning when the pumps are de-energized. Lee fixed volume dispense pumps are available in three different sizes to cover a wide range of dispense volumes:

- LPM Series: 10 to 25 μL
- LPL Series: 25 to 50 μL
- LPG Series: 100 to 175 μL

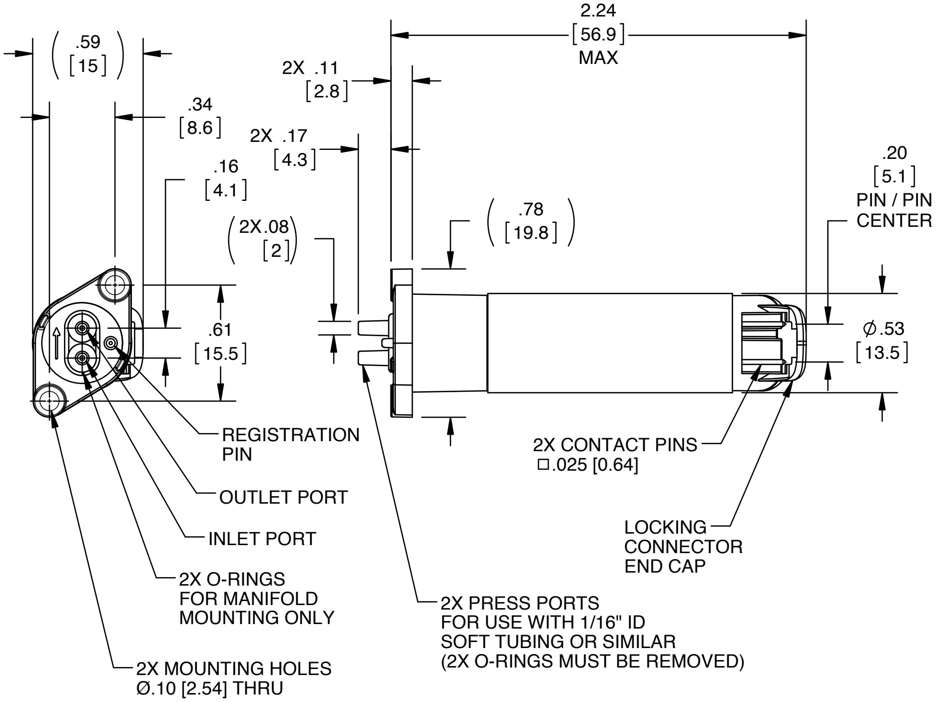
These pumps are generally used in medical and scientific applications, in markets such as in vitro diagnostics, human genomics and biotechnology. The following general performance characteristics are offered in this product platform:

- Chemically Inert
- Self-Priming
- High Dispense Accuracy and Repeatability
- Low Power Consumption

Each pump is 100% functionally tested for performance and designed using materials that ensure consistent long-term performance. The Lee Company can customize the performance of a pump to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Combination Manifold/Soft Tube Ported Style

The LPM Series pumps allow the use of either soft press-on tubing or manifold mounting. This provides design flexibility and ease of transitioning from breadboards to final manifolds. The special end cap design simplifies electrical connections and eliminates the need for soldering.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

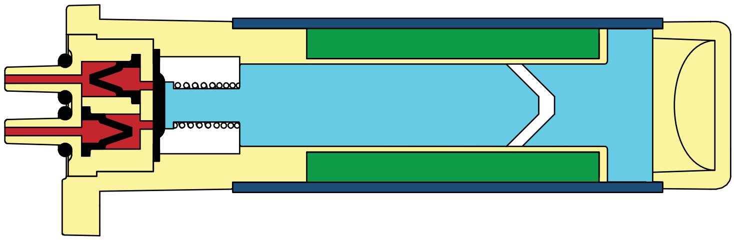
PART NUMBER[1]	VOLUME (µL)	ACCURACY (%)	POWER (W)	WETTED MATERIALS[2]
LPMA _ _50110L	10	±15	1.5	PEEK/FKM
LPMA _ _50625L	25	±6	2.0	PEEK/FKM
LPMA _ _51110L	10	±15	1.5	PEEK/EPDM
LPMA _ _51625L	25	±6	2.0	PEEK/EPDM

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

LPMA _ _50110L

Coil Voltage: 12 = 12 Vdc
24 = 24 Vdc

(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.



Flow Path

Elastomer (check valve/seal/o-rings

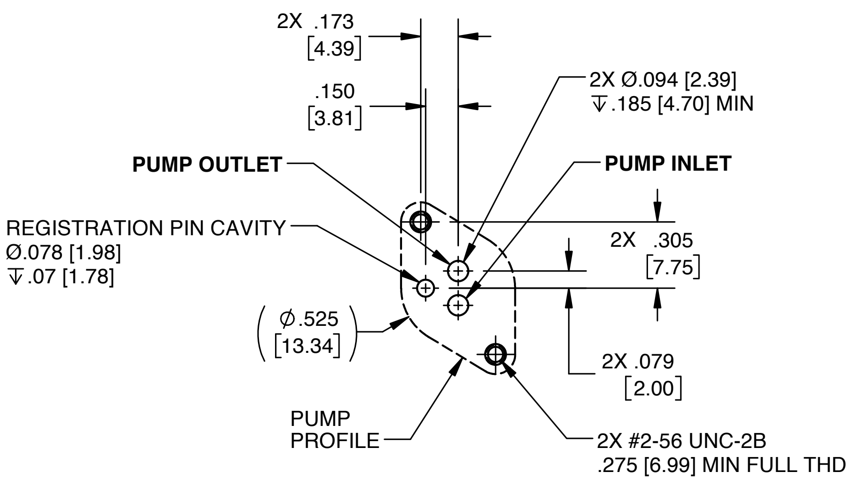
Housing

Coil

Shield

Armature/Plunger Stop

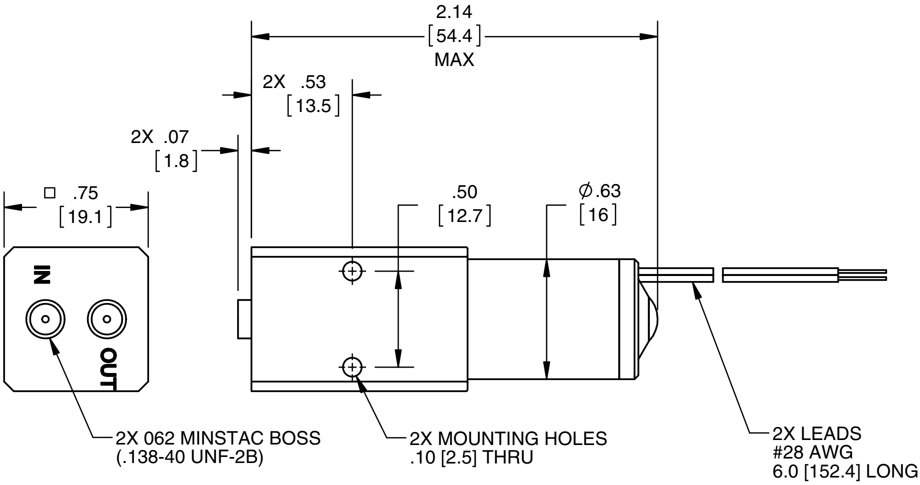
Pump Mounting Details



Reference Drawing Number LSIX1001470A for Mounting Details.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

062 MINSTAC Port Style



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER [1]	VOLUME (µL)	ACCURACY (%)	POWER (W)	WETTED MATERIALS [2]
LPLA _ _10350L	50	±3	2	PEEK/FKM
LPLA _ _11350L	50	±3	2	PEEK/EPDM
LPLA _ _10550L	50	±5	2	PEEK/FKM
LPLA _ _11550L	50	±5	2	PEEK/EPDM
LPLA _ _10050L	50	±10	2	PEEK/FKM
LPLA _ _11050L	50	±10	2	PEEK/EPDM

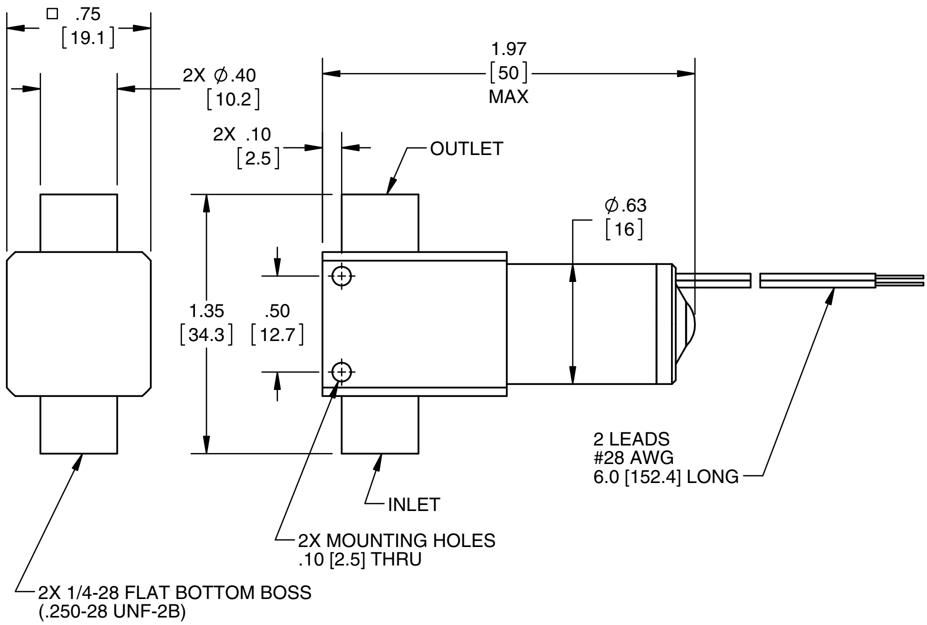
NOTES: (1) Pumps are available in 12 and 24 Vdc configurations.

LPLA _ _10350L

Coil Voltage: 12 = 12 Vdc
24 = 24 Vdc

(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

1/4-28 Flat Bottom Port Style



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER [1]	VOLUME (µL)	ACCURACY (%)	POWER (W)	WETTED MATERIALS [2]
LPLA _ _30350L	50	±3	2	PEEK/FKM
LPLA _ _31350L	50	±3	2	PEEK/EPDM
LPLA _ _30550L	50	±5	2	PEEK/FKM
LPLA _ _31550L	50	±5	2	PEEK/EPDM
LPLA _ _30050L	50	±10	2	PEEK/FKM
LPLA _ _31050L	50	±10	2	PEEK/EPDM

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

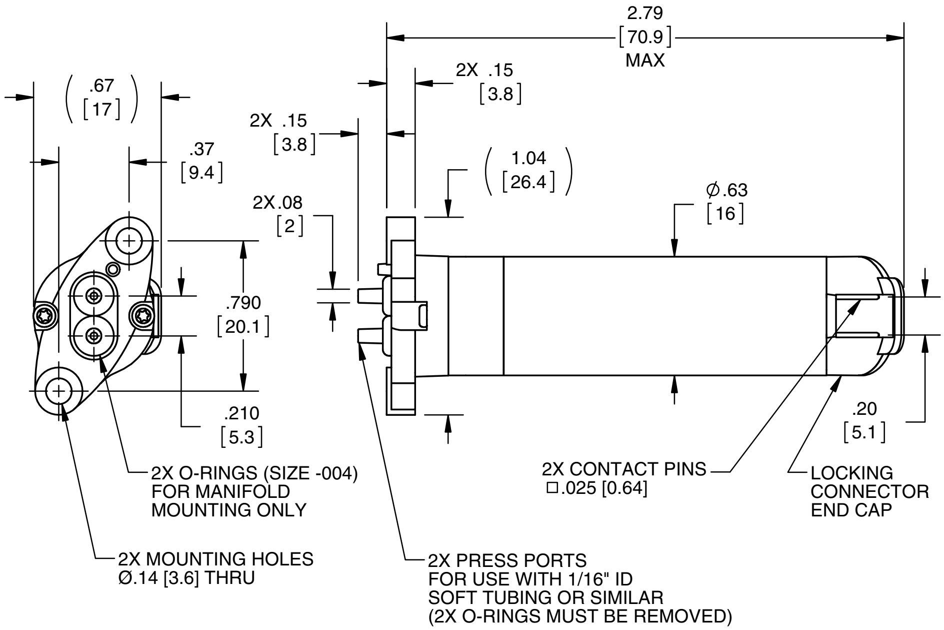
LPLA _ _30350L

Coil Voltage: 12 = 12 Vdc
24 = 24 Vdc

(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Combination Manifold/Soft Tube Port Style

The LPL2 Series pumps allow the use of either soft press-on tubing or manifold mounting. This provides design flexibility and ease of transitioning from breadboards to final manifolds. The special end cap design simplifies electrical connections and eliminates the need for soldering.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

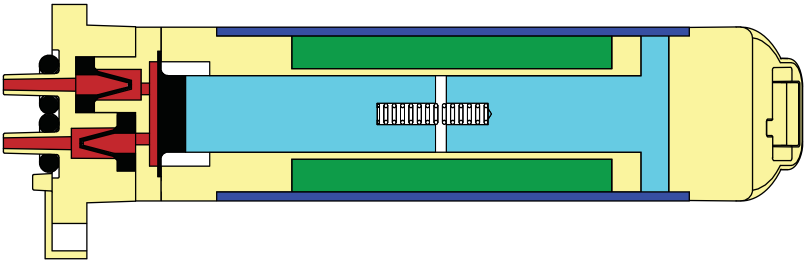
PART NUMBER [1]	VOLUME (µL)	ACCURACY (%)	POWER (W)	WETTED MATERIALS [2]
LPLA _ _50650L	50	±6	2.5	PEEK/FKM
LPLA _ _50625L	25	±12	2.5	PEEK/FKM
LPLA _ _51650L	50	±6	2.5	PEEK/EPDM
LPLA_ _51625L	25	±12	2.5	PEEK/EPDM

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

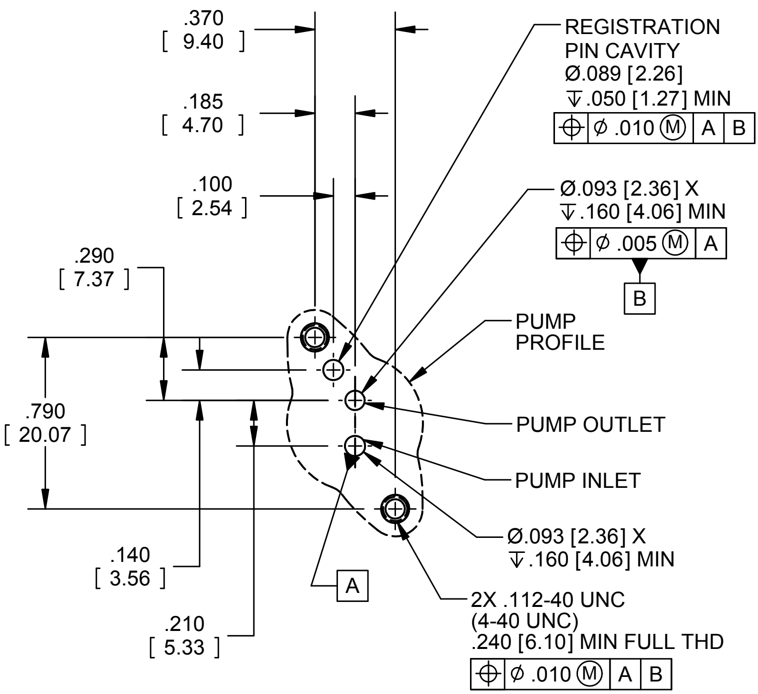
LPLA _ _50650L

Coil Voltage: 12 = 12 Vdc
24 = 24 Vdc

(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.



Pump Mounting Details

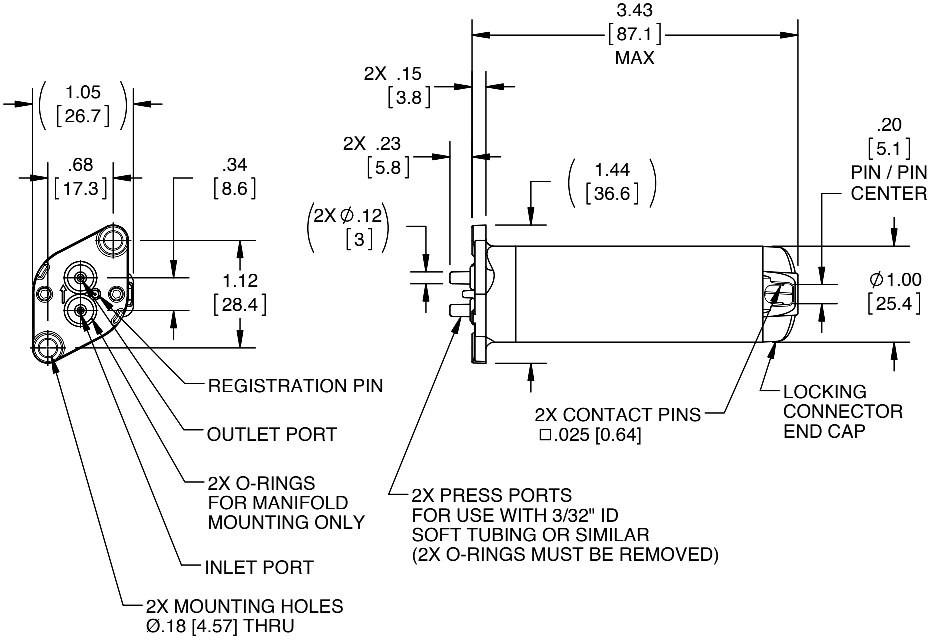


Reference Drawing Number LSIX1001440A for Mounting Details.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Combination Manifold/Soft Tube Ported Style

The LPG Series pumps allow the use of either soft press-on tubing or manifold mounting. This provides design flexibility and ease of transitioning from breadboards to final manifolds. The special end cap design simplifies electrical connections and eliminates the need for soldering.



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

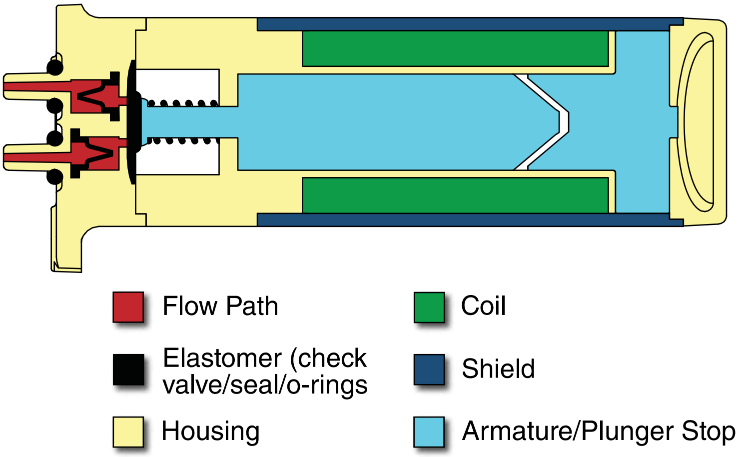
PART NUMBER [1]	VOLUME (µL)	ACCURACY (%)	POWER (W)	WETTED MATERIALS [2]
LPGA _ _50010D	100	± 10	7	PEEK/FKM
LPGA _ _51010D	100	± 10	7	PEEK/EPDM
LPGA _ _50618D	175	± 6	7	PEEK/FKM
LPGA_ _51618D	175	± 6	7	PEEK/EPDM

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

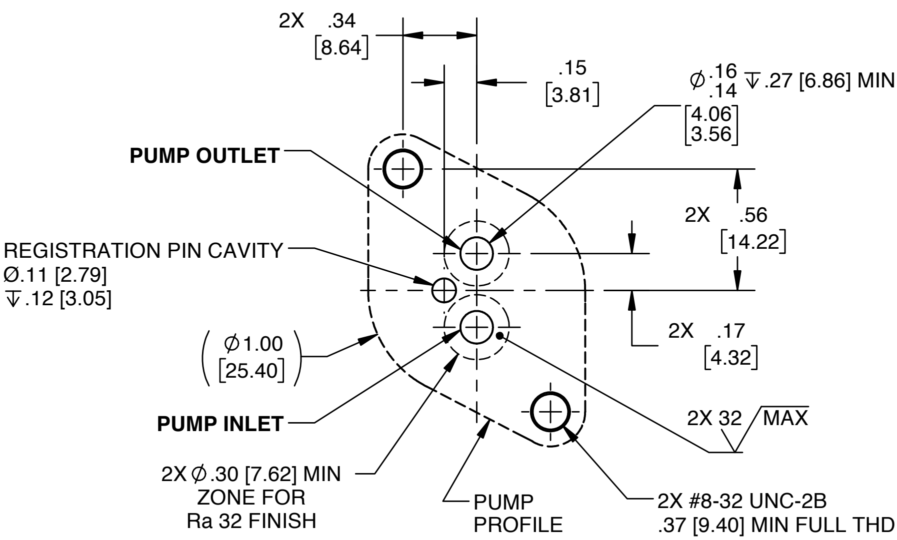
LPGA _ _50010D

Coil Voltage: 12 = 12 Vdc
24 = 24 Vdc

(2) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.



Pump Mounting Details



Reference Drawing Number LSIX1001490A for Mounting Details.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Standard Manifolds

Manifolds are available to adapt LPM, LPL2 and LPG pumps to threaded tubing.

SERIES	PORT CONNECTIONS	PART NUMBER [1]	
		PMMA	PEEK
LPM	062 MINSTAC	LSMX0517520B	LSMX0517510B
	1/4-28	LSMX0517420B	LSMX0517410B
LPL2	1/4-28	LSMX0517220B	LSMX0517210B
LPG	1/4-28	LSMX0519120B	LSMX0519110B

NOTE: (1) Part numbers are for the manifold and mounting screws only.
Pumps are sold separately.

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

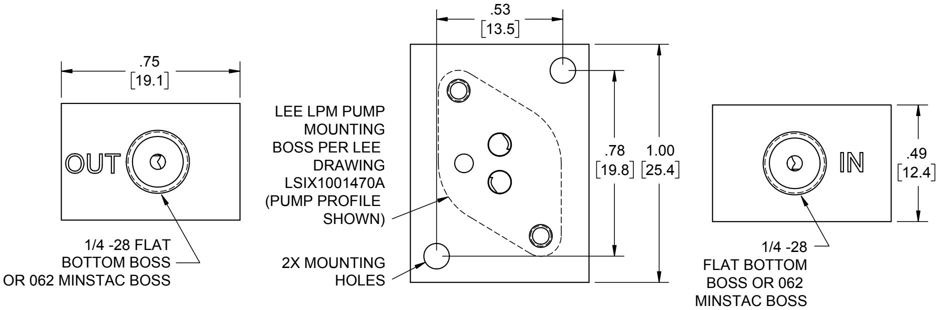
Replacement O-Rings

Fixed volume dispense pumps are shipped with two o-rings.

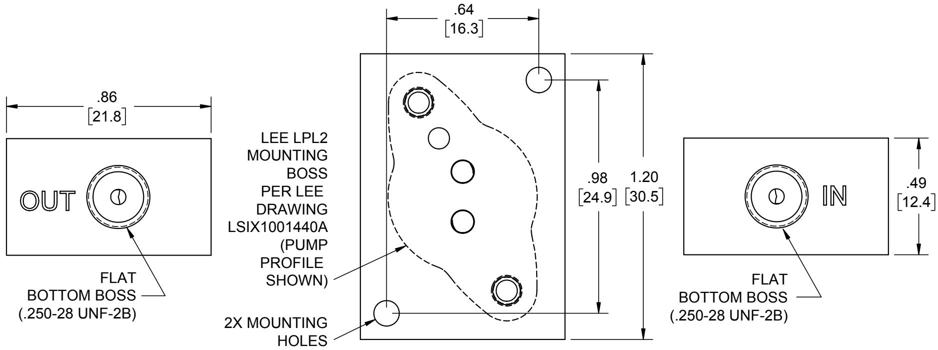
SERIES	PART NUMBER	
	EPDM	FKM
LPM	LSWX0508610A	LSWX0508600A
LPL2	LSWX0508440A	LSWX0508430A
LPG	LSWX0508690A	LSWX0508680A

Standard Manifolds

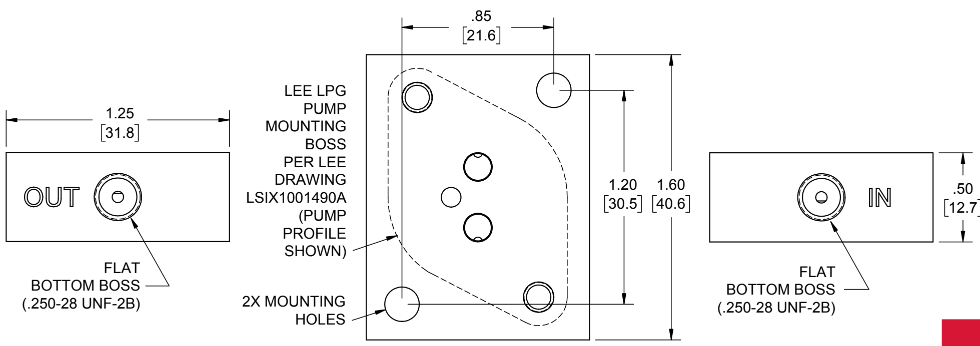
LPM Series



LPL2 Series



LPG Series



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

GENERAL SPECIFICATIONS

The following specifications apply to all Fixed Volume Dispense Pumps, unless otherwise noted.

Cycle Life

The pumps will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Operating Pressure

The pumps will operate within the specified pressure range when supplied with the rated voltage ± 5%.

- Maximum case pressure: 5 psig
- Inlet and outlet port pressure range:
  - LPL Series: ± 30 in. H_20
  - LPM and LPG Series: ± 60 in. H_20
- Variations in pressure due to head or restriction can affect dispense volume accuracy.

Operating Temperature

- Ambient operating temperature range is dependent on the elastomer; reference table below for details.
- Maximum coil temperature not to exceed 200°F (90°C).
- Increasing the operating temperature tends to limit coil performance. The pump duty cycle and energized time must be evaluated for conformance with the maximum rated operating and coil temperatures.

ELASTOMER	AMBIENT OPERATING TEMPERATURE RANGE
EPDM	30°F to 120°F (-1°C to 49°C)
FKM	45°F to 120°F (7C to 49°C)

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing
- Pumps should be stored completely wet or completely dried with nitrogen before prolonged periods of inactivity to avoid elastomeric stiction.

Response Time

- Maximum operating frequency:
  - LPL and LPL2 Series: 2 Hz
  - LPM and LPG Series: 5 Hz
- Operating the pumps at higher frequencies will affect dispense accuracy and life expectancy.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of inactivity may also have an impact on the initial response time of the pump.

Electrical Connections

There are two different connection designs available:

- *Lead-Wires*: Pumps are supplied with a 6", #28 AWG lead-wire with the ends of the wires stripped and tinned. An electrical connector can be added as part of a custom design.
- *Pins with Locking End Caps*: Pumps are supplied with two 0.025" square electrical pins spaced 0.20" center to center. This design is compatible with most standard electrical connectors designed for 0.10" spacing. The locking end provides an added secondary retention clip that is compatible with AMP Part Number 104257-2 style connectors. The Lee Company also offers compatible lead-wire assemblies in two different lengths:
  - Lee Company Part Number LSWX0504300A – Length, 6 inches
  - Lee Company Part Number LSWX0606700A – Length, 24 inches

Electrical Characteristics

- Standard operating voltages available: 12 and 24 Vdc (±5%)
- Refer to individual tables on pages I3-10 for power consumption.
- Pumps are not rated for continuous duty; 50% maximum duty cycle.

Port Connections

- Soft Tube Port: Designed for use with soft, flexible tubing; 1/16" (1.6 mm) I.D. or 3/32" (2.4 mm) I.D. depending on the design. It's important to note that the o-rings must be removed from the ports prior to installing any tubing. Replacement o-rings are available if needed: LSWX0508600A (FKM) or LSWX0058610A (EPDM).
- ¼ - 28 Port: Designed for use with standard ¼-28 flat bottom fittings.
- 062 MINSTAC Ports: Designed for use with The Lee Company's 062 MINSTAC PTFE tubing system. Refer to MINSTAC (Section L) for further details.
- Manifold Mount: See pump mounting details for additional information.

Mounting Information

- Flange Mount: The pumps should be mounted to a surface using the following screws:
  - LPM: 2x #2 screws
  - LPL2: 2x #4 screws
  - LPG: 2x #8 screws
- 062 MINSTAC: The pumps should be mounted to a surface using #2 (M2) mounting screws.
- ¼-28 Port: The pumps should be mounted to a surface using #2 (M2) mounting screws.

Filtration

Filtration of 35 microns or finer is recommended.

Variable Volume Dispense Pumps

The Lee Company's Variable Volume Dispense Pumps are stepper motor driven, positive displacement pumps that feature unparalleled reliability and performance. Their size, weight and maintenance free design allows for the pumps to be positioned where the fluidic requirements dictate, regardless of accessibility.

LPD Series – This series of pumps meets the demands of modern day applications providing consistent long-term performance and reliability.

LPV Series – This series of pumps offers specialized configurations, including manifold mounted and flushable dual seal designs. LPV Series Pumps are available in standard NEMA 17 and "stacked can" motors where size and weight are critical design requirements.

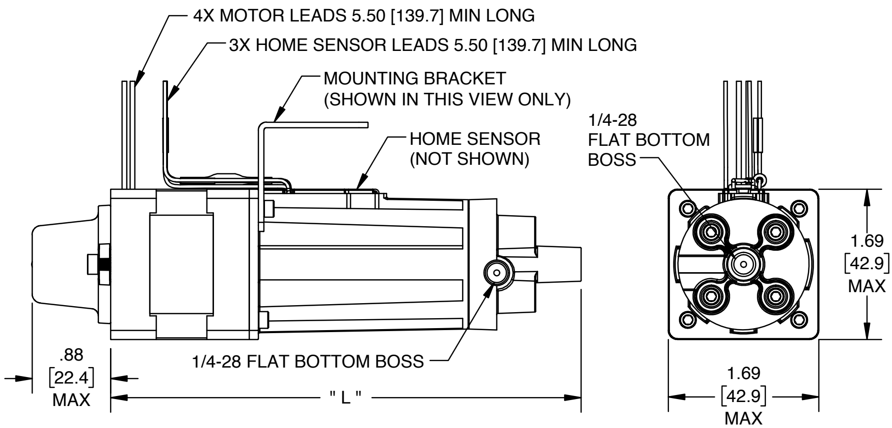
All Lee Variable Volume Dispense Pumps are offered in standard and high performance models. The standard model is equipped with a home sensor, whereas most high performance models include a home sensor and encoder for more demanding applications. These pumps are generally used in medical and scientific applications in markets such as in vitro diagnostics, human genomics, biotechnology and analytical chemistry. The following general performance characteristics are offered in this product platform:

- Maintenance Free Design
- Long Life Expectancy
- Self-Priming
- Wide Range of Dispense Volumes
- High Dispense Accuracy and Precision

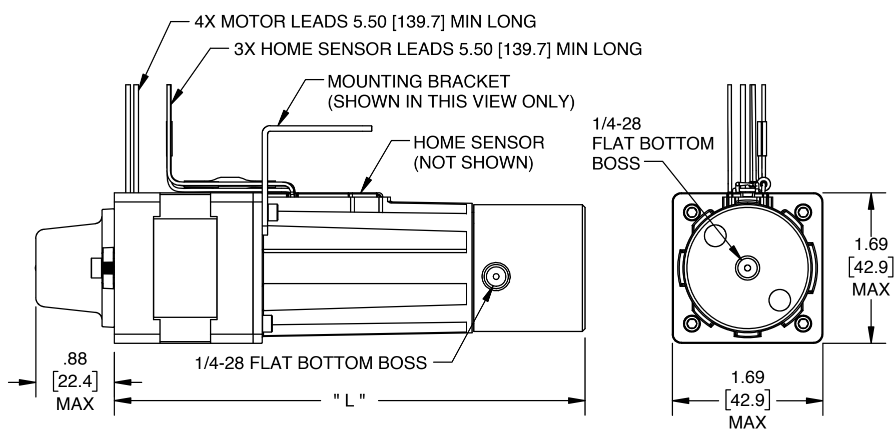
Each pump is 100% functionally tested for performance and designed using materials that will ensure consistent long-term performance. The Lee Company can customize the performance of a pump to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Standard Performance Model

CONFIGURATION A



CONFIGURATION B

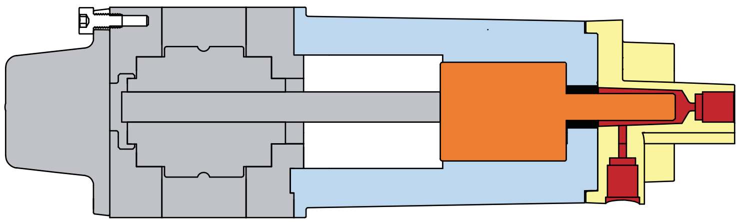


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	VOLUME (µL)	PORT HEAD MATERIAL[1]	FULL STEP DISPENSE RESOLUTION (µL)	MAXIMUM DISCHARGE PRESSURE (psig)
LPDA2720150L	50	PMMA	0.04	60
LPDA2750150L	50	PEEK	0.04	60
LPDA2720125D	250	PMMA	0.2	60
LPDA2750125D	250	PEEK	0.2	60
LPDA2720110H	1000	PMMA	0.5	60
LPDA2750110H	1000	PEEK	0.5	60
LPDA2720130H	3000	PMMA	1.0	95
LPDA2750130H	3000	PEEK	1.0	95

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Standard Performance Model



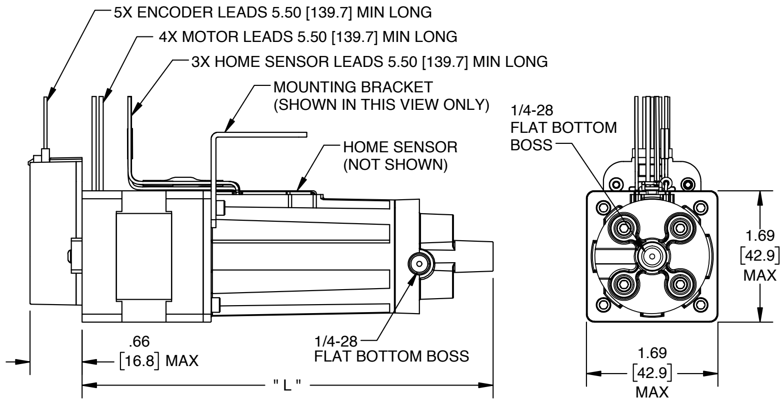
Flow Path   Pump Housing   Piston
Motor   Seal   Port Head

- Wetted materials: TZP, port head (see table below), UHMW-PE, and 316 SS (3000 µL dispense volume only).
- Dispense accuracy: ± 0.6% (100% total volume)
- Home sensor (full discharge)
- Motor: NEMA 17 bipolar stepper motor
- Drive current: 400-420 mA (RMS) per phase (50 µL, 250 µL and 1000 µL volumes)
  650-750 mA (RMS) per phase (3000 µL volume)
- External valving required

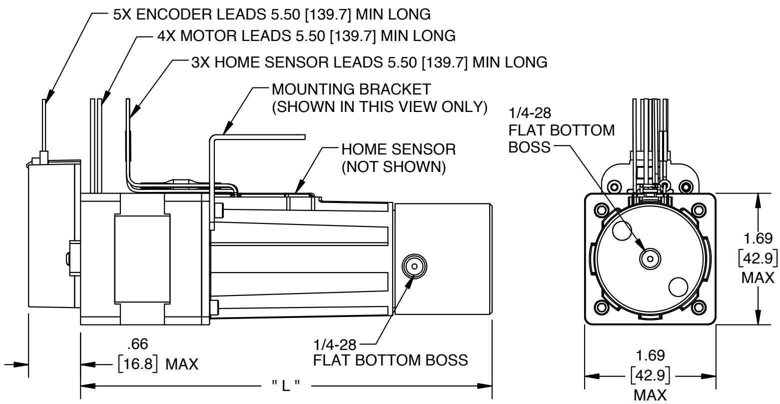
	PRECISION		MAX. SPEED HALF STEPS (pps)	MAXIMUM LENGTH "L"	CONFIGURATION
	CV% (10% TOTAL VOLUME)	CV% (100% TOTAL VOLUME)			
	≤ 0.4%	≤ 0.04%	4000	5.24" (133.1 mm)	A
	≤ 0.4%	≤ 0.04%	4000		B
	≤ 0.4%	≤ 0.04%	4000		A
	≤ 0.4%	≤ 0.04%	4000		B
	≤ 0.4%	≤ 0.04%	4000	5.65" (143.5 mm)	B
	≤ 0.4%	≤ 0.04%	4000		B
	≤ 0.4%	≤ 0.04%	4000	6.21" (157.7 mm)	B
	≤ 0.4%	≤ 0.04%	4000		B

