

CALIBRATION LABORATORIES

NVLAP LAB CODE 200972-0


SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

<p>ESSCO CALIBRATION LABORATORY 27 Industrial Avenue, Unit #9 Chelmsford, MA 01824-3618 Mr. Michael Stanislovitis Phone: 800-325-2201 x148 Fax 978-256-1331 E-mail: mstanislovitis@esscolab.com URL: http://www.esscolab.com</p>	<p>Fields of Calibration Dimensional Electromagnetics – DC/Low Frequency Time and Frequency Mechanical Electromagnetics – RF/Microwave Thermodynamic</p> <p>This laboratory is compliant to ANSI/NCSL Z540-1-1994; Part 1. (NVLAP Code: 20/A01)</p>
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Note 3}	Remarks
DIMENSIONAL			
GAGE BLOCKS (20/D03)			
Gage Block Calibration	0.01 in to 0.049 in 0.05 in to 0.15 in > 0.15 in to 1 in > 1 in to 2 in > 2 in to 3 in > 3 in to 4 in > 4 in to 5 in > 5 in to 6 in > 6 in to 8 in > 8 in to 10 in > 10 in to 12 in > 12 in to 16 in > 16 in to 20 in	2.7 μ in 2.5 μ in 3.0 μ in 4.2 μ in 5.0 μ in 6.2 μ in 8.2 μ in 8.8 μ in 10 μ in 12 μ in 14 μ in 16 μ in 21 μ in	Comparison to master blocks
LENGTH & DIAMETER (20/D05)			
Length Standards, Rods	0.1 in to 20 in	2.3 μ in/in + 9.3 μ in	Comparison to gage blocks
Calipers ^{Note 4}	0 in to 80 in	5.3 μ in/in + 270 μ in	Comparison to gage blocks
Thickness Setting Discs	0.01 in to 0.24 in	21 μ in	Comparison to gage blocks

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Micrometer ^{Note 4}	0 in to 40 in	2.1 $\mu\text{in/in}$ + 28 μin	Comparison to gage blocks
Supermicrometer	0 in to 1 in	12 μin	Comparison to gage blocks
Anvil Parallelism ^{Note 4}	0 μin nominal	13 μin	Optical flat
Anvil Flatness ^{Note 4}	0 μin nominal	5.0 μin	Optical flat
Optical Flats	0 μin nominal	2.3 μin	Comparison to standard flat
Parallelism	0 μin nominal	2.7 μin	Gage block comparator
Bore Micrometers and Gages	0.0625 in to 8 in	7.8 $\mu\text{in/in}$ + 47 μin	Comparison to master rings
Dial/Test Indicator ^{Note 4}	0 in to 12 in	6.7 $\mu\text{in/in}$ + 1.5 μin	Gage blocks or Micrometer head
Height Gages ^{Note 4}	0 in to 40 in	1.3 $\mu\text{in/in}$ + 15 μin	Comparison to gage blocks
Depth Gages ^{Note 4}	0 in to 12 in	23 $\mu\text{in/in}$ + 11 μin	Comparison to gage blocks
Durometer (Indicator Length)	0.05 in 0.10 in 0.20 in	0.00018 in 0.00018 in 0.00021 in	(Note: Spring force component listed in mechanical section)
Electronic Gage Amplifier	0 in to 1 in	8.0 μin	Comparison to gage blocks
Crimp Tools – Crimp Height	0.011 to 1 in	0.00026 in	Indirect comparison to crimp micrometer
MEASURING WIRES (20/D07)			
Thread Wires	4 threads/in to 120 threads/in	8.3 μin	Labmaster, gage blocks
SPHERICAL DIAMETER, PLAIN PLUG/RINGS (20/D11)			
Pin Gages ^{Note 4}	0.011 in to 1 in	60 μin	Supermicrometer

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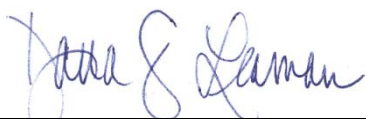
CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Note 3}	Remarks
Plain Plugs	0 in to 12 in	3.0 $\mu\text{in/in}$ + 3 μin	Labmaster
Plain Ring Gages Discrete sizes	0.04 in 0.125 in 0.25 in 1.0 in 4.0 in	5.9 μin 4.8 μin 4.7 μin 4.9 μin 7.5 μin	Comparison to master gages
Variable Range	0.02 in to 0.04 in > 0.04 in to 1.0 in > 1.0 in to 12 in	8.2 μin 15 μin 1.5 $\mu\text{in/in}$ + 15 μin	Comparison to master gages
Crimp Tools – Die Dimension	0.011 in to 0.5 in	0.00062 in	Pin gages
SURVEYING RODS and TAPES (20/D13)			
Rules	0 in to 40 in > 40 in to 80 in > 80 in to 120 in	0.0016 in 0.0032 in 0.0047 in	Max Levy Microrule
Tape Measures	0 ft to 100 ft	0.0063+.00025 in/ft	Tape-to-tape method
THREADED PLUG/RINGS (20/D14)			
Thread Plugs – Pitch Diameter 6 TPI to 80 TPI 0.25 mm to 10 mm (Pitch)	0.01 in to 5 in 0.1 mm to 127 mm	96 μin 2.4 μm	Thread wires/ Supermicrometer

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty ($k=2$) ^{Note 3}	Remarks
ELECTROMAGNETICS – DC/LOW FREQUENCY				
AC RESISTANCE and CURRENT (20/E02)				
Alternating Current– Generate ^{Note 4}	0 μA to 220 μA	10 Hz to 20 Hz 20 Hz to 40 Hz	283 $\mu\text{A/A}$ + 19 nA 0.16 mA/A + 10 nA	Fluke 5730A

