SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: December 31, 2025 Certificate Number: 5825.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1, 6]:

I. Dimensional

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Dial/Cylinder Gauge Testers	Up to 25 mm (25 to 100) mm	0.21 µm 0.25 µm	Gauge blocks, electronic micrometers
End Bars	Up to 500 mm (500 to 1000) mm	$\sqrt{(0.15\mu m)^2 + (1.9 \times 10^{-6} \times l_0)^2}$ $\sqrt{(0.16\mu m)^2 + (1.8 \times 10^{-6} \times l_0)^2}$	Gauge blocks, electronic micrometers
Extensometers, Linear Displacement Transducers[3]	Up to 50 mm (50 to 100) mm (100 to 1000) mm	$\sqrt{(0.14\mu m)^2 + (1.7 \times 10^{-6} \times l_0)^2}$ $\sqrt{(0.79\mu m)^2 + (1.8 \times 10^{-6} \times l_0)^2}$ $\sqrt{(7.9\mu m)^2 + (1.8 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Filler Gauge[3]	(0.01 to 5) mm	0.34 µm	Bench comparators, ULM

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Gauge Blocks	(0.5 to 100) mm	$\sqrt{(71\text{nm})^2 + (1.3 \times 10^{-6} \times l_0)^2}$	Gauge block comparators, gauge blocks
Height Gauges/Measuring Machines[3]	Up to 1000 mm	$\sqrt{(1.2\mu\text{m})^2 + (3.0 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Standard Measuring Machines[3]	Up to 500 mm	$\sqrt{(0.25\mu\text{m})^2 + (2.2 \times 10^{-6} \times l_0)^2}$	Gauge blocks, long gauge blocks
Electronic Micrometers	Up to 0.02 mm (0.02 to 0.2) mm (0.2 to 2) mm	0.08 µm 0.16 µm 0.78 µm	Gauge blocks
Height Micrometers – Blocks Head Riser Blocks	 Up to 610 mm Up to 30 mm Up to 600 mm	 $\sqrt{(1.2\mu\text{m})^2 + (2.8 \times 10^{-6} \times l_0)^2}$ $\sqrt{(1.3\mu\text{m})^2 + (2.8 \times 10^{-6} \times l_0)^2}$ $\sqrt{(1.2\mu\text{m})^2 + (2.8 \times 10^{-6} \times l_0)^2}$	Gauge blocks, long gauge blocks, electronic micrometers, surface plate
Laser Scan Micrometers[3]	(0.1 to 55) mm	0.56 µm	Pin gauge
Standard Tape Rules, Peripheral Gauges	Up to 10 m (10 to 20) m (20 to 30) m (30 to 40) m (40 to 50) m	0.20 mm 0.24 mm 0.32 mm 0.42 mm 0.54 mm	Calibration system

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Cylindrical Plug/Pin Gauges, Thread Measuring Wire Gauges	(0.1 to 100) mm	$\sqrt{(0.29\mu m)^2 + (2.8 \times 10^{-6} \times l_0)^2}$	Standard measuring machines
Radius Gauges	Up to 50 mm	3.0 µm	Profile projectors
Cylindrical Ring Gauges	(1 to 100) mm	$\sqrt{(0.77\mu m)^2 + (3.0 \times 10^{-6} \times l_0)^2}$	Standard measuring machines, standard ring gauges
Step Gauges	Up to 1000 mm	$\sqrt{(1.6\mu m)^2 + (4.2 \times 10^{-6} \times l_0)^2}$	Gauge blocks, electronic micrometers
Taper Thickness Gauges	(0.1 to 60) mm	0.03 mm	Profile projectors
Ultrasonic Thickness Gauges[3]	Up to 100 mm	2.5 µm	Ultrasonic thickness specimens, surface plate
Ultrasonic/Coating Thickness Specimens – Coating Ultrasonic	 Up to 8 mm Up to 100 mm	 1.4 µm $\sqrt{(1.4\mu m)^2 + (1.8 \times 10^{-6} \times l_0)^2}$	Gauge blocks, standard measuring machines, electronic micrometers
Coating Thickness Testers[3]	Up to 0.25 mm (0.25 to 1.05) mm (1.05 to 7.9) mm	1.5 µm 2.0 µm 6.9 µm	Coating thickness specimens

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Torque Arms –			
Torque Arm	Up to 500 mm	$\sqrt{(4.0\mu m)^2 + (1.8 \times 10^{-6} \times l_0)^2}$	Contact coordinate measuring machines
Wire	Up to 5 mm	0.9 µm	Standard measuring machines
Bevel Protractors –			
Angle Accuracy	Up to 90° (90 to 360)°	1.3′ 2.0′	Angle gauge blocks, precision surface plates, profile projectors
Angle of Accessories	Up to 360°	2.3′	
Plate/Square/Electric Levels –			
Angle	± 200″ ± 1000″ ± 2000″	0.3″ 0.5″ 0.9″	Fine angle generators, electronic micrometers, squareness testers, precision surface plates
Squareness	Up to 300 mm	2.3 µm	
Flatness	300 mm × 60 mm	1.0 µm	
Precisions Squares –			
Squareness	Up to 450 mm	$\sqrt{(2.0\mu m)^2 + (3.0 \times 10^{-6} \times l_0)^2}$	Cylindrical square, squareness master, precision squares
Parallelism	Up to 450 mm	1.2 µm	
Straightness	Up to 450 mm	2.9 µm	

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Form Testers[3] –			
Z-Axis	Up to 60 mm	0.15 µm	Standard scales
X-Axis	Up to 200 mm	$\sqrt{(0.57\mu m)^2 + (1.9 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Angle	Up to 120°	1.3′	Angle gauge blocks
Optical Flats	∅ (10 to 130) mm	0.06 µm	Optical flats, Monochromatic light sources
Optical Parallels –			
Flatness	∅ (10 to 30) mm	0.059 µm	Optical flats, monochromatic light sources, gauge block comparators
Parallelism	∅ (10 to 30) mm	0.080 µm	
Parallel blocks –			
Parallelism	Up to 1000 mm	1.2 µm	Electronic micrometers, surface plate
Flatness	Up to 1000 mm	1.2 µm	
Difference of Blocks	Up to 1000 mm	1.8 µm	
Precision Surface Plates[3] – Flatless Only			
Area	Up to 2500 cm^2 (2500 to 5000) cm^2 (5000 to 10 000) cm^2 (10 000 to 15 000) cm^2 (15 000 to 30 000) cm^2 (30 000 to 60 000) cm^2	1.0 µm 1.2 µm 1.4 µm 1.6 µm 2.2 µm 2.8 µm	Electric levels

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Roundness Measurement Instruments[3] –			
Accuracy of Detector	Up to 1000 µm	0.23 µm	Roundness standard specimens, cylindrical squares, optical flats
Rotation Accuracy of Circumference Direction	Up to 360°	16 nm	
Rotation Accuracy of Shaft Direction	Up to 360°	16 nm	
Straightness	Up to 300 mm	1.3 µm	
Straight Rules	Up to 3000 mm	$\sqrt{(0.32\mu m)^2 + (2.2 \times 10^{-6} \times l_0)^2}$	Tape measure calibration system
Contact Coordinate Measuring Machines[3] –			
Accuracy	Up to 600 mm	$\sqrt{(0.53\mu m)^2 + (2.0 \times 10^{-6} \times l_0)^2}$	Step gauges, precision squares, straight edges
Straightness	Up to 600 mm	2.1 µm	
Squareness (Deviation from 90°)	Up to 600 mm	1.1″	
Non-Contact Coordinate Measuring Machines[3] –			
Accuracy	Up to 1000 mm	$\sqrt{(0.43\mu m)^2 + (2.8 \times 10^{-6} \times l_0)^2}$	Standard scales

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Measuring Microscopes, Profile Projectors[3] –			
Length Accuracy	Up to 300 mm	$\sqrt{(0.45\mu m)^2 + (2.8 \times 10^{-6} \times l_0)^2}$	Standard scales, precision squares
Right Angle Accuracy	Up to 360°	1.7′	
Magnification Accuracy	×2 to ×100	3.3×10^{-4}	
Squareness Accuracy	Up to 300 mm	3.6 µm	
Micro Measuring Microscopes[3]	Up to 50 mm	2.7 µm	Standard scales
Thread Plug Gauges –			
External Diameter Effective Diameter Pitch Half Angle	Up to 100 mm Up to 100 mm (0.2 to 6) mm Up to 45°	0.48 µm 1.6 µm 1.2 µm 1.8′	Standard measuring machines, thread measuring wires, profile projectors
V-blocks, Box blocks –			
Flatness Parallelism Gradient Mutual Difference Squareness	Up to 150 mm Up to 150 mm Up to 150 mm Up to 150 mm Up to 150 mm	1.0 µm 1.2 µm 0.6 µm 0.9 µm $\sqrt{(2.0\mu m)^2 + (3.0 \times 10^{-6} \times l_0)^2}$	Pin gauges, test bars, precision surface plates, electronic micrometers, squareness tester
Inside/Outside/Gear Tooth Calipers, Caliper Gauges[3]	Up to 150 mm (150 to 1500) mm	$\sqrt{(3.8\mu m)^2 + (6.4 \times 10^{-6} \times l_0)^2}$ $\sqrt{(7.6\mu m)^2 + (6.8 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Cylinder Gauges/Bore Gauges[3] –			
Cylinder Gauges Bore Gauges	Up to 800 mm (0.5 to 18.5) mm	0.79 µm 0.80 µm	Dial gauge testers, gauge blocks

Parameter/Equipment	Range	CMC[2, 9] (±)	Comments
Depth Gauges and Depth Micrometers[3]	Up to 300 mm (300 to 1000) mm	$\sqrt{(1.0\ \mu m)^2 + (4.0 \times 10^{-6} \times l_0)^2}$ $\sqrt{(7.1\ \mu m)^2 + (4.1 \times 10^{-6} \times l_0)^2}$	Gauge blocks, precision surface plates
Dial/Digital Gauges[3]	Up to 50 mm (50 to 150) mm	$\sqrt{(1.6\mu m)^2 + (2.0 \times 10^{-6} \times l_0)^2}$ $\sqrt{(0.94\mu m)^2 + (2.3 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Micro Indicators, Test Indicators[3]	Up to 2 mm	0.33 µm	Dial gauge testers
Micrometer Heads	Up to 50 mm	0.61 µm	Gauge blocks, electronic micrometers
3-Point Micrometers	(1 to 200) mm	3.2 µm	Standard ring gauges, precision surface plates
Inside Micrometers[3]	(5 to 300) mm (300 to 1500) mm	$\sqrt{(1.6\mu m)^2 + (4.9 \times 10^{-6} \times l_0)^2}$ $\sqrt{(2.3\mu m)^2 + (4.2 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Outside Micrometers[3]	Up to 25 mm (25 to 500) mm (500 to 1500) mm	$\sqrt{(0.36\mu m)^2 + (4.2 \times 10^{-6} \times l_0)^2}$ $\sqrt{(1.6\mu m)^2 + (4.0 \times 10^{-6} \times l_0)^2}$ $\sqrt{(2.5\mu m)^2 + (4.0 \times 10^{-6} \times l_0)^2}$	Gauge blocks
Standard Sieves – Wire Rod Diameter Sieve Opening	 (0.01 to 8) mm (0.01 to 125) mm	 1.7 µm 2.6 µm	Profile projectors

Parameter/Equipment	Range	CMC[2] (±)	Comments
Welding Gauges –			
Height/Depth Measuring Scale	Up to 100 mm	0.009 mm	Profile projectors
Thick Measuring Scale	Up to 16 mm	0.009 mm	
Rule Measuring Scale	Up to 50 mm	0.096 mm	
Angle Measuring Scale	Up to 90°	0.13°	
Taper Measuring Scale	Up to 7 mm	0.096 mm	

II. Dimensional Testing/Calibration[10]

Parameter	Range	CMC[2, 9]	Comments
Length[10]	Up to 500 mm	$\sqrt{(2.0\ \mu m)^2 + (18 \times 10^{-6} \times l_0)^2}$	Contact coordinate measuring machines
Angle[10]	Up to 360°	2.2′	Profile projector

III. Mechanical

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electric Balances[3]	Up to 2 g (2 to 5) g (5 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g (0.5 to 1) kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 30) kg (30 to 50) kg (50 to 100) kg (100 to 200) kg (200 to 300) kg (300 to 600) kg	0.031 mg 0.047 mg 0.046 mg 0.12 mg 0.12 mg 0.15 mg 3.4 mg 3.5 mg 3.6 mg 2.9 mg 5.9 mg 22 mg 0.82 g 1.5 g 3.2 g 5.4 g 11 g	Standard weights
Platform Scale Balances[3]	Up to 20 kg (20 to 200) kg	1.2 g 58 g	Standard weights
Spring Scale Balances[3]	Up to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 30) kg (30 to 50) kg	2.9 g 5.8 g 12 g 29 g 58 g 0.12 kg	Standard weights

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Weights, F1 Class	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg	0.0030 mg 0.0022 mg 0.0022 mg 0.0029 mg 0.0047 mg 0.0041 mg 0.0055 mg 0.0079 mg 0.0084 mg 0.010 mg 0.013 mg 0.018 mg 0.025 mg 0.033 mg 0.061 mg 0.12 mg 0.22 mg 0.57 mg 1.2 mg 2.3 mg 6.1 mg 12 mg 26 mg	Standard weights, electric balance
Mass – Measure	Up to 50 mg (50 to 500) mg (0.5 to 5) g (5 to 50) g (50 to 100) g (100 to 200) g (200 g to 500) g (0.5 to 1) kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 26) kg (26 to 35) kg	0.006 mg 0.009 mg 0.017 mg 0.036 mg 0.055 mg 0.10 mg 0.29 mg 0.54 mg 1.0 mg 2.8 mg 5.4 mg 10 mg 13 mg 88 mg	Standard weights, electric balance
Force – Measuring Equipment	(10 to 500) N (0.5 to 5) kN (5 to 10) kN (10 to 20) kN (20 to 50) kN (50 to 100) kN	0.15 % 0.0031 % 0.028 % 0.046 % 0.039 % 0.034 %	Weight set, deadweight force standards, hydraulic force standards

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Force – Measure[3]			
Compression	10 N to 1000 kN	0.21 %	Electric force gauge
Tension	50 N to 100 kN	0.20 %	
Push-Pull Gauges	(0.2 to 50) N (50 to 1000) N (1000 to 2000) N (2000 to 5000) N	0.15 % 0.17 % 0.23 % 0.18 %	Deadweight force standards, weights
Torque – Measuring Equipment	(0.005 to 100) N·m	0.71 %	Weights, torque arms
Torque – Measure[3]			
Clockwise	(0.06 to 0.6) N·m (0.6 to 1) N·m (1 to 2.5) N·m (2.5 to 5) N·m (5 to 10) N·m (10 to 25) N·m (25 to 50) N·m (50 to 100) N·m (100 to 250) N·m (250 to 500) N·m (500 to 1000) N·m (1000 to 2000) N·m	1.4 % 1.0 % 0.81 % 0.47 % 0.70 % 0.47 % 0.39 % 0.58 % 0.45 % 0.18 % 0.69 % 0.75 %	Torque testers
Counterclockwise	(0.06 to 0.6) N·m (0.6 to 1) N·m (1 to 2.5) N·m (2.5 to 5) N·m (5 to 10) N·m (10 to 25) N·m (25 to 50) N·m (50 to 100) N·m (100 to 250) N·m (250 to 500) N·m (500 to 1000) N·m (1000 to 2000) N·m	1.2 % 0.65 % 0.87 % 0.51 % 0.54 % 0.53 % 0.47 % 0.67 % 0.57 % 0.37 % 0.55 % 0.89 %	

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Absolute Pressure Gauges	(5 kPa to 7 MPa) abs	0.057 %	Pressure controllers
Compound Pressure Gauges[3]	(-95 to 7000) kPa	|0.049 %| + 0.35 kPa	Pressure calibrators
Pneumatic Differential Pressure Gauges[3]	Up to 7 MPa	|0.052 %| + 0.36 kPa	Pressure calibrators
Gauge Pressure Gauges[3] –			
Gauge Pressure Gauges	Up to 500 kPa (0.5 to 10) MPa (10 to 40) MPa (40 to 100) MPa (100 to 200) MPa	|0.054 %| + 0.015 kPa 0.019 % 0.071 % 0.014 % 0.070 %	Pressure calibrators, pneumatic pressure balance, hydraulic pressure balance
Pressure Recorders	Up to 500 kPa (0.5 to 10) MPa (10 to 40) MPa (40 to 100) MPa (100 to 200) MPa	|3.0 %| + 1.0 kPa 1.2 % 1.5 % 1.2 % 0.59 %	
Pressure Transducers / Transmitters[3] –	(-95 to 0) kPa (0 to 500) kPa (0.5 to 10) MPa (10 to 100) MPa	|0.27 %| + 0.14 kPa |0.31 %| + 0.14 kPa 0.34 % 0.31 %	Pressure calibrators, dead weight testers
Pressure Transducers / Transmitters	(100 to 200) MPa 5 kPa abs to 7 MPa abs	0.26 % 0.30 %	
Dial Type Vacuum Gauges[3]	(-95 to 0) kPa	| 1 %| + 0.10 kPa	Pressure calibrators

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Pressure – Measure and Measuring Equipment			
Gauge Pressure[3]	Up to 500 kPa (0.5 to 10) MPa (10 to 40) MPa	|0.036 %| + 0.018 kPa 0.013 % 0.071 %	Pressure calibrators, dead weight testers
Gauge Pressure	(40 to 200) MPa	0.069 %	
Absolute Pressure	(5 to 200) kPa abs. (200 to 7000) kPa abs.	0.080 % 0.045 %	
Vacuum – Measure and Measuring Equipment[3]	(-95 to 0) kPa	|0.051 %| + 0.0051 kPa	Pressure calibrators