High Performance Model

CONFIGURATION A



CONFIGURATION B

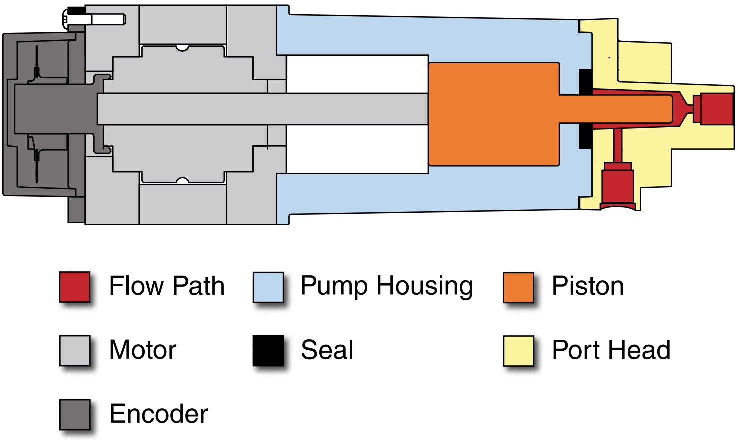


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	VOLUME (µL)	PORT HEAD MATERIAL[1]	FULL STEP DISPENSE RESOLUTION (µL)	MAXIMUM DISCHARGE PRESSURE (psig)
LPDA1720350L	50	PMMA	0.04	60
LPDA1750350L	50	PEEK	0.04	60
LPDA1720325D	250	PMMA	0.2	60
LPDA1750325D	250	PEEK	0.2	60
LPDA1720310H	1000	PMMA	0.5	60
LPDA1750310H	1000	PEEK	0.5	60
LPDA1720330H	3000	PMMA	1.0	95
LPDA1750330H	3000	PEEK	1.0	95

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

High Performance Model

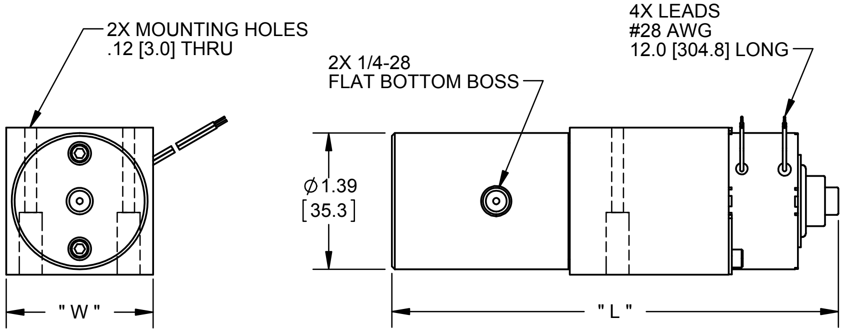


- Wetted materials: TZP, port head (see table below), UHMW-PE, and 316 SS (3000 µL dispense volume only).
- Dispense accuracy: ± 0.5% (100% total volume)
- External valving required
- Home sensor (full discharge)
- Encoder: 2 channel, quadrature
- Motor: NEMA 17 bipolar stepper motor
- Drive current: 400-420 mA (RMS) per phase (50 µL, 250 µL and 1000 µL volumes)
  650-750 mA (RMS) per phase (3000 µL volume)
- Integrated backlash compensation (except on 3000 µL dispense volume)

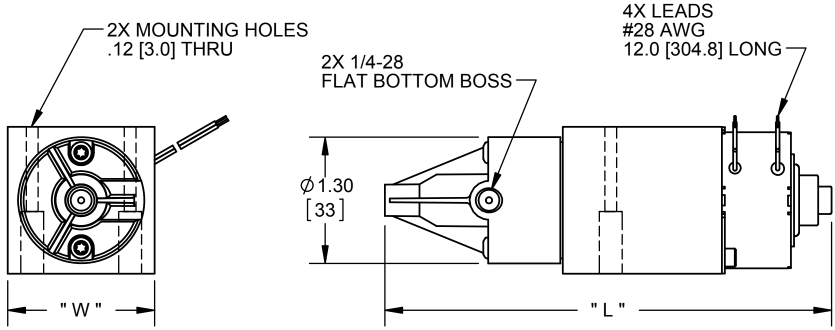
	PRECISION		MAX. SPEED HALF STEPS (pps)	MAXIMUM LENGTH "L"	CONFIGURATION
	CV% (10% TOTAL VOLUME)	CV% (100% TOTAL VOLUME)			
	≤ 0.4%	≤ 0.04%	4000	5.24" (133.1 mm)	A
	≤ 0.4%	≤ 0.04%	4000		B
	≤ 0.1%	≤ 0.01%	4000		A
	≤ 0.1%	≤ 0.01%	4000		B
	≤ 0.1%	≤ 0.01%	4000	6.17" (156.7 mm)	B
	≤ 0.1%	≤ 0.01%	4000		B
	≤ 0.4%	≤ 0.04%	4000	6.21 (157.7 mm)	B
	≤ 0.4%	≤ 0.04%	4000		B

Standard Performance Model

CONFIGURATION A



CONFIGURATION B

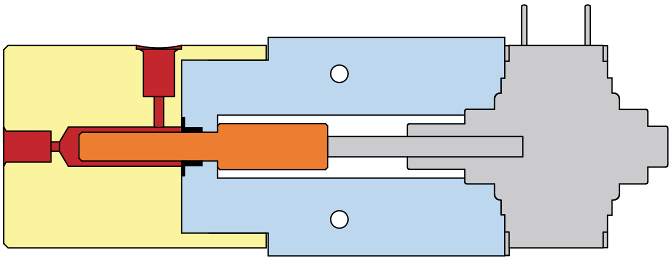


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	VOLUME (µL)	PISTON MATERIAL[1]	PORT HEAD MATERIAL[1]	FULL STEP DISPENSE RESOLUTION (µL)	MAXIMUM DISCHARGE PRESSURE (psig)
LPVA1020050L	50	TZP	PMMA	0.1	30
LPVA1050050L	50	TZP	PEEK	0.1	30
LPVA1051050L	50	Sapphire	PEEK	0.1	30
LPVA1520025D	250	TZP	PMMA	0.5	30
LPVA1550025D	250	TZP	PEEK	0.5	30
LPVA1551025D	250	Sapphire	PEEK	0.5	30
LPVA1520075D	750	TZP	PMMA	1.5	15
LPVA1550075D	750	TZP	PEEK	1.5	15
LPVA1551075D	750	Sapphire	PEEK	1.5	15

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

Standard Performance Model

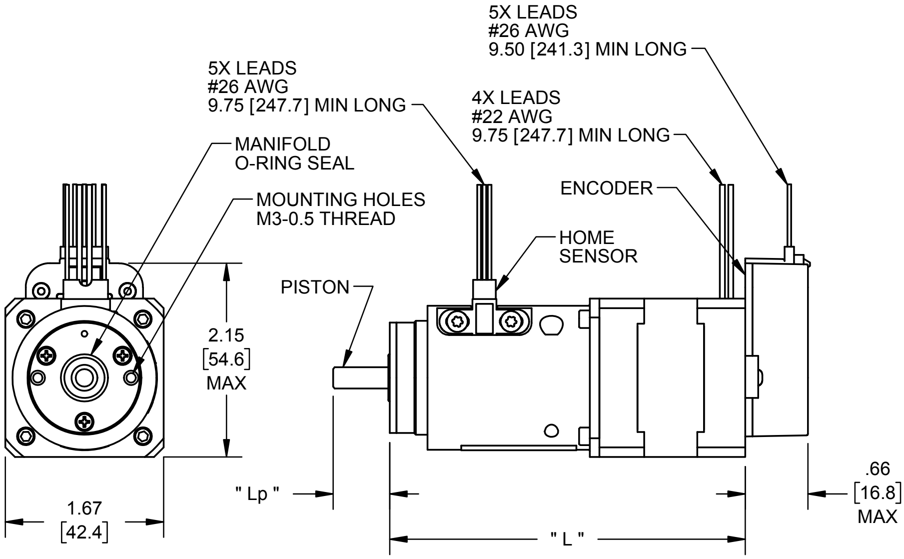


Flow Path
Pump Housing
Piston
Motor
Seal
Port Head

- Wetted materials: piston and port head (see table below), UHMW-PE
- Dispense accuracy: ± 0.5% (100% total volume)
- External valving required
- Motor: stacked can bipolar stepper motor
- Drive current: 260-290 mA (RMS) per phase (250 µL and 750 µL volumes)
  210-240 mA (RMS) per phase (50 µL volume)
- Cycle life: these pumps will typically operate across a minimum of 5 million cycles on water, depending on application conditions. See page J17 for additional details.

	PRECISION		MAX. SPEED HALF STEPS (pps)	MAX. LENGTH "L"	MAX. WIDTH "W"	CONFIGURATION
	CV% (10% TOTAL VOLUME)	CV% (100% TOTAL VOLUME)				
	≤ 0.4%	≤ 0.04%	1000	3.90" (99.1 mm)	1.25" (31.7 mm)	A
	≤ 0.4%	≤ 0.04%	1000			A
	≤ 0.4%	≤ 0.04%	1000			A
	≤ 0.4%	≤ 0.04%	1000	4.58" (116.3 mm)	1.50" (38.1 mm)	A
	≤ 0.4%	≤ 0.04%	1000			A
	≤ 0.4%	≤ 0.04%	1000			A
	≤ 0.4%	≤ 0.04%	1000	4.61" (117.1 mm)		A
	≤ 0.4%	≤ 0.04%	1000			B
	≤ 0.4%	≤ 0.04%	1000			B

High Performance – Manifold Mount Model



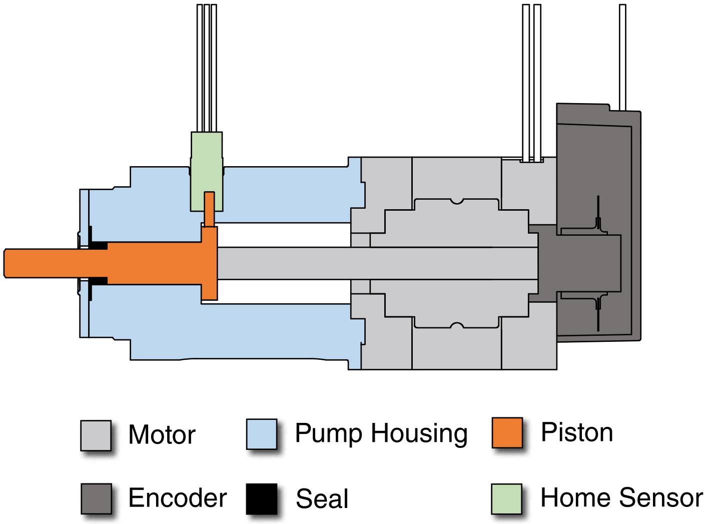
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Refer to table below for manifold boss drawing numbers.

PART NUMBER	VOLUME (µL)	FULL STEP DISPENSE RESOLUTION (µL)	MAXIMUM DISCHARGE PRESSURE (psig)	PRECISION		
				CV% (10% TOTAL VOLUME)	CV% (100% TOTAL VOLUME)	
LPVA1700350L	50	0.04	60	≤ 0.5%	≤ 0.05%	
LPVA1700325D	250	0.20	60	≤ 0.3%	≤ 0.03%	
LPVA1700375D	750	0.47	30	≤ 0.3%	≤ 0.03%	
LPVA1700310H	1000	0.40	30	≤ 0.3%	≤ 0.03%	
LPVA1700330H	3000	1.00	95	≤ 0.3%	≤ 0.03%	

NOTE: (1) See pages J11-12 for additional details.

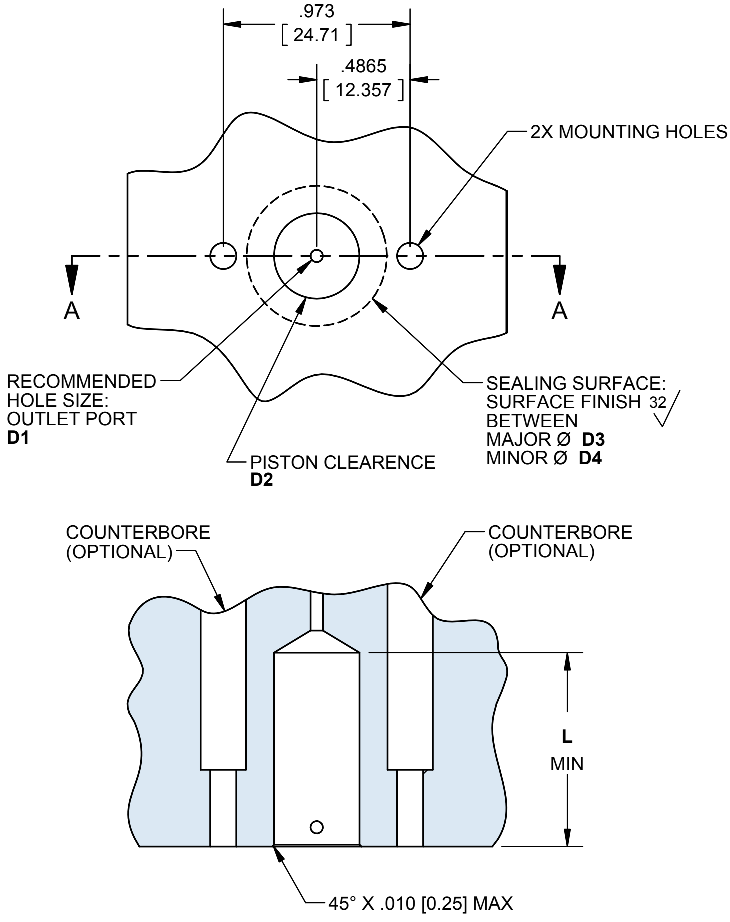
High Performance – Manifold Mount Model



- Wetted materials: TZP, UHMW-PE, 316 SS and EPDM. Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.
- External valving required
- Encoder and home sensor included
- Motor: NEMA 17 bipolar stepper motor
- Drive current: 400-420 mA (RMS) per phase (50 μL and 250 μL volumes)
  650-750 mA (RMS) per phase (750 μL, 1000 μL and 3000 μL volumes)

	MAX. SPEED HALF STEPS (pps)	MOUNTING BOSS DRAWING[1]	MAXIMUM LENGTH "L"	PISTON LENGTH "Lp"	DISPENSE ACCURACY (100% TOTAL VOLUME)
	5000	LSIX1001420A	3.78" (96.0 mm)	0.6" (15.2 mm)	≤ 0.75%
	4000	LSIX1001140A			≤ 1.5%
	4000	LSIX1001120A	3.89" (98.8 mm)	0.67" (17.0 mm)	≤ 0.5%
	4000	LSIX1001460A	4.58" (116.3 mm)	0.98" (24.9 mm)	≤ 0.03%
	4000	LSIX1001150A	4.70" (119.4 mm)	0.8" (20.3 mm)	≤ 2.0%

Pump Mounting Details
High Performance – Manifold Mount
50, 250, 750 and 1000 µL Models

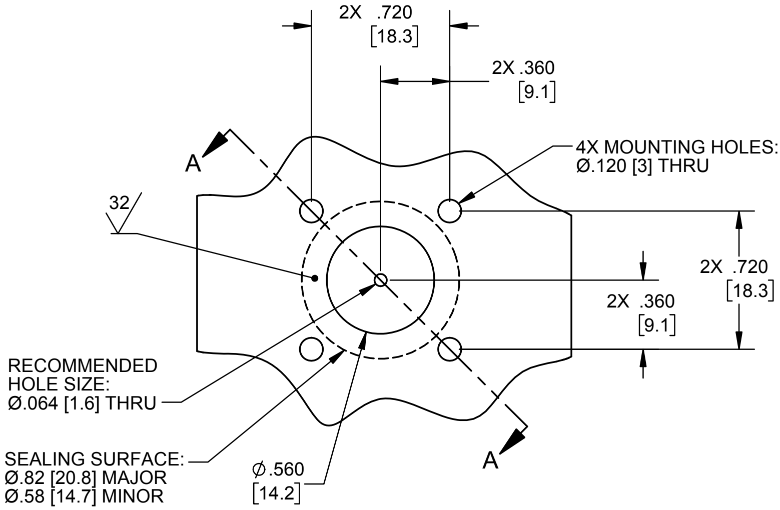


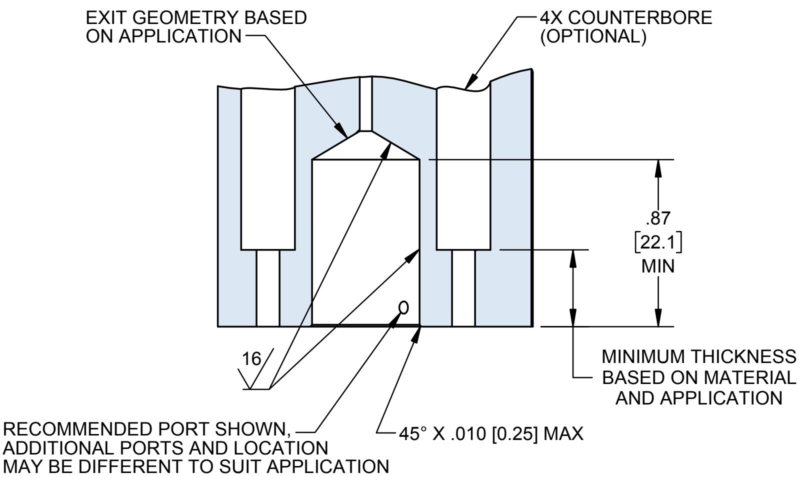
SECTION A-A

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	DISPENSE VOLUME (µL)	MOUNTING BOSS DRAWING11	EXIT PORT	PISTON CLEARANCE	SEALING SURFACE MIN – MAX		MIN DEPTH
			D1	D2	D3	D4	L
LPVA1700350L	50	LSIX1001420A	0.032"	0.136"	0.175"	0.500"	0.62"
LPVA1700325D	250	LSIX1001140A	0.032"	0.265"	0.290"	0.570"	0.74"
LPVA1700375D	750	LSIX1001120A	0.064"	0.464"	0.480"	0.750"	0.59"
LPVA1700310H	1000	LSIX1001460A	0.064"	0.445"	0.460"	0.730"	1.01"

Pump Mounting Details
High Performance – Manifold Mount
3000 µL Model



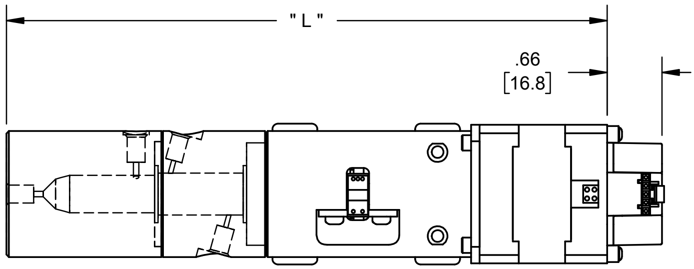


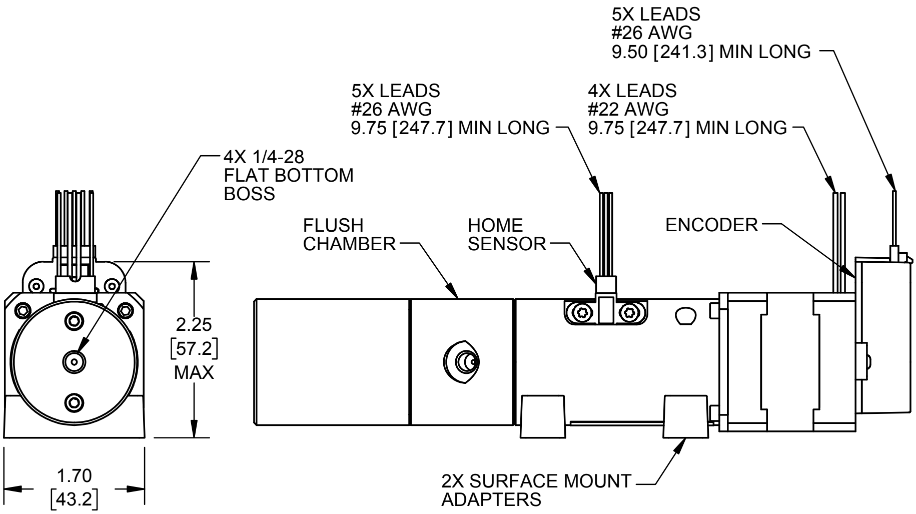
SECTION A-A

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	DISPENSE VOLUME (µL)	MOUNTING BOSS DRAWING	EXIT PORT	PISTON CLEARANCE	SEALING SURFACE MIN – MAX		MIN DEPTH
			D1	D2	D3	D4	L
LPVA1700330H	3000	LSIX1001150A	0.064"	0.560"	0.575"	0.820"	0.87"

High Performance – Dual Seal Model



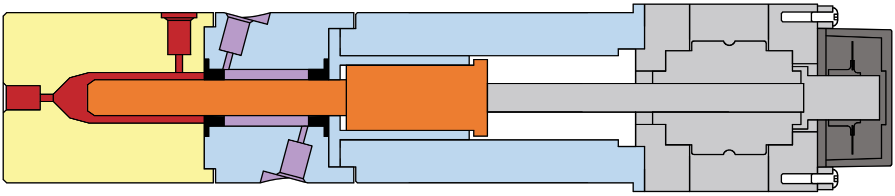


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	VOLUME (µL)	PORT HEAD MATERIAL[1]	FULL STEP DISPENSE (µL)	MAXIMUM DISCHARGE PRESSURE (psig)	
LPVA1725350D	500	PMMA	0.47	30	
LPVA1755350D	500	PEEK	0.47	30	
LPVA1725310H	1000	PMMA	0.40	30	
LPVA1755310H	1000	PEEK	0.40	30	

NOTE: (1) Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

High Performance – Dual Seal Model



Flow Path | Pump Housing | Piston
Barrier Area | Seal | Port Head
Encoder | Motor

- Wetted materials:
  - Pump chamber: port head (see table below), TZP, UHMW-PE
  - Flush chamber: TZP, UHMW-PE, PEEK, 316 SS
- Dispense accuracy: ± 0.5% (100% total volume)
- External valving required
- Home sensor (full discharge)
- Encoder: 2 channel, quadrature
- Motor: NEMA 17 bipolar stepper motor
- Drive current: 650-750 mA (RMS) per phase

	PRECISION		MAX. SPEED HALF STEPS (pps)	MAX. LENGTH "L"
	CV% (10% TOTAL VOLUME)	CV% (100% TOTAL VOLUME)		
	≤ 0.3%	≤ 0.03%	4000	5.86" (148.8 mm)
	≤ 0.3%	≤ 0.03%	4000	5.86" (148.8 mm)
	≤ 0.3%	≤ 0.03%	4000	7.24" (183.9 mm)
	≤ 0.3%	≤ 0.03%	4000	7.24" (183.9 mm)

Stepper Motor

The Lee Company's Variable Volume Pumps are driven using a bi-polar stepper motor. The stepper motor is a brushless DC electric motor characterized by the discrete number of steps in a rotation. This feature allows a motor to be held at a certain step without the need for any feedback, resulting in a very precisely controlled pump. Our pumps utilize two different styles of bipolar stepper motors; a Hybrid NEMA Type 17 and a "Stacked Can" Ø 1.5" motor. The NEMA 17 is characterized by high torque and precision, whereas the stacked can motor offers a lower profile and lighter weight.

Stepper motors can be driven in a variety of ways, so it is important to consider the operating current and voltage requirements when selecting a motor controller. While a stepper motor is limited by a certain number of discrete steps per revolution, a micro-stepping enabled controller allows the motor to move only fractions of a step. A micro step is generally defined as splitting a step into multiple component parts. This is accomplished by very carefully controlling the current in each stepper motor phase, which can effectively produce multiple partial steps within a single step thereby increasing the dispense resolution.

The trade-off to micro stepping is that the increments typically decrease by a power of two (e.x. 1/2, 1/4, 1/8, etc.), because dividing a step into smaller parts requires both phases to be energized at once (at different levels). This results in a reduction of the output torque which may limit the discharge pressure of the pump. In practical applications, a maximum of 1/16 micro-steps per step should be implemented, but the allowable micro step increment is determined by the stepper motor controller.

Home Sensor / End of Stroke Sensor

Most Lee Variable Volume Pumps include a home sensor, also known as an end of stroke sensor, which is used to indicate when the pump has reached a full dispense position (piston is fully extended). The home sensor is an optical-electrical device which relies on an LED emitter (in the infrared spectrum), and a sensor. Placed within a line of sight of one another, once that sight is broken the sensor switches from a HIGH to a LOW state.

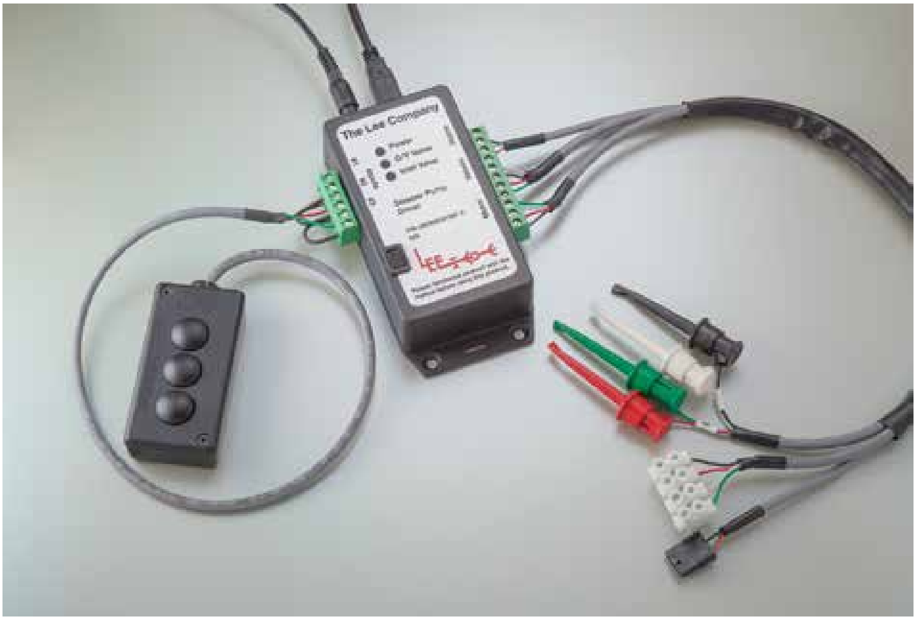
To interface with the home sensor, the controller requires an input as well as an output to power the components. Because the home sensor emitter is an LED, which is a current-driven device, an integrated resistor is included to limit current. Some stepper controllers include an integrated resistor which may need to be removed or modified to function properly. The Lee Company has the capability to provide a pump design with the resistor modified or removed if necessary.

Encoder

Some Lee Variable Volume Pumps include an encoder, which is an optical electronic device that provides a pulse output as the motor rotates. The encoder output is not intended as an indication of fluid dispense, but rather as verification that the stepper motor has completed the requested number of steps. The standard encoder used on our variable volume pumps is 200 steps per revolution, but encoders with 400 steps per revolution can be supplied as a custom design.

Drive Electronics Starter Kit

The Lee Company offers a pump driver kit (LSKX0502150C) for application development. This includes a motor controller, software, and the necessary wire connectors to drive any of our variable volume pumps. The pump, valves and fluidic connectors are not included. Our drive kit design is based on the All Motion © EZ17 Stepper Driver and there are several 'pre-packaged' routines included. The user can also program the controller directly to further expand the capabilities of the pump.



Drive Electronics Starter Kit includes:

- Stepper Pump Driver
- Power Supply
- USB Cable
- Three Button Switch Box
- Extension Cable
- Installation CD
- Quick Start Guide
- Home Sensor Adaptor Cable

This kit does not support encoder interface.

J

GENERAL SPECIFICATIONS

The following specifications apply to all Variable Volume Dispense Pumps, unless otherwise noted.

Cycle Life

Unless otherwise specified, the pumps will typically operate across a minimum of 10 million cycles on water, depending on application conditions.

Operating Pressure

The pumps are self-priming, so they have the capability of operating across a wide pressure range.

- Maximum discharge pressure: Refer to individual pump tables for maximum discharge pressure.

Operating Temperature

- Ambient operating temperature range is 40°F to 150°F (4°C to 66°C)

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing
- Pumps should be stored completely wet or completely dried with nitrogen before prolonged periods of inactivity.

Operating Speed

- Refer to the individual pump drawings for maximum operating speed and harmonic frequency.
- The pumps may be operated in full-step, half-step or micro-step mode, depending on the electrical drive design and application parameters.
- Operating the pumps at higher speeds may affect dispense accuracy and life expectancy.

Electrical Characteristics

- Pumps are equipped with a two-phase bipolar motor.
- Home sensors provide an end of stroke (full discharge) indication; the sensor output will remain low when piston is fully extended.
- Encoders are two channel, quadrature (no index pulse) designs.

Port Connections

- All pumps require external valves for operation.
- ¼ - 28 Port: These ports are designed to be used with standard ¼-28 flat bottom fittings.
- Manifold Mount: Refer to pump mounting details on pages J11-12 for additional information.

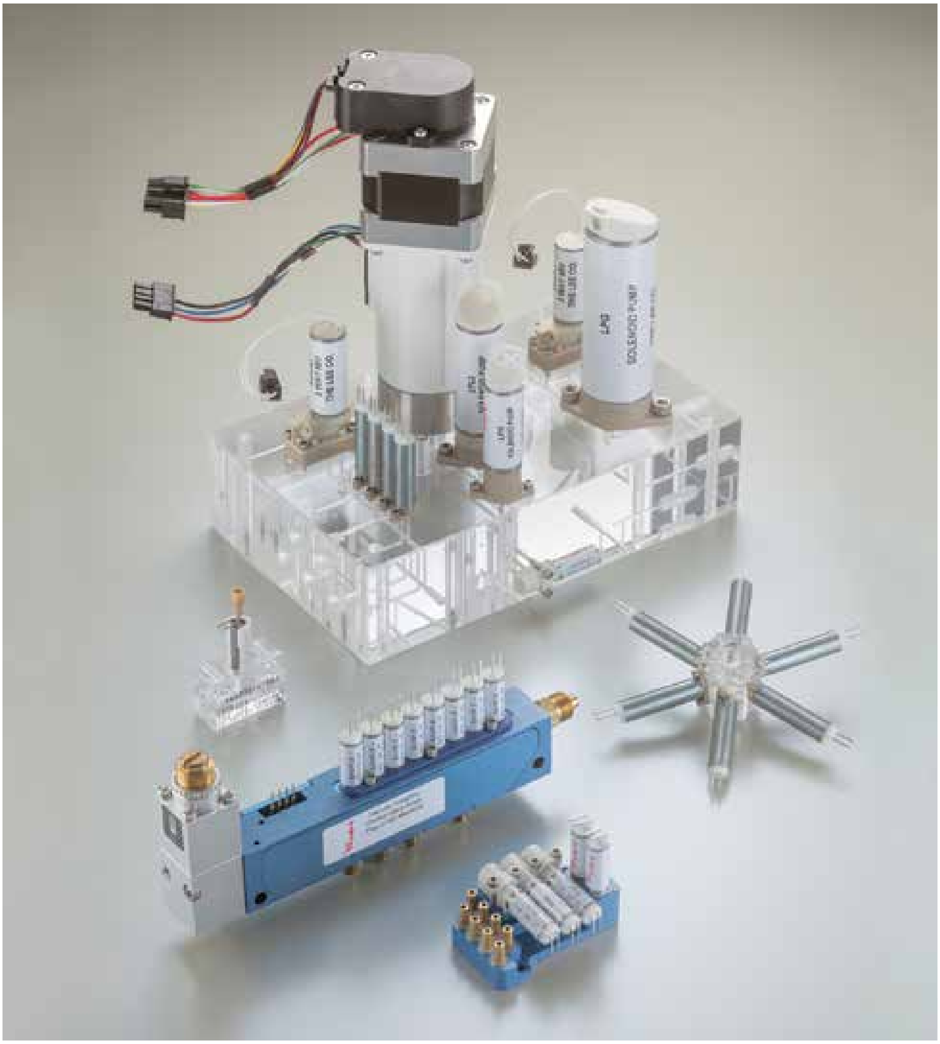
Mounting Information

Pumps should be mounted with the outlet port up (motor down) to optimize bubble purging.

- ¼-28 Port: The pumps should be mounted to a surface using #4 (2.5 mm) mounting screws.
- Manifold Mount: Refer to pump mounting details for additional information. The pumps require M3-0.5 screws for mounting and the torque specification is 50 to 70 in-oz (0.353 to 0.494 N-m) maximum.

Manifold Technology

The Lee Company Electro-Fluidic Systems Division 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.

The images above illustrate conventional manifold designs, populated with 3-Port (left) and 2-Port (right) HDI Platform solenoid valves. Equipped with barb ports to accommodate soft tube connections, the subsystem can be easily integrated into any unit.

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.

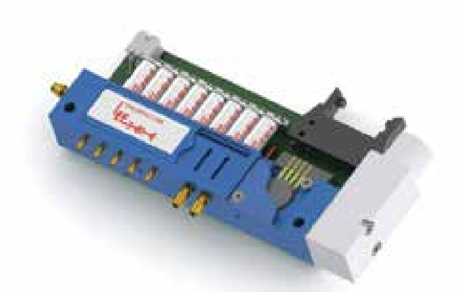
The image above shows a multi-layered manifold design populated with LFV Series solenoid valves.

Ant Farm Manifold Technique

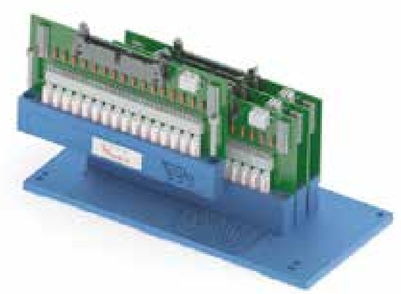
The Ant Farm Technique involves machining a series of intricate flow paths or channels into the face of the manifold. After the machining operation, a plate is bonded over the flow passages to complete the circuit. In complex applications, the channels can be milled into more than one face of the manifold 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 HDI Platform valves (plug-in and face mount) in order to accommodate specific space constraints and flow schematic requirements of a system. 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 HDI Platform solenoid valves and other critical components (pressure transducer and regulator).



This complex manifold design takes 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.

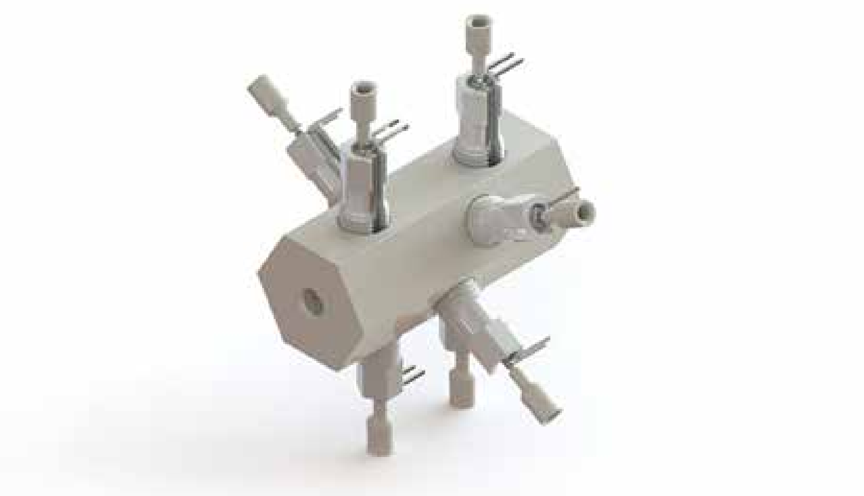
Combination Manifold Technique

Combination manifolds are used to incorporate discrete components into a single unit. The Lee variable volume pumps have a port head that can be customized to 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.

This manifold design demonstrates another level of capability where HDI Platform solenoid valves can be integrated into an LPV Series pump with a custom port head.

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.



The image above illustrates the use of our VHS Series solenoid valves in a custom manifold design.

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 or alodine)
  - PMMA
  - PEEK
  - PEI
  - PSU
  - PBT
- Multi-Layered:
  - Aluminum (anodized)
  - PMMA
- Ant Farm:
  - Aluminum (anodized for increased corrosion resistance)
- 3-D Printing: 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 recommended 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.

Notes

MINSTAC

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 L45-47

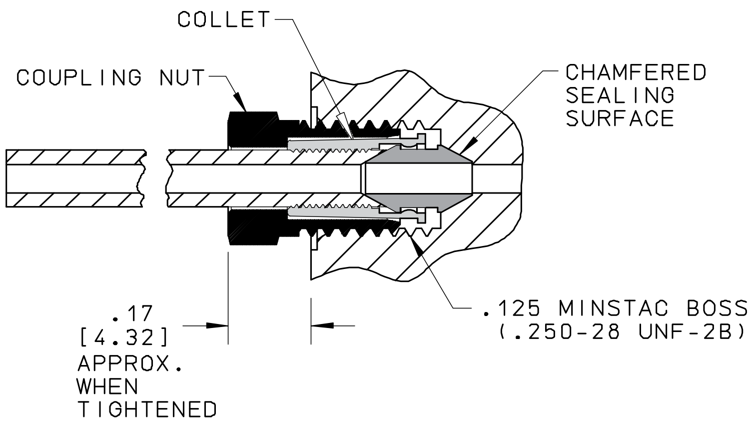
Fluid Control Components

Check Valves L48
Filters L49-51
Safety Screens L52-53
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 PTFE tubing, and threading a specially designed Collet onto its end. This assembly provides a leak-proof connection from PTFE tubing to the wide range of MINSTAC components and fittings, all without the problems associated with the cold flow characteristics of PTFE.

