ACCREDITED
CALIBRATION 1599.01

Certificate Of Calibration
Fluke Calibration Phoenix
Primary Pressure and Flow Laboratory

Description:	MASS FLOW TERMINAL	**Certificate Number:**	15001
Manufacturer:	FLUKE	**Date of Calibration:**	11 Oct 2013
Model:	molbox1+ A700K-A	**Date Due:**	
Serial Number:		**Temperature:**	21 to 25°C
Issue Date:	11 Oct 2013	**Relative Humidity:**	10 to 70% RH
		Pressure:	96 to 100 kPa
Procedure:	LAB145 Rev. B		

Customer:	**Job Number:**
	Customer Asset #:
PO Number:	

This calibration is traceable to the SI through recognized national measurement institutes, ratiometric techniques, or natural physical constants and is in compliance with ISO17025:2005, ANSI/NCSL Z540.1, and when specified by our customers NRC regulations 10CFR50 Appendix B and 10CFR21, and/or other quality requirements defined in customers purchase descriptions. The calibration has been completed in accordance with the Fluke Calibration, Phoenix - Primary Pressure and Flow Laboratory Quality Assurance Program Manual (LQAPM), Rev. E, dated January, 2013. Calibration certificates without signatures are not valid. This certificate applies to only the item identified and shall not be reproduced other than in full, without the specific written approval by Fluke Corporation. This certificate shall not be used to claim product endorsement by the accreditation body.

This calibration certificate may contain data that is not covered by the Scope of Accreditation. The unaccredited test points, where applicable, are indicated by an asterisk (*), or confined to clearly marked sections. Functional tests are not accredited.

Measurement uncertainties at the time of test are given where applicable. They are calculated in accordance with the method described in the ISO Guide to the Expression of Uncertainty in Measurement. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95 %.

Comments:

Cert. #:
Cal Date: 11 Oct 2013
Due Date:
S/N :
602.491.9100 www.flukecal.com

METROLOGIST

Certificate Number: 15001!

Date of Calibration: 11 Oct 2013

Standards Used:

Asset	Description	Cal-Date	Due-Date
208	DH INSTRUMENTS PG7601 BASE	22-Jul-2013	22-Apr-2014
US36071742	HEWLETT PACKARD 34401A MULTIMETER	03-May-2013	03-May-2014
SET NO. 1	DH INSTRUMENTS MOLBLOC SIMULATOR SET MOLSIM	22-Mar-2012	22-Mar-2014
2231	DH INSTRUMENTS MS-AMH-38 MASS SET	30-Jul-2013	30-Jan-2014
1559	FLUKE PC-7100/7600-20 PISTON-CYLINDER	31-Oct-2011	31-Oct-2013

Test Description:

A molbox is intended to be used to support molbloc mass flow elements by calculating the mass flow of the gas flowing through a molbloc by providing calibrated measurements for pressure, resistance (for the calculation of temperatures from the PRT's embedded in the molbloc), gas property data for the specific gas selected, and reading the molbloc specific dimentional properties and coefficients from individual molblocs. The pressure measurements are calibrated by adjustment of transducer dependent adders and multipliers through comparison with Fluke pressure calibration chain standards. The temperature measurements are calibrated by adjustment of values related to the resistance of the molbox internal standard resistors through comparison with Fluke resistance standards. These calibration values are stored in the molbox memory, and the results of the comparisons are shown in the data tables in this certification.

All molboxes have a final flow test performed with specific Fluke molbloc standards for verification of functional performance and the results are reported in this certification, but this is not accredited data and it is not considered part of the calibration as no calibration adjustment can be made based solely on this information. This final flow test does not define the flow capabilities of this molbox.

Note that independent of the molbox, the full scale flow values for individual molblocs vary for different types of gases due to the differences in gas characteristics, types of calibrations performed on the molblocs, or differences in the physical type or range of the molblocs. Refer to the individual molbloc calibration certificates for the actual calibrated full scale flow range or ranges when used with this molbox.

A minimum of four hours were allowed for the temperature of the molbox to stabilize before commencing the test.

This molbox has the analog option installed for MFC control and measurement. The DC voltage and current values are calibrated by adjustment of adders and multipliers through comparison with a reference multimeter and are stored in the molbox memory, but this has no relationship to the calculation or uncertainty of mass flow reported by molbox/molbloc.

