



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

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CALIBRATION

Valid To: November 30, 2018

Certificate Number: 4012.01

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 ^{2,4} (±)	Comments
pH – Measuring Equipment ³ , Fixed Points	4 pH 7 pH 10 pH	0.44 % 0.37 % 0.35 %	pH solutions
Conductivity – Measuring Equipment ³ , Fixed Points	25 µS/cm 1015 µS/cm 1408 µS/cm	5.0 % 0.84 % 0.74 %	Conductivity solutions
Gas Detection Equipment ³ –			
Carbon Monoxide Indicators	0.002 % CO 0.01 % CO 0.1 % CO 0.5 % CO	3.0 % 1.3 % 1.3 % 1.3 %	Standard gases
Propane LEL Indicators	50 % LEL	1.7 %	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Gas Detection Equipment ³ – (cont)			
H ₂ S (Hydrogen Sulfide)	0.0025 % H ₂ S	1.5 %	Standard gases
O ₂ (Oxygen)	18 % O ₂	0.62 %	
Isobutylene	0.01 % Isobutylene	1.5 %	
CO ₂	0.5 % CO ₂ 5 % CO ₂	1.4 % 0.82 %	

II. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Micrometers ³	Up to 27 in (27 to 48) in	(48 + 4.6L) μin (550 + 2.7L) μin	Gage blocks
Calipers ³	Up to 40 in	(580 + 1.7L) μin	Gage blocks
Flatness ³	Up to 40 in	15 μin	Optical Flats
Parallelism ³	Up to 1 in	15 μin	Optical Flats
Ring Gages –			
Plain Ring Gages	Up to 16 in	(14 + 4.6L) μin	Fowler Labconcept
Threaded Ring Gages	Up to 6 in	(22 + 4.7L) μin	Using set plugs
Plug Gages –			
Plain Plugs	Up to 16 in	(14 + 4.6L) μin	Fowler Labconcept
Threaded Plugs (OD)	Up to 6 in	(15 + 3.7L) μin	Fowler Labconcept
Threaded Plugs (PD)	Up to 6 in	(19 + 3.4L) μin	Lab concept measurement over wires



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Surface Plates, Granite ³ – Flatness	Up to (24 × 24) in	95 μin	Repeat-o-meter
	Up to (72 × 144) in	97 μin	Planekator
Coating Thickness Gages ³ – Eddy Current & Magnetic Induction, Fixed Point	Up to 3000 μm	(14 + 4.5L) μm	Coating thickness standards
Dial Indicator ³	Up to 4 in	67 μin	Fowler labconcept

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
DC Voltage – Generate ³	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	7.5 μV/V + 0.4 μV 5 μV/V + 0.7 μV 3.5 μV/V + 2.5 μV 3.5 μV/V + 4 μV 5 μV/V + 40 μV 6.5 μV/V + 400 μV	Fluke 5730A-03
	1 V 1.018 V 10 V 100 V 1000 V	1.2 μV 1.2 μV 5.6 μV 5.6 μV/V 5.6 μV/V	Fluke 732A, 752A, 8508A, 5730A
DC Voltage – Measure ³	Up to 200 mV 200 mV to 20 V (20 to 200) V (200 to 1000) V	5 μV/V + 0.5 μV 3.5 μV/V + 0.2 μV 5.5 μV/V + 0.2 μV 5.5 μV/V + 0.5 μV	Fluke 8508A opt 001
	1 V 1.018 V 10 V 100 V 1000 V	1.2 μV 1.2 μV 5.6 μV 5.6 μV/V 5.6 μV/V	Fluke 732A, 752A, 8508A, 5730A