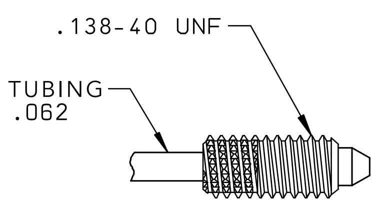
Standard tubing assemblies are available from stock with one or two fitting ends installed. Special lengths and fitting assembly tool kits are also available. Please request T.R. 062 for complete assembly instructions and tool kit part numbers.



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

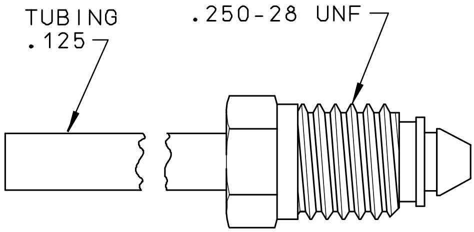
The 062 MINSTAC fitting system is for use with 0.062" (1.57 mm) O.D. PTFE tubing and uses a 0.138-40 UNF fitting end. The system utilizes an internally threaded collet that grips the outer diameter of the PTFE tubing end, preventing cold flow. The coupling screw acts like a compression fitting and presses the chamfered end of the tubing against one end of the PCTFE ferrule, as the other end of the ferrule is pressed against the sealing surface in the boss. This self-aligning fitting provides a reliable leak proof system.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

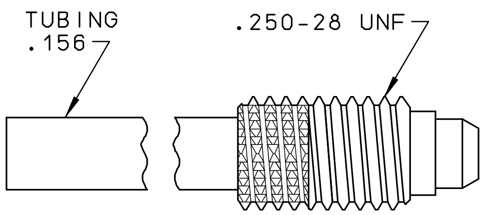
125 MINSTAC

The 125 MINSTAC fitting system is for use with 0.125" (3.18 mm) O.D. PTFE tubing and uses a 0.25-28 UNF fitting end. The system utilizes an internally threaded collet that grips the outer diameter of the PTFE 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 PCTFE ferrule, as the other end of the ferrule is pressed against the sealing surface in the boss. This self-aligning fitting provides a reliable leak proof system.



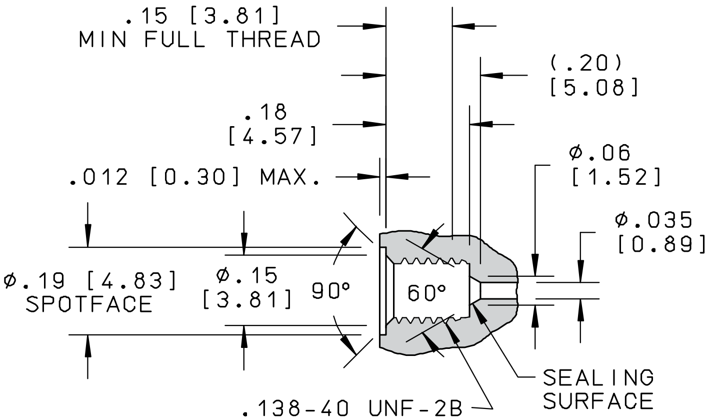
156 MINSTAC

The 156 MINSTAC fitting system is for use with 0.156" (3.96 mm) O.D. tubing and uses a 0.25-28 UNF fitting end. The system utilizes an internally threaded collet that grips the outer diameter of the PTFE 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 PCTFE ferrule, as the other end of the ferrule is pressed against the sealing surface in the boss. This self-aligning fitting provides a reliable leak proof system.



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

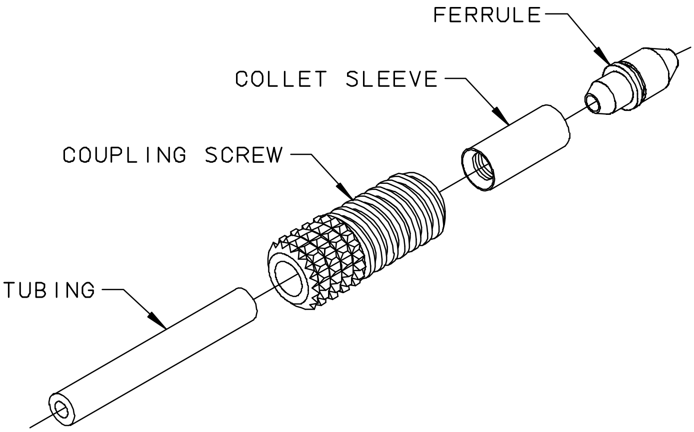
062 Boss Configuration



Boss Drawing TMIX1300000A

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

062 Fitting Assembly



Anodized Aluminum	Coupling Screw: TMAA3202079Z
303 Stainless	Collet Sleeve: TMCA3202030Z
PCTFE	Ferrule: TMBA3202910Z

PRE-ASSEMBLED PTFE TUBING
PART NUMBERING INFORMATION

TU T C 3216 9 05 L

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

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

Tubing and Coupling Screw Color: Natural
Other colors such as black, brown, red, orange, yellow, green, blue, violet and gray are available upon request. Please contact your local Lee Sales Engineer for additional assistance.

Nominal Tubing I.D.:
1226 = 0.012"; 3216 = 0.032"; 4012 = 0.040"

Number of pre-assembled fittings (per ordered length):
A = None (bulk tubing)
B = 1
C = 2

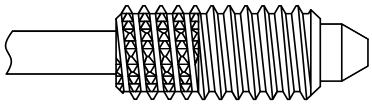
Material – T = PTFE

Tube Assembly (TU): Standard MINSTAC[1]

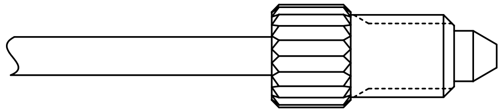
NOTES:
(1) See page L7 for additional styles (MIN-LOK and MIN-Spline).
(2) Pre-assembled PTFE tubing is available in lengths up to 100 cm. Please contact your local Lee Sales Engineer for assistance if longer lengths are required. Bulk tubing (TUTA) is only available in 300 cm (30D) and 3,000 cm (30H) lengths.

062 MINSTAC Tubing Assembly Styles

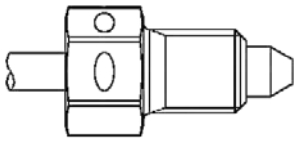
Standard MINSTAC – smallest package



"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

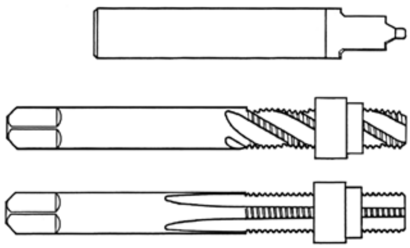
MINSTAC Tubing Assemblies are available in pre-made assemblies. Special lengths and configurations are available for OEM applications.

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:

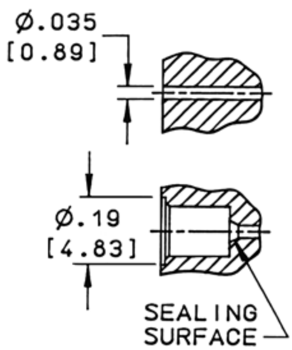
Boss Preparation Tools



Combination Boss Drill: TTTA3200643A

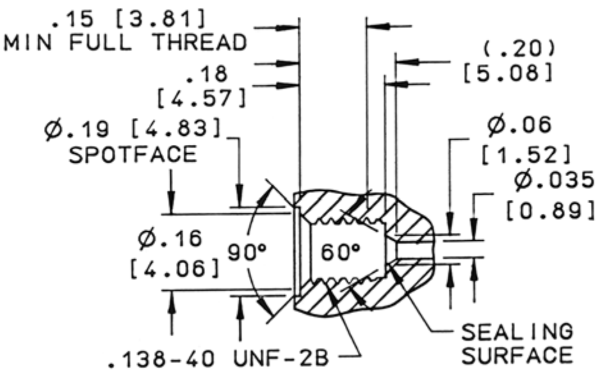
Plug Tap: TTTA3200743A

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.



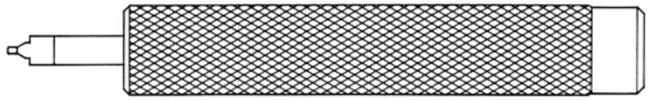
NOTE: Care must be taken to ensure that the taps will follow true in the hole produced by the Combination Drill.

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

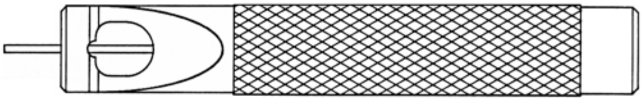
L

062 MINSTAC Tubing Preparation and Coupling Assembly

Coupling Assembly Tools



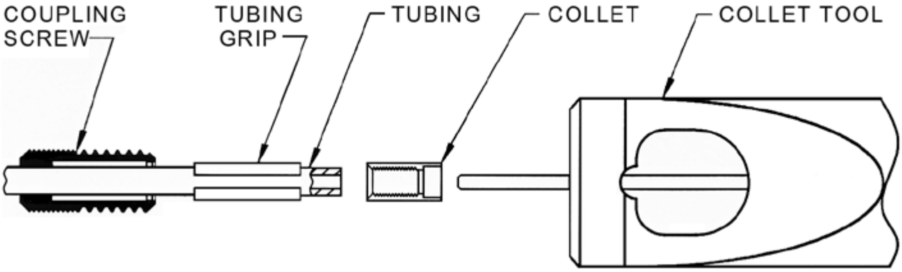
Chamfer Tool
TTTA3201543A



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.



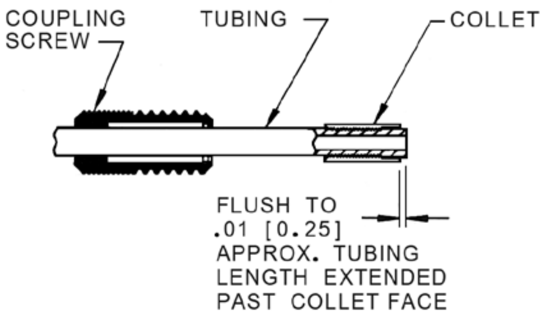
* The Lee Collet Tool (Part Number TTTA3201443A) is for use with 0.032" (0.81 mm) I.D. tubing. The following tools should be substituted for use with their respective sized tubing:

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

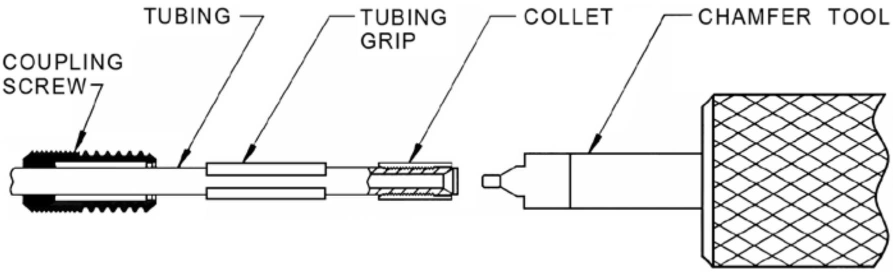
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Procedure continued:

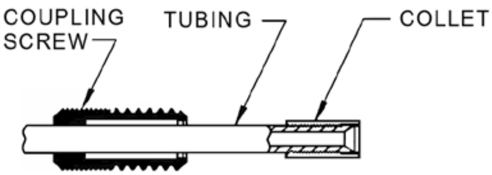
3. While holding the tubing with the rubber Tubing Grip (Part Number TTTX0500900A), screw the Collet onto the tubing end. This should require about 15-20 turns of the Collet Tool. Remove the tool from the coupling end and check that the tubing extends at least to the end of the collet.



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:



TTTA3201643A: 0.012" (0.30 mm) I.D. tubing

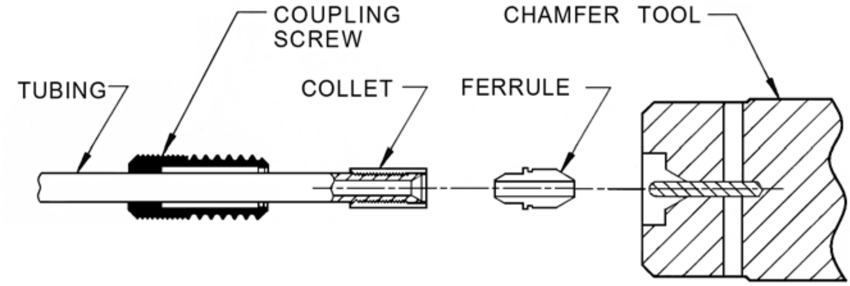
TTTA4000243A: 0.040" (1.02 mm) I.D. tubing

5. Slide the Coupling Screw over the Collet.

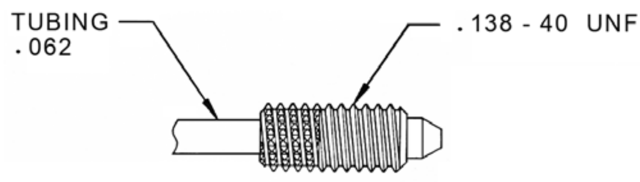
Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

Procedure continued:

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

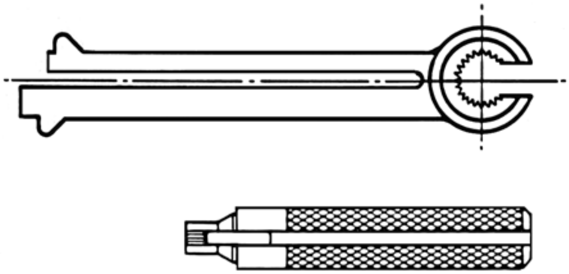


7. While holding the Coupling Screw, insert the Ferrule into the Coupling Screw (approx. 4 lbs. (1.8 kg.) force is required). The Ferrule will "snap" in place. The coupling assembly is now complete.



062 MINSTAC Coupling Installation

Coupling Installation Tools



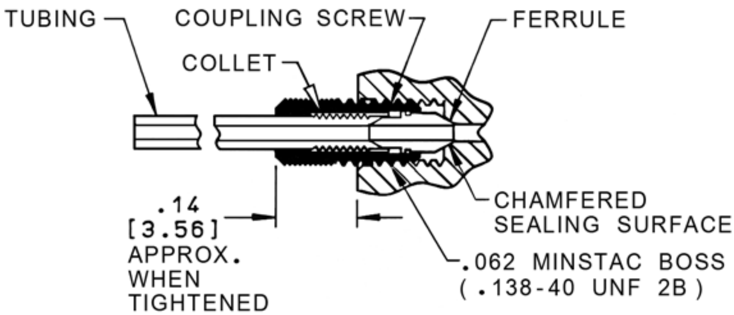
Torque Wrench
TTTA3201243A

Wrench
TTTA3200543C

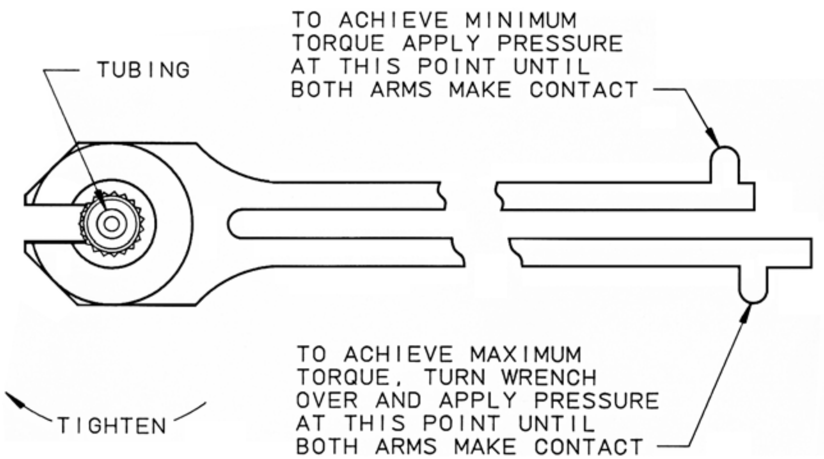
Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

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.

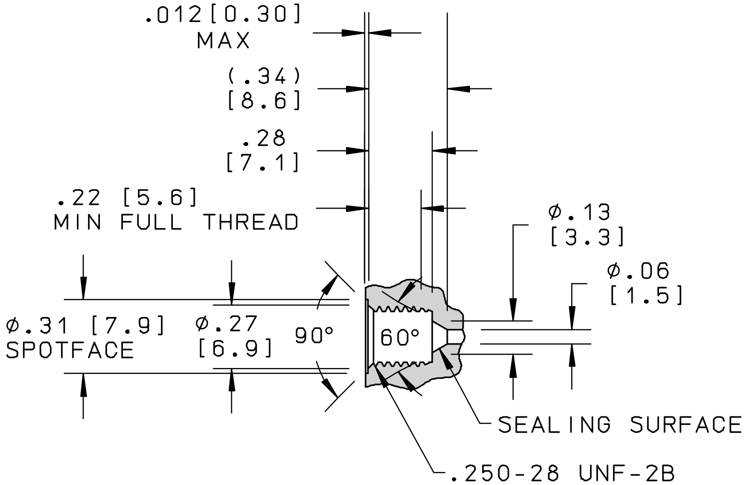


NOTE: Minimum recommended torque: 5 ozf•in (0.035 N-m)
Maximum recommended torque: 10 ozf•in (0.07 N-m)

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

L

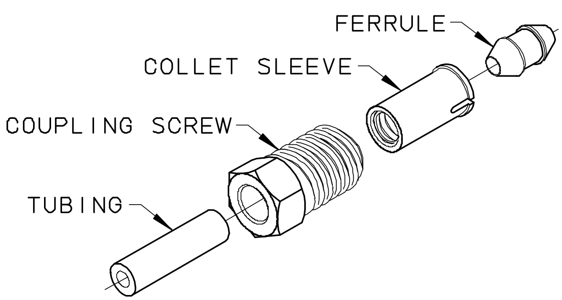
125 Boss Configuration



Boss Drawing TMIX5000000A

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

125 Fitting Assembly



PBT	Coupling Screw: TMAA6201929Z
PBT	Collet Sleeve: TMCA6201920Z
PCTFE	Ferrule: TMBA6201910Z

PRE-ASSEMBLED PTFE TUBING
PART NUMBERING INFORMATION

TM T C 6230 9 05 L

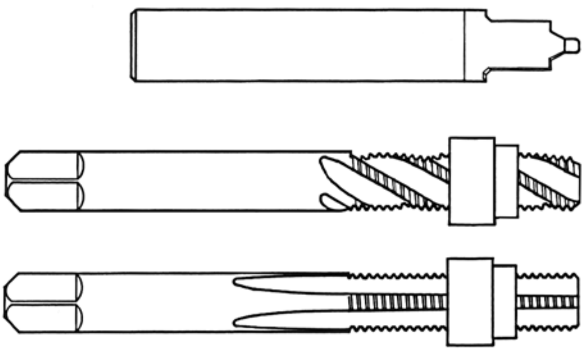
- **L** — Length Multiplier:
  - L = CM x 1
  - D = CM x 10
  - H = CM x 100
- **05** — First two significant digits of tubing length. Available in 5 cm increments (05, 10, 15 etc.)[1]
- **9** — Tubing Color: Natural
  Other colors such as black, brown, red, orange, yellow, green, blue, violet and gray are available upon request. Please contact your local Lee Sales Engineer for additional assistance.
- **6230** — Nominal Tubing I.D.:
  3247 = 0.032", 6230 = 0.062"
- **C** — Number of pre-assembled fittings (per ordered length):
  - A = None (bulk tubing)
  - B = 1 with ferrule
  - C = 2 with ferrule
- **T** — Material – T = PTFE
- **TM** — Product Code:
  - TM = .125 MINSTAC Tube Assembly
  - TU = Bulk Tubing (no fitting)

NOTES:

(1) Pre-assembled PTFE tubing is available in lengths up to 100 cm. Please contact your local Lee Sales Engineer for assistance if longer lengths are required.
Bulk tubing (TUTA) is only available in 300 cm (30D) and 3,000 cm (30H) lengths.

125 MINSTAC Boss Preparation

Boss Preparation Tools



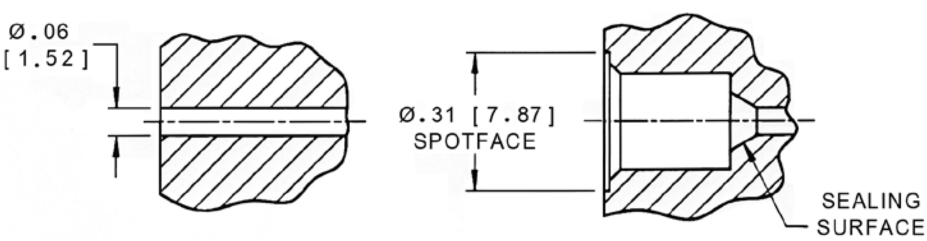
Combination Boss Drill
TTTA6201927A

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 0.006" (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.

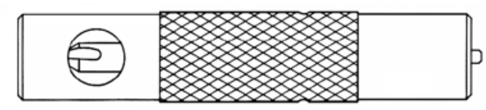


NOTE: Care must be taken to ensure that the taps will follow true in the hole produced by the Combination Drill.

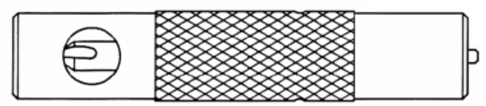
Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

125 MINSTAC Tubing Preparation and Coupling Assembly

Coupling Assembly Tools



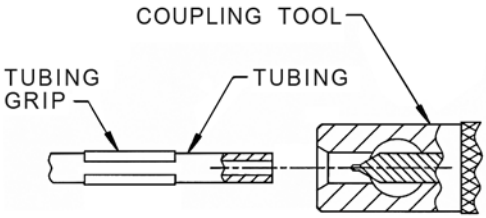
125 MINSTAC TTTA6200143A *

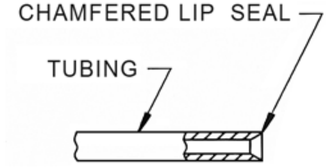


125 MINSTAC TTTA6200343 (no ferrule) *

Procedure:

1. Cut the tubing reasonably square to the desired length.
2. 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.

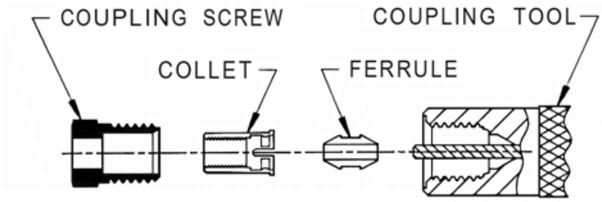




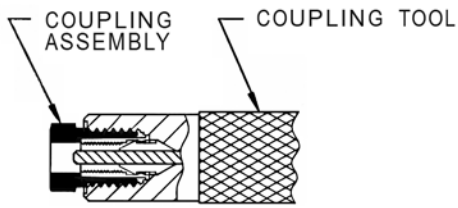
* Use the Lee Coupling Assembly Tool (Part Number TTTA6200143A) for use with 0.062" (1.57 mm) I.D. tubing. Substitute the Lee Coupling Assembly Tool (Part Number TTTA6200243A) for use with 0.032" (0.81 mm) I.D. tubing.

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

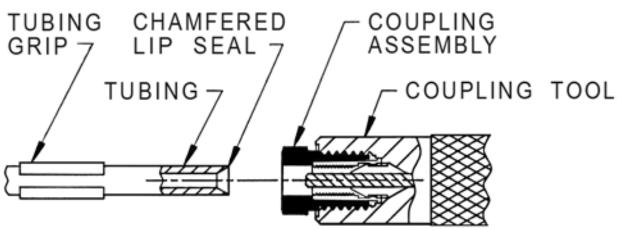
Procedure continued:



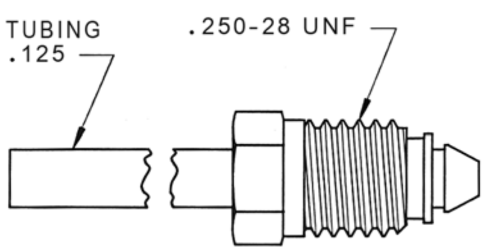
3. Slip the Ferrule (Part Number TMBA6201910Z) onto pin of the Coupling Assembly Tool. (See page L40 for 1/4-28 Flat Bottom Ferrule).
4. Slide the flanged end of Collet Sleeve (Part Number TMCA6201920Z) over the Ferrule until it snaps in place.



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



6. 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.

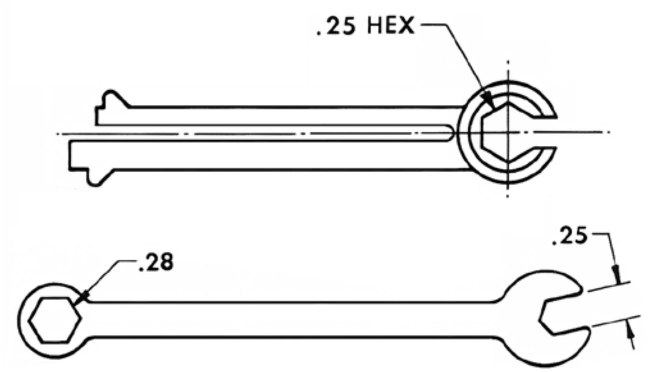


7. Unscrew the coupling from the tool. The assembly is now ready for installation into a 125 MINSTAC boss.

L

125 MINSTAC Coupling Installation

Coupling Installation Tools



Torque Wrench
TTTA6202227A

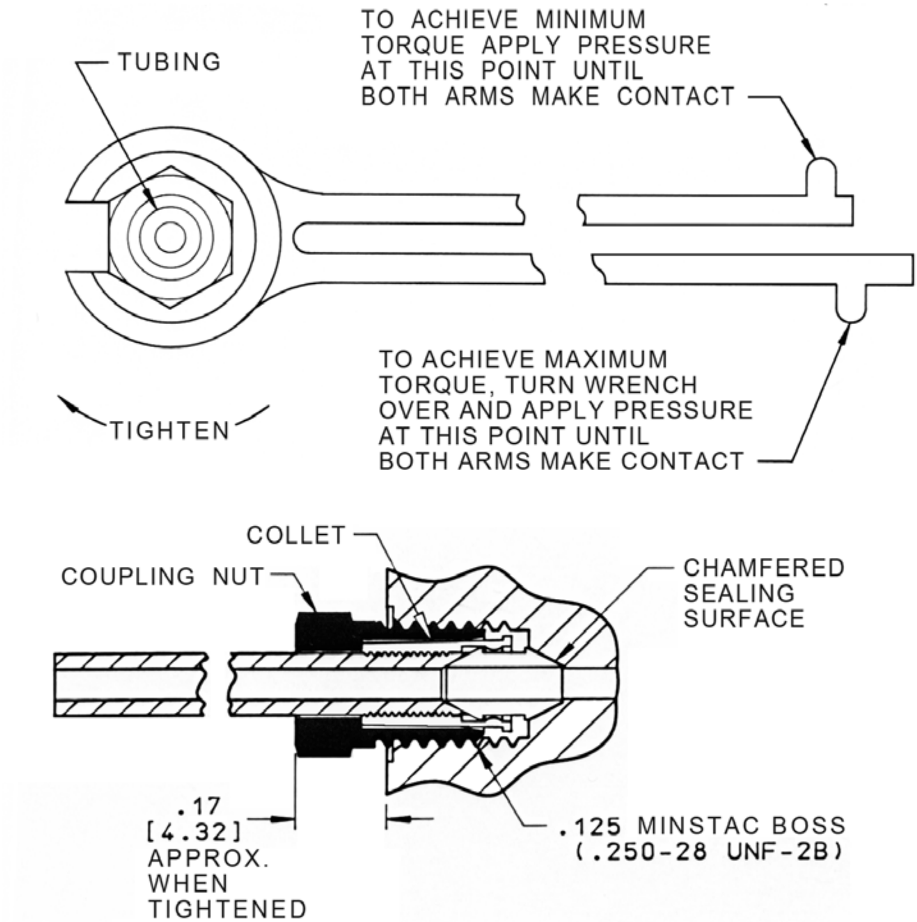
Wrench
TTTA6200227C

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.

L

Procedure continued:



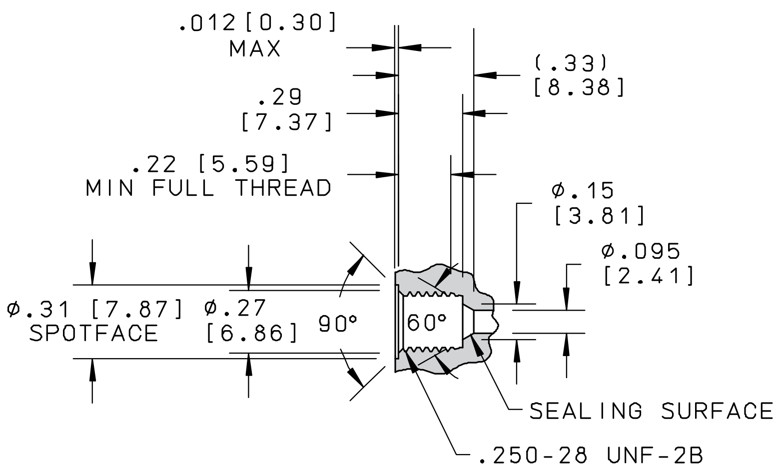
NOTE: Minimum recommended torque: 7 ozf•in (0.05 N-m)
Maximum recommended torque: 21 ozf•in (0.15 N-m)

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

Notes

L

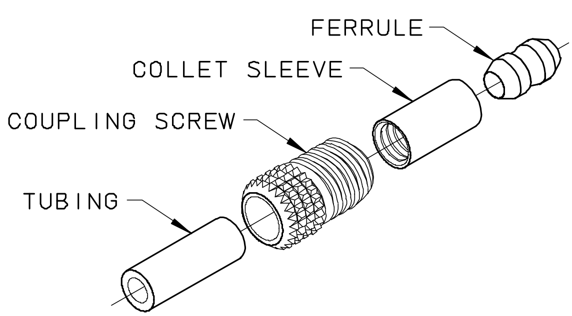
156 Boss Configuration



Boss Drawing TMIX9000000A

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

156 Fitting Assembly



Anodized Aluminum	Coupling Screw: TMAA9501079Z
PEEK	Collet Sleeve: TMCA9501950Z
PCTFE	Ferrule: TMBA9501910Z

PRE-ASSEMBLED PTFE TUBING PART NUMBERING INFORMATION

TU T C 9531 9 05 L

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

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

Tubing and Coupling Screw Color: Natural
Other colors such as black, brown, red, orange, yellow, green, blue, violet and gray are available upon request. Please contact your local Lee Sales Engineer for additional assistance.

Nominal Tubing I.D.:
9531 = 0.095"

Number of pre-assembled fittings (per ordered length):
A = None (bulk tubing)
B = 1
C = 2

Material – T = PTFE

Product Code – Tube Assembly

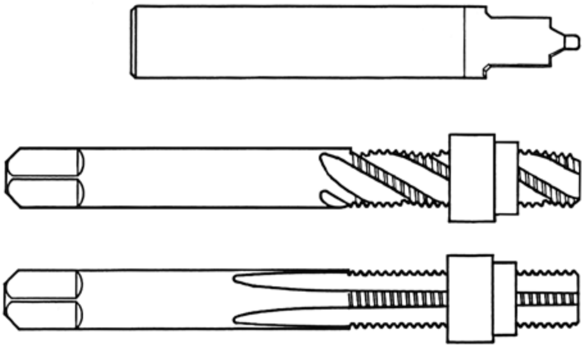
NOTES:

(1) Pre-assembled PTFE tubing is available in lengths up to 100 cm. Please contact your local Lee Sales Engineer for assistance if longer lengths are required. Bulk tubing (TUTA) is only available in 300 cm (30D) and 3,000 cm (30H) lengths.

L

156 MINSTAC Boss Preparation

Boss Preparation Tools



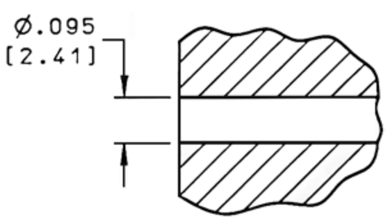
Combination Boss Drill
TTTA9500227A

Plug Tap
TTTA6201627A

Bottoming Tap
TTTA6201727A

Procedure:

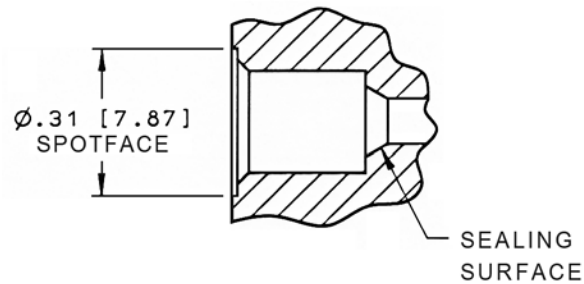
1. Drill a 0.096" (2.44 mm) diameter pilot hole in the desired boss location.



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

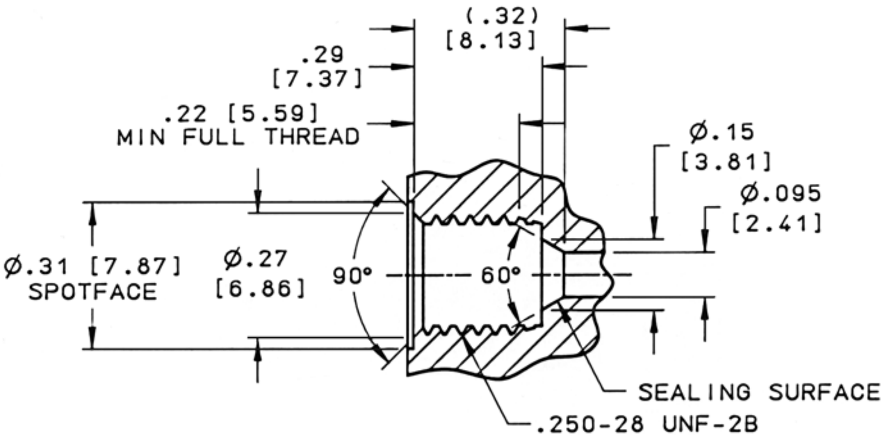
Procedure continued:

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.

