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Calibration

molbox1+™ Flow Terminal

± 0.125 % of reading—lowest uncertainty for gas flow calibration

Technical Data

The molbox1+ flow terminal from Fluke Calibration represents a significant update to the molbloc/molbox gas flow calibration system. molbox1+ combined with molbloc flow elements enables you to achieve the lowest uncertainty available for gas flow meter and controller calibrations. A special configuration, molbox1+S, allows you to use molbloc-S sonic nozzle flow elements at higher pressures than were previously possible, greatly extending their usable flow range.

A molbloc/molbox1+ gas flow calibration system is the ideal solution for calibrating flow meters, thermal mass flow controllers (MFCs), rotameters, turbine meters, bubble meters, and other flow measurement devices. With real-time measurements, no moving parts and supported by traceable calibration in several different gases and operating pressures, molbloc/molbox can handle virtually any calibration application without compromise. molbloc/molbox systems are widely used in many industries, including pharmaceuticals, semiconductors, aerospace, environmental monitoring, energy production, reference gas blending, and research and standards laboratories.

molbox1+ features at a glance

- ± 0.125 % of reading uncertainty on mass flow measurements with molbloc-L and molbloc-S elements with premium calibrations
- molbox1+S configuration gives extra rangeability with molbloc-S elements without requiring vacuum pumps
- Now use any molbloc element for both high and low pressure applications in the same gas
- Even more robust internal pneumatic design
- Full suite of software automation products and hardware accessories to create a complete gas flow calibration system—including new COMPASS® for Flow calibration assistance software

Unparalleled uncertainty specifications

molbox1+ innovations enable the molbloc/molbox1+ system to achieve the lowest gas flow measurement uncertainties in the industry.

The lower uncertainty is made possible by several key improvements, including:

- Use of Fluke Calibration's exclusive quartz reference pressure transducer (Q-RPT) technology to precisely measure both absolute and differential pressure. molbox1+ Q-RPTs are specially characterized sensors benefitting from the same technology used in Fluke Calibration's pressure transfer standards.
- "Premium" molbloc calibrations linearize molbloc flow output to better capitalize on existing precision and repeatability.
- Expanded molbloc modelization enables improved performance of molbloc-L laminar flow elements across their range of operating pressures.
- Reduced uncertainty on gas properties utilizing data from NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP).
- Continued improvements in Fluke Calibration's molbloc calibration chain, based on fundamental mass- and time-based mass flow measurements using Fluke Calibration's own dynamic Gravimetric Flow Standard.

Two levels of molbloc flow element calibration are now available to let you balance uncertainty and cost:

- **Premium:** ± 0.125 % of reading flow measurement uncertainty (with molbox1+)
- **Standard:** ± 0.2 % of reading flow measurement uncertainty (with molbox1 or molbox1+)

New molblocs are eligible for either calibration type. Existing molblocs are compatible with molbox1+ at ± 0.2 % of reading uncertainty with no changes required. See below for details on upgrade service to existing molblocs to allow premium calibration and measurement specifications.

The molbloc/molbox system has stood the test of time since the early 1990's, used in many demanding calibration laboratories, intercomparisons and government organizations worldwide. Fluke Calibration's uncertainty specifications are conservative and backed by a thorough uncertainty analysis and metrology support. Fluke Calibration's innovation and design is continually aimed at making sure our products deliver specifications that can be realized by the user, not under best case conditions but in your real-world application.

molbox1+S expands rangeability—without vacuum pumps

molbox1+S is a special configuration of molbox 1+ that enables you to cover a wide range (10:1 range turndown) with molbloc-S sonic nozzle flow elements, without requiring costly vacuum pumps. molbox1+S is available with upstream Q-RPT pressure range up to 2 MPa (300 psia) to allow molbloc-S elements to be conveniently used over a wide flow range upstream of flow meters being tested at atmospheric pressure, a common application. This extra rangeability makes it simple to configure a calibration system using fewer molbloc elements and minimal accessories. It also greatly extends the range of your existing molbloc-S elements when a high pressure molbloc calibration is added.

molbloc-S range example with device under test at atmospheric pressure

Molbloc-S element	Usable range with SP calibration and molbox1 A700K	Usable range with HP calibration and molbox1+S A2M
1E2-S	15 to 50 slm*	20 to 200 slm
5E2-S	67 to 250 slm*	100 to 1000 slm

*Minimum usable flow of molbloc-S elements with SP calibrations are limited by back pressure requirements for sonic flow when used upstream of a device at atmospheric pressure. Flow values are in standard liters per minute referenced to 0 °C.

molbox1+S is designed for use with molbloc-S elements and therefore is configured for absolute pressure measurement only, reducing its cost. It also reduces flow system complexity and overall cost, as well as ongoing recalibration costs.

Use the same molbloc in multiple applications

Multiple molbloc calibrations are now supported for each gas. This means that you can now have a molbloc calibrated separately for use both at high pressure (upstream of the device under test) and low pressure (downstream of the device under test) to support different applications instead of requiring two molblocs or manually loading separate molbloc calibration files. All calibrations are stored on the molbloc EEPROM and the user simply selects the calibration type from the molbox1+ front panel or via molbox1+ remote interface.

