



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

ELEMENT MATERIALS TECHNOLOGY DETROIT - WARREN 11 MILE  
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CALIBRATION

Valid until: March 31, 2019

Certificate Number: 0038.05

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1</sup>:

I. Chemical

Parameter/Equipment	Range	CMC <sup>2</sup> , 7 (±)	Comments
pH Measuring Equipment <sup>3</sup>	(4,7,10) units	0.03 units	Standard solutions
Conductivity – Fixed Values <sup>3</sup>	10 µS 100 µS 1000 µS (1413 to 110 000) µS	5.4 % 2.3 % 0.50 % 0.33 %	Standard solutions

II. Dimensional

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Flatness <sup>3</sup>	(0.125 to 2) in	9.9 µin	Optical flats, monochromatic light

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Optical Flats	(0.5 to 2) in	9.3 μin	Grade 1 optical flats, monochromatic light
Micrometers <sup>3</sup> –			
Inside	(0.2 to 20) in	(39 + 4.0L) μin	Gage blocks
Outside	(0.001 to 6) in (6 to 36) in	(40 + 2.3L) μin (400 + 1.6L) μin	Gage blocks, length standards, D5947, D3767
Depth	(0.001 to 12) in	(75 + 39L) μin	Gage blocks
Calipers <sup>3</sup>	(0.001 to 18) in (18 to 72) in	(71 + 21L) μin (210 + 9.3L) μin	Gage blocks
Length Indicators <sup>3</sup> (Dial, Test, LVDTs)	(-0.5 to 0.5) in  Up to 6 in  (6 to 36) in	18 μin  (46 + 2.3L) μin  (400 + 1.6L) μin	Gage blocks  Gage blocks, micrometer head
Length Indicator Calibrators	(0.00005 to 6) in	(46 + 9.3L) μin	Gage blocks
Height Gages <sup>3</sup>	(0.001 to 24) in (24 to 36) in	(230 + 1.3L) μin (200 + 2.4L) μin	Gage blocks, LVDT, surface plate
Rulers <sup>3</sup>	0.5 in to 6.0 ft	0.014 in	Standard rule
Tape Measure	0.5 in to 6 ft (6 to 12) ft (12 to 24) ft	0.028 in 0.032 in 0.077 in	Standard rule
Angle <sup>3</sup>	0.01° to 45°  0° to 360°	0.004°  0.071°	Angle sine plate, gage blocks  Optical comparator

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Radius	(0 to 12) in	420 μin	Optical comparator/ overlays

### III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 5, 6, 7, 9</sup> (±)	Comments
DC Current – Measure <sup>3</sup>	(10 to 100) nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A  (1 to 3) A (3 to 1000) A	42 μA/A + 54 pA 30 μA/A + 66 pA 30 μA/A + 190 pA 30 μA/A + 1.6 nA 30 μA/A + 12 nA 30 μA/A + 120 nA 47 μA/A + 1.2 μA 0.014 % + 19 μA  0.14 % + 700 μA 0.009 % + 7 mA	HP 3458A        HP 34401 HP 3458A opt 2 w/current shunt
DC Current – Generate <sup>3</sup>	(0 to 330) μA  (Up to 220) μA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A  (11 to 20) A  (20 to 160) A (160 to 525) A (525 to 1000) A	180 μA/A + 24 nA  58 μA/A + 11 nA 58 μA/A + 210 nA 70 μA/A + 1.7 μA 93 μA/A + 58 μA 0.042 % + 720 μA  0.12 % + 1.9 mA  0.26 % + 140 mA 0.26 % + 140 mA 0.26 % + 180 mA	Fluke 5520A  Fluke 5700A   Fluke 5700A w/ 5725A  Fluke 5520A  Fluke 5520A/Fluke 50-turn coil
DC Voltage –Generate <sup>3</sup>	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	9.3 μV/V + 0.86 μV 8.1 μV/V + 2.2 μV 8.1 μV/V + 17 μV 8.1 μV/V + 26 μV 9.3 μV/V + 210 μV 11 μV/V + 2.1 mV	Fluke 5700A