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	220 µA to 2.2 mA	40 Hz to 1 kHz	0.12 mA/A + 10 nA	
		1 kHz to 5 kHz	0.25 mA/A + 12 nA	
		5 kHz to 10 kHz	0.83 mA/A + 65 nA	
	2.2 mA to 22 mA	10 Hz to 20 Hz	0.20 mA/A + 0.14 µA	
		20 Hz to 40 Hz	0.16 mA/A + 32 nA	
		40 Hz to 1 kHz	0.15 mA/A + 44 nA	
		1 kHz to 5 kHz	0.23 mA/A + 130 nA	
		5 kHz to 10 kHz	1.2 mA/A + 0.94 µA	
	22 mA to 220 mA	10 Hz to 20 Hz	0.25 mA/A + 1.2 µA	
		20 Hz to 40 Hz	0.11 mA/A + 1.0 µA	
		40 Hz to 1 kHz	0.10 mA/A + 0.35 µA	
		1 kHz to 5 kHz	0.18 mA/A + 0.55 µA	
		5 kHz to 10 kHz	0.80 mA/A + 5.0 µA	
	220 mA to 2.2 A	10 Hz to 20 Hz	0.24 mA/A + 3.9 µA	
		20 Hz to 40 Hz	0.14 mA/A + 3.4 µA	
		40 Hz to 1 kHz	0.099 mA/A + 2.5 µA	
		1 kHz to 5 kHz	0.17 mA/A + 3.5 µA	
		5 kHz to 10 kHz	0.79 mA/A + 12 µA	
2.2 A to 11 A	40 Hz to 1 kHz	0.24 mA/A + 34 µA		
	1 kHz to 5 kHz	0.35 mA/A + 79 µA		
	5 kHz to 10 kHz	6.0 mA/A + 160 µA		
11 A to 20.5 A	40 Hz to 1 kHz	0.54 mA/A + 0.19 mA	Fluke 5730A w/5725A	
	1 kHz to 5 kHz	1.1 mA/A + 0.48 mA		
	5 kHz to 10 kHz	4.2 mA/A + 0.89 mA		
11 A to 20.5 A	45 Hz to 100 Hz	1.4 mA/A + 5.7 mA	Fluke 5520A	
	100 Hz to 1 kHz	1.8 mA/A + 5.7 mA		
	1 kHz to 5 kHz	35 mA/A + 5.8 mA		



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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty ($k=2$) ^{Note 3}	Remarks
(no field capability)	20 A to 120 A	10 Hz to 65 Hz 65 Hz to 300 Hz 0.3 kHz to 1 kHz 1 kHz to 3 kHz 3 kHz to 6 kHz 6 kHz to 10 kHz	1.3 mA/A 2.0 mA/A 6.3 mA/A 16 mA/A 33 mA/A 76 mA/A	Fluke 52120A/Fluke 5700A
Current Clamp, Non-Toroidal ^{Note 4}	20 A to 1000 A	45 Hz to 65 Hz 65 Hz to 440 Hz	7.2 mA/A + 0.27 A 12 mA/A + 0.27 A	Fluke 5500A Coil
Current Clamp, Toroidal ^{Note 4}	20 A to 1000 A	45 Hz to 65 Hz 65 Hz to 440 Hz	3.3 mA/A + 27 mA 9.2 mA/A + 29 mA	
Current Clamp	0 A to 300 A 120 A to 1000 A 120 A to 3000 A	1 kHz to 3 kHz 0.3 kHz to 1 kHz 10 Hz to 300 Hz	6.7 mA/A 5.6 mA/A 5.6 mA/A	Fluke 5210A/3 kA Coil
AC Current – Measure ^{Note 4}	1 nA to 200 μ A	1 Hz to 10 Hz 10 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	0.37 mA/A + 0.023 μ A 0.39 mA/A + 0.023 μ A 0.84 mA/A + 0.023 μ A 4.6 mA/A + 0.023 μ A	Fluke 8508A DMM
	200 μ A to 2 mA	1 Hz to 10 Hz 10 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	0.36 mA/A + 0.23 μ A 0.35 mA/A + 0.23 μ A 0.82 mA/A + 0.23 μ A 4.6 mA/A + 0.23 μ A	
	2 mA to 20 mA	1 Hz to 10 Hz 10 Hz to 10 kHz 10 kHz to 30 kHz 30 kHz to 100 kHz	0.37 mA/A + 2.3 μ A 0.36 mA/A + 2.3 μ A 0.83 mA/A + 2.3 μ A 4.6 mA/A + 2.3 μ A	

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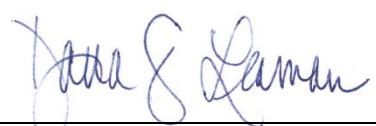
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	20 mA to 200 mA	1 Hz to 10 Hz	0.37 mA/A + 23 μ A	Fluke 5790B and A40B Shunts
		10 Hz to 10 kHz	0.34 mA/A + 23 μ A	
		10 k Hz to 30 kHz	0.73 mA/A + 23 μ A	
	200 mA to 2 A	10 Hz to 2 kHz	0.72 mA/A + 0.23 mA	
		2 kHz to 10 kHz	0.85 mA/A + 0.23 mA	
		10 kHz to 30 kHz	3.5 mA/A + 0.23 mA	
	2 A to 20 A	10 Hz to 2 kHz	0.95 mA/A + 2.8 mA	
		2 kHz to 10 kHz	2.9 mA/A + 2.3 mA	
	100 nA to 1 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	66 μ A/A	
		40 Hz to 20 kHz	53 μ A/A	
		20 kHz to 50 kHz	61 μ A/A	
		50 kHz to 100 kHz	110 μ A/A	
	1 mA to 10 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	57 μ A/A	
		40 Hz to 20 kHz	27 μ A/A	
		20 kHz to 50 kHz	41 μ A/A	
		50 kHz to 100 kHz	61 μ A/A	
	10 mA to 20 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	57 μ A/A	
		40 Hz to 20 kHz	27 μ A/A	
		20 kHz to 50 kHz	41 μ A/A	
		50 kHz to 100 kHz	61 μ A/A	
	20 mA to 50 mA	10 Hz to 20 Hz	160 μ A/A	
20 Hz to 40 Hz		57 μ A/A		
40 Hz to 20 kHz		28 μ A/A		
20 kHz to 50 kHz		44 μ A/A		
50 kHz to 100 kHz		62 μ A/A		



