

molbox RFM™

Reference Flow Monitor

Technical Data



Features

- Compact presentation
- Covers the flow range of 1 sccm to 100 slm with molbloc-L, and up to 5000 slm with molbloc-S
- Select from 20 different gases with molbloc-L and 10 with molbloc-S
- Accredited measurement uncertainty of $\pm 0.5\%$ of reading with 100:1 rangeability
- Internal valving for on-board purge, leak test and tare support
- Includes advanced measurement functions such as totalize, average, hi/lo and deviation
- Complete front panel control and RS232 and IEEE-488 remote communications
- Measures mass and volume flow with user settable reference pressure and temperature conditions

molbox RFM is a support unit for making mass flow measurements using molbloc-L laminar and molbloc-S sonic flow elements.

molbloc flow elements are connected to molbox RFM with two pressure connections and one data line. molbox RFM reads calibration data off the molbloc EEPROM and measures molbloc upstream and downstream pressure with its built-in high accuracy Reference Pressure Transducers (RPTs). An ohmic measurement system reads the resistance of the molbloc platinum resistance thermometers from which molbloc temperature is calculated. Using

the molbloc calibration data, pressures, temperature and gas properties stored in molbox RFM memory, the flow rate of the gas flowing through the molbloc is calculated. For molbloc-L flow elements, a microrange option is available to increase flow measurement resolution and accuracy under 10% FS of the flow range.

molbox RFM and molbloc flow elements are useful in a variety of measurement, test and calibration applications in which highly accurate measurement of low gas flows where maximum accuracy is the most notable specification is needed. molbox RFM is specifically designed for

applications in which a highly compact presentation, great rangeability and reduced cost are the primary considerations. A second model, molbox1, is available for applications in which lowest possible uncertainty is the top priority.

To configure your mass flow calibration system, see the pages that follow to select the molbloc and pressure dependent calibrations to best cover your flow ranges and pressure conditions. molstic mounting systems and COMPASS® for molbox calibration software are available to complete the system (see molstic and COMPASS product brochures).

Flow measurement specifications

molbox RFM measures the flow through molbloc flow elements. The flow range, usable operating pressure, and differential pressure for molbloc-L, or the flow range and absolute pressure range for molbloc-S, depend on the molbloc element used and the calibration options. For molbloc-L ranges up to 3E4, the resolution and accuracy under 10 % FS are improved by the microrange option. For the 1E5-L molbloc, the microrange option is necessary to achieve the specification.

molbox RFM

	molbloc-L (ranges 1E1-L thru 3E4-L)	molbloc-S (all ranges)
Measurement update rate	1 second	1 second
Range	0 to molbloc full scale depending on gas and molbloc pressure dependent calibration type (see molbloc-L tables)	The flow related to 20 kPa to 200 kPa absolute (3 psia to 30 psia) or 50 kPa to 500 kPa absolute (7 psia to 70 psia) upstream (see molbloc-S table)
Resolution	0.01 % FS	± 0.01 % of reading
Linearity	± 0.23 % of reading from 10 % to 100 % FS, ± 0.023 % FS under 10 % FS	± 0.25 % of reading
Repeatability	± 0.1% of reading from 10 % to 100 % FS, ± 0.01% FS under 10 % FS	± 0.1 % of reading
Precision ¹	± 0.25 % of reading from 10 % to 100 % FS, ± 0.025 % FS under 10 % FS	± 0.3 % of reading
Predicted stability ² (one year)	± 0.15 % of reading from 10% to 100% FS, ± 0.015 % FS under 10% FS	± 0.2 % of reading
Measurement uncertainty ³	± 0.5 % of reading from 10% to 100% FS, ± 0.05 % FS under 10% FS	± 0.5 % of reading from 50 kPa to 500 kPa, ± 0.5 % of the flow @ 50 kPa from 20 kPa to 50 kPa