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
DC High Voltage – Measure ³	Up to 40 kV	2 %	Fluke 80k40HV probe
DC Current – Generate ³	0.1 nA to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 µA/A + 6 nA 35 µA/A + 7 nA 35 µA/A + 40 nA 45 µA/A + 0.7 µA 80 µA/A + 12 µA	Fluke 5730A-03
	(2.2 to 3) A (3 to 11) A (11 to 20.5) A (20 to 100) A (20 to 1000) A	0.038 % + 40 µA 0.050 % + 500 µA 0.1 % + 750 µA 0.04 % of Rdg 0.5 % + 0.5 A	Fluke 5520A SC1100 SR-100/ Fluke 8508A Fluke 5520A w/ COIL
	8 A	0.01%	G&H OL 83A
DC Current – Measure ³	Up to 2 mA (2 to 20) mA	12 µA/A + 2 µA 14 µA/A + 2 µA	Fluke 8508A opt 001
	(20 to 100) mA 100 mA to 1 A (1 to 15) A (15 to 100) A	8.5 µA/A 8.5 µA/A + 6 µA 40 µA/A + 8 µA 0.040 % + 24 µA	Fluke 8508A opt 001 w/ Shunts
Resistance – Measure ³	Up to 2 Ω (2 to 20) Ω 20 Ω to 200 kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ	17 µΩ/Ω + 2 µΩ 9.5 µΩ/Ω + 0.7 µΩ 8 µΩ/Ω + 0.25 µΩ 9 µΩ/Ω + 0.5 µΩ 20 µΩ/Ω + 5 µΩ 0.012 %+ 50 µΩ 0.15 % + 2 µΩ	Fluke 8508A opt 001



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Resistance ³ – Generate	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ 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 (330 to 1100) MΩ	40 μΩ/Ω + 0.001 Ω 30 μΩ/Ω + 0.0015 Ω 28 μΩ/Ω + 0.0014 Ω 28 μΩ/Ω + 0.002 Ω 28 μΩ/Ω + 0.002 Ω 28 μΩ/Ω + 0.02 Ω 28 μΩ/Ω + 0.02 Ω 28 μΩ/Ω + 0.2 Ω 28 μΩ/Ω + 0.2 Ω 32 μΩ/Ω + 2 Ω 32 μΩ/Ω + 2 Ω 60 μΩ/Ω + 30 Ω 0.013 % + 50 Ω 0.025 % + 2.5 kΩ 0.050 % + 3 kΩ 0.3 % + 100 kΩ 1.5 % + 500 kΩ	Fluke 5520A SC1100
	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 μΩ 95 μΩ/Ω 95 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 6.5 μΩ/Ω 6.5 μΩ/Ω 6.5 μΩ/Ω 6.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 13 μΩ/Ω 18 μΩ/Ω 40 μΩ/Ω 47 μΩ/Ω 100 μΩ/Ω	Fluke 5730-03
	1 Ω 10 kΩ	7.1 μΩ/Ω 4.3 μΩ/Ω	Fluke 742A-1 Fluke 742A-10k
High Resistance – Generate ³	1 MΩ to 1GΩ (1 to 100) GΩ	0.2 % 1 %	Biddle 72-6346-1 decade resistor
	1 GΩ	11 μΩ/Ω	Fluke 8508A-7000k



Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Capacitance – Generate ³	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	0.5 % + 0.01 nF 0.25 % + 0.01 nF 0.25 % + 0.1 nF 0.25 % + 0.3 nF 0.25 % + 1 nF 0.25 % + 3 nF 0.25 % + 10 nF 0.4 % + 30 nF 0.45 % + 100 nF 0.45 % + 300 nF 0.45 % + 1 μF 0.45 % + 3 μF 0.45 % + 10 μF 0.75 % + 30 μF 1.1 % + 100 μF	Fluke 5520A SC1100
Capacitance – Measure ³			
12 Hz to 100 kHz	400 pF to 25 μF (25 to 100) μF	0.02 % + 1 digit 0.05 % + 1 digit	Genrad 1689 RLC Digibridge – The CMC is only valid at 1 kHz – The CMC is only valid at 50 Hz
12 Hz to 100 kHz	(100 to 500) μF (0.5 to 1) mF	0.05 % + 1 digit 0.09 % + 1 digit	
Inductance – Measure ³			
12 Hz to 100 kHz	1 mH to 10 H	0.02 % + 1 digit	Genrad 1689 RLC Digibridge – The CMC is only valid at 1 kHz