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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	50 mA to 100 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	57 μ A/A	
		40 Hz to 20 kHz	27 μ A/A	
		20 kHz to 50 kHz	42 μ A/A	
		50 kHz to 100 kHz	59 μ A/A	
	100 mA to 200 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	57 μ A/A	
		40 Hz to 20 kHz	28 μ A/A	
		20 kHz to 50 kHz	42 μ A/A	
		50 kHz to 100 kHz	59 μ A/A	
	200 mA to 500 mA	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	58 μ A/A	
		40 Hz to 20 kHz	28 μ A/A	
		20 kHz to 50 kHz	42 μ A/A	
		50 kHz to 100 kHz	60 μ A/A	
	0.5 A to 1 A	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	58 μ A/A	
		40 Hz to 20 kHz	29 μ A/A	
		20 kHz to 50 kHz	44 μ A/A	
		50 kHz to 100 kHz	62 μ A/A	
1 A to 2 A	10 Hz to 20 Hz	160 μ A/A		
	20 Hz to 40 Hz	58 μ A/A		
	40 Hz to 20 kHz	29 μ A/A		
	20 kHz to 50 kHz	47 μ A/A		
	50 kHz to 100 kHz	77 μ A/A		
2 A to 5 A	10 Hz to 20 Hz	160 μ A/A		
	20 Hz to 40 Hz	60 μ A/A		
	40 Hz to 20 kHz	34 μ A/A		
	20 kHz to 50 kHz	53 μ A/A		
	50 kHz to 100 kHz	95 μ A/A		

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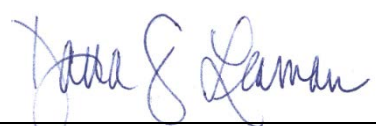
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
AC Resistance – Generate	5 A to 10 A	10 Hz to 20 Hz	160 μ A/A	Agilent 16074A
		20 Hz to 40 Hz	70 μ A/A	
		40 Hz to 20 kHz	48 μ A/A	
		20 kHz to 50 kHz	74 μ A/A	
		50 kHz to 100 kHz	110 μ A/A	
	10 A to 20 A	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	67 μ A/A	
		40 Hz to 20 kHz	59 μ A/A	
		20 kHz to 50 kHz	86 μ A/A	
		50 kHz to 100 kHz	140 μ A/A	
	20 A to 50 A	10 Hz to 20 Hz	160 μ A/A	
		20 Hz to 40 Hz	75 μ A/A	
		40 Hz to 20 kHz	74 μ A/A	
		20 kHz to 50 kHz	96 μ A/A	
		50 kHz to 100 kHz	170 μ A/A	
	50 A to 100 A	10 Hz to 20 Hz	170 μ A/A	
		20 Hz to 40 Hz	82 μ A/A	
		40 Hz to 20 kHz	93 μ A/A	
		20 kHz to 50 kHz	110 μ A/A	
		50 kHz to 100 kHz	200 μ A/A	
0.1 Ω	> 0.1 Hz to 1 MHz	0.18 %		
1 Ω	1 MHz to 13 MHz	0.27 %		
	> 0.1 Hz to 1 MHz	0.12 %		
10 Ω	1 MHz to 13 MHz	0.12 %		
	> 0.1 Hz to 1 MHz	0.036 %		
100 Ω	1 MHz to 13 MHz	0.036 %		
	> 0.1 Hz to 1 MHz	0.035 %		
1 k Ω	1 MHz to 13 MHz	0.036 %		
	> 0.1 Hz to 1 MHz	0.035 %		



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AC Resistance – Measure	10 kΩ	1 MHz to 13 MHz	0.035 %	Agilent 4284A
		> 0.1 Hz to 1 MHz	0.040 %	
		1 MHz to 13 MHz	0.14 %	
	100 kΩ	> 0.1 Hz to 1 MHz	0.099 %	
		1 MHz to 13 MHz	0.62 %	
	0 Ω to 15 Ω	50 Hz to 1 MHz	0.14 %	
15 Ω to 320 kΩ	100 Hz to 100 kHz	0.08 %		
320 kΩ to 10 MΩ	100 Hz to 100 kHz	0.26 %		

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
DC RESISTANCE and CURRENT (20/E05)			
Direct Current – Generate ^{Note 4}	0 pA to 2 pA	4.9 fA/pA + 12 fA	Keithley 263
	2 pA to 20 pA	4.1 fA/pA + 17 fA	
	20 pA to 200 pA	2.9 fA/pA + 42 fA	
	0.2 nA to 2 nA	0.76 pA/nA + 0.12 pA	
	2 nA to 20 nA	0.76 pA/nA + 1.2 pA	
	20 nA to 200 nA	0.41 pA/nA + 12 pA	Fluke 5730A
	0.2 μA to 2 μA	0.29 nA/μA + 0.12 nA	
	2 μA to 20 μA	0.27 nA/μA + 1.7 nA	
	20 μA to 200 μA	0.29 nA/μA + 12 nA	
	2 μA to 220 μA	23 μA/A + 1.6 nA	
	220 μA to 2.2 mA	23 μA/A + 4.0 nA	
	2.2 mA to 20 mA	27 μA/A + 38 nA	
	22 mA to 220 mA	33 μA/A + 0.25 μA	
	220 mA to 2.2 A	40 μA/A + 7.7 μA	
	2.2 A to 11 A	0.11 mA/A + 0.26 mA	
11 A to 20 A	0.77 mA/A + 0.77 mA		
20 A to 120 A	0.43 mA/A		