Parameter/Equipment	Range	CMC <sup>2,5,7</sup> ( $\pm$ )	Comments
DC Voltage – Measure <sup>3</sup>	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	6 $\mu$ V/V + 440 nV 4.7 $\mu$ V/V + 640 nV 4.7 $\mu$ V/V + 4.0 $\mu$ V 7 $\mu$ V/V + 83 $\mu$ V 7 $\mu$ V/V + 1.6 mV	HP 3458A opt 002
	(1 to 2) kV (2 to 20) kV	0.06 % + 0.62 V 0.06 % + 8.4 V	Vahalla 4600 kilovolt meter

Parameter/Range	Frequency	CMC <sup>2,9</sup> ( $\pm$ )	Comments
Capacitance – Generate <sup>3</sup>			
Fixed Values, 0.001 $\mu$ F 0.1 $\mu$ F 1 $\mu$ F	1 kHz 1 kHz 1 kHz	0.06 % + 0.001 nF 0.06 % + 0.07 nF 0.06 % + 0.6 nF	Standard capacitors
Synthesized Capacitance			
(0.19 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (0.7 to 1.1) $\mu$ F (1.1 to 3.3) $\mu$ F (3.3 to 11) $\mu$ F (11 to 33) $\mu$ F (110 to 330) $\mu$ F (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF	10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 600) Hz (10 to 150) Hz (10 to 120) Hz Up to 50 Hz Up to 20 Hz Up to 6 Hz Up to 2 Hz Up to 0.6 Hz	0.58 % + 0.014 nF 0.58 % + 0.013 nF 0.29 % + 0.017 nF 0.29 % + 0.12 nF 0.29 % + 1.4 nF 0.29 % + 4.0 nF 0.29 % + 15 nF 0.47 % + 45 nF 0.52 % + 510 nF 0.52 % + 1.7 $\mu$ F 0.52 % + 3.8 $\mu$ F 0.52 % + 13 $\mu$ F 0.87 % + 40 $\mu$ F	Fluke 5520A

Parameter/Equipment	Range	CMC <sup>2, 5, 6, 7, 9</sup> ( $\pm$ )	Comments
Resistance – Measure <sup>3</sup>	(0 to 1) $\Omega$ (1 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$	18 $\mu\Omega/\Omega$ + 18 $\mu\Omega$ 18 $\mu\Omega/\Omega$ + 70 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 660 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 1.5 m $\Omega$ 16 $\mu\Omega/\Omega$ + 43 m $\Omega$ 12 $\mu\Omega/\Omega$ + 170 m $\Omega$ 18 $\mu\Omega/\Omega$ + 6.1 $\Omega$ 59 $\mu\Omega/\Omega$ + 170 $\Omega$ 0.060 % + 3.0 k $\Omega$ 0.59 % + 200 k $\Omega$	HP 3458A
Resistance – Generate <sup>3</sup>			
Fixed Values	(1, 1.9) $\Omega$ 10 $\Omega$ 19 $\Omega$ 100 $\Omega$ 190 $\Omega$ 1 k $\Omega$ 1.9 k $\Omega$ 10 k $\Omega$ 19 k $\Omega$ 100 k $\Omega$ 190 k $\Omega$ 1 M $\Omega$ 1.9 M $\Omega$ 10 M $\Omega$ 19 M $\Omega$ 100 M $\Omega$	120 $\mu\Omega$ 100 $\mu\Omega$ 170 $\mu\Omega$ 300 $\mu\Omega$ 440 $\mu\Omega$ 2.4 m $\Omega$ 3.9 m $\Omega$ 19 m $\Omega$ 42 m $\Omega$ 230 m $\Omega$ 580 m $\Omega$ 5.7 $\Omega$ 8.7 $\Omega$ 140 $\Omega$ 300 $\Omega$ 4400 $\Omega$	Fluke 5700A
	(0 to 11) $\Omega$ (11 to 33) $\Omega$ (33 to 110) $\Omega$ (110 to 330) $\Omega$ (0.33 to 1.1) k $\Omega$ (1.1 to 3.3) k $\Omega$ (3.3 to 11) k $\Omega$ (11 to 33) k $\Omega$ (33 to 110) k $\Omega$ (110 to 330) k $\Omega$	47 $\mu\Omega/\Omega$ + 1.2 m $\Omega$ 35 $\mu\Omega/\Omega$ + 1.8 m $\Omega$ 33 $\mu\Omega/\Omega$ + 1.8 m $\Omega$ 33 $\mu\Omega/\Omega$ + 2.9 m $\Omega$ 33 $\mu\Omega/\Omega$ + 6.1 m $\Omega$ 33 $\mu\Omega/\Omega$ + 35 m $\Omega$ 33 $\mu\Omega/\Omega$ + 83 m $\Omega$ 33 $\mu\Omega/\Omega$ + 350 m $\Omega$ 33 $\mu\Omega/\Omega$ + 850 m $\Omega$ 37 $\mu\Omega/\Omega$ + 3.2 $\Omega$	Fluke 5520A