IV. Fluid Quantities

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Flow Velocity	(0.1 to 2) m/s (2 to 55) m/s	8.1 % 0.53 %	ILA / LDV SONDE FP50US
Gas Flow Rate	(0.0018 to 260) m^3/h	0.25 %	Sonic nozzle
Liquid Flow Rate	(0.005 to 50) m^3/h	0.24 %	Reference flowmeter

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Air Particle Counter –			
Laser Reference Voltage	(0 to 10) V	5.4 mV	Agilent 34401A TSI 4043H
Flow Rate	(1 to 100) L/min	2.5 %	
Threshold Voltage	(0 to 10) V	5.4 mV	Agilent 34401A
Counting Efficiency[3]			
CPC	(0 to 1.0) µm	3.0 %	TSI 3068B
OPC	(0.1 to 1.0) µm	4.7 %	TSI 3772, PMS LASAIRII-110, CRM standard size particles
Liquid Particle Counter –			
Laser Reference Voltage	(0 to 10) V	5.4 mV	Agilent 34401A, Matheson FM-1050, Matheson FM1050S-V, PMS / FC-100CRM standard size particles
Flow Rate	(10 to 25) mL/min (25 to 300) mL/min	8.1 % 5.0 %	
Threshold Voltage	(0 to 10) V	5.4 mV	Agilent 34401A,
Particle Dilution Systems –			
PCRF (Particle Concentration Reduction Factor)	(30 to 100) nm	8.3 %	TSI 3776, 3772 AVL LIST GmbH AVL499 APG
Dynamic Viscometers	(2.5 to 200 000) mPa·s	1.7 %	Polyscience / AD29VB3S-A13K Wika / CTR2000 viscosity standard

Parameter/Equipment	Range	CMC[2, 4, 7] (±)	Comments
Volumetric Glass Wares	(0.1 to 2) ml (2 to 10) ml (10 to 25) ml (25 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1000) ml (1000 to 2000) ml (2000 to 5000) ml	3.0 µl 9.7 µl 0.024 ml 0.087 ml 0.21 ml 0.42 ml 0.84 ml 1.7 ml 4.2 ml	Standard weights, electric balance pure water, digital thermometer
Pycnometers	Up to 50 ml (50 to 100) ml (100 to 500) ml	0.042 ml 0.083 ml 0.41 ml	Standard weights, electric balance pure water, digital thermometer
Piston Type Volume Meters	(0.1 to 5) µl (5 to 10) µl (10 to 20) µl (20 to 50) µl (50 to 100) µl (0.1 to 0.2) ml (0.2 to 0.5) ml (0.5 to 1) ml (1 to 2) ml (2 to 5) ml (5 to 10) ml (10 to 20) ml	0.065 µl 0.067 µl 0.072 µl 0.096 µl 0.13 µl 0.24 µl 0.53 µl 1.2 µl 2.3 µl 5.3 µl 0.012 ml 0.023 ml	Standard weights, electric balance pure water, digital thermometer
Volume – Measure	(0.1 to 2) ml (2 to 10) ml (10 to 25) ml (25 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1000) ml (1000 to 2000) ml (2000 to 5000) ml	3.0 µl 9.7 µl 0.024 ml 0.087 ml 0.21 ml 0.42 ml 0.84 ml 1.7 ml 4.2 ml	Standard weights, electric balance pure water, digital thermometer

V. Time & Frequency

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Timebase Frequency	100 kHz to 10 MHz	1.1×10^{-12} Hz/Hz	Odetics 425-311 HP 53132A
Frequency – Generate[3]	1 Hz to 40 GHz	9.7×10^{-10} Hz/Hz	Odetics 425-311 Agilent 33250A Agilent E8257D
Frequency – Measure[3]	1 Hz (1 to 100) Hz 100 Hz to 100 kHz 100 kHz to 3 GHz (3 to 40) GHz	72 µHz 7.9×10^{-6} Hz/Hz 6.7×10^{-7} Hz/Hz 6.7×10^{-9} Hz/Hz 1.5 Hz	Odetics 425-311 HP 53132A HP 53152A
Stopwatch	Day (86 400 s) Month (25 921 000 s)	6.6 ms 0.67 s	Witschi Analyser Q1
Timers[3]	(1 to 10 000) s	88 ms	HP 5334B, Agilent 33250A
Rotational Speed – Standard RPM Generators[3] Standard RPM	 (1 to 1000) rpm (1000 to 100 000) rpm	 0.088 rpm 0.90 rpm	 Odetics 425-311, H.P 53132A, Kriss-P03A
Rotational Speed – Standard RPM Generators[3] Standard RPM	 (1 to 60) rpm (60 to 900) rpm (900 to 99 000) rpm	 0.089 rpm 0.15 rpm 1.5 rpm	 TESTO 470

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Contact Type Tachometers –			
Contact RPM	(1 to 4000) rpm	0.11 rpm	Odetics 425-311, Kriss P01C
Photo Type Tachometers –			
Photo RPM	(1 to 600) rpm (600 to 100 000) rpm	0.090 rpm 0.90 rpm	Odetics 425-311, Keysight 33210A, Kriss-P02A

VI. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Voltage – Generate[3]	0 mV (0.1 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V (1 to 2) kV (2 to 100) kV	0.50 µV 14 µV/V 6.7 µV/V 4.6 µV/V 4.4 µV/V 8.1 µV/V 0.082 % 0.067 %	Fluke 5730A Spellman SL100P300 /SIC/220, Hipotronics KVM-200D, Fluke 8508A
DC Voltage – Measure[3]	0 mV (0 to 10) mV (10 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV (1 to 2) kV (2 to 4) kV (4 to 100) kV	0.12 µV 15 µV/V 4.9 µV/V 3.9 µV/V 3.7 µV/V 5.3 µV/V 5.5 µV/V 0.068 % 0.063 % 0.062 %	Fluke 8508A Hipotronics KVM-200D, Fluke 8508A
Meter Calibrators	100 mV 100 mV to 1 kV	0.33 µV 2.5 µV/V	Fluke 732B, Fluke 752A, Fluke 8508A
DC Standards	1.018 V 10 V	2.6 µV 26 µV	Fluke 732B, Fluke 8508A

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Voltage – Generate[3]			
1 mV	10 Hz 10 Hz to 100 kHz 100 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	3.5 µV 0.13 % 0.58 % 0.82 % 1.1 % 3.5 %	Fluke 5730A, Fluke 5725A, NI Pxi-5122
(1 to 10) mV	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 2 MHz (2 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	7.7 µV 0.076 % 0.058 % 0.057 % 0.072 % 0.12 % 0.16 % 0.27 % 0.27 % 0.51 % 1.3 %	
(10 to 100) mV	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz 200 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	42 µV 0.043 % 0.019 % 0.016 % 0.023 % 0.057 % 0.11 % 0.13 % 0.24 % 0.48 % 1.2 %	
100 mV to 1 V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 2 MHz	0.33 mV 0.033 % 0.013 % 62 µV/V 94 µV/V 0.014 % 0.049 % 0.14 % 0.12 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Voltage – Generate (cont)[3]			
100 mV to 1 V	(2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.24 % 0.48 % 1.2 %	Fluke 5730A, Fluke 5725A, NI Pxi-5122
(1 to 3) V	10 Hz 10 Hz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	10 mV 0.12 % 0.24 % 0.48 % 1.2 %	
(3 to 10) V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	3.3 mV 0.033 % 0.013 % 58 µV/V 94 µV/V 0.013 % 0.039 % 0.14 % 0.22 %	
(10 to 100) V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	34 mV 0.033 % 0.013 % 72 µV/V 0.011 % 0.022 %	
(100 to 1000) V	40 Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.37 V 87 µV/V 0.021 % 0.073 %	
(50 to 60) Hz	(1 to 2) kV (2 to 4) kV (4 to 8) kV (8 to 10) kV (10 to 20) kV (20 to 30) kV (30 to 60) kV (60 to 70) kV	7.9 % 4.4 % 2.7 % 2.4 % 1.7 % 1.4 % 1.3 % 1.4 %	Phenix 6CP120/60-7.5

Parameter/Range	Frequency	CMC[2, 4, 5, 8] (±)	Comments
AC Voltage – Measure[3]			
1 mV	10 Hz (10 to 20) Hz 20 Hz to 100 kHz 100 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 40) MHz (40 to 50) MHz	1.3 µV 0.13 % 0.065 % 0.20 % 0.32 % 0.59 % 1.1 % 1.5 % 1.5 %	Fluke 5790B
(1 to 10) mV	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz 50 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 40) MHz (40 to 50) MHz	4.9 µV 0.049 % 0.038 % 0.029 % 0.037 % 0.054 % 0.083 % 0.12 % 0.21 % 0.45 % 0.72 % 0.73 %	
(10 to 100) mV	10 Hz (10 to 20) Hz (20 to 40) Hz 40 to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 40) MHz (40 to 50) MHz	27 µV 0.027% 0.012 % 63 µV/V 64 µV/V 0.022 % 0.034 % 0.035 % 0.047 % 0.060 % 0.12 % 0.19 % 0.43 % 0.72 % 0.73 %	
100 mV to 1 V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz	0.24 mV 0.024 % 77 µV/V 29 µV/V 54 µV/V	

Parameter/Range	Frequency	CMC[2, 4, 5, 8] (±)	Comments
AC Voltage – Measure (cont)[3]			
100 mV to 1 V	(50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 40) MHz (40 to 50) MHz	84 µV/V 0.019 % 0.031 % 0.059 % 0.12 % 0.19 % 0.43 % 0.71 % 0.72 %	Fluke 5790B
(1 to 3) V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 40) MHz (40 to 50) MHz	0.70 mV 0.024 % 78 µV/V 33 µV/V 57 µV/V 95 µV/V 0.023 % 0.047 % 0.059 % 0.12 % 0.19 % 0.43 % 0.71 % 0.72 %	
(3 to 10) V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	2.4 mV 0.024 % 78 µV/V 33 µV/V 57 µV/V 95 µV/V 0.023 % 0.047 % 0.15 %	
(10 to 100) V	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	24 mV 0.024 % 80 µV/V 37 µV/V 38 µV/V 81 µV/V 0.012 %	

Parameter/Range	Frequency	CMC[2, 4, 5, 8] (±)	Comments
AC Voltage – Measure (cont)[3]			
(100 to 700) V	40 Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	30 mV 43 µV/V 0.013 % 0.050 %	Fluke 5790B
(700 to 1 000) V	40 Hz 40 Hz to 20 kHz (20 to 30) kHz	70 mV 47 µV/V 0.016 %	
(50 to 60) Hz	(1 to 2) kV (2 to 4) kV (4 to 8) kV (8 to 10) kV (10 to 20) kV (20 to 40) kV (40 to 75) kV	0.89 % 0.51 % 0.41 % 0.36 % 0.33 % 0.31 % 0.30 %	Vitrek 4700

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Current – Generate[3]	0 µA (0 to 10) µA (10 to 200) µA 200 µA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A (20 to 100) A (100 to 200) A (200 to 500) A (500 to 750) A 750 A to 1 kA (1 to 1.5) kA (1.5 to 2) kA (2 to 2.5) kA	7.0 nA 0.074 % 85 µA/A 46 µA/A 44 µA/A 60 µA/A 0.011 % 0.016 % 0.016 % 0.043 % 0.031 % 0.083 % 0.090 % 0.061 % 0.052 % 0.038 %	Fluke 5730A Fluke 52120A Fluke 25 Turn 3000A Current Coil

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Current – Measure[3]	10 pA (10 to 100) pA (0.1 to 1) nA (1 to 100) nA (0.1to 1) µA 1 µA (1 to 10) µA (10 to 100) µA (100 to 200) µA (0.2 to 1) mA (1 to 2) mA (2 to 10) mA (10 to 20) mA (20 to 200) mA (0.2 to 1) A (1 to 15) A (15 to 20) A (20 to 50) A (50 to 100) A (100 to 200) A (200 to 1000) A (1000 to 1500) A	0.12 pA 1.2 % 0.27 % 0.24 % 0.015 % 65 pA 8.9 µA/A 8.5 µA/A 7.9 µA/A 11 µA/A 9.5 µA/A 29 µA/A 17 µA/A 10 µA/A 25 µA/A 24 µA/A 28 µA/A 48 µA/A 47 µA/A 0.020 % 0.018 % 0.023 %	Keithley 6517A HP 3458A Fluke 8508A Fluke 742A series, Guildline 9230A Series, Fluke 355

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Generate[3]			
20 µA	1 kHz (1 to 10) kHz	13 nA 0.55 %	Fluke 5730A, Fluke 52120A
(20 to 200) µA	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	77 nA 0.039 % 0.025 % 0.017 % 0.041 % 0.17 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Generate (cont)[3]			
200 µA to 2 mA	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.64 nA 0.032 % 0.021 % 0.015 % 0.031 % 0.17 %	Fluke 5730A, Fluke 52120A
(2 to 20) mA	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	6.4 µA 0.032 % 0.021 % 0.015 % 0.028 % 0.16 %	
(20 to 200) mA	10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	64 µA 0.032 % 0.021 % 0.014 % 0.027 % 0.14 %	
200 mA to 2 A	10 Hz 10 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.69 mA 0.035 % 0.10 % 0.85 %	
(2 to 4) A	10 Hz (10 to 50) Hz (50 to 57) Hz (57 to 60) Hz (60 to 300) Hz (300 to 400) Hz 400 Hz to 1 kHz (1 to 3) kHz (3 to 5) kHz (5 to 10) kHz	3.6 mA 0.090 % 0.090 % 0.090 % 0.11 % 0.19 % 0.19 % 0.60 % 1.6 % 4.3 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Generate (cont)[3]			
(4 to 10) A	10 Hz (10 to 50) Hz (50 to 57) Hz (57 to 60) Hz (60 to 300) Hz (300 to 400) Hz 400 Hz to 1 kHz (1 to 3) kHz (3 to 5) kHz (5 to 10) kHz	8.9 mA 0.089 % 0.089 % 0.089 % 0.11 % 0.19 % 0.19 % 0.58 % 1.7 % 4.2 %	Fluke 5730A, Fluke 52120A
(10 to 20) A	10 Hz (10 to 50) Hz (50 to 57) Hz (57 to 60) Hz (60 to 300) Hz (300 to 400) Hz 400 Hz to 1 kHz (1 to 3) kHz (3 to 5) kHz (5 to 10) kHz	18 mA 0.090 % 0.090 % 0.090 % 0.11 % 0.19 % 0.19 % 0.60 % 1.7 % 4.2 %	
(20 to 60) A	10 Hz (10 to 50) Hz (50 to 57) Hz (57 to 60) Hz (60 to 300) Hz (300 to 400) Hz 400 Hz to 1 kHz (1 to 3) kHz (3 to 6) kHz (6 to 10) kHz	27 mA 0.045 % 0.045 % 0.045 % 0.072 % 0.23 % 0.23 % 0.65 % 1.8 % 5.5 %	
(60 to 120) A	10 Hz (10 to 50) Hz (50 to 57) Hz (57 to 60) Hz (60 to 300) Hz (300 to 400) Hz 400 Hz to 1 kHz (1 to 3) kHz (3 to 6) kHz (6 to 10) kHz	53 mA 0.044 % 0.044 % 0.044 % 0.072 % 0.23 % 0.23 % 0.64 % 1.8 % 5.4 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Generate (cont)[3]			
(120 to 200) A (200 to 300) A (300 to 400) A (400 to 500) A (500 to 750) A (750 to 900) A 900 A to 1 kA (1 to 1.5) kA (1.5 to 2) kA (2 to 2.5) kA (2.5 to 3) kA	60 Hz	0.041 % 0.030 % 0.025 % 0.022 % 0.019 % 0.019 % 0.097 % 0.066 % 0.051 % 0.047 % 0.036 %	Fluke 25 turn 3000A current coil
AC Current – Measure[3]			
10 µA	10 Hz 10 Hz to 10 kHz	5.6 nA 0.035 %	Fluke 5790B, Fluke A40B series
(10 to 100) µA	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	29 nA 0.010 % 0.012 %	
(0.1 to 0.4) mA	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.11 µA 85 µA/A 0.010 %	
(0.4 to 0.8) mA	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.20 µA 79 µA/A 0.010 %	
(0.8 to 1) mA	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.24 µA 74 µA/A 94 µA/A	
(1 to 4) mA	10 Hz 10 Hz to 10 kHz	1.0 µA 60 µA/A	
(4 to 8) mA	10 Hz 10 Hz to 10 kHz	2.0 µA 68 µA/A	
(8 to 10) mA	10 Hz 10 Hz to 10 kHz	2.4 µA 61 µA/A	
(10 to 40) mA	10 Hz 10 Hz to 10 kHz	10 µA 69 µA/A	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Measure (cont)[3]			
(40 to 80) mA	10 Hz 10 Hz to 10 kHz	20 µA 65 µA/A	Fluke 5790B, Fluke A40B series
(80 to 100) mA	10 Hz 10 Hz to 10 kHz	24 µA 58 µA/A	
(0.1 to 0.4) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.10 mA 74 µA/A 75 µA/A	
(0.4 to 0.8) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.20 mA 69 µA/A 71 µA/A	
(0.8 to 1) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	0.24 mA 62 µA/A 64 µA/A	
(1 to 4) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	1.1 mA 92 µA/A 0.013 %	
(4 to 8) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	2.1 mA 88 µA/A 0.014 %	
(8 to 10) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	2.5 mA 83 µA/A 0.013 %	
(10 to 15) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	4.0 mA 0.011 % 0.012 %	
(15 to 20) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	5.0 mA 0.010 % 0.012 %	
(20 to 40) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	11 mA 0.013 % 0.017 %	
(40 to 50) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	13 mA 0.012 % 0.017 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Current – Measure (cont)[3]			
(50 to 80) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	23 mA 0.015 % 0.020 %	Fluke 5790B, Fluke A40B series
(80 to 100) A	10 Hz 10 Hz to 1 kHz (1 to 10) kHz	28 mA 0.014 % 0.020 %	
(100 to 300) A (300 to 1000) A (1000 to 1400) A	(50 to 60) Hz	4.3 % 2.4 % 3.0 %	Fluke 355

