

# DLIHV Series Vaporizer

Vaporizers

## High Capacity Liquid Vaporizer Systems

### Overview

With the introduction of the Direct Liquid Inject (DLI) vaporizer technology, Brooks Instrument established itself as the leader in the vaporization and flow control of critical liquid precursors for use in functional coatings (e.g., TiN, SiC, etc.), chemical vapor deposition (CVD) and atomic layer deposition (ALD) thin films used in microelectronics, fiber optic, and industrial coatings applications. DLI technology overcomes the many limitations inherent with bubbler, vapor draw and flash vaporizer technologies. The Brooks' DLI Vaporizer combines unique atomization and non-contact heat exchanger technologies to provide near instantaneous vaporization that prevents liquid carry-over in the process chamber and averts the decomposition of thermally-sensitive materials.

Emerging vaporization applications are requiring the delivery of greater rates of water vapor and silicon precursor vapors (e.g., OMCTS, MTS, TMCTS). Manufacturers of fiber optic preforms now require large amounts of silicon precursor vapor in their outside vapor deposition (OVD) and vapor axial deposition (VAD) processes. New humidification applications require 5 kg/hr or more of water vapor. The increased flow demands for water vapor are compounded by the fact that water takes at least ten times more power to vaporize than a conventional silicon precursor, and that water requires a significantly greater amount of carrier gas to atomize due to the polar nature of the molecule.

Current vaporization technologies were unable to provide a viable solution for the industry until Brooks Instrument introduced its 2nd generation DLI heat exchanger technology, called DLI High Capacity Vaporizer (DLIHV). The DLIHV system offers one of the highest capacity vaporizers in the industry. The 6000W model consistently and

### Features and Benefits

Features	Benefits
Heat exchange coils & heating elements cast in aluminum outer shell offer optimal heat transfer efficiency	<ul style="list-style-type: none"> <li>• Homogeneous, stable temperature distribution</li> <li>• Reduces risk for thermal composition of liquid</li> <li>• No liquid carry-over into process chamber</li> <li>• Prolongs heat exchanger lifetime</li> </ul>
Wetted materials made from 316L SS (optionally electropolished, passivated or Titanium)	<ul style="list-style-type: none"> <li>• Prevents corrosion and ensures process cleanliness</li> </ul>
Atomizer generates superfine aerosol droplets (<10µm diameter)	<ul style="list-style-type: none"> <li>• Increases surface area &amp; heat transfer enabling complete vaporization at lower temperatures</li> </ul>
Liquid precursor flow rate controlled by inlet liquid mass flow controller	<ul style="list-style-type: none"> <li>• Rapid response to changing vapor setpoints provides "vapor-on-demand"</li> <li>• Flow accuracy of ±0.2% of setpoint available</li> </ul>
Multiple, configurable vaporizer models	<ul style="list-style-type: none"> <li>• Accommodates a wide range of liquid properties</li> <li>• Operates effectively in both vacuum and high pressure environments</li> <li>• Modular design enable easy modification from application to application</li> </ul>

## Overview (continued)

reliably delivers water vapor mass flow rates up to ~5 kg/hr (83 g/min). The atomizer design provides a more favorable liquid-to-gas ratio reducing the flow rate of carrier gas per mass of liquid precursor. The embedded coil heat exchanger design optimizes the heat transfer efficiency to the incoming atomized liquid/ carrier gas mixture by increasing the surface area inside the heat exchanger. This design ensures the complete vaporization of all liquid that is not initially evaporated by the hot gas. The increased heat transfer efficiency permits the heater to run at lower temperatures and reduce the heater power duty cycle, thus increasing the reliability and lifetime of the heat exchanger.