molbox RFM with Microrange option

	molbloc-L (ranges 1E1-L thru 3E4-L)	molbloc-L (ranges 1E5 only)
Measurement update rate	1 second	1 second
Range	0 to molbloc full scale depending on gas and molbloc pressure dependent calibration type (see molbloc-L tables)	0 to molbloc full scale depending on gas and molbloc pressure dependent calibration type (see molbloc-L tables)
Resolution	0.01 % FS, 0.001 % FS under 10 % FS	0.01 % FS
Linearity	± 0.23 % of reading from 1 % to 100 % FS, ± 0.0023 % FS under 1 % FS	± 0.25 % of reading from 5 % to 100 % FS, ± 0.0125 % FS under 5 % FS
Repeatability	± 0.1 % of reading from 1 % to 100 % FS, ± 0.001 % FS under 1 % FS	± 0.2 % of reading from 5 % to 100 % FS, ± 0.01 % FS under 5 % FS
Precision ¹	± 0.25 % of reading from 1 % to 100 % FS, ± 0.0025 % FS under 1 % FS	± 0.32 % of reading from 5 % to 100 % FS, ± 0.016 % FS under 5 % FS
Predicted stability ² (one year)	± 0.15 % of reading from 1 % to 100 % FS, ± 0.0015 % FS under 1 % FS	± 0.2 % of reading from 5 % to 100 % FS, ± 0.01 % FS under 5 % FS
Measurement uncertainty ³	± 0.5 % of reading from 1 % to 100 % FS, ± 0.005 % FS under 1 % FS	± 0.5 % of reading from 5 % to 100 % FS, ± 0.025 % FS under 5 % FS

¹ Precision: Combined linearity, hysteresis, repeatability.

² Predicted Stability: Maximum change in zero and span over one year for typical molbox RFM and molbloc used under typical conditions. As stability can only be predicted, stability for a specific molbox RFM should be established from experience.

³ Measurement Uncertainty: Maximum deviation of the molbox RFM flow indication from the true value of the flow through the molbloc including precision, stability and DHI calibration standard uncertainty. Measurement uncertainty specifications for molblocs are valid only for gases with which the molbloc has been calibrated. All molblocs are calibrated for N₂. Calibrations with other gases are optional. DHI calibration capability is not maintained at all times for all gases on all molbloc designations. Check for availability before ordering.

molbloc-S (all ranges)

Specifications are the same as a molbox RFM without Microrange. The Microrange transducer is disabled whenever the molbox RFM is connected to a molbloc-S.

Pressure dependent calibration types for molbloc-S

The operating range of molbloc-S is dependent upon the absolute upstream pressure. Two different calibration options are offered to accommodate the requirement of the user's application. The Standard Pressure (SP) calibration of 50 kPa to 500 kPa absolute (7 psia to 70 psia) gives the most flexibility and allows partial use of the range without a vacuum. The Low Pressure (LP) calibration of 20 kPa to 200 kPa (3 psia to 30 psia) requires the use of a vacuum downstream. The resulting flow range for different gases at these pressures can be found in the molbloc-S range table below.

Calibration type	Operating pressure	Considerations
Standard pressure	50 kPa to 500 kPa absolute (7 psia to 70 psia)	Must be flowing to a vacuum to obtain full range
Low pressure	20 kPa to 200 kPa absolute (3 psia to 30 psia)	

molbloc-S ranges with standard and low pressure calibrations

				molbloc-S designator, KF (sccm/kPa), and full scale flow (slm @ 0°C)										
				Designator	1E1-S	2E1-S	5E1-S	1E2-S	2E2-S	5E2-S	1E3-S	2E3-S	5E3-S	1E4-S
				KF (sccm/kPa)	10	20	50	100	200	500	1000	2000	5000	10000
Gases		Ratio	Cal type											
Inert	Nitrogen	N2	1.000	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	2.00	3.50	7.7	15.0	28.0	67.0	129	248	596	1173
	Argon	Ar	0.837	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				1.67	3.00	6.9	13.9	24.3	61.0	122	245	526	1053	
Helium	He	2.647	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	9.00	16.00	29.7	54.1	98.0	218.4	383	768	1928	3865	
Sulfur hexafluoride	SF6	0.435	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	0.63	1.10	2.7	5.5	10.9	23.4	47	94	235	471	
Xenon	Xe	0.460	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	0.80	1.50	3.3	6.7	13.4	33.7	58	116	290	580	
Flammable	Ethane ¹	C2H6	0.996	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	1.40	2.80	6.2	12.4	24.9	62.4	107	214	537	1074
	Ethylene ¹	C2H4	3.730	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				1.70	3.00	6.5	13.1	26.2	65.8	113	226	565	1132	
Hydrogen	H2	1.320	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	10.50	15.80	36.1	65.2	116.2	255.0	512	1026	2573	4415	
Methane	CH4	0.789	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	2.64	4.50	10.0	17.6	35.3	88.6	178	304	763	1527	
Propane ¹	C3H8	0.563	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	1.16	2.00	5.0	10.0	20.0	42.9	86	172	431	862	
Fluoro-carbons	Carbon tetrafluoride ¹	CF4	0.447	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	0.84	1.60	3.6	7.2	14.5	36.3	62	125	312	624
Hexafluoroethene ¹	C2F6	0.629	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	0.65	1.10	2.8	5.6	11.2	24.1	48	96	241	483	
Trifluoromethane ¹	CHF3	0.983	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	0.95	1.90	4.1	8.2	16.3	41.0	70	141	352	705	
Other	Air	Air	0.795	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	1.97	3.40	7.7	15.0	28.0	67.0	129	248	596	1173
	Carbon dioxide	CO2	1.000	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				1.40	2.40	6.0	10.6	21.2	53.2	91	183	458	916	
Carbon monoxide	CO	0.795	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	2.00	3.50	7.8	15.6	27.4	68.7	138	276	592	1186	
Nitrous oxide	N2O	0.367	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	1.40	2.40	6.0	10.6	21.1	53.0	91	182	456	912	
Octafluorocyclobutane ¹	C4F8	0.935	SP2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
			LP	0.73	1.47	3.7	7.3	14.7	36.7	73	147	367	733	
			minimum	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	
Oxygen	O2		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	1.87	3.20	7.3	14.6	25.6	64.2	129	258	553	1107	