Parameter/Equipment	Range	CMC[2, 4, 5, 8] (±)	Comments
DC Power – Generate[3]	0.1 W (0.1 to 0.5) W (0.5 to 0.6) W (0.6 to 1) W (1 to 1.2) W (1.2 to 2.4) W (2.4 to 3) W (3 to 4.8) W (4.8 to 5) W (5 to 6) W (6 to 12) W (12 to 24) W (24 to 30) W (30 to 50) W (50 to 60) W (60 to 100) W (100 to 120) W (120 to 240) W (240 to 300) W (300 to 500) W (500 to 600) W (600 to 1000) W (1 to 1.2) kW (1.2 to 2.4) kW (2.4 to 4.8) kW (4.8 to 5) kW (5 to 6) kW	0.16 mW 0.038 % 0.029 % 0.017 % 0.014 % 0.0075 % 0.0084 % 0.0044 % 0.0074 % 0.0067 % 0.0077 % 0.0063 % 0.0042 % 0.0050 % 0.0040 % 0.0071 % 0.0066 % 0.0056 % 0.0057 % 0.0066 % 0.0059 % 0.0065 % 0.0075 % 0.0067 % 0.0053 % 0.0048 % 0.0079 %	Fluke 5522A, Clarke-hess 8100

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Power – Generate (cont)[3]	(6 to 9.6) kW (9.6 to 10) kW (10 to 12) kW (12 to 24) kW (24 to 30) kW (30 to 60) kW (60 to 120) kW (120 to 240) kW (240 to 500) kW	0.0054 % 0.0070 % 0.010 % 0.0079 % 0.015 % 0.014 % 0.015 % 0.014 % 0.013 %	Fluke 5522A, Clarke-hess 8100 Fluke 25 turn 3000A current coil
AC Power – Generate[3]			
Power			
(50 to 60) Hz	0.06 W (0.06 to 0.12) W (0.12 to 0.24) W (0.24 to 0.48) W (0.48 to 0.6) W (0.6 to 1.2) W (1.2 to 6) W (6 to 12) W (12 to 60) W (60 to 120) W (120 to 600) W (600 to 1 200) W (1.2 to 9.6) kW (9.6 to 19.2) kW (19.2 to 60) kW (60 to 120) kW (120 to 240) kW	0.071 mW 0.060 % 0.035 % 0.028 % 0.017 % 0.024 % 0.015 % 0.015 % 0.013 % 0.015 % 0.013 % 0.015 % 0.024 % 0.024 % 0.014 % 0.015 % 0.015 %	Fluke 6105A, Fluke 25 turn 3000A current coil
Power Factor			
(50 to 60) Hz	(-1 to 1) PF	0.000 16 PF	Fluke 6105A
Harmonic			
(50 to 60) Hz	THD-V (0.5 to 20) % THD-I (0.5 to 20) %	0.024 % 0.022 %	Fluke 6105A

Parameter/Equipment	Range	CMC[2, 4, 5, 8] (±)	Comments
AC Power – Generate (cont)			
Flicker			
P_{st} (1 to 4000) cpm	1	0.39 %	Fluke 6105A N4L PPA5511
$P_{inst\cdot max}$			
Sinusoidal			
1	(0.5 to 25) Hz	0.38 %	
1	(25 to 33.333) Hz	0.39 %	
Square			
1	(0.5 to 28) Hz	0.40 %	
1	(28 to 30.5) Hz	1.1 %	
1	(30.5 to 33.333) Hz	0.40 %	
P_{st} Range			
1620 cpm	0.25	0.39 %	
	0.25 to 5	0.40 %	
AC Power – Measure[3]			
Power			
(50 to 60) Hz	(0.12) W	0.35 mW	ZES Zimmer LMG670
	(0.12 to 0.48) W	0.16 %	
	(0.48 to 2.4) W	0.075 %	
	(2.4 to 24) W	0.11 %	
	(24 to 240) W	0.092 %	
	(240 to 600) W	0.077 %	
	(600 to 1200) W	0.076 %	
	(1200 to 2400) W	0.080 %	
	(2400 to 4800) W	0.078 %	
Power Factor			
(50 to 60) Hz	(-1 to 1) PF	0.000 70 PF	ZES Zimmer LMG670
Harmonic			
(50 to 60) Hz	THD-V (0.5 to 20) %	0.038 %	ZES Zimmer LMG670
	THD-I (0.5 to 20) %	0.038 %	

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Resistance – Generate[3]			
	1 mΩ	0.28 µΩ	Yokogawa 2792 series
	10 mΩ	1.2 µΩ	Guildline 9330 series
	100 mΩ	0.71 µΩ	Tinsley 5685A
	1 Ω	3.3 µΩ	IET HARS-X-10-.001-K
	(1 to 10) Ω	0.0083 %	
	(10 to 100) Ω	0.0039 %	
	(0.1 to 1) kΩ	0.0035 %	
	(1 to 10) kΩ	0.0039 %	
	(10 to 100) kΩ	0.0047 %	
	(0.1 to 1) MΩ	0.0060 %	
	(1 to 10) MΩ	0.0099 %	IET HRRS-B-8-100k-4kV
	(10 to 100) MΩ	0.051 %	
	(0.1 to 1) GΩ	0.12 %	
	(1 to 10) GΩ	0.22 %	
	(10 to 100) GΩ	0.39 %	
	(0.1 to 1) TΩ	0.68 %	
	(1 to 10) TΩ	1.2 %	
Fixed Points	1 Ω	0.12 mΩ	Fluke 5730A
	1.9 Ω	0.21 mΩ	
	10 Ω	0.27 mΩ	
	19 Ω	0.51 mΩ	
	100 Ω	1.2 mΩ	
	190 Ω	2.3 mΩ	
	1 kΩ	8.0 mΩ	
	1.9 kΩ	15 mΩ	
	10 kΩ	80 mΩ	
	19 kΩ	0.15 Ω	
	100 kΩ	1.1 Ω	
	190 kΩ	1.9 Ω	
	1 MΩ	5.0 Ω	
	1.9 MΩ	41 Ω	
	10 MΩ	0.47 kΩ	
	19 MΩ	1.1 kΩ	
	100 MΩ	12 kΩ	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
AC Resistance – Generate[3]			
100 mΩ 200 mΩ 300 mΩ (300 to 500) mΩ	(50 to 60) Hz	1.2 mΩ 1.7 mΩ 1.4 mΩ 1.3 %	Rara IRH300 series
Fixed Points			
1 Ω	1 kHz	1.2 mΩ	HP 16074A, Keysight 42030A
10 Ω	1 kHz 1 kHz to 5 MHz (5 to 10) MHz (10 to 13) MHz	3.6 mΩ 0.12 Ω 0.13 Ω 0.14 Ω	
100 Ω	1 kHz 1 kHz to 13 MHz	36 mΩ 1.2 Ω	
1 kΩ	1 kHz 1 kHz to 13 MHz	0.36 Ω 12 Ω	
10 kΩ	1 kHz 1 kHz to 1 MHz	3.6 Ω 0.12 kΩ	
100 kΩ	1 kHz 1 kHz to 1 MHz	38 Ω 1.2 kΩ	

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
DC Resistance – Measure[3]	1 mΩ	0.01 mΩ	Fluke 8508A
	(1 to 10) mΩ	0.071 %	Fluke 5730A
	(10 to 100) mΩ	0.0098 %	
	(0.1 to 1) Ω	0.0089 %	
	(1 to 10) Ω	0.0048 %	
	(10 to 100) Ω	0.0093 %	
	(0.1 to 10) kΩ	0.0092 %	
	(10 to 100) kΩ	0.0093 %	
	(0.1 to 1) MΩ	0.0010 %	
	(1 to 10) MΩ	0.000 80 %	
	(10 to 100) MΩ	0.0023 %	
	(0.1 to 1) GΩ	0.015 %	
	(1 to 10) GΩ	0.14 %	
	(10 to 100) GΩ	0.35 %	Quadtech 1865
	(0.1 to 1) TΩ	1.4 %	
Fixed Points	1 Ω	4.1 μΩ	Fluke 8508A
	10 Ω	0.06 mΩ	Guildline 9330 series
	100 Ω	0.53 mΩ	Fluke 724A series
	1 kΩ	5.3 mΩ	Tinsley 5685A
	10 kΩ	53 mΩ	IET SRL-10G
	100 kΩ	0.77 Ω	
	1 MΩ	11 Ω	
	10 MΩ	0.14 Ω	
	100 MΩ	2.7 kΩ	
	1 GΩ	34 kΩ	
	10 GΩ	3.5 MΩ	

Parameter/Equipment	Frequency	CMC[2, 4, 8] (±)	Comments
AC Resistance – Measure[3]			
100 mΩ (0.1 to 1) Ω 1Ω to 100 kΩ	1 kHz	0.67 mΩ 0.35 % 0.12 %	Keysight E4980AL
Fixed Points			
1 Ω	1 kHz	1.2 mΩ	HP 16074A, Keysight 42030A, Keysight E4980AL
10 Ω	1 kHz 1 MHz	6 mΩ 15 mΩ	
100 Ω	1 kHz 1 MHz	0.41 Ω 0.44 Ω	
1 kΩ	1 kHz 100 kHz 1 MHz	0.3 Ω 0.2 Ω 1.0 Ω	
10 kΩ	1 kHz 100 kHz 1 MHz	5 Ω 11 Ω 11 Ω	
100 kΩ	1 kHz 100 kHz 1 MHz	0.41 kΩ 0.42 kΩ 0.15 kΩ	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
Capacitance – Generate[3]			
1 pF	1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.36 fF 0.037 % 0.053 % 0.059 % 0.080 % 0.10 % 0.37 % 0.47 %	HP 16380A series, IET SCA series
(1 to 10) pF	1 kHz 1 kHz to 5 MHz (5 to 13) MHz	3.6 fF 0.036 % 0.050 %	
(10 to 100) pF	1 kHz 1 kHz to 3 MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	36 fF 0.036 % 0.037 % 0.038 % 0.049 % 0.061 %	
100 pF to 1 nF	1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.36 pF 0.036 % 0.039 % 0.046 % 0.057 % 0.072 % 0.21 % 0.30 %	
(1 to 10) nF	120 Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.91 pF 0.0094 % 0.0091 % 0.0090 %	
(10 to 100) nF	120 Hz 120 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	9.0 pF 0.0087 % 0.0089 % 0.0088 %	
10 nF to 1 µF	120 Hz 120 Hz to 10 kHz (10 to 100) kHz	0.10 nF 0.0086 % 0.011 %	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
Capacitance – Generate (cont)[3]			
(1 to 10) µF	100 Hz 100 Hz to 1 kHz	4.7 nF 0.032 %	HP 16380A series, IET SCA series
(10 to 100) µF	100 Hz 100 Hz to 1 kHz	7.7 nF 0.071 %	
100 µF to 1 mF	100 Hz 100 Hz to 1 kHz	1.2 µF 0.23 %	
Capacitance – Measure[3]			
1 pF	1 kHz 1 kHz to 1 MHz	0.02 aF 1.2 %	Keysight E4980AL AH 2700A
(1 to 10) pF	50 Hz (50 to 400) Hz 400 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 100) kHz (100 to 500) kHz (0.5 to 1) MHz	0.21 fF 0.0011 % 0.0012 % 0.0021 % 0.0051 % 0.36 % 0.35 % 0.36 %	
(10 to 100) pF	50 Hz (50 to 400) Hz (400 to 1000) Hz (1 to 10) kHz (10 to 20) kHz (20 to 100) kHz (100 to 500) kHz (0.5 to 1) MHz	2.1 fF 0.0015 % 0.0011 % 0.0021 % 0.0031 % 0.13 % 0.35 % 0.36 %	
100 pF to 1 nF	1 kHz (1 to 500) kHz (0.5 to 1) MHz	0.06 pF 0.13 % 0.36 %	
(1 to 10) nF	1 kHz (1 to 12.5) kHz (12.5 to 100) kHz	0.21 pF 0.13 % 0.35 %	
(10 to 100) nF	1 kHz (1 to 12.5) kHz	5.1 pF 0.13 %	
100 nF to 1 µF	1 kHz (1 to 12.5) kHz	0.11 nF 0.35 %	
10 µF	1 kHz	0.035 µF	

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
Capacitance – Measure (cont)[3]			
100 µF	120 Hz	0.35 µF	Keysight E4980AL AH 2700A
1 mF	120 Hz	0.012 mF	
Inductance – Generate[3]			
100 µH 100 µH to 1 H	1 kHz	20 nH 0.014 %	Gen-rad 1482 Series
Inductance – Measure[3]			
100 µH	100 Hz (0.1 to 1) kHz (1 to 10) kHz	1.2 µH 0.35 % 0.12 %	Keysight E4980AL
100 µH to 1 mH	100 Hz (0.1 to 10) kHz	3.5 µH 0.12 %	
(1 to 10) mH	100 Hz (0.1 to 10) kHz	35µH 0.12 %	
(10 to 100) mH	100 Hz (0.1 to 1) kHz	0.12 mH 0.12 %	
100 mH to 1 H	100 Hz (0.1 to 1) kHz	1.2 mH 0.12 %	
(1 to 10) H	100 Hz (0.1 to 1) kHz	12 mH 0.12 %	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Temperature Calibrators –			
Type B	600 °C (600 to 1 000) °C (1000 to 1500) °C (1500 to 1820) °C	0.49 °C 0.32 °C 0.26 °C 0.26 °C	Fluke 8508A
Type E	-200 °C (-200 to 0) °C (0 to 250) °C (250 to 500) °C (500 to 1000) °C	0.12 °C 0.05 °C 0.04 °C 0.04 °C 0.04 °C	
Type J	-210 °C (-210 to 0) °C (0 to 250) °C (250 to 500) °C (500 to 1200) °C	0.15 °C 0.06 °C 0.06 °C 0.06 °C 0.06 °C	
Type K	-200 °C (-200 to 0) °C (0 to 500) °C (500 to 1000) °C (1000 to 1372) °C	0.19 °C 0.08 °C 0.07 °C 0.08 °C 0.09 °C	
Type N	-200 °C (-200 to 0) °C (0 to 500) °C (500 to 1000) °C (1000 to 1300) °C	0.29 °C 0.12 °C 0.08 °C 0.08 °C 0.09 °C	
Type R	-20 °C (-20 to 0) °C (0 to 500) °C (500 to 1000) °C (1000 to 1768) °C	0.62 °C 0.55 °C 0.27 °C 0.22 °C 0.24 °C	
Type S	-20 °C (-20 to 0) °C (0 to 500) °C (500 to 1000) °C (1000 to 1768) °C	0.60 °C 0.54 °C 0.30 °C 0.26 °C 0.29 °C	
Type T	-200 °C (-200 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 400) °C	0.19 °C 0.08 °C 0.07 °C 0.06 °C 0.05 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Conductivity Meters	14.36 MS/m 22.90 MS/m 34.26 MS/m 58.38 MS/m	0.13 MS/m 0.20 MS/m 0.29 MS/m 0.50 MS/m	Fischer calibration standards
Oscilloscope Calibrators –			
DC Voltage	0 mV (0 to 2.5) mV (2.5 to 5) mV (5 to 10) mV (10 to 25) mV (25 to 50) mV (50 to 100) mV (100 to 250) mV (250 to 500) mV (0.5 to 1) V (1 to 2.5) V (2.5 to 5) V (5 to 10) V (10 to 25) V (25 to 50) V (50 to 100) V (100 to 150) V (150 to 200) V	0.087 µV 0.012 % 62 µV/V 65 µV/V 26 µV/V 13 µV/V 60 µV/V 25 µV/V 13 µV/V 58 µV/V 24 µV/V 12 µV/V 61 µV/V 25 µV/V 13 µV/V 60 µV/V 41 µV/V 31 µV/V	Fluke 8508A
Square/Edge Wave Voltage			
1 kHz	5 mV (5 to 10) mV (10 to 25) mV (25 to 50) mV (50 to 100) mV (100 to 250) mV (250 to 500) mV (0.5 to 1) V (1 to 2.5) V (2.5 to 5) V (5 to 10) V	4.6 µV 0.097 % 0.042 % 0.026 % 0.018 % 0.017 % 0.0087 % 0.020 % 0.016 % 0.018 % 0.020 %	Fluke 8508A

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscope Calibrators – (cont)			
Square/Edge Wave Voltage			
1 kHz	(10 to 25) V (25 to 50) V (50 to 100) V (100 to 130) V (130 to 200) V	0.037 % 0.028 % 0.020 % 0.015 % 0.012 %	Fluke 8508A
100 kHz	10 mV (10 to 25) mV (25 to 50) mV (50 to 100) mV (100 to 250) mV (250 to 500) mV (0.5 to 1) V (1 to 2.5) V	28 µV 0.27 % 0.18 % 0.13 % 0.14 % 0.16 % 0.11 % 0.096 %	
Square/Edge Wave Frequency	10 Hz 10 Hz to 1 MHz	8.7 µHz 0.058 µHz/Hz	HP 53132A
Edge TD Pulse Drive			
(10 to 100) Hz	11 V (11 to 100) V	5.9 mV 58 µV/V	HP 3458A
(0.1 to 1) kHz	11 V (11 to 100) V	5.5 mV 68 µV/V	
Edge Duty Cycle	50 %	0.078 %	Tektronix DPO 4102B
Edge Rise Time	300 ps (300 to 500) ps	0.64 ps 0.15 %	Tektronix DPO4102B
Leveled Sine Wave – Harmonic			
50 kHz to 6 GHz	-10 dBc (-10 to -80) dBc	0.64 dB 0.64 dB	Agilent E4440A