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Generate ³			
Up 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 (0.5 to 1) MHz	0.024 % + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 0.020 % + 4 μV 0.050 % + 5 μV 0.11 % + 10 μV 0.14 % + 20 μV 0.27 % + 20 μV	Fluke 5730A-03
(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 (0.5 to 1) MHz	0.024 % + 12 μV 90 μV/V + 7 μV 57 μV/V + 7 μV 0.012 % + 7 μV 0.031 % + 17 μV 0.065 % + 20 μV 0.14 % + 25 μV 0.27 % + 45 μV	
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 (0.5 to 1) MHz	0.024 % + 40 μV 90 μV/V + 15 μV 42 μV/V + 8 μV 67 μV/V + 10 μV 85 μV/V + 30 μV 0.034 % + 80 μV 0.10 % + 200 μV 0.17 % + 300 μV	
(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 (0.5 to 1) MHz	0.024 % + 400 μV 90 μV/V + 150 μV 42 μV/V + 50 μV 67 μV/V + 100 μV 83 μV/V + 200 μV 0.025 % + 600 μV 0.10 % + 2000 μV 0.15 % + 3200 μV	
(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 (0.5 to 1) MHz	0.024 % + 4 mV 90 μV/V + 1.5 mV 52 μV/V + 0.6 mV 80 μV/V + 1 mV 0.015 % + 2.5 mV 0.090 % + 16 mV 0.44 % + 40 mV 0.80 % + 80 mV	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Generate ³ (cont)			
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.030 % + 16 mV 70 μV/V + 3.5 mV	Fluke 5730A-03
(220 to 330) V	(1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.020 % + 6 mV 0.025 % + 6 mV 0.030 % + 6 mV 0.2 % + 50 mV	Fluke 5520A SC1100
(330 to 1020) V	(1 to 5) kHz (5 to 10) kHz	0.025 % + 10 mV 0.030 % + 10 mV	
AC Voltage - Source Wideband Amplitude ³			
30 Hz to 500 kHz	300 μV to 1.1 mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV 330 mV to 1.1 V (1.1 to 3.5) V	0.8 % + 2 μV 0.7 % + 3 μV 0.7 % + 8 μV 0.6 % + 16 μV 0.6 % + 40 μV 0.5 % + 0.10 mV 0.5 % + 0.4 mV 0.4 % + 0.5 mV	Fluke 5730A-03
AC Voltage - Source Wideband Flatness ³			
Up to 1.1 mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.3 % 0.12 % 0.11 % 0.11 % 0.11 % 0.24 % + 3 μV 0.23 % + 3 μV 0.41 % + 3 μV 0.62 % + 3 μV 0.17 % + 15 μV	Fluke 5730A-03



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage - Source Wideband Flatness ³ (cont)			
(1.1 to 3) mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz	0.3 % 0.11 % 0.11 % 0.11 % 0.11 % 0.11 % + 3 μV 0.12 % + 3 μV 0.33 % + 3 μV 0.53 % + 3 μV	Fluke 5730A-03
(3 to 3.5) mV	(10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz	0.31 % 0.11 % 0.11 % 0.11 % 0.11 % 0.11 % + 3 μV 0.11 % + 3 μV 0.24 % + 3 μV 0.49 % + 3 μV	
AC Voltage ³ – Measure			
Up to 220 mV	(1 to 10) Hz	0.017 % + 70 μV	Fluke 8508A opt 001
220 mV to 220 V	(1 to 10) Hz	0.015 % + 60 μV	
(220 to 1000) V	(1 to 10) Hz	0.015 % + 70 μV	
600 μV 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	0.17 % + 1.3 μV 0.074 % + 1.3 μV 0.042 % + 1.3 μV 0.081 % + 2 μV 0.12 % + 2.5 μV 0.23 % + 4 μV 0.24 % + 8 μV 0.35 % + 8 μV	Fluke 5790A-03
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μV 0.07 % + 1 μV 0.17 % + 1 μV 0.3 % + 1 μV 0.7 % + 2 μV	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Measure (cont)			
(2.2 to 7) 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	0.085 % + 1.3 μV 0.037 % + 1.3 μV 0.021 % + 1.3 μV 0.04 % + 2 μV 0.06 % + 2.5 μV 0.12 % + 4 μV 0.13 % + 8 μV 0.23 % + 8 μV	Fluke 5790A-03
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % + 1 μV 0.07 % + 1 μV 0.1 % + 1 μV 0.17 % + 1 μV 0.37 % + 1 μV	
(7 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	0.029 % + 1.3 μV 0.019 % + 1.3 μV 0.011 % + 1.3 μV 0.021 % + 2 μV 0.031 % + 2.5 μV 0.081 % + 4 μV 0.089 % + 8 μV 0.17 % + 8 μV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.07 % 0.07 % 0.1 % 0.17 % 0.37 %	
(22 to 70) 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	0.024 % + 1.5 μV 0.012 % + 1.5 μV 65 μV/V + 1.5 μV 0.013 % + 2 μV 0.026 % + 2.5 μV 0.051 % + 4 μV 0.067 % + 8 μV 0.11 % + 8 μV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Measure (cont)			
(70 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	0.021 % + 1.5 μV 85 μV/V + 1.5 μV 38 μV/V + 1.5 μV 69 μV/V + 2 μV 0.016 % + 2.5 μV 0.025 % + 4 μV 0.038 % + 8 μV 0.1 % + 8 μV	Fluke 5790A-03
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	
(220 to 700) 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	0.021 % + 1.5 μV 76 μV/V + 1.5 μV 33 μV/V + 1.5 μV 51 μV/V + 2 μV 79 μV/V + 2.5 μV 0.018 % + 4 μV 0.03 % + 8 μV 0.096 % + 8 μV	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	
700 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	0.02 % 66 μV/V 24 μV/V 46 μV/V 71 μV/V 0.016 % 0.026 % 0.09 %	
Wideband Flatness – 500 kHz to 30 MHz (Relative to 1 kHz)	500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % 0.05 % 0.1 % 0.15 % 0.35 %	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Measure (cont)			
(7 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	0.02 % 67 μV/V 27 μV/V 48 μV/V 81 μV/V 0.019 % 0.04 % 0.12 %	Fluke 5790A-03
(22 to 70) 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	0.02 % 68 μV/V 32 μV/V 57 μV/V 94 μV/V 0.02 % 0.041 % 0.12 %	
(70 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	0.02 % 68 μV/V 31 μV/V 69 μV/V 98 μV/V 0.021 % 0.05 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 99 μV/V 41 μV/V 0.013 % 0.05 %	
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.02 % 99 μV/V 38 μV/V 0.013 % 0.05 %	