Parameter/Equipment	Range	CMC <sup>2,4,9</sup> (±)	Comments
Resistance – Generate <sup>3</sup> (cont)	(0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (0.33 to 1.1) GΩ	37 μΩ/Ω + 7.0 Ω 70 μΩ/Ω + 51 Ω 0.016 % + 210 Ω 0.029 % + 3.6 kΩ 0.058 % + 9.9 kΩ 0.35 % + 140 kΩ 1.8 % + 1.4 MΩ	Fluke 5520A
Oscilloscopes <sup>3</sup> –			Fluke 5520A SC1100 opt
DC Signal (50 Ω Load)	0 V to ± 6.6 V	0.43 % + 47 μV	
DC Signal (1 MΩ Load)	0 V to ± 130 V	1.6 % + 47 μV	
Square Wave Signal (50 Ω Load)	0 V to ± 6.6 V	0.78 % + 47 μV	
Square Wave Signal (1 MΩ Load)	0 V to ± 130 V	1.1 % + 47 μV	
Bandwidth (50 kHz Reference)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2.2 % + 120 μV 2.7 % + 120 μV 4.9 % + 120 μV 6.0 % + 120 μV	
Risetime Into 50 Ω	Single Sided	120 ps	
Timing Markers	1 ns to 50 ms/div  50 ms to 5 s/div	2.9 parts in 10 <sup>6</sup> of output period + 0.6R  0.58 % of output period + 0.6R	

Parameter/Range	Frequency	CMC <sup>2, 6, 7</sup> (±)	Comments
AC Current – Generate <sup>3</sup>			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.081 % + 40 nA 0.041 % + 30 nA 0.017 % + 30 nA 0.07 % + 60 nA 0.19 % + 110 nA	Fluke 5700A
220 µA to 2.2 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.081 % + 170 nA 0.041 % + 120 nA 0.017 % + 100 nA 0.07 % + 490 nA 0.19 % + 950 nA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.081 % + 2.6 µA 0.041 % + 1.4 µA 0.017 % + 1.0 µA 0.07 % + 4.9 µA 0.19 % + 9.5 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.081 % + 27 µA 0.041 % + 14 µA 0.017 % + 13 µA 0.07 % + 49 µA 0.19 % + 100 µA	
220 mA to 2.2 A	(20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.076 % + 150 µA 0.076 % + 140 µA 0.087 % + 260 µA 0.99 % + 2.1 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.054 % + 1.2 mA 0.11 % + 1.6 mA 0.42 % + 1.6 mA	Fluke 5700A/5725A
(11 to 20) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.14 % + 7.4 mA 0.18 % + 7.4 mA 3.0 % + 8.7 mA	Fluke 5520A
(20 to 1000) A	(45 to 400) Hz	0.59 % + 200 mA	Fluke 5520A w/Fluke 50-turn coil