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscope Calibrators – (cont)			
HF Sine Output Voltage			
50 kHz to 600 MHz	60 mVpp (60 to 300) mVpp (300 to 600) mVpp (0.6 to 5.5) Vpp	1.0 mV 1.6 % 1.5 % 1.6 %	HP E4416A, Agilent E9340A
(0.6 to 1) GHz	60 mVpp (60 to 300) mVpp (300 to 600) mVpp (0.6 to 3.5) Vpp	1.0 mV 1.6 % 1.5 % 1.6 %	
(1 to 2) GHz	60 mVpp (60 to 300) mVpp (300 to 600) mVpp (0.6 to 3) Vpp	1.0 mV 1.6 % 1.5 % 1.6 %	
(2 to 6) GHz	60 mVpp (60 to 300) mVpp (300 to 600) mVpp (0.6 to 1.2) Vpp	1.0 mV 1.6 % 1.5 % 1.6 %	
Leveled Sine Wave – Frequency	500 MHz (0.5 to 6) GHz	1.4 Hz 0.032 µHz/Hz	HP 53132A
Leveled Sine Wave – Amplitude Peak to Peak			
10 Hz	5 mV (5 to 100) mV (0.1 to 1) V (1 to 5.5) V	4.3 µV 59 µV/V 0.13 % 0.015 %	Fluke 5790B
(0.01 to 50) kHz	5 mV (5 to 100) mV (0.1 to 1) V (1 to 5.5) V	5.2 µV 82 µV/V 0.12 % 0.022 %	

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscope Calibrators – (cont)			
Wave Generator – Square			
10 Hz	10 mV (10 to 900) mV (0.9 to 2.5) V (2.5 to 3.75) V (3.75 to 55) V	3.3 µV 67 µV/V 0.052 % 0.026 % 45 µV/V	Fluke 5790B
(0.01 to 1) kHz	10 mV (10 to 900) mV (0.9 to 2.5) V (2.5 to 3.75) V (3.75 to 55) V	3.1 µV 53 µV/V 0.093 % 0.066 % 76 µV/V	
(1 to 10) kHz	2.5 V (2.5 to 3.75) V (3.75 to 55) V	1.3 mV 0.069 % 87 µV/V	
Wave Generator – Sine			
10 Hz	10 mV (0.01 to 55) V	3.1 µV 30 µV/V	Fluke 5790B
(0.01 to 1) kHz	10 mV (0.01 to 55) V	3.0 µV 21 µV/V	
Wave Generator – Triangle			
10 Hz	10 mV (0.01 to 55) V	3.1 µV 29 µV/V	Fluke 5790B
(0.01 to 1) kHz	10 mV (0.01 to 55) V	3.1 µV 39 µV/V	
Pulse Generator – Period	10 ns (0.01 to 20) µs (20 to 100) µs	0.76 ps 0.0039 % 0.000 78 %	HP 53132A
Pulse Generator – Width	4 ns (4 to 100) ns	1.3 ps 0.10 %	Tektronix DPO4102B

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscope Calibrators – (cont)			
Time Mark	1 ns (1 to 2) ns (2 to 5) ns (5 to 10) ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1) µs (1 to 2) µs (2 to 5) µs (5 to 10) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1) s (1 to 2) s (2 to 5) s (5 to 10) s (10 to 20) s	2.7 ps 0.14 % 0.054 % 0.027 % 0.014 % 0.0054 % 0.0027 % 0.0014 % 0.000 54 % 0.000 28 % 0.000 14 % 0.000 056 % 0.000 081 % 0.000 041 % 0.000 016 % 0.000 077 % 0.000 038 % 0.000 015 % 0.000 077 % 0.000 038 % 0.000 015 % 0.000 077 % 0.000 038 % 0.000 015 % 0.000 077 % 0.000 004 % 0.000 015 % 0.000 077 % 0.000 038 % 0.000 015 % 0.000 077 % 0.000 004 %	HP 53132A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscope Calibrators – (cont)			
Frequency	50 mHz	7.7 nHz	HP 53132A
	(50 to 100) mHz	0.000 077 %	
	(100 to 200) mHz	0.000 038 %	
	(200 to 500) mHz	0.000 015 %	
	(0.5 to 1) Hz	0.000 077 %	
	(1 to 2) Hz	0.000 038 %	
	(2 to 5) Hz	0.000 015 %	
	(5 to 10) Hz	0.000 077 %	
	(10 to 20) Hz	0.000 038 %	
	(20 to 50) Hz	0.000 015 %	
	(50 to 100) Hz	0.000 077 %	
	(100 to 200) Hz	0.000 038 %	
	(200 to 500) Hz	0.000 015 %	
	(0.5 to 1) kHz	0.000 077 %	
	(1 to 2) kHz	0.000 038 %	
	(2 to 5) kHz	0.000 015 %	
	(5 to 10) kHz	0.000 077 %	
	(10 to 20) kHz	0.000 038 %	
	(20 to 50) kHz	0.000 015 %	
	(50 to 100) kHz	0.000 077 %	
	(100 to 200) kHz	0.000 038 %	
	(200 to 500) kHz	0.000 015 %	
	(0.5 to 1) MHz	0.000 077 %	
	(1 to 2) MHz	0.000 038 %	
	(2 to 5) MHz	0.000 015 %	
	(5 to 10) MHz	0.000 077 %	
	(10 to 20) MHz	0.000 038 %	
	(20 to 50) MHz	0.000 015 %	
	(50 to 100) MHz	0.000 077 %	
	(100 to 200) MHz	0.000 038 %	
	(200 to 500) MHz	0.000 015 %	
	(0.5 to 1.1) GHz	0.000 062 %	
MeasZ (Resistance)	40 Ω	15 mΩ	ESI DB62
	40 Ω to 1.5 MΩ	0.029 %	
MeasZ (Capacitance)	50 pF	0.26 pF	HP 4440B
	(50 to 100) pF	0.30 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscopes –			
DC Voltage	0 mV (0 to 1) mV (1 to 2) mV (2 to 3) mV (3 to 4) mV (4 to 5) mV (5 to 6) mV (6 to 7) mV (7 to 8) mV (8 to 9) mV (9 to 10) mV (10 to 15) mV (15 to 25) mV (20 to 25) mV (25 to 30) mV (30 to 35) mV (35 to 40) mV (40 to 45) mV (45 to 50) mV (50 to 60) mV (60 to 70) mV (70 to 80) mV (80 to 90) mV (90 to 100) mV (100 to 150) mV (150 to 200) mV (200 to 250) mV (250 to 300) mV (300 to 350) mV (350 to 400) mV (400 to 450) mV (450 to 500) mV (0.5 to 0.6) V (0.6 to 0.7) V (0.7 to 0.8) V (0.8 to 0.9) V (0.9 to 1) V (1 to 2.5) V (2.5 to 5) V (5 to 10) V (10 to 25) V (25 to 30) V (30 to 35) V (35 to 40) V (40 to 45) V (45 to 50) V	4.6 µV 3.0 % 1.5 % 1.0 % 0.76 % 0.61 % 0.51 % 0.49 % 0.43 % 0.38 % 0.34 % 0.23 % 0.18 % 0.18 % 0.15 % 0.13 % 0.11 % 0.098 % 0.088 % 0.078 % 0.12 % 0.10 % 0.093 % 0.084 % 0.056 % 0.048 % 0.069 % 0.058 % 0.050 % 0.043 % 0.039 % 0.035 % 0.037 % 0.083 % 0.073 % 0.065 % 0.058 % 0.059 % 0.029 % 0.067 % 0.058 % 0.048 % 0.041 % 0.036 % 0.032 % 0.029 %	Fluke 9500B, Fluke 5522A (scope opt)

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscopes – (cont)			
DC Voltage	(50 to 60) V (60 to 70) V (70 to 80) V (80 to 90) V (90 to 100) V (100 to 200) V	0.030 % 0.042 % 0.037 % 0.033 % 0.030 % 0.029 %	Fluke 9500B, Fluke 5522A (scope opt)
Square Wave			
1 kHz	1 mV (1 to 2) mV (2 to 3) mV (3 to 4) mV (4 to 5) mV (5 to 6) mV (6 to 7) mV (7 to 8) mV (8 to 9) mV (9 to 10) mV (10 to 15) mV (15 to 20) mV (20 to 25) mV (25 to 30) mV (30 to 35) mV (35 to 40) mV (40 to 45) mV (45 to 50) mV (50 to 100) mV (100 to 250) mV (250 to 500) mV (0.5 to 1) V (1 to 2.5) V (2.5 to 5) V (5 to 10) V (10 to 25) V (25 to 50) V (50 to 60) V (60 to 70) V (70 to 80) V (80 to 90) V (90 to 100) V (100 to 150) V (150 to 200) V	19 µV 0.93 % 0.62 % 0.46 % 0.37 % 0.31 % 1.2 % 1.0 % 0.90 % 0.81 % 0.54 % 0.41 % 0.32 % 0.27 % 0.23 % 0.20 % 0.18 % 0.16 % 0.71 % 0.28 % 0.14 % 0.70 % 0.28 % 0.14 % 0.70 % 0.28 % 0.14 % 0.12 % 0.17 % 0.15 % 0.13 % 0.12 % 0.16 % 0.12 %	Fluke 9500B

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscopes – (cont)			
Bandwidth			
50 kHz to 1 MHz	60 mV (0.06 to 3) V	2.2 mV 2.2 %	Fluke 9500B Keysight N5173B HP E4416A
(1 to 550) MHz	60 mV (0.06 to 3) V	2.7 mV 2.7 %	Agilent E9300A HP 11667C
(0.55 to 40) GHz	60 mV (60 to 600) mV (0.6 to 3) V	1.5 mV 2.6 % 3.0 %	
Time Marker	1 ns (1 to 2) ns (2 to 5) ns (5 to 10) ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1) µs (1 to 2) µs (2 to 5) µs (5 to 10) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1) s (1 to 2) s (2 to 5) s (5 to 10) s (10 to 20) s	8.4 fs 0.000 50 % 0.000 20 % 0.000 69 % 0.000 34 % 0.000 14 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 75 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 39 % 0.000 16 % 0.000 78 % 0.000 29 %	Fluke 9500B

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscopes – (cont)			
Frequency	100 mHz	0.99 µHz	Fluke 9500B
	(100 to 200) mHz	0.000 50 %	
	(200 to 500) mHz	0.000 20 %	
	(0.5 to 1) Hz	0.000 71 %	
	(1 to 2) Hz	0.000 36 %	
	(2 to 5) Hz	0.000 15 %	
	(5 to 10) Hz	0.000 71 %	
	(10 to 20) Hz	0.000 35 %	
	(20 to 50) Hz	0.000 14 %	
	(50 to 100) Hz	0.000 71 %	
	(100 to 200) Hz	0.000 36 %	
	(200 to 500) Hz	0.000 15 %	
	(0.5 to 1) kHz	0.000 71 %	
	(1 to 2) kHz	0.000 35 %	
	(2 to 5) kHz	0.000 14 %	
	(5 to 10) kHz	0.000 71 %	
	(10 to 20) kHz	0.000 35 %	
	(20 to 50) kHz	0.000 14 %	
	(50 to 100) kHz	0.000 71 %	
	(100 to 200) kHz	0.000 35 %	
	(200 to 500) kHz	0.000 14 %	
	(0.5 to 1) MHz	0.000 71 %	
	(1 to 2) MHz	0.000 35 %	
	(2 to 5) MHz	0.000 15 %	
	(5 to 10) MHz	0.000 71 %	
	(10 to 20) MHz	0.000 36 %	
	(20 to 50) MHz	0.000 15 %	
	(50 to 100) MHz	0.000 71 %	
	(100 to 200) MHz	0.000 35 %	
	(200 to 500) MHz	0.000 14 %	
	(0.5 to 1) GHz	0.000 71 %	
AC Voltage			
50 Hz to 10 kHz	10 mV	5.8 µV	
	(10 to 15) mV	0.042 %	Fluke 5370A
	(15 to 20) mV	0.033 %	
	(20 to 25) mV	0.044 %	
	(25 to 30) mV	0.037 %	
	(30 to 35) mV	0.034 %	
	(35 to 40) mV	0.030 %	
	(40 to 45) mV	0.027 %	
	(45 to 50) mV	0.024 %	
	(50 to 60) mV	0.028 %	
	(60 to 70) mV	0.022 %	
	(70 to 80) mV	0.020 %	
	(80 to 90) mV	0.021 %	
	(90 to 100) mV	0.017 %	

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscopes – (cont)			
AC Voltage			
50 Hz to 10 kHz	(100 to 150) mV (150 to 200) mV (200 to 250) mV (250 to 300) mV (300 to 350) mV (350 to 400) mV (400 to 450) mV (450 to 500) mV (500 to 600) mV (600 to 700) mV (700 to 800) mV (800 to 900) mV (0.9 to 1) V (1 to 1.5) V (1.5 to 2) V (2 to 2.5) V (2.5 to 3) V (3 to 3.5) V (3.5 to 4) V (4 to 4.5) V (4.5 to 5) V (5 to 6) V (6 to 7) V (7 to 8) V (8 to 9) V (9 to 10) V (10 to 15) V (15 to 20) V (20 to 25) V (25 to 30) V (30 to 35) V (35 to 40) V (40 to 45) V (45 to 50) V (50 to 60) V (60 to 70) V (70 to 80) V (80 to 90) V (90 to 100) V	0.013 % 0.012 % 0.020 % 0.018 % 0.016 % 0.016 % 0.015 % 0.014 % 0.018 % 0.017 % 0.016 % 0.015 % 0.017 % 0.013 % 0.013 % 0.012 % 0.010 % 0.0093 % 0.0082 % 0.0077 % 0.0075 % 0.014 % 0.013 % 0.011 % 0.015 % 0.0097 % 0.0098 % 0.0081 % 0.014 % 0.012 % 0.011 % 0.010 % 0.0094 % 0.0092 % 0.015 % 0.019 % 0.017 % 0.016 % 0.011 %	Fluke 5370A
Input Resistance	50 Ω 75 Ω 1 MΩ	5.9 mΩ 5.9 mΩ 0.34 kΩ	Fluke 8508A
10 MHz Reference	10 MHz	0.078 µHz/Hz	HP 53132A