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Current ³ – Generate			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 16 nA 0.016 % + 10 nA 0.010 % + 8 nA 0.028 % + 12 nA 0.11 % + 65 nA	Fluke 5730A-03
(0.22 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	0.025 % + 40 nA 0.016 % + 35 nA 0.010 % + 35 nA 0.020 % + 110 nA 0.11 % + 650 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	0.025 % + 400 nA 0.016 % + 350 nA 0.010 % + 350 nA 0.020 % + 550 nA 0.11 % + 5000 nA	
(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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.010 % + 2.5 µA 0.020 % + 3.5 µA 0.11 % + 10 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 35 µA 0.045 % + 80 µA 0.70 % + 160 µA	
(2.2 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 100 µA 0.06 % + 100 µA 0.6 % + 1 mA 2.5 % + 5 mA	
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.06 % + 2 mA 0.1 % + 2 mA 3 % + 2 mA	Fluke 5520A SC 1100
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3 % + 5 mA	
(20 to 1000) A (20 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.28 % + 0.09 A 0.79 % + 0.1 A	Fluke 5520A/COIL 50 turn coil



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Phase – Generate ³ 0° to 180°	(10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.1 ° 0.25 ° 0.5 ° 2.5 ° 5 ° 10 °	Fluke 5520A SC 1100
Phase – Measure 0° to 360° Sine Wave 10 mV to 350 V 10 mV to 12.5 V 12.5 V to 350 V	(5 to 10) Hz 10 Hz to 50 kHz (50 to 100) kHz 10 Hz to 10 kHz	230 m° 51 m° 230 m° 51 m°	Clarke-Hess Model 6000
AC Current ³ – Measure Up to 200 µA 200 µA to 20 mA (20 to 200) mA 200 mA to 2 A (2 to 20) A (1 to 10) mA (10 to 30) mA	1 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz 10 Hz to 2 kHz (2 to 10) kHz 5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.031 % + 100 µA/A 0.071 % + 100 µA/A 0.4 % + 100 µA/A 0.031 % + 100 µA/A 0.030 % + 100 µA/A 0.071 % + 100 µA/A 0.4 % + 100 µA/A 0.031 % + 100 µA/A 0.029 % + 100 µA/A 0.063 % + 100 µA /A 0.062 % + 100 µA/A 0.074 % + 100 µA/A 0.3 % + 100 µA/A 0.082 % + 100 µA/A 0.25 % + 100 µA/A 0.002 % 0.003 % 0.004 % 0.006 % 0.002 % 0.003 % 0.005 % 0.007 %	Fluke 8508A opt 001 5790A w/ A40 Shunts



Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Current ³ – Measure (cont)			
(30 to 300) mA	5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.003 % 0.004 % 0.007 % 0.010 %	5790A w/ A40 Shunts
300 mA to 3 A	5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz	0.004 % 0.007 % 0.013 % 0.024 %	
(3 to 10) A	5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz	0.005 % 0.008 % 0.014 %	
(3 to 10) A	5 Hz to 400 Hz 400 Hz to 20 kHz 20 kHz to 50 kHz	0.007 % 0.012 % 0.018 %	
Oscilloscopes ³ –			
Amplitude DC			
DC Signal 50 Ohm Load	(0 to ± 6.6) V	0.25 % + 40 μV	Fluke 5520A SC1100
1 M Ohm Load	(0 to ± 130) V	0.05 % + 40 μV	
Amplitude-Square Wave (Peak to Peak)			
50 Ohm Load	± 1 mV to ± 6.6 V	0.25 % + 40 μV	
1 M Ohm Load	± 1 mV to ± 130 V	0.1 % + 40 μV	
Time Marker (into 50 Ohm)	5 s to 50 ms 20 ms to 1 ns	(25 + 1000t) μs/s 2.5 μs/s	t = time in Seconds
Edge Spec (Rise Time)	≤ 10 MHz	300 ps	
Bandwidth c Leveled Sine Wave			
(into 50 Ohm Load)	50 kHz reference	2 % + 300 μV	Fluke 5520A SC1100
5 mV to 5.5 V	50 kHz to 100 MHz (100 to 300) MHz	3.5 % + 300 μV 4 % + 300 μV	



Parameter/Equipment	Range	CMC ² (±)	Comments
Pulse Characterization –			
Rise Time – Generate	1 kHz to 2 MHz Nominal 250 ps	300 ps	Fluke 5520A SC1100
	2 MHz to 10 MHz Nominal 250 ps	300 ps	
Rise Time – Measure	30 ps to 1 µs	21 ps	CSA803C w/ SD-26
Electrical Calibration of Thermocouple Indicating Devices ³ –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A SC1100
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	
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	
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	



Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices ³ – (cont)			
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	Fluke 5520A SC1100
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	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	



Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTD Indicators ³ –			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C	Fluke 5520A SC1100
Pt 385, 200 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.04 °C 0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.14 °C 0.16 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.05 °C 0.06 °C 0.08 °C 0.08 °C 0.09 °C 0.11 °C	
Pt 385, 1000 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.03 °C 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.07 °C 0.23 °C	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of RTD Indicators ³ – (cont)			
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.23 °C	Fluke 5520A SC1100
Pt 3926, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C	
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.08 °C 0.14 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.3 °C	
Vibration – Measure			
Voltage Sensitivity @ 100 Hz	10 mV/g	2.0 %	Dytran Instruments 3120B
Frequency Response	(20 to 100) Hz (100 to 2500) Hz (2500 to 10 000) Hz	1.6 % 1.4 % 2.8 %	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
RF Absolute Power ³ – Measure			
-65 to -35 dBm	1mW Reference	0.38 %	HP 8478B Sensor w/ HP 432A Power Meter
	≥ 0.01 to ≤ 0.03 GHz	2.8 %	
	> 0.03 to ≤ 4.00 GHz	1.9 %	HP 8484A sensor w/ Agilent E4419B Power Meter
	> 4.00 to ≤ 8.00 GHz	2.4 %	
	> 8.00 to ≤ 10.00 GHz	2.5 %	
	> 10.00 to ≤ 13.00 GHz	3.0 %	
	> 13.00 to ≤ 15.00 GHz	3.5 %	
	> 15.00 to ≤ 18.00 GHz	3.8 %	
-35 to + 20 dBm	DC to ≤ 0.1 GHz	0.044 dB	
	> 0.1 to ≤ 2.4 GHz	0.052 dB	Rhode & Schwarz NRP-Z55 w/ Fluke 96270A
	> 2.4 to ≤ 8 GHz	0.057 dB	
	> 8 to ≤ 12.4 GHz	0.066 dB	
	> 12.4 to ≤ 18 GHz	0.084 dB	
	> 18 to ≤ 26.5 GHz	0.088 dB	
	> 26.5 to ≤ 33 GHz	0.10 dB	
	> 33 to ≤ 40 GHz	0.110 dB	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Tuned RF Power, Absolute – Measure			
2.5 MHz to 26.5 GHz	(+10 to 0) dBm (0 to -10) dBm (-10 to -40) dBm (-40 to -50) dBm (-50 to -80) dBm (-80 to -90) dBm (-90 to 110) dBm (-110 to -127) dBm	0.3 dB 0.3 dB 0.31 dB 0.33 dB 0.34 dB 0.37 dB 0.39 dB 0.54 dB	HP 8902A w/ HP 11722A, 11792A, and 11793A
Amplitude Modulation – Measure			
(0.15 to 10) MHz	Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	2 % + 1 digit	HP 8902A w/ HP 11722A, 11792A, and 11793A
	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	
(10 to 1300) MHz	Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 %	1 % + 1 digit	
	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	
(1.3 to 26.5) GHz	Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	1.5 % + 1 digit	
10 MHz to 26.5 GHz	Rate: 20 Hz to 10 kHz, Depth: to 99 %	3 % + 1 digit	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Frequency Modulation – Measure			
(0.25 to 10) MHz	Rate: 20 Hz to 10 kHz, Dev: ≤ 40 kHz pk	2 % + 1 digit	HP 8902A w/ HP 11722A, 11792A, and 11793A
10 MHz to 1.3 GHz	Rate: 50 Hz to 100 kHz, Dev: ≤ 400 kHz pk	1 % + 1 digit	
10 MHz to 26.5 GHz	Rate: 20 Hz to 200 kHz, Dev: ≤ 400 kHz pk	5 % + 1 digit	
	Rate: 50 Hz to 100 kHz, Dev: ≤ 400 kHz pk	1 % + 1 digit	
	Rate: 20 Hz to 200 kHz, Dev: ≤ 400 kHz pk	5 % + 1 digit	
Phase Modulation – Measure			
150 kHz to 10 MHz	200 Hz to 10 kHz Rate	4 % + 1 digit	HP 8902A w/ HP 11722A, 11792A, and 11793A
10 MHz to 26.5 GHz	200 Hz to 20 kHz Rate	3 % + 1 digit	
Power – Range Accuracy	3 μW to 100 mW	0.29 %	HP 11683A
Distortion – Measure			
(-80 to 0) dB (-65 to 0) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	HP 8903B
RF Amplitude Frequency Response – Measure			
	9.00 kHz to 2.90 GHz (2.90 to 6.46) GHz (6.46 to 13.00) GHz (13.00 to 19.70) GHz (19.70 to 22.00) GHz	1.0 dB 1.5 dB 2.0 dB 3.0 dB 3.0 dB	HP 8562A