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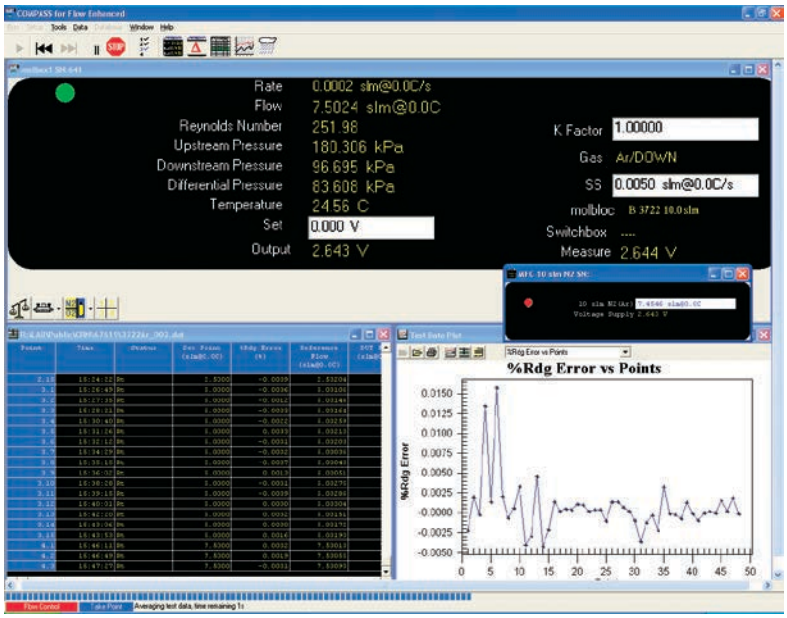
COMPASS® for molbox and new COMPASS® for Flow software add automation and more

COMPASS calibration assistance software takes molbloc/molbox to the next step in automating calibrations. COMPASS and a personal computer work with molbloc/molbox to create a modern, full function, turnkey system for calibrating and testing flow devices.

COMPASS sets up device under test (DUT) records (also known as unit under test), defines and associates test procedures with DUTs, runs tests, acquires reference and test data, produces standard and custom calibration reports. Mass flow device gas correction factors and gas density corrections for volumetric devices like rotameters are easily supported, with options to dynamically calculate the corrected flow using automatic input of pressure and temperature measurements. All reference, DUT and test data are collected and stored in standard delimited files that can be easily downloaded to other applications.



A new version of the software, COMPASS for Flow, brings features to flow calibration that were previously only available in Fluke Calibration's COMPASS for Pressure software. These include:

- Ability to export data to Fluke Calibration MET/TRACK® software.
- Enhanced support for devices under test requiring custom calculations on output indications, special communications support and calibration of multiple devices at once.
- Macro support to handle almost unlimited test system automation.
- More complete and flexible support for accessory devices like MFC-CB (Fluke Calibration mass flow controller control box).

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General specifications

Power requirements	85 V ac to 264 V ac, 47 Hz to 440 Hz, 18 VA max consumption
Normal operating temperature range	15 °C to 30 °C (59 °F to 86 °F)
Storage temperature range	-20 °C to 70 °C (-4 °F to 158 °F)
Vibration	Meets MIL-T-28800D
Weight	6.8 kg (15 lb) max
Dimensions (WxHxD)	32 cm x 12 cm x 30 cm (12.6 in x 4.7 in x 11.8 in) approx.
Communication ports	RS-232 (COM1), RS-232 (COM2), IEEE-488.2
Pressure connections (molbox1+ and molbloc)	Quick connectors equivalent to Swagelok® QM Series (SS-QM2-B200)
Flow ranges	<1 sccm to >5000 slm. See separate molbloc-L and molbloc-S range tables
Flow measurement rate	1 second
Gases supported (Consult your sales representative for a current list of gases available for factory molbloc calibration.)	Nitrogen (N2), Air, Argon (Ar), Carbon Monoxide (CO), Helium (He), Oxygen (O2), Carbon Dioxide (CO2), Carbon Tetrafluoride (CF4), Ethane (C2H6), Ethylene (C2H4), Fluoroform (CHF3), Hexafluoroethane (C2F6), Hydrogen (H2), Methane (CH4), Nitrous Oxide (N20), Propane (C3H8), Sulfur Hexafluoride (SF6), Butane (C4H10), Octafluorocyclobutane (C4F8), Xenon (Xe)
Valve driver option	(8) 12 V outputs. Each output can sink 500 mA at 12 V, max 1 Amp total
MFC control option (analog input/output)	**Nominal voltage range:** 0 V dc to 6 V dc input, 0 V dc to 5 V dc output **Nominal current range:** 4 mA to 20 mA input, 4.01 mA to 20 mA output **Accuracy:** ± 0.1 % FS (set), ± 0.05 % FS (measure)

Pressure measurement

Type	Q-RPT Characterized Quartz Reference Pressure Transducers – Oscillating quartz crystal with mechanical bellows
Calibrated pressure range (full scale)	
A700K	0 to 600 kPa absolute (0 to 87 psia)
A350K	0 to 300 kPa absolute (0 to 44 psia)
S A1.4M (molbloc-S only)	0 to 1.2 MPa absolute (0 to 174 psia)
S A2M (molbloc-S only)	0 to 2 MPa absolute (0 to 290 psia)
Measurement uncertainty (one-year)	
Absolute pressure[4]	± (0.01 % of reading or 0.003 % Q-RPT span, whichever is greater)
Differential pressure (A700K with Tare)	± (8.4 Pa (0.0012 psi) or 0.032 % ΔP, whichever is greater)
Differential pressure (A350K with Tare)	± (4.2 Pa (0.0006 psi) or 0.026 % ΔP, whichever is greater)

