



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005,
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid To: May 31, 2012

Certificate Number: 1022.02

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Chemical

Parameter/Equipment	Range	CMC ² (±)	Comments
pH Measuring Equipment ³	(4, 7, 10) units	0.016 units	Buffer solutions
Electrolytic Conductivity Measuring Equipment ³	5 µS/cm 10 µS/cm 100 µS/cm 1000 µS/cm 10 000 µS/cm	0.65 µS/cm 0.52 µS/cm 2.4 µS/cm 24 µS/cm 230 µS/cm	Conductivity solutions

II. Dimensional

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
Gage Blocks	(Up to 1) in (1 to 4) in (4 to 11) in (11 to 40) in	3.1L µin 3.1L µin (21 + 1.4L) µin (82 + 2L) µin	Gage blocks and USM, 130B-24 LMM
Length Standards, Foils & Thickness Gauges	(Up to 11) in (11 to 40) in	(21 + 1.4L) µin (82 + 2L) µin	Gage blocks and USM LMM

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Length Standards ³	(11 to 48) in	$(30 + 2L) \mu\text{in}$	Gage blocks and height comparator
Calipers ³	(0.001 to 72) in	$6 \mu\text{in/in} + 0.6R$	Gage blocks
Indicators ³	(0.001 to 6) in	$6 \mu\text{in/in} + 0.6R$	Gage blocks
Micrometers ³	(0.001 to 72) in	$6 \mu\text{in/in} + 0.6R$	Gage blocks
Height Gages ³	(0.001 to 48) in	$6 \mu\text{in/in} + 0.6R$	Gage blocks
Steel Rules ³	Up to 48 in	0.09 in	Gage blocks
Steel Tapes	(1 to 50) ft	0.09 in	Master tape
Linear Displacement Measuring Equipment ³	(0 to 24) in (1 to 50) ft	$60 \mu\text{in/in} + 0.0027 \text{ in}$ $0.007 + 0.05 \text{ ft}$	Mitutoyo 570-314 Starrett 530-30CME
Plain Diameter – Internal	(Up to 11) in (11 to 40) in	$(27 + 1.4D) \mu\text{in}$ $(82 + 2L) \mu\text{in}$	Master rings and USM LMM
External	(Up to 11) in (11 to 40) in	$(26 + 1.4D) \mu\text{in}$ $(82 + 2L) \mu\text{in}$	Gage blocks and USM LMM
Plain Diameter ³ – External	Up to 1 in	$31 \mu\text{in}$	Zygo 1202B
Internal Straight Threads ³ – Functional Fit	(0.1 to 4) in	$400 \mu\text{in}$	Thread setting gages
Threaded Plug Gages – Simple Pitch Diameter, (4 to 80 TPI)	(0.1 to 8) in (8 to 40) in	$(77 + 2D) \mu\text{in}$ $(82 + 2L) \mu\text{in}$	Gage blocks with thread wires and USM LMM

Parameter/Equipment	Range	CMC ² (±)	Comments
Flatness ³	Up to 3 in diameter (3 to 6) in	11 μin 4.6 μin	Optical flats
Optical Comparators ³ – Linear Travel Magnification	Up to 30 in 10x to 100x	120 μin 0.0011 in	Comparison to master Scales Magnification checker and spheres
Angle ³ – Measuring Equipment	Up to 360°	7.1”	Angle encoder
Angle – Measuring Equipment	0° to 60° 90° ± 3’	8.7” 2.8”	Gage blocks, sine bar Cylinder square
Angle ³ – Measure	0° to 60°	8.1”	Gage blocks, sine bar and electronic level

III. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 6, 7} (±)	Comments
DC Voltage ³ – Measure and Generate	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	9.5 μV/V + 0.4 μV 6 μV/V + 0.4 μV 4.7 μV/V + 0.6 μV 6.9 μV/V + 35 μV 7.9 μV/V + 120 μV	Agilent 3458A opt 002 w/ Fluke 5700A
DC Voltage – Generate, Fixed Points	100 mV 1 V 10 V 100 V 1000 V	2.5 μV/V 2.5 μV/V 2.1 μV/V 2.6 μV/V 3.6 μV/V	Fluke 732B/752A
DC High Voltage ³ – Measure Generate	(1 to 60) kV (1 to 40) kV	0.13 % 0.13 %	Ross divider and DVM