Parameter/Range	Frequency	CMC ² (±)	Comments
VSWR – Measure	(0.01 to 18.0) GHz	0.09 dB	VSWR of 1 to 1.4 Giga-tronics 8003 with 80501
Absolute Power Measure – Swept Mode	(0.01 to 1.0) GHz (1.0 to 2.0) GHz (2.0 to 4.0) GHz (4.0 to 6.0) GHz (6.0 to 8.0) GHz (8.0 to 12.4) GHz (12.4 to 18.0) GHz	0.082 dB 0.089 dB 0.096 dB 0.1 dB 0.11 dB 0.13 dB 0.14 dB	Giga-tronics 8003 with 80301A or 80302A and 80501
Levelled Sine Wave Output – Absolute Amplitude Accuracy			
Level (dBm) (> + 20 to + 24) dBm	10 Hz to 100 kHz > 100 kHz to 128 MHz	0.03 dB 0.05 dB	Fluke 96270A with 96040A-50
(> + 14 to + 20) dBm	10 Hz to 100 kHz > 100 kHz to 128 MHz (> 128 to 300) MHz > 300 MHz to 1.4 GHz	0.03 dB 0.05 dB 0.07 dB 0.2 dB	
(- 17 to + 14) dBm	10 Hz to 100 kHz > 100 kHz to 128 MHz (> 128 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 4) GHz	0.03 dB 0.05 dB 0.07 dB 0.2 dB 0.3 dB	
(- 48 to - 17) dBm	10 Hz to 100 kHz > 100 kHz to 128 MHz (> 128 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 3) GHz > (3 to 4) GHz	0.03 dB 0.05 dB 0.07 dB 0.2 dB 0.3 dB 0.5 dB	
(> - 74 to < - 48) dBm	100 kHz to < 10MHz (10 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 4) GHz	0.2 dB 0.1 dB 0.4 dB 0.5 dB	