## Product Description

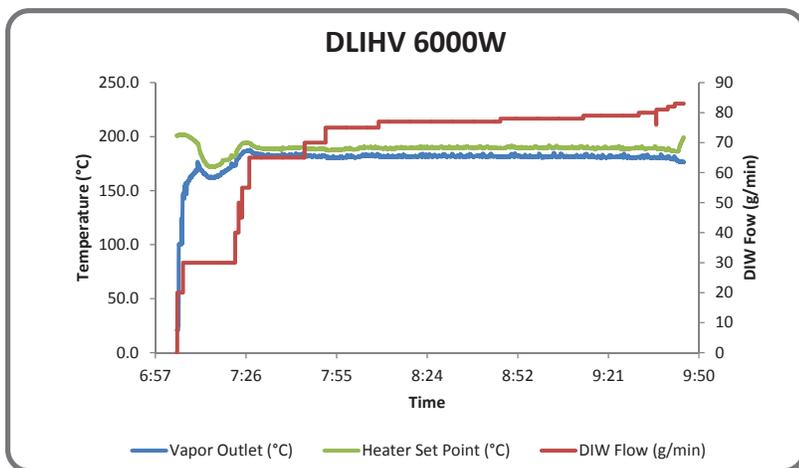
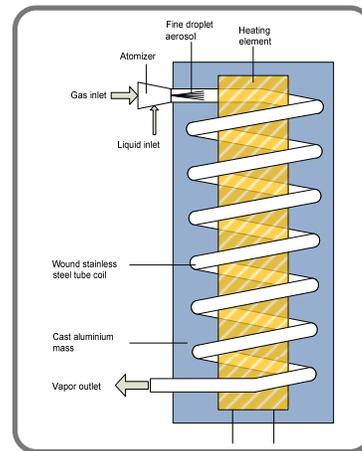
The DLIHV Series vaporizer is an integrated system which combines Brooks Instrument's proprietary atomizer along with a heat exchanger that is wrapped in a silicon thermal insulation jacket inside an aluminum enclosure and mounted on an aluminum back plate.

Brooks' proprietary atomizer exponentially multiplies the specific surface area of an inlet fluid by creating millions of sub-10 micron size droplets through the use of a supersonic shock front caused by the rapid expansion of a carrier gas through an orifice. Increasing the fluid's surface area improves the heat transfer efficiency. The 316L stainless steel atomizer, with removable orifice, is a fully-serviceable, interchangeable component sized for the desired fluid and mass flow rate.

The heat exchanger, with its highly effective heat transfer design, quickly and efficiently vaporizes the mixture of micron diameter droplets and carrier gas. The consistent control of both temperature and pressure conditions inside of the heat exchanger ensures that incoming liquid droplets are not only efficiently vaporized but remain in a vapor state and don't recondense. Depending upon the heater size, the DLIHV can reliably deliver up to 83 g/min (~5 kg/hr) of water vapor.

The DLIHV circulation heater is constructed of a 316L stainless steel helical coiled tube cast in an aluminum body with tubular elements. The aluminum body serves as the heat transfer media between the tubular heating elements in the center of the heater and the coiled tube through which the fluid passes. The aluminum casting around the stainless steel tubing increases the thermal mass ensuring accurate temperature control of the fluid so as to prevent thermal degradation.

- Wetted Materials: 316L SS (standard); passivation or Titanium (optional)
- Dual K-type thermocouples: one for operating temperature and one for over-temp limit
- Removable atomizer & exit orifice(s) are sized to the desired operating conditions
- Silicon insulation jacket
- Variety of process connections: tube stub; tube compression; face seal (1/8" to 1/2")