Parameter/Equipment	Range	CMC ^{2, 5, 6, 7} (\pm)	Comments
DC Current ³ – Generate	Up to 220 μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A	44 μ A/A + 28 nA 38 μ A/A + 10 nA 38 μ A/A + 48 nA 48 μ A/A + 0.81 μ A 74 μ A/A + 14 μ A 0.4 % + 0.56 mA	Fluke 5700A w/ 5725A
	(11 to 20) A	0.12 % + 0.87 mA	Fluke 5520A
	(11 to 100) A	0.056 %	Fluke 5700/1620A/3458A
	(100 to 1000) A	0.3 % + 60 mA	Fluke 5500A/coil
DC Current ³ – Measure	(10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	19 μ A/A + 1 nA 19 μ A/A + 10 nA 21 μ A/A + 70 nA 40 μ A/A + 4.6 μ A 0.012 % + 16 μ A	Agilent 3458A opt 002
	(1 to 10) A (10 to 100) A (11 to 1000) A	0.31 mA 33 μ A/A 0.5 %	w/ L&N 4222 w/ L&N 4361 w/ RAM shunt
DC Resistance ³ – Generate, Fixed Values	1 Ω 1.9 Ω 10 Ω 19 Ω (100, 190) Ω (1, 1.9, 10, 19) k Ω (100, 190) k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	110 $\mu\Omega/\Omega$ 110 $\mu\Omega/\Omega$ 33 $\mu\Omega/\Omega$ 31 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$ 55 $\mu\Omega/\Omega$ 0.014 %	Fluke 5700A
	1 G Ω 10 G Ω 100 G Ω	0.11 % 2.3 % 3.6 %	Keithley resistors

Parameter/Equipment	Range	CMC ^{2, 5, 6, 7} (\pm)	Comments
DC Resistance – Generate, Fixed Values	0.1 Ω (1, 1.9, 10) Ω 100 Ω , 1 k Ω (10, 19) k Ω 100 k Ω 1 M Ω 10 M Ω 19 M Ω	12 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 7 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 8 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 26 $\mu\Omega/\Omega$	L&N 4015-B Fluke 742A series fixed resistors
Resistance ³ – Generate	Up to 10.99 Ω 11 Ω to 1.099 k Ω (1.1 to 10.99) k Ω (11 to 109.99) k Ω (0.11 to 1.099) M Ω (1.1 to 3.299) M Ω (3.3 to 10.99) M Ω (11 to 32.99) M Ω (33 to 109.99) M Ω (110 to 330) M Ω (330 to 1100) M Ω	41 $\mu\Omega/\Omega$ + 0.001 Ω 32 $\mu\Omega/\Omega$ + 0.002 Ω 30 $\mu\Omega/\Omega$ + 0.02 Ω 30 $\mu\Omega/\Omega$ + 0.2 Ω 36 $\mu\Omega/\Omega$ + 2.3 Ω 78 $\mu\Omega/\Omega$ + 39 Ω 0.014 % + 52 Ω 0.026 % + 2.6 k Ω 0.052 % + 3.2 k Ω 0.31 % + 100 k Ω 1.6 % + 520 k Ω	Fluke 5520A, 4-wire Fluke 5520A, 2-wire
Resistance – Measure	(0.1 to 1) Ω (1 to 1.9) Ω (1.9 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 19) k Ω (19 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 19) M Ω (19 to 100) M Ω	60 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 4.8 $\mu\Omega/\Omega$ 4.8 $\mu\Omega/\Omega$ 4.9 $\mu\Omega/\Omega$ 7.3 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$	Fluke 5700A, Agilent 3458A and 742A series resistors
Resistance ³ – Measure	(0 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) k Ω (10 to 100) k Ω (100 to 1000) k Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	20 $\mu\Omega/\Omega$ + 60 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 58 m Ω 11 $\mu\Omega/\Omega$ + 60 m Ω 12 $\mu\Omega/\Omega$ + 6 m Ω 12 $\mu\Omega/\Omega$ + 60 m Ω 16 $\mu\Omega/\Omega$ + 2.4 Ω 60 $\mu\Omega/\Omega$ + 116 Ω 0.063 % + 1.2 k Ω 0.6 % + 12 k Ω	Agilent 3458A