Parameter/Range	Frequency	CMC ² (±)	Comments
Levelled Sine Wave Output - Absolute Amplitude Accuracy			
(> - 84 to - 74) dBm	100 kHz to < 10MHz (10 to 128) MHz (> 128 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 4) GHz	0.5 dB 0.1 dB 0.3 dB 0.5 dB 1 dB	Fluke 96270A with 96040A-50
(> - 94 to - 84) dBm	100 kHz to < 10MHz (10 to 128) MHz (> 128 to 300) MHz > 300 MHz to 3 GHz	0.5 dB 0.3 dB 0.5 dB 1 dB	
(- 130 to - 94) dBm	(10 to 128) MHz (> 128 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 3) GHz	0.3 dB 0.5 dB 0.5 dB 1.0 dB	
(> + 14 to + 18) dBm	10 Hz to 125 MHz	0.12 dB	Fluke 96270A with 96040A-75
(> + 8 to + 14) dBm	10 Hz to 125 MHz (> 125 to 300) MHz > 300 MHz to 1.4 GHz	0.12 dB 0.15 dB 0.25 dB	
(- 23 to + 8) dBm	10 Hz to 125 MHz (> 125 to 300) MHz > 300 MHz to 1.4 GHz > (1.4 to 3) GHz > (3 to 4) GHz	0.12 dB 0.15 dB 0.25 dB 0.3 dB 0.5 dB	
(- 54 to < - 23) dBm	10 Hz to 125 MHz (> 125 to 300) MHz > 300 MHz to 4 GHz	0.15 dB 0.2 dB 0.5 dB	
(> - 80 to < - 54) dBm	> 100 kHz to 300 MHz > 300 MHz to 4 GHz	0.2 dB 0.5 dB	
(> - 90 to - 80) dBm	> 100 kHz to 300 MHz > 300 MHz to 4 GHz	0.7 dB 1 dB	
(> - 100 to - 90) dBm	> 100 kHz to 300 MHz > 300 MHz to 3 GHz	0.7 dB 1 dB	
(- 120 to - 100) dBm	10 MHz to 3 GHz	1.5 dB	

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Calibration Factor Microwave Splitter / Sensor	100 MHz 1 GHz; 2.4 GHz 8 GHz 12 GHz 18 GHz 22 GHz; 26.5 GHz	1.1 % 1.4 % 2.2 % 2.3 % 2.9 % 3.5 %	Fluke 96270A with Rohde & Schwarz NRP-Z55 (x2), Agilent 11667B & Sucoflex 102EA
Power Flatness Microwave Splitter / Sensor	> 1 kHz to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 12.4) GHz (> 12.4 to 18) GHz (>18 to 26.5) GHz	0.05 dB 0.07 dB 0.1 dB 0.13 dB 0.16 dB	Fluke 96270A with Rohde & Schwarz NRP-Z55 (x2), Agilent 11667B & Sucoflex 102EA
Voltage Flatness Microwave Splitter / Sensor			
VSWR = 1.0	> 1 kHz to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 8) GHz (> 8 to 12.4) GHz (> 12.4 to 18) GHz (>18 to 26.5) GHz	0.53 % 0.7 % 1.1 % 1.2 % 1.5 % 1.7 %	Fluke 96270A with Rohde & Schwarz NRP-Z55 (x2), Agilent 11667B & Sucoflex 102EA
VSWR = 1.2	> 1 kHz to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 8) GHz (> 8 to 12.4) GHz (> 12.4 to 18) GHz (>18 to 26.5) GHz	1.4 % 1.5 % 1.8 % 1.8 % 2 % 2.2 %	
VSWR = 1.6	> 1 kHz to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 8) GHz (> 8 to 12.4) GHz (> 12.4 to 18) GHz (>18 to 26.5) GHz	3.4 % 3.4 % 3.5 % 3.5 % 3.6 % 3.8 %	

IV. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Air/Nitrogen Flow ³	Up to 100 SLM	0.73 %	CME FCS Laminar Flow Elements
Liquid Flow	Up to 250 GPM	0.33 %	FT-32 turbine flow system
Air Velocity – Measuring Equipment	Up to 5800 ft/min	1.8 %	Alnor RVA801 with Wind Tunnel

V. Mechanical

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Pressure and Vacuum Gauges – Pneumatic Gauge	-30 inHg to 1000 psig	0.02 % of Autoranged Span	DHI PPC4EX-7M
Pressure and Vacuum Gauges – Pneumatic - Absolute	(0 to 1000) psia	0.02 % of Autoranged Span + 0.007 psi	DHI PPC4EX-7M
Pneumatic	(0.2 to 718) psia/psig	0.003% of Indicated Value	Ruska 2465
Hydraulic	(100 to 50 000) psig	0.008 % of Indicated Value	DHI 5306