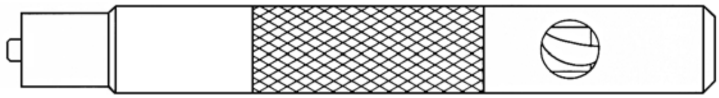
NOTE: Care must be taken to ensure that the Taps will follow true in the hole produced by the Combination Drill.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

156 MINSTAC Tubing Preparation and Coupling Assembly

Tubing Preparation and Coupling Assembly Tools

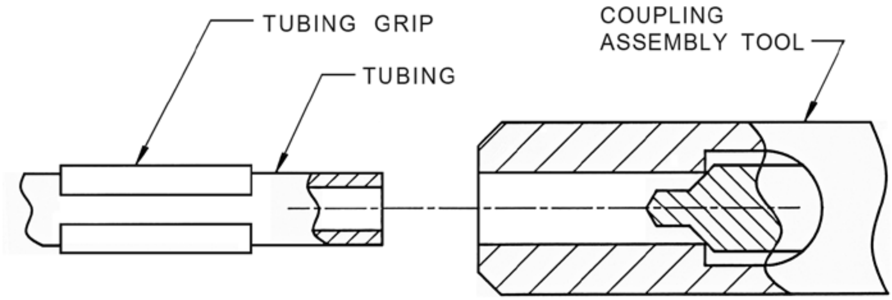


Coupling Assembly Tool TTTA9500127A

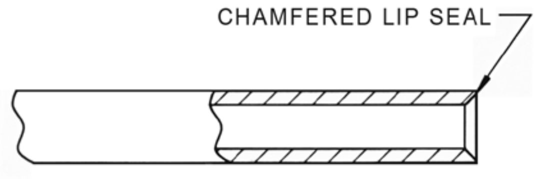
L

Procedure:

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



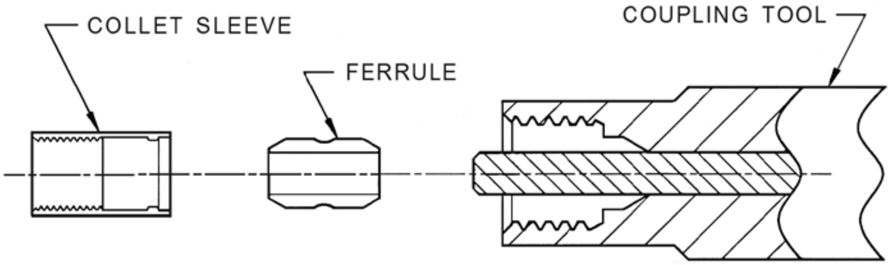
2. Hold the tubing with the Tubing Grip. Slide the center drill end of Lee Coupling Assembly Tool (Part Number TTTA9500127A) onto the tubing. Hand twist the tool clockwise to form a chamfered lip seal. The resulting chamfer should extend to the O.D. of the tubing.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

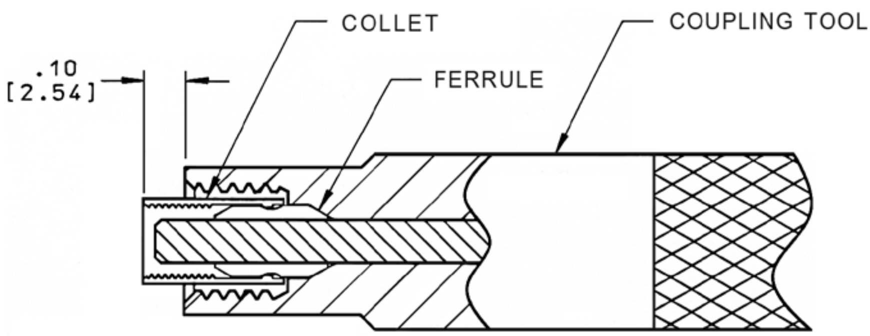
Procedure continued:

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

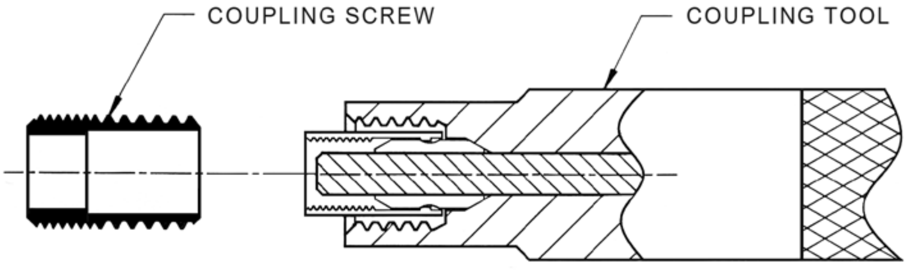


4. Slide internally unthreaded end of the Collet Sleeve (Part Number TMCA9501950Z) over the Ferrule until it snaps in place.

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



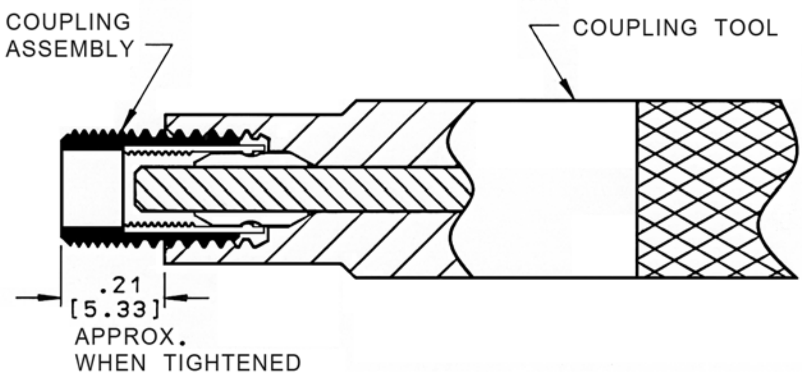
5. Thread the Coupling Screw (Part Number TMAA9501079Z) over the Collet Sleeve until it bottoms on the Collet Sleeve.



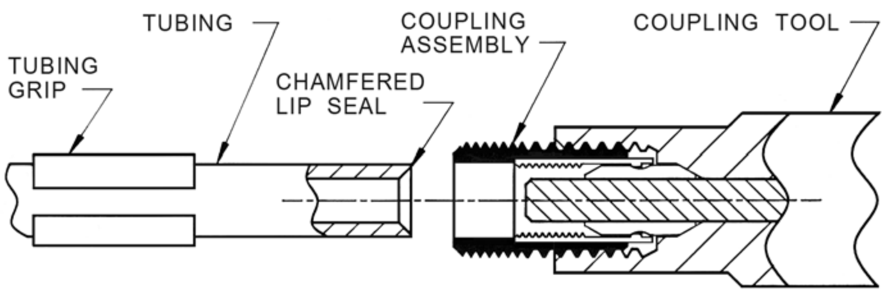
Unless otherwise specified, dimensions are in inches [*mm*]*. Drawings are not to scale.*

Procedure continued:

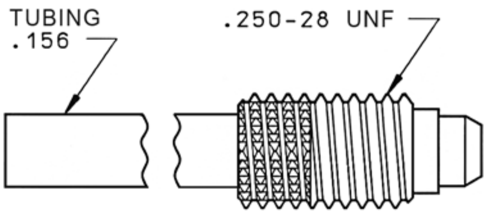
NOTE: The Coupling Screw should protrude approximately 0.21" (5.3 mm from the end of tool).



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.

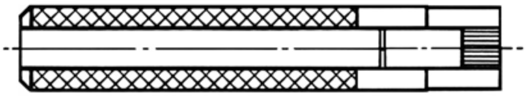


Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

156 MINSTAC Coupling Installation

Coupling Installation Tools

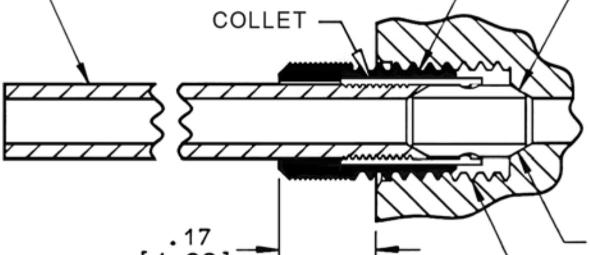
Torque Wrench
TTTA9500343A



Wrench
TTTA9500427C

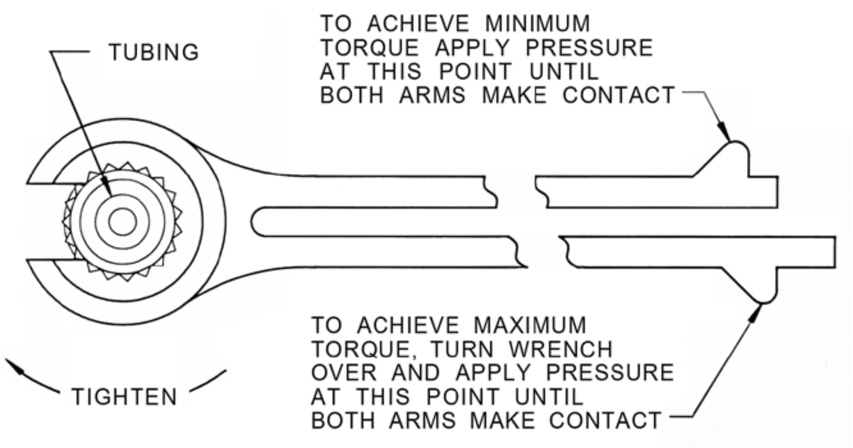
Procedure:

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



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.



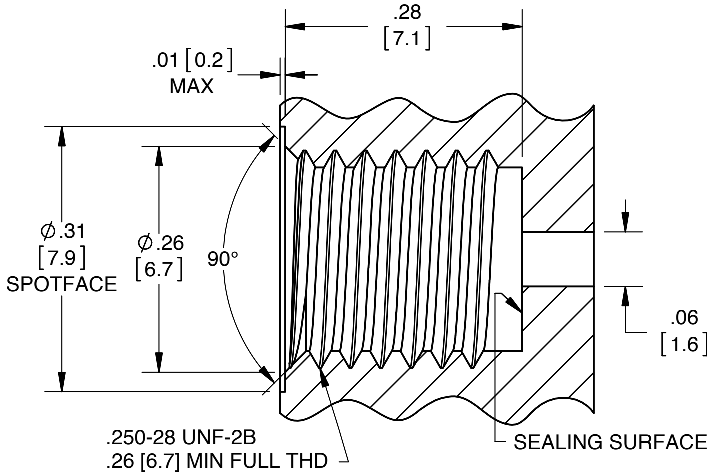
NOTE: Minimum recommended torque: 7 ozf•in (0.05 N-m)
Maximum recommended torque: 21 ozf•in (0.15 N-m)

Torque values based on fittings threaded into PEEK bosses.

Notes

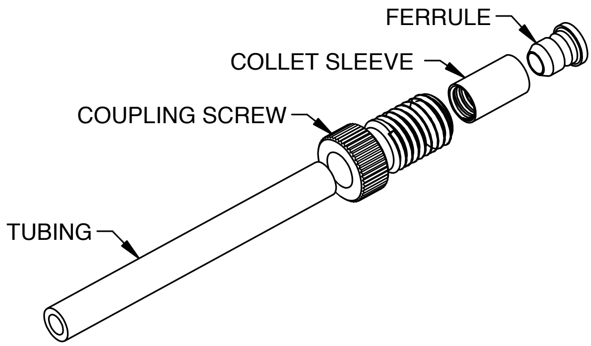
L

1/4-28 Boss Configuration



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

1/4-28 Fitting Assembly



Anodized Aluminum	Coupling Screw: TMAA9503079Z
PEEK	Collet Sleeve: TMCA9501950Z
PCTFE	Ferrule: TMBA9503910Z

L

PRE-ASSEMBLED PTFE TUBING
PART NUMBERING INFORMATION

TQ T C 9531 9 05 L

- **L** — Length Multiplier:
  - L = CM x 1
  - D = CM x 10
  - H = CM x 100
- **05** — First two significant digits of tubing length. Available in 5 cm increments (05, 10, 15 etc.)[1]
- **9** — Tubing Color: Natural
  Other colors such as black, brown, red, orange, yellow, green, blue, violet and gray are available upon request. Please contact your local Lee Sales Engineer for additional assistance.
- **9531** — Nominal Tubing I.D.:
  9531 for 0.095" I.D.
- **C** — Number of pre-assembled fittings (per ordered length):
  - A = Bulk Tubing (no fitting)
  - B = 1 with ferrule
  - C = 2 with ferrule
- **T** — Material – T = PTFE
- **TQ** — Product Code – TQ = 1/4-28 Flat Bottom
  TU = Bulk Tubing (no fitting)

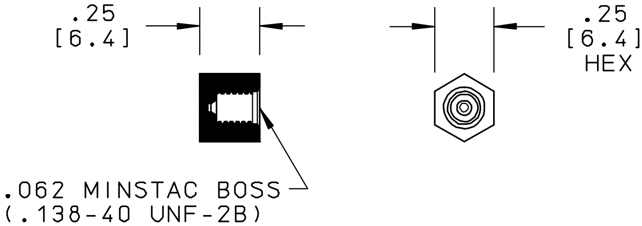
TQT Part Numbers sold as complete tubing assemblies only.

NOTES:

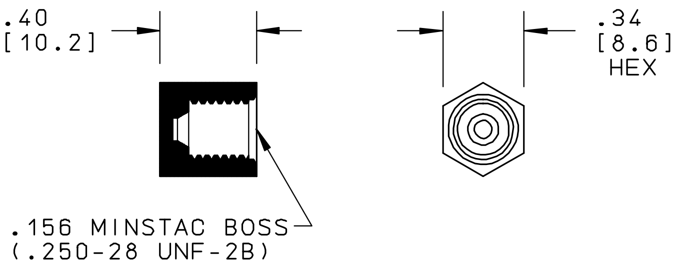
(1) Pre-assembled PTFE tubing is available in lengths up to 100 cm. Please contact your local Lee Sales Engineer for assistance if longer lengths are required.
Bulk tubing (TUTA) is only available in 300 cm (30D) and 3,000 cm (30H) lengths.

L

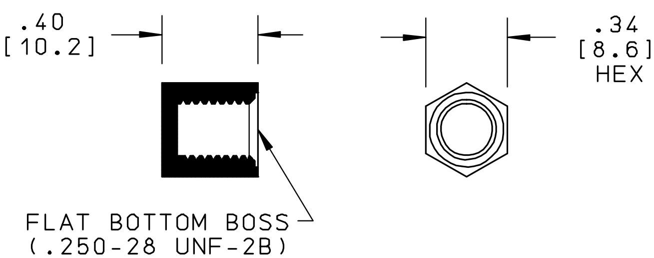
062 MINSTAC
TMLA3201950Z – PEEK



156 MINSTAC
TMLA9501950Z – PEEK



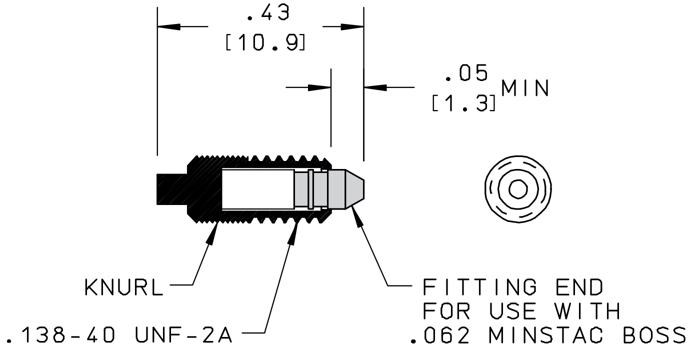
1/4-28 Flat Bottom
TMLA9502950Z – PEEK



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

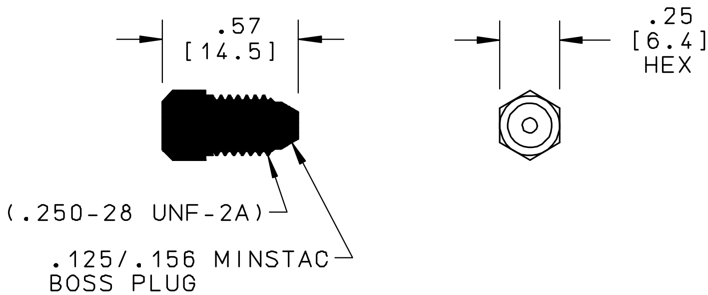
062 MINSTAC

TMPA3201919Z – PCTFE



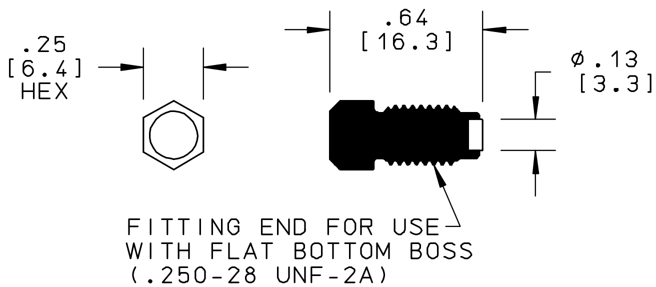
125/156 MINSTAC

TMPA9501959Z – PEEK



1/4-28 Flat Bottom

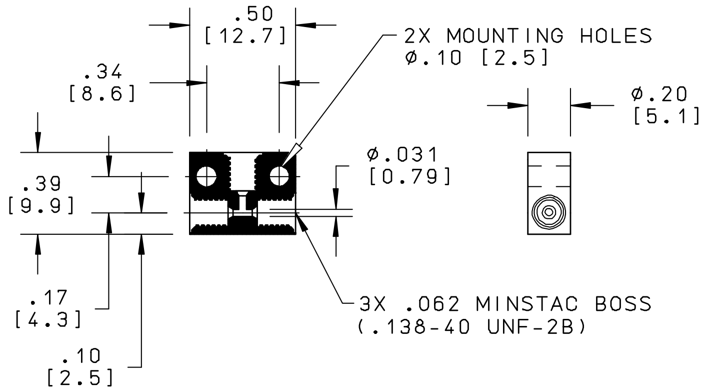
TMPA9502909ZA – PEEK -PTFE



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

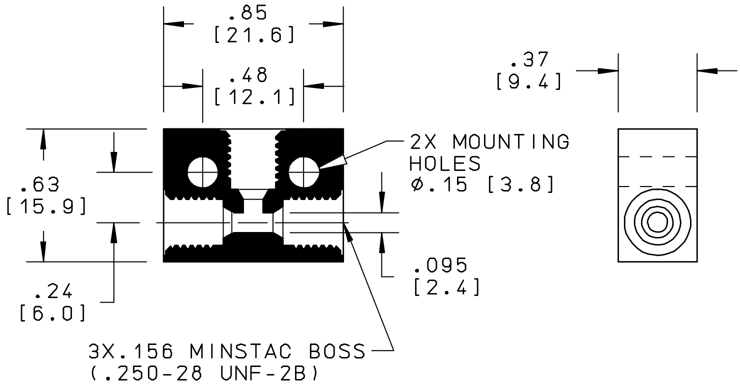
062 MINSTAC

TMMA3203950Z – PEEK



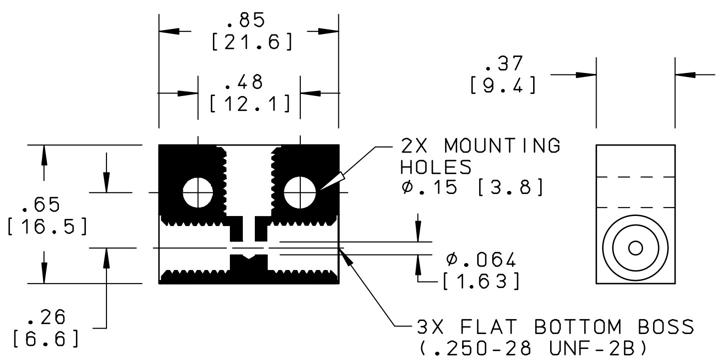
125/156 MINSTAC

TMMA9503950Z – PEEK



1/4-28 Flat Bottom

TMMA9504950Z – PEEK

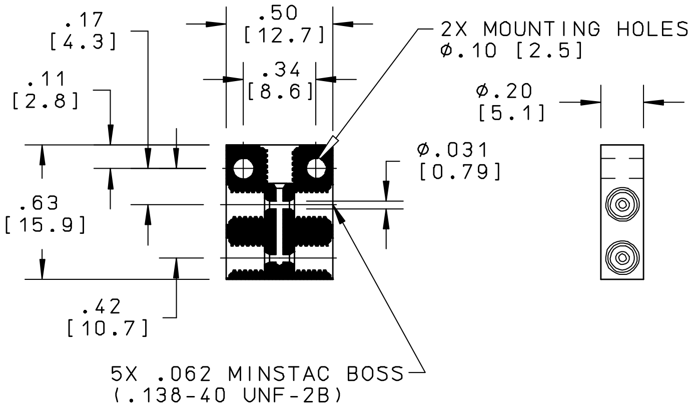


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

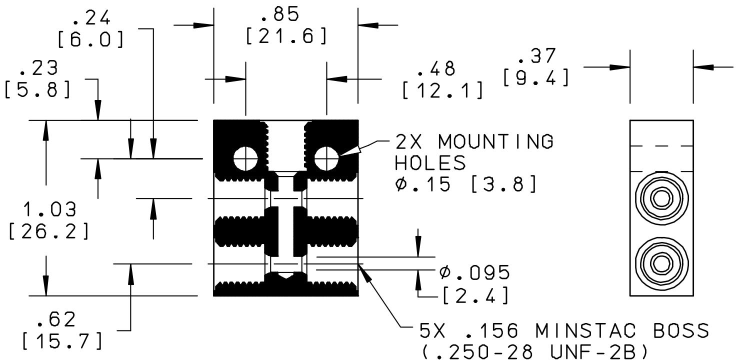
062 MINSTAC

TMMA3201950Z – PEEK



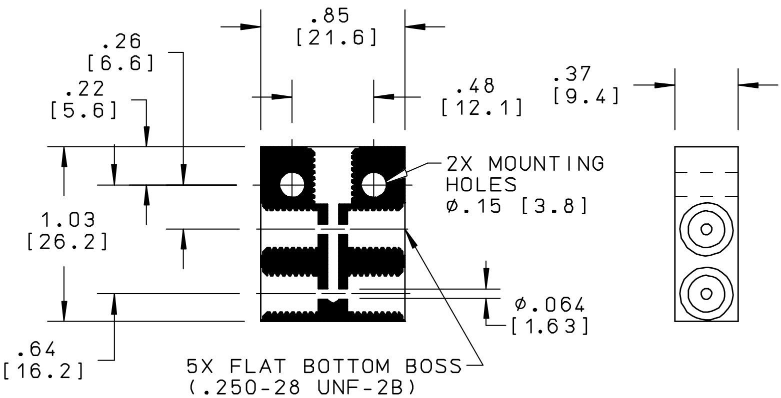
125/156 MINSTAC

TMMA9501950Z – PEEK



1/4-28 Flat Bottom

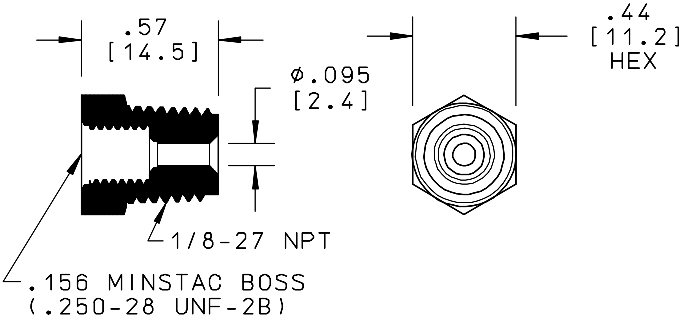
TMMA9502950Z – PEEK



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

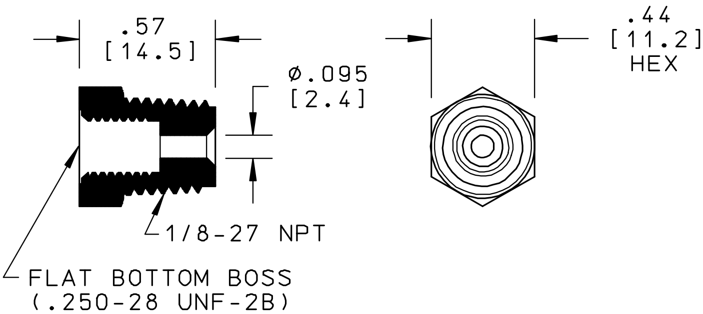
125/156 MINSTAC 1/8" Pipe Bushing

TMGA9502950Z – PEEK



1/4-28 Flat Bottom 1/8" Pipe Bushing

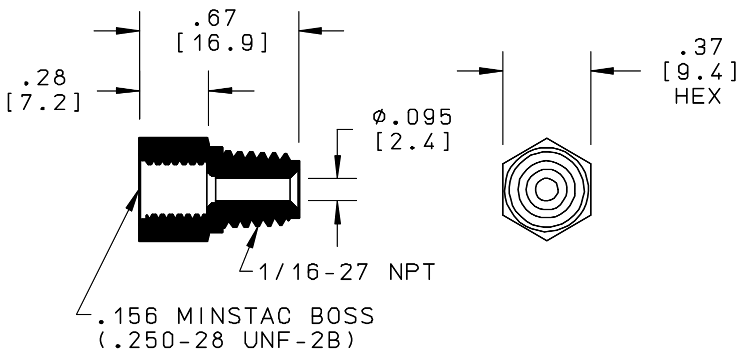
TMGA9504950Z – PEEK



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

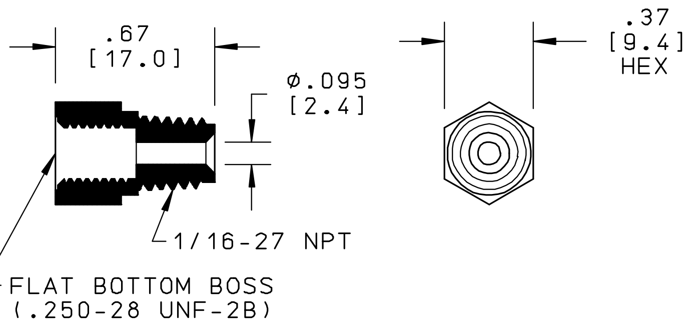
125/156 MINSTAC 1/16" Pipe Bushing

TMGA9501950Z – PEEK



1/4-28 Flat Bottom 1/16" Pipe Bushing

TMGA9503950Z – PEEK

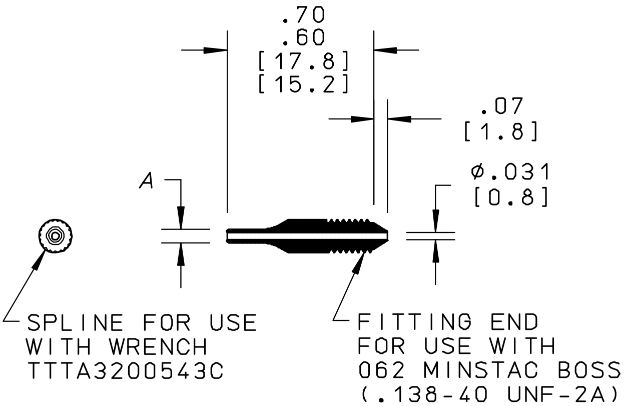


Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

062 MINSTAC – Tubing Adapter

Diameter A = 0.05" (1.3 mm) O.D. Recommended for use with a 0.042" I.D. tube
TMDA3207920Z: PBT
TMDA3207950Z: PEEK

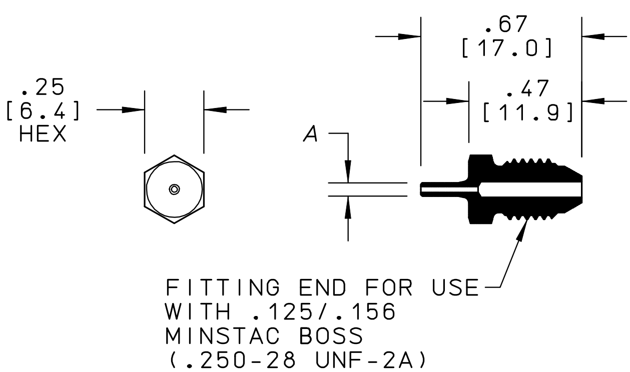
Diameter A = 0.07" (1.8 mm) O.D. Recommended for use with a 0.060" I.D. tube
TMDA3201930Z: POM
TMDA3201950Z: PEEK



125/156 MINSTAC Boss – Tubing Adapter

Diameter A = 0.05" (1.3 mm) O.D. Recommended for use with a 0.042" I.D. tube
TMDA9507950Z: PEEK

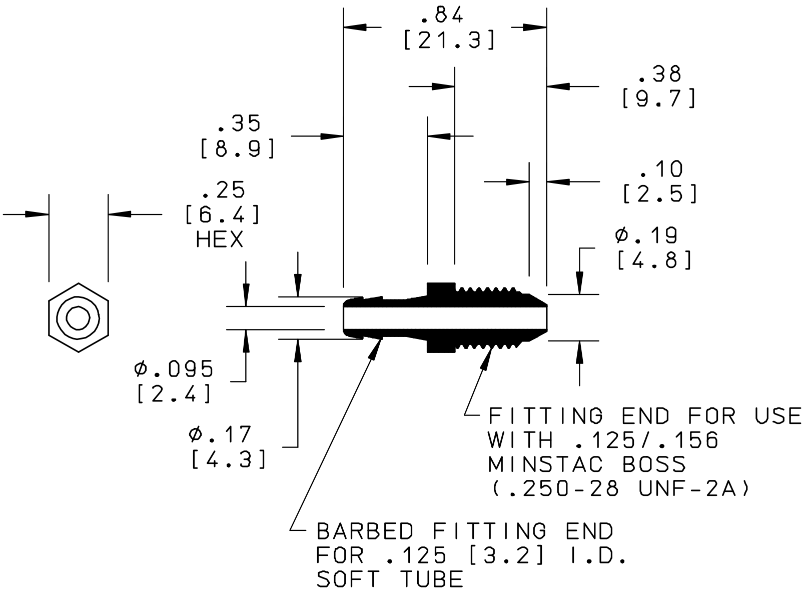
Diameter A = 0.07" (1.8 mm) O.D. Recommended for use with a 0.060" I.D. tube
TMDA9501950Z: PEEK



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

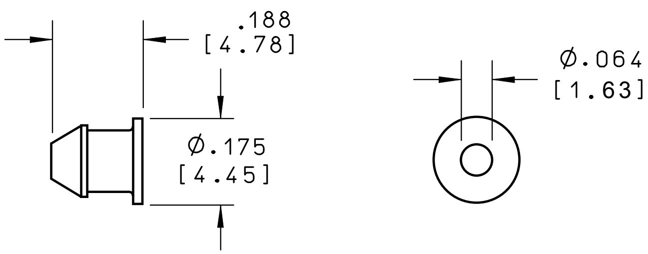
125/156 MINSTAC Soft Tubing Adapter

TMDA9501920Z – PBT



125/156 MINSTAC 1/4-28 Flat Bottom Ferrule

TMBA6202910Z – PCTFE

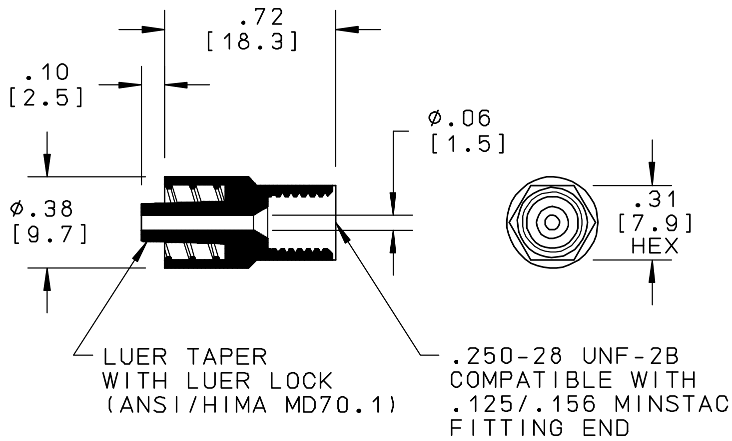


Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

L

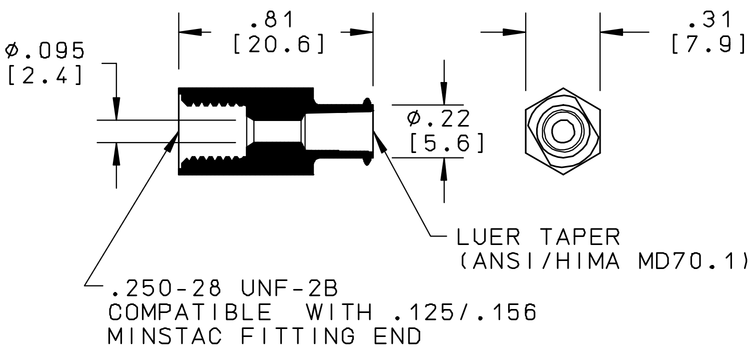
125/156 Female MINSTAC – Male Luer Lock Adapter

TMRA9503950Z – PEEK



125/156 Female MINSTAC – Female Luer Lock Adapter

TMRA9502950Z – PEEK

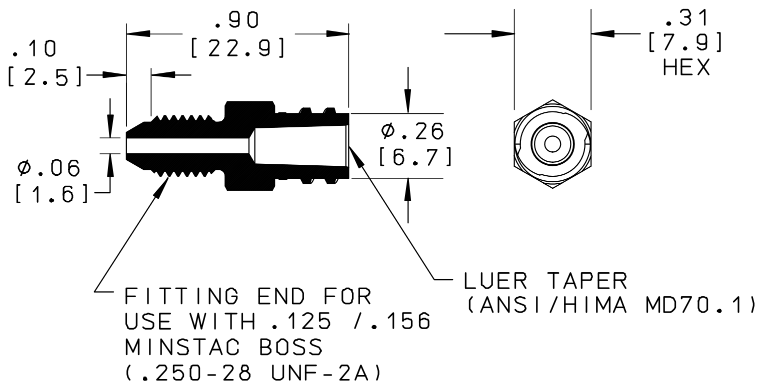


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

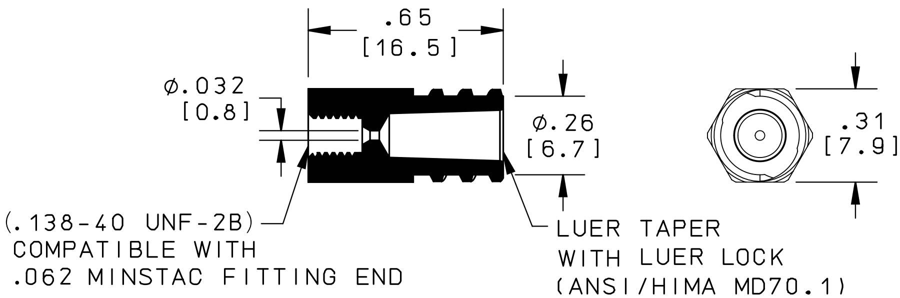
125/156 Male MINSTAC – Female Luer Lock Adapter

TMRA9501950Z – PEEK



062 Female MINSTAC – Female Luer Lock Adapter

TMRA3202950Z – PEEK

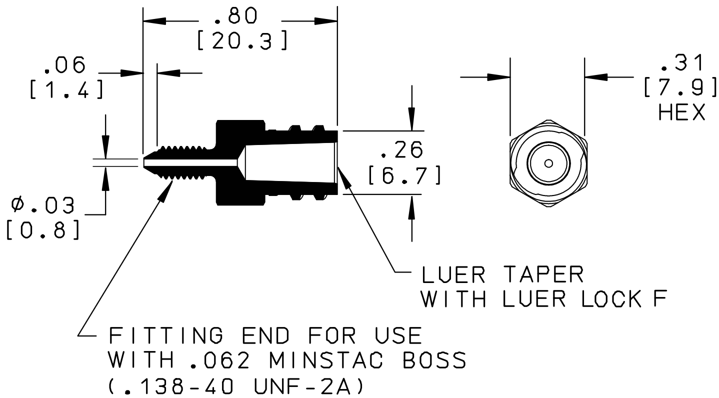


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

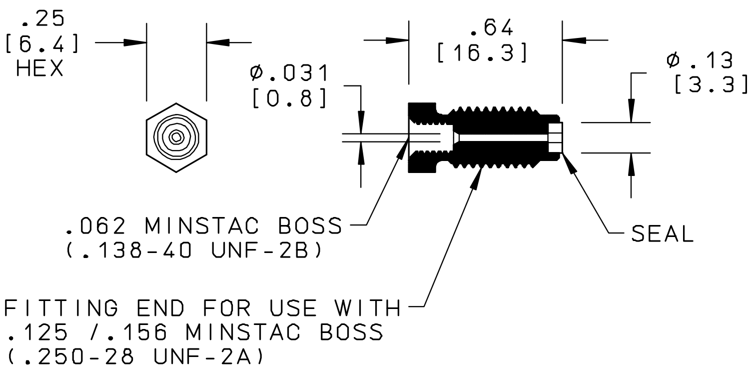
062 Male MINSTAC – Female Luer Lock Adapter