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
AC Voltage ³ – Generate			
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 (0.5 to 1) MHz	0.14 % + 8.8 μV 0.06 % + 5.4 μV 0.033 % + 5.4 μV 0.063 % + 5.4 μV 0.095 % + 8.5 μV 0.18 % + 14 μV 0.21 % + 27 μV 0.38 % + 27 μV	Fluke 5700A
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 (0.5 to 1) MHz	0.05 % + 10 μV 0.02 % + 10 μV 0.01 % + 7 μV 0.02 % + 8 μV 0.03 % + 11 μV 0.07 % + 19 μV 0.11 % + 37 μV 0.29 % + 41 μV	
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 (0.5 to 1) MHz	0.048 % + 12 μV 0.02 % + 8 μV 59 μV/V + 8 μV 0.01 % + 8 μV 0.022 % + 23 μV 0.039 % + 23 μV 0.09 % + 31 μV 0.27 % + 98 μV	
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 (0.5 to 1) MHz	0.048 % + 78 μV 0.024 % + 23 μV 0.019 % + 5 μV 0.021 % + 16 μV 0.025 % + 62 μV 0.039 % + 120 μV 0.088 % + 0.31 mV 0.18 % + 0.78 mV	
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 (0.5 to 1) MHz	0.047 % + 0.8 mV 0.015 % + 0.25 mV 40 μV/V + 0.07 mV 90 μV/V + 0.17 mV 0.018 % + 0.32 mV 0.045 % + 1.4 mV 0.11 % + 4 mV 0.23 % + 7.1 mV	

Parameter/Range	Frequency	CMC ^{2, 6, 7} (±)	Comments
AC Voltage ³ – Generate (cont)			
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	0.024 % + 4.1 mV 0.016 % + 2.4 mV 0.005 % + 0.9 mV 0.01 % + 0.8 mV 0.027 % + 7.9 mV 0.12 % + 78 mV 0.41 % + 86 mV	Fluke 5700A
750 V	(30 to 50) kHz (50 to 100) kHz	0.03 % + 11 mV 0.11 % + 37 mV	w/ Fluke 5725A
1100 V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	69 µV/V + 4.1 mV 0.01 % + 6.8 mV 0.03 % + 11 mV	w/ Fluke 5725A
AC Voltage ³ – Measure			
(0.01 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	0.035 % + 3.5 µV 0.024 % + 1.3 µV 0.035 % + 1.3 µV 0.12 % + 1.3 µV 0.58 % + 1.3 µV 4.6 % + 2.4 µV	Agilent 3458A opt 002
10 mV 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 (0.3 to 1) MHz (1 to 2) MHz	95 µV/V + 47 µV/V 92 µV/V + 24 µV/V 0.017 % + 24 µV/V 0.035 % + 24 µV/V 0.093 % + 24 µV/V 0.35 % + 0.012 % 1.2 % + 0.012 % 1.8 % + 0.012 %	
(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 (0.3 to 1) MHz	0.024 % + 4.7 mV 0.024 % + 2.3 mV 0.024 % + 2.3 mV 0.041 % + 2.3 mV 0.14 % + 2.3 mV 0.47 % + 12 mV 1.8 % + 12 mV	

Parameter/Range	Frequency	CMC ^{2, 5, 6, 7} (±)	Comments
AC Voltage ³ – Measure (cont) (100 to 707) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 47 mV 0.047 % + 23 mV 0.07 % + 23 mV 0.14 % + 23 mV 0.35 % + 23 mV	Agilent 3458A opt 002
AC High Voltage ³ – Measure (1 to 42) kV	60 Hz	0.32 %	Ross divider and DVM
AC Current ³ – Generate (9 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.06 % + 25 nA 0.031 % + 20 nA 0.012 % + 16 nA 0.05 % + 40 nA 0.14 % + 80 nA	Fluke 5700A/5725A
(29 to 329) µA	(10 to 30) kHz	1.6 % + 0.4 µA	Fluke 5520A
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	0.06 % + 40 nA 0.031 % + 35 nA 0.012 % + 35 nA 0.05 % + 0.4 µA 0.14 % + 0.8 µA	Fluke 5700A/5725A
330 µA to 3.3 mA	(10 to 30) kHz	1.0 % + 0.6 µA	Fluke 5520A
(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	0.06 % + 0.4 µA 0.031 % + 0.35 µA 0.012 % + 0.35 µA 0.05 % + 4 µA 0.14 % + 8 µA	Fluke 5700A/5725A
(3.3 to 33) mA	(10 to 30) kHz	0.4 % + 4 µA	Fluke 5520A
(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	0.06 % + 4 µA 0.031 % + 3.5 µA 0.012 % + 3.5 µA 0.05 % + 40 µA 0.14 % + 80 µA	Fluke 5700A/5725A