Ratio = Inverse square root density ratio of the current gas to nitrogen

KF = Pressure to flow conversion ratio, sccm/kPa

To estimate a flow in a given gas at a given pressure: Flow(slm) = KF * pressure in kPa absolute/1000 * Gas Ratio

Cal types:

SP = Standard Pressure calibration 50 kPa to 500kPa absolute; table shows flow @ 500 kPa, flow @ 50 kPa is 10% of value shown.

LP = Low Pressure calibration 20 kPa to 200 kPa; table shows flow @ 200 kPa, flow @ 20 kPa is 10% of value shown.

minimum = table shows estimated minimum flow without vacuum if atmospheric pressure is ~ 100 kPa

Note: Non-Standard Pressure (NSP) calibrations are available up to 600 kPa absolute

¹ This gas is not currently supported by the molbox RFM

² The vapor pressure of octafluorocyclobutane is 230 kPa absolute, SP operation is not possible

All flows are nominal and approximate; in gases other than N2 and Air, flows may vary up to 10 % due to differences in characteristics and manufacturing

Pressure dependent calibration types for molbloc-L

Different pressure dependent calibration options for molbloc-Ls determine the range of operating pressures over which a molbloc-L can be used within its mass flow measurement specifications. The calibration option also affects the molbloc-L flow range and the differential pressure associated with the flow range. The different calibration options are offered to accommodate the requirement of the user's application. All molbloc-Ls are delivered with an N₂ calibration (full mod, low pressure) by default. Calibrations with other gases or N₂ calibration other than full mod, low pressure, must be specified.

Calibration type	Operating pressure	Nominal differential pressure at FS flow
Full mod, low pressure	250 kPa to 325 kPa absolute (22 psig to 33 psig) upstream of molbloc	0 kPa to 50 kPa (7.5 psi)
Full mod, high pressure	325 kPa to 525 kPa absolute (33 psig to 62 psig) upstream of molbloc	0 kPa to 50 kPa (7.5 psi)
Full mod, downstream	Atmospheric pressure downstream of molbloc	0 kPa to 100 kPa (15 psi)
Single P, low pressure (non-N ₂ gases only)	Any specified single molbloc upstream pressure between 250 kPa and 325 kPa absolute (22 psig to 33 psig)	0 kPa to 50 kPa (7.5 psi)
Single P, high pressure (non-N ₂ gases only)	Any specified single molbloc upstream pressure between 325 kPa and 525 kPa absolute (33 psig to 62 psig)	0 kPa to 50 kPa (7.5 psi)