Parameter/Range	Frequency	CMC <sup>2, 5, 9</sup> (±)	Comments
AC Current – Measure <sup>3</sup>			
(5 to 100) $\mu$ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.47 % + 40 nA 0.18 % + 40 nA 0.07 % + 40 nA 0.07 % + 40 nA	HP 3458A
100 $\mu$ A to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 250 nA 0.18 % + 250 nA 0.07 % + 250 nA 0.04 % + 250 nA 0.07 % + 250 nA 0.47 % + 470 nA 0.64 % + 1.8 $\mu$ A	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 2.5 $\mu$ A 0.18 % + 2.5 $\mu$ A 0.07 % + 2.5 $\mu$ A 0.04 % + 2.5 $\mu$ A 0.07 % + 2.5 $\mu$ A 0.47 % + 4.7 $\mu$ A 0.64 % + 18 $\mu$ A	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.47 % + 25 $\mu$ A 0.18 % + 25 $\mu$ A 0.07 % + 25 $\mu$ A 0.04 % + 25 $\mu$ A 0.07 % + 25 $\mu$ A 0.47 % + 47 $\mu$ A 0.64 % + 180 $\mu$ A	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.47 % + 260 $\mu$ A 0.19 % + 260 $\mu$ A 0.10 % + 260 $\mu$ A 0.12 % + 260 $\mu$ A 0.35 % + 260 $\mu$ A 1.2 % + 480 $\mu$ A	



Parameter/Range	Frequency	CMC <sup>2, 5, 7</sup> (±)	Comments
AC Current – Measure (cont) <sup>3</sup>			
(1 to 3) A	(3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz	1.3 % + 700 µA 0.41 % + 710 µA 0.18 % + 710 µA	HP 34401
(3 to 1000) A	(40 to 400) Hz	120 µA/A + 2.5 mA	HP 3458A opt 2 w/shunt
AC Voltage – Measure <sup>3</sup>			
(1 to 10) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.036 % + 4.2 µV 0.025 % + 2.7 µV 0.035 % + 2.9 µV 0.12 % + 2.9 µV 0.58 % + 3.1 µV 4.7 % + 4.4 µV	HP 3458A opt 2
(10 to 100) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.009 % + 5.8 µV 0.009 % + 3.9 µV 0.017 % + 4.2 µV 0.035 % + 4.0 µV 0.093 % + 7.4 µV 0.35 % + 17 µV 1.2 % + 52 µV 1.8 % + 52 µV	
100 mV to 1 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.009 % + 50 µV 0.009 % + 28 µV 0.017 % + 29 µV 0.035 % + 32 µV 0.093 % + 32 µV 0.35 % + 130 µV 1.2 % + 280 µV 1.8 % + 280 µV	
(1 to 10) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.009 % + 580 µV 0.009 % + 330 µV 0.017 % + 280 µV 0.035 % + 340 µV 0.093 % + 340 µV 0.35 % + 1.3 mV 1.2 % + 3.2 mV 1.8 % + 3.2 mV	

Parameter/Range	Frequency	CMC <sup>2, 5, 6, 7, 9</sup> (±)	Comments
AC Voltage – Measure (cont) <sup>3</sup>			
(10 to 100) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.024 % + 5.1 mV 0.024 % + 2.9 mV 0.024 % + 3.1 mV 0.041 % + 3.4 mV 0.14 % + 4.0 mV 0.47 % + 13 mV 1.8 % + 13 mV	HP 3458A opt 2
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 55 mV 0.047 % + 40 mV 0.07 % + 40 mV 0.14 % + 40 mV 0.35 % + 40 mV	
(1 to 2) kV	(20 to 100) Hz (100 to 400) Hz	0.12 % + 2.4 V 0.58 % + 12 V	Valhalla 4600 hi-voltage meter
(2 to 15) kV	(20 to 60) Hz	0.58 % + 18 V	
AC Voltage – Generate <sup>3</sup>			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.064 % + 6.5 μV 0.025 % + 6.5 μV 0.013 % + 1.9 μV 0.043 % + 6.8 μV 0.099 % + 9.2 μV 0.13 % + 16 μV 0.2 % + 30 μV 0.4 % + 31 μV	Fluke 5700A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.064 % + 7.1 μV 0.025 % + 7.0 μV 0.013 % + 7.1 μV 0.043 % + 7.3 μV 0.099 % + 9.7 μV 0.13 % + 17 μV 0.2 % + 31 μV 0.4 % + 40 μV	