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6, 7} (\pm)	Comments
AC Current ³ – Generate (cont)			
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz 5 to 10) kHz	0.04 % + 0.17 mA 0.085 % + 0.38 mA 0.33 % + 0.75 mA	Fluke 5700A/5725A
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.14 % + 5.8 mA 0.18 % + 5.8 mA 3.6 % + 5.8 mA	Fluke 5520A
AC Current ³ – Measure			
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	0.46 % + 0.035 μ A 0.18 % + 0.035 μ A 0.07 % + 0.035 μ A	Agilent 3458A
(0.1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 0.024 μ A 0.18 % + 0.024 μ A 0.07 % + 0.024 μ A 0.036 % + 0.024 μ A	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 0.085 μ A 0.18 % + 0.085 μ A 0.07 % + 0.085 μ A 0.036 % + 0.085 μ A	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 0.82 μ A 0.19 % + 0.82 μ A 0.093 % + 0.82 μ A 0.12 % + 0.82 μ A	
100 mA to 20 A	DC to 5 kHz	0.036 % + 0.14 %*F	w/ Fluke Y5020 shunt
AC Resistance Measuring Equipment –			
0.1 Ω 1 Ω 10 Ω (0.1, 1, 10, 100) k Ω	DC to 1 MHz	1.1 % 0.12 % 0.11 % 0.032 %	16074A AC resistance standards

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Capacitance – Generate, Fixed Points (1, 10,100) pF and 1 nF (10, 100) nF and 1 μF	1 kHz to 13 MHz 120 Hz to 1 kHz	0.036 % 0.037 %	Standard capacitors
Capacitance ³ – Generate, Fixed Points 100 pF to 1.1 μF	1 kHz	0.03 %	GenRad 1423-A capacitance decade
Capacitance ³ – Measure 50 pF to 1 μF	120 Hz, 1 kHz	0.24 % + 0.19 pF	GenRad 1657 RLC Digibridge
Inductance ³ – Measure 10 μH to 10 H	120 Hz, 1 kHz	0.25 %	GenRad 1657 RLC Digibridge
Inductance ³ – Generate Fixed Points 100 μH 10 mH 100 mH 10 H	400 Hz, 1 kHz	0.13 % 0.06 % 0.09 % 0.09 %	Standard inductors

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouples ³ – Generate and Measure			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °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	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.4 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs ³ – Generate			
Pt 385, 100 Ω	(-200 to 0) °C	0.06 °C	Fluke 5520A
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.10 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
Pt 3926, 100 Ω	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
Pt 3916, 100 Ω	(-200 to -190) °C	0.25 °C	Fluke 5520A; 4-wire compensation
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 300) °C	0.07 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
Pt 385, 200 Ω	(-200 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
Pt 385, 500 Ω	(-200 to -80) °C	0.04 °C	
	(-80 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
Pt 385, 1000 Ω	(-200 to 0) °C	0.03 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 400) °C	0.06 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.22 °C	

Parameter/Equipment	Range	CMC ^{2, 6, 7} (±)	Comments
Electrical Calibration of RTDs ³ – Generate (cont)			
Ni 120, 120 Ω	(-80 to 100) °C (100 to 300) °C	0.08 °C 0.14 °C	Fluke 5520A; 4-wire compensation
Cu 427, 10 Ω	(-100 to 260) °C	0.30 °C	
Thermocouple ³ – Indicating Systems & Measure	K, J, T, E, S, R	0.053 % + 0.14 °C	Agilent 3458A w/ Fluke 5520A
Distortion ³	20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.0 dB	Agilent 8903A
Oscilloscopes ³ –			
Risetime	Single Sided	< 300 ps ± 120 ps	Fluke 5520A-SC1100
Bandwidth	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (0.6 to 1.1) GHz	3.5 % + 300 μV 4 % + 300 μV 6 % + 300 μV 7 % + 300 μV	
	(1.1 to 4.2) GHz (4.2 to 18) GHz (18 to 26.5) GHz	0.31 dB 0.74 dB 0.84 dB	Agilent 8340A

