Calibration Certificate

Equipment:	Minneapolis BlowerDoor Fan
Manufacturer:	The Energy Conservatory, Inc. USA
Model:	4
Serial #:	CE5817
Calibration Facility:	The Energy Conservatory, 2801 21st Ave. S., Minneapolis, MN 55407
Customer Name:	BlowerDoor GmbH
Customer #:	GEINGE
Certificate #:	4-220-CE5817-05-26-17
Calibration Date:	26.05.17

Published Fan Flow Calibration Parameters

	Open	A	B	C	D	E
Coefficient (C)	745,4	273,2	81,69	19,30	12,31	4,761
Exponent (n)	0,4848	0,4952	0,4968	0,5157	0,5032	0,5166

$$\dot{V} = C \cdot \Delta p^{n}$$

C [$m^3/(h\ Pa^n)$]

Measured Data

Flow Ring	Chamber Orifice Diameter (inch)	Chamber Back Pressure (Pa)	Chamber Flow (m^3/h)	Calculated Fan Flow (m^3/h)	Error (from chamber) (%)
Open	18,0	50,4	5372,6	5350,6	-0,4
A	12,0	47,9	2604,9	2593,6	-0,4
B	9,0	49,8	1002,2	998,4	-0,4
C	4,5	49,6	246,3	240,0	-2,5
D	3,0	48,8	119,9	119,5	-0,3
E	1,75	42,8	44,2	43,9	-0,4 m^3/h

Note: Motor position during calibration: 12.3 mm.

Conditions: Temperature: 25 °C, Pressure: 986 hPa

1. This fan meets the flow measurement requirements of Standards ASTM E779, ASTM E1554, CGSB 149.10-M86, EN13829, ATTMA Technical Standard 1 and NFPA 2001 when used with the Published Calibration Parameters shown above, and the fan is used in accordance with the manufacturer's installation and operating instructions.

2. Calibration is conducted in accordance with ASTM Standard E1258 using a test chamber constructed according to ASHRAE Standard 51/AMCA Standard 210. The Energy Conservatory's accuracy assurance reference is comprised of a NIST traceable Mensor Series 6100 Digital Pressure Transducer.

3. Measured airflow is volumetric only at standard air density of 1.2041 kg/m^3.

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The Energy Conservatory

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Calibration Certificate

Equipment:	Minneapolis BlowerDoor Fan
Manufacturer:	The Energy Conservatory, Inc. USA
Model:	4
Serial #:	CE5818
Calibration Facility:	The Energy Conservatory, 2801 21st Ave. S., Minneapolis, MN 55407
Customer Name:	BlowerDoor GmbH
Customer #:	GEINGE
Certificate #:	4-220-CE5818-05-26-17
Calibration Date:	26.05.17

Published Fan Flow Calibration Parameters

	Open	A	B	C	D	E
Coefficient (C)	745,4	273,2	81,69	19,30	12,31	4,761
Exponent (n)	0,4848	0,4952	0,4968	0,5157	0,5032	0,5166

$$\dot{V} = C \cdot \Delta p^{n}$$

C [$m^3/(h\ Pa^n)$]

Measured Data

Flow Ring	Chamber Orifice Diameter (inch)	Chamber Back Pressure (Pa)	Chamber Flow (m^3/h)	Calculated Fan Flow (m^3/h)	Error (from chamber) (%)
Open	18,0	48,7	5376,4	5360,2	-0,3
A	12,0	49,6	2601,8	2584,1	-0,7
B	9,0	49,5	1002,2	995,2	-0,7
C	4,5	50,1	248,4	240,7	-3,1
D	3,0	48,3	120,0	119,9	0,0
E	1,75	41,3	44,1	44,0	-0,1 m^3/h

Note: Motor position during calibration: 11.9 mm.

Conditions: Temperature: 25 °C, Pressure: 986 hPa

1. This fan meets the flow measurement requirements of Standards ASTM E779, ASTM E1554, CGSB 149.10-M86, EN13829, ATTMA Technical Standard 1 and NFPA 2001 when used with the Published Calibration Parameters shown above, and the fan is used in accordance with the manufacturer's installation and operating instructions.

2. Calibration is conducted in accordance with ASTM Standard E1258 using a test chamber constructed according to ASHRAE Standard 51/AMCA Standard 210. The Energy Conservatory's accuracy assurance reference is comprised of a NIST traceable Mensor Series 6100 Digital Pressure Transducer.