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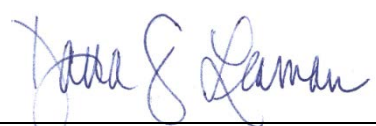
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Current Clamp – Non-Toroidal ^{Note 4}	20 A to 1000 A	5.8 mA/A + 0.58 A	Fluke 5520A w/5500 coil
Current Clamp, Toroidal ^{Note 4}	20 A to 1000 A	3.0 mA/A + 0.058 A	
Current Clamp	1000 A to 2500 A	4.9 mA/A	Fluke 52120A / 3 kA Coil
Direct Current – Measure ^{Note 4}	0 pA to 2 pA	16 fA/A + 13 fA	Keithley 617
	2 pA to 20 pA	14 fA/A + 110 fA	
	20 pA to 200 pA	18 fA/A + 110 fA	
	200 pA to 2 nA	2.6 pA/A + 1.3 pA	
	2 nA to 20 nA	2.8 pA/A + 5.3 pA	
	20 nA to 100 nA	34 μ A/A + 47 pA	
	100 nA to 1 μ A	17 μ A/A	HP 3458A/002
	1 μ A to 200 μ A	7.7 μ A/A + 0.45 nA	Fluke 8508A
	200 μ A to 2 mA	8 μ A/A + 3.8 nA	
	2 mA to 20 mA	8.8 μ A/A + 39 nA	
	20 mA to 200 mA	35 μ A/A + 0.78 μ A	
	0.2 A to 2 A	0.17 mA/A + 16 μ A	
	2 A to 20 A	0.39 mA/A + 0.42 mA	Guildline 9230/ Fluke 8508A
20 A to 100 A	0.23 mA/A		
Resistance – Variable Generate ^{Note 4}	0 Ω to 11 Ω	47 $\mu\Omega/\Omega$ + 1.2 m Ω	Fluke 5520A
	11 Ω to 33 Ω	40 $\mu\Omega/\Omega$ + 1.7 m Ω	
	33 Ω to 110 Ω	34 $\mu\Omega/\Omega$ + 1.8 m Ω	
	110 Ω to 330 Ω	34 $\mu\Omega/\Omega$ + 2.4 m Ω	
	330 Ω to 1.1 k Ω	34 $\mu\Omega/\Omega$ + 2.4 m Ω	
	1.1 k Ω to 3.3 k Ω	34 $\mu\Omega/\Omega$ + 22 m Ω	
	3.3 k Ω to 11 k Ω	34 $\mu\Omega/\Omega$ + 23 m Ω	
	11 k Ω to 33 k Ω	34 $\mu\Omega/\Omega$ + 0.22 Ω	
	33 k Ω to 110 k Ω	34 $\mu\Omega/\Omega$ + 0.24 Ω	
	110 k Ω to 330 k Ω	44 $\mu\Omega/\Omega$ + 1.6 Ω	



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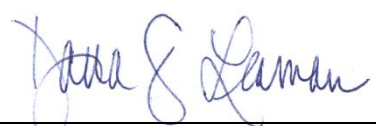
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Resistance – Fixed Generate Instrument-Based ^{Note 4}	330 kΩ to 1.1 MΩ	40 μΩ/Ω + 3.0 Ω	Fluke 5730A
	1.1 MΩ to 3.3 MΩ	0.12 mΩ/Ω	
	3.3 MΩ to 11 MΩ	0.16 mΩ/Ω + 86 Ω	
	11 MΩ to 33 MΩ	0.70 mΩ/Ω + 2.5 kΩ	
	33 MΩ to 110 MΩ	0.76 mΩ/Ω + 3.5 kΩ	
	110 MΩ to 330 MΩ	0.65 mΩ/Ω	
	330 MΩ to 1100 MΩ	15 mΩ/Ω + 730 kΩ	
	1 Ω	37 μΩ	
	1.9 Ω	54 μΩ	
	10 Ω	0.11 mΩ	
	19 Ω	0.13 mΩ	
	100 Ω	0.55 mΩ	
	190 Ω	0.90 mΩ	
	1 kΩ	5.9 mΩ	
1.9 kΩ	7.4 mΩ		
10 kΩ	44 mΩ	Keithley 263	
19 kΩ	0.074 Ω		
100 kΩ	0.71 Ω		
190 kΩ	0.75 Ω		
1 MΩ	10 Ω		
1.9 MΩ	13 Ω		
10 MΩ	0.22 kΩ		
19 MΩ	0.49 kΩ		
100 MΩ	6.4 kΩ		
10 GΩ	0.35 GΩ		
100 GΩ	3.6 GΩ		
Fixed Resistor-Based	0.001 Ω	0.12 μΩ	L & N 4333 Guildline 9230/100 Guildline 9230/15 Fluke 742A-1 Fluke 742A-1.9 Guildline 9334-10
	0.01 Ω	0.14 μΩ	
	0.1 Ω	0.78 μΩ	
	1 Ω	2.1 μΩ	
	1.9 Ω	1.8 μΩ	
	10 Ω	11 μΩ	



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Resistance – Measure ^{Note 4}	100 Ω	0.18 mΩ	Guildline 9334-100 Fluke 742A-1K Fluke 742A-10K Fluke 742A-19K Fluke 742A-100K Fluke 742A-1M Guildline 9334-10M Fluke 742A-19M Guildline 9334-100M Guildline 9334-1G IET VRS-100-10-1K-BP	
	1 kΩ	3.5 mΩ		
	10 kΩ	25 mΩ		
	19 kΩ	49 mΩ		
	100 kΩ	0.28 Ω		
	1 MΩ	2.3 Ω		
	10 MΩ	110 Ω		
	19 MΩ	0.38 kΩ		
	100 MΩ	8.4 kΩ		
	1 GΩ	38 kΩ		
	10 GΩ	21 MΩ		
	100 GΩ	99 MΩ		
	1 TΩ	5.0 GΩ		
		0 Ω to 2 Ω	3.5 μΩ/Ω + 1.1 μΩ	Fluke 8508 transfer accuracy
		2 Ω to 20 Ω	2.2 μΩ/Ω + 11 μΩ	
		20 Ω to 200 Ω	1.6 μΩ/Ω + 14 μΩ	
		200 Ω to 2 kΩ	3.6 μΩ/Ω + 69 μΩ	
		2 kΩ to 20 kΩ	2.0 μΩ/Ω + 1.1 mΩ	
		20 kΩ to 200 kΩ	2.3 μΩ/Ω + 10 mΩ	
		200 kΩ to 2 MΩ	2.6 μΩ/Ω + 0.67 Ω	
	2 MΩ to 20 MΩ	20 μΩ/Ω + 70 Ω		
	20 MΩ to 200 MΩ	41 μΩ/Ω + 14 kΩ		
	0.2 MΩ to 2 GΩ	0.11 mΩ/Ω + 97 kΩ		
	2 GΩ to 20 GΩ	0.69 mΩ/Ω + 9.5 MΩ		
(No field capability above 20 GΩ)	20 GΩ to 200 GΩ	0.93 mΩ/Ω	Guildline 6530B	
	200 GΩ to 2 TΩ	1.4 mΩ/Ω		
	2 TΩ to 20 TΩ	4.0 mΩ/Ω		
	20 TΩ to 200 TΩ	6.9 mΩ/Ω		
DC VOLTAGE (20/E06)				
DC Voltage – Variable Generate ^{Note 4}	0 V to 220 mV 0.22 V to 2.2 V	2.2 μV/V + 0.39 μV 2.0 μV/V + 0.62 μV	Fluke 5730A	