molbloc-L ranges with low pressure calibrations

Gases		molbloc-L 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	1000	5000	10000	30000	100000
	Argon	Ar	10	50	100	200	500	1000	5000	10000	30000	80000
	Helium	He	10	50	100	200	500	1000	5000	10000	30000	100000
	Sulfur hexafluoride	SF ₆	10	50	100	200	500	1000	2000 500	6000 1000	6000 4000	—
	Xenon	Xe	10	40	80	150	400	800	3500 500	8000	11000 3000	30000 20000
Flammable	Butane	C ₄ H ₁₀	20	100	130 30	270 50	670 140	2300	2200 1400	7000 3000	—	—
	Ethane	C ₂ H ₆	20	100	200	400	1000	2000	6000 1000	18000 2000	18000 6000	60000 50000
	Ethylene	C ₂ H ₄	16	18	160	320	800	1600	7000 1000	16000	20000 5000	70000 40000
	Hydrogen	H ₂	20	100	200	400	1000	2000	10000	20000	60000	200000
	Methane	CH ₄	16	80	160	320	800	1600	8000	16000	40000 5000	120000 40000
	Propane	C ₃ H ₈	20	100	200	400	1000	2000	3000 1000	10000 2000	10000 7000	—
Fluoro-carbons	Carbon tetrafluoride	CF ₄	10	50	100	200	500	1000	4000 600	10000	12000 3000	36000 25000
	Hexafluoroethene	C ₂ F ₆	10	50	100	200	500	1000	2000 600	6000 1200	6000 4000	—
	Trifluoromethane	CHF ₃	10	50	100	200	500	1000	4000 600	10000	12000 4000	38000 30000
Other	Air	Air	10	50	100	200	500	1000	5000	10000	30000	100000
	Carbon dioxide	CO ₂	10	50	100	200	500	1000	5000	10000	20000 4000	60000 30000
	Carbon monoxide	CO	10	50	100	200	500	1000	5000	10000	30000	100000
	Nitrous oxide	N ₂ O	10	50	100	200	500	1000	5000	10000	20000 4000	60000 30000
	Octafluorocyclobutane ¹	C ₄ F ₈	15	60 9	65 17	130 34	330 85	1100 175	1050 840	3400 1700	—	—
Oxygen	O ₂	10	50	100	200	500	1000	5000	10000	30000	80000	

See page 5 for footnotes.

molbloc-L ranges with high pressure calibrations

		molbloc-L 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	2000	10000	20000	40000 7500	N/A
	Argon	Ar	20	100	200	400	1000	2000	10000	17000	35000 6000	N/A
	Helium	He	20	100	200	400	1000	2000	10000	20000	65000	N/A
	Sulfur hexafluoride	SF ₆	25	100 15	120 30	250 50	600 150	2000 300	2000 1400	6200 2800	–	N/A N/A
	Xenon	Xe	20	100	150	350	650	1700	3350 950	11000 1900	11000 5700	N/A
Flammable	Butane ²	C ₄ H ₁₀	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ethane	C ₂ H ₆	40	200	350 50	700 100	1800 200	4000	6000 2300	20000 4500	20000 13800	N/A N/A
	Ethylene	C ₂ H ₄	40	200	350	700	1800	4000	7000 2000	22000 4000	22000 12700	N/A
	Hydrogen	H ₂	40	200	400	900	2000	4500	22000	45000	130000	N/A
	Methane	CH ₄	35	175	350	700	1700	3500	13000 2000	33000	42000 12000	N/A
	Propane	C ₃ H ₈	50	200 25	200 50	400 100	1000 250	3500 500	3500 2600	11000 5400	– –	N/A
Fluoro-carbons	Carbon tetrafluoride	CF ₄	20	100	200	400	1000	2000	3700 1200	12000 2400	12000 7300	N/A
	Hexafluoroethene	C ₂ F ₆	25	100 15	120 30	250 50	600 150	2000 300	1800 1500	6000 3000	– –	N/A
	Trifluoromethane	CHF ₃	25	125	240 30	450 60	1200 150	2500	4000 1500	12000 3000	12000 8800	N/A
Other	Air	Air	20	100	200	400	1000	2000	10000	20000	40000 7200	N/A
	Carbon dioxide	CO ₂	25	125	250	500	1250	2500	6600 1400	20000 2500	40000 8800	N/A
	Carbon monoxide	CO	20	100	200	400	1000	2000	10000	20000	40000 7500	N/A
	Nitrous oxide	N ₂ O	25	125	250	500	1250	2500	11000 1500	20000 3000	20000 9000	N/A
	Octafluorocyclobutane ²	C ₄ F 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	1000	2000	10000	20000	40000 6500	N/A

A bold value indicates that the maximum flow is limited by the maximum Reynolds number value of 1200 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.

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.

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.