TMRA3201950Z – PEEK



062 MINSTAC – 1/4-28 Flat Bottom Adapter

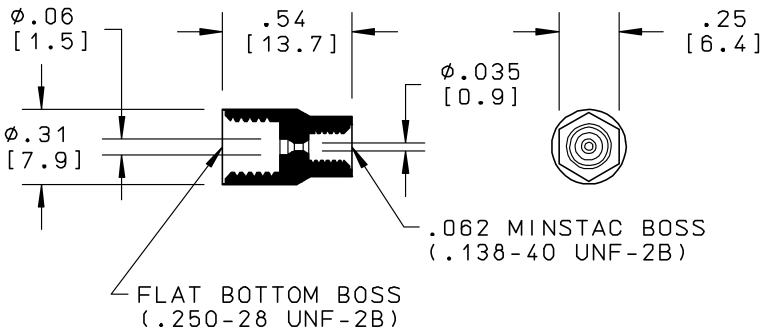
TMDA3204950Z – PEEK – PTFE



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

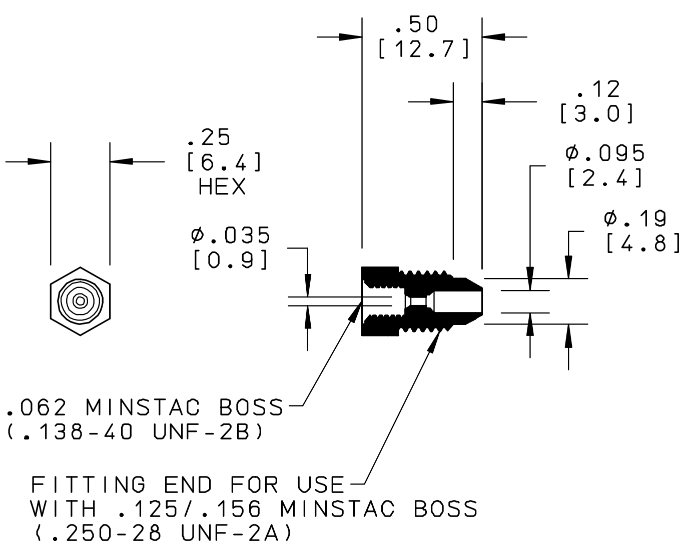
1/4-28 Flat Bottom – 062 MINSTAC

TMDA3212950Z – PEEK



062 MINSTAC Adapter – 125/156 MINSTAC

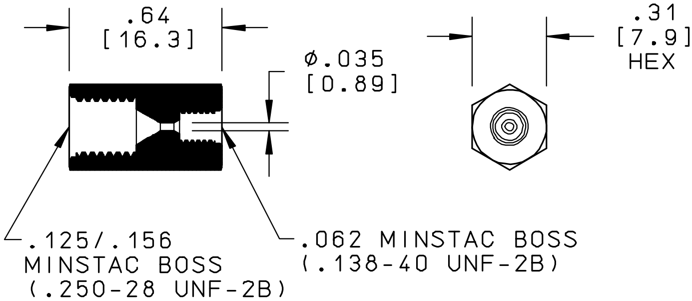
TMDA3203950Z – PEEK



Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

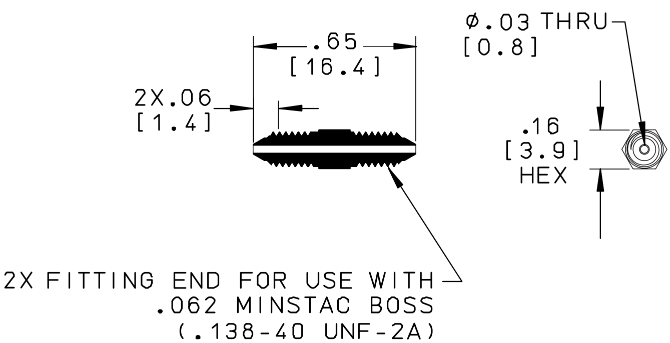
125/156 MINSTAC – 062 MINSTAC Adapter

TMDA9502950Z – PEEK



062 MINSTAC Male – 062 MINSTAC Male

TMUA3205950Z – PEEK



062 MINSTAC Tubing Union

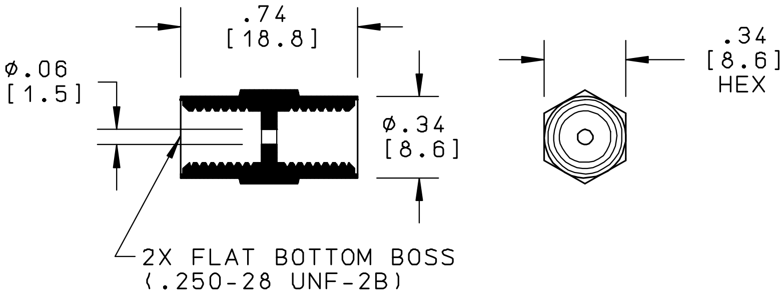
TMUA3201950Z – PEEK

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

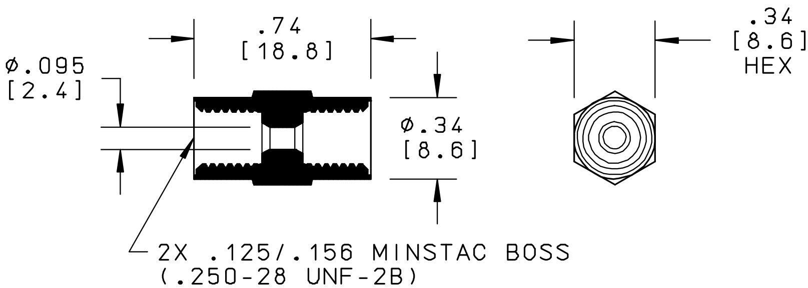
1/4-28 Flat Bottom Tubing Union

TMUA9503950Z – PEEK



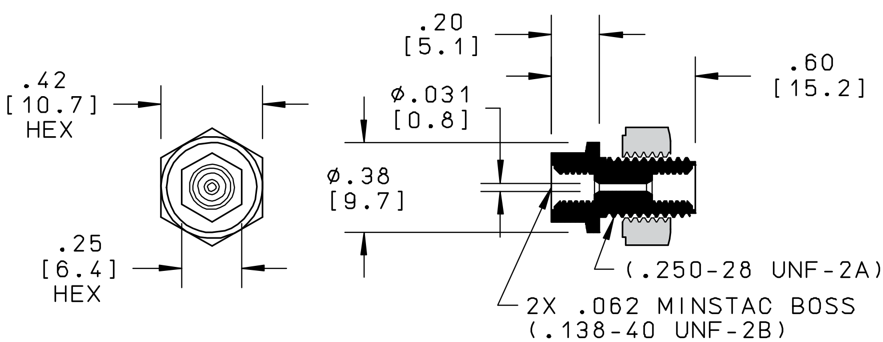
125/156 MINSTAC Tubing Union

TMUA9501950Z – PEEK



062 MINSTAC Bulkhead Union

TMUA3202950Z – PEEK – Nut: Nylon

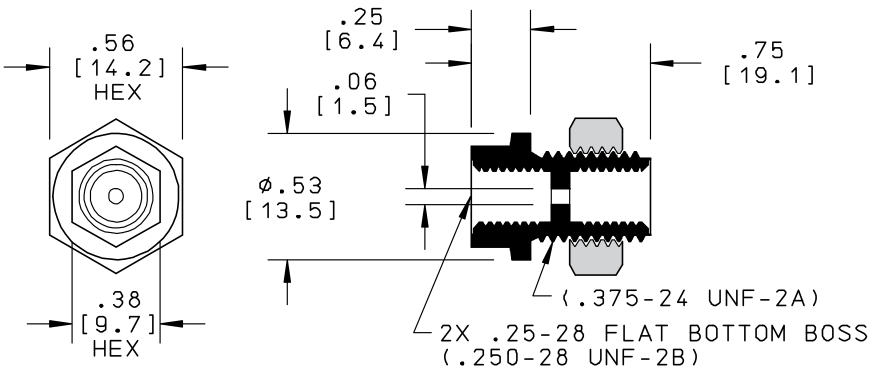


Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

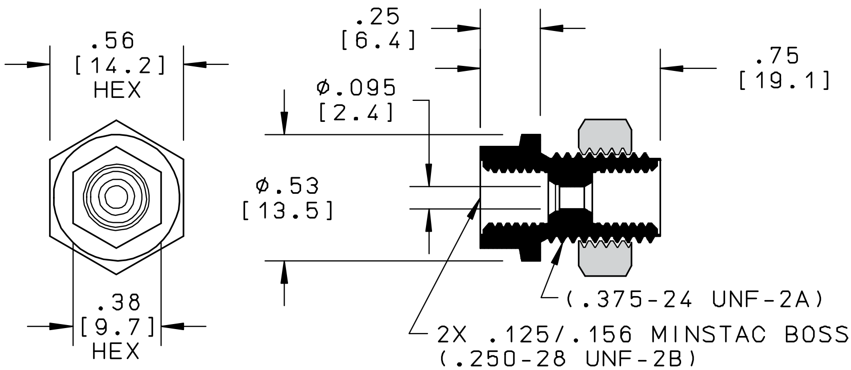
1/4-28 Flat Bottom Bulkhead Union

TMUA9504950Z – PEEK – Nut: Nylon



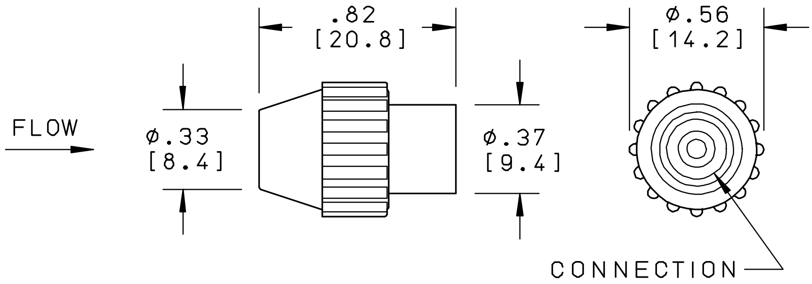
125/156 MINSTAC Bulkhead Union

TMUA9502950Z – PEEK – Nut: Nylon



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Check Valves



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	CONNECTION	LOHM RATE [1]
TKLA3201112H	062 MINSTAC (.138-40)	1000
TKLA9501130D	156 MINSTAC (1/4-28)	300
TKLA9502130D	1/4-28 Flat Bottom Boss	300

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

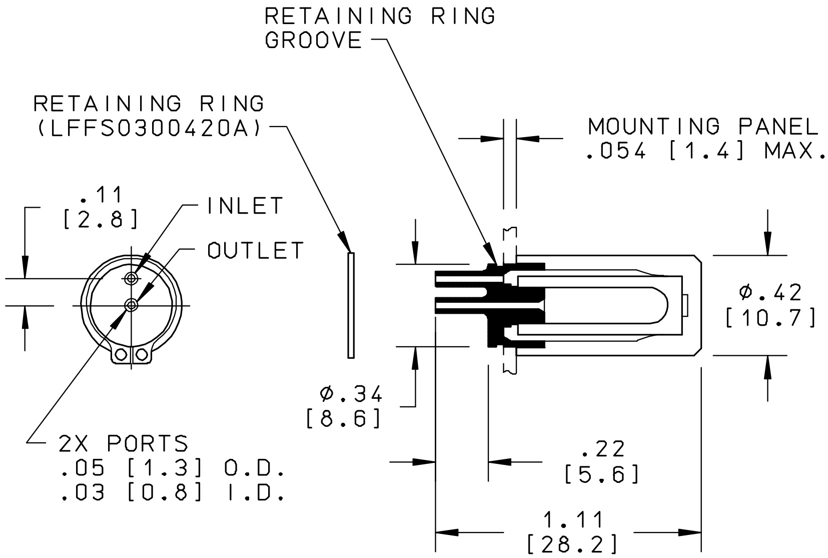
- Chemically inert
- Materials: PEEK body, FFKM diaphragm
- Cracking pressure: 4 in. H_20 (1.0 kPa)
- Leakage: 10 µL/min. at 28 in. H_20 in checked direction
- Maximum pressure in checked direction:
  75 psig (517 kPa) (062 MINSTAC)
  40 psig (276 kPa) (125/156 MINSTAC, 1/4-28 Flat Bottom Boss)
- Lohm rate:
  1000 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]. Drawings are not to scale.

L

Lee Panel Mount Filter*

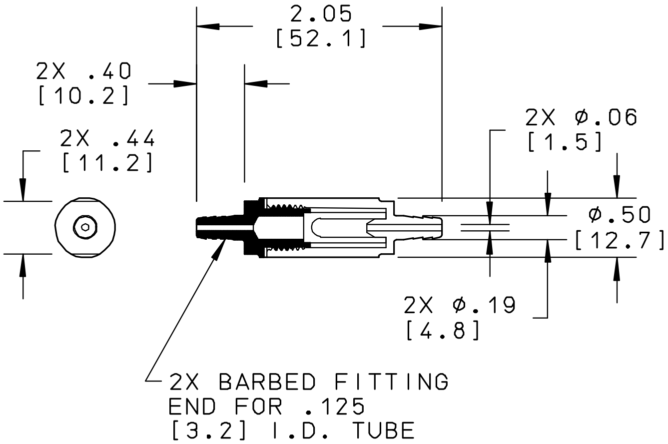
LFFA4202035A: 35 micron

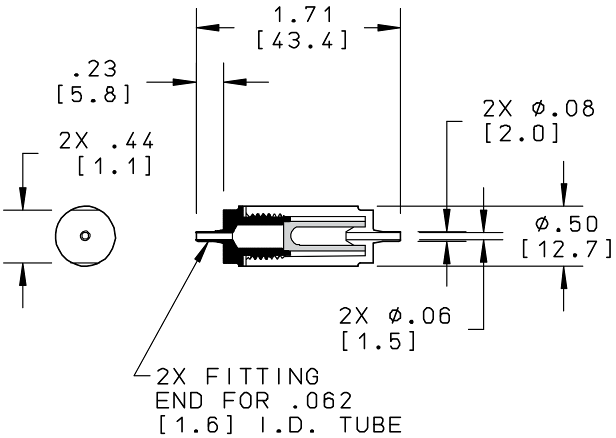


- Micron rating: 35 micron nominal
- Lohm rating: 1500 Lohms. Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Operating pressure: 30 psig (207 kPa) maximum
- Panel mounted Ø 0.350" (8.89 mm) diameter hole, 0.054" (1.37 mm) maximum plate thickness
- Material:
  Filter: UHMW PE
  Housing: PBT and PC
- Optional retaining ring available, LFFS0300420A
- Use with 0.040" ID Soft Tubing (TUVA4220900A)

* Suitable for solenoid valves with 0.054" ports.

In-Line Filter	Tube I.D.
TCFA1201035A: 35 micron	0.125" (3.2 mm)
TCFA6202035A: 35 micron	0.062" (1.6 mm)





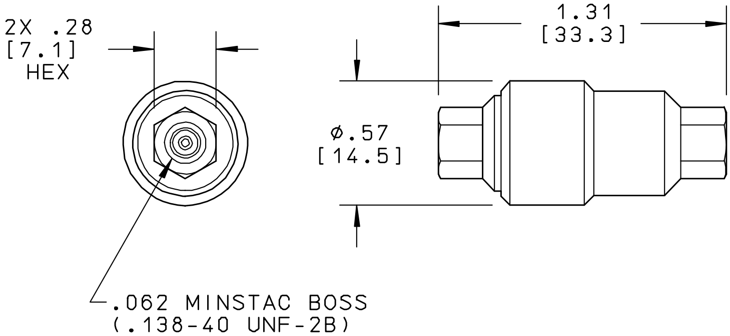
- Materials:
  Body: PC
  Filter element: UHMW PE
- Replacement filter element: 35 micron TCFS0300210A
- Maximum operating pressure: 30 psig (207 kPa)

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

L

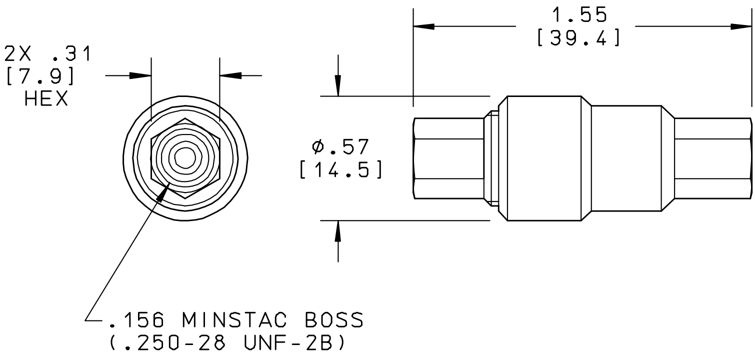
062 MINSTAC In-Line Filter

TKFA3202135A: 35 micron (1300 Lohm)
TKFA3202110A: 10 micron (1300 Lohm)



125/156 MINSTAC In-Line Filter

TKFA9502135A: 35 micron (300 Lohm)
TKFA9502110A: 10 micron (300 Lohm)

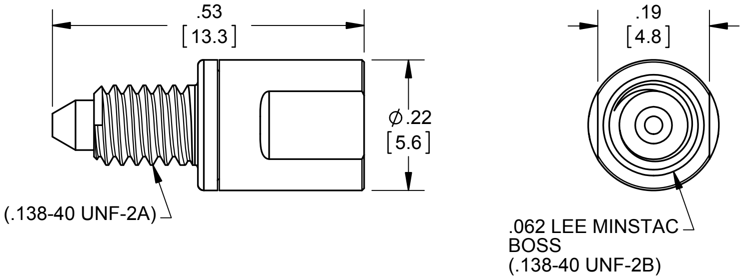


- Materials:
  Body: PEEK
  Filter element: UHMW PE
  Seal: PTFE
- Replacement filter element:
  35 micron TCFS0300560A
  10 micron TCFS0301040A
- Operating pressure: 100 psig (690 kPa)

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

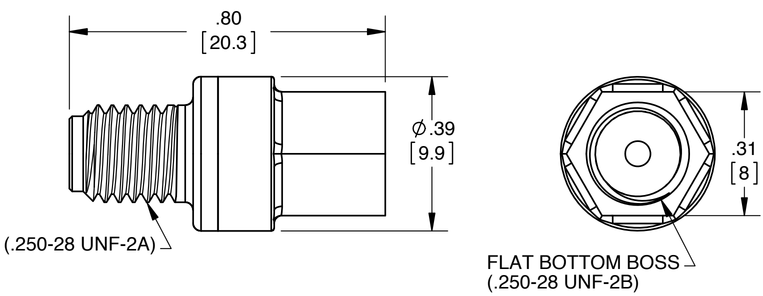
062 MINSTAC Safety Screen

INMX0350000A: 12 micron



1/4-28 Flat Bottom Safety Screen

INMX0350250A: 35 micron
INMX0350650A: 12 micron



- Materials: PEEK, PTFE (1/4-28 only)
- Maximum operating pressure: 120 psig (827 kPa)
- Lohm rates:
  INMX0350000A: 2100 Lohms
  INMX0350250A: 250 Lohms
  INMX0350650A: 600 Lohms

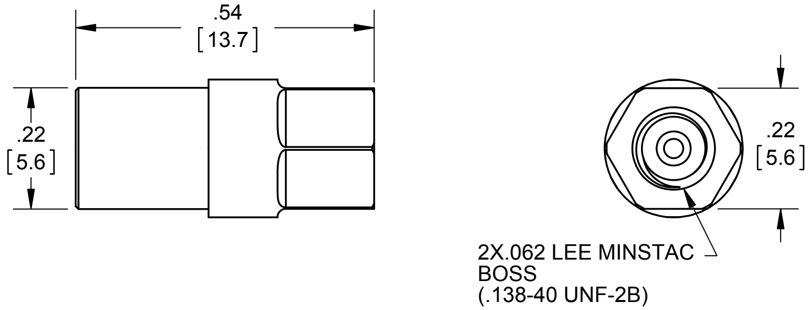
  Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Internal screen is not replaceable

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

L

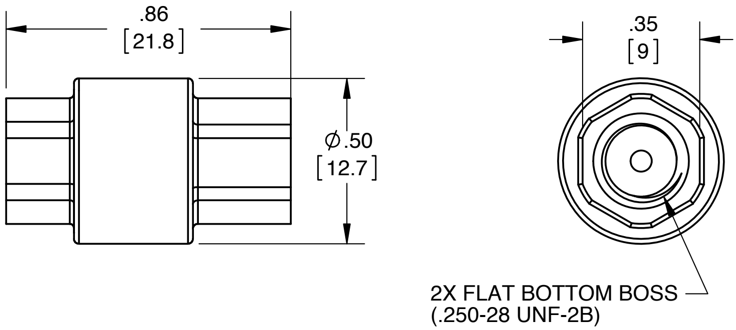
062 MINSTAC – Safety Screen

INMX0502300A: 12 micron



1/4-28 Flat Bottom – Safety Screen

INMX0503300A: 35 micron



- Materials: PEEK
- Maximum operating pressures:
  INMX0502300A: 150 psig
  INMX0503300A: 120 psig
- Lohm rates:
  INMX0502300A: 1450 Lohms
  INMX0503300A: 280 Lohms
  Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.
- Internal screen is not replaceable

Unless otherwise specified, dimensions are in inches [mm]. *Drawings are not to scale.*

Notes

L

MINSTAC Starter Kits

Lee offers several starter kits to familiarize the new user with the versatility of the MINSTAC system and assist in organizing preproduction breadboards.

062 MINSTAC Fitting End Kit

Lee Part Number TMZA3202010Z

Kit Includes:	1	–	TTTA3201443A	Collet Tool
	1	–	TTTA3201543A	Chamfer Tool
	1	–	TTTA3201243A	Torque Wrench
	1	–	TTTA6202027A	Knife
	25	–	TMAA3202079Z	Coupling Screws
	25	–	TMBA3202910Z	Ferrules
	25	–	TMCA3202030Z	Collet Sleeves
	1	–	TUTA3216930D	10 feet of Tubing
	1	–	TTTX0500900A	Rubber Tubing Grip

062 MINSTAC Tool Kit

Lee Part Number TTTA3201043C

Kit Includes:	1	–	TTTA3201543A	Chamfer Tool
	1	–	TTTA3201443A	Collet Installation Tool
	1	–	TTTA3200643A	Combination Spade Drill
	1	–	TTTA3200743A	Plug Tap with Stop
	1	–	TTTA3200843A	Bottoming Tap with Stop
	1	–	TTTA3200543C	Spline Wrench
	1	–	TTTA3201243A	Torque Wrench

125 MINSTAC Fitting End Kit

Lee Part Number TMZA6201010Z

Kit Includes:	1	–	TTTA6200143A	Coupling Assembly Tool
	1	–	TTTA6200343A	Coupling Assembly Tool (ferruleless)
	1	–	TTTA6202027A	Knife
	1	–	TTTA6202227A	Torque Wrench
	25	–	TMAA6201929Z	Coupling Screws
	25	–	TMBA6201910Z	Ferrules
	25	–	TMCA6201920Z	Collets
	1	–	TUTA6230930D	10 feet of Tubing (TFE)
	1	–	TTTX0500900A	Rubber Tubing Grip

125 MINSTAC Tool Kit

Lee Part Number TTTA6201827C

Kit Includes:	1	–	TTTA6200143A	Coupling Assembly Tool
	1	–	TTTA6200343A	Coupling Assembly Tool (ferruleless)
	1	–	TTTA6201927A	Combination Spade Drill
	1	–	TTTA6200227C	Combination Wrench – .25 in.
	1	–	TTTA6201627A	Plug Tap with Stop
	1	–	TTTA6201727A	Bottoming Tap with Stop
	1	–	TTTA6202227A	Torque Wrench

156 MINSTAC Fitting End Kit

Lee Part Number TMZA9501110Z

Kit Includes:	1	–	TTTA9500127A	Coupling Assembly Tool
	1	–	TTTA9500343A	Torque Wrench
	1	–	TTTA6202027A	Knife
	25	–	TMAA9501079Z	Coupling Screws
	25	–	TMBA9501910Z	Ferrules
	25	–	TMCA9501950Z	Collet Sleeves
	1	–	TUTA9531930D	10 feet of Tubing
	1	–	TTTX0500900A	Rubber Tubing Grip

156 MINSTAC Tool Kit

Lee Part Number TTTA9500443C

Kit Includes:	1	–	TTTA9500127A	Coupling Assembly Tool
	1	–	TTTA9500227A	Combination Boss Drill
	1	–	TTTA9500343A	Torque Wrench
	1	–	TTTA9500427C	Wrench
	1	–	TTTA6201627A	Plug Tap with Stop
	1	–	TTTA6201727A	Bottoming Tap with Stop

Nozzles

The Lee Company offers a complete line of nozzles, capable of providing precise dispensing or atomization of fluids. Available in several different mounting styles, these nozzles can be integrated with our VHS Series solenoid valves or used separately and connected with soft flexible tubing.

Dispensing Nozzles

The dispensing nozzles can be mounted to our VHS Series valves for dispensing applications. Available in different mounting styles, this setup not only reduces the overall size, but more importantly, it minimizes the amount of transition fluid between the valve sealing surface and nozzle which improves the overall reaction time at the system level.

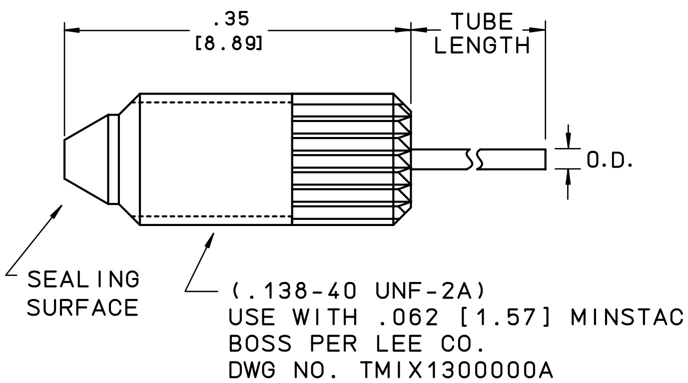
Atomizing Nozzles

The atomizing nozzles are available in both air-assisted and airless designs. Our air-assisted nozzles provide atomization with as little as 5 psi of fluid and air. These nozzles are available for use with soft flexible tubing. The airless nozzles provide atomization at relatively low pressures (30 psi) without the need for an external air source.

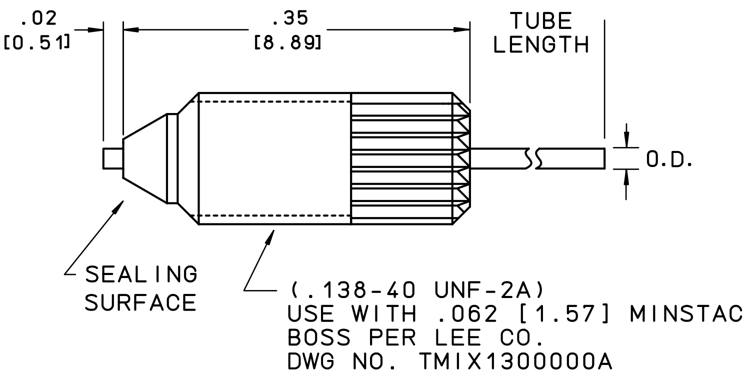
All nozzles are made with materials that will ensure consistent long-term performance. The Lee Company can customize performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.

Dispensing Nozzles

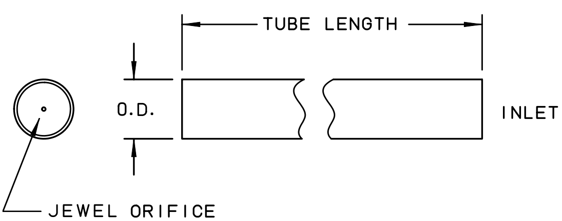
CONFIGURATION A



CONFIGURATION B



CONFIGURATION C



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

062 MINSTAC Straight Tube

PART NUMBER	CONFIGU-RATION	TUBE I.D.	TUBE O.D.	TUBE LENGTH	LOHM RATE[1]
INZA3070940K	A	0.007" (0.18 mm)	0.02" (0.51 mm)	0.35" (8.9 mm)	40,000 (Ref. Cv = 0.005)
INZA3102514K	A	0.010" (0.25 mm)	0.02" (0.51 mm)	1.00" (25.4 mm)	14,000 (Ref. Cv = 0.0014)
INZA5102514K	B*	0.010" (0.25 mm)	0.02" (0.51 mm)	1.00" (25.4 mm)	
INZA5100914K	B*	0.010" (0.25 mm)	0.02" (0.51 mm)	0.35" (8.9 mm)	
INZA3100914K	A	0.010" (0.25 mm)	0.02" (0.51 mm)	0.35" (8.9 mm)	
INZA3330997D	A	0.030" (0.76 mm)	0.05" (1.27 mm)	0.37" (9.4 mm)	975 (Ref. Cv = 0.0205)
INZA3362597D	A	0.030" (0.76 mm)	0.07" (1.65 mm)	1.00" (25.4 mm)	

- Wetted materials: stainless steel, (* PTFE coated tube) and epoxy. PTFE coating is a surface treatment for wetting only. Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

062 MINSTAC with Jeweled Orifice

PART NUMBER	CONFIGU-RATION	ORIFICE I.D.	TUBE O.D.	TUBE LENGTH	LOHM RATE[1]
INZA4620928T	A	0.002" (0.05 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	280,000 (Ref. Cv = 0.001)
INZA4630912T	A	0.003" (0.08 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	125,000 (Ref. Cv = 0.002)
INZA4542560K	A	0.004" (0.10 mm)	0.020" (0.5 mm)	1.00" (25.4 mm)	60,000 (Ref. Cv = 0.003)
INZA4640960K	A	0.004" (0.10 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	
INZA6542460K	B*	0.004" (0.10 mm)	0.020" (0.5 mm)	0.96" (24.4 mm)	
INZA4650935K	A	0.005" (0.13 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	35,000 (Ref. Cv = 0.006)
INZA4652535K	A	0.005" (0.13 mm)	0.050" (1.3 mm)	0.97" (24.6 mm)	
INZA4655035K	A	0.005" (0.13 mm)	0.050" (1.3 mm)	1.97" (50.0 mm)	
INZA4670915K	A	0.0075" (0.19 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	15,400 (Ref. Cv = 0.0013)
INZA6670915K	A*	0.0075" (0.19 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	
INZA4710975H	A	0.010" (0.25 mm)	0.050" (1.3 mm)	0.35" (8.9 mm)	7500 (Ref. Cv = 0.0027)

- Wetted materials: stainless steel, (* PTFE coated tube), sapphire and epoxy. PTFE coating is a surface treatment for wetting only. Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

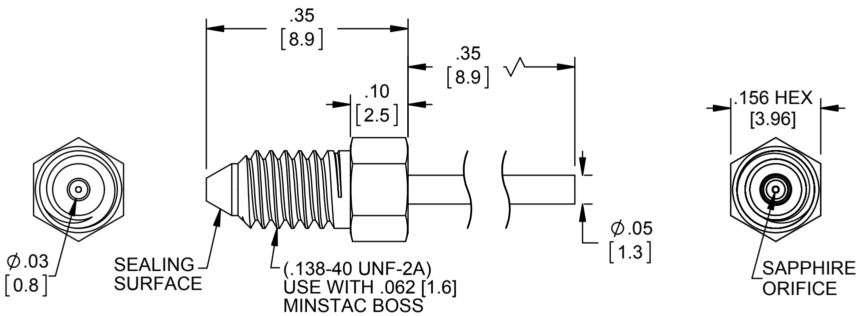
Straight Tube with Jeweled Orifice

PART NUMBER	CONFIGU-RATION	ORIFICE I.D.	TUBE O.D.	TUBE LENGTH	LOHM RATE[1]
INZA2631412T	C	0.003" (0.08 mm)	0.050" (1.3 mm)	0.57" (14.5 mm)	125,000 (Ref. Cv = 0.0002)
INZA2543460K	C	0.004" (0.10 mm)	0.020" (0.51 mm)	1.33" (33.8 mm)	60,000 (Ref. Cv = 0.0003)
INZA2540660K	C	0.004" (0.10 mm)	0.020" (0.51 mm)	0.25" (6.4 mm)	
INZA2651435K	C	0.005" (0.13 mm)	0.050" (1.3 mm)	0.57" (14.5 mm)	35,000 (Ref. Cv = 0.0006)
INZA2653035K	C	0.005" (0.13 mm)	0.050" (1.3 mm)	1.17" (29.7 mm)	
INZA2671415K	C	0.0075" (0.19 mm)	0.050" (1.3 mm)	0.57" (14.5 mm)	15,400 (Ref. Cv = 0.0013)
INZA2961331H	C	0.016" (0.41 mm)	0.043" (1.09 mm)	0.50" (12.7 mm)	3100 (Ref. Cv = 0.0065)
INZA2621428T	C	0.002" (0.05 mm)	0.050" (1.3 mm)	0.57" (14.5 mm)	280,000 (Ref. Cv = 0.0001)

- Wetted materials: stainless steel and sapphire.

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

Hex Dispensing Nozzles



- Compatible with Lee Company 062 MINSTAC bosses
- Compatible with all Lee Company 062 MINSTAC components and valves
- Wetted materials: stainless steel, sapphire

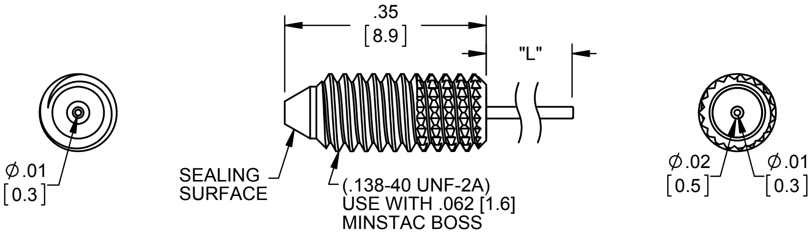
HEX MINSTAC with Jeweled Orifice

PART NUMBER	ORIFICE I.D.	LOHM RATE[1]
INZA7710975H	0.010" (0.25 mm)	7500 (Ref. Cv = 0.0027)
INZA7670915K	0.008" (0.20 mm)	15,400 (Ref. Cv = 0.0013)
INZA7650935K	0.005" (0.13 mm)	35,000 (Ref. Cv = 0.0006)
INZA7640960K	0.004" (0.10 mm)	60,000 (Ref. Cv = 0.0003)
INZA7630912T	0.003" (0.08 mm)	125,000 (Ref. Cv = 0.0002)
INZA7620928T	0.002" (0.05 mm)	280,000 (Ref. Cv = 0.0001)

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Shape Memory Alloy Dispensing Nozzles



Shape memory alloy nozzles allow precise dispensing and flexibility. The nickel titanium 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 materials: nickel titanium, stainless steel, epoxy
- Compatible with Lee Company 062 MINSTAC bosses

062 MINSTAC with Straight Nickel Titanium Tube

PART NUMBER	LENGTH "L"	LOHM RATE[1]
INZA9102520K	1.0" (25.4 mm)	20,000 (Ref. Cv = 0.0010)
INZA9105132K	2.0" (50.8 mm)	32,000 (Ref. Cv = 0.0006)
INZA9107642K	3.0" (76.2 mm)	42,000 (Ref. Cv = 0.0005)

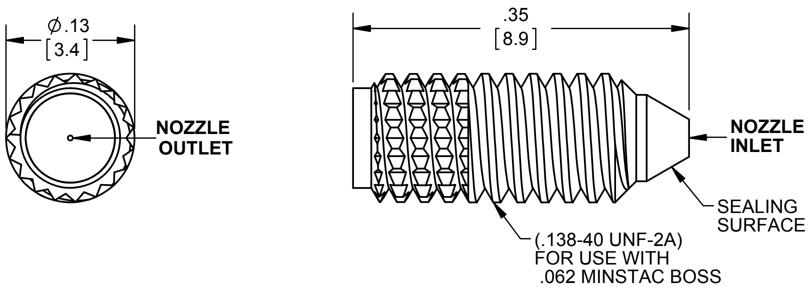
NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

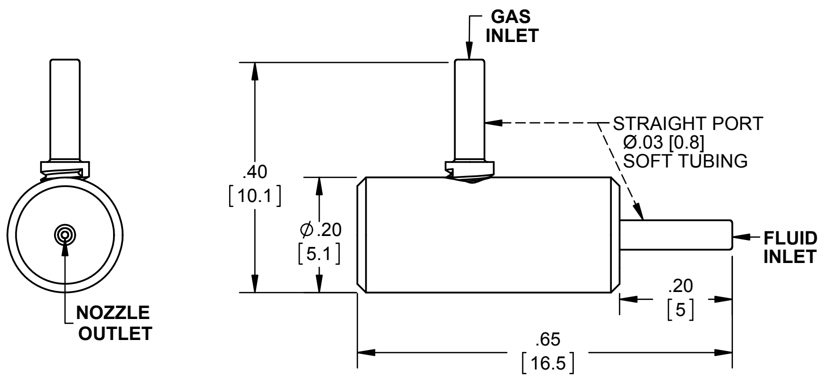
M

Atomizing Nozzles

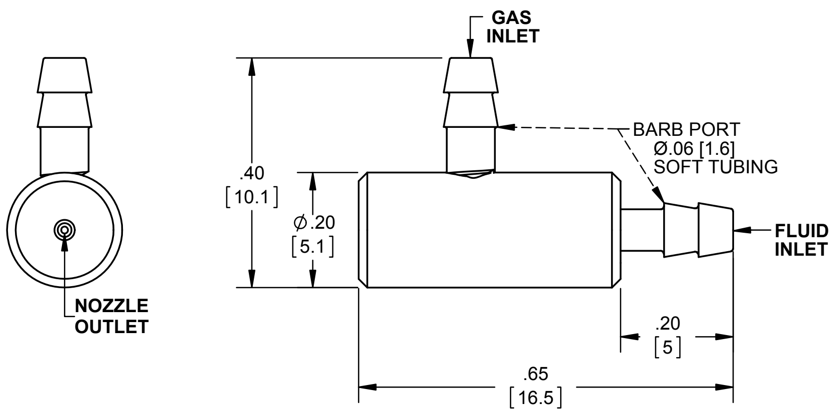
CONFIGURATION A



CONFIGURATION B



CONFIGURATION C



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Airless Atomizing Nozzles

PART NUMBER	CONFIGURATION	LOHM RATE[1]	OPERATING PRESSURE (psig)
IAZA1200167K	A	67,000 (Ref. Cv = 0.0003)	30-1000
IAZA1200163K	A	63,000 (Ref. Cv = 0.0003)	30-1000
IAZA1200147K	A	47,000 (Ref. Cv = 0.0004)	30-1000
IAZA1200134K	A	34,000 (Ref. Cv = 0.0006)	30-1000
IAZA1200122K	A	22,000 (Ref. Cv = 0.0009)	30-1000
IAZA1200110K	A	10,000 (Ref. Cv = 0.0020)	30-1000

- Airless nozzles designed for use with 062 MINSTAC system.
- Spray cone: 50° hollow
- Wetted materials: stainless steel

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

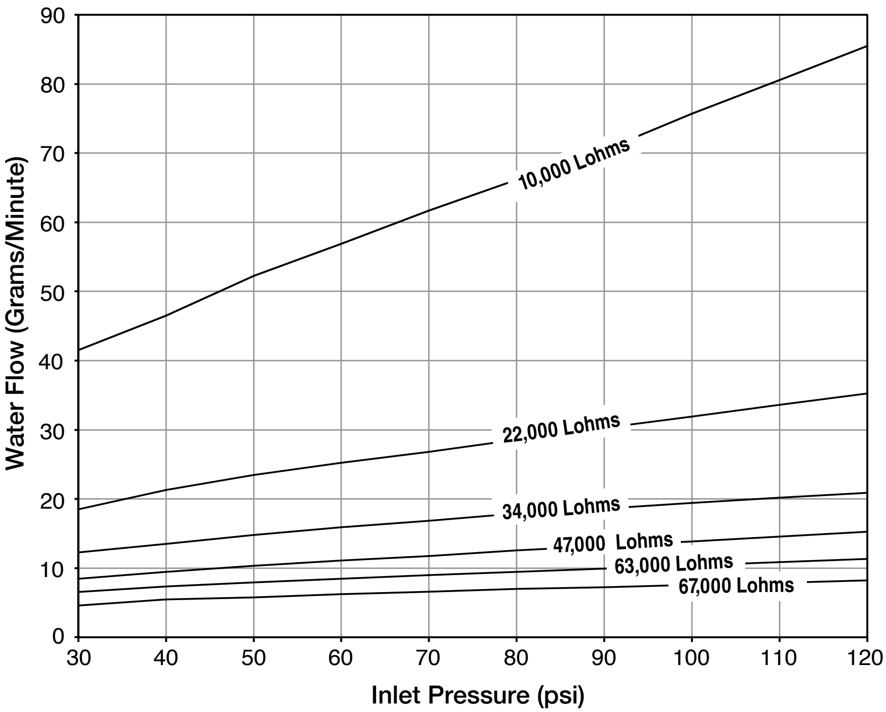
Air-Assisted Atomizing Nozzles

PART NUMBER	CONFIGURATION	LOHM RATE[1]	OPERATING PRESSURE (psig)
IAZA5200315K	B	15,000 (Ref. Cv = 0.0013)	5-60
IAZA5200375H	B	7500 (Ref. Cv = 0.003)	5-60
IAZA5200415K	C	15,000 (Ref. Cv = 0.0013)	5-60
IAZA5200515K	C	15,000 (Ref. Cv = 0.0013)	5-60
IAZA5200475H	C	7500 (Ref. Cv = 0.003)	5-60

- Spray cone: 50° solid
- External air pressure of 5 psig min. is required for atomization.
- Wetted materials: stainless steel, PEEK (IAZA5200515K only) and cyanoacrylate

NOTE: (1) Refer to Engineering Reference (Section R), for a full description of the Lohm Laws.