Uncertainty Specifications:

PRESSURE:

±(0.01% of reading or 0.003% of FS, whichever is greater), plus 0.005% of FS for one year

RESISTANCE (as Temperature):

±0.05°C for one year (±0.04Ω divided by a dual PRT slope of 0.7792 = 0.05°C)

FINAL FLOW TEST - FUNCTIONAL TEST, NOT ACCREDITED

±0.125 % of reading for the absolute flow value, and ±0.05% of reading difference between Channel A and B

ANALOG OPTION:

± 6 mVDC or ±0.02 mADC input measurement for one year

Test Results:

The following tables provide data from comparisons between this molbox and Fluke laboratory reference standards. Each comparison may contain columns with some or all of the following information:

Reference: Reference value supplied or measured, or Reference Pressure defined by the reference at equilibrium

Test: Test molbox indication or output

Difference: Absolute difference as (Test-Reference) in applicable units, or Relative difference in percent of reading [(Test-Reference) / Reference]

Tolerance: Tolerance listed in applicable units calculated from the typical uncertainty specification on Page 3. The tolerance may be notated as "As Received" or "Adjustment" tolerance, where Adjustment tolerance does not include uncertainty in the reference or uncertainty due to 12 month stability

MU: The Measurement Uncertainty of the test point, which includes the reference uncertainty and a Type A component of the molbox under test

TUR: The ratio of the Measurement Uncertainty to the molbox uncertainty (as Tolerance)

Status: The Tolerance (In = "IT", Out = "OOT") status of the test point

Adder: The calibration adder in the unit of measure for offset adjustment

Multiplier: The calibration multiplier for slope adjustment

AUTOZ: The Auto Zero pressure offset value applied by the customer since the last calibration(user correction for drift of the transducers)

Standard Resistors: The calibration values of the onboard standard resistors

Test Results (continued):

AS RECEIVED DATA FOR UPSTREAM (HI) TRANSDUCER

Reference Pressure (kPa)	Test Reading (kPa)	Absolute Difference (kPa)	As Received Tolerance (kPa)	MU (kPa)	TUR (-)	Status (-)
19.8512	19.841	-0.010	0.056	0.0007	80.0:1	IT
99.9843	99.972	-0.012	0.056	0.0020	28.0:1	IT
200.7569	200.744	-0.013	0.056	0.0036	15.6:1	IT
299.1225	299.106	-0.017	0.065	0.0052	12.5:1	IT
449.8230	449.804	-0.019	0.080	0.0076	10.5:1	IT
600.2560	600.236	-0.020	0.095	0.0100	9.5:1	IT
449.8230	449.805	-0.018	0.080	0.0076	10.5:1	IT
299.1223	299.108	-0.014	0.065	0.0052	12.5:1	IT
200.7566	200.745	-0.012	0.056	0.0036	15.6:1	IT
99.9841	99.972	-0.012	0.056	0.0020	28.0:1	IT
19.8512	19.841	-0.010	0.056	0.0007	80.0:1	IT

Pressure Adder: 58.1 Pa
Pressure Multiplier: 0.999995
AUTOZ: -9.515 Pa

Reference Uncertainty: ±(0.0016% of rdg + 0.40Pa)

AS LEFT DATA FOR UPSTREAM (HI) TRANSDUCER

Reference Pressure (kPa)	Test Reading (kPa)	Absolute Difference (kPa)	Adjustment Tolerance (kPa)	MU (kPa)	TUR (-)	Status (-)
19.8512	19.851	0.000	0.017	0.0007	24.3:1	IT
99.9843	99.984	0.000	0.017	0.0020	8.5:1	IT
200.7569	200.757	0.000	0.017	0.0036	4.7:1	IT
299.1225	299.122	0.000	0.024	0.0052	4.6:1	IT
449.8230	449.822	-0.001	0.036	0.0076	4.7:1	IT
600.2560	600.257	0.001	0.048	0.0100	4.8:1	IT
449.8230	449.823	0.000	0.036	0.0076	4.7:1	IT
299.1223	299.123	0.001	0.024	0.0052	4.6:1	IT
200.7566	200.758	0.001	0.017	0.0036	4.7:1	IT
99.9841	99.984	0.000	0.017	0.0020	8.5:1	IT
19.8512	19.851	0.000	0.017	0.0007	24.3:1	IT

Pressure Adder: 77.6 Pa
Pressure Multiplier: 1.000012
AUTOZ: 0 Pa

Reference Uncertainty: ±(0.0016% of rdg + 0.40Pa)

Test Results (continued):

AS RECEIVED DATA FOR DOWNSTREAM (LO) TRANSDUCER

Reference Pressure (kPa)	Test Reading (kPa)	Absolute Difference (kPa)	As Received Tolerance (kPa)	MU (kPa)	TUR (-)	Status (-)
19.8512	19.878	0.027	0.056	0.0007	80.0:1	IT
99.9843	100.010	0.026	0.056	0.0020	28.0:1	IT
200.7569	200.781	0.024	0.056	0.0036	15.6:1	IT
299.1225	299.144	0.022	0.065	0.0052	12.5:1	IT
449.8230	449.840	0.017	0.080	0.0076	10.5:1	IT
600.2560	600.274	0.018	0.095	0.0100	9.5:1	IT
449.8230	449.844	0.021	0.080	0.0076	10.5:1	IT
299.1223	299.147	0.025	0.065	0.0052	12.5:1	IT
200.7566	200.784	0.027	0.056	0.0036	15.6:1	IT
99.9841	100.012	0.028	0.056	0.0020	28.0:1	IT
19.8512	19.879	0.028	0.056	0.0007	80.0:1	IT