General specifications

Power requirements	85 V ac to 264 V ac, 47 Hz to 440 Hz, 18 VA max consumption	
Operating temperature range	15 °C to 35 °C (59 °F to 95 °F)	
Storage temperature range	-20 °C to 70 °C (-4 °F to 158 °F)	
Vibration	Meets MIL-T-28800D	
Weight	2.55 kg (5.6 lb) max	
Dimensions (H x W x D)	8 cm x 22.5 cm x 20 cm (3.1 in x 8.9 in x 7.9 in) approx.	
Microprocessor	Motorola 68302, 16 MHz	
Communication ports	RS-232 (COM1), RS-232 (COM2), IEEE-488	
Reference pressure transducers (RPTs)	Standard	2 x 600 kPa (87 psia) piezoresistive silicon
	Microrange Option	12.5 kPa (1.8 psid) piezoresistive silicon
Gases supported	for molbloc-L	Nitrogen (N ₂), Air, Argon (Ar), Carbon Monoxide (CO), Helium (He), Oxygen (O ₂), Carbon Dioxide (CO ₂), Carbon Tetrafluoride (CF ₄), Ethane (C ₂ H ₆), Ethylene (C ₂ H ₄), Fluoroform (CHF ₃), Hexafluoroethane (C ₂ F ₆), Hydrogen (H ₂), Methane (CH ₄), Nitrous Oxide (N ₂ O), Propane (C ₃ H ₈), Sulfur Hexafluoride (SF ₆)
	for molbloc-S	N ₂ , He, Ar, H ₂ , O ₂ , CH ₄ , Air, N ₂ O, SF ₆ , CO ₂ , CO
Pressure connections	Quick connectors equivalent to Swagelok QM Series (-QM2-B200)	
Pressure limits	Maximum working pressure: 600 kPa absolute (87 psia)	
Flow ranges	Covers the flow range of 1 sccm to	
	100 slm with molbloc-L, and up to 5000 slm with molbloc-S	
Flow measurement uncertainty	± 0.5 % of reading	
CE conformance	Available. Must be specified	

Ordering information

Model

molbox RFM Reference flow monitor

Includes

Users manual, calibration certificate, power cord, (2) molbox RFM to molbloc pressure lines, (1) molbox RFM to molbloc data line, (2) Straight through pressure quick connectors

Options

RFM 02 Microrange

Accessories

RFM-RMK (401465) Rack mount kit

mfc-CB Analog MFC interface system (see mfc-CB brochure)

molstic molbloc mounting systems (see molstic brochure)

COMPASS® for molbox for Windows (401211) Calibration software

Fluke. Keeping your world up and running.®

Fluke Calibration

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Printed in U.S.A. 6/2010 3191934B B-EN-N

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molbox1+™ Flow Terminal

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

Technical Data



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

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.

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 benefiting 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 molbox1+ 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.

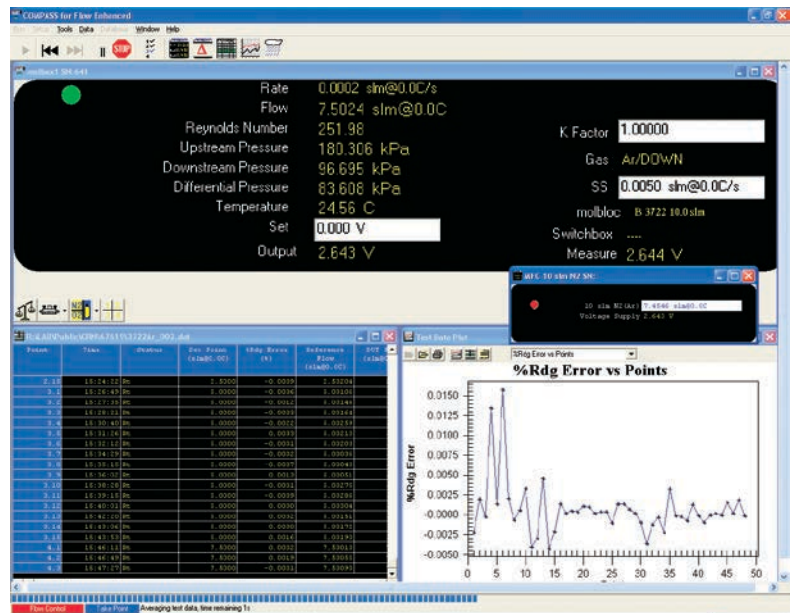
Use the same molbloc in multiple applications

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.

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).

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 (N ₂), Air, Argon (Ar), Carbon Monoxide (CO), Helium (He), Oxygen (O ₂), Carbon Dioxide (CO ₂), Carbon Tetrafluoride (CF ₄), Ethane (C ₂ H ₆), Ethylene (C ₂ H ₄), Fluoroform (CHF ₃), Hexafluoroethane (C ₂ F ₆), Hydrogen (H ₂), Methane (CH ₄), Nitrous Oxide (N ₂ O), Propane (C ₃ H ₈), Sulfur Hexafluoride (SF ₆), Butane (C ₄ H ₁₀), Octafluorocyclobutane (C ₄ F ₈), 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 pressure⁴	± (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)

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.

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

Fluke Calibration. Precision, performance, confidence.™

Electrical	RF	Temperature	Pressure	Flow	Software
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Printed in U.S.A. 9/2014 3500469E_EN Pub ID: 11563-eng Rev 03

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