Temperature measurement

Type	molbloc PRTs with molbox1+ Ohmic Measurement System
Range (FS)	0 to 40 °C
Resolution	0.01 °C
molbloc PRT precision	± 0.02 °C (15 to 30 °C)
On-board	
Reference resistor	100 and 110 Ω ± 0.01 %, stability < 25 ppm/year
Ohmic measurement	± 0.02 % of reading (15 °C to 30 °C)

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Flow measurement

with molbloc-L laminar flow elements		
	Standard molbloc calibration	**Premium molbloc calibration**
Range	0 to 100 % molbloc full scale	0 to 100 % molbloc full scale
Resolution	0.0015 % FS	0.0015 % FS
Precision[1]	± 0.07 % of reading, ± 0.007 % FS under 10 % FS	± 0.07 % of reading, ± 0.007 % FS under 10 % FS
Stability (one-year)[2]	± 0.09 % of reading, ± 0.009 % FS under 10 % FS	± 0.03 % of reading, ± 0.003 % FS under 10 % FS
Measurement uncertainty[3] **(For any gas for which the molbloc in use is calibrated)**	**± 0.2 % of reading**, ± 0.02 % FS under 10 % FS	**± 0.125 % of reading**, ± 0.0125 % FS under 10 % FS
with molbloc-S sonic nozzle flow elements		
	Standard molbloc calibration	**Premium molbloc calibration**
Range	10 % to 100 % molbloc full scale	10 % to 100 % molbloc full scale
Resolution	0.0015 % FS	0.0015 % FS
Precision[1]	± 0.06 % of reading	± 0.06 % of reading
Stability (one-year)[2]	± 0.05 % of reading	± 0.03 % of reading
Measurement uncertainty[3] **(For any gas for which the molbloc in use is calibrated)**	**± 0.2 % of reading**	**± 0.125 % of reading**[4]

[1] Precision: Combined linearity, hysteresis, repeatability.
[2] Stability: Maximum change in zero and span over specified time period for typical molbox and molbloc used under typical conditions. As stability can only be predicted, stability for a specific molbox and molbloc should be established from experience.
[3] Measurement uncertainty: Maximum deviation of the molbox1+ flow indication from the true value of the flow through the molbloc including precision, stability and Fluke calibration.
[4] With regular use of Autozero. Add 0.005 % of Q-RPT span for one year without use of AutoZero, (translates to 0.005 % FS for molbloc-S, does not significantly affect molbloc-S standard calibration or molbloc-L uncertainty.)

All uncertainty specifications reported at k=2

Upgrading is easy

Upgrading from molbox1 to molbox1+ is economical and easy. A hardware and software upgrade can be performed at a Fluke Calibration factory. To upgrade and achieve the new specifications and features offered by molbox1+ the following steps are performed on your system at Fluke Calibration.

1) **molbox1+ hardware/software changes.** Any required parts are changed to make your molbox materially identical to a factory produced molbox1+. The molbox is flashed to v6.0 embedded software. Two options are available: **Upgrade** your existing molbox1 to meet molbox1+ specifications, or **Trade up** to a new molbox1+, capturing savings by reusing a few key parts.
2) **Q-RPT characterization of molbox1 internal pressure transducers.** Both existing internal pressure transducers are used in the new molbox1+. Extensive characterization of the transducers enhances their precision and ensures they meet molbox1+ specifications.
3) **molbloc hardware updates.** molbloc-L or molbloc-S elements to be used with the molbox1+ require hardware modifications to support the premium uncertainty specification and a new data structure.
4) **New molbloc gas calibrations.** molblocs are fully modeled and calibrated following hardware updates to realize the benefits of the enhanced gas property data used in molbox1+, Fluke Calibration's improved calibration chain and new molbloc linearization and modeling techniques.

The entire system will be upgraded and returned to you with new specifications and calibration certificates at a fraction of the cost of a new system.

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Ordering information

molbox1+ Models

Item No.	Model	Description	molbloc Compatibility
3500013	MOLBOX1+ A700K	700 KPa (100 psia) Flow Terminal	For molbloc-L and molbloc-S
3500024	MOLBOX1+ A350K	350 KPa (50 psia) Flow Terminal	For molbloc-L and molbloc-S
3500049	MOLBOX1+S A2M	SONIC 2 MPa (300 psia) Flow Terminal	New molbloc-S only terminal
3500051	MOLBOX1+S A1.4M	SONIC 1.4 MPa (200 psia) Flow Terminal	New molbloc-S only terminal

Options and accessories

3078336 MFC Control Option
Set and read analog voltage and current MFCs. Optional board is built-into molbox1+ and connector is on rear panel. Delivered with MFC cable and connection kit.

3069585 Rack Mount Kit
Standard 19 in. rack mount kit for molbox1+. Panel is 5.25 in. (3U) high.

New molbloc calibration options

Each molbloc calibration option can now be ordered as standard or premium. Premium molbloc calibrations result in an improved uncertainty specification when the molbloc is used with a molbox1+ terminal. molbloc pressure-dependent calibration options are listed below. molbloc flow ranges are dependent on the calibration pressure option and gas chosen. See the molbloc-L range sheet and molbloc-S data sheet for available molbloc ranges.

molbloc-L (specify Premium or Standard)

Calibration Type	Operating Pressure (absolute)
Downstream	Atmospheric pressure downstream of the molbloc
Low Pressure	200 to 325 kPa (29 to 47 psi) absolute upstream of the molbloc
High Pressure	325 to 525 kPa (47 to 76 psi) absolute upstream of the molbloc

molbloc-S (specify Premium or Standard)