Parameter/Equipment	Range	CMC ² (±)	Comments
Pressure and Vacuum Gauges ³ – Hydraulic & Pneumatic (On-Site)	(0 to 900) mmHg (15 to 30) psig (30 to 300) psig (300 to 500) psig (500 to 3000) psig (3000 to 10 000) psig	0.23 mmHg 0.015 psig 0.15 psig 0.13 psig 1.5 psig 8 psig	Fluke PPH Calibrator
Sound – Generate @ 1 kHz	110 dB	0.42 dB	SPL Calibrator
<p>Scales and Balances³ –</p> <p>Metric</p> <p>Up to 20 g Up to 200 g</p> <p>Up to 1000 g Up to 5000 g Up to 10 000 g Up to 50 000 g</p> <p>English</p> <p>Up to 10 lb Up to 25 lb Up to 50 lb Up to 150 lb Up to 250 lb Up to 500 lb</p>		<p>0.024 mg 0.17 mg</p> <p>2.7 mg 8.7 mg 23 mg 1.4 g</p> <p>0.0012 lb 0.002 lb 0.009 lb 0.023 lb 0.065 lb 0.13 lb</p>	<p>ASTM Class 1 weights</p> <p>ASTM Class 2 weights</p> <p>ASTM Class F weights</p>
<p>Force³ – Measuring Equipment</p> <p>Compression</p> <p>(0 to 500) lb (500 to 5000) lb (5000 to 20 000) lb</p> <p>Tension</p> <p>(0 to 500) lb (500 to 5000) lb (5000 to 10 000) lb (10 000 to 20 000) lb (20 000 to 100 000) lb</p>		<p>0.13 lb 2.4 lb 9.1 lb</p> <p>0.13 lb 2.4 lb 6.0 lb 9.1 lb 42 lb</p>	<p>ASTM class F weights South Ocean MS-1 Transcell BSS-20K</p> <p>ASTM class F weights South Ocean MS-1 Transcell BSS-10K Transcell BSS-20K Rinstrum TLWS-100K</p>



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Optical Rotational Speed, RPM ³ – Measure & Generate	(1 to 100 000) rpm	0.014 RPM	Agilent 33250A
Rotational Speed, RPM ³ – Measure & Generate	(0 to 5500) rpm	0.015 % + 0.6R	Quantum Dynamics N-11-FCS/3
Torque Transducers	20 in·ozf to 100 in·lbf 100 in·lbf to 125 ft·lbf (125 to 2000) ft·lbf	0.04 % 0.06 % 0.08 %	Various torque arms and weights
Torque Devices	2 in·ozf to 2000 ft·lbf	± 0.1 % i. v.	AKO TSD2050 Torque Master

VI. Optical Quantities

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Illuminance – Lux meters	423 to 15k Lux	1.8 %	FEL 1000W lamp with PSU

VI. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Relative Humidity – Measure & Measuring Equipment	(10 to 90) % RH	1.3 % RH	Vaisala HMI-41 w/HMP-46
Temperature ³ – Measure	-196 °C to 0 °C 0 °C to 100 °C 100 °C to 420 °C 420 °C to 960 °C	0.042 °C 0.042 °C 0.060 °C 0.064 °C	Hart Scientific 1521 w/5618B / 5627A Hart Scientific 1523 w/5624



Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Infrared Devices ³	Ambient to 212 °F (212 to 572) °F (572 to 932) °F	0.92 °C 1.2 °C 1.5 °C	Fluke 9132 $\epsilon = 0.95$ $\lambda = (8 \text{ to } 14) \mu\text{m}$

VII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency ³ – Measuring Equipment	1 mHz to 27 GHz	0.05 $\mu\text{Hz}/\text{Hz}$	Fluke 96270A
Frequency ³ – Measure	1 Hz to 160 MHz 40 MHz to 1.3 GHz	3.2 $\mu\text{Hz}/\text{Hz}$ 5.9 $\mu\text{Hz}/\text{Hz}$	Racal Dana 1992
	10 Hz to 26.5 GHz	0.05 $\mu\text{Hz}/\text{Hz} + 1 \text{ count}$	HP 5343A

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

² 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.

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 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.

⁴ In the statement of CMC, R is the resolution of the unit under test, L is the numerical value of the nominal length of the device measured in inches. In the statement of the CMC, percent is defined as percent of reading.

⁵ 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

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Chesapeake, VA

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 the requirements of ANSI/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 and 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 28th day of November 2016.

A handwritten signature in black ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 4012.01
Valid to November 30, 2018

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