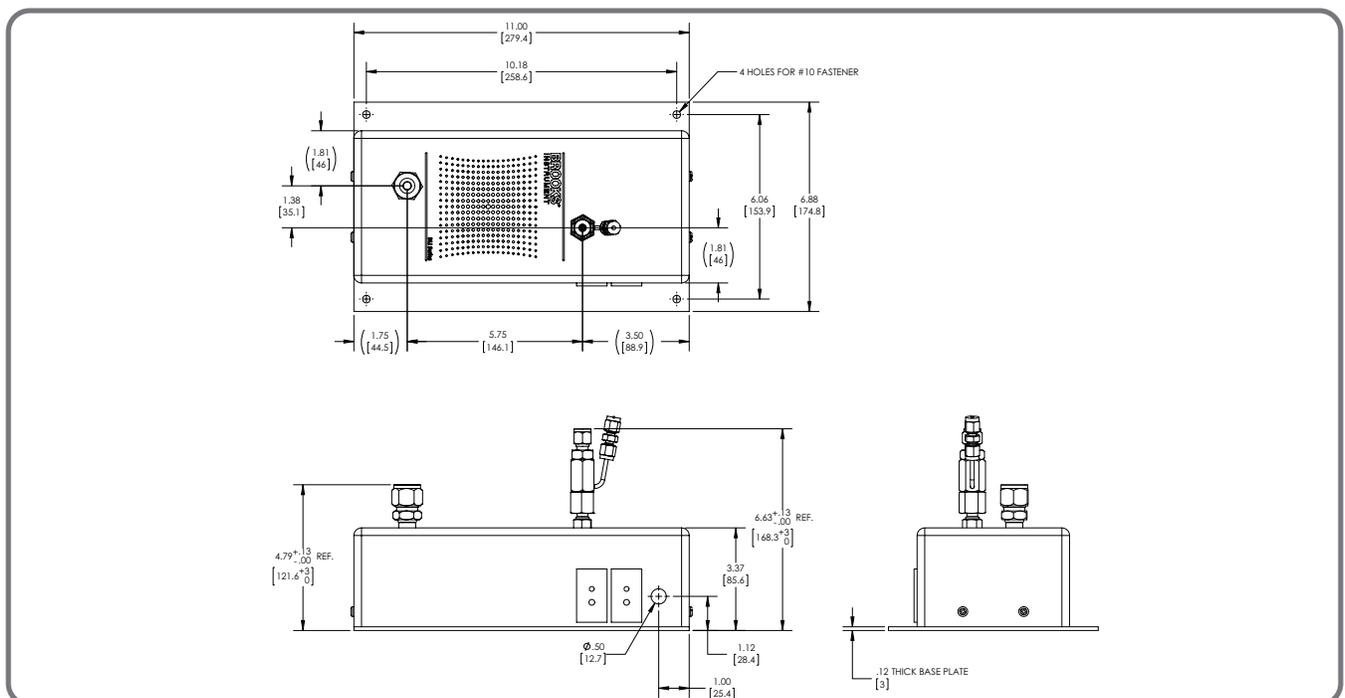


## Product Specifications

Table 1 DLIHV Specifications

Performance:	1500 Watt	3000 Watt	6000 Watt
Flow Range	15 g/min	30 g/min	83 gm/min
Flow Accuracy	Dependent on liquid flow controller		
Response Time	Dependent on liquid flow controller		
<b>Ratings:</b>			
Maximum Operating Pressure	1500 psig	1500 psig	1500 psig
Maximum Working Temperature	150°C	150°C	250°C
Leak Integrity (external)	1 x 10 <sup>-9</sup> cc/sec helium		
Differential Pressure	(1.2 x Outlet Pressure) + 10 psi		
<b>Mechanical:</b>			
<b>Materials of Construction</b>			
Process Wetted	316L stainless steel		
Optional	Titanium heat exchanger/Passivation		
Process Seals	Viton® or Kalrez®		
Housing	Enclosure: Painted aluminum Base Plate: Aluminum		
Process Fitting Options	Carrier Gas Inlet: 1/4" or 1/2" tube compression or male VCR® Liquid Inlet: 1/8" or 1/4" tube compression or male VCR Vapor Outlet: 1/4" or 1/2" male VCR or tube stub		
Thermocouple Connection Options	Universal female panel jack		
Dimensions	See Figure 1	See Figure 2	See Figure 3
<b>Electrical:</b>			
Power Requirements (Heater)	120 or 240 Vac	240 Vac	240 Vac
<b>Certifications, Approvals and Compliance:</b>			
Environmental Compliance	RoHs Directive (2011/65/Eu)		