Calibration Type	Operating Pressure (absolute)
Low pressure	20 to 200 kPa (3 to 30 psia) absolute upstream of the molbloc
Standard pressure	50 to 500 kPa (7 to 70 psia) absolute upstream of the molbloc
High Pressure (New calibration option)	200 kPa to 2 MPa (29 to 300 psia) absolute upstream of the molbloc

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Printed in U.S.A. 9/2014 3500469E_EN Pub ID: 11563-eng Rev 03

molbloc-L ranges with low pressure and downstream calibrations

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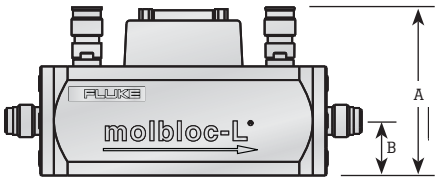
	Gases		molbloc size and full scale flow (sccm @ 0 °C) Size 1E1	5E1	1E2	2E2	5E2	1E3	5E3	1E4	3E4	1E5
Inert	Nitrogen	N_2	10	50	100	200	500	1 000	5 000	10 000	30 000	100 000
	Argon	Ar	10	50	100	200	500	1 000	5 000	10 000	30 000	80 000
	Helium	He	10	50	100	200	500	1 000	5 000	10 000	30 000	100 000
	Sulfur hexafluoride	SF_6	10	50	100	200	500	1 000	**2 000 500**	**6 000 1 000**	**6 000 4 000**	–
	Xenon	Xe	10	40	80	150	400	800	**3 500 500**	8 000	**11 000 3 000**	**30 000 20 000**
Flammable	Butane	C_4H_{10}	20	100	**130 30**	**270 50**	**670 140**	2 300	**2 200 1 400**	**7 000 3 000**	–	–
	Ethane	C_2H_6	20	100	200	400	1000	2 000	**6 000 1 000**	**18 000 2 000**	**18 000 6 000**	**60 000 50 000**
	Ethylene	C_2H_4	16	80	160	320	800	1 600	**7 000 1 000**	16 000	**20 000 5 000**	**70 000 40 000**
	Hydrogen	H_2	20	100	200	400	1000	2 000	10 000	20 000	60 000	200 000
	Methane	CH_4	16	80	160	320	800	1 600	8 000	16 000	**40 000 5 000**	**120 000 40 000**
	Propane	C_3H_8	20	100	200	400	1000	2 000	**3 000 1 000**	**10 000 2 000**	**10 000 7 000**	–
Fluoro-carbons	Carbon tetrafluoride	CF_4	10	50	100	200	500	1 000	**4 000 600**	10 000	**12 000 3 000**	**36 000 25 000**
	Hexafluoroethene	C_2F_6	10	50	100	200	500	1 000	**2000 600**	**6000 1200**	**6 000 4 000**	–
	Trifluoromethane	CHF_3	10	50	100	200	500	1 000	**4000 600**	10000	**12 000 4 000**	**38 000 30 000**
Other	Air	Air	10	50	100	200	500	1 000	5000	10 000	30 000	100 000
	Carbon dioxide	CO_2	10	50	100	200	500	1 000	5 000	10 000	**20 000 4 000**	**60 000 30 000**
	Carbon monoxide	CO	10	50	100	200	500	1 000	5 000	10 000	30 000	100 000
	Nitrous oxide	N_2O	10	50	100	200	500	1 000	5 000	10 000	**20 000 4 000**	**60 000 30 000**
	Octafluorocyclobutane[1]	C_4F_8	15	**60 9**	**65 17**	**130 34**	**330 85**	**1 100 175**	**1 050 840**	**3 400 1 700**	–	–
	Oxygen	O_2	10	50	100	200	500	1 000	5 000	10 000	30 000	80 000

See page 2 for footnotes.

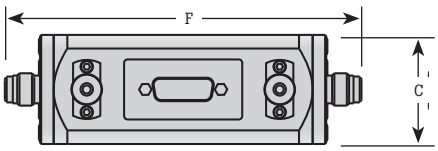
molbloc-L dimensions

All Except 1E5

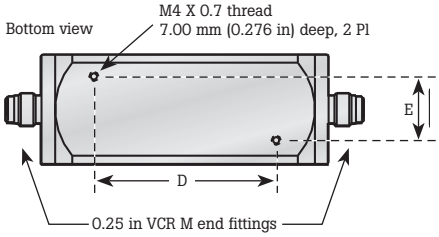
Side view



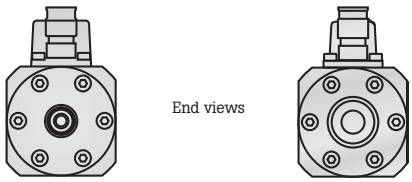
Top view



Bottom view



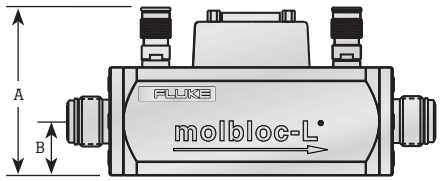
End views



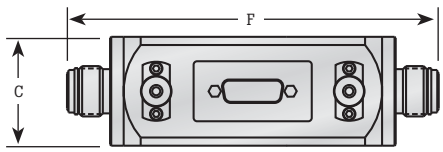
	5E3 and lower	1E4,3E4	1E5
A	58.50 mm (2.303 in)	74.50 mm (2.933 in)	74.50 mm (2.933 in)
B	16.00 mm (0.630 in)	24.00 mm (0.945 in)	24.00 mm (0.945 in)
C	32.00 mm (1.260 in) sq	48.00 mm (1.890 in) sq	48.00 mm (1.890 in) sq
D	68.84 mm (2.750 in)	80.00 mm (3.150 in)	80.00 mm (3.150 in)
E	19.06 mm (0.750 in)	28.00 mm (1.102 in)	28.00 mm (1.102 in)
F	124.00 mm (4.881 in)	157.00 mm (6.181 in)	164.00 mm (6.458 in)