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
DC Voltage – Fixed Generate	2.2 V to 11 V 11 V to 22 V 22 V to 220 V 220 V to 1.1 kV	1.2 μ V/V + 2.3 μ V 1.3 μ V/V + 3.2 μ V 2.0 μ V/V + 38 μ V 2.4 μ V/V + 0.31 mV	Hipotronics Source and Vitrek 4700 w/HLV70
	1.0 kV to 50 kV	0.49 mV/V + 0.21 V	
DC Voltage – Measure Note 4	10 V	3.8 μ V	Fluke 732A
DC Voltage – Measure Note 4	0 V to 200 mV	1.3 μ V/V + 23 nV	Fluke 8508A w/732A,752A
	200 mV to 2 V	0.56 μ V/V + 0.15 μ V	
	2 V to 20 V	0.80 μ V/V + 1.3 μ V	
	20 V to 200 V	0.49 μ V/V + 1.9 μ V	
	200 V to 1000 V	0.71 μ V/V + 13 μ V	
DC Voltage – Measure Note 4	1 kV to 50 kV	0.49 mV/V + 0.21 V	Vitrek 4700 w/HLV70
	50 kV to 70 kV	0.47 mV/V + 1.4 V	

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
AC VOLTAGE (20/E09)				
AC Voltage – Generate Note 4	0 V to 2.2 mV	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.24 mV/V + 4.3 μ V 0.11 mV/V + 4.3 μ V 0.051 mV/V + 4.3 μ V 0.068 mV/V + 4.7 μ V 0.16 mV/V + 5.9 μ V 0.29 mV/V + 11 μ V 0.71 mV/V + 23 μ V 2.0 mV/V + 25 μ V	Fluke 5730A

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	2.2 mV to 22 mV	10 Hz to 20 Hz	0.20 mV/V + 4.8 μV	
		20 Hz to 40 Hz	0.077 mV/V + 4.7 μV	
		40 Hz to 20 kHz	51 μV/V + 4.4 μV	
		20 kHz to 50 kHz	0.065 mV/V + 5.3 μV	
		50 kHz to 100 kHz	0.15 mV/V + 6.7 μV	
		100 kHz to 300 kHz	0.29 mV/V + 12 μV	
		300 kHz to 500 kHz	0.68 mV/V + 27 μV	
		500 kHz to 1 MHz	1.8 mV/V + 46 μV	
	22 mV to 220 mV	10 Hz to 20 Hz	0.21 mV/V + 15 μV	
		20 Hz to 40 Hz	0.076 mV/V + 10 μV	
		40 Hz to 20 kHz	48 μV/V + 11 μV	
		20 kHz to 50 kHz	89 μV/V + 7.5 μV	
		50 kHz to 100 kHz	0.20 mV/V + 17 μV	
		100 kHz to 300 kHz	0.36 mV/V + 20 μV	
		300 kHz to 500 kHz	0.89 mV/V + 27 μV	
		500 kHz to 1 MHz	2.6 mV/V + 51 μV	
	220 mV to 2.2 V	10 Hz to 20 Hz	0.22 mV/V + 40 μV	
		20 Hz to 40 Hz	85 μV/V + 15 μV	
		40 Hz to 20 kHz	41 μV/V + 9.6 μV	
		20 kHz to 50 kHz	65 μV/V + 12 μV	
		50 kHz to 100 kHz	0.098 mV/V + 32 μV	
		100 kHz to 300 kHz	0.28 mV/V + 79 μV	
		300 kHz to 500 kHz	0.83 mV/V + 0.20 mV	
		500 kHz to 1 MHz	1.4 mV/V + 0.27 mV	
	2.2 V to 22 V	10 Hz to 20 Hz	0.22 mV/V + 0.40 mV	
		20 Hz to 40 Hz	83 μV/V + 0.15 mV	
		40 Hz to 20 kHz	40 μV/V + 46 μV	
		20 kHz to 50 kHz	67 μV/V + 93 μV	
50 kHz to 100 kHz		0.11 mV/V + 0.16 mV		
100 kHz to 300 kHz		0.32 mV/V + 0.53 mV		
300 kHz to 500 kHz		0.90 mV/V + 1.8 mV		
500 kHz to 1 MHz		1.7 mV/V + 0.29 mV		



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	22 V to 220 V	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.22 mV/V + 4 mV 87 µV/V + 1.4 mV 51 µV/V + 0.52 mV 77 µV/V + 0.94 mV 0.15 mV/V + 2.3 mV 0.63 mV/V + 16 mV 3.8 mV/V + 38 mV 7.1 mV/V + 79 mV	limits on voltage versus frequency
	220 V to 750 V	15 Hz to 50 Hz 50 Hz to 1 kHz 30 kHz to 50 kHz 50 kHz to 100 kHz	0.26 mV/V + 16 mV 58 µV/V + 3.0 mV 0.34 mV/V + 11 mV 1.3 mV/V + 43 mV	Fluke 5730A w/5725A
	220 V to 1100 V	40 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 30 kHz	0.070 mV/V + 4.3 mV 0.11 mV/V + 5.8 mV 0.34 mV/V + 11 mV	Quadtech Sentry 20 w/Vitretek 4700 & HLV70
	1.1 kV to 5 kV	50 Hz to 60 Hz	2.5 mV/V + 1.5 V	
	5 kV to 44 kV	50 Hz to 60 Hz	1.4 mV/V + 27 V	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}