IV. Electrical – RF & Microwave

Parameter/Range	Frequency	CMC ² (±)	Comments
Return Loss ³ (VSWR)			Agilent 8902A with:
	5 MHz to 2 GHz	0.62 dB	Wiltron 60NF50
	(2 to 7) GHz	0.64 dB	Wiltron 58A50
	(7 to 11) GHz	0.72 dB	
	(11 to 12.5) GHz	0.82 dB	
	(12.5 to 15) GHz	0.94 dB	
	(15 to 17) GHz	1.3 dB	
	(17 to 18) GHz	1.4 dB	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
Power Meter ³ – Power Reference @ 1 mW	50 MHz	1.9 %	Power transfer using Agilent 432A, 478A-H76
Relative Power ³ – Measure (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB	10 MHz to 26.5 GHz	0.06 dB 0.07 dB 0.07 dB 0.11 dB 0.11 dB 0.12 dB 0.13 dB 0.19 dB 0.19 dB 0.35 dB	Agilent 8902A
Absolute Power ³ – Measure (-70 to -30) dBm (-30 to +10) dBm (+10 to +20) dBm	10 MHz to 18 GHz 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz	2.7 % + <i>M</i> 1.9 % + <i>M</i> 3.1 % + <i>M</i> 2.6 % + <i>M</i> 4 % + <i>M</i> 4.3 % + <i>M</i> 4.3 % + <i>M</i>	Agilent E4418B or 437B: Agilent 8484A, N-type Agilent 8482A, N-type Agilent 8481A, N-type Agilent 8485A, 3.5 mm Agilent 8482A, N-type Agilent 8481A, N-type Agilent 8485A, 3.5 mm
Amplitude Modulation ³ – Carrier: (0.15 to 10) MHz Depth: Up to 99 % Carrier: 10 MHz to 1.3 GHz Depth: Up to 99 %	(20 to 50) Hz 50 Hz to 100 kHz (20 to 50) Hz 50 Hz to 100 kHz	3.5 % 2.5 % 1.4 % 3.5 %	Agilent 8902A
Frequency Modulation ³ – Carrier: 250 kHz to 10 MHz Dev: Up to 40 kHz Carrier: 10 MHz to 1.3 GHz Dev: Up to 400 kHz	20 Hz to 10 kHz (20 to 50) Hz 50 Hz to 100 kHz (100 to 200) kHz	2.5 % 5.9 % 1.4 % 5.9 %	Agilent 8902A

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Phase Modulation ³ –			
Carrier: 150 kHz to 10 MHz	200 Hz to 10 kHz	4.7 %	Agilent 8902A
Carrier: 10 MHz to 1.3 GHz	200 Hz to 20 kHz	3.6 %	

V. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
Hydrometers ³	(0.7 to 1.2) sp. gr. (1.2 to 2.0) sp. gr.	0.0007 sp. gr. 0.0012 sp. gr.	ASTM E126; By comparison using reference hydrometer
Gas Flow ³	(1 to 1000) sccm (1 to 10) slm (10 to 30) slm (30 to 60) slm	0.26 % + 0.02 % of FS 0.26 % + 0.02 % of FS 0.28 % + 0.02 % of FS 0.4 % + 0.03 % of FS	DH Molbloc system
Volume ³	(0 to 4000) mL (4 to 30) L	0.05 mL + 0.6R 0.37 mL + 0.6R	Gravimetric/ electronic balances
Viscosity ³ – Ford, Dip and Other Viscosity Cups	Cup nos. 1 through 5	2.8 %	ASTM D1200-94, D4212-93, ISO-2431

VI. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Mass Measurement ³	(Up to 400) g (400 to 4000) g (4 to 31) kg	0.01 g 0.04 g 0.32 g	Electronic balance, class 6 limited