## Product Dimensions



# Product Dimensions (continued)

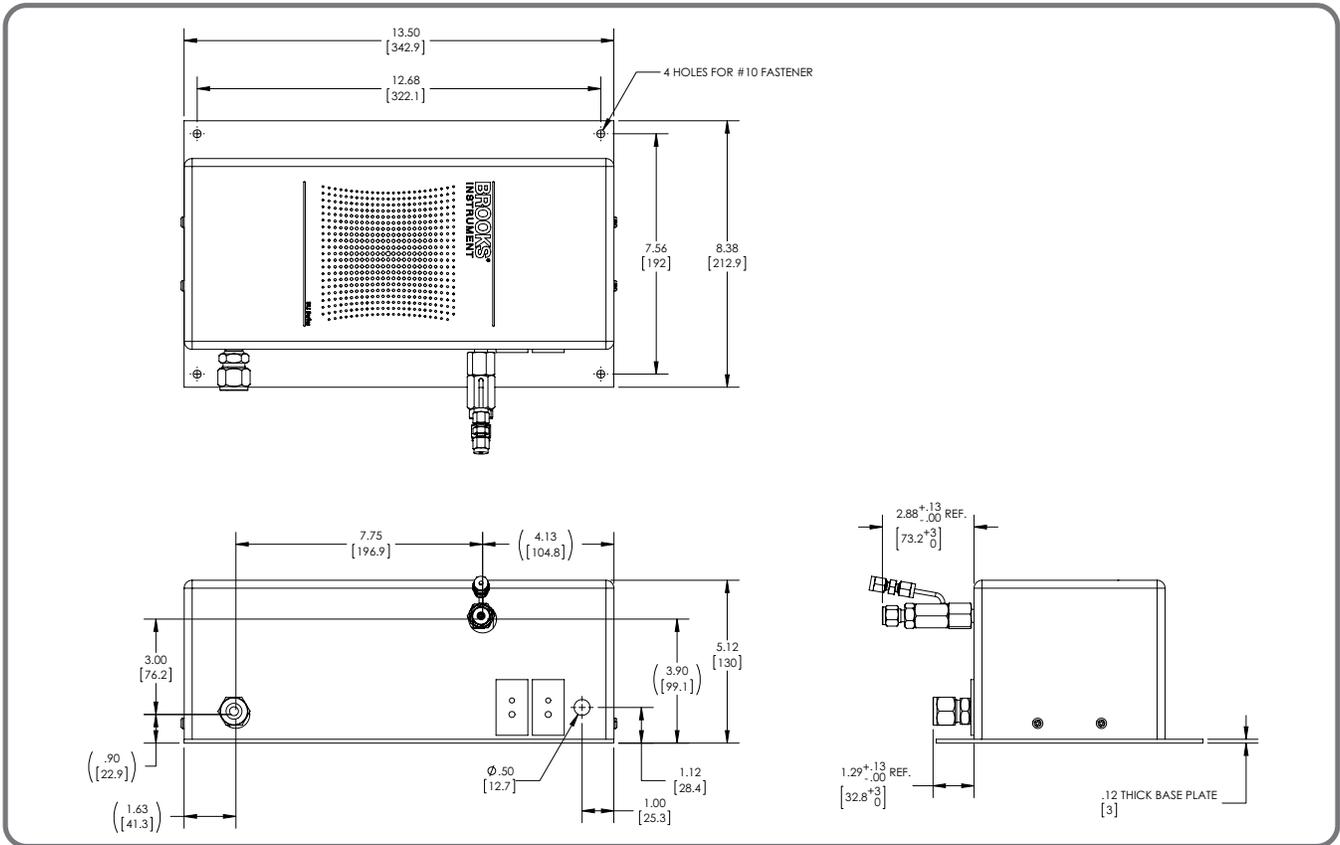