LF AC VOLTAGE 20 (/E09)												
792A Source & Measure AC Voltage	Expanded uncertainties are in $\mu\text{V/V}$ for the level shown at left at indicated frequencies below											
	10 Hz	20 Hz	40 Hz	100 Hz	1k Hz	10 kHz	20 kHz	50 kHz	100 kHz	300 kHz	500 kHz	1 MHz
2 mV	630	580	570	570	570	570	570	880	1100	1800	2900	4100
6 mV	270	220	220	220	220	220	220	320	400	650	1100	2000
20 mV	130	92	88	88	84	82	82	120	160	270	520	990
60 mV	72	49	48	48	40	35	35	43	83	140	210	310
200 mV	39	30	28	32	21	22	23	32	49	78	110	190
600 mV	32	20	14	15	16	16	15	16	18	25	28	60
0.6 V	29	20	14	14	14	14	14	15	17	25	29	42
1 V	29	20	15	14	14	14	14	15	17	24	28	42
2 V	30	22	18	17	16	16	16	17	18	25	30	44
6 V	29	21	16	16	15	15	15	16	16	25	29	43
20 V	32	22	15	15	15	15	15	16	17	25	30	54
60 V	30	22	16	16	17	16	17	17	18	29		
200 V	43	21	17	17	16	16	16	18	21			
600 V			26	26	26	26	26	28	48			
1000 V			16	17	16	16	17					

Additional point: 1000 V at 30 kHz, expanded uncertainty = 16 $\mu\text{V/V}$

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
AC Voltage – Measure ^{Note 4}	0 V to 2.2 mV	10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.13 mV/V + 0.98 μV 0.10 mV/V + 0.98 μV 99 $\mu\text{V/V}$ + 0.98 μV 89 $\mu\text{V/V}$ + 1.5 μV 0.10 mV/V + 1.9 μV 0.21 mV/V + 3.1 μV 0.60 mV/V + 6.2 μV 2.2 mV/V + 6.1 μV	Fluke 5790B/05

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	2.2 mV to 7 mV	10 Hz to 20 Hz	84 $\mu\text{V/V} + 0.99 \mu\text{V}$	
		20 Hz to 40 Hz	53 $\mu\text{V/V} + 0.98 \mu\text{V}$	
		40 Hz to 20 kHz	51 $\mu\text{V/V} + 1.0 \mu\text{V}$	
		20 kHz to 50 kHz	21 $\mu\text{V/V} + 1.6 \mu\text{V}$	
		50 kHz to 100 kHz	60 $\mu\text{V/V} + 1.9 \mu\text{V}$	
		100 kHz to 300 kHz	0.15 mV/V + 3.0 μV	
		300 kHz to 500 kHz	0.38 mV/V + 6.2 μV	
		500 kHz to 1 MHz	1.6 mV/V + 6.1 μV	
	7 mV to 22 mV	10 Hz to 20 Hz	81 $\mu\text{V/V} + 0.82 \mu\text{V}$	
		20 Hz to 40 Hz	49 $\mu\text{V/V} + 0.93 \mu\text{V}$	
		40 Hz to 20 kHz	41 $\mu\text{V/V} + 0.95 \mu\text{V}$	
		20 kHz to 50 kHz	49 $\mu\text{V/V} + 1.5 \mu\text{V}$	
		50 kHz to 100 kHz	76 $\mu\text{V/V} + 1.8 \mu\text{V}$	
		100 kHz to 300 kHz	0.18 mV/V + 2.7 μV	
		300 kHz to 500 kHz	0.37 mV/V + 5.9 μV	
		500 kHz to 1 MHz	0.80 mV/V + 6.1 μV	
22 mV to 70 mV	10 Hz to 20 Hz	63 $\mu\text{V/V} + 1.1 \mu\text{V}$		
	20 Hz to 40 Hz	40 $\mu\text{V/V} + 0.97 \mu\text{V}$		
	40 Hz to 20 kHz	32 $\mu\text{V/V} + 1.2 \mu\text{V}$		
	20 kHz to 50 kHz	48 $\mu\text{V/V} + 1.3 \mu\text{V}$		
	50 kHz to 100 kHz	90 $\mu\text{V/V} + 1.4 \mu\text{V}$		
	100 kHz to 300 kHz	0.19 mV/V + 2.2 μV		
	300 kHz to 500 kHz	0.33 mV/V + 5.3 μV		
	500 kHz to 1 MHz	0.81 mV/V + 5.9 μV		
70 mV to 220 mV	10 Hz to 20 Hz	12 $\mu\text{V/V} + 38 \mu\text{V}$		
	20 Hz to 40 Hz	24 $\mu\text{V/V} + 1.9 \mu\text{V}$		
	40 Hz to 20 kHz	2.8 $\mu\text{V/V} + 36 \mu\text{V}$		
	20 kHz to 50 kHz	30 $\mu\text{V/V} + 1.3 \mu\text{V}$		
	50 kHz to 100 kHz	62 $\mu\text{V/V} + 0.85 \mu\text{V}$		
	100 kHz to 300 kHz	125 $\mu\text{V/V} + 2.6 \mu\text{V}$		