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Balances ³	1 mg to 7.4 kg 1 mg to 220 g 1 mg to 220 g	2.6 µg/g + 0.6R 5 µg/g + 0.6R 10 µg/g + 0.6R	Handbook 44 w/ Class 1 weights Class 2 weights Class 3 weights
Scales ³	2 mg to 38 kg 0.1 oz to 3700 lb	0.01 % + 0.6R 90 µlb/lb + 0.6R	Class F weights Class 6 weights
Torque ³ – Measuring Equipment Measure	(0.125 to 20) lbf·ft (8 to 250) lbf·ft (250 to 1000) lbf·ft (10 to 100) lbf·in (8 to 100) lbf·ft (80 to 800) lbf·ft	0.031 % + 0.011 lbf·ft 0.031 % + 0.09 lbf·ft 0.03 % + 0.23 lbf·ft 0.29 % 0.24 % 0.23 %	Torque arm and weight set Torque tester
Wheel Load Scales and Dynamometers ³	(2000 to 5000) lbf (5000 to 25 000) lbf	0.34 lbf + 0.6R 1.4 lbf + 0.6R	H-frame with standard load cells
Force ³ – Compression & Tension	(0 to 1400) lbf (1400 to 50 000) lbf	0.025 % 0.031 % of FS	Class 6 weights/DMM Load cells
Pressure Measuring Equipment ³ – Hydraulic Pneumatic	(10 to 10 000) psi (0.3 to 10) psia (10 to 20) psia (20 to 30) psia (30 to 300) psia (300 to 600) psia (600 to 1000) psia (Up to 10) psig (10 to 20) psig (20 to 30) psig (30 to 300) psig (300 to 600) psig (600 to 1000) psig	0.068 % 0.002 psi 0.005 psi 0.007 psi 0.06 psi 0.12 psi 0.20 psi 0.002 psi 0.003 psi 0.004 psi 0.042 psi 0.083 psi 0.15 psi	Dead weight tester DHI PPC2+

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Pressure Measuring Equipment –	(0 to 2) inH ₂ O	0.005 inH ₂ O + 0.6R	Dwyer microtector
Indirect Verification of Rockwell Hardness Testers ³	HRBW: Low Mid High HRC: Low Mid High HREW: Low High HR30N: Low Mid High HR30TW: Low High	0.67 HRBW 0.67 HRBW 0.67 HRBW 0.43 HRC 0.54 HRC 0.53 HRC 0.20 HREW 0.20 HREW 0.2 HR30N 0.5 HR30N 0.3 HR30N 1.2 HR30TW 0.2 HR30TW	ASTM E-18 w/ traceable blocks
Direct Verification of Durometers ³ –			ASTM D2240 using
Spring Force	A, B, O, D, C, DO scales	0.6 points	Shore durocalibrator
Indenter Shape		Pass/Fail	Microscope
Extrusion Plastometer ³ –			ASTM D1238 with:
Piston Diameter	---	69 μin	Micrometer
Cylinder/Bore Dia.	---	120 μin	Micrometer
Timer	---	0.0023 s	Counter
Mass	---	0.04 g	Digital balance
Switch Travel	---	0.0016 in	Caliper
Temperature	< 300 °C	0.028 °C	PRT
	≥ 300 °C	0.037 °C	PRT

VII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Temperature Measuring Equipment ³	-80 °C (-45 to 140) °C (140 to 660) °C	0.15 °C 0.0036 % + 0.014 °C 0.0036 % + 0.044 °C	Hart 5628 w/ 1502 w/ 9107 w/ 9127
Temperature ³ – Measure	(-197 to 660) °C	0.0036 % + 0.012 °C	Hart 5628 w/ 1502
Relative Humidity ³ – Measure	(15 to 95) % RH	1.3 % RH	Thunder 5A-1MP psychrometer

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Frequency Measuring Equipment ³	10 MHz Reference	1.2 parts in 10 ¹⁰ + 0.6 LSD	Rubidium oscillator
	1 MHz to 26.5 GHz	1.2 parts in 10 ¹⁰ + 0.6 LSD	Rubidium oscillator and 3325B or 8340B
Frequency ³ – Measure	1 MHz to 26.5 GHz	1.2 parts in 10 ¹⁰ + 0.6 LSD	Rubidium oscillator locked to 53132A or 53181A

¹ This laboratory offers commercial calibration service and field calibration service.

² “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 of nearly ideal measuring equipment. Best uncertainties represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The CMC of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer’s device, to the environment and to influences from the circumstances of the specific calibration. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC.

- ³ 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 uncertainties achievable on a customer's site can normally be expected to be larger than the Best Measurement Capabilities (BMC) that the accredited laboratory has been assigned as CMC 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 uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC.
- ⁴ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches; D is the numerical value of the nominal diameter of the device measured in inches; R is the numerical value of the resolution of the device in its respective units; F is the frequency in kHz; M is the source of mismatch uncertainty; FS represents “full scale”; and LSD represents “last significant digit”.
- ⁵ In the statement of CMC, percentages are read as percent of reading/output, unless otherwise noted.
- ⁶ The measurands stated are generated with the Fluke 732B, 742A, 5500A and 5700A, series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- ⁷ The measurands stated are measured with the Agilent 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range or floor specification.