3. Measured airflow is volumetric only at standard air density of 1.2041 kg/m^3.

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Calibration Certificate

Equipment:	Minneapolis BlowerDoor Fan
Manufacturer:	The Energy Conservatory, Inc. USA
Model:	4
Serial #:	CE5819
Calibration Facility:	The Energy Conservatory, 2801 21st Ave. S., Minneapolis, MN 55407
Customer Name:	BlowerDoor GmbH
Customer #:	GEINGE
Certificate #:	4-220-CE5819-05-26-17
Calibration Date:	26.05.17

Published Fan Flow Calibration Parameters

	Open	A	B	C	D	E
Coefficient (C)	745,4	273,2	81,69	19,30	12,31	4,761
Exponent (n)	0,4848	0,4952	0,4968	0,5157	0,5032	0,5166

$$\dot{V} = C \cdot \Delta p^n$$

C [$m^3/(h\ Pa^n)$]

Measured Data

Flow Ring	Chamber Orifice Diameter (inch)	Chamber Back Pressure (Pa)	Chamber Flow (m^3/h)	Calculated Fan Flow (m^3/h)	Error (from chamber) (%)
Open	18,0	51,4	5425,8	5411,4	-0,3
A	12,0	49,9	2584,9	2573,8	-0,4
B	9,0	51,6	1003,2	996,4	-0,7
C	4,5	49,9	248,6	240,0	-3,5
D	3,0	49,5	120,8	120,6	-0,2
E	1,75	44,7	44,2	44,1	-0,1 m^3/h

Note: Motor position during calibration: 12.9 mm.

Conditions: Temperature: 25 °C, Pressure: 987 hPa

1. This fan meets the flow measurement requirements of Standards ASTM E779, ASTM E1554, CGSB 149.10-M86, EN13829, ATTMA Technical Standard 1 and NFPA 2001 when used with the Published Calibration Parameters shown above, and the fan is used in accordance with the manufacturer's installation and operating instructions.

2. Calibration is conducted in accordance with ASTM Standard E1258 using a test chamber constructed according to ASHRAE Standard 51/AMCA Standard 210. The Energy Conservatory's accuracy assurance reference is comprised of a NIST traceable Mensor Series 6100 Digital Pressure Transducer.

3. Measured airflow is volumetric only at standard air density of 1.2041 kg/m^3.

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Calibration Certificate

Equipment:	DG700E.F
Manufacturer:	The Energy Conservatory, Inc. USA
Serial #:	63929-107
Calibration Facility:	The Energy Conservatory, 2801 21st Ave. S., Minneapolis, MN 55407
Customer #:	GEINGE
Certificate #:	DG700E.F-63929-11-10-17
Calibration Date:	10.11.2017
Temperature:	70.0 F (21.1 °C)

Calibration Data:

Positive Polarity:

Standard (Pa)	Channel A (Pa)	Difference	Channel B (Pa)	Difference
9,3	9,3	-0,1%	9,3	-0,6%
23,0	23,1	0,1%	23,0	-0,1%
36,8	36,8	-0,1%	36,8	0,0%
48,8	48,8	0,0%	48,8	-0,1%
56,1	56,1	0,0%	56,1	0,0%
98,9	98,9	0,1%	98,9	0,0%
121,9	121,8	0,0%	121,8	0,0%
175,1	175,0	0,0%	175,0	0,0%
269,9	269,8	0,0%	269,9	0,0%
473,2	473,1	0,0%	473,1	0,0%
920,8	920,6	0,0%	920,6	0,0%
1209,0	1209,0	0,0%	1208,8	0,0%
	Calibration		Calibration	
	0.993768		0.992691	
	1.573e-06		9.726e-07	
	1.508e-08		1.187e-08	

Negative Polarity:

-9,4	-9,3	-0,2%	-9,3	-0,1%
-23,1	-23,1	0,1%	-23,1	0,1%
-36,9	-36,9	0,0%	-36,9	0,0%
-48,9	-48,9	-0,1%	-48,9	0,0%
-56,3	-56,2	-0,1%	-56,3	0,0%
-99,0	-99,0	-0,1%	-99,0	-0,1%
-121,9	-121,8	0,0%	-121,8	-0,1%
-175,0	-174,9	-0,1%	-175,0	0,0%
-270,1	-270,1	0,0%	-270,0	0,0%
-473,3	-473,3	0,0%	-473,3	0,0%
-921,1	-921,3	0,0%	-921,2	0,0%
-1207,8	-1207,6	0,0%	-1207,5	0,0%
-0,01	-0,05	-0,04 Pa	-0,05	-0,04 Pa
	Calibration		Calibration	
	0.992780		0.991876	
	6.911e-08		-8.467e-07	
	1.244e-08		1.011e-08	

1 The published accuracy specifications for the DG700 gauge is +/- 1.0% of reading, or 0.15 Pa (whichever is greater). The calibration interval for this gauge is 24 months. This calibration is NIST traceable.

2 The manufacturer's reference for the purpose of accuracy assurance is a Mensor Series 6100 Digital Pressure Transducer. S/N: 821774 Calibration Date: 14.08.17

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Calibration Certificate

Equipment:	DG700E.F
Manufacturer:	The Energy Conservatory, Inc. USA
Serial #:	63930-107
Calibration Facility:	The Energy Conservatory, 2801 21st Ave. S., Minneapolis, MN 55407
Customer #:	GEINGE
Certificate #:	DG700E.F-63930-11-10-17
Calibration Date:	10.11.2017
Temperature:	70.0 F (21.1 °C)

Calibration Data:

Positive Polarity:

Standard (Pa)	Channel A (Pa)	Difference	Channel B (Pa)	Difference
9,3	9,3	-0,5%	9,3	-0,4%
23,0	23,0	0,0%	23,0	-0,1%
36,8	36,8	-0,1%	36,8	0,0%
48,8	48,8	0,0%	48,8	0,0%
56,2	56,2	0,0%	56,2	0,0%
98,9	98,9	0,0%	99,0	0,1%
121,9	121,9	0,0%	121,9	0,0%
175,1	175,1	0,0%	175,1	0,0%
269,9	269,9	0,0%	269,9	0,0%
473,2	473,0	0,0%	473,1	0,0%
920,8	920,5	0,0%	920,5	0,0%
1209,0	1209,1	0,0%	1209,0	0,0%
	Calibration		Calibration	
	0.996353		0.998552	
	4.229e-07		1.894e-07	
	1.738e-08		1.448e-08	

Negative Polarity:

-9,4	-9,4	0,0%	-9,4	0,1%
-23,1	-23,1	0,0%	-23,1	0,1%
-36,9	-36,9	0,0%	-36,9	0,0%
-48,9	-48,9	0,1%	-48,9	-0,1%
-56,3	-56,3	0,1%	-56,2	-0,1%
-99,1	-99,1	0,0%	-99,0	-0,1%
-121,9	-121,9	0,0%	-121,8	-0,1%
-175,0	-175,0	0,0%	-174,9	-0,1%
-270,1	-270,1	0,0%	-270,1	0,0%
-473,3	-473,3	0,0%	-473,4	0,0%
-921,1	-921,1	0,0%	-921,3	0,0%
-1207,8	-1207,8	0,0%	-1207,5	0,0%
-0,01	-0,01	0,00 Pa	-0,06	-0,05 Pa
	Calibration		Calibration	
	0.995626		0.996811	
	2.921e-06		-1.181e-06	
	1.572e-08		9.905e-09	

1 The published accuracy specifications for the DG700 gauge is +/- 1.0% of reading, or 0.15 Pa (whichever is greater). The calibration interval for this gauge is 24 months. This calibration is NIST traceable.

2 The manufacturer's reference for the purpose of accuracy assurance is a Mensor Series 6100 Digital Pressure Transducer. S/N: 821774 Calibration Date: 14.08.17

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Calibration Certificate

Calibration Facility: 2801 21st Ave. S., Minneapolis, MN 55407
Calibration Date: October 19, 2017
Customer Name: BlowerDoor GmbH
Customer #: GEINGE
Certificate #: MLM-1051-121916

Equipment: Micro-Leakage Meter
Serial #: 1051
Pressure (hPa): 993

MLM Calibration Parameters

MLM Disk	Published Coefficient (C)	Published Exponent (n)
Disk 1	**5,669**	**0,4880**
Disk 2	**0,9769**	**0,4913**
Disk 3	**0,1832**	**0,4811**
Disk 4	**0,04732**	**0,4759**

Calibration Data

			Inlet air density				Volumetric Flows		
Flow Ring	Chamber Configuration	Master Flow (m^3/h)	Master kg/m^3	MLM kg/m^3	MLM Delta Pressure (Pa)	MLM Indicated Flow[2] (m^3/h)	Adjusted Master Flow[3] (m^3/h)	MLM Flow (m^3/h)	% Error (from AMF)
Disk 1	2" LFE	12,5	1,183	1,181	5,0	12,5	12,6	12,6	0,2
Disk 1	2" LFE	52,7	1,182	1,174	96,5	52,7	53,0	53,4	0,7
Disk 1	2" LFE	84,6	1,181	1,168	256,3	84,9	85,6	86,2	0,7
Disk 2	1" LFE	2,39	1,183	1,178	6,1	2,37	2,40	2,38	-0.02 m3/h
Disk 2	2" LFE	11,52	1,182	1,181	149,5	11,43	11,54	11,55	0,1
Disk 2	2" LFE	20,65	1,182	1,179	486,8	20,42	20,70	20,64	-0,3
Disk 3	1" LFE	0,657	1,183	1,181	13,6	0,643	0,658	0,649	-0.010 m3/h
Disk 3	1" LFE	2,157	1,183	1,179	160,3	2,107	2,165	2,129	-1,6
Disk 3	1" LFE	3,551	1,183	1,176	442,8	3,435	3,571	3,475	-2,7
Disk 4	1" LFE	0,205	1,183	1,182	21,1	0,202	0,205	0,203	-0.002 m3/h
Disk 4	1" LFE	0,517	1,183	1,182	151,6	0,516	0,517	0,521	0.004 m3/h
Disk 4	1" LFE	0,854	1,182	1,181	437,2	0,855	0,855	0,863	0.008 m3/h

1. The Energy Conservatory's accuracy assurance references are comprised of a NIST traceable Mensor Series 6100 Digital Pressure Transducer and Meriam laminar flow elements Z50MC2-2 and 50MW20-1.
2. Indicated flow is the reading from TEC guages and software using standard air density of 1.2041 kg/m3.
3. Adjusted Master Flow is the actual flow into the MLM. This is the Master Flow adjusted for the difference between the inlet air densities of the Master and MLM.

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