Nozzle Dispense (Steady State)



This chart illustrates steady state flow through the nozzles.
Flow rates can be further modified by using pulse width modulation through a VHS valve.

Special Nozzles

Special nozzle designs are available for OEM applications. Please contact The Lee Company for technical assistance.

- Sharp Tip
- Wash Nozzles
- Bent Nozzle
- Barb Connection
- Long Length
- Multi-Lumen
- Nozzle Integrated into Valve

Lee Check and Relief Valves

The Lee Company offers a wide range of cartridge-style check and relief valves for installation into metal or plastic housings and fittings. These valves are available with a high quality metal to metal seat or with an elastomeric seal design offering zero leak performance. All valves are 100% tested to ensure consistent, long term operation. For additional information on Lee check and relief valves, please contact your Lee Sales Engineer.

- 100% tested which eliminates need for system rework
- Multiple material options for design flexibility and compatibility with aggressive fluids
- Screened versions available to block rogue contamination and ensure system reliability

Lee Orifices

Lee Orifices are economical, reliable, highly accurate miniature restrictors. These orifices are 100% flow tested to ensure that every part is within ±5% of its nominal flow rate (tighter flow tolerances are available as special orders). Tight flow tolerances are only possible if entrance and exit conditions are closely controlled. This provides far more accuracy than an orifice specified by hole tolerance. An ordinary hole held to a very tight hole tolerance will not result in a tight follow tolerance.

The Lee Company offers a wide variety of configurations for installation into metal or plastic housings and fittings. They are also available in gas or liquid versions. Gas orifices are tested on clean dry nitrogen and liquid orifices are tested on distilled water. Great care is taken to ensure the accuracy of our automated test systems. To further increase accuracy, orifices are tested in the direction of use. For additional information on Lee Orifices, please contact your Lee Sales Engineer.

- Accurate flow eliminates expensive alternative components and ensures consistent system performance
- 100% flow tested to ensure all parts are within flow tolerance
- Multiple material options for design flexibility and compatibility with different fluids
- Integral safety screens simplify assembly and ensure reliability

Lee Safety Screens

Lee Safety Screens are designed to protect critical fluid control components from rogue contamination. Safety screens are available in a wide range of installation configurations and sizes to meet various system requirements.

Stainless steel woven wire mesh designs offer a reliable and economical solution. Etched safety screens provide maximum open area to reduce pressure drop across the component and increase resistance to clogging. Drilled screens have high pressure capability, can be easily flushed, and are offered in a variety of materials such as PEEK for resistance against harsh chemicals and brass for use in oxygen systems.

For additional information on Lee Safety Screens, please contact your local Lee Sales Engineer.

- Maximum contamination protection (micron ratings from 4 to 500) without unnecessary clogging
- Variety of configurations and sizes available for installation and design flexibility
- Multiple material options for compatibility with a wide range of liquids and gases

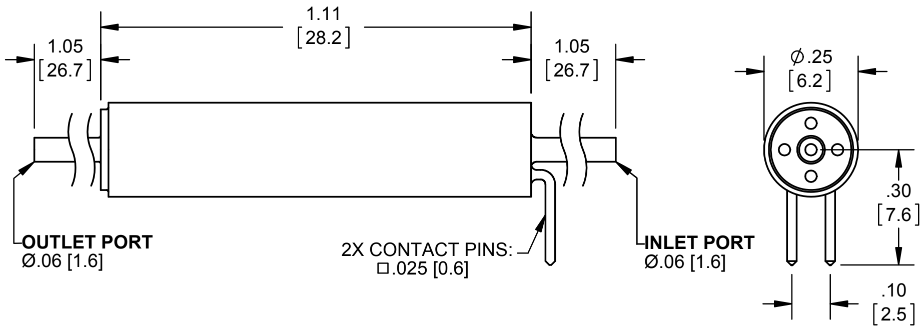
Notes

IEP Series

The IEP Series solenoid valves are designed for applications requiring extended performance. Available as a 2-way normally closed design, these valves are capable of operating across a wide range of pressure and temperature without sacrificing size. These valves are typically used in applications such as scanning electron microscopes, CubeSat propulsion, precision combustion systems, oil well analyzers and cryogenic surgery devices. The following general performance characteristics are offered in this product platform:

- Low Internal Volume
- Operating Pressures up to 800 psig
- Operating Temperatures up to 275°F (135°C)
- Response Time as Fast as 0.5 ms
- Spike and Hold Drive Required
- Lohm Rate: 4100
- Available Elastomers: EPDM, FKM and FFKM

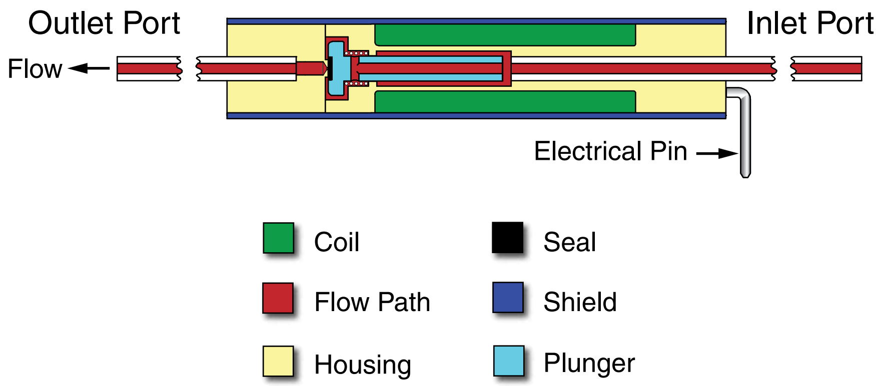
Each valve is 100% functionally tested for performance, and designed using materials that ensure consistent long-term performance. The Lee Company can customize valve performance to meet specific application requirements. Please contact your local Lee Sales Engineer for additional technical assistance and application information.



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

PART NUMBER	SPIKE VOLTAGE (Vdc)	MAX. SPIKE DURATION [1] (ms)	HOLD VOLTAGE (Vdc)	POWER AT HOLDING VOLTAGE (mW)
IEPA1211141H	12	3.8	1.6	250
IEPA2411141H	24	3.8	3.0	250
IEPA1221141H	12	3.8	1.6	250
IEPA2421141H	24	3.8	3.0	250
IEPA1211541H	12	3.8	1.6	250
IEPA2411541H	24	3.8	3.0	250
IEPA1221541H	12	3.8	1.6	250
IEPA2421541H	24	3.8	3.0	250
IEPA1211241H	12	3.8	1.6	250
IEPA2411241H	24	3.8	3.0	250

NOTES: (1) Spike duration is based on max. operating pressure at 70°F (21°C).
Lower operating pressures will allow for shorter spike durations.
Higher operating temperatures will require longer spike durations.



	OPERATING PRESSURE RANGE (psig)	AMBIENT TEMPERATURE RANGE	MAXIMUM COIL TEMPERATURE	LOHM RATE[2]	SEAL MATERIAL[3]
	0-800	0°F to 120°F (-17°C to 49°C)	250°F (121°C)	4100 (Ref. Cv = .005)	FKM
	0-800		250°F (121°C)		FKM
	0-800	0°F to 275°F (-17°C to 135°C)	400°F (204°C)		FKM
	0-800		400°F (204°C)		FKM
	0-300	40°F to 120°F (4°C to 49°C)	250°F (121°C)		FFKM
	0-300		250°F (121°C)		FFKM
	0-300	40°F to 275°F (4°C to 135°C)	400°F (204°C)		FFKM
	0-300		400°F (204°C)		FFKM
	0-800	-20°F to 120°F (-29°C to 49°C)	250°F (121°C)		EPDM
	0-800		250°F (121°C)		EPDM

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

(3) Wetted materials: 316 SS, FeCr alloy, seal material and epoxy. Refer to Engineering Reference Section, pages R53-54, for material information and abbreviations.

GENERAL SPECIFICATIONS

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

Weight

4.7 grams

Internal Volume

62 μL

Operating Pressure

The valves will operate within the specified pressure range when supplied with the rated voltage ± 5%.

Valve Proof Pressure: 2x Normal Rated Pressure
Valve Burst Pressure: 3x Normal Rated Pressure

Operating Temperature

- Refer to part number table on pages O3-4.
- Increasing the operating temperature tends to limit coil performance. The valve duty cycle and energized time must be evaluated for conformance with the maximum rated operating and coil temperatures.

Storage Conditions

- Temperature: -40°F to 175°F (-40°C to 80°C)
- Relative humidity: 85% (max); non-condensing

Electrical Characteristics

- The IEP Series valves require the use of a spike and hold drive to safely operate. Driving these valves any other way may result in damage to the valve. Refer to Engineering Reference Section, pages R35-36, for recommended electrical drive schematics.
- The Lee Company offers a Spike and Hold Driver (Reference Lee Company Part Number IECX0501350A or IECX0501500A) for development use.

SPIKE VOLTAGE (Vdc)	RESISTANCE (ohms)	ENERGIZED INDUCTANCE (mH)	DE-ENERGIZED INDUCTANCE (mH)
12	10.6	22.2	5
24	37	16.5	4.2

Electrical Connection

These valves are designed with axial 0.025" sq. pins that are spaced 0.100" center to center. The Lee Company offers a lead wire connector assembly as a separate accessory that is compatible with this pin spacing.

- Lee Company Part Number IHWX0248010A – Length, 8 inches
- Lee Company Part Number IHWX0248120A – Length, 24 inches

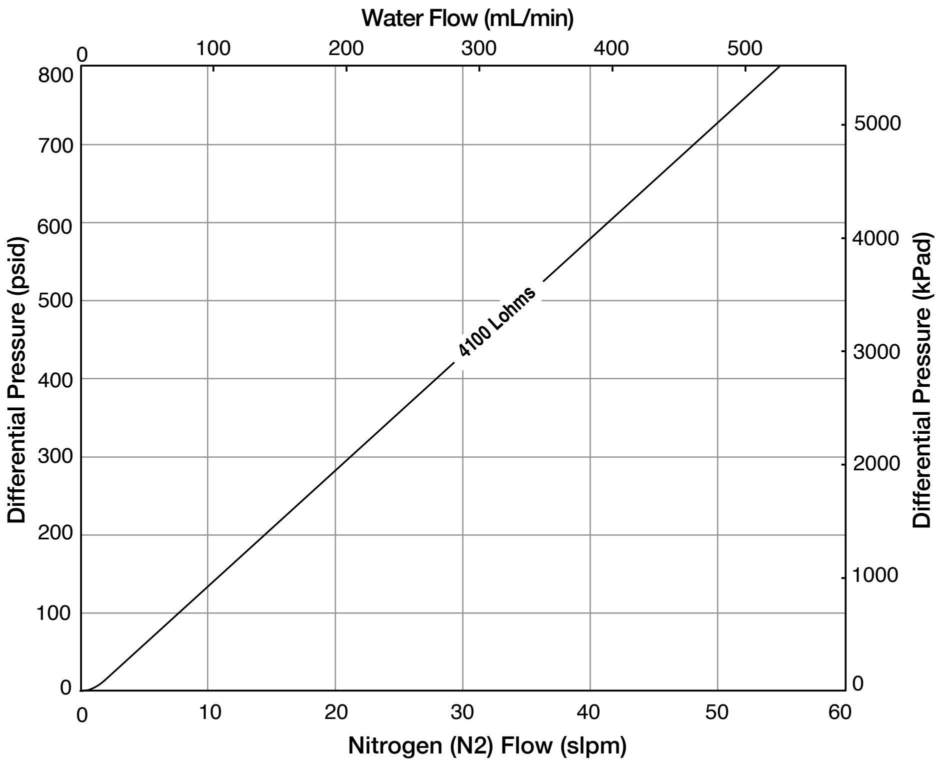
Response Time

- The typical response time is 0.5 ms on air at 10 psig based on the spike and hold drive parameter.
- Response times are dependent upon system conditions, power, environment, etc. The response will typically increase as the ambient operating temperature decreases. Extended periods of valve inactivity may also have an impact on the initial response time of the valve.

Filtration

Filtration of 10 microns or finer is recommended.

Typical Flow Characteristics
IEP Series Valves



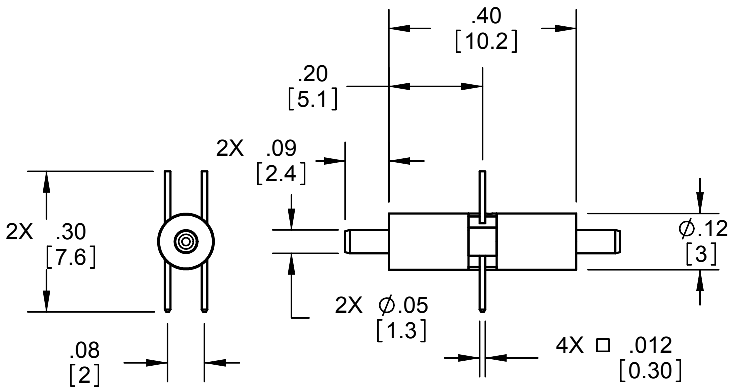
120 Series

The World's Smallest Solenoid Valve

Part Number LFLX0510200B

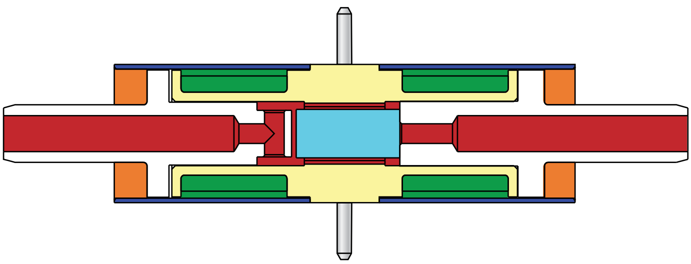
The Lee Series 120 Solenoid Valve is a 2-way, ultra-miniature, magnetically latched solenoid valve ideal for compact battery-powered pneumatic applications such as air piloting, lab automation (lab-on-a-chip), and other miniature, power-sensitive markets such as fuel cells or for R&D proof of concept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



Unless otherwise specified, dimensions are in inches [mm]. Drawings are not to scale.

Cross Section View



GENERAL SPECIFICATIONS

- Flow media: air; compatible gases
- Operating voltage: 5 Vdc; 1 ms pulse to switch (1.8 mJ/switch)
- Flow capacity (air): 5000 Lohms (1 SLPM @ 5 psid)
- Operating pressure: Vac-15 psig (0-5 psid)
- Coil resistance: 14 Ohms at 70°F (21°C)
- Weight: 300 mg
- Leakage: 1 SCCM (max) at 5 psid
- Maximum frequency: 10 Hz
- Ported Style: connection to 0.042" ID soft tubing
- Wetted materials: PPS (housing), ceramic (magnet), 430 SS (flow ports & shield), epoxy

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 optimize system performance.

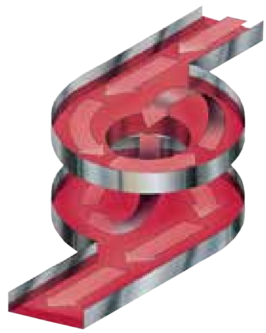
- Low Internal Volume – 10 µL and 250 µL Models
- Special Sizes as Small as 3 µL Available
- Material – 316 Stainless Steel
- Maximum Flow – 45 mL/min. at 70°F, 6000 psid Water
- Screen Protected Passages
- Zero Dead Volume
- Proof-tested to 10,000 psi

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.

SPIN CHAMBER



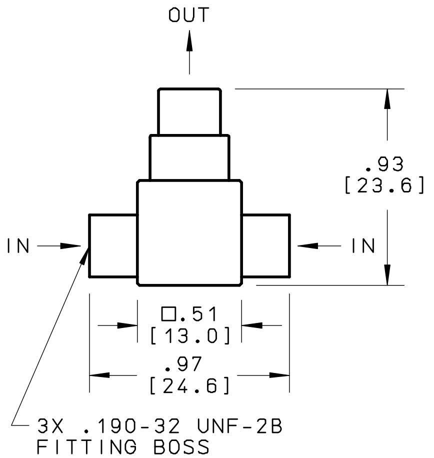
MIXING ACTION

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.

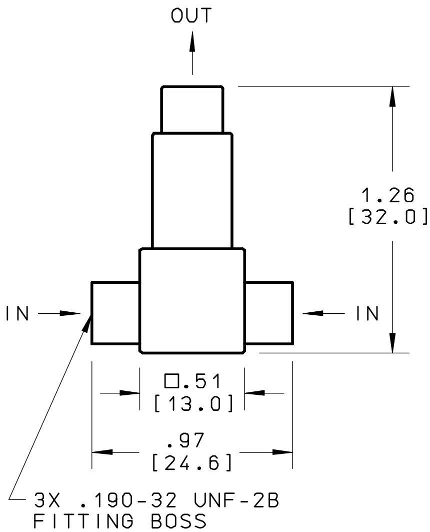
FLOW (µL/min)	THROUGHPUT TIME (SEC.)		PRESSURE DROP (psi)
	10 µL MIXER	250 µL MIXER	
50	12.0	300	0.01
100	6.0	150	0.04
200	3.0	75	0.1
500	1.2	30	1.0
1000	0.6	15	4.0
2000	0.3	7	16.0
4000	0.15	3	64.0

Any irregularities in either of the input flows will tend to be time averaged during the throughput time of the mixer.

10 µL Model
Part Number TCMA0120113T



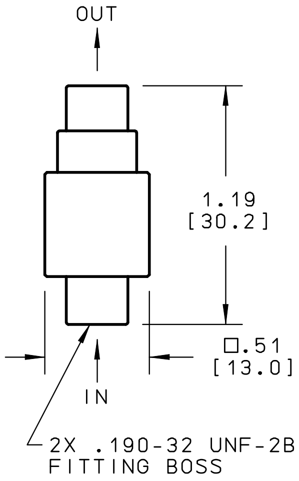
250 µL Model
Part Number TCMA2520113T



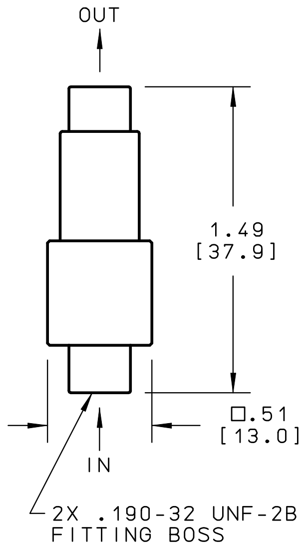
- Wetted materials: 316 stainless steel
  Au/Ni braze per AMS 4787
- Proof pressure: tested to 10,000 psi
- Passage size: 130 micron nominal
- Internal protective filtration: 17 µ nominal, 45 µ absolute
- Lohm rate: 130,000 Lohms ±15%
- Internal volume: 10 µL and 250 µL
- Fittings: compatible with 10-32 threaded, 38° nominal coned port for 1/16" OD tubing (nuts, ferrules and tubing are customer supplied)

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

In-Line 10 µL Model
Part Number TCMA0110113T



In-Line 250 µL Model
Part Number TCMA2510113T



PART NUMBER	INTERNAL VOLUME	MATERIAL
TCMA0120113T	10 µL	316 Stainless Steel
TCMA2520113T	250 µL	316 Stainless Steel
TCMA0110113T	10 µL	316 Stainless Steel
TCMA2510113T	250 µL	316 Stainless Steel

Unless otherwise specified, dimensions are in inches [*mm*]. *Drawings are not to scale.*

Lohm Laws
Definition....R3
Liquid Flow....R4-5
Liquid Flow – Units Constant K....R6
Viscosity “V” Factor....R7
Liquid Lohm Rate vs. Hole Diameter....R8
Liquid Flow Formulas....R9
Gas vs. Liquid Calibration....R10
Gas Lohm Laws....R11-17
Gas Flow Rate of Various Air at Room Temperature....R12
Units Constant K – Volumetric / Gravimetric....R15-17
Absolute Pressure Measurement....R18
Gas Flow Characteristics / Momentum Forces....R19-21
Pneumatic Power Dissipation....R22
Gas Properties....R23
Transient Gas Flow....R24-25

Tubing Flow
Resistance to Flow in Tubing....R26
Tubing Flow Curves....R27-28
Tubing Volume vs. Length....R29

System Cleanliness....R30

Electrical Engineering
Ohm’s Law....R31
Lee Solenoid Circuit Schematics....R33-38
Basic Transistor/Fast Response....R33-34
Spike and Hold....R35-36
Latching Solenoid....R37-38

Reference Information
Primary Standards....R39
Conversion Factors....R40-44
Viscosity....R45-50
Specific Gravity....R51-52
Materials....R53-54

Glossary....R55-56

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:

$$\text{Lohms} = \frac{100}{\text{flow (gal/min. } H_2O \text{ @ 25 psid)}}$$

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 R8 will be helpful in relating Lohms to hole diameter and flow coefficient, C_V, 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 R13.

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 R7 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 R6 for table of values

The Lohm Law for Liquid Flow is: $\text{Lohms} = \dfrac{KV}{I}\sqrt{\dfrac{H}{S}}$

$$I = \frac{KV}{\text{Lohms}}\sqrt{\frac{H}{S}} \qquad H = \frac{\text{Lohms}^2\, I^2\, S}{K^2\, V^2}$$

When testing with water at 25 psid ($\sqrt{H} = 5$), 80°F and flow rate in gallons per minute,

$$\text{Lohms} = \frac{100}{I} \qquad I = \frac{100}{\text{Lohms}}$$

Notes: 1. V and S are equal to 1 for water at 80°F

2. $\text{Lohms} = \dfrac{20}{C_v} = \dfrac{.67}{C_d\, d^2}$ 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; υ = 5.0 cs from curve on pages R47-48.
2. Use υ and ΔP to determine viscosity correction factor, V = .87, from curve on page R7.
3. Select unit constant K from table on page R6.
4. Compute Lohms required.

$$L = 20 \frac{V}{I}\sqrt{\frac{H}{S}} = 20 \frac{.87}{.1}\sqrt{\frac{6}{1.07}} = 412 \text{ Lohms}$$

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 R47-48. υ = 5 cs
2. Use knowledge of system to assume initial solution.
   H = 4 psid
3. Use assumed H to determine V = 0.75 from chart on page R7.
4. Select units constant K from table on page R6.
5. Compute trial ΔP

$$H = S \frac{I^2 L^2}{K^2 V^2} = 1.07 \bullet \left(\frac{57 \bullet 1000}{75700 \bullet .75}\right)^2 = 1.08 \text{ psid}$$

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:

$$L = \frac{KV}{I} \sqrt{\frac{H}{S}}$$

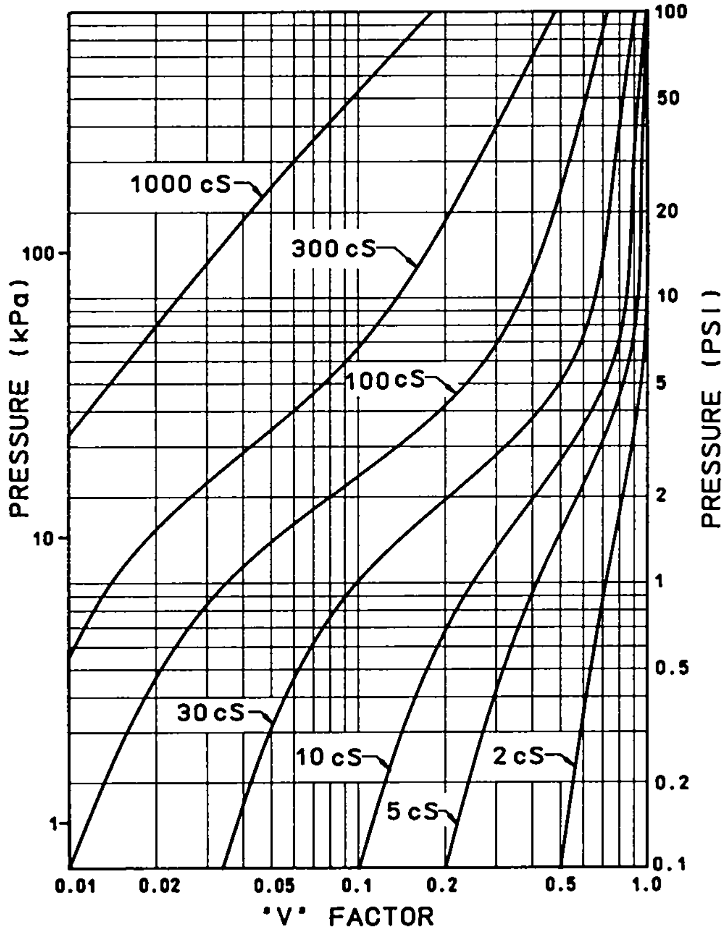
FLOW UNITS	PRESSURE UNITS						
	psi	bar	kPa	N/m^2	kg/cm^2	ft H_2O	mm/Hg
gpm	20	76.2	7.62	.24	75.4	13.2	2.78
L/min	75.7	288	28.8	.91	285	50	10.5
mL/min	75,700	288,000	28,800	911	285,000	50,000	10,500
in^3/min	4,620	17,600	1,760	55.6	17,400	3,040	642
ft^3/min	2.67	10.2	1.02	.032	10	1.76	.372

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:

$$L = \frac{1760 \sqrt{300}}{43} = 709 \text{ Lohms} \quad (S = V = 1.0)$$

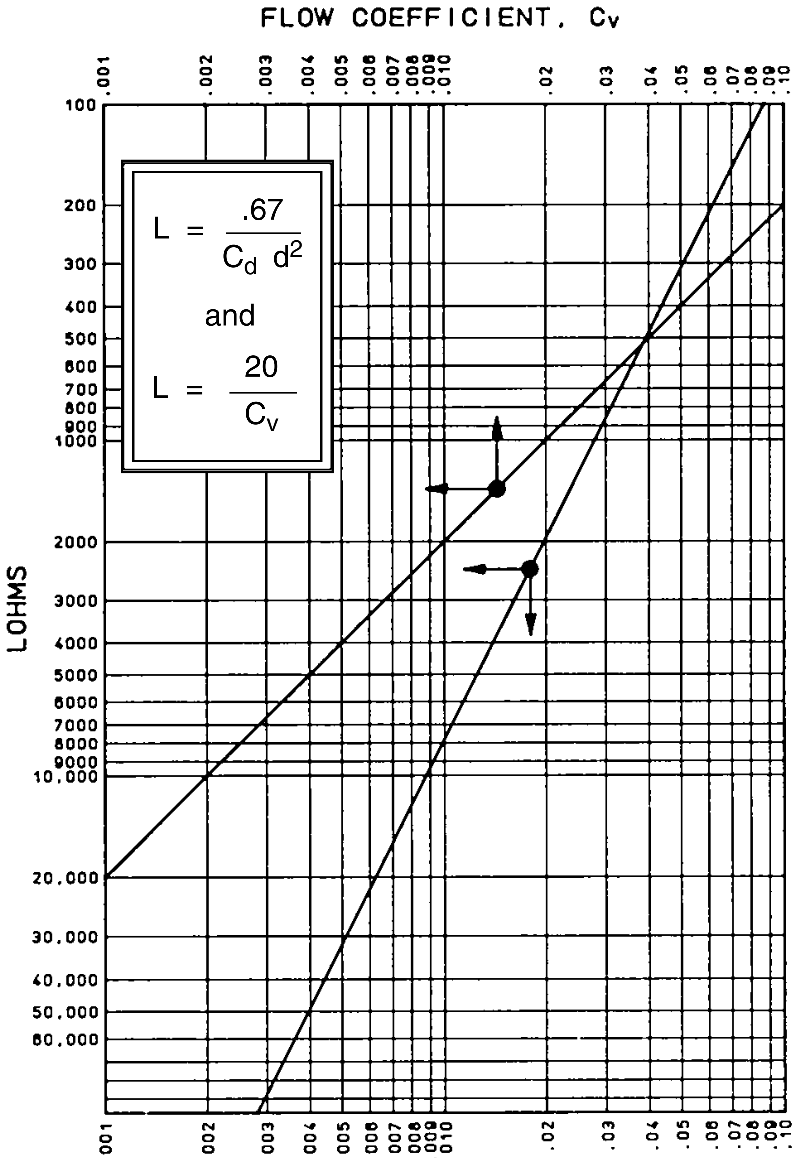
VISCOSITY CORRECTION FACTOR "V"
For Single Orifice



Note: "V" Factor Curve may vary depending on specific geometry of the device.

LIQUID LOHM RATE VERSUS HOLE DIAMETER

(Single Orifice Restrictor)



GRAPHICAL EXTENSION
.500 DIA.=3 LOHMS, .250 DIA.=12 LOHMS, .025 DIA.=1200 LOHMS

LIQUID FLOW – TWO FORMULAS FOR COMBINATIONS OF RESTRICTORS

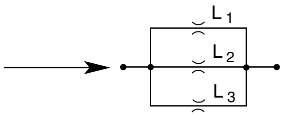
For parallel flow, the total Lohm rating is:

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots + \frac{1}{L_N}$$

Please note that this relationship is identical to the electrical equation.

Example:

PARALLEL FLOW



L_1 = 2,000 Lohms
L_2 = 3,000 Lohms
L_3 = 5,000 Lohms

$$\frac{1}{L_T} = \frac{1}{2000} + \frac{1}{3000} + \frac{1}{5000} =$$ .00103 and therefore L_T = 970 Lohms

For Series Flow, the total Lohm rating is:

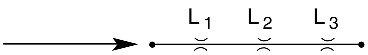
$$L_T = \sqrt{L_1^2 + L_2^2 + L_3^2 + \ldots + L_N^2}$$

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:

SERIES FLOW:



$$L_T = \sqrt{2{,}000^2 + 3{,}000^2 + 5{,}000^2} = 6{,}164 \text{ Lohms}$$

When $L_1 = L_2 = L_3$, then $L_T = L\sqrt{N}$

N = Number of equal resistors in series

For passageway size: $D_T = \dfrac{D}{N^{1/4}}$

D = Diameter of the actual orifices,each with a Lohm rate = L_1

D_T = Diameter of a single equivalent orifice, with a Lohm rate = L_T

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 ($P_1 / P_2 < 1.2$).

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

Pressure .... 14.70 psia (29.92 in. Hg)

Temperature .... 59°F (518.7°R)

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:

$$\text{SCFM} = 0.032\left(\frac{300}{14.7}\right)\left(\frac{519}{700}\right) = 0.48$$

R

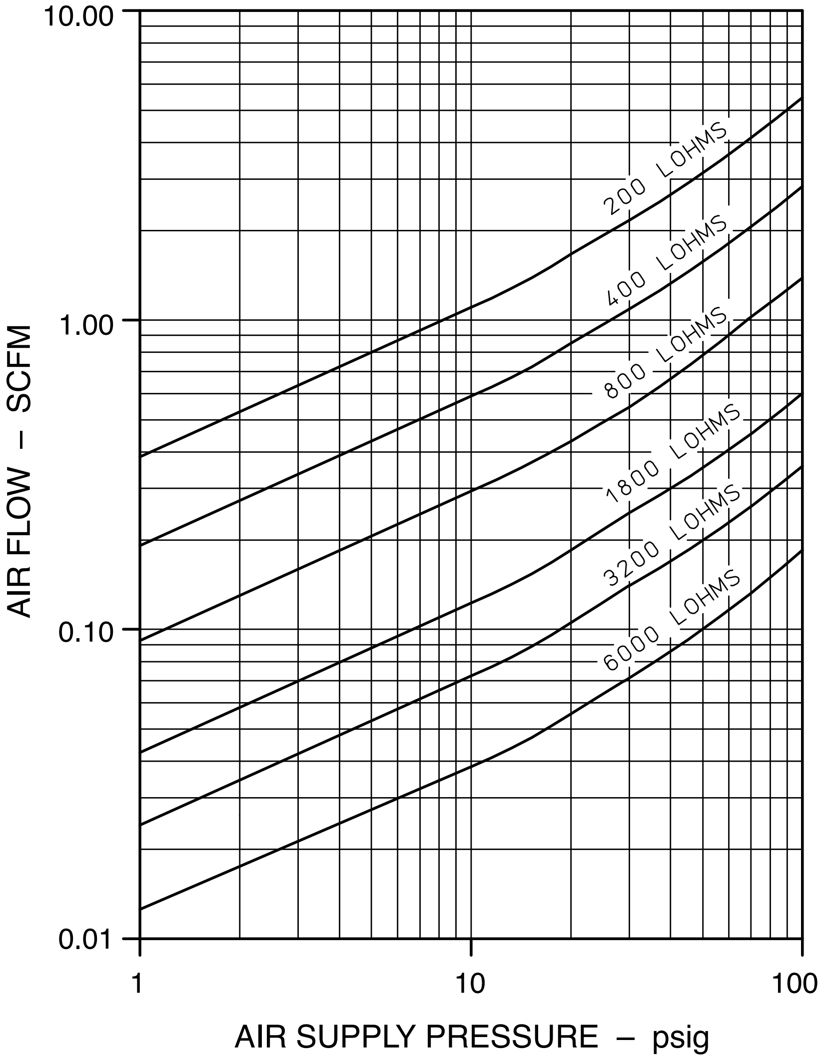
LOHM LAWS (GAS)

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.

**GAS FLOW RATE OF VARIOUS RESTRICTION
AIR AT ROOM TEMPERATURE**



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:

$$\text{Lohms} = \frac{K\, f_T\, P_1}{Q}$$

(Sonic region)
i.e. $P_1/P_2 \geq 1.9$

$$\text{Lohms} = \frac{2\, K\, f_T \sqrt{\Delta P \;\; P_2}}{Q}$$

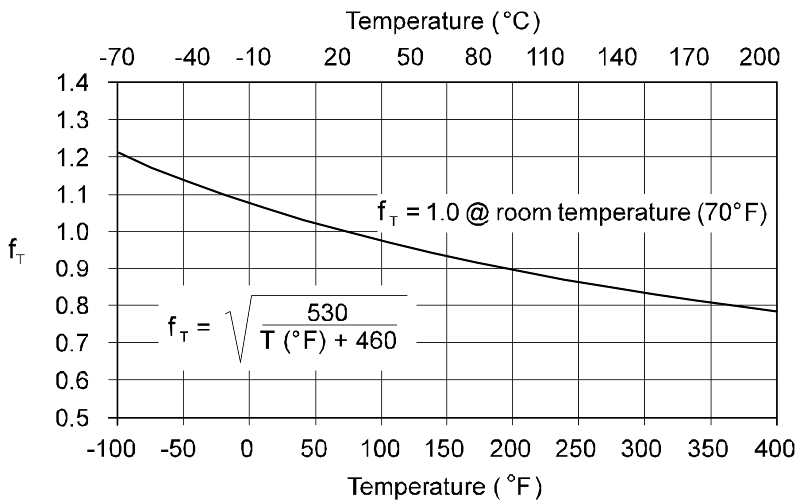
(Subsonic region)
i.e. $P_1/P_2 < 1.9$

NOMENCLATURE

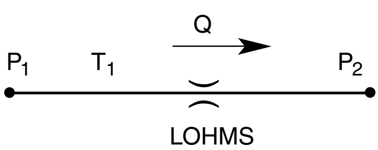
K = Gas units constant (see pages R15-16)
f_T = Temperature correction factor (see page R14)
P_1 = Upstream absolute pressure (psia)
P_2 = Downstream absolute pressure (psia)
Q = Gas flow (std L/min)
ΔP = $P_1 - P_2$ (psid)

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.