Parameter/Range	Frequency	CMC <sup>2, 6, 7</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.064 % + 21 μV 0.025 % + 15 μV 0.013 % + 13 μV 0.037 % + 16 μV 0.099 % + 34 μV 0.13 % + 42 μV 0.2 % + 52 μV 0.4 % + 150 μV	Fluke 5700A
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.058 % + 140 μV 0.019 % + 87 μV 87 μV/V + 61 μV 0.014 % + 64 μV 0.029 % + 110 μV 0.05 % + 250 μV 0.13 % + 470 μV 0.26 % + 1.3 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.058 % + 2.1 mV 0.019 % + 860 μV 87 μV/V + 630 μV 0.014 % + 650 μV 0.029 % + 740 μV 0.058 % + 2.5 mV 0.15 % + 5.4 mV 0.32 % + 15 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.058 % + 21 mV 0.019 % + 11 mV 93 μV/V + 6.3 mV 0.026 % + 9 mV 0.058 % + 14 mV 0.18 % + 110 mV 0.55 % + 110 mV 1.4 % + 230 mV	

Parameter/Range	Frequency	CMC <sup>2, 6, 7</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.042 % + 50 mV 99 μV/V + 44 mV	Fluke 5700A
(220 to 750) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.011 % + 23 mV 0.02 % + 19 mV 0.07 % + 45 mV 0.27 % + 110 mV	Fluke 5700A w/ 5725A
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.011 % + 30 mV 0.02 % + 31 mV 0.07 % + 66 mV	Fluke 5700A w/ 5725A

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of RTD Indicating Devices <sup>3</sup> –			
Pt 385, 200 Ω	(-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C	0.053 °C 0.064 °C 0.15 °C 0.17 °C 0.19 °C	Fluke 5520A
500 Ω	(-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.066 °C 0.078 °C 0.10 °C 0.14 °C	
1000 Ω	(-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.064 °C 0.076 °C 0.097 °C 0.28 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of RTD Indicating Devices <sup>3</sup> – (cont)			
PtNi 385 120 Ω (Ni 120)	(-80 to 100) °C (100 to 260) °C	0.085 °C 0.17 °C	Fluke 5520A
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	
Pt 385, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C (630 to 800) °C	0.064 °C 0.085 °C 0.12 °C 0.15 °C 0.27 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to 0) °C (0 to 260) °C (260 to 600) °C (600 to 630) °C	0.29 °C 0.063 °C 0.086 °C 0.12 °C 0.27 °C	
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C	0.063 °C 0.085 °C 0.12 °C 0.15 °C	
Calibration of Thermocouple Indicators, Sensors and Sensing Systems <sup>3</sup> –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.53 °C 0.43 °C 0.38 °C 0.41 °C	Fluke 5520A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (180 to 2316) °C	0.37 °C 0.42 °C 0.39 °C 0.60 °C 0.98 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Calibration of Thermocouple Indicators, Sensors and Sensing Systems <sup>3</sup> –			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.60 °C 0.24 °C 0.22 °C 0.24 °C 0.29 °C	Fluke 5520A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.34 °C 0.22 °C 0.20 °C 0.22 °C 0.29 °C	
Type K	(-200 to -100) °C (-100 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.41 °C 0.25 °C 0.33 °C 0.48 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.34 °C 0.26 °C 0.25 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.49 °C 0.29 °C 0.26 °C 0.26 °C 0.35 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.68 °C 0.44 °C 0.41 °C 0.49 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.57 °C 0.45 °C 0.46 °C 0.56 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.75 °C 0.31 °C 0.22 °C 0.20 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Calibration of Thermocouple Indicators, Sensors and Sensing Systems <sup>3</sup> (cont) –			
Type U	(-200 to 0) °C (0 to 600) °C	0.67 °C 0.35 °C	Fluke 5520A
Type J	(-210 to 760) °C	0.069 °C	
Type K	(-270 to 1370) °C	0.064 °C	
Type T	(-270 to 400) °C	0.073 °C	HP 3458A opt 2, junction at ice point, ice bath

#### IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Force – Tension and Compression <sup>3</sup>	Up to 1000 lbf (1000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 30 000) lbf	0.02 % 4.5 lbf 7.8 lbf 24 lbf	Dead weight ASTM E74 w/load cells, load cell calibrator
Verification of Tensile Testers <sup>3</sup> –			
Displacement, Position	(0.01 to 4) in (4 to 24) in (24 to 72) in	140 μin 0.0060 in 0.061 in	ASTM E4 w/
Crosshead Speed	(0.001 to 4) in/min  (4 to 72) in/min	(0.02 % in/min) <i>L</i>  (0.11 % in/min) <i>L</i>	Digital indicator, precision rule, laser  Stopwatch, indicator/rule; <i>L</i> is the length of travel.
Tensile and Compressive Force	Up to 1000 lbf (1000 to 5000) lbf (5000 to 10 000) lbf (10 000 to 30 000) lbf	0.02 % 4.5 lbf 7.8 lbf 24 lbf	Dead weight load cells

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Verification of Extensometers <sup>3</sup> –  Gage Length	(0.001 to 4) in (4 to 72) in	(140 μin + 24L) μin (0.017 in + 0.0005L) in	ASTM E83 w/  Micrometer head w/fixture Steel rule
Extrusion Plastometers <sup>3</sup>  Bore Measurement Piston Land Diameter Piston Foot Length Die Orifice Weight Height of Switch/Switch Calibration  Temperature  Timer Go/No-Go Gage	(0.35 to 0.55) in (0.35 to 0.50) in (0.20 to 0.30) in (0.37 to 0.38) in (50 to 30 000) g (0.1 to 12) in  (50 to 260) °C (260 to 420) °C  (10 to 6000) sec (0 to 1) in	74 μin 84 μin 84 μin 84 μin 0.27 g 460 μin  0.075 °C 0.082 °C  0.41 s 16 μin	ASTM D1238, ISO 1133
Impact Testing Machines <sup>3</sup> –  Pendulum Straightness Striker Radius Striker Angle Vertical Fall Free Hang Weight Height Difference Striker Centered	(0.001 to 0.5) in (0.02 to 0.16) in (20 to 60)° (0 to 25) in (0.5 to 1.2) in Up to 12 000 g ± 0.25 in ± 0.25 in	130 μin 0.0063 in 0.78° (0.059 + 7.1L) in 140 μin 0.27 g 400 μin 0.0063 in	ASTM D256, ISO 180



Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Wyzenbeek Oscillatory Abrasion Testers <sup>3</sup> –  Cycle Rate/Counter Specimen Tension/Force Pressure Pad Hardness	(80 to 100) osc/min (0.5 to 7) lbf (10 to 90) duro	1.7 counts 0.085 lbf 1.6 duro units	Stop watch Force gage Durometer
Plastic Impact Specimen Notcher & Plastic Impact Notches Specimen <sup>3</sup> –  Notch Verification Device Notch Angle Notch Radius Thickness under Notch	(0 to 1) in  (40 to 50)° (0.005 to 0.015) Radius (0.3 to 0.5) in	58 µin  0.071° 520 µin 220 µin	ASTM D256
Abrasion Testers <sup>3</sup> –  Platform Speed Wheel Position Platform Flatness Arm Weight Add-on Weights Nozzle Flatness	(20 to 120) rpm (0.001 to 0.25) in ± 0.15 in (200 to 300) g (200 to 600) g (0.001 to 0.5) in	0.25 rpm 0.0012 in 690 µin 6.0 g 0.23 g 0.0014 in	Tachometer Caliper Indicator Load cell Balance Micrometer
Pressure <sup>3</sup> –  Pneumatic	(0 to 40) inH <sub>2</sub> O  (0 to 5) psia/Pres (5 to 11) psia/Pres (11 to 17) psia/Pres (17 to 24) psia/Pres (24 to 60) psia/Pres (60 to 150) psia/Pres (150 to 715) psia/Pres (715 to 1500) psia/Pres	0.005 in H <sub>2</sub> O  0.0032 psia 0.062 % applied 0.024 % applied 0.024 % applied 0.024 % applied 0.024 % applied 0.024 % applied 0.024 % applied	Hook gage  Precision pressure calibration system

Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Pressure <sup>3</sup> – (cont)			
Pneumatic	(0 to 10) psig (10 to 24) psig (24 to 60) psig (60 to 135) psig (135 to 700) psig (700 to 1485) psig	0.0069 psig 0.030 % applied 0.030 % applied 0.030 % applied 0.029 % applied 0.029 % applied	Precision pressure calibration system
Hydraulic	(5 to 100) psig (100 to 10 000) psig	0.027 % + 0.002 psig 0.054 % + 0.002 psig	Dead weight calibrator
Scales & Balances <sup>3</sup> –			
1 mg to 11 kg	Resolution: 0.001 mg 0.01 mg 0.1 mg 1 mg 10 mg 100 mg 1 g 10 g  (0.5 to 100) lb (100 to 500) lb  (500 to 1000) lb	0.0015 mg + 0.0039 % 0.015 mg + 0.0039 % 0.16 mg + 0.0039 % 1.5 mg + 0.0039 % 8.3 mg + 0.0039 % 83 mg + 0.0039 % 0.83 g + 0.0039 % 8.3 g + 0.0039 %  0.008 lb 0.033 lb  0.12 lb	ASTM Class 1 weights, CMC stated as the base plus percent of applied load  Class 5 weights  Class 5, 6 weights using Handbook 44
Mass	(0.5, 1, 2) lb 5 lb 10 lb 20 lb 50 lb 100 lb  (0 to 12 500) g (12 500 to 22 700) g (22 700 to 64 000) g	0.0084 oz 0.012 oz 0.015 oz 0.022 oz 0.0089 oz 0.021 oz  0.19 g 1.4 g 1.5 g	Class 1, 5, 6 mass standards, substitution method using precision balance  Direct measurement with precision scales

Parameter/Equipment	Range	CMC <sup>2, 4, 7</sup> ( $\pm$ )	Comments
Tachometers <sup>3</sup> –			
Optical	(10 to 100 000) rpm	0.0006 % + 0.6R	Multifunction generator and LED
Mechanical Coupled	(55 to 10 000) rpm (10 000 to 40 000) rpm	0.085 rpm (0.2 + 0.007 %) rpm	Tachometer calibrator
Linear Velocity	(175 to 188 000) in/min	0.34 in/min	
Shaft Speed <sup>3</sup>	(0.01 to 1000) rpm (1000 to 25 000) rpm	0.31 rpm 0.69 rpm	Tachometer
Magnetic Wand Insertion Probe <sup>3</sup>	(1 to 20) lbf	0.14 lbf	ASTM F2075 utilizing pull-test methods
Torque Wrenches <sup>3</sup>	5 in·lbf to 250 ft·lbf (250 to 1000) ft·lbf	0.46 % applied value 1.6 % applied value	Torque calibrator Dead weight
Torque Transducers and Calibrators <sup>3</sup> –			
Torque	(0 to 2000) ft·lbf	0.20 % applied value	Torque arm, wheels, and Class 1,5, 6 weights
Angle	(0 to 360) degrees	0.29°	Angle encoder