Pressure Adder: 58 Pa
Pressure Multiplier: 1.000001
AUTOZ: -47.968 Pa

Reference Uncertainty: ±(0.0016% of rdg + 0.40Pa)

AS LEFT DATA FOR DOWNSTREAM (LO) TRANSDUCER

Reference Pressure (kPa)	Test Reading (kPa)	Absolute Difference (kPa)	Adjustment Tolerance (kPa)	MU (kPa)	TUR (-)	Status (-)
19.8512	19.850	-0.001	0.017	0.0007	24.3:1	IT
99.9843	99.983	-0.001	0.017	0.0020	8.5:1	IT
200.7569	200.757	0.000	0.017	0.0036	4.7:1	IT
299.1225	299.121	-0.002	0.024	0.0052	4.6:1	IT
449.8230	449.820	-0.003	0.036	0.0076	4.7:1	IT
600.2560	600.257	0.001	0.048	0.0100	4.8:1	IT
449.8230	449.824	0.001	0.036	0.0076	4.7:1	IT
299.1223	299.124	0.002	0.024	0.0052	4.6:1	IT
200.7566	200.759	0.002	0.017	0.0036	4.7:1	IT
99.9841	99.985	0.001	0.017	0.0020	8.5:1	IT
19.8512	19.851	0.000	0.017	0.0007	24.3:1	IT

Pressure Adder: 77.6 Pa
Pressure Multiplier: 1.000019
AUTOZ: 0 Pa

Reference Uncertainty: ±(0.0016% of rdg + 0.40Pa)

Test Results (continued):

TEMPERATURE (RESISTANCE) MEASUREMENTS

The molbox temperature measurements were calculated using three nominal resistance levels for each channel to verify the resistance measurements made on a molbloc's PRTs used to calculate temperatures. The following data shows the nominal reference temperatures and the temperatures measured by the molbox. The tolerance is applied to the average temperature measurement (T1 + T2)/2 and is ±0.05°C (0.04 Ω) of the nominal value which corresponds to approximately ± 0.032% of reading on flow.

AS RECEIVED

	CHANNEL A					CHANNEL B			
Reference	Test	MU	TUR	Status	Reference	Test	MU	TUR	Status
0° T1 =	-0.02	0.02	2.6:1	IT	0° T1 =	-0.02	0.02	2.6:1	IT
T2 =	-0.01	0.02	2.6:1		T2 =	-0.02	0.02	2.6:1	
25.67° T1 =	25.67	0.02	2.4:1	IT	25.67° T1 =	25.66	0.02	2.3:1	IT
T2 =	25.68	0.02	2.4:1		T2 =	25.66	0.02	2.4:1	
38.5° T1 =	38.51	0.02	2.3:1	IT	38.5° T1 =	38.51	0.02	2.2:1	IT
T2 =	38.51	0.02	2.3:1		T2 =	38.49	0.02	2.2:1	

TEMPERATURE ADDER AND MULTIPLIER
TA= -0.026
TM= 1.000800

TEMPERATURE ADDER AND MULTIPLIER
TA= -0.030
TM= 1.000900

STANDARD RESISTOR VALUES, APPLIES TO BOTH CHANNELS Reference Uncertainty: ±0.015% of reading
100 OHM 99.985
110 OHM 109.985

AS LEFT

	CHANNEL A					CHANNEL B			
Reference	Test	MU	TUR	Status	Reference	Test	MU	TUR	Status
0° T1 =	0.00	0.02	2.6:1	IT	0° T1 =	0.01	0.02	2.5:1	IT
T2 =	0.00	0.02	2.5:1		T2 =	0.00	0.02	2.6:1	
25.67° T1 =	25.67	0.02	2.3:1	IT	25.67° T1 =	25.67	0.02	2.4:1	IT
T2 =	25.67	0.02	2.3:1		T2 =	25.66	0.02	2.4:1	
38.5° T1 =	38.48	0.02	2.2:1	IT	38.5° T1 =	38.52	0.02	2.3:1	IT
T2 =	38.51	0.02	2.2:1		T2 =	38.50	0.02	2.2:1	

TEMPERATURE ADDER AND MULTIPLIER
TA= -0.012
TM= 1.000100

TEMPERATURE ADDER AND MULTIPLIER
TA= -0.010
TM= 1.000400

STANDARD RESISTOR VALUES, APPLIES TO BOTH CHANNELS Reference Uncertainty: ±0.015% of reading
100 OHM 99.985
110 OHM 109.985

FINAL FLOW TEST RESULTS (FUNCTIONAL TEST, NOT ACCREDITED)

A final flow test was performed on this molbox1+ using two molbloc references and one molbox1+ reference from the Fluke metrology service. The following table gives the results of the test. The tolerance for this test is ±0.125 % of reading for the absolute flow value and ±0.05% of reading for the difference between channel A and channel B.