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Oscilloscopes – (cont)			
CAL OUT Voltage			
DC	100 mV (0.1 to 1) V (1 to 2) V (2 to 3) V (3 to 4) V (4 to 5) V (5 to 6) V (6 to 7) V (7 to 8) V (8 to 9) V (9 to 10) V (10 to 11) V (11 to 12) V	61 µV 61 µV/V 36 µV/V 24 µV/V 18 µV/V 14 µV/V 12 µV/V 10 µV/V 8.9 µV/V 7.9 µV/V 7.1 µV/V 48 µV/V 44 µV/V	Fluke 8508A
1 kHz	100 mV (0.1 to 1) V (1 to 2) V (2 to 3) V (3 to 4) V (4 to 5) V (5 to 6) V (6 to 7) V (7 to 8) V (8 to 9) V (9 to 10) V (10 to 11) V (11 to 12) V	63 µV 0.011 % 0.046 % 0.031 % 0.023 % 0.019 % 0.015 % 0.013 % 0.012 % 0.010 % 0.0093 % 0.086 % 0.079 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Multifunction Calibrator – Voltage			
DC Voltage (Positive & Negative)	0 mV (0.1 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	0.12 µV 1.6 µV/V 0.92 µV/V 1.0 µV/V 1.0 µV/V 10 µV/V	Fluke 8508A Fluke 732B Fluke 752A
AC Voltage (100 µV)	10 Hz (10 to 40) Hz (40 to 100) Hz (100 to 500) Hz (0.5 to 1) kHz (1 to 10) kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (1 to 2) MHz (2 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	20 nV 0.020 % 0.020 % 0.020 % 0.020 % 0.020 % 0.020 % 0.020 % 0.020 % 0.021 % 0.025 % 0.025 % 0.045 % 0.13 % 0.029 % 0.045 % 0.20 % 0.076 % 0.16 %	Fluke 5790B Fluke 5730A
(0.1 to 1) mV	10 Hz (10 to 40) Hz (40 to 100) Hz (100 to 500) Hz (0.5 to 1) kHz (1 to 10) kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (1 to 2) MHz (2 to 5) MHz (5 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.21 µV 0.021 % 0.021 % 0.021 % 0.021 % 0.021 % 0.021 % 0.021 % 0.022 % 0.021 % 0.026 % 0.026 % 0.046 % 0.13 % 0.030 % 0.045 % 0.20 % 0.076 % 0.16 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Multifunction Calibrator – Voltage (cont)			
AC Voltage			
(1 to 100) mV	10 Hz	3.7 µV	Fluke 5790B
	(10 to 40) Hz	14 µV/V	Fluke 5730A
	(40 to 100) Hz	13 µV/V	
	(100 to 500) Hz	13 µV/V	
	(0.5 to 1) kHz	13 µV/V	
	(1 to 10) kHz	16 µV/V	
	(10 to 20) kHz	16 µV/V	
	(20 to 30) kHz	24 µV/V	
	(30 to 50) kHz	24 µV/V	
	(50 to 100) kHz	48 µV/V	
	(100 to 200) kHz	85 µV/V	
	(200 to 300) kHz	85 µV/V	
	(300 to 500) kHz	0.013 %	
	(0.5 to 1) MHz	0.024 %	
	(1 to 2) MHz	0.017 %	
	(2 to 5) MHz	0.028 %	
	(5 to 10) MHz	0.032 %	
	(10 to 20) MHz	0.062 %	
	(20 to 30) MHz	0.13 %	
(0.1 to 1) V	10 Hz	30 µV	
	(10 to 40) Hz	8.1 µV/V	
	(40 to 100) Hz	8.6 µV/V	
	(100 to 500) Hz	8.6 µV/V	
	(0.5 to 1) kHz	8.5 µV/V	
	(1 to 10) kHz	8.4 µV/V	
	(10 to 20) kHz	11 µV/V	
	(20 to 30) kHz	11 µV/V	
	(30 to 50) kHz	21 µV/V	
	(50 to 100) kHz	40 µV/V	
	(100 to 200) kHz	40 µV/V	
	(200 to 300) kHz	67 µV/V	
	(300 to 500) kHz	0.026 %	
	(0.5 to 1) MHz	0.016 %	
	(1 to 2) MHz	0.029 %	
	(2 to 5) MHz	0.037 %	
	(5 to 10) MHz	0.059 %	
	(10 to 20) MHz	0.13 %	
	(20 to 30) MHz	0.010 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Multifunction Calibrator – Voltage (cont)			
AC Voltage			
(1 to 3) V	10 Hz	92 µV	Fluke 5790B, Fluke 5730A
	(10 to 40) Hz	7.0 µV/V	
	(40 to 100) Hz	6.2 µV/V	
	(100 to 500) Hz	6.2 µV/V	
	(0.5 to 1) kHz	6.2 µV/V	
	(1 to 10) kHz	6.8 µV/V	
	(10 to 20) kHz	6.8 µV/V	
	(20 to 30) kHz	7.6 µV/V	
	(30 to 50) kHz	7.6 µV/V	
	(50 to 100) kHz	8.0 µV/V	
	(100 to 200) kHz	26 µV/V	
	(200 to 300) kHz	26 µV/V	
	(300 to 500) kHz	32 µV/V	
	(0.5 to 1) MHz	0.024 %	
	(1 to 2) MHz	0.010 %	
	(2 to 5) MHz	0.024 %	
	(5 to 10) MHz	0.033 %	
	(10 to 20) MHz	0.057 %	
	(20 to 30) MHz	0.12 %	
(3 to 10) V	10 Hz	0.34 mV	
	(10 to 40) Hz	7.6 µV/V	
	(40 to 100) Hz	7.4 µV/V	
	(100 to 500) Hz	7.5 µV/V	
	(0.5 to 1) kHz	7.4 µV/V	
	(1 to 10) kHz	7.7 µV/V	
	(10 to 20) kHz	7.7 µV/V	
	(20 to 30) kHz	8.5 µV/V	
	(30 to 50) kHz	8.4 µV/V	
	(50 to 100) kHz	13 µV/V	
	(100 to 200) kHz	23 µV/V	
	(200 to 300) kHz	23 µV/V	
	(300 to 500) kHz	29 µV/V	
	(0.5 to 1) MHz	0.024 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Multifunction Calibrator – Voltage (cont)			
AC Voltage			
(10 to 20) V	10 Hz	0.58 mV	Fluke 5790B, Fluke 5730A
	(10 to 40) Hz	7.3 µV/V	
	(40 to 100) Hz	7.3 µV/V	
	(100 to 500) Hz	7.3 µV/V	
	(0.5 to 1) kHz	7.3 µV/V	
	(1 to 10) kHz	7.5 µV/V	
	(10 to 20) kHz	7.5 µV/V	
	(20 to 30) kHz	8.4 µV/V	
	(30 to 50) kHz	8.4 µV/V	
	(50 to 100) kHz	13 µV/V	
	(100 to 200) kHz	23 µV/V	
	(200 to 300) kHz	23 µV/V	
	(300 to 500) kHz	29 µV/V	
	(0.5 to 1) MHz	0.024 %	
(20 to 60) V	10 Hz	2.1 mV	
	(10 to 40) Hz	9.8 µV/V	
	(40 to 100) Hz	8.1 µV/V	
	(100 to 500) Hz	8.1 µV/V	
	(0.5 to 1) kHz	8.1 µV/V	
	(1 to 10) kHz	8.5 µV/V	
	(10 to 20) kHz	8.5 µV/V	
	(20 to 30) kHz	10 µV/V	
	(30 to 50) kHz	10 µV/V	
	(50 to 100) kHz	12 µV/V	
	(100 to 200) kHz	33 µV/V	
	(200 to 300) kHz	33 µV/V	
(60 to 100) V	10 Hz	4.4 mV	
	(10 to 40) Hz	11 µV/V	
	(40 to 100) Hz	9.2 µV/V	
	(100 to 500) Hz	9.2 µV/V	
	(0.5 to 1) kHz	9.2 µV/V	
	(1 to 10) kHz	9.7 µV/V	
	(10 to 20) kHz	9.7 µV/V	
	(20 to 30) kHz	12 µV/V	
	(30 to 50) kHz	12 µV/V	
	(50 to 100) kHz	21 µV/V	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Multifunction Calibrator – Voltage (cont)			
AC Voltage			
(100 to 600) V	40 Hz (40 to 100) Hz (100 to 500) Hz (0.5 to 1) kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	9.3 mV 15 µV/V 15 µV/V 15 µV/V 16 µV/V 16 µV/V 24 µV/V 46 µV/V	Fluke 5790B, Fluke 5730A
(600 to 1000) V	40 Hz (40 to 100) Hz (100 to 500) Hz (0.5 to 1) kHz (1 to 10) kHz (10 to 20) kHz (20 to 30) kHz	16 mV 16 µV/V 15 µV/V 15 µV/V 17 µV/V 17 µV/V 30 µV/V	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Multifunction Calibrator – Current			
DC Current			
(Positive & Negative)	0 µA (0 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 20) A	0.36 nA 0.59 µA/A 0.84 µA/A 0.92 µA/A 0.58 µA/A 9.4 µA/A 8.5 µA/A 27 µA/A	Fluke 8508A, Fluke 742A series, Guildline 9230A-30

Parameter/Range	Frequency	CMC[2] (±)	Comments
Multifunction Calibrator – Current (cont)			
AC Current			
(10 µA)	10 Hz	0.81 nA	Fluke 5790B
	(10 to 40) Hz	54 µA/A	Fluke A40B series
	(40 to 45) Hz	71 µA/A	
	(45 to 100) Hz	68 µA/A	
	(100 to 200) Hz	67 µA/A	
	(200 to 500) Hz	61 µA/A	
	(0.5 to 1) kHz	67 µA/A	
	(1 to 2) kHz	65 µA/A	
	(2 to 5) kHz	63 µA/A	
	(5 to 10) kHz	69 µA/A	
	(10 to 30) kHz	77 µA/A	
(10 to 100) µA	10 Hz	5.3 nA	
	(10 to 40) Hz	23 µA/A	
	(40 to 45) Hz	58 µA/A	
	(45 to 100) Hz	55 µA/A	
	(100 to 200) Hz	53 µA/A	
	(200 to 500) Hz	46 µA/A	
	(0.5 to 1) kHz	54 µA/A	
	(1 to 2) kHz	54 µA/A	
	(2 to 5) kHz	52 µA/A	
	(5 to 10) kHz	59 µA/A	
	(10 to 30) kHz	62 µA/A	
(0.1 to 1) mA	10 Hz	42 nA	
	(10 to 40) Hz	21 µA/A	
	(40 to 45) Hz	22 µA/A	
	(45 to 100) Hz	25 µA/A	
	(100 to 200) Hz	37 µA/A	
	(200 to 500) Hz	28 µA/A	
	(0.5 to 1) kHz	28 µA/A	
	(1 to 2) kHz	30 µA/A	
	(2 to 5) kHz	8.5 µA/A	
	(5 to 10) kHz	26 µA/A	
	(10 to 30) kHz	27 µA/A	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Multifunction Calibrator – Current (cont)			
AC Current			
(1 to 10) mA	10 Hz	0.33 µA	Fluke 5790B, Fluke A40B series
	(10 to 40) Hz	21 µA/A	
	(40 to 45) Hz	14 µA/A	
	(45 to 100) Hz	13 µA/A	
	(100 to 200) Hz	12 µA/A	
	(200 to 500) Hz	13 µA/A	
	(0.5 to 1) kHz	12 µA/A	
	(1 to 2) kHz	14 µA/A	
	(2 to 5) kHz	12 µA/A	
	(5 to 10) kHz	14 µA/A	
	(10 to 30) kHz	16 µA/A	
(10 to 100) mA	10 Hz	3.3 µA	
	(10 to 40) Hz	15 µA/A	
	(40 to 45) Hz	16 µA/A	
	(45 to 100) Hz	15 µA/A	
	(100 to 200) Hz	18 µA/A	
	(200 to 500) Hz	17 µA/A	
	(0.5 to 1) kHz	18 µA/A	
	(1 to 2) kHz	14 µA/A	
	(2 to 5) kHz	23 µA/A	
	(5 to 10) kHz	19 µA/A	
	(10 to 30) kHz	21 µA/A	
(100 to 330) mA	10 Hz	46 µA	
	(10 to 40) Hz	98 µA/A	
	(40 to 45) Hz	98 µA/A	
	(45 to 100) Hz	98 µA/A	
	(100 to 200) Hz	98 µA/A	
	(200 to 500) Hz	99 µA/A	
	(0.5 to 1) kHz	98 µA/A	
	(1 to 2) kHz	97 µA/A	
	(2 to 5) kHz	98 µA/A	
	(5 to 10) kHz	98 µA/A	
	(10 to 30) kHz	0.010 %	
(0.33 to 1) A	10 Hz	30 µA	
	(10 to 40) Hz	38 µA/A	
	(40 to 45) Hz	43 µA/A	
	(45 to 100) Hz	53 µA/A	
	(100 to 200) Hz	53 µA/A	
	(200 to 500) Hz	36 µA/A	
	(0.5 to 1) kHz	8.7 µA/A	
	(1 to 2) kHz	35 µA/A	
	(2 to 5) kHz	39 µA/A	
	(5 to 10) kHz	73 µA/A	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Multifunction Calibrator – Current (cont)			
AC Current			
(1 to 3) A	10 Hz	0.38 mA	Fluke 5790B
	(10 to 40) Hz	80 µA/A	Fluke A40B series
	(40 to 45) Hz	0.010 %	
	(45 to 100) Hz	81 µA/A	
	(100 to 200) Hz	81 µA/A	
	(200 to 500) Hz	0.010 %	
	(0.5 to 1) kHz	81 µA/A	
	(1 to 2) kHz	81 µA/A	
	(2 to 5) kHz	81 µA/A	
	(5 to 10) kHz	81 µA/A	
(3 to 10) A	45 Hz	0.22 mA	
	(45 to 100) Hz	26 µA/A	
	(100 to 200) Hz	26 µA/A	
	(200 to 500) Hz	51 µA/A	
	(0.5 to 1) kHz	26 µA/A	
	(1 to 2) kHz	26 µA/A	
	(2 to 5) kHz	27 µA/A	
(10 to 20) A	45 Hz	0.52 mA	
	(45 to 100) Hz	24 µA/A	
	(100 to 200) Hz	23 µA/A	
	(200 to 500) Hz	26 µA/A	
	(0.5 to 1) kHz	25 µA/A	
	(1 to 2) kHz	26 µA/A	
	(2 to 5) kHz	26 µA/A	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Multifunction Calibrator – Resistance	0 Ω (0 to 1) Ω (1 to 1.9) Ω (1.9 to 10) Ω (10 to 19) Ω (19 to 100) Ω (100 to 190) Ω (0.19 to 1) kΩ (1 to 1.9) kΩ (1.9 to 10) kΩ (10 to 19) kΩ (19 to 100) kΩ (100 to 190) kΩ (0.19 to 1) MΩ (1 to 1.9) MΩ (1.9 to 10) MΩ (10 to 19) MΩ (19 to 100) MΩ (0.1 to 1) GΩ	2.3 μΩ 3.8 μΩ/Ω 3.8 μΩ/Ω 10 μΩ/Ω 5.5 μΩ/Ω 3.6 μΩ/Ω 1.9 μΩ/Ω 2.6 μΩ/Ω 1.3 μΩ/Ω 8.6 μΩ/Ω 2.3 μΩ/Ω 2.5 μΩ/Ω 1.3 μΩ/Ω 3.9 μΩ/Ω 2.1 μΩ/Ω 7.7 μΩ/Ω 8.0 μΩ/Ω 19 μΩ/Ω 17 μΩ/Ω	Fluke 8508A, Fluke 742A series, IET SRL-100M Guildline 9334A-1G
Multifunction Calibrator – Frequency	10 Hz to 30 MHz	0.058 μHz/Hz	Fluke 8508A, Fluke 742A series, IET SRL-100M Guildline 9334A-1G

Parameter/Frequency	Range	CMC[2] (±)	Comments
Analog & Digital Multimeter – DC			
Voltage Positive & Negative	0 mV (0 to 100) mV (100 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	0.19 μV 3.5 μV/V 1.5 μV/V 2.6 μV/V 1.3 μV/V 1.4 μV/V	Fluke 5730A

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
Analog & Digital Multimeter – DC (cont)			
Current Positive & Negative	100 nA 0 µA (0 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 20) A	2.7 pA 0.35 nA 0.037 % 0.0037 % 0.000 91 % 0.0017 % 0.0092 % 0.0018 % 0.0033 % 0.0077 % 0.0076 %	Fluke 5730A IET SRL-100M
Resistance	0 Ω (0 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ	2.1 µΩ 3.5 µΩ/Ω 0.94 µΩ/Ω 8.4 µΩ/Ω 1.1 µΩ/Ω 3.1 µΩ/Ω 6.9 µΩ/Ω 18 µΩ/Ω 16 µΩ/Ω 0.019 %	Fluke 5730A, Fluke 742A series, IET SRL series, Guildline 9330 series

Parameter/Range	Frequency	CMC[2] (±)	Comments
Analog & Digital Multimeter – AC			
Voltage 1 mv	10 Hz (10 to 40) Hz (40 to 500) Hz (0.5 to 1) kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 200) kHz (200 to 500) kHz (0.5 to 1) MHz	0.72 µV 0.70 µV 0.69 µV 0.69 µV 0.68 µV 0.68 µV 0.86 µV 1.7 µV 1.7 µV 2.4 µV 6.2 µV	Fluke 5730A

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Analog & Digital Multimeter – AC (cont)			
Voltage			
(1 to 100) mV	10 Hz	89 µV	Fluke 5730A
	(10 to 40) Hz	43 µV/V	
	(40 to 500) Hz	41 µV/V	
	(0.5 to 1) kHz	41µV/V	
	(1 to 10) kHz	46 µV/V	
	(10 to 20) kHz	46 µV/V	
	(20 to 50) kHz	64 µV/V	
	(50 to 100) kHz	0.010 %	
	(100 to 200) kHz	0.020 %	
	(200 to 500) kHz	0.030 %	
	(0.5 to 1) MHz	0.064 %	
(0.1 to 1) V	10 Hz	77 µV/V	
	(10 to 40) Hz	39 µV/V	
	(40 to 500) Hz	22 µV/V	
	(0.5 to 1) kHz	22 µV/V	
	(1 to 10) kHz	22 µV/V	
	(10 to 20) kHz	22 µV/V	
	(20 to 50) kHz	31 µV/V	
	(50 to 100) kHz	45 µV/V	
	(100 to 200) kHz	0.013 %	
	(200 to 500) kHz	0.028 %	
	(0.5 to 1) MHz	0.13 %	
(1 to 10) V	10 Hz	70 µV/V	
	(10 to 40) Hz	35 µV/V	
	(40 to 500) Hz	22 µV/V	
	(0.5 to 1) kHz	94 µV/V	
	(1 to 10) kHz	21 µV/V	
	(10 to 20) kHz	21 µV/V	
	(20 to 50) kHz	31 µV/V	
	(50 to 100) kHz	43 µV/V	
	(100 to 200) kHz	0.015 %	
	(200 to 500) kHz	0.029 %	
	(0.5 to 1) MHz	0.010 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Analog & Digital Multimeter – AC (cont)			
Voltage			
(10 to 100) V	10 Hz	87 µV/V	Fluke 5730A
	(10 to 40) Hz	42 µV/V	
	(40 to 500) Hz	26 µV/V	
	(0.5 to 1) kHz	26 µV/V	
	(1 to 10) kHz	26 µV/V	
	(10 to 20) kHz	26 µV/V	
	(20 to 50) kHz	32 µV/V	
	(50 to 100) kHz	62 µV/V	
(100 to 1000) V	40 Hz	26 µV/V	
	(40 to 500) Hz	20 µV/V	
	(0.5 to 1) kHz	20 µV/V	
	(1 to 10) kHz	51 µV/V	
	(10 to 20) kHz	51 µV/V	
	(20 to 30) kHz	0.016 %	
Current			
10 µA	10 Hz	10 nA	Fluke 5730A, Fluke 5725A, Fluke 52120A
	(10 to 40) Hz	7.1 nA	
	(40 to 500) Hz	1.2 nA	
	(0.5 to 1) kHz	3.7 nA	
	(1 to 5) kHz	6.6 nA	
	(5 to 10) kHz	7.5 nA	
(10 to 100) µA	10 Hz	0.010 %	
	(10 to 40) Hz	71 µA/A	
	(40 to 500) Hz	71 µA/A	
	(0.5 to 1) kHz	71 µA/A	
	(1 to 5) kHz	0.016 %	
	(5 to 10) kHz	0.040 %	
(0.1 to 1) mA	10 Hz	0.011 %	
	(10 to 40) Hz	61 µA/A	
	(40 to 500) Hz	61 µA/A	
	(0.5 to 1) kHz	61 µA/A	
	(1 to 5) kHz	0.012 %	
	(5 to 10) kHz	0.040 %	
(1 to 10) mA	10 Hz	0.014 %	
	(10 to 40) Hz	65 µA/A	
	(40 to 500) Hz	62 µA/A	
	(0.5 to 1) kHz	62 µA/A	
	(1 to 5) kHz	0.017 %	
	(5 to 10) kHz	0.060 %	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Analog & Digital Multimeter – AC (cont)			
Current			
(10 to 100) mA	10 Hz (10 to 40) Hz (40 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.014 % 76 µA/A 65 µA/A 65 µA/A 0.017 % 0.061 %	Fluke 5730A, Fluke 5725A, Fluke 52120A
(0.1 to 1) A	10 Hz (10 to 40) Hz (40 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.013 % 0.013 % 0.010 % 0.010 % 0.027 % 0.10 %	
(1 to 10) A	40 Hz (40 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.025 % 0.011 % 0.011 % 0.015 % 0.019 %	
(10 to 20) A	40 Hz (40 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.017 % 0.016 % 0.023 % 0.050 % 0.15 %	
Frequency	10 Hz (10 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 10) MHz	0.24 mHz 0.0025 % 0.0023 % 0.010 % 0.0025 % 0.0023 % 0.0023 %	HP 33120A