Figure 2 Dimensions - DLIHV 3000 Watt

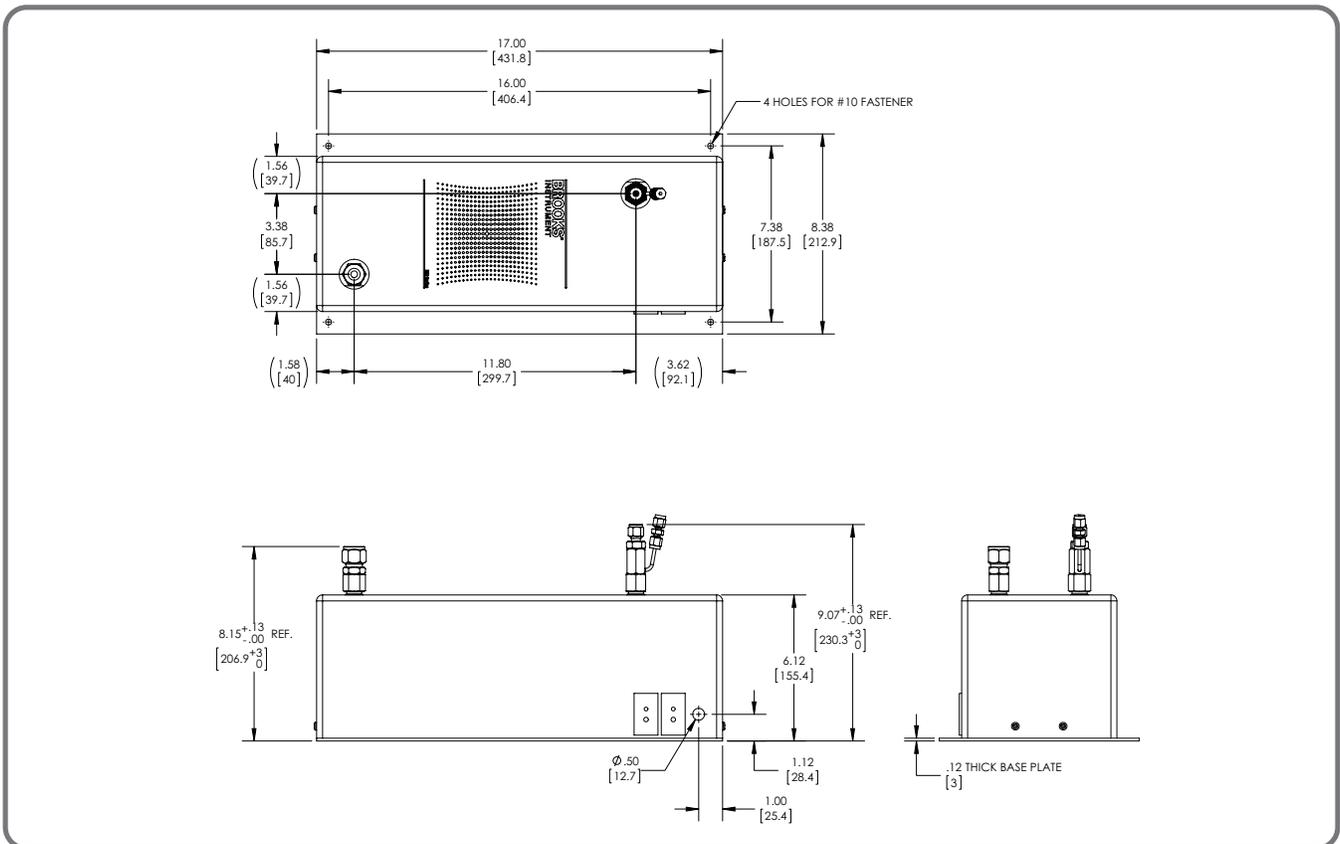
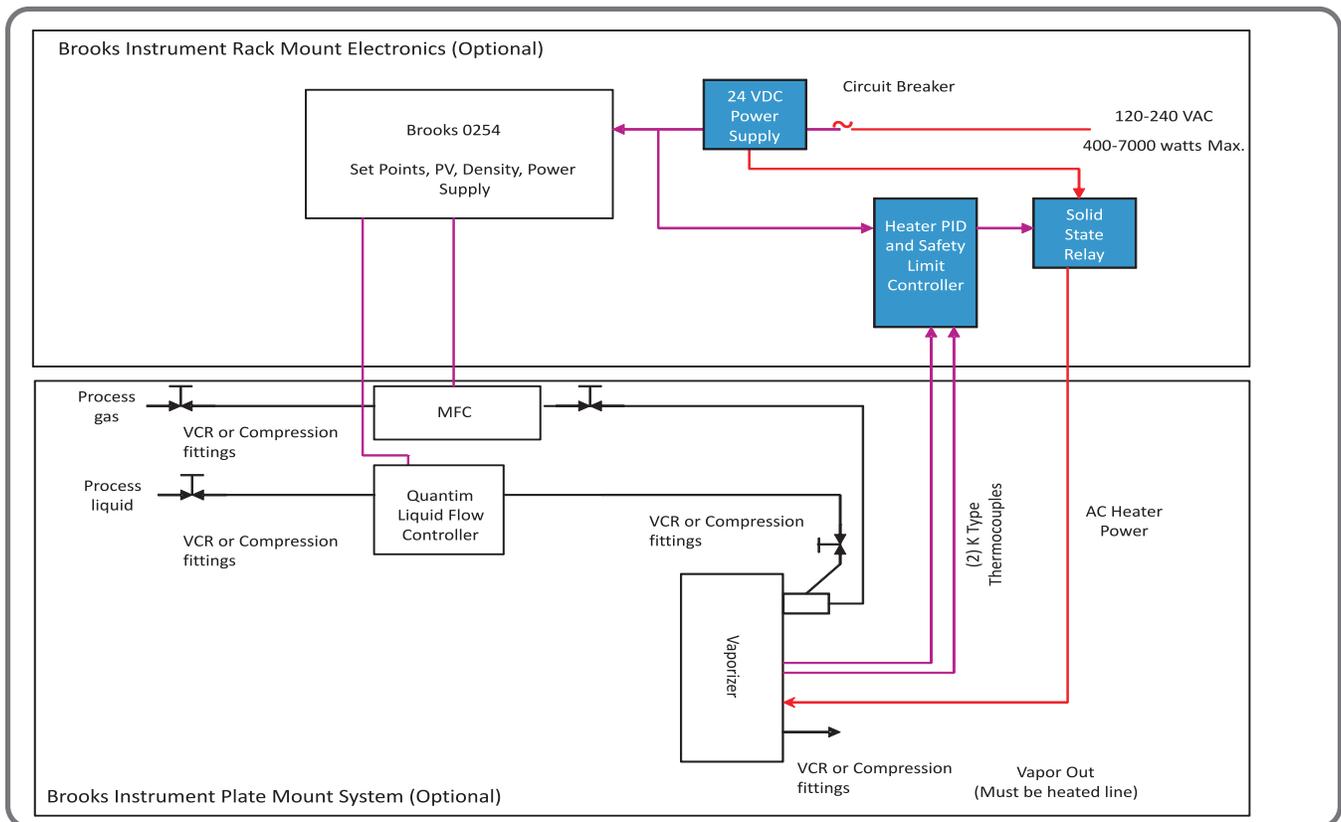