1E5

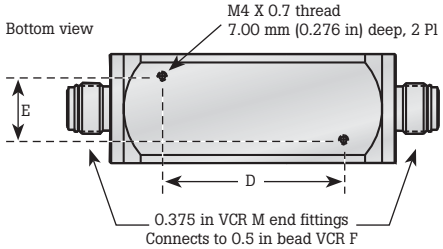
Side view



Top view



Bottom view



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molbloc-L ranges with high pressure calibrations

			molbloc size and full scale flow (sccm @ 0 °C)									
			Size									
	Gases		1E1	5E1	1E2	2E2	5E2	1E3	5E3	1E4	3E4	1E5
Inert	Nitrogen	N_2	20	100	200	400	1000	2 000	10 000	20 000	**50 000 7 500**	N/A
	Argon	Ar	20	100	200	400	1 000	2 000	10 000	17 000	**45 000 6 000**	N/A
	Helium	He	20	100	200	400	1000	2 000	10 000	20 000	65 000	N/A
	Sulfur hexafluoride	SF_6	25	**100 15**	**120 30**	**250 50**	**600 150**	**2 000 300**	**2 000 1 400**	**6 200 2 800**	–	N/A N/A
	Xenon	Xe	20	100	150	350	650	1 700	**3 350 950**	**11 000 1 900**	**11 000 5 700**	N/A
Flammable	Butane[2]	C_4H_{10}	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ethane	C_2H_6	40	200	**350 50**	**700 100**	**1 800 200**	4 000	**6 000 2 300**	**20 000 4 500**	**20 000 13 800**	N/A N/A
	Ethylene	C_2H_4	40	200	350	700	2 000	4 000	**7 000 2 000**	**22 000 4 000**	**22 000 12 700**	N/A
	Hydrogen	H_2	40	200	400	900	2 000	4 500	22 000	45 000	130 000	N/A
	Methane	CH_4	35	175	350	700	1 700	3 500	**13 000 2 000**	33 000	**42 000 12 000**	N/A
	Propane	C_3H_8	50	**200 25**	**200 50**	**400 100**	**1 000 250**	**3 500 500**	**3 500 2 600**	**11 000 5 400**	–	N/A
Fluoro-carbons	Carbon tetrafluoride	CF_4	20	100	200	400	1 000	2 000	**3 700 1 200**	**12 000 2 400**	**12 000 7 300**	N/A
	Hexafluoroethene	C_2F_6	25	**100 15**	**120 30**	**250 50**	**600 150**	**2 000 300**	**1 800 1 500**	**6 000 3 000**	–	N/A
	Trifluoromethane	CHF_3	25	125	**240 30**	**450 60**	**1 200 150**	2 500	**4 000 1 500**	**12 000 3 000**	**12 000 8 800**	N/A
Other	Air	Air	20	100	200	400	1 000	2 000	10 000	20 000	**50 000 7 200**	N/A
	Carbon dioxide	CO_2	25	125	250	500	1 250	2 500	**6 600 1 400**	**20 000 2 500**	**20 000 8 800**	N/A
	Carbon monoxide	CO	20	100	200	400	1 000	2 000	10 000	20 000	**40 000 7 500**	N/A
	Nitrous oxide	N_2O	25	125	250	500	1 250	2500	**11 000 1 500**	**20 000 3 000**	**20 000 9 000**	N/A
	Octafluorocyclobutane[2]	C_4F_8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Oxygen	O_2	20	100	200	400	1 000	2 000	10 000	20 000	**40 000 6 500**	N/A

A bold value indicates that the maximum flow is limited by the maximum Reynolds number value of 1 200 which is reached before the normal differential pressure range is reached. In that case, the second value gives the minimum flow for which measurement uncertainty (accuracy) is equal to the nominal uncertainty specification. Divide the second value by 10 when using molbox RFM microrange option.

Where there is no value in the field (–), this indicates that the maximum Reynolds number is reached before the differential pressure reaches 5 kPa (1 kPa in the case of the 1E5 molbloc), therefore calibration with that gas is not useful.

[1] Due to low vapor pressure, only downstream calibration type is available.
[2] The operating pressure range is greater than the vapor pressure value for this gas.