VII. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 4, 8] (±)	Comments
RF Power Sensors[3, 11] –			
Calibration Factor:	9 kHz to 1 GHz	1.5 %	R&S NRP-Z55, Keysight 8487A
Type N	(1 to 10) GHz	1.5 %	
3.5 mm	(10 to 18) GHz	1.9 %	
2.92 mm	(18 to 26) GHz	1.9 %	
2.4 mm	(26 to 34) GHz	2.3 %	
	(34 to 38) GHz	2.4 %	
	(38 to 43) GHz	3.5 %	
	(43 to 50) GHz	4.2 %	
RF Power – Measure[3, 11]			
(-10 to 20) dBm	5 Hz to 100 MHz	0.05 dB	Agilent N1911A, Agilent E9304A-H18, Keysight 8487A, R&S NRP-Z55, Keysight V8486A, Keysight W8486A
	100 MHz to 1 GHz	0.05 dB	
	(1 to 8) GHz	0.06 dB	
	(8 to 18) GHz	0.09 dB	
	(18.5 to 26.5) GHz	0.08 dB	
	(26.5 to 33) GHz	0.09 dB	
	(33 to 40) GHz	0.09 dB	
	(40 to 50) GHz	0.23 dB	
	(50 to 75) GHz	0.23 dB	
	(75 to 110) GHz	0.27 dB	
(-20 to -10) dBm	5 Hz to 100 MHz	0.05 dB	
	100 MHz to 1 GHz	0.06 dB	
	(1 to 8) GHz	0.06 dB	
	(8 to 18) GHz	0.09 dB	
	(18.5 to 26.5) GHz	0.08 dB	
	(26.5 to 33) GHz	0.09 dB	
	(33 to 40) GHz	0.09 dB	
	(40 to 50) GHz	0.23 dB	
	(50 to 75) GHz	0.21 dB	
	(75 to 110) GHz	0.27 dB	
(-30 to -20) dBm	5 Hz to 100 MHz	0.19 dB	
	100 MHz to 1 GHz	0.19 dB	
	(1 to 8) GHz	0.19 dB	
	(8 to 18) GHz	0.20 dB	
	(18.5 to 26.5) GHz	0.20 dB	
	(26.5 to 33) GHz	0.20 dB	
	(33 to 40) GHz	0.20 dB	
	(40 to 50) GHz	0.23 dB	
	(50 to 75) GHz	0.21 dB	
	(75 to 110) GHz	0.27 dB	

Parameter/Frequency	Range	CMC[2, 8] (±)	Comments
Reflection Coefficients S_{11}/S_{22} (mag) – Measure[3]			
5 Hz to 3 GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.0059 (lin) 0.0062 (lin) 0.0067 (lin) 0.0073 (lin) 0.0080 (lin) 0.0090 (lin) 0.010 (lin) 0.012 (lin) 0.013 (lin) 0.015 (lin)	Agilent E5061B, Agilent N5230C, Agilent 85032F, Keysight 85054D, Agilent 85052D, Maury 85056KE02, Keysight 85056D, OML V15VNA2-T/R, OML V10VNA2-T/R, Keysight W11644A, Keysight V11644A
(3 to 20) GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.0092 (lin) 0.0093 (lin) 0.0094 (lin) 0.0096 (lin) 0.010 (lin) 0.011 (lin) 0.011 (lin) 0.012 (lin) 0.014 (lin) 0.015 (lin)	
(20 to 40) GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.012 (lin) 0.012 (lin) 0.012 (lin) 0.013 (lin) 0.014 (lin) 0.015 (lin) 0.017 (lin) 0.019 (lin) 0.022 (lin) 0.025 (lin)	
(40 to 50) GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.059 (lin) 0.059 (lin) 0.059 (lin) 0.060 (lin) 0.062 (lin) 0.066 (lin) 0.071 (lin) 0.079 (lin) 0.089 (lin) 0.10 (lin)	

Parameter/Frequency	Range	CMC[2, 7] (±)	Comments
Reflection Coefficients S_{11}/S_{22} (mag) – Measure[3] (cont)			
(50 to 75) GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.060 (lin) 0.060 (lin) 0.060 (lin) 0.061 (lin) 0.063 (lin) 0.067 (lin) 0.072 (lin) 0.080 (lin) 0.090 (lin) 0.11 (lin)	Agilent E5061B, Agilent N5230C, Agilent 85032F, Keysight 85054D, Agilent 85052D, Maury 85056KE02, Keysight 85056D, OML V15VNA2-T/R, OML V10VNA2-T/R, Keysight W11644A, Keysight V11644A
(75 to 110) GHz	(0 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.3) lin (0.3 to 0.4) lin (0.4 to 0.5) lin (0.5 to 0.6) lin (0.6 to 0.7) lin (0.7 to 0.8) lin (0.8 to 0.9) lin (0.9 to 1) lin	0.061 (lin) 0.061 (lin) 0.062 (lin) 0.063 (lin) 0.065 (lin) 0.068 (lin) 0.073 (lin) 0.081 (lin) 0.091 (lin) 0.11 (lin)	
Transmission Coefficients S_{21}/S_{12} –Measure[3]			
5 Hz to 3 GHz	(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	0.09 dB 0.10 dB 0.12 dB 0.14 dB 0.18 dB 0.26 dB 0.49 dB 1.2 dB 3.2 dB	Agilent E5061B, Agilent N5230C, Agilent 85032F, Keysight 85054D, Agilent 85052D, Maury 85056KE02, Keysight 85056D, OML V15VNA2-T/R, OML V10VNA2-T/R, Keysight W11644A, Keysight V11644A
(3 to 20) GHz	(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	0.07 dB 0.08 dB 0.09 dB 0.10 dB 0.14 dB 0.24 dB 0.46 dB 1.1 dB 2.8 dB	

Parameter/Frequency	Range	CMC[2, 7] (±)	Comments
Transmission Coefficients S_{21}/S_{12} –Measure[3] (cont)			
(20 to 40) GHz	(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	0.15 dB 0.15 dB 0.16 dB 0.17 dB 0.21 dB 0.30 dB 0.56 dB 1.3 dB 3.3 dB	Agilent E5061B, Agilent N5230C, Agilent 85032F, Keysight 85054D, Agilent 85052D, Maury 85056KE02, Keysight 85056D, OML V15VNA2-T/R, OML V10VNA2-T/R, Keysight W11644A, Keysight V11644A
(40 to 50) GHz	(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	0.66 dB 0.66 dB 0.67 dB 0.67 dB 0.68 dB 0.72 dB 0.92 dB 1.8 dB 4.4 dB	
(50 to 75) GHz	(0 to 10) dB (10 to 20) dB (20 to 30) dB (30 to 40) dB (40 to 50) dB (50 to 60) dB	0.29 dB 0.29 dB 0.29 dB 0.29 dB 0.29 dB 0.31 dB	
(75 to 110) GHz	(0 to 10) dB (10 to 20) dB (20 to 30) dB (30 to 40) dB (40 to 50) dB (50 to 60) dB	0.29 dB 0.29 dB 0.29 dB 0.29 dB 0.29 dB 0.31 dB	

Parameter/Frequency	Range	CMC[2, 4, 7] (±)	Comments
Tuned RF Level – Measure[3, 11]			
9 kHz to 8 GHz	(0 to 30) dBm (-40 to 0) dBm (-80 to -40) dBm (-120 to -80) dBm (-140 to -120) dBm	0.15 dB 0.16 dB 0.18 dB 0.20 dB 0.21 dB	R&S FSMR R&S NRP-Z37
(8 to 18) GHz	(0 to 30) dBm (-40 to 0) dBm (-80 to -40) dBm (-120 to -80) dBm (-140 to -120) dBm	0.20 dB 0.20 dB 0.22 dB 0.24 dB 0.25 dB	
(18 to 26.5) GHz	(0 to 30) dBm (-40 to 0) dBm (-80 to -40) dBm (-120 to -80) dBm (-140 to -120) dBm	0.27 dB 0.27 dB 0.29 dB 0.31 dB 0.32 dB	
Amplitude Modulation – Measure[3]			
AM Depth CW: 150 kHz to 10 MHz, Rate: 50 Hz to 10 kHz	(5 to 99) %	2.4 %	HP 8902A measuring receiver
CW: 10 MHz to 1.3 GHz Rate: 50 Hz to 10 kHz	(5 to 99) %	1.2%	
Frequency Modulation – Measure[3]			
FM Deviation CW: 150 kHz to 10 MHz, Rate: 50 Hz to 10 kHz	(1 to 40) kHz	2.4 %	HP 8902A measuring receiver
CW: 10 MHz to 1.3 GHz, Rate: 50 Hz to 10 kHz	(1 to 400) kHz	1.4 %	

Parameter/Frequency	Range	CMC[2, 4, 7] (±)	Comments
Phase Modulation – Measure[3]			
Phase Deviation CW: 150 kHz to 10 MHz, Rate: 200 Hz to 10 kHz	(1 to 10) rad	5.0 %	HP 8902A measuring receiver
CW: 10 MHz to 1.3 GHz, Rate: 200 Hz to 10 kHz	(1 to 10) rad	4.0 %	
2nd/3rd Harmonics & Spurious – Measure[3]	20 Hz to 20 GHz (20 to 40) GHz	1.4 dB 1.6 dB	R&S FSMR measuring receiver, R&S FSW43 signal & spectrum analyzer, N9030A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
EFT / Burst Generators[3] – Electrical Fast Transient Damped Oscillatory Burst Simulator			IEC-61000-4-4, IEC-61000-4-18, ISO 7637-2, ISO 7637-3, Mil-Std-461G
Peak Voltage (50 Ω)	(10 to 20) V (20 to 50) V (50 to 200) V (200 to 500) V (0.5 to 1) kV (1 to 2) kV (2 to 2.5) kV (2.5 to 3) kV (3 to 4) kV	3.8 % 3.3 % 3.8 % 3.3 % 3.8 % 3.1 % 2.9 % 2.7 % 3.8 %	Tektronix DPO4102B Haefely PAT 50A
Peak Voltage (1 kΩ)	(10 to 40) V (40 to 100) V (100 to 400) V (0.4 to 1) kV (1 to 2) kV (2 to 4) kV (4 to 5) kV (5 to 6) kV (6 to 8) kV	4.3 % 3.8 % 4.3 % 3.8 % 4.3 % 3.7 % 3.4 % 3.3 % 3.1 %	Tektronix DPO4102B Haefely PAT 1000

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
EFT / Burst Generators[3] – (cont)			
Rise Time / Fall Time / Duration / Burst Period / Repetition Rate / Burst Duration	(1.0 to 2.0) ns (2.0 to 5.0) ns (5.0 to 10.0) ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1.0) µs (1.0 to 2.0) µs (2.0 to 5.0) µs (5.0 to 10.0) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1.0) s (1.0 to 2.0) s (2.0 to 5.0) s	0.70 % 0.28 % 0.15 % 0.075 % 0.031 % 0.060 % 0.067 % 0.027 % 0.12 % 0.058 % 0.023 % 0.059 % 0.031 % 0.013 % 0.083 % 0.042 % 0.061 % 2.8 % 3.5 % 0.023 % 0.059 % 0.030 % 0.016 % 0.058 % 0.067 % 0.027 % 0.21 % 0.10 % 0.042 %	Tektronix DPO4102B
Frequency	(2.5 to 5) kHz (5 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 3) MHz (3 to 10) MHz (10 to 30) MHz (30 to 100) MHz	0.033 % 0.088 % 0.066 % 0.12 % 0.032 % 0.066 % 0.036 % 0.15 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
ESD Simulators –			IEC 61000-4-2, IEC 61340-3-1, ISO 10605
ESD Discharge Current (Ip, Ip2, I30 ns, I60 ns, I130 ns, I180 ns, I360 ns, I400 ns, I800 ns)	(0.10 to 0.30) A (0.30 to 0.50) A (0.50 to 1.0) A (1.0 to 10.0) A (10.0 to 30.0) A (30.0 to 100.0) A (100.0 to 125.0) A (125.0 to 150.0) A	2.0 % 2.1 % 2.0 % 2.1 % 3.0 % 3.9 % 3.4 % 3.0 %	R&S RTO1022, MWF MESD-T04G
Rise / Fall Time	(0.5 to 1.0) ns	0.037 ns	R&S RTO1022
ESD Voltage	(0.1 to 0.5) kV (0.5 to 1) kV (1 to 2) kV (2 to 4) kV (4 to 6) kV (6 to 8) kV (8 to 10) kV (10 to 12) kV (12 to 14) kV (14 to 16) kV (16 to 18) kV (18 to 20) kV (20 to 25) kV (25 to 30) kV	6.8 V 0.70 % 1.4 % 0.75 % 0.61 % 0.48 % 0.40 % 0.40 % 0.60 % 0.32 % 0.30 % 0.28 % 0.29 % 0.26 %	Brandenbuge 149-04 and probe
ESD Peak Current (HBM)	(0.15 to 0.17) A (0.17 to 0.33) A (0.33 to 0.67) A (0.67 to 1.33) A (1.33 to 2.67) A (2.67 to 5.23) A	14 mA 8.2 % 8.2 % 8.2 % 9.0 % 7.2 %	R&S RTO1022, Tektronix CT-1/P6041, Weinschel 24-20-34-LIM
ESD Peak Current (MM)	(1.5 to 1.75) A (1.75 to 3.5) A (3.5 to 7.0) A (7 to 16) A	8.6 % 9.3 % 8.8 % 8.1 %	
Rise / Fall Time (MM or HBM)	(1 to 11) ns	0.037 ns	R&S RTO1022
Decay Time (MM or HBM)	(100 to 200) ns	0.58 ns	
Peak voltage (MM or HBM)	(10 to 100) V (0.1 to 8) kV	3.5 V 3.8 %	R&S RTO1022, Tektronix P6015A

Parameter/Equipment	Range	CMC[2] (±)	Comments
RF Power Meter Calibrators[3] – Power Range: (Volage Measurement, Resistance Measurement)	 3 µW 10 µW 30 µW 100 µW 300 µW 1 mW 3 mW 10 mW 30 mW 100 mW	 0.27 nW 0.44 nW 1.8 nW 2.9 nW 15 nW 0.02 µW 0.10 µW 0.18 µW 0.45 µW 2.5 µW	 HP 3458A
EMC Transducers[3] – Transfer Impedance 5 Hz to 3 GHz	 (-34 to 16) dBΩ (16 to 46) dBΩ (46 to 86) dBΩ	 0.18 dB 1.3 dB 3.6 dB	 CISPR 16-1-2, IEC 61000-4-6; Agilent E5061B Agilent 85032F
Absorbing Clamps – Clamp Factor	 30 MHz to 1 GHz	 2.1 dB	 CISPR 16-1-3, CISPR 16-1-4; Agilent E5061B Agilent 85032F

Parameter/Equipment	Frequency	CMC[2, 8] (±)	Comments
EMI Test Receivers[3] –			
CISPR Pulse Response	9 kHz to 1 GHz	0.7 dB	CISPR 16-1-1, ANSI C63.2; Schwarzbeck IGUU 2918
CISPR Pulse Repetition Frequency Response	9 kHz to 1 GHz	0.7 dB	
Overall Selectivity	9 kHz to 40 GHz	0.08 dB	
IF Rejection Ratio	9 kHz to 40 GHz	0.31 dB	
Image Frequency Rejection Ratio	9 kHz to 40 GHz	0.31 dB	
Other Spurious Response	9 kHz to 40 GHz	0.31 dB	
Random Noise	9 kHz to 1 GHz (1 to 15) GHz (15 to 40) GHz	0.08 dB 0.12 dB 0.22 dB	
RF Impulse Generators[3] –			
Impulse Level	9 kHz to 1 GHz	0.28 dB	Schwarzbeck GUU2918, R&S ESU26
LISNs[3] –			
Impedance	10 Hz to 1 GHz	0.5 Ω	ANSI C63.4, CISPR 25, CISPR 16-1-2, MIL-STD-461G, ISO 7637-2; Agilent E5061B Keysight 85032F
Phase Angle	10 Hz to 15 kHz 15 kHz to 1 GHz	1.2° 0.5°	
Voltage Division Factor	10 Hz to 1 GHz	0.14 dB	
Isolation			
9 kHz to 200 MHz	(0 to 50) dB (50 to 60) dB (60 to 70) dB (70 to 80) dB (80 to 90) dB	0.2 dB 0.3 dB 0.5 dB 1.0 dB 2.7 dB	

Parameter/Equipment	Frequency/Range	CMC[2, 4] (±)	Comments
CDNs[3] –			
Impedance	15 Hz to 300 MHz	3.4 Ω	IEC 61000-4-6, CISPR 16-1-2, Agilent E5061B, Keysight 85032F
Phase Angle	15 Hz to 300 MHz	1.3°	
Voltage Division Factor	15 Hz to 300 MHz	0.15 dB	
ISNs[3] –			
Impedance	9 kHz to 1 GHz	3.3 Ω	CISPR 22, CISPR 32, CISPR 16-1-2, Agilent E5061B, Keysight 85032F
Phase Angle	9 kHz to 1 GHz	1.0°	
Voltage Division Factor	150 kHz to 30 MHz	0.15 dB	
Isolation			
150 kHz to 30 MHz	Up to 70 dB (70 to 80) dB (80 to 110) dB	0.45 dB 1.1 dB 2.5 dB	
Longitudinal Conversion Loss			
150 kHz to 30 MHz	Up to 50 dB (50 to 60) dB (60 to 70) dB (70 to 80) dB	0.22 dB 0.28 dB 0.47 dB 0.70 dB	
EM Clamps[3] –			
Coupling Factor	100 kHz to 1 GHz	0.15 dB	IEC 61000-4-6, Agilent E5061B, Keysight 85032F
Decoupling Factor	100 kHz to 100 MHz	0.52 dB	
Impedance	100 kHz to 16 MHz 16 MHz to 100 MHz	8 % 3 %	
Network Analyzers[3] –			
Magnitude Dynamic Accuracy @ 1 GHz & 2 GHz	(0 to 10) dB (10 to 50) dB (50 to 100) dB	0.026 dB 0.031 dB 0.065 dB	Keysight 8494B, Keysight 8496B