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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks	
	220 mV to 700 mV	300 kHz to 500 kHz	259 $\mu\text{V/V} + 5.7 \mu\text{V}$		
		500 kHz to 1 MHz	772 $\mu\text{V/V} + 6.1 \mu\text{V}$		
		700 mV to 2.2 V	10 Hz to 20 Hz		54 $\mu\text{V/V} + 1.2 \mu\text{V}$
			20 Hz to 40 Hz		24 $\mu\text{V/V} + 1.2 \mu\text{V}$
			40 Hz to 20 kHz		22 $\mu\text{V/V} + 1.0 \mu\text{V}$
			20 kHz to 50 kHz		21 $\mu\text{V/V} + 1.5 \mu\text{V}$
			50 kHz to 100 kHz		47 $\mu\text{V/V} + 1.8 \mu\text{V}$
			100 kHz to 300 kHz		105 $\mu\text{V/V} + 3.4 \mu\text{V}$
			300 kHz to 500 kHz		214 $\mu\text{V/V} + 6.2 \mu\text{V}$
			500 kHz to 1 MHz		749 $\mu\text{V/V} + 7.9 \mu\text{V}$
	2.2 V to 7 V	10 Hz to 20 Hz	50 $\mu\text{V/V} + 1.1 \mu\text{V}$		
		20 Hz to 40 Hz	23 $\mu\text{V/V} + 0.36 \mu\text{V}$		
		40 Hz to 20 kHz	18 $\mu\text{V/V} + 0.06 \mu\text{V}$		
		20 kHz to 50 kHz	19 $\mu\text{V/V} + 0.08 \mu\text{V}$		
		50 kHz to 100 kHz	42 $\mu\text{V/V} + 0.10 \mu\text{V}$		
		100 kHz to 300 kHz	90 $\mu\text{V/V} + 0.66 \mu\text{V}$		
		300 kHz to 500 kHz	183 $\mu\text{V/V} + 1.5 \mu\text{V}$		
		500 kHz to 1 MHz	729 $\mu\text{V/V} + 7.5 \mu\text{V}$		
	7 V to 22 V	10 Hz to 20 Hz	50 $\mu\text{V/V} + 1.8 \mu\text{V}$		
		20 Hz to 40 Hz	23 $\mu\text{V/V} + 2.8 \mu\text{V}$		
		40 Hz to 20 kHz	18 $\text{mV/V} + 0.87 \mu\text{V}$		
		20 kHz to 50 kHz	21 $\mu\text{V/V} + 0.25 \mu\text{V}$		
		50 kHz to 100 kHz	50 $\mu\text{V/V} + 28 \text{nV}$		
		100 kHz to 300 kHz	119 $\mu\text{V/V} + 4.3 \mu\text{V}$		
300 kHz to 500 kHz		304 $\mu\text{V/V} - 15 \mu\text{V}$			
500 kHz to 1 MHz		958 $\mu\text{V/V} + 44 \mu\text{V}$			



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	22 V to 70 V	20 kHz to 50 kHz	22 μ V/V + 1.3 μ V	
		50 kHz to 100 kHz	51 μ V/V + 1.6 μ V	
		100 kHz to 300 kHz	119 μ V/V + 5.2 μ V	
		300 kHz to 500 kHz	296 μ V/V + 18 μ V	
		500 kHz to 1 MHz	960 μ V/V + 51 μ V	
	70 V to 220 V	10 Hz to 20 Hz	51 μ V/V + 6.3 μ V	
		20 Hz to 40 Hz	25 μ V/V + 24 μ V	
		40 Hz to 20 kHz	21 μ V/V + 5.8 μ V	
		20 kHz to 50 kHz	22 μ V/V + 71 μ V	
		50 kHz to 100 kHz	53 μ V/V + 110 μ V	
		100 kHz to 300 kHz	120 μ V/V + 50 μ V	
		300 kHz to 500 kHz	304 μ V/V + 20 μ V	
		500 kHz to 1 MHz	962 μ V/V + 6.3 μ V	
	220 V to 700 V	10 Hz to 20 Hz	51 μ V/V + 27 μ V	
		20 Hz to 40 Hz	27 μ V/V + 51 μ V	
		40 Hz to 20 kHz	22 μ V/V + 8.8 μ V	
		20 kHz to 50 kHz	29 μ V/V + 24 μ V	
		50 kHz to 100 kHz	57 μ V/V + 57 μ V	
	700 V to 1100 V	100 kHz to 300 kHz	136 μ V/V + 24 μ V	
		300 kHz to 500 kHz	390 μ V/V + 8.4 μ V	
10 Hz to 20 Hz		38 μ V/V + 21 mV		
20 Hz to 40 Hz		13 μ V/V + 25 mV		
40 Hz to 20 kHz		25 μ V/V + 0.20 mV		
	220 V to 700 V	20 kHz to 50 kHz	88 μ V/V + 0.43 mV	
		50 kHz to 100 kHz	391 μ V/V + 0.20 mV	
		10 Hz to 20 Hz	57 μ V/V + 47 μ V	
		20 Hz to 40 Hz	29 μ V/V + 93 μ V	
		40 Hz to 20 kHz	24 μ V/V + 2.3 mV	
	700 V to 1100 V	20 kHz to 50 kHz	87 μ V/V + 0.69 mV	
		50 kHz to 100 kHz	390 μ V/V + 0.16 mV	



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
AC Voltage – Wideband Generate ^{Note 4}	1 mV to 10 mV	1 MHz to 4 MHz 4 MHz to 8 MHz	54 mV/V + 11 µV 155 mV/V + 8.2 µV	HP 3458A
	10 mV to 100 mV	1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	11.5 mV/V + 19 µV 30.4 mV/V + 130 µV 30 mV/V + 220 µV 116 mV/V + 160 µV	
	0.1 V to 1 V	1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	11.6 mV/V + 110 µV 30.4 mV/V + 1.3 mV 30 mV/V + 2.2 mV 116 mV/V + 1.6 mV	
	1 V to 10 V	1 MHz to 2 MHz 2 MHz to 4 MHz 4 MHz to 8 MHz 8 MHz to 10 MHz	11.6 mV/V + 1.2 mV 31 mV/V + 6.2 mV 31 mV/V + 7.9 mV 116 mV/V + 8.5 mV	
	1.1 kV to 5 kV 5 kV to 50 kV	50 Hz to 60 Hz 50 Hz to 60 Hz	2.5 mV/V + 1.5 V 1.4 mV/V + 27 V	Vitrek 4700 w/HLV70
	0.3 mV to 1.1 mV	10 Hz to 30 Hz 30 Hz to 120 kHz 120 kHz to 2 MHz 2 MHz to 10 MHz 10 MHz to 20 MHz 20 MHz to 30 MHz 30 MHz to 50 MHz	0.24 % 0.085 % 0.39 % 0.55 % 0.71 % 2.3 % 3.6 %	Fluke 5730A / 05
	1.1 mV to 3.3 mV	10 Hz to 30 Hz 30 Hz to 120 kHz 120 kHz to 2 MHz	0.24 % 0.08 % 0.16 %	