Channel A				Channel B				Channel A-B	
Reference [sccm]	Test [sccm]	Difference [% of rdg]	Status	Reference [sccm]	Test [sccm]	Difference [% of rdg]	Status	Difference [% of rdg]	Status
1000.020	999.920	-0.010	Flow IT	1000.050	999.830	-0.022	Flow IT	0.012	A-B IT
500.020	499.840	-0.036	Flow IT	499.970	499.760	-0.042	Flow IT	0.006	A-B IT
199.990	199.990	0.000	Flow IT	200.010	199.960	-0.025	Flow IT	0.025	A-B IT

Test Results (continued):

MFC ANALOG OPTION MEASUREMENTS

A calibration was performed on the MFC analog board option installed in this molbox using a laboratory multimeter reference. The following tables give the results of this calibration. Tolerances for the MFC board measurements are ±6mV for voltage and ±0.02 mA for current.

As Received Voltage Data

Reference Uncertainty: to 1 volt ±(0.004%rdg + 0.0086mV), 1 to 10 volt ±(0.0039%rdg + 0.05mV)

Reference (V)	Set Difference (V)	Set MU (V)	Status	Measure Difference (V)	Measure MU (V)	Status	Sense Difference (V)	Sense MU (V)	Status
0.100128	-0.00013	0.00023	IT	-0.00113	0.00088	IT	0.00087	0.00115	IT
2.999652	0.00035	0.00028	IT	-0.00025	0.00090	IT	0.00095	0.00116	IT
5.499502	0.00050	0.00035	IT	-0.00050	0.00092	IT	-0.00030	0.00118	IT
		TUR			TUR			TUR	
Adder (V)	-0.00010	26.1:1		-0.00090	6.8:1		0.00090	5.2:1	
Multiplier	1.00030	21.4:1		1.00010	6.7:1		0.99981	5.2:1	
		17.1:1			6.5:1			5.1:1	

As Left Voltage Data

Reference Uncertainty: to 1 volt ±(0.004%rdg + 0.0086mV), 1 to 10 volt ±(0.0039%rdg + 0.05mV)

Reference (V)	Set Difference (V)	Set MU (V)	Status	Measure Difference (V)	Measure MU (V)	Status	Sense Difference (V)	Sense MU (V)	Status
0.100088	-0.00009	0.00009	IT	-0.00009	0.00242	IT	-0.00069	0.00273	IT
2.999832	0.00017	0.00019	IT	0.00117	0.00243	IT	0.00097	0.00273	IT
5.499716	0.00028	0.00028	IT	-0.00052	0.00244	IT	-0.00072	0.00274	IT
		TUR			TUR			TUR	
Adder (V)	-0.00020	66.7:1		0.00010	2.5:1		-0.00020	2.2:1	
Multiplier	1.00042	31.6:1		0.99998	2.5:1		1.00002	2.2:1	
		21.4:1			2.5:1			2.2:1	

As Received Current Data

Reference Uncertainty: 1 to 21 mA ±(0.013% of rdg + 0.00023mA)

Reference (mA)	Set Difference (mA)	Set MU (mA)	Status	Measure Difference (mA)	Measure MU (mA)	Status
4.999931	0.0001	0.00088	IT	-0.0017	0.00088	IT
10.00023	-0.0002	0.00153	IT	-0.0010	0.00153	IT
19.00093	-0.0009	0.00270	IT	0.0001	0.00270	IT
		TUR			TUR	
Adder (mA)	0.0002	22.7:1		-0.0008	22.7:1	
Multiplier	0.9992	13.1:1		1.0008	13.1:1	
		7.4:1			7.4:1	

As Left Current Data

Reference Uncertainty: 1 to 21 mA ±(0.013% of rdg + 0.00023mA)

Reference (mA)	Set Difference (mA)	Set MU (mA)	Status	Measure Difference (mA)	Measure MU (mA)	Status
5.000003	0.0000	0.00088	IT	-0.0006	0.00109	IT
10.00006	-0.0001	0.00153	IT	-0.0005	0.00166	IT
19.00008	-0.0001	0.00270	IT	0.0009	0.00278	IT
		TUR			TUR	
Adder (mA)	0.0007	22.7:1		0.0015	18.3:1	
Multiplier	0.9991	13.1:1		1.0007	12.0:1	
		7.4:1			7.2:1	

End of Report