Figure 3 Dimensions - DLIHV 6000 Watt

## Vaporizer System - Ancillary Measurement and Control Devices

### Vaporizer System

In order for the Brooks Instrument DLIHV vaporizer to perform at the optimal level, it needs to be supplied and controlled by multiple ancillary measurement and control devices that impact overall performance. Brooks Instrument can provide you with a completely integrated solution, either standard (as described in the schematic below) or custom to meet your individual regulatory and organizational operational and safety requirements.



The most common integrated system is a plate-mount system consisting of the DLIHV heat exchanger mounted on a brushed stainless steel or aluminum backplate, along with the Brooks' Quantim® Coriolis liquid mass flow controller and a Brooks' carrier gas thermal mass flow controller. Optional components include a pneumatic liquid shutoff valve, the Brooks' SolidSense II pressure transducer or the Brooks' XacTorr® CMX Series digital vacuum capacitance manometer.

### Gas Flow Controller

Brooks' thermal mass flow controllers are designed for the most accurate, reliable and stable gas flow control in high purity and ultra-high purity applications. Each DLIHV vaporizer requires a thermal mass flow controller for the carrier gas into the atomizer. Brooks offers a wide variety of digital, analog, elastomer-sealed and all-metal seal UHP designs to meet the unique required flow conditions for your DLIHV vaporizer.

### Liquid Flow Controller

Brooks' Quantim Coriolis liquid mass flow controller is designed for the accurate, reliable and stable liquid flow control in high purity applications like the DLIHV vaporizer. Each DLIHV vaporizer requires a liquid mass flow controller for the water/precursor into the atomizer. Unlike conventional liquid thermal



## Vaporizer System - Ancillary Measurement and Control Devices (continued)

flow controllers, the Quantim is a true mass flow controller that is insensitive to liquid properties. Quantim also measures liquid density which can provide important diagnostic confirmation about the liquid being controlled.

### Liquid Inlet Shutoff Valve

Some applications may require the ability to completely shutoff the flow of liquid into the vaporizer and thus isolate the liquid source line. In this case, we recommend a pneumatic liquid shutoff valve between the liquid flow controller and the atomizer.

### Pressure Transducer

Brooks' SolidSense II pressure transducer is designed for stable, accurate, and reliable pressure monitoring in ultra-high purity (UHP) applications. When placed on the inlet carrier gas pressure it helps to ensure that your vaporizer system maintains a minimal pressure differential between the atomizer inlet and the vaporizer outlet.

### Vacuum Manometer

Brooks' XacTorr CMX Series digital vacuum capacitance manometer provides a reliable, consistent UHP measurement of pressure conditions in the sub-atmospheric range. When placed on the outlet side of the DLIHV vaporizer it helps to ensure that your vaporizer system is operating the proper pressure range to maintain a vapor state. When placed on the inlet side of the atomizer it allows the user to monitor pressure differential between the atomizer inlet and the vaporizer outlet.