Calibration type	Operating pressure (absolute)
Downstream	Atmospheric pressure downstream of the molbloc
Low Pressure	200 to 325 kPa (29 to 47 psi absolute) upstream of the molbloc
High Pressure	325 to 525 kPa (47 to 76 psi absolute) upstream of the molbloc

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Printed in U.S.A. 8/2014 3542583D_EN
Pub-ID 13240-eng

molbloc-S ranges with high pressure, standard pressure and low pressure calibrations

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				molbloc-S size, K_F (sccm/kPa), and full scale flow (slm @ 0 °C)										
				Size	1E1-S	2E1-S	5E1-S	1E2-S	2E2-S	5E2-S	1E3-S	2E3-S	5E3-S	1E4-S
				K_F (sccm/kPa)	10	20	50	100	200	500	1000	2000	5000	10000
	Gases		Ratio	Cal type										
Inert	Nitrogen	N_2	1.000	HP	20.00	40.00	100.0	200.0	400.0	1000.0	2000	4000	10000	20000
				SP	5.00	10.00	25.0	50.0	100.0	250.0	500	1000	2500	5000
				LP	2.00	4.00	10.0	20.0	40.0	100.0	200	400	1000	2000
				minimum w/o vac	2.00	3.50	7.7	15.0	28.0	67.0	129	248	596	1173
	Argon	Ar	0.837	HP	16.74	33.49	83.7	167.4	334.9	837.2	1674	3349	8372	16744
				SP	4.19	8.37	20.9	41.9	83.7	209.3	419	837	2093	4186
				LP	1.67	3.35	8.4	16.7	33.5	83.7	167	335	837	1674
				minimum w/o vac	1.70	3.00	6.5	12.9	23.3	57.1	108	208	498	996
	Helium	He	2.647	HP	52.94	105.87	264.7	529.4	1058.7	2646.8	5294	10587	26468	52936
				SP	13.23	26.47	66.2	132.3	264.7	661.7	1323	2647	6617	13234
				LP	5.29	10.59	26.5	52.9	105.9	264.7	529	1059	2647	5294
				minimum w/o vac	9.40	13.10	25.7	51.4	91.5	199.4	399	695	1738	3281
	Sulfur hexafluoride	SF_6	0.435	HP	8.70	17.39	43.5	87.0	173.9	434.8	870	1739	4348	8695
				SP	2.17	4.35	10.9	21.7	43.5	108.7	217	435	1087	2174
				LP	0.87	1.74	4.3	8.7	17.4	43.5	87	174	435	870
				minimum w/o vac	0.80	1.40	3.1	5.9	11.4	26.9	54	100	250	500
	Xenon	Xe	0.460	HP	9.21	18.42	46.0	92.1	184.2	460.4	921	1842	4604	9209
				SP	2.30	4.60	11.5	23.0	46.0	115.1	230	460	1151	2302
				LP	0.92	1.84	4.6	9.2	18.4	46.0	92	184	460	921
				minimum w/o vac	0.80	1.40	3.6	6.5	12.9	29.7	59	110	267	529
Flammable	Ethane	C_2H_6	0.960	HP	19.21	38.42	96.0	192.1	384.2	960.4	1921	3842	9604	19208
				SP	4.80	9.60	24.0	48.0	96.0	240.1	480	960	2401	4802
				LP	1.92	3.84	9.6	19.2	38.4	96.0	192	384	960	1921
				minimum w/o vac	1.50	3.00	6.7	13.4	25.2	61.9	119	229	552	1104
	Ethylene	C_2H_4	0.996	HP	19.92	39.83	99.6	199.2	398.3	995.8	1992	3983	9958	19916
				SP	4.98	9.96	24.9	49.8	99.6	248.9	498	996	2489	4979
				LP	1.99	3.98	10.0	19.9	39.8	99.6	199	398	996	1992
				minimum w/o vac	1.70	3.10	7.5	13.9	27.7	64.2	128	237	572	1144
	Hydrogen	H_2	3.730	HP	74.60	149.19	373.0	746.0	1491.9	3729.8	7460	14919	37298	74596
				SP	18.65	37.30	93.2	186.5	373.0	932.4	1865	3730	9324	18649
				LP	7.46	14.92	37.3	74.6	149.2	373.0	746	1492	3730	7460
				minimum w/o vac	8.30	14.50	36.2	62.5	114.5	280.9	509	980	2312	4623
	Methane	CH_4	1.320	HP	26.40	52.81	132.0	264.0	528.1	1320.2	2640	5281	13202	26403
				SP	6.60	13.20	33.0	66.0	132.0	330.0	660	1320	3300	6601
				LP	2.64	5.28	13.2	26.4	52.8	132.0	264	528	1320	2640
				minimum w/o vac	2.60	4.40	10.2	20.1	36.7	88.2	170	327	786	1517
	Propane	C_3H_8	0.789	HP	15.77	31.55	78.9	157.7	315.5	788.7	1577	3155	7887	15774
				SP	3.94	7.89	19.7	39.4	78.9	197.2	394	789	1972	3944
				LP	1.58	3.15	7.9	15.8	31.5	78.9	158	315	789	1577
				minimum w/o vac	1.30	2.30	5.5	10.5	20.8	48.8	98	181	453	907
Fluoro-carbons	Carbon tetrafluoride	CF_4	0.563	HP	11.26	22.51	56.3	112.6	225.1	562.9	1126	2251	5629	11257
				SP	2.81	5.63	14.1	28.1	56.3	140.7	281	563	1407	2814
				LP	1.13	2.25	5.6	11.3	22.5	56.3	113	225	563	1126
				minimum w/o vac	0.90	1.80	4.1	7.9	15.7	36.3	70	134	323	647
	Hexafluoro-ethene	C_2F_6	0.447	HP	8.95	17.89	44.7	89.5	178.9	447.3	895	1789	4473	8947
				SP	2.24	4.47	11.2	22.4	44.7	111.8	224	447	1118	2237
				LP	0.89	1.79	4.5	8.9	17.9	44.7	89	179	447	895
				minimum w/o vac	0.80	1.30	3.2	5.9	11.8	27.6	55	103	257	514
	Trifluoromeths-ane	CHF_3	0.629	HP	12.59	25.18	62.9	125.9	251.8	629.4	1259	2518	6294	12588
				SP	3.15	6.29	15.7	31.5	62.9	157.3	315	629	1573	3147
				LP	1.26	2.52	6.3	12.6	25.2	62.9	126	252	629	1259
				minimum w/o vac	1.00	2.00	4.4	8.8	17.2	40.6	78	150	362	723
Other	Air	Air	0.983	HP	19.67	39.34	98.3	196.7	393.4	983.5	1967	3934	9835	19670
				SP	4.92	9.83	24.6	49.2	98.3	245.9	492	983	2459	4917
				LP	1.97	3.93	9.8	19.7	39.3	98.3	197	393	983	1967
				minimum w/o vac	2.00	3.40	7.6	15.2	27.4	67.1	127	244	585	1170
	Carbon dioxide	CO_2	0.795	HP	15.91	31.81	79.5	159.1	318.1	795.3	1591	3181	7953	15906
				SP	3.98	7.95	19.9	39.8	79.5	198.8	398	795	1988	3977
				LP	1.59	3.18	8.0	15.9	31.8	79.5	159	318	795	1591
				minimum w/o vac	1.40	2.50	6.2	11.1	22.1	51.2	102	189	473	914
	Carbon monoxide	CO	1.000	HP	20.00	40.00	100.0	200.0	400.0	1000.0	2000	4000	10000	19999
				SP	5.00	10.00	25.0	50.0	100.0	250.0	500	1000	2500	5000
				LP	2.00	4.00	10.0	20.0	40.0	100.0	200	400	1000	2000
				minimum w/o vac	2.00	3.50	7.7	15.4	27.8	68.3	129	248	595	1190
	Nitrous oxide	N_2O	0.795	HP	15.90	31.80	79.5	159.0	318.0	795.1	1590	3180	7951	15902
				SP	3.98	7.95	19.9	39.8	79.5	198.8	398	795	1988	3976
				LP	1.59	3.18	8.0	15.9	31.8	79.5	159	318	795	1590
				minimum w/o vac	1.40	2.50	6.2	11.1	22.1	51.2	102	189	473	914
	Octafluoro-cyclobutane[1]	C_4F_8	0.367	LP	0.73	1.47	3.7	7.3	14.7	36.7	73	147	367	733
				minimum w/o vac	0.60	1.10	2.4	4.8	9.2	22.7	44	84	211	421
	Oxygen	O_2	0.935	HP	18.71	37.42	93.5	187.1	374.2	935.4	1871	3742	9354	18708
				SP	4.68	9.35	23.4	46.8	93.5	233.9	468	935	2339	4677
				LP	1.87	3.74	9.4	18.7	37.4	93.5	187	374	935	1871
				minimum w/o vac	1.90	3.40	7.3	14.4	26.4	63.8	120	232	557	1113