TEMPERATURE CORRECTION FACTOR



LOHM LAWS - GAS FLOW



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 (see pages R15-16)

T_1 = 90 f_T = 0.98

P_1 = 5.0 + 14.7 = 19.7 psia, P_2 = 14.7 psia

P_1/P_2 = 19.7/14.7 = 1.34 (subsonic)

ΔP = 5.0 psid

Q = 1.00 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:

$$\text{Lohms} = \frac{K\, f_T\ P_1}{Q} \qquad \text{(Sonic)}$$

VOLUMETRIC FLOW UNITS							
Abs. Pres	psia			bar		kPa	mm/Hg
FLOW	SLPM	SCFM	in ^{3}/min	SLPM	SCFM	SLPM	mL/min
H_2	1030	36.3	62,700	14,900	526	149	19,900
He	771	27.2	47,100	11,200	395	112	14,900
Neon	343	12.1	20,900	4,980	176	49.8	6,640
Nat. Gas	319	11.3	19,400	4,620	163	46.2	6,160
N_2	276	9.730	16,800	4,000	141	40.0	5,330
CO	274	9.69	16,700	3,980	141	39.8	5,300
Air	271	9.56	16,500	3,930	139	39.3	5,230
Ethane	251	8.86	15,300	3,640	129	36.4	4,850
O_2	257	9.08	15,700	3,730	132	37.3	4,970
Argon	245	8.65	14,900	3,550	125	35.5	4,730
CO_2	213	7.52	13,000	3,090	109	30.9	4,110
N_2O	214	7.56	13,100	3,100	110	31.0	4,140
SO_2	176	6.21	10,700	2,550	90.1	25.5	3,400
Freon-12	123	4.34	7,510	1,780	63.0	17.8	2,380

UNITS CONSTANT "K" – GRAVIMETRIC

See examples on page R20 of using the Units Constant "K" with flow specified in either volume or weight units.

$$\text{Lohms} = \frac{K\, f_T\, P_1}{w} \qquad \text{(Sonic)}$$

GRAVIMETRIC FLOW UNITS							
Abs. Pres	psia			bar		kPa	mm/Hg
FLOW	PPH	lb_m/s	kg/min	PPH	kg/min	kg/min	gm/min
H_2	11.6	0.00322	0.0876	168	1.27	0.0127	1.69
He	17.3	0.00479	0.131	250	1.89	0.0189	2.52
Neon	38.7	0.0108	0.293	561	4.25	0.0425	5.66
Nat. Gas	34.8	0.00966	0.263	505	3.82	0.0382	5.09
N_2	43.2	0.0120	0.326	626	4.73	0.0473	6.31
CO	43.0	0.0119	0.325	623	4.71	0.0471	6.28
Air	43.8	0.0122	0.331	636	4.81	0.0481	6.41
Ethane	42.2	0.0117	0.319	611	4.62	0.0462	6.16
O_2	46.0	0.0128	0.348	667	5.04	0.0504	6.72
Argon	54.6	0.0152	0.413	792	5.99	0.0599	7.99
CO_2	52.4	0.0145	0.396	759	5.74	0.0574	7.65
N_2O	52.7	0.0146	0.398	764	5.77	0.0577	7.70
SO_2	63.0	0.0175	0.476	914	6.91	0.0691	9.21
Freon-12	83.2	0.0231	0.629	1,210	9.12	0.0912	12.2

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?

$K = 112$ (see pages R15-16)

$T_1 = 70°F$, $f_T = 1.00$ (see page R14)

$P_1 = 1{,}500$ kPa, $P_2 = 101$ kPa

$P_1/P_2 = 14.9$ (sonic)

$Q = 8.20$ 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 lb_m/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?

$K = 0.0128$ (see pages R15-16)

$T_1 = 70°F$, $f_T = 1.00$

$P_1 = 1{,}200$ psia, $P_2 = 850$ psia

$P_1/P_2 = 1.41$ (subsonic)

$\Delta P = 350$ psid

$w = 0.0015\ lb_m/s$

$$L = \frac{2 \times 0.0128 \times 1.00 \times \sqrt{350 \times 850}}{0.0015} = 9{,}300 \text{ Lohms}$$

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.

$$\boxed{\text{Pres. (psia)} = \text{Pres. (psig)} + 0.4912 \times \text{Pres. (in. Hg @ 32°F)}}$$

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.

$K = 276$ (see pages R15-16)

$T_1 = 70°F$, $f_T = 1.00$ (see page R14)

$P_2 = 0.4912 \times 29.5 = 14.5$ psia

$P_1 = 10.0 + 14.5 = 24.5$ psia

$P_1 / P_2 = 24.5/14.5 = 1.69$ (subsonic)

$\Delta P = 24.5\text{-}14.5 = 10.0$ psid

$Q = 2.00$ 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.

i.e. $\boxed{p\,V = m\,R\,T}$ (see page R23 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 up stream 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 R13).

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.

<u>**The Rule of Forbidden Signals:**</u> *****

"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, <u>flow rate will be independent of downstream pressure</u>. This situation applies to a single orifice restrictor flowing air when the overall pressure ratio exceeds 1.89/1

* von Kármán, Jour. Aero. Sci., Vol. 14, No. 7 (1947)

MOMENTUM FORCES – GAS FLOW

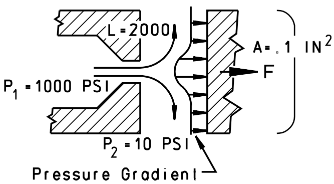
When a flowing stream of gas is subject to a change in velocity (either speed or direction), forces arise which are the reaction to the change in momentum of the stream. This is particularly important in valve design where the position of a moving element may be affected.

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.

$$F = \frac{0.4 \times P_1}{L} \qquad F = \frac{SLPM}{700} \quad \text{(sonic flow)}$$

EXAMPLE: Where a gas changes direction.

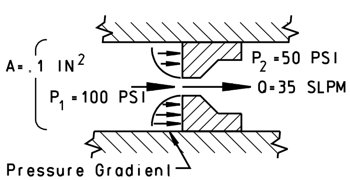
$$F = \frac{0.4 \times P_1}{L} = \frac{0.4 \times 1000}{2000} = 0.2 \text{ lbf}$$



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.

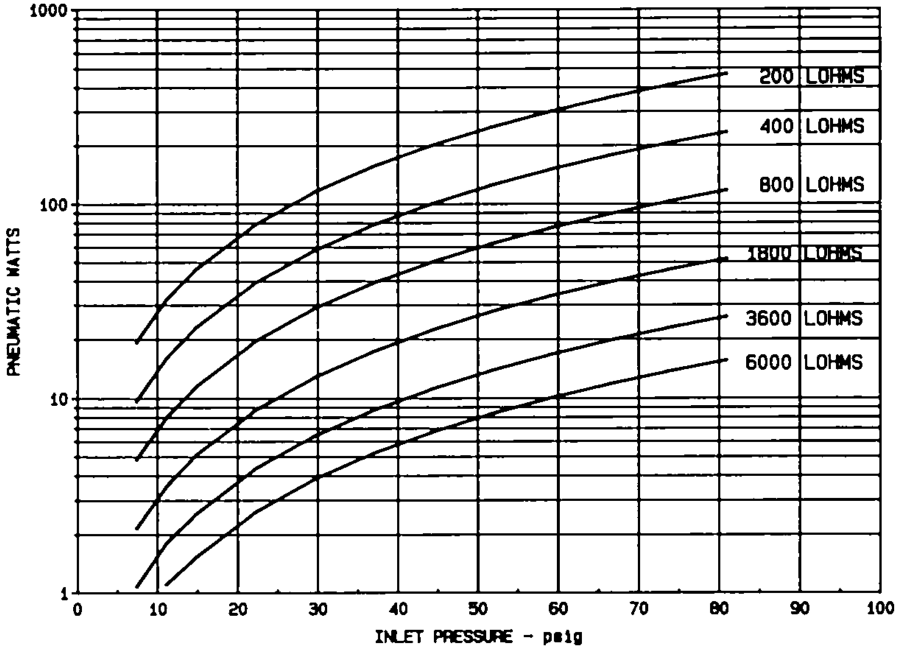
EXAMPLE: Where a gas changes speed.

$$F = \frac{SLPM}{700} = \frac{35}{700} = 0.05 \text{ lbf}$$



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.

PNEUMATIC POWER DISSIPATION



For more precise calculations, or to extend the range of the pneumatic power dissipation graph, the following formula may be used for air.

$$\text{Watts} = \frac{1{,}641\,P_1}{L}\left[\left(\frac{P_1}{P_2}\right)^{1/4} - 1\right]$$

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

GAS	k	R ft lb/lb°R	DENSITY lb_m/ft^3	DENSITY lb_m/std L	C_P* Btu/lb°R	C_V* Btu/lb°R
H_2	1.40	766.6	0.00532	0.000188	3.420	2.435
He	1.66	386.1	0.01056	0.000373	1.250	0.754
Neon	1.66	76.6	0.0533	0.00188	0.248	0.150
Nat. Gas	1.22	79.2	0.0516	0.00182	0.560	0.458
N_2	1.40	55.2	0.0739	0.00261	0.247	0.176
CO	1.41	55.2	0.0739	0.00261	0.243	0.172
Air	1.40	53.3	0.0764	0.00270	0.241	0.173
Ethane	1.21	51.4	0.0793	0.00280	0.386	0.320
O_2	1.40	48.3	0.0845	0.00298	0.217	0.155
Argon	1.67	38.7	0.1053	0.00372	0.124	0.074
CO_2	1.28	35.1	0.1162	0.00410	0.205	0.160
N_2O	1.26	35.1	0.1162	0.00410	0.221	0.176
SO_2	1.25	24.1	0.1691	0.00597	0.154	0.123
Freon-12	1.13	12.8	0.319	0.01127	0.145	0.129

*values at 68°F and 14.7 psia

c_P = Specific heat at constant pressure

c_V = Specific heat at constant volume

k = Ratio of specific heats, $\frac{c_P}{c_V}$

R = Gas Constant, $\frac{R}{\text{Molecular Wt.}}$

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, τ, 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 R15. Keep the units of pressure vessel volume (V) consistent with the volumetric flow units.

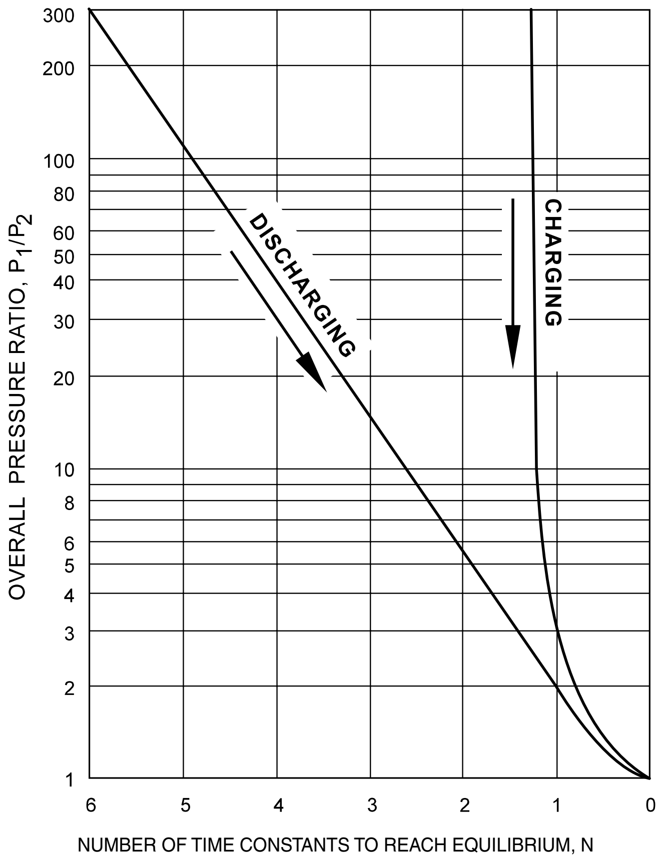
The larger the value of τ, the more sluggish the system.

Once τ 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:

$$t = \tau (N_i - N_f) \qquad t = \text{Time (sec)}$$

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:

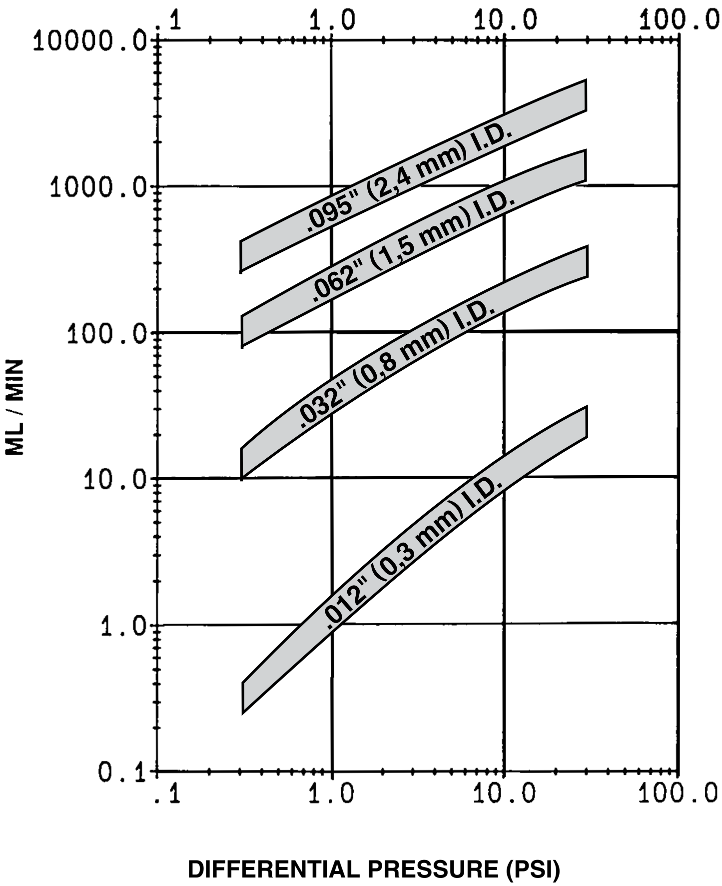
$$\frac{30\text{ cm}}{10\text{ cm}} \times 4\text{ psid} = 12\text{ psid}$$

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

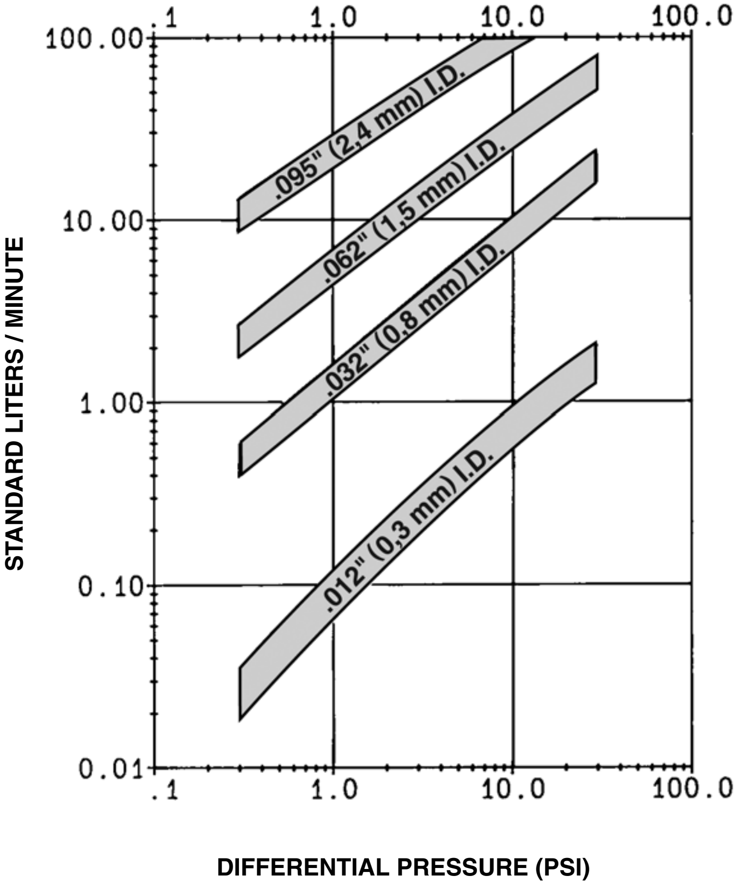
EFFECTS OF TUBE DIAMETER



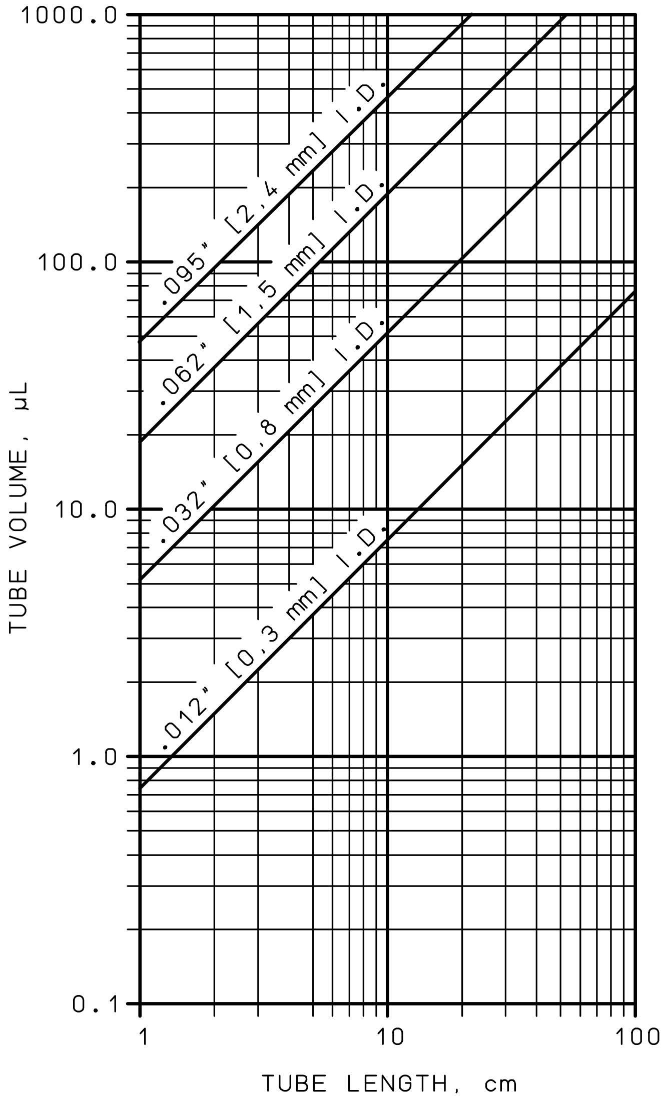
TUBING FLOW CURVES – AIR FLOW

For 10 cm Tube Length

EFFECTS OF TUBE DIAMETER



TUBING VOLUME vs. LENGTH



SYSTEM CLEANLINESS

One of the leading factors that can interfere with fluidic system performance is contamination. The presence of contamination can lead to several problems, such as fluid behavior, excessive leakage (which can impact operation of pumps and valves), and higher maintenance costs. The source of contamination can originate from many sources, such as dirty fluid, manufacturing debris or even defective components during operation.

Fluidic systems are typically comprised of components that have varying degrees of sensitivity to contamination, mostly determined by the minimum passage size and clearances throughout the flow path. There are several different attributes of contamination that must be considered beyond just size, such as the shape, length, texture, and hardness of a particulate. This understanding must be addressed during the design phase by taking into consideration the component's geometry, passage size and flow path of each component throughout the system.

The first line of defense is to ensure that the system is free of all manufacturing debris prior to assembly. This includes making sure all components are properly flushed and handled with care prior to installation. The next step is to incorporate proper system level filtration. However, contamination can still make its way into the system even with proper filtration in place. Since contamination can also originate from within the system due to the normal wear of components, incorporating safety screens immediately upstream from components is a prudent design practice. The added benefit of using safety screens is to protect the components during any maintenance of the system. We typically suggest a screen size range of 10 to 35 microns depending on the type of component. Please refer to the individual product sections for the recommended level of filtration and contact your Lee Company Sales Engineer for any assistance required.

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.

$$V = I \times R$$

V = electric potential (volts)
I = current (amperes)
R = 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 = 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.

DC ELECTRICAL EQUATIONS			
VOLTAGE	CURRENT	RESISTANCE	POWER
$I \times R$	$\frac{V}{R}$	$\frac{V}{I}$	$V \times I$
$\frac{P}{I}$	$\frac{P}{V}$	$\frac{V^2}{P}$	$\frac{V^2}{R}$
$\sqrt{(P \times R)}$	$\sqrt{\left(\frac{P}{R}\right)}$	$\frac{P}{I^2}$	I^2R

Notes

LEE SOLENOID CIRCUIT SCHEMATICS

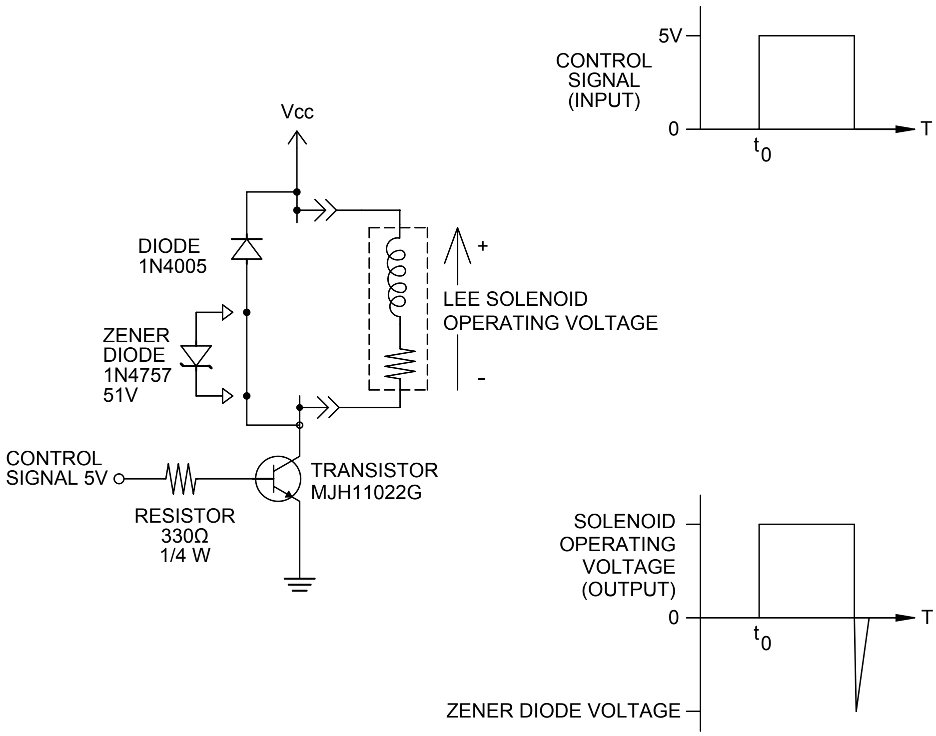
Solenoids of all different sizes are used in most electro-mechanical systems. Because solenoids are so prolific, there are also many different ways to drive them. These methods include several off the shelf options such as PWM chips, mechanical relays, and alternate circuit designs. The Lee Company has developed circuit schematics that can be used to drive many of the solenoid operated valves and pumps in this handbook. The following pages will outline a few specific circuit schematics which may serve as general guidelines and can be reproduced or modified by the end user to meet specific application requirements. For questions about which circuit is best suited for your application, contact a Lee Company Sales Engineer.

Basic Transistor / Fast Response (Lee Drawing LFIX1002200A)

This circuit schematic demonstrates the simplest form of solenoid drive circuitry and may be used to actuate most solenoid operated valves and pumps in this handbook. The circuit requires an input voltage (Vcc) to actuate the solenoid as well as a control signal input (from a controller, function generator, or timing circuit), which switches a transistor. This, in turn, allows the drive current to energize the solenoid. A diode is placed in parallel with the solenoid to protect the transistor from the inductive voltage spike which occurs as the solenoid de-energizes. A significant voltage drop between the power supply and solenoid may occur if there is unexpected resistance, such as long lead wires or other electrical components. Therefore, be sure to verify that the solenoid is receiving its rated actuation voltage by measuring directly across the solenoid's pins. Depending on your application requirements, this circuit may be configured for two different operating modes:

1. Basic Driver – In the simplest operating mode, this most basic solenoid drive schematic does not require the 51V Zener diode.
2. Fast Response Driver – A 51V Zener diode placed in series with a flyback protection diode improves the latch-out response (time to close) of the solenoid when power is removed.

Basic Transistor Circuit Schematic



Circuit Schematic for reference only. Contact a Lee Sales Engineer for drawing LFIX1002200A which includes additional notes and operating instructions.

Spike & Hold
(Lee Drawing LFIX1002250A)

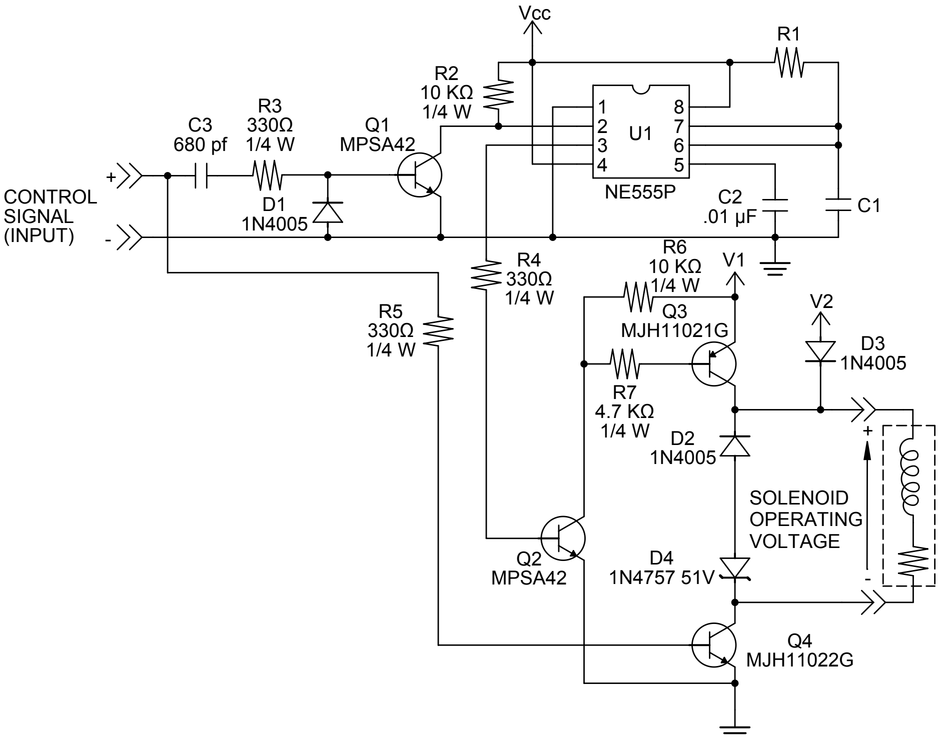
This circuit can be used as either an enhanced response time driver or as a low power consumption driver. The circuit initially supplies a brief actuation voltage (V1, “Spike” Voltage), for a period of time (ts), then switches to a lower voltage (V2, “Hold” Voltage), to keep the solenoid in an energized state for an extended time. The duration of the spike (ts) is determined by a resistor and capacitor (R1 and C1 indicated on LFIX1002250A, Note 4), connected to a 555 timer chip. Typically, the spike duration is slightly longer than the response time of the solenoid. A control signal input is required (from a controller, function generator, or timing circuit), to actuate the solenoid. The solenoid will remain actuated for as long as the control signal is applied. A significant voltage drop between the power supply and solenoid may occur if there is unexpected resistance, such as long lead wires or other electrical components. Therefore, be sure to verify that the solenoid is receiving its rated actuation voltage by measuring directly across the solenoid's pins. When measuring the signal between the solenoid pins with an oscilloscope, ensure that a differential probe is used.

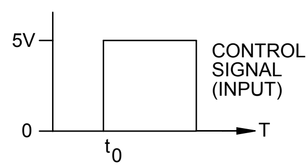
Depending on whether you require lower power or faster response, this driver may be configured for two different operating modes:

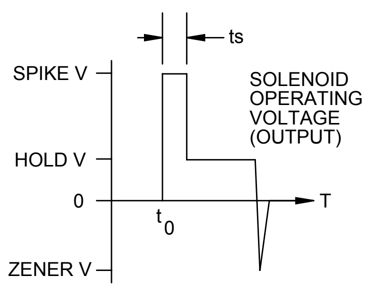
1. Fast response spike & hold driver – Solenoid response time can be improved for both actuation (time to open), and latch-out (time to close), of the solenoid by applying an “over-drive” voltage greater than the rated actuation voltage to V1, and adding a 51V Zener Diode (D4, indicated on LFIX1002250A, Note 5.1). After quickly actuating the solenoid, the driver switches to a lower holding voltage applied at V2 to reduce resistive heating and avoid damage to the solenoid. A 51V Zener diode placed in series with a flyback protection diode improves the latch-out response (time to close) of the solenoid when power is removed.

2. Low power consumption driver – Overall power consumption can be significantly reduced (typically 75-90%), by applying the rated solenoid voltage to V1, and a lower hold voltage to V2. For most solenoids the hold voltage is half of the rated actuation voltage, unless otherwise indicated on the inspection drawing. For more specific recommendations regarding the voltage or spike duration for your particular application or part number, please contact a Lee Company Sales Engineer.

Spike & Hold Circuit Schematic







Circuit Schematic for reference only. Contact a Lee Sales Engineer for drawing LFIX1002250A which includes additional notes and operating instructions.

Latching Solenoid (Lee Drawing LFIX1002350A)

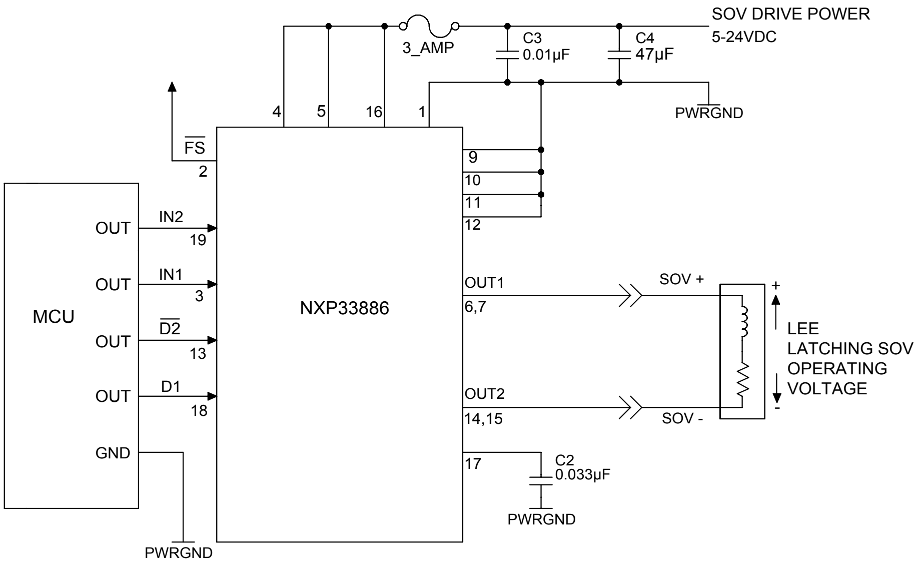
The primary advantage of a latching solenoid valve is that power is not required to maintain the valve's flow state (either open or closed) between actuations. That is, a de-energized latching valve will hold its current flow state. Because of this magnetically latched feature, latching solenoid valves have polarized leads which require a different type of drive circuitry. The flow state of the solenoid is determined by a negative or positive voltage pulse, so a circuit capable of bi-directional current flow is required. The recommended LFIX1002350A schematic includes an H-bridge chip which reverses the direction of current flow, allowing for effective latching solenoid valve switching. A significant voltage drop between the power supply and solenoid may occur if there is unexpected resistance, such as long lead wires or other electrical components. Therefore, be sure to verify that the solenoid is receiving its rated actuation voltage by measuring directly across the solenoid's pins.

This schematic requires the rated input voltage to actuate the solenoid as well as switching commands provided by a micro-controller (MCU), or other programmable logic controller (PLC). Switching commands should be provided as a 5 Vdc "HIGH" or "LOW" signal, of which four are required. Two pins are required to enable the H-bridge chip, and two others are required to trigger either a positive or negative pulse to the solenoid. A description of each pin is included below, along with a state diagram. Information about solenoid pin assignments and the porting arrangements can be found on the inspection drawing for each latching solenoid valve.

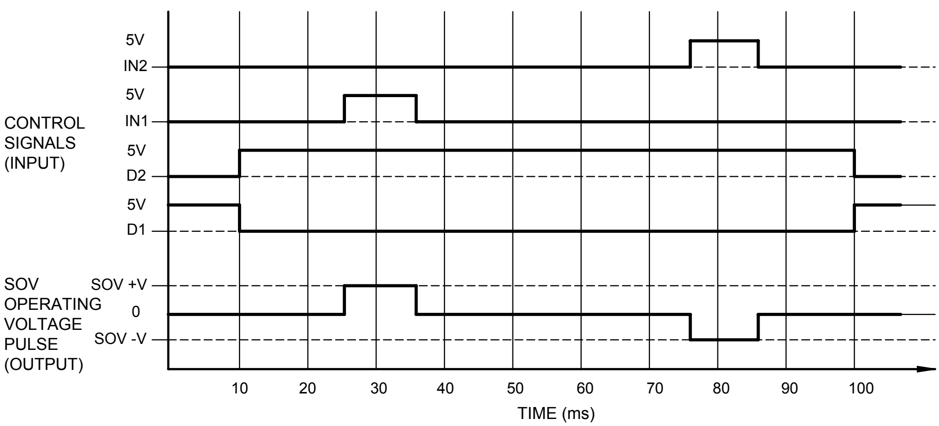
<u>MCU Pin Assignments (Waveform Graph)</u>

- IN1 – HIGH provides a +5 Vdc pulse. The pulse length (time) should be slightly longer than response time of the solenoid.
- IN2 – HIGH provides a -5 Vdc pulse. The pulse length (time) should be slightly longer than response time of the solenoid.
- D1 - Enables NXP33886 (H-Bridge Chip), should be HIGH when actuating (in either direction).
- D2 - Enables NXP33886 (H-Bridge Chip), should be LOW when actuating (in either direction).

Latching Valve Circuit Schematic



Waveform Graph



Circuit Schematic for reference only. Contact a Lee Sales Engineer for drawing LFIX1002350A which includes additional notes and operating instructions.