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Noise Figure Meters[3, 11] –			
Noise Figure	10 MHz to 18 GHz	0.4 dB	Agilent 346A
Noise Impulse Simulators[3] –			
Peak Voltage	(10 to 20) V (20 to 50) V (50 to 200) V (200 to 250) V (250 to 500) V (0.5 to 1) kV (1 to 2) kV (2 to 2.5) kV (2.5 to 3) kV (3 to 4) kV	3.8 % 3.3 % 3.8 % 3.4 % 3.3 % 3.8 % 3.1 % 2.8 % 2.7 % 3.8 %	Tektronix DPO4102B, Haefely PAT 50A
Rise/Fall/Duration/Period/ Repetition Rate/Burst Duration	(0.1 to 1.0) ns (1.0 to 2.0) ns (2.0 to 5.0) ns (5.0 to 10.0) ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1.0) µs (1.0 to 2.0) µs (2.0 to 5.0) µs (5.0 to 10.0) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1.0) s (1.0 to 2.0) s (2.0 to 5.0) s	1.4 % 0.70 % 0.28 % 0.16 % 0.080 % 0.032 % 0.060 % 0.070 % 0.028 % 0.12 % 0.058 % 0.023 % 0.059 % 0.031 % 0.013 % 0.084 % 0.042 % 0.061 % 2.8 % 3.5 % 0.023 % 0.059 % 0.030 % 0.016 % 0.058 % 0.029 % 0.012 % 0.21 % 0.10 % 0.042 %	Tektronix DPO4102B

Parameter/Equipment	Range	CMC[2, 4,] (±)	Comments
RF Power Meters[3] –			
Instrument Accuracy	3 µW to 100 mW	0.43 %	HP 11683A
CAL. Out Accuracy			
50 MHz	1 mW	0.56 %	HP 432A, HP 8478B
RF High Power Meters[3, 11] – Calibration Factor			
10 kHz to 1 GHz	(1 to 10) W (10 to 50) W (50 to 100) W (100 to 200) W	7.5 % 1.7 % 1.5 % 1.5 %	Bird 6091

Parameter/Equipment	Frequency	CMC[2, 4,] (±)	Comments
RF Spectrum Analyzers[3, 11] –			
Frequency Readout	5 Hz to 110 GHz	0.96 mH/Hz	SRS FS725, Keysight 53210A, R&S NRP-Z55, Agilent E9304A-H18, Agilent 8487A, Keysight V8486A, Keysight W8486A, Agilent 33250A, HP 83650B, OML S19MS-A, S12MS-A, S08MS-A, HP 8494H, HP 8496H, Keysight 8494B, Keysight 8496B
Marker Frequency Counter	5 Hz to 110 GHz	0.06 Hz	
Frequency Span	5 Hz to 110 GHz	1.4 mH/Hz	
Resolution Bandwidth	1 Hz to 100 MHz	4.2%	
Resolution Bandwidth Selectivity	1 Hz to 100 MHz	0.002 dB	
Resolution Bandwidth Switching Error	1 Hz to 100 MHz	0.001 dB	
Input Attenuator Accuracy	(0 to 100) dB	0.08 dB	
Scale Fidelity	(0 to 100) dB	0.08 dB	
Reference Level Accuracy	(0 to 100) dB	0.06 dB	

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
RF Spectrum Analyzers[3, 11] – (cont)			
Frequency Response	5 Hz to 50 MHz 50 MHz to 8 GHz (8 to 13) GHz (13 to 18) GHz (18 to 20) GHz (20 to 40) GHz (40 to 50) GHz (50 to 75) GHz (75 to 110) GHz	0.11 dB 0.12 dB 0.15 dB 0.19 dB 0.21 dB 0.23 dB 0.37 dB 0.33 dB 0.34 dB	SRS FS725, Keysight 53210A, R&S NRP-Z55, Agilent E9304A-H18, Agilent 8487A, Keysight V8486A, Keysight W8486A, Agilent 33250A, HP 83650B, OML S19MS-A, S12MS-A, S08MS-A, Keysight 8494B, Keysight 8496B
Average Noise Level	5 Hz to 3 GHz (3 to 12) GHz (12 to 18) GHz (18 to 40) GHz (40 to 50) GHz	0.6 dB 1.0 dB 1.4 dB 1.7 dB 2.1 dB	

Parameter/Equipment	Range	CMC[2] (±)	Comments
RF Speed Guns – Speed	(5 to 1000) m/s	0.02 m/s	Agilent 33250A, H.P 53152A, antenna

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
Surge Generators[3] –			IEC 61000-4-5, IEC 61000-4-9, IEC 61000-4-10, IEC 61000-4-12, IEC 61000-4-18, ISO 7637-2, ISO 7637-3, ISO 16750-2, MIL-STD-461G, MIL-STD-1275E
Voltage	(2 to 10) V (10 to 20) V (20 to 50) V (50 to 100) V (100 to 200) V (200 to 500) V (500 to 1000) V (1 to 2) kV (2 to 4) kV (4 to 6) kV (6 to 8) kV (8 to 10) kV (10 to 12) kV (12 to 15) kV (15 to 18) kV (18 to 20) kV	1.1 % 0.76 % 0.44 % 0.42 % 0.47 % 0.17 % 0.40 % 1.6 % 0.88 % 0.89 % 0.77 % 0.79 % 0.66 % 0.77 % 0.68 % 0.61 %	Tektronix DPO4102B, Tektronix P6015A
Current	(1 to 2) A (2 to 5) A (5 to 10) A (10 to 20) A (20 to 50) A (50 to 100) A (100 to 200) A (200 to 500) A (500 to 1000) A (1000 to 2000) A (2000 to 3000) A (3000 to 5000) A (5000 to 7000) A (7000 to 10 000) A (10 000 to 20 000) A (20 000 to 50 000) A (50 000 to 100 000) A	1.4 % 0.73 % 0.62 % 0.61 % 0.56 % 0.42 % 0.61 % 0.56 % 0.042 % 0.61 % 0.93 % 0.56 % 0.61 % 0.43 % 0.59 % 0.24 % 0.13 %	Tektronix DPO4102B, Pearson 110, Pearson 4997, Pearson 4418, Weinschel 24-20-34-LIM, Weinschel 24-40-34-LIM

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
Surge Generators[3] (cont) –			
Rise Time / Fall Time / Duration	(0.2 to 1) ns (1 to 2) ns (2 to 5) ns (5 to 10) ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1) µs (1 to 2) µs (2 to 5) µs (5 to 10) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1) s (1 to 2) s (2 to 5) s (5 to 10) s	1.5 % 0.75 % 0.30 % 0.60 % 0.30 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 %	Tektronix DPO4102B
Frequency	(0.1 to 1) Hz 1 Hz to 10 MHz	0.000 59 % 0.000 12 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Dip Simulators[3] –			IEC 61000-4-11, IEC 61000-4-29, IEC 61000-4-34, ISO 7637-2, ISO 16750-2
Output Voltage			
DC	(1 to 10) V (10 to 50) V (50 to 100) V (100 to 150) V (150 to 200) V (200 to 250) V (250 to 300) V (300 to 400) V	0.065 % 0.0079 % 0.015 % 0.0088 % 1.5 % 1.3 % 1.1 % 1.0 %	HP 34401A
(50 to 60) Hz	(50 to 100) V (100 to 150) V (150 to 200) V (200 to 250) V (250 to 300) V (300 to 400) V	0.34 % 0.31 % 0.24 % 0.21 % 0.18 % 0.15 %	
Output Frequency	(50 to 60) Hz	0.035 %	
Dip & Up Voltage			
DC			
(0 to 12) V 0 % (0 to 40) % (40 to 70) % (70 to 80) % (80 to 120) %	 0 V Up to 4.8 V (4.8 to 8.4) V (8.4 to 9.6) V (9.6 to 14.4) V	 0.22 V 5.3 % 3.6 % 3.3 % 2.8 %	Tektronix DPO4102B, Teseq MD200A
(12 to 25) V 0 % (0 to 40) % (40 to 70) % (70 to 80) % (80 to 120) %	 0 V Up to 10 V (10 to 17.5) V (17.5 to 20) V (20 to 30) V	 0.22 V 3.2 % 2.6 % 2.6 % 2.4 %	
(25 to 50) V 0 % (0 to 40) % (40 to 70) % (70 to 80) % (80 to 120) %	 0 V Up to 20 V (20 to 35) V (35 to 40) V (40 to 60) V	 0.22 V 2.6 % 2.4 % 2.4 % 2.3 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Dip Simulators[3] – (cont)			
Dip & Up Voltage			
DC			
(50 to 100) V			
0 %	0 V	0.24 V	Tektronix DPO4102B, Teseq MD200A
(0 to 40) %	Up to 40 V	2.5 %	
(40 to 70) %	(40 to 70) V	2.4 %	
(70 to 80) %	(70 to 80) V	2.4 %	
(80 to 120) %	(80 to 120) V	2.3 %	
(100 to 200) V			
0 %	0 V	0.23 V	
(0 to 40) %	Up to 80 V	2.6 %	
(40 to 70) %	(80 to 140) V	2.4 %	
(70 to 80) %	(140 to 160) V	2.4 %	
(80 to 120) %	(160 to 240) V	2.3 %	
(200 to 300) V			
0 %	0 V	0.24 V	
(0 to 40) %	Up to 120 V	2.8 %	
(40 to 70) %	(120 to 210) V	2.5 %	
(70 to 80) %	(210 to 240) V	2.4 %	
(80 to 120) %	(240 to 360) V	2.4 %	
(300 to 400) V			
0 %	0 V	0.24 V	
0 % to 40 %	Up to 160 V	2.6 %	
40 % to 70 %	(160 to 280) V	2.4 %	
70 % to 80 %	(280 to 320) V	2.4 %	
80 % to 120 %	(320 to 480) V	2.3 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Dip Simulators[3] – (cont)			
Dip & Up Voltage			
AC (50 Hz ~ 60 Hz)			Tektronix DPO4102B Teseq MD200A
(100 to 110) V			
0 %	0 V	0.24 V	
0 % to 40 %	Up to 160 V	3.1 %	
40 % to 70 %	(160 to 280) V	2.6 %	
70 % to 80 %	(280 to 320) V	2.5 %	
80 % to 120 %	(320 to 480) V	2.4 %	
(110 to 120) V			
0 %	0 V	0.24 V	
0 % to 40 %	Up to 160 V	3.0 %	
40 % to 70 %	(160 to 280) V	2.6 %	
70 % to 80 %	(280 to 320) V	2.5 %	
80 % to 120 %	(320 to 480) V	2.4 %	
(120 to 220) V			
0 %	0 V	0.25 V	
0 % to 40 %	Up to 160 V	3.1 %	
40 % to 70 %	(160 to 280) V	2.6 %	
70 % to 80 %	(280 to 320) V	2.6 %	
80 % to 120 %	(320 to 480) V	2.4 %	
(220 to 230) V			
0 %	0 V	0.25 V	
0 % to 40 %	Up to 160 V	3.1 %	
40 % to 70 %	(160 to 280) V	2.6 %	
70 % to 80 %	(280 to 320) V	2.5 %	
80 % to 120 %	(320 to 480) V	2.4 %	
(230 to 380) V			
0 %	0 V	0.27 V	
0 % to 40 %	Up to 160 V	3.3 %	
40 % to 70 %	(160 to 280) V	2.7 %	
70 % to 80 %	(280 to 320) V	2.6 %	
80 % to 120 %	(320 to 480) V	2.4 %	
(380 to 400) V			
0 %	0 V	0.27 V	
0 % to 40 %	Up to 160 V	3.2 %	
40 % to 70 %	(160 to 280) V	2.6 %	
70 % to 80 %	(280 to 320) V	2.6 %	
80 % to 120 %	(320 to 480) V	2.4 %	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Dip Simulators[3] – (cont)			
Delta Time	0.2 ns (0.2 to 1) ns (1 to 2) ns (2 to 5) ns (5 to 10 ns (10 to 20) ns (20 to 50) ns (50 to 100) ns (100 to 200) ns (200 to 500) ns (0.5 to 1) µs (1 to 2) µs (2 to 5) µs (5 to 10) µs (10 to 20) µs (20 to 50) µs (50 to 100) µs (100 to 200) µs (200 to 500) µs (0.5 to 1) ms (1 to 2) ms (2 to 5) ms (5 to 10) ms (10 to 20) ms (20 to 50) ms (50 to 100) ms (100 to 200) ms (200 to 500) ms (0.5 to 1) s (1 to 2) s (2 to 5) s (5 to 10) s	0.015 ns 1.5 % 0.75 % 0.30 % 0.60 % 0.30 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 % 0.29 % 0.12 % 0.59 %	Tektronix DPO4102B
Inrush Current	50 A (50 to 100) A (100 to 500) A (500 to 1000) A	0.26 A 0.42 % 0.44 % 0.39 %	Tektronix DPO4102B, Pearson 110, Weinschel 24-40-34-LIM
Frequency	10 Hz to 1 kHz	0.12 %	Tektronix DPO4102B

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
E-field Probes[3] – Correction Factor 5 kHz to 18 GHz (18 to 40) GHz	 (1 to 200) V/m (1 to 200) V/m	 13 % 14%	IEEE Std.1309, IEC 61000-4-3; reference E-field probes, power amplifiers, TEM/GTEM cell, FAC (open-ended chamber)
H-field Probes – Frequency Response 10 Hz to 400 kHz 400 kHz to 220 MHz 220 MHz to 1 GHz Linearity 50 Hz	 (0.16 to 40) A/m (0.02 to 2.97) A/m (0.02 to 1.48) A/m (0.16 to 400) A/m	 6 % 14 % 16 % 4 %	IEEE Std. 1309, reference H-field probes, TEM cell, Schwarzbeck HHS5204-12 Helmholz coil

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Antenna VSWR – Up to 60	20 MHz to 18 GHz (18 to 40) GHz (40 to 110) GHz (110 to 140) GHz (140 to 220) GHz	0.02 (lin mag) 0.02 (lin mag) 0.02 (lin mag) 0.03 (lin mag) 0.03 (lin mag)	ANSI C63.5, CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02, Keysight 85056D, Keysight V11644A, Keysight W11644A, Eravant STQ-TO-06-S1, Eravant STQ-TO-05-S1
Antenna Symmetry/Balance – Up to 20 dB	30 MHz to 18 GHz (18 to 40) GHz	1.0 dB 1.2 dB	ANSI C63.5, CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02, Keysight 85056D

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Antenna Radiation Pattern – Up to 70 dB	700 MHz to 18 GHz (18 to 40) GHz	1.4 dB 1.4 dB	CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02, Keysight 85056D
Dipole Antennas – Antenna Factor Up to 80 dB/m	20 MHz to 18 GHz	1.1 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6; Keysight N5234A, Keysight 85054D
Biconical Antennas – Antenna Factor Up to 80 dB/m	20 MHz to 18 GHz (18 to 40) GHz	1.2 dB 1.5 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02
Log Periodic Antennas – Antenna Factor Up to 80 dB/m	20 MHz to 18 GHz (18 to 40) GHz	1.2 dB 1.4 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02
Loop Antennas – Antenna Factor Up to 110 dB/m	10 Hz to 30 MHz	1.3 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6; Standard loop antenna, HP 3458A
Monopole Antennas – Antenna Factor Up to 110 dB/m	1 kHz to 30 MHz	1.4 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6, ECSM; Keysight E5061B, Keysight 85032B

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Horn Antennas – Antenna Factor Up to 70 dB/m	 200 MHz to 18 GHz (18 to 40) GHz (40 to 110) GHz (140 to 220) GHz	 0.9 dB 1.4 dB 0.7 dB 0.8 dB	ANSI C63.5, SAE ARP958, CISPR 16-1-6; Keysight N5234A, Keysight 85054D, Maury 85056KE02, Keysight 85056D, Keysight V11644A, Keysight W11644A, Eravant STQ-TO-06-S1, Eravant STQ-TO-05-S1

VIII. Magnetic Quantities

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Flux Meters	0.1 mWb (0.1 to 1) mWb 1 mWb to 10 Wb	0.59 µWb 0.10 % 0.08 %	Walker MTC-1, HP 34401A
Flux Sources	(0.1 to 1) mWb (1 to 10) mWb (10 to 100) mWb (0.1 to 10) Wb	0.11 mWb/Wb 14 µWb/Wb 6.1 µWb/Wb 12 µWb/Wb	Fluke 8508A, HP 53131A, Rohde & Schwarz RTO1022
Magnetometers	0 mT (>0 to 1) mT (1 to 25) mT (40 to 1000) mT (1 to 1.9) T	2.3 µT 0.66 % 0.27 % 0.071 % 0.077 %	Walker FGM-3D1, KRISS KMS-1003, Ohm-labs CS-10, H.P 34401A, Lakeshore FC-EM7, Metrolab PT-2026
Reference/Standard Magnets	(5 to 20) mT (0.05 to 2) T	0.27 % 0.13 %	Walker FGM-3D1, KRISS KMS-1003, Ohm-labs CS-10, HP 34401A, Lakeshore 475, Lakeshore FC-EM7, Metrolab PT-206