[1] The vapor pressure of Octafluorocyclobutane is 230 kPa absolute, Only LP operation is possible. Downstream vacuum is recommended.

Ratio = Inverse square root desity ratio of the indicated gas to that of nitrogen. Also the ratio of mass flow rates in each gas for a given molbloc-S element.
KF = Pressure to flow conversion ratio, sccm/kPa
To estimate a flow in a given gas at a given pressure: Flow(slm) = K_F * pressure in kPa absolute / 1000 * gas ratio
All flows are approximate; in gases other than nitrogen and air, flows may vary up to 10% due to differences in nozzle characteristics and manufacturing

Cal Types: HP = High Pressure calibration 200 kPa to 2 Mpa absolute; table shows flow @ 2 Mpa, minimum flow is 10% of value shown
SP = Standard Pressure calibration 50 kPa to 500 kPa absolute (up to 600 kPa available); table shows flow @ 500 kPa, minimum flow with vacuum is 10% of value shown
LP = Low Pressure calibration 20 kPa to 200 kPa absolute; table shows flow @ 200 kPa, minimum flow with vacuum is 10% of value shown
minimum w/o vac = estimated minimum critical flow without vacuum when atmopheric pressure (100 kPa, 14.7 psia) is downstream of molbloc-S. The minimum calibrated flow for each calibration type is 10% of the full scale flow rate shown; downstream vacuum may be required.

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Nominal molbloc-S nitrogen (N2) flow rate at various upstream pressures

		molbloc-S mass flow rate (slm @ 0 °C) when molbloc-S upstream pressure is:[1,2]								
Designator	K_F [sccm/kPa]	20 kPa (3 psia)	50 kPa (7 psia)	100 kPa (15 psia)	Minimum without vacuum[3]	200 kPa (30 psia)	500 kPa (70 psia)	800 kPa (116 psia) (typ. compressor)	1.2 MPa (174 psia)	2 MPa (290 psia)
1E1-S	10	0.2	0.5	1	1.8	2	5	8	12	20
2E1-S	20	0.4	1	2	3.2	4	10	16	24	40
5E1-S	50	1	2.5	5	7.7	10	25	40	60	100
1E2-S	100	2	5	10	15	20	50	80	120	200
2E2-S	200	4	10	20	28	40	100	160	240	400
5E2-S	500	10	25	50	67	100	250	400	600	1000
1E3-S	1000	20	50	100	129	200	500	800	1200	2000
2E3-S	2000	40	100	200	248	400	1000	1600	2400	4000
5E3-S	5000	100	250	500	596	1000	2500	4000	6000	10000
1E4-S	10000	200	500	1000	1173	2000	5000	8000	12000	20000

[1] Flow values in table are valid only when critical flow is established
[2] When volumetrically based mass flow units with reference temperatures other than 0 °C are used, flow values will generally be higher; the flow values for a given molbloc and upstream pressure are approximately 7% higher when expressed in slm at 20 °C. Flow values at a given pressure may vary by up to ±2% due to flowpath machining tolerances.
[3] Minimum upstream pressure to achieve critical flow with atmospheric pressure (approximately 100 kPa) downstream of molbloc-S (no vacuum).