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 x 10^{-6} meter ^{2} /second
1 fluid ounce (U.S.)	=	2.95735295625 x 10^{-5} meter ^{3}
1 foot	=	0.3048 meter
1 gallon (U.S.)	=	3.785411784 x 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 x 10^{-6} meter
1 milliliter	=	1 x 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 foot of H_2O at 4°C	=	2,988.98 pascals
1 gram/centimeter^3	=	1,000 kilograms/meter^3
1 inch of H_2O at 4°C	=	249.082 pascals
1 inch of Hg at 0˚C	=	3,386.389 pascals
1 pound$_F$ / inch^2	=	6,894.7572 pascals
1 pound$_M$ / inch^3	=	27,679.905 kilograms/meter^3
1 quart (U.S.)	=	9.4635295 x 10^{-4} meter^3
1 drop	=	50 microliters
1 bar	=	14.503774 pound$_F$ /inch^2

CONVERSION FACTORS:

MASS

To Convert ↓ / Into →	lb$_M$ (avdp)	oz$_M$ (avdp)	slug	gram	kg$_m$
lb$_M$ (avdp)	—	16.00	3.108 x 10^{-2}	453.6	0.4536
oz$_M$ (avdp)	6.250 x 10^{-2}	—	1.943 x 10^{-3}	28.35	2.835 x 10^{-2}
slug	32.17	514.8	—	1.459 x 10^4	14.59
gram	2.205 x 10^{-3}	3.527 x 10^{-2}	6.852 x 10^{-5}	—	1.000 x 10^{-3}
kg$_m$	2.205	35.27	6.852 x 10^{-2}	1,000	—

Multiply by

CONVERSION FACTORS

VOLUME

To Convert ↓ / Into →	ft^3	in^3	gal (U.S.)	quart (U.S.)	fl oz (U.S.)	liter	mL	m^3
ft^3	—	1,728	7.481	29.92	957.5	28.32	2.832×10^4	2.832×10^{-2}
in^3	5.787×10^{-4}	—	4.329×10^{-3}	1.732×10^{-2}	0.5541	1.639×10^{-2}	16.39	1.639×10^{-5}
gal (U.S.)	0.1337	231.0	—	4.000	128.0	3.785	3,785	3.785×10^{-3}
quart (U.S.)	3.342×10^{-2}	57.75	0.2500	—	32.00	0.9464	946.4	9.464×10^{-4}
fl oz (U.S.)	1.044×10^{-3}	1.805	7.813×10^{-3}	3.125×10^{-2}	—	2.957×10^{-2}	29.57	2.957×10^{-5}
liter	3.531×10^{-2}	61.02	0.2642	1.057	33.81	—	1,000	1.000×10^{-3}
mL	3.531×10^{-5}	6.102×10^{-2}	2.642×10^{-4}	1.057×10^{-3}	3.381×10^{-2}	1.000×10^{-3}	—	1.000×10^{-6}
m^3	35.31	6.102×10^4	264.2	1,057	3.381×10^4	1,000	1.000×10^6	—

Multiply by

CONVERSION FACTORS

PRESSURE

To Convert ↓ / Into →	lb/in²	in. Hg at 0°C	in. H_2O at 4°C	ft H_2O at 4°C	atm	kg_F/cm^2	kg_F/m^2	kPa
lb/in²	—	2.036	27.68	2.307	6.805×10^{-2}	7.031×10^{-2}	703.1	6.895
in. Hg at 0°C	0.4912	—	13.60	1.133	3.342×10^{-2}	3.453×10^{-2}	345.3	3.386
in. H_2O at 4°C	3.613×10^{-2}	7.355×10^{-2}	—	8.333×10^{-2}	2.458×10^{-3}	2.540×10^{-3}	25.40	0.2491
ft H_2O at 4°C	0.4335	0.8826	12.00	—	2.950×10^{-2}	3.048×10^{-2}	304.8	2.989
atm	14.70	29.92	406.8	33.90	—	1.033	1.033×10^{4}	101.3
kg_F/cm^2	14.22	28.96	393.7	32.81	0.9678	—	1.000×10^{4}	98.07
kg_F/m^2	1.422×10^{-3}	2.896×10^{-3}	3.937×10^{-2}	3.281×10^{-3}	9.678×10^{-5}	1.000×10^{-4}	—	9.807×10^{-3}
kPa	0.1450	0.2953	4.015	0.3346	9.869×10^{-3}	1.020×10^{-2}	102.0	—

Multiply by

CONVERSION FACTORS – VOLUME TO MASS
WATER AT 39.2°F (4°C)

MASS

VOLUME — To Convert ↓ / Into →	lb_M (avdp)	oz_M (avdp)	slug	gram	kg_m
ft^3	62.43	998.8	1.940	2.832×10^{4}	28.32
in^3	3.613×10^{-2}	0.5780	1.123×10^{-3}	16.39	1.639×10^{-2}
gal (U.S.)	8.345	133.5	0.2594	3785	3.785
quart (U.S.)	2.086	33.38	6.484×10^{-2}	946.3	0.9463
fl oz (U.S.)	6.520×10^{-2}	1.043	2.026×10^{-3}	29.57	2.957×10^{-2}
liter	2.205	35.27	6.852×10^{-2}	1,000	1.000
mL	2.205×10^{-3}	3.527×10^{-2}	6.852×10^{-5}	1.000	1.000×10^{-3}
m^3	2,205	3.527×10^{4}	68.52	1.000×10^{6}	1,000

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

$$I\ \frac{\text{lbs}}{\text{hr}} = \left[I\ \frac{\text{mL}}{\text{min}}\right]\left[\begin{array}{c}\text{conversion}\\ \text{factor mL — lbs}\end{array}\right]\left[\begin{array}{c}\text{conversion}\\ \text{factor min — hrs}\end{array}\right]\left[S\right]$$

$$= \left[2\ \frac{\text{mL}}{\text{min}}\right]\left[2.205 \times 10^{-3}\ \frac{\text{lbs}}{\text{mL}}\right]\left[\frac{60\text{ min}}{1\text{ hr}}\right]\left[0.80\right]$$

$$= .21\ \frac{\text{lb}}{\text{hr}}$$

CONVERSION FACTORS – MASS TO VOLUME
WATER AT 39.2°F (4°C)

MASS

To Convert → / Into ↓ (VOLUME)	lb_M (avdp)	oz_M (avdp)	slug	gram	kg_m
ft^3	1.602×10^{-2}	1.001×10^{-3}	0.5154	3.532×10^{-5}	3.532×10^{-2}
in^3	27.68	1.730	890.6	6.103×10^{-2}	61.03
gal (U.S.)	0.1198	7.489×10^{-3}	3.855	2.642×10^{-4}	0.2642
quart (U.S.)	0.4793	2.996×10^{-2}	15.42	9.464×10^{-4}	0.9464
fl oz (U.S.)	15.34	0.9586	493.5	3.381×10^{-2}	33.81
liter	0.4536	2.835×10^{-2}	14.59	1.000×10^{-3}	1.000
mL	453.6	28.35	1.459×10^{4}	1.000	1,000
m^3	4.536×10^{-4}	2.835×10^{-5}	1.459×10^{-2}	1.000×10^{-6}	1.000×10^{-3}

Multiply by

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:

$$\text{gal} = 3.0\ \text{kg} \times \frac{.2642}{1.02} \frac{\text{gal}}{\text{kg}} = 0.777\ \text{gal}$$

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

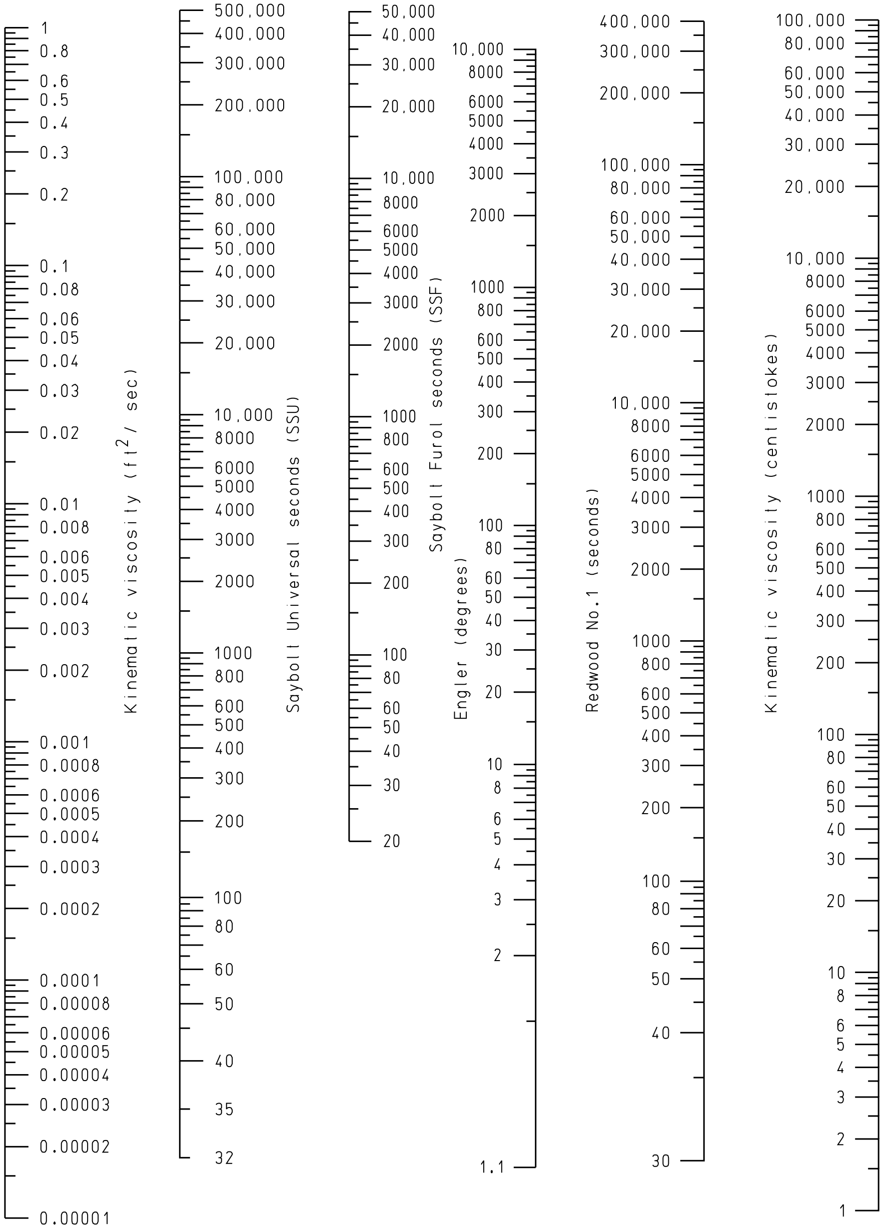
Kinematic Viscosity: the absolute viscosity divided by density.

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

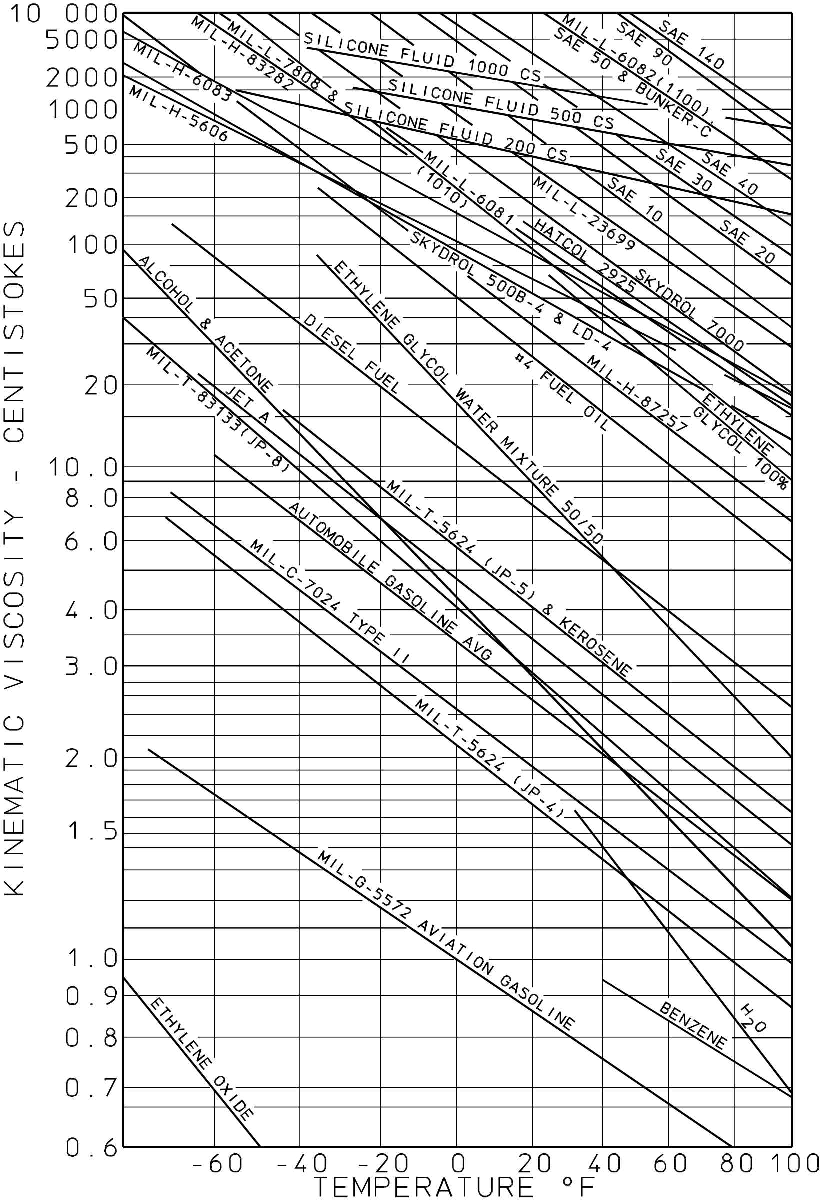
VISCOSITY CONVERSION CHART



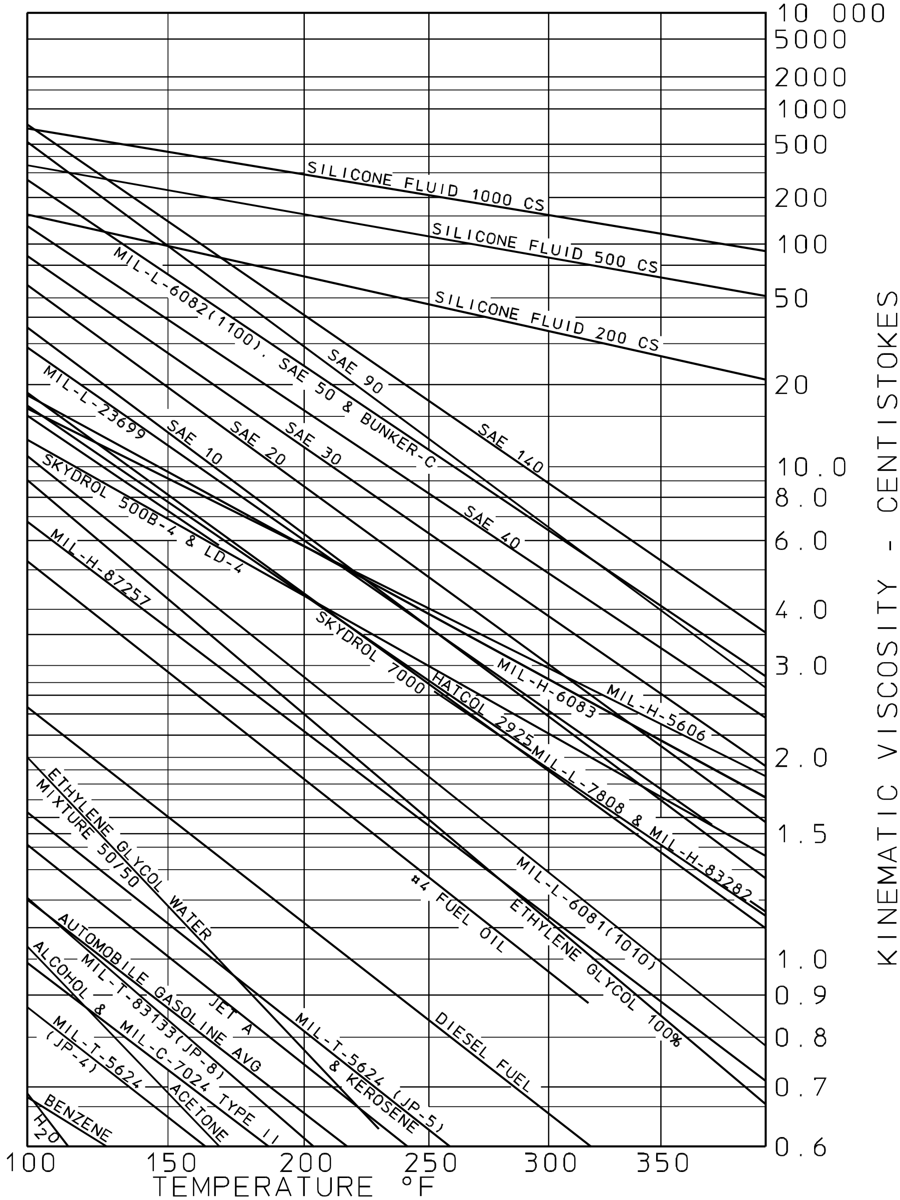
CONNECT HORIZONTALLY

NOTE: Centistokes = $\frac{\text{Centipoise}}{\text{Density}}$

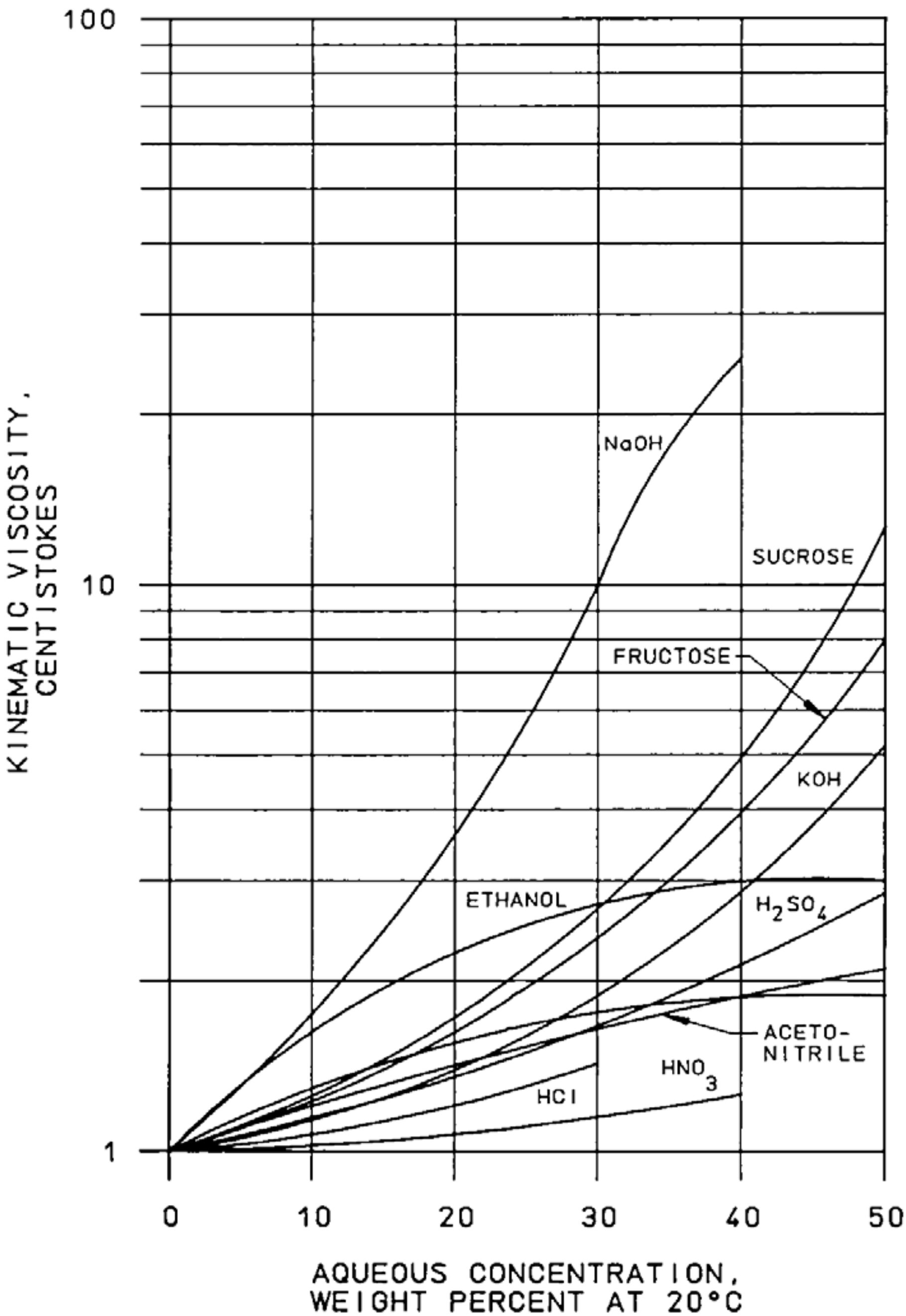
VISCOSITY OF TYPICAL FLUIDS vs. TEMPERATURE



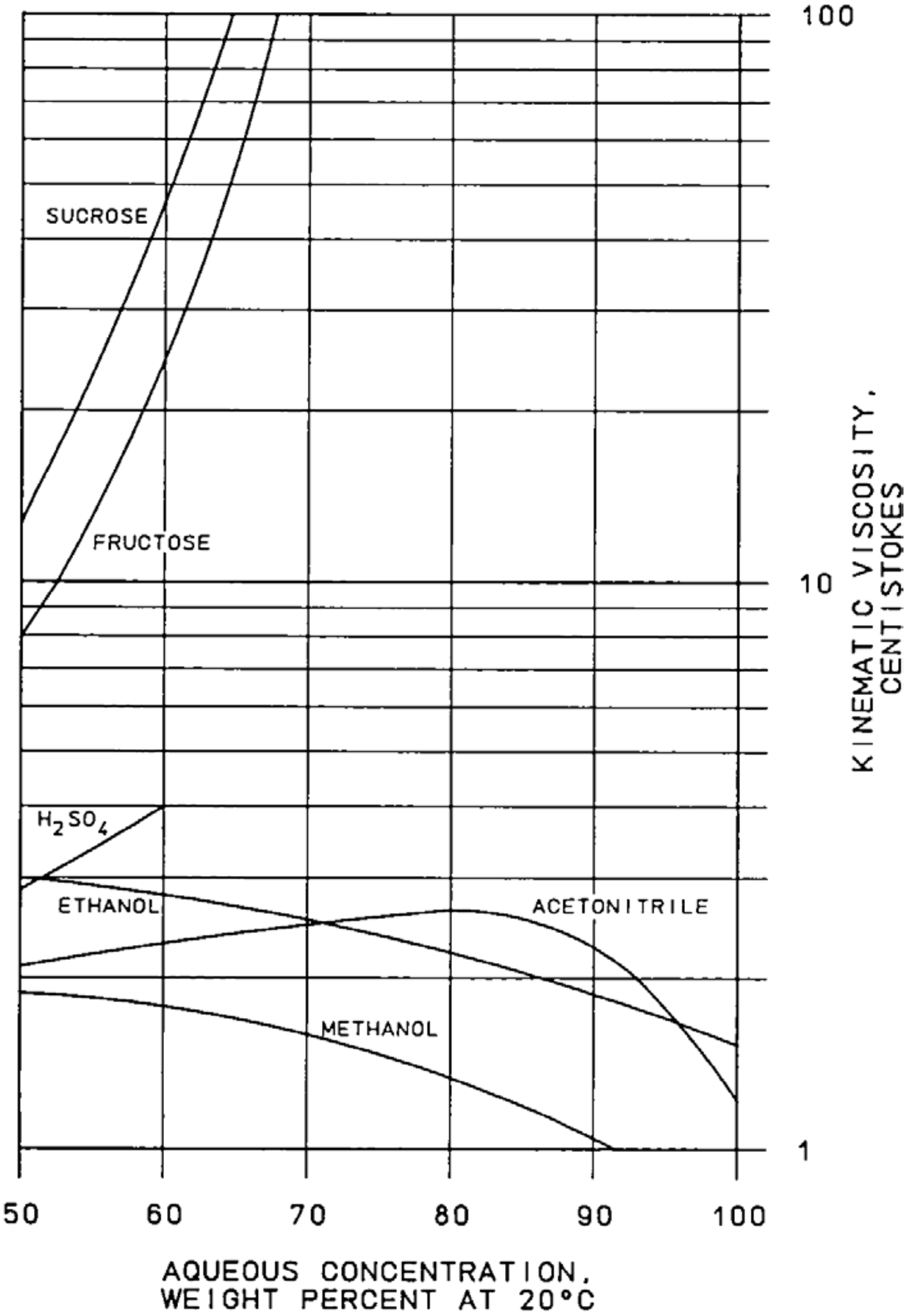
VISCOSITY OF TYPICAL FLUIDS vs. TEMPERATURE



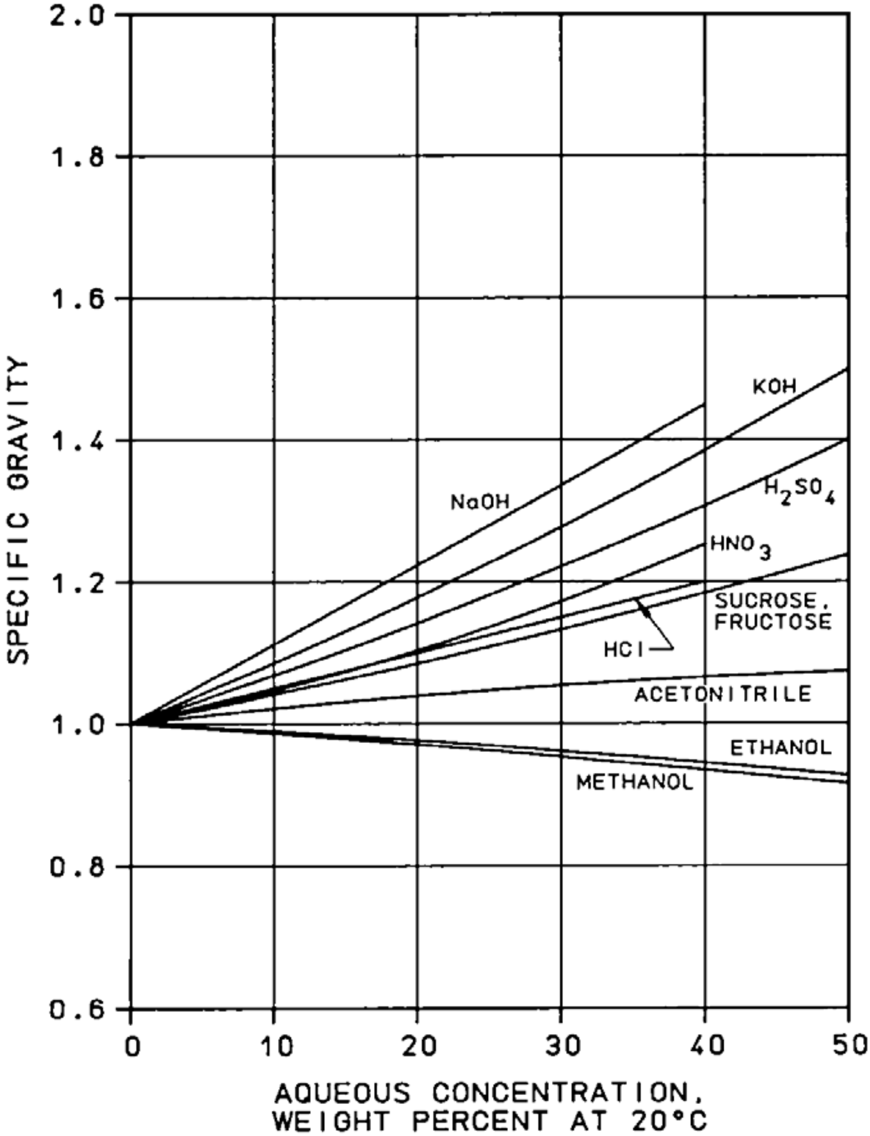
VISCOSITY vs. CONCENTRATION



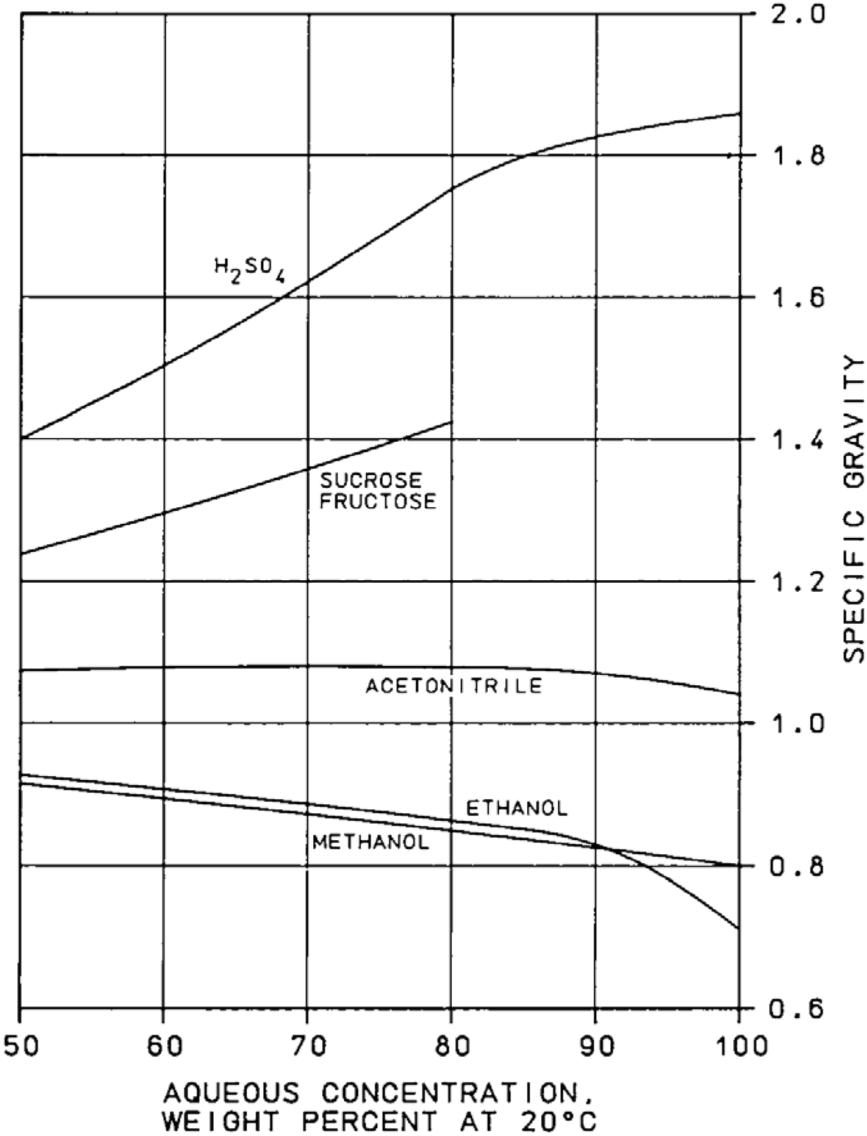
VISCOSITY vs. CONCENTRATION



SPECIFIC GRAVITY vs. CONCENTRATION



SPECIFIC GRAVITY vs. CONCENTRATION



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.

PLASTIC	MECHANICAL STRENGTH	GENERAL CHEMICAL RESISTANCE	THERMAL RESIS-TANCE	FEATURED PROPERTIES
EVA *Ethylene-vinyl acetate*	3	3	2	Physically conformable
LCP *Liquid crystal polymer*	5	4	4	Superior balance of all properties
PBT *Polybutylene terephthalate*	3	3	3	Good balance of all properties
PC *Polycarbonate*	3	3	3	Optical clarity
PCTFE *Polychlorotrifluoroethylene*	3	4	3	Resists most chemicals, zero water absorption
PEEK *Polyetheretherketone*	4	4	5	Thermal stability & good solvent resistance
PEI *Polyetherimide*	3	4	4	Translucent, amber color. Good solvent resistance
PES *Polyethersulfone*	3	3	4	Dimensionally stable
PFA *Perfluoroalkoxy resin*	2	5	2	Chemical & solvent resistant
PMMA *Polymethyl Methacrylate*	3	3	3	Transparent, good general properties
POM *Polyoxymethylene*	3	3	2	Wear resistance
PPA *Polyphthalamide*	3	3	4	Thermal and dimensional stability
PPS *Polyphenylene sulfide*	4	3	4	Very good mechanical strength
PSU *Polysulfone*	3	3	4	Low moisture absorp-tion, transparent
PTFE *Polytetrafluoroethylene*	2	5	2	Unsurpassed chemical resistance
PVC *Polyvinylchloride*	3	3	3	High flexibility
PVDF *Polyvinylidene fluoride*	3	4	3	Chemical & solvent resistant, porous form
UHMW PE *Ultra-high molecular weight polyethylene*	3	3	3	Porous form, solvent resistant

MATERIALS (continued)

ELASTOMER	WEAR RESISTANCE	GENERAL CHEMICAL RESISTANCE	THERMAL RESISTANCE	FEATURED PROPERTIES
EPDM *Ethylene/propylene rubber*	3	4	3	Very good solvent resistance
FKM *Fluoroelastomer*	5	4	4	Superior balance of properties
CR *Polychloroprene*	3	3	3	Good balance of properties
FFKM *Perfluoroelastomer*	3	5	5	Unsurpassed chemical resistance
SI *Silicone*	3	3	4	Good balance of properties

OTHER MATERIALS	MECHANICAL STRENGTH	GENERAL CHEMICAL RESISTANCE	THERMAL RESISTANCE	FEATURED PROPERTIES
TZP *Tetragonal Zirconia Polycrystal*	5	5	5	Superior surface finish and excellent dimensional stability
Sapphire (Aluminum Oxide)	5	5	5	Superior surface finish and excellent dimensional stability

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

Glossary

This glossary serves to introduce the user to some of the terminology used throughout this handbook. These descriptions are proposed to serve as a reference point in product discussions to eliminate problems with 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 closeness of a measured value to the intended, specified, or actual value. Compare to PRECISION.

Ambient Temperature: Temperature of the media surrounding external surfaces of a part.

Burst Pressure: The maximum pressure a part can endure before it will break.

Coefficient of Variation (CV): This value, expressed in terms of percentage, reflects the dispersion of data used to help define consistency of performance. It is calculated by taking the standard deviation of a distribution and dividing it by the mean value.

Coil Voltage: Voltage at which the coil must energize if the solenoid 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.

Cross-Over Volume (Carry-over Volume): Any internal geometry dependent volumetric error introduced by the internal volume of a solenoid valve between the valve point and the common flow point. This is most commonly used in discussions of 3-way valve models as 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 3-way valve. For example, this term refers to the flow that takes place between the normally closed and normally open ports of the 3-way valve in the time between the beginning of actuation and the end of actuation, when both ports are partially open.

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 solenoid valve is closed when the coil is de-energized.

Duty Cycle: The ratio, expressed in terms of percentage, of the energized period to the total period. Example, if a solenoid valve is on for 8 seconds and off for 12 seconds, the total cycle time is 20 seconds and therefore the duty cycle is 40%.

Energized: Power applied to the coil causing the solenoid valve to change state. A normally closed valve will open when energized.

Filter: A device used to remove contaminants from the fluid media.

Normally Closed: A normally closed solenoid valve is closed when de-energized, preventing flow. When energized, the valve opens, allowing flow.

Normally Open: A normally open solenoid valve is open when de-energized, allowing flow. When energized, the valve closes, preventing flow.

Operating Pressure: The pressure specified for normal operation.

Precision: The degree of closeness of two or more measurements to each other. Compare to ACCURACY.

Pressure Differential: The pressure difference between the inlet and outlet pressure.

Proof Pressure: The level of pressure that may be applied to the part without causing permanent damage.

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.

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 standard products to help designers find the right solutions to their problems. Should your requirements fall beyond what is listed in this handbook, we will be pleased to work with you and develop a custom design that meets your exact application specifications as we have the capability to design and manufacture variations to the products listed in this handbook on a prototype basis or for future production.

In this case, we assign a special part number to the design and the subsequent purchase of this part number would be in accordance with the originators requirements. In some cases, a non-recurring charge may be necessary to partially offset the costs of design, manufacturing, testing or tooling. Our policy for specially designed products is that the design will be the sole property of the Lee Company, without exception.

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2. 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

TRADE NAME	TRADE MARK
THE LEE COMPANY	LEE ®
LIF	LIF ®
MINSTAC	LEE MINSTAC ®

TRADEMARKS OF THE LEE COMPANY

TRADE NAME	TRADE MARK	TRADE NAME	TRADE MARK	TRADE NAME	TRADE MARK
Lee Plug	®	Lee JEVA	®	Lee Chek	®
Lee Plug RFO	®	Lee Visco Jet	®	Lee Pri	®
Lee Jet	®	Lee Cro	®	Lee Tri	®
Lee Hi Watt Jet	®	Lee Restrictor Chek	®	Lee Shuttle Valve	®
Lee kW Jet	®	Lee Flow Control	®	Lee Safety Screens	®
Lee Micro Jet	®	Lee Flosert	®	Lee HI-BAR Screens	®
Lee Bender Jet	®	Lee Spin Jet	®	Lee Micro Damp	®
Lee Axial Visco Jet	®	Lee JELA	®	Lee Kipster	®

S

WARRANTY

The Lee Company is proud to warrant that all products 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. In order to assist our customers, we maintain a staff of sales engineers that can recommend the proper products to satisfy a particular system requirement. However, the buyer assumes sole responsibility of verifying the compatibility of our products with 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, incidental, consequential, or punitive damages, provided the product was used for its intended purpose and in its intended environment. This constitutes the exclusive remedy available to the buyer. The Lee Company disclaims any express of implied warranty for merchantability or fitness for a particular purpose.

This warranty shall apply only on the conditions that; Buyer purchased the items directly from the Lee Company or a Lee Company Authorized Representative (as per the Lee Company website), potential defects are reported to us in a timely manner, potentially defective items have been returned to us for analysis, Lee Company engineering has determined the products to be defective, and the products have not been subject to any modification or replication program (i.e. reverse engineering), either formal or informal, sponsored or supported by Buyer.

Innovation in Miniature

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