IX. Thermodynamics

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Temperature – Measuring Equipment[3]	(-80 to 500) ℃ (500 to 1100) ℃	0.04 ℃ 1.0 ℃	Accumac AM1960, Fluke 1594A, ASL F650-B-Y, Kambic OB-22/2 ULT, & OB-22/2, Fluke 6055, Heto CB208, KRISS S-Type, WOO JIN BT-003, Nova Nova-high-fur, HART 9101, HP 3458A
Without Sensor	(-80 to 500) ℃ (500 to 1100) ℃	0.03 ℃ 0.07 ℃	IET HARS-X-10-.001-K Fluke 5730A, HART 9101
Temperature – Measure[3]	(-80 to 500) ℃ (500 to 1100) ℃ (1100 to 1600) ℃	0.03 ℃ 1.0 ℃ 2.6 ℃	Accumae AM1960, Fluke 1594A, KRISS S-type, AST Eng. B-type, Hart 9101, HP 34401A
Infrared Radiation Temperature – Measuring Equipment			
Ɛ = 0.995, λ = (8 to 14) µm	(-20 to 0) ℃ (0 to 50) ℃ (50 to 200) ℃	0.8 ℃ 0.5 ℃ 0.6 ℃	Heitronics TRTII, Isotech 982, 976, Sensor Therm CS1500, Developments IR574, Kambic OB-15/2 BBLT, Heitronics KT19.82II
Ɛ = 0.995, λ = 3.9 µm	(200 to 800) ℃ (800 to 1000) ℃	1.4 ℃ 1.6 ℃	
Relative Humidity – Measuring Equipment[3]	(5 to 98) % RH	2.1 % RH	Michell S8000 remote, Hart 1529-R, KRISS H2 humidity generator, Espec PL-3J, Espec PSL-2KP, Shinyei SRH-1R135ADR

Parameter/Equipment	Range	CMC[2, 7] (±)	Comments
Relative Humidity – Measure[3]	(5 to 98) % RH	2.0 % RH	Michell S8000 remote, Hart 1529-R
Dew Point Temperature – Measuring Equipment	(-20 to 47) °C DP	0.7 °C DP	Michell S8000 remote, Shinyei SRH-1R135ADR

X. Acoustics & Vibration

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Sound Calibrator –			
Multifunction Calibrator			
(94 to 114) dB	31.5 Hz (31.5 to 8000) Hz (8000 to 12 500) Hz	0.12 dB 0.09 dB 0.10 dB	G.R.A.S 40AF & 12AQ, Agilent 34401A, HP 53131A,
Pistonphone, Sound Calibrator			
(114 to 134) dB (94 to 134) dB	250 Hz 1000 Hz	0.08 dB 0.09 dB	G.R.A.S 40AG & 12AQ, Agilent 34401A, HP 53131A

Parameter/Equipment	Frequency	CMC[2, 4] (±)	Comments
Microphones –			
Pistonphone			
(-50.00 dB to -20.00) dB	250 Hz	0.14 dB	G.R.A.S 42AP, NI PCI-4461, G.R.A.S 90CA
3-port coupler			
(-50.00 to -20.00) dB	20 Hz (20 to 25) Hz (25 to 31.5) Hz (31.5 to 40) Hz (40 to 50) Hz (50 to 63) Hz (63 to 4000) Hz (4000 to 6300) Hz (6300 to 8000) Hz (8000 to 10 000) Hz (10 000 to 12 500) Hz (12 500 to 16 000) Hz (16 000 to 20 000) Hz	0.15 dB 0.13 dB 0.12 dB 0.11 dB 0.10 dB 0.09 dB 0.08 dB 0.09 dB 0.11 dB 0.12 dB 0.13 dB 0.24 dB 0.35 dB	G.R.A.S 40AF, Zoontech ZT601 & ZT602, HP 34401A, HP 53131A, HP 33120A
Sound Level Meters[3] –			
Multifunction Calibrator			
(94.0 to 114.0) dB	(63 to 125) Hz (125 to 2000) Hz (2000 to 4000) Hz (4000 to 8000) Hz	0.3 dB 0.2 dB 0.3 dB 0.4 dB	B&K 4226
3-Port Coupler			
(84.0 to 104.0) dB	20 Hz (20 to 50) Hz (50 to 125) Hz (125 to 2500) Hz (2500 to 8000) Hz (8000 to 12 500) Hz (12 500 to 20 000) Hz	0.5 dB 0.4 dB 0.3 dB 0.2 dB 0.3 dB 0.4 dB 0.5 dB	G.R.A.S 40AF, Zoontech ZT601 & ZT602, HP 34401A, HP 53131A, HP 33120A
Vibration Calibrators[3]	(20 to 1250) Hz	1.9 %	B&K 8305, Agilent 34401A, H.P 53131A, Tektronix DPO4102B

Parameter/Equipment	Frequency	CMC[2, 4] (±)	Comments
Vibration Transducer[3] –			
Sensitivity (Normal)	1 Hz (1 to 5) Hz (5 to 8) Hz (8 to 20) Hz (20 to 630) Hz (630 to 1250) Hz (1250 to 2500) Hz (2500 to 5000) Hz (5000 to 10 000) Hz (10 000 to 15 000) Hz (15 000 to 20 000) Hz	1.9 % 2.0 % 1.9 % 1.2 % 1.1 % 1.2 % 1.7 % 2.1 % 2.8 % 3.7 % 4.5 %	B&K 8305, Keysight 34461A, Tektronix TDS2012C, Agilent 33210A, Ni PXI-5122, B&K 4809, B&K 2718, APS APS-113,APS APS-125
Sensitivity (Shock) (0.1 – 11) ms	200 m/s^2 (200 to 500) m/s^2 (500 to 2000) m/s^2 (2000 to 20 000) m/s^2 (20 000 to 100 000) m/s^2	3.6 % 3.2 % 3.1 % 3.6 % 4.3 %	PCB 301A12, Tektronix DPO4102B, PCB 482C, Spektra SE-201
Vibration Measuring Instruments –			
Acceleration	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (100 to 630) Hz (630 to 1250) Hz (1250 to 2500) Hz	1.7 % 1.8 % 1.7 % 1.8 % 1.9 % 2.1 %	B&K 8305, Keysight 34461A, Agilent 33210A, B&K 4809, B&K 2718
Velocity	10 Hz (10 to 160) Hz (160 to 630) Hz (630 to 1250) Hz (1250 to 2500) Hz	1.8 % 1.7 % 1.8 % 2.1 % 2.7 %	
Displacement	(10 to 160) Hz (160 to 315) Hz	1.6 % 2.2 %	
Shock	200 m/s^2 (200 to 500) m/s^2 (500 to 1000) m/s^2 (1000 to 1500) m/s^2 (1500 to 2000) m/s^2	4.9 % 3.5% 3.3 % 3.2 % 3.7 %	PCB 301A12, Tektronix DPO4102B, PCB 482C, IMV I260-SA1M

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Vibration Tester[3] –			
Acceleration	(3 to 10) Hz (10 to 630) Hz (630 to 3000) Hz	3.1 % 2.9 % 3.1 %	B&K 8305, PCB 301A12, B&K 2692-0S4, PCB 482C, Keysight 34461A, H.P 53131A, NI PXI-5122, Tektronix DPO4102B
Frequency	(3 to 8) Hz (8 to 3000) Hz	0.59 mHz 5.8 mHz	
Displacement	(3 to 10) Hz (10 to 40) Hz (40 to 100) Hz (100 to 160) Hz (160 to 315) Hz	3.3 % 2.9 % 3.0 % 3.6 % 8.5 %	
Shock	(200 to 1000) m/s² (1000 to 20 000) m/s² (20 000 to 100 000) m/s²	5.0 % 5.3 % 5.7 %	

XI. Optical Quantities

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Illuminance Meters	1 lx (1 to 2000) lx	3.0 % 2.8 %	Fluke Y5020, Optronic OL83A, Optronic OL730C, Optronic P-854, standard lamp 2856 K, Pimac 50 W, Agilent 34401A, HP 34401A
UV Irradiance Meters –			
365 nm	60 µW/cm² to 200 mW/cm²	4.8 %	Optronic OL730A-5A Keithlet 485
405 nm	60 µW/cm² to 70 mW/cm²	4.8 %	
Luminance Meters[3] –			
Luminance	(2 to 10) cd/㎡ (10 to 100) cd/㎡ (100 to 1000) cd/㎡ (1000 to 13 000) cd/㎡	2.9 % 1.8 % 1.7 % 1.9 %	Optronic OL455-125A-1, Instrument Systems CAS140D153U31

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Total Luminous Flux Meters[3] – Total Luminous Flux	(70 to 2198) lm	4.0%	Kriss C70215-0, halogen lamp 5 W, Ohm-labs CS-20, Keysight N8741A, Keysight 34461A, Instrument Systems ISP1000
Luminous Intensity Meters[3] – Luminous Intensity	(865.4 to 924.6) cd	3.7%	FEL lamp 1 kW, Ohm-labs CS-20, Keysight N8741A, Keysight 34461A
Color Temperature Meters –		.	Ohm-labs CS-20, Keysight N8741A, Keysight 34461A
Color Temperature	(2836 to 2876) K	22 K	2856 K 1 kW
Color Temperature[3]	(2752 to 2759) K	22 K	2772 K 150 W
Color Temperature	(3011 to 3058) K	22 K	3038 K 1 kW
Color Temperature Standard Lamps – Color Temperature	2856 K	22 K	Instrument Systems CAD140D, Keysight 34461A, Ohm-labs CS-20, 2 856 K 1 kW

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Colorimeter; Source Color[3] –			
Color Coordinates (CIE 1931 x, y)			
CIE-A	X: 0.448 to 0.454 Y: 0.411 to 0.417	0.003 x 0.003 y	Fluke Y5020, Optronic OL83A, 2 856 K 400 W, 2 856 K 50 W, HP 34401A, Optronic OL455-125A-1, Instrument Systems CAS140D153U31
Red	X: 0.671 to 0.677 Y: 0.321 to 0.327	0.004 x 0.004 y	
Green	X: 0.375 to 0.381 Y: 0.537 to 0.543	0.004 x 0.004 y	
Blue	X: 0.146 to 0.152 Y: 0.090 to 0.096	0.004 x 0.004 y	
White	X: 0.394 to 0.400 Y: 0.389 to 0.395	0.004 x 0.004 y	
Total Luminous Flux Standard Lamps –			
Total Luminous Flux	(70 to 2198) lm	3.6 %	Halogen lamp 5 W, Ohm-labs CS-20, Keysight N8741A, Keysight 34461A, Instrument Systems ISP1000
Luminous Intensity Lamps –			
Luminous Intensity	(16.21 to 906.3) cd	2.6 %	Optronic P-854, KEITHLEY 6485, Ohm-labs CS-20, Keysight N8741A, Keysight 34461A,

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Spectral Irradiance Lamps –			
Spectral Irradiance	250 nm (250 to 255) nm (255 to 265) nm (265 to 275) nm (275 to 285) nm (285 to 295) nm (295 to 305) nm (305 to 330) nm (330 to 370) nm (370 to 390) nm (390 to 475) nm (475 to 1020) nm	7.7 % 6.7 % 6.4 % 5.9 % 5.4 % 5.2 % 4.5 % 4.1 % 3.6 % 2.9 % 2.6 % 2.2 %	Spectral irradiance standard lamp, Instrument Systems CAS140D(LED25), Ohm-labs CS-20, Keysight N8741A, Keysight 34461A
Total Spectral Radiant Flux Lamps[3] –			
Total Spectral Radiant Flux	350 nm (350 to 365) nm (365 to 380) nm (380 to 410) nm (410 to 480) nm (480 to 850) nm	5.8 % 5.2 % 4.5 % 3.6 % 3.0 % 2.6 %	Total spectral radiant flux standard lamp, Instrument Systems CAS140D(ISP1000), Ohm-labs CS-20, Keysight N8741A, Keysight 34461A

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Luminance Standard Lamps –			
Luminance	(2 to 10) cd/m² (10 to 100) cd/m² (100 to 1000) cd/m² (1000 to 13 000) cd/m²	2.9 % 1.7 % 1.6 % 1.9 %	Optronic OL455-125A-1, Instrument Systems CAS140D153U31
Color Coordinates (CIE 1931 x, y)			
CIE-A	X: 0.448 to 0.454 Y: 0.411 to 0.417	0.003 x 0.003 y	
Red	X: 0.671 to 0.677 Y: 0.321 to 0.327	0.004 x 0.004 y	
Green	X: 0.375 to 0.381 Y: 0.537 to 0.543	0.004 x 0.004 y	
Blue	X: 0.146 to 0.152 Y: 0.090 to 0.096	0.004 x 0.004 y	
White	X: 0.394 to 0.400 Y: 0.389 to 0.395	0.004 x 0.004 y	
Spectral Radiance Standard Sources –			
Spectral Radiance	380 nm (380 to 395) nm (395 to 410) nm (410 to 425) nm (425 to 450) nm (450 to 1030) nm (1030 to 1035) nm	4.3 % 4.1 % 3.6 % 3.1 % 2.8 % 2.5 % 2.6 %	Optronic OL455-125A-1 Instrument Systems CAS140D153U31

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Spectral Irradiance Meters –			
Wavelength	(350 to 850) nm	0.51 nm	Oriel #6035, (HgAr), Thorlabs CP532
Spectral Irradiance (0.124 to 211) $mW \cdot m^{-2} \cdot nm^{-1}$	250 nm (250 to 255) nm (255 to 275) nm (275 to 295) nm (295 to 340) nm (340 to 400) nm (400 to 590) nm (590 to 1020) nm	7.9 % 7.5 % 6.1 % 4.9 % 4.0 % 3.1 % 2.5 % 2.0 %	Spectral irradiance standard lamps, Keysight N8741A, Ohm-labs CS-20, Keysight 34461A
Total Spectral Radiant Flux Meters[3] –			
Wavelength	(350 to 850) nm	0.51 nm	Oriel #6035, (HgAr), Thorlabs CP532
Total Spectral Radiant Flux (1.2 to 90) $mW \cdot nm^{-1}$	350 nm (350 to 355) nm (355 to 370) nm (370 to 390) nm (390 to 425) nm (425 to 455) nm (455 to 850) nm	4.4 % 4.2 % 3.8 % 3.1 % 2.5 % 2.1 % 2.0 %	Total spectral radiant flux lamp, Keysight N8741A, Ohm-labs CS-20 Keysight 34461A
Spectral Radiance Meters –			
Wavelength	(350 to 850) nm	0.51 nm	Oriel #6035, (HgAr), Thorlabs CP532
Spectral Radiance (0.9 to 36.5) $mW \cdot m^{-2} nm^{-1} sr^{-1}$	380 nm (380 to 395) nm (395 to 410) nm (410 to 425) nm (425 to 445) nm (445 to 465) nm (465 to 1030) nm (1030 to 1035) nm	4.1 % 3.9 % 3.4 % 2.9 % 2.6 % 2.4 % 2.2 % 2.4 %	Optronic OL455-125A-1

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Optical Sources –			
Wavelength	1310 nm 1550 nm	8.5×10^{-7} nm 5.9×10^{-7} nm	ADCMT 8471, wavelength CMC is a relative value
Optical output	1310 nm, 1550 nm (-60 to 0) dBm	0.07 dB	Expo IQS-1500
Optical Meters –			
Wavelength	1310 nm, 1550 nm	0.091 nm	EXFO IQS-1500 optical calibration system
Optical input	1310 nm, 1550 nm (-60 to 0) dBm	0.07 dB	
Linearity	1310 nm, 1550 nm (-60 to 0) dB	0.07 dB	
Resolution	1310 nm, 1550 nm RBW (0.1 to 1) nm	0.091 nm	
Optical Attenuators –			
Attenuation	1310 nm, 1550 nm (-60 to 0) dB	0.07 dB	EXFO IQS-1500 optical calibration system

Parameter/Equipment	Range	CMC[2] (±)	Comments
Optical Time Domain Reflectometers –			
Wavelength	1310 nm, 1550 nm	0.36 nm	Optical fiber spectrum analyzer
Length			
1310 nm	3 km 13 km	0.1 m 0.34 m	KRISS 3 km/ 13 km optical fiber standard length
1550 nm	3 km 13 km	0.1 m 0.34 m	
Return Loss			
1310 nm	3 km (2.79 dB) 13 km (7.26 dB)	0.10 dB 0.20 dB	KRISS 3 km/ 13 km optical fiber standard loss
1550 nm	3 km (1.56 dB) 13 km (4.07 dB)	0.08 dB 0.10 dB	

XII. Chemical Quantities

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Gas Analyzers[3] –			
Oxygen (O_2)	Up to 21 cmol/mol	2.2 %	Standard gas: O_2
Carbon monoxide (CO)	Up to 310 µmol/mol	2.1 %	Standard gas: CO
Methane (CH_4)	Up to 2.2 cmol/mol	3.7 %	Standard gas: CH_4
Carbon Dioxide (CO_2)	Up to 10.5 cmol/mol	2.0 %	Standard gas: CO_2
hydrogen sulfide (H_2S)	Up to 53 µmol/mol	5.0 %	Standard Gas: H_2S

[1] This laboratory offers commercial and field calibration & dimension testing services.

[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. 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, percentages are percentage of reading, unless otherwise indicated.

[5] In the statement of CMC, the unitless CMC was calculated as a relative standard uncertainty of measurement.

[6] This scope meets A2LA's *P112 Flexible Scope Policy*.

[7] The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.

[8] 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. CMCs 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.

[9] In the statement of CMC, l_o is the nominal value of the length, including numerical value and unit for a quantitative-based mathematical equation.

[10] This laboratory meets R205 – Specific Requirements: Calibration Laboratory Accreditation Program for the types of dimensional tests listed and is considered equivalent to that of a calibration.

[11] Mismatch uncertainty is not included in the CMC values.

Accredited Laboratory

A2LA has accredited

HCT CO., LTD

Icheon-si, Gyungki-do, South Korea

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *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 April 2017*).

Presented this 15th day of March 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 5825.01
Valid to December 31, 2025

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