### Rack Mount Electronics Monitoring & Control

The Brooks' DLI Vaporizer requires both monitoring and control to perform the following functions:

- Provide power and set points to the liquid & gas mass flow controllers
- Monitor readings from mass flow controllers and ancillary components i.e., pressure transducer & vacuum capacitance manometers
- Control the DLIHV heater temperature

Brooks' Remote Electronics Unit is a 19" rack mount system that's configured with a 24VDC power supply and any of the following three components:

- Brooks' 0254-Series Secondary Electronics is a four-channel power supply, readout and setpoint controller for thermal mass flow, Quantim Coriolis mass flow, and/or pressure devices.
- Watlow® EZ-ZONE PM Integrated PID and Limit Temperature Controller, provides simple and reliable closed-loop control of the DLIHV heat exchanger.



## Model Code

Code Description	Code	Option Description
<b>I.</b> Base Model Code	<b>DLIHV</b>	Direct Liquid Injection High Capacity Vaporizer
<b>II.</b> Heater	<b>N</b>	1500 W, 120 Vac
	<b>P</b>	1500 W, 240 Vac
	<b>V</b>	3000 W, 240 Vac
	<b>Y</b>	6000 W, 240 Vac
<b>III.</b> Thermocouple Connector	<b>2</b>	Universal Panel Jack, Female
<b>IV.</b> Liquid Valve Atomizer	<b>A</b>	None
<b>V.</b> Atomizer Orifice	<b>B</b>	0.003 inch diameter
	<b>C</b>	0.005 inch diameter
	<b>D</b>	0.007 inch diameter
	<b>1</b>	0.010 inch diameter
	<b>2</b>	0.020 inch diameter
	<b>3</b>	0.030 inch diameter
	<b>4</b>	0.040 inch diameter
	<b>5</b>	0.050 inch diameter
	<b>6</b>	0.060 inch diameter
	<b>E</b>	0.070 inch diameter
	<b>F</b>	0.082 inch diameter
	<b>G</b>	0.093 inch diameter
	<b>H</b>	0.106 inch diameter
	<b>J</b>	0.120 inch diameter
<b>K</b>	0.140 inch diameter	
<b>Z</b>	Custom diameter	
<b>VI.</b> Atomizer & Seal Material	<b>B</b>	Small threaded with Viton
	<b>C</b>	Small threaded with Kalrez
	<b>H</b>	Large threaded with Viton
	<b>J</b>	Large threaded with Kalrez
<b>VII.</b> Liquid Inlet - Gas Inlet	<b>A</b>	1/8" female tube compression - 1/4" female tube compression
	<b>B</b>	1/8" male VCR - 1/4" male VCR
	<b>C</b>	1/4" female tube compression - 1/4" female tube compression
	<b>D</b>	1/4" male VCR - 1/4" male VCR
	<b>L</b>	1/8" female tube compression - 1/2" female tube compression
	<b>M</b>	1/8" male VCR - 1/2" male VCR
	<b>P</b>	1/4" female tube compression - 1/2" female tube compression
	<b>Q</b>	1/4" male VCR - 1/2" male VCR 1/8" tube stub - 1/4" male VCR
<b>VIII.</b> Vapor Outlet	<b>1</b>	1/4" female VCR
	<b>2</b>	1/2" female VCR
	<b>4</b>	1/4" male VCR
	<b>5</b>	1/2" male VCR
	<b>7</b>	1/2" x 6" tube stub (mates to 1/2" MVCR to capture exit orifice)
<b>IX.</b> Outlet Orifice	<b>A</b>	None
	<b>B</b>	0.010
	<b>C</b>	0.020
	<b>D</b>	0.030
	<b>E</b>	0.040
	<b>F</b>	0.050
	<b>G</b>	0.060
	<b>H</b>	0.070
	<b>J</b>	0.080
	<b>K</b>	0.090
	<b>L</b>	0.100
	<b>M</b>	0.110
	<b>N</b>	0.120
	<b>P</b>	0.130
	<b>Q</b>	0.140
	<b>S</b>	0.150
	<b>T</b>	0.160
	<b>U</b>	0.170
	<b>V</b>	0.180
<b>Z</b>	Custom Size	
<b>X.</b> Pressure Transmitter	<b>A</b>	None

### Sample Standard Model Code

I	II	III	IV	V	VI	VII	VIII	IX	X
DLIHV	V	2	A	3	C	Q	2	F	A

## Brooks Service and Support

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit [www.BrooksInstrument.com](http://www.BrooksInstrument.com) to locate the service location nearest to you.

### START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required. For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

### CUSTOMER SEMINARS AND TRAINING

Brooks Instrument can provide customer seminars and dedicated training to engineers, end users, and maintenance persons.

*Please contact your nearest sales representative for more details.*

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

### TRADEMARKS

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