Parameter/Equipment	Range	CMC <sup>2,7</sup> (±)	Comments
Durometer Calibration – (Type A, B, C, D, DO, O, OO)			ASTM D2240
Indenter Extension and Shape –			
Diameter	Up to 0.105 in	220 μin	Optical comparator
Radius	Up to 0.125 in	430 μin	
Angle	25° to 40°	0.075°	
Extension	Up to 0.105 in	220 μin	
Indenter Display	0 to 100 durometer units	0.7 durometer units	Gage blocks
Spring Calibration – Force	Up to 45 N	0.04 N	Durometer calibrator
Accelerometers	Reference (100 Hz) (3 to 9.99) Hz 10 Hz to 1 kHz (1 to 2) kHz (2 to 10) kHz	0.54 % 0.59 % 0.71 % 1.2 % 2.8 %	Vibration calibration system referenced at 100 Hz or 160 Hz

#### V. Optical Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Gloss	(20, 60, 85) GU	1.3 GU	Reference gloss tiles



## VII. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2, 4, 7</sup> ( $\pm$ )	Comments
Relative Humidity – Measure and Measuring Equipment <sup>3</sup>	(10 to 90) % RH (90 to 95) % RH	0.83 % RH 1.2 % RH	Thunder Scientific two pressure humidity generator
Temperature – Measure <sup>3</sup>	(-190 to -40) °C (-40 to 0) °C (0 to 230) °C (230 to 420) °C (420 to 660) °C  (660 to 1400) °C	0.035 °C 0.023 °C 0.036 °C 0.082 °C 0.11 °C  0.12 % + 1.7 °C	PRT     Thermocouple
Ovens <sup>3</sup> –  Temperature Uniformity  Time Constant  Ventilation Rate	  (40 to 500) °C  10 s to 60 m  (1 to 600) exchanges	  1.4 °C  38 ms + 0.6R  4.9 % exchanges	ASTM E145, ISO 188 and other standard methods  Stop watch  Scanner, power measurement system

## VIII. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2, 4, 8</sup> ( $\pm$ )	Comments
Frequency – Measure <sup>3</sup>	Up to 1.3 GHz	$5.6 \times 10^{-10}f$	GPS receiver, frequency counter
Frequency – Measuring Equipment <sup>3</sup>	Up to 1.0 GHz	$5.6 \times 10^{-10}f$	GPS receiver, signal generator
Timers / Stop Watches <sup>3</sup> –  Mechanical  Electronic	  5 s to 72 hr  0.010 s to 24 hr	  38 ms + 0.6R  270 $\mu$ s + 0.6R	  Frequency counter

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- <sup>1</sup> This laboratory offers commercial calibration services as well as field calibration services, where noted.
- <sup>2</sup> Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.
- <sup>3</sup> Field calibration service is available for this calibration and this laboratory meets A2LA R104 – *General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.
- <sup>4</sup>  $L$  is the numerical value of the nominal length in inches unless otherwise noted.  $R$  is the resolution of the unit under test.
- <sup>5</sup> Based on using the standard at the temperature the HP 3458A was calibrated ( $t_{cal} \pm 5$  °C) and a auto-calibration (ACAL) was performed within the previous 24 hours ( $\pm 1$  °C of ambient temperature). CMC is based upon 1-year specifications and is read as a fraction of the reading plus range error.
- <sup>6</sup> Based on using the standard at the temperature the Fluke 5700A was calibrated ( $t_{cal} \pm 5$  °C) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than 5 °C. For resistance, a zero calibration is performed at least every 12 hours within  $\pm 1$  °C of use. CMC is based upon 1-year specifications and is read as a fraction or percent output plus floor specification.
- <sup>7</sup> In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.
- <sup>8</sup> In the statement of CMC,  $f$  is the frequency and  $t$  is the time.
- <sup>9</sup> The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.





## *Accredited Laboratory*

A2LA has accredited

# **ELEMENT MATERIALS TECHNOLOGY DETROIT – WARREN 11 MILE**

*Warren, MI*

for technical competence in the field of

## **Calibration**

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).



Presented this 17<sup>th</sup> day of March 2017.

A blue ink signature of the Senior Director of Accreditation Services.

Senior Director, Accreditation Services  
For the Accreditation Council  
Certificate Number 0038.01  
Valid to March 31, 2019  
Revised December 31, 2018

*For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.*