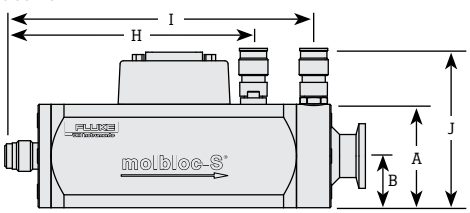
molbloc-S dimensions

	1E1-S	2E1-S	5E1-S	1E2-S	2E2-S	5E2-S	1E3-S	2E3-S	5E3-S	1E4-S
A	48.0 mm (1.89 in) sq	48.0 (1.89 in) sq	48.0 (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	80.0 mm (3.15 in) sq	80.0 mm (3.15 in) sq
B	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	24.0 mm (0.94 in)	40.0 mm (1.57 in)	40.0 mm (1.57 in)
C	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	48.0 mm (1.89 in) sq	80.0 mm (3.15 in) sq	80.0 mm (3.15 in) sq
D	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	80.0 mm (3.15 in)	176.0 mm (6.93 in)	176.0 mm (6.93 in)
E	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	28.0 mm (1.10 in)	44.0 mm (1.73 in)	44.0 mm (1.73 in)
F	167.5 mm (6.59 in)	167.5 mm (6.59 in)	167.5 mm (6.59 in)	167.5 mm (6.59 in)	171.0 mm (6.73 in)	171.0 mm (6.73 in)	171.0 mm (6.73 in)	175.0 mm (6.89 in)[1]	299.7 mm (11.80 in)[1]	331.0 mm (13.03 in)[1]
G	KF16 flange	KF16 flange	KF16 flange	KF16 flange	KF16 flange	KF16 flange	KF16 flange	KF16 flange	KF40 flange	KF40 flange
H	100.0 mm (3.94 in)	100.0 mm (3.94 in)	100.0 mm (3.94 in)	100.0 mm (3.94 in)	84.0 mm (3.31 in)	84.0 mm (3.31 in)	84.0 mm (3.31 in)	84.0 mm (3.31 in)	154.0 mm (6.06 in)	154.0 mm (6.06 in)
I	128.0 mm (5.04 in)	128.0 mm (5.04 in)	128.0 mm (5.04 in)	128.0 mm (5.04 in)	128.0 mm (5.35 in)	128.0 mm (5.35 in)	128.0 mm (5.35 in)	128.0 mm (5.35 in)	236.0 mm (9.29 in)	236.0 mm (9.29 in)
J	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	73.0 mm (2.87 in)	106.0 mm (4.17 in)	106.0 mm (4.17 in)
K	167.5 mm (6.59 in)	167.5 mm (6.59 in)	167.5 mm (6.59 in)	167.5 mm (6.59 in)	171.0 mm (6.73 in)	171.0 mm (6.73 in)	171.0 mm (6.73 in)	171.0 mm (6.73 in)	290.0 mm (11.42 in)	290.0 mm (11.42 in)
L	¼ in VCR Male[2]	¼ in VCR Male[2]	¼ in VCR Male[2]	¼ in VCR Male[2]	½ in VCR M[2]	½ in VCR M[2]	½ in VCR M[2]	½ in VCR M[2]	KF25 flange	KF25 flange

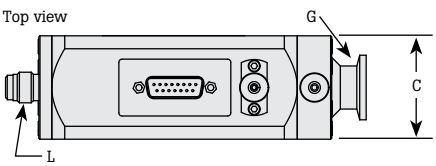
[1] On some molbloc-S elements, the venturi nozzle extends beyond the molbloc downstream flange, making the overall length dimension, F, longer than the fitting-to-fitting length dimension, K. A 40 mm diameter ISO-KF nipple is supplied with 5E3-S and 1E4-S molblocs because for these molbloc sizes the nozzle overhang may interfere with downstream connections or connection of a blank off cap for leak testing.
[2] Default connector type is listed. Additional upstream connector options may be available. Contact your DHI Sales Representative for details.

All Except 5E3-S and 1E4-S

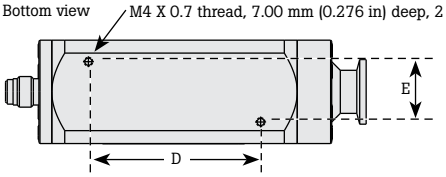
Side view



Top view

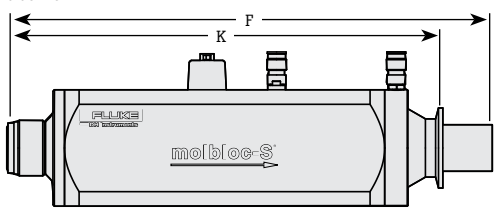


Bottom view

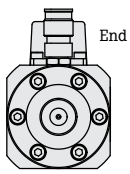


5E3-S and 1E4-S

Side view[1]



End view



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Printed in U.S.A. 10/2009 3542576B F-EN-N