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
		2 MHz to 10 MHz	0.31 %	
		10 MHz to 20 MHz	0.47 %	
		20 MHz to 30 MHz	1.3 %	
		30 MHz to 50 MHz	2.5 %	
	3.3 mV to 11 mV	10 Hz to 30 Hz	0.23 %	
		30 Hz to 120 kHz	0.079 %	
		120 kHz to 2 MHz	0.10 %	
		2 MHz to 10 MHz	0.18 %	
		10 MHz to 20 MHz	0.35 %	
		20 MHz to 30 MHz	0.82 %	
		30 MHz to 50 MHz	1.7 %	
		11 mV to 33 mV	10 Hz to 30 Hz	
	30 Hz to 120 kHz		0.079 %	
	120 kHz to 2 MHz		0.089 %	
	2 MHz to 10 MHz		0.17 %	
	10 MHz to 20 MHz		0.33 %	
	20 MHz to 30 MHz		0.80 %	
	30 MHz to 50 MHz		1.7 %	
	33 mV to 110 mV		10 Hz to 30 Hz	
		30 Hz to 2 MHz	0.083 %	
2 MHz to 10 MHz		0.16 %		
10 MHz to 20 MHz		0.33 %		
20 MHz to 30 MHz		0.80 %		
30 MHz to 50 MHz		1.7 %		
110 mV to 330 mV	10 Hz to 30 Hz	0.23 %		
	30 Hz to 2 MHz	0.082 %		
	2 MHz to 10 MHz	0.16 %		

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
AC Voltage – Wideband Measure	0.33 V to 1.1 V	10 MHz to 20 MHz	0.32 %	Fluke 5790B/05
		20 MHz to 30 MHz	0.79 %	
		30 MHz to 50 MHz	1.7 %	
	1.1 V to 3.5 V	10 Hz to 30 Hz	0.23 %	
		30 Hz to 2 MHz	0.081 %	
		2 MHz to 10 MHz	0.16 %	
		10 MHz to 20 MHz	0.32 %	
		20 MHz to 30 MHz	0.79 %	
		30 MHz to 50 MHz	1.7 %	
	0.1 mV to 2.2 mV	10 Hz to 30 Hz	0.088 %	
		30 Hz to 120 kHz	0.050 %	
		120 kHz to 2 MHz	0.13 %	
		2 MHz to 10 MHz	0.21 %	
		10 MHz to 20 MHz	0.32 %	
		20 MHz to 30 MHz	0.71 %	
	2.2 mV to 7 mV	30 MHz to 50 MHz	0.88 %	
10 Hz to 30 Hz		0.082 %		
30 Hz to 120 kHz		0.051 %		
120 kHz to 500 kHz		0.079 %		
500 kHz to 2 MHz		0.080 %		
		2 MHz to 10 MHz	0.11 %	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	7 mV to 22 mV	10 MHz to 20 MHz	0.17 %	
		20 MHz to 30 MHz	0.42 %	
		30 MHz to 50 MHz	0.46 %	
	22 mV to 70 mV	10 Hz to 30 Hz	0.081 %	
		30 Hz to 120 kHz	0.040 %	
		120 kHz to 500 kHz	0.055 %	
		500 kHz to 2 MHz	0.056 %	
		2 MHz to 10 MHz	0.084 %	
		10 MHz to 20 MHz	0.15 %	
		20 MHz to 30 MHz	0.32 %	
	70 mV to 220 mV	30 MHz to 50 MHz	0.52 %	
		10 Hz to 30 Hz	0.10 %	
		30 Hz to 120 kHz	0.040 %	
		120 kHz to 500 kHz	0.040 %	
		500 kHz to 2 MHz	0.042 %	
		2 MHz to 10 MHz	0.084 %	
10 MHz to 20 MHz		0.12 %		
220 mV to 700 mV	20 MHz to 30 MHz	0.31 %		
	30 MHz to 50 MHz	0.51 %		
	10 Hz to 30 Hz	0.080 %		
	30 Hz to 120 kHz	0.032 %		
	120 kHz to 500 kHz	0.032 %		
	220 mV to 700 mV	500 kHz to 2 MHz	0.041 %	
		2 MHz to 10 MHz	0.083 %	
		10 MHz to 20 MHz	0.13 %	
	220 mV to 700 mV	20 MHz to 30 MHz	0.28 %	
		30 MHz to 50 MHz	0.51 %	
		10 Hz to 30 Hz	0.079 %	
	220 mV to 700 mV	30 Hz to 120 kHz	0.025 %	
		120 kHz to 500 kHz	0.025 %	



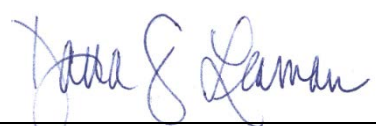
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	0.7 V to 2.2 V	500 kHz to 1.2 MHz	0.041 %	
		1.2 MHz to 2 MHz	0.041 %	
		2 MHz to 10 MHz	0.083 %	
		10 MHz to 20 MHz	0.13 %	
		20 MHz to 30 MHz	0.30 %	
		30 MHz to 50 MHz	0.51 %	
		10 Hz to 30 Hz	0.080 %	
	2.2 V to 7 V	30 Hz to 120 kHz	0.025 %	
		120 kHz to 500 kHz	0.025 %	
		500 kHz to 2 MHz	0.041 %	
		2 MHz to 10 MHz	0.10 %	
		10 MHz to 20 MHz	0.13 %	
		20 MHz to 30 MHz	0.30 %	
		30 MHz to 50 MHz	0.50 %	
CAPACITANCE (20/E10)				
Capacitance – Measure	0.001 nF to 1.2 μF	100 Hz to 10 kHz	8 μF/F	ESI 701B
	1.2 μF to 800 μF 800 μF to 100 mF 100 mF to 1000 mF		1.3 nF/μF 1.7 μF/mF + 4.3 nF 3.1 μF/mF + 57 μF	HP 4284A
Capacitance – Generate, Variable ^{Note 4}	0.19 nF to 0.39 nF	10 Hz to 10 kHz	5.8 pF/nF + 12 pF	Fluke 5520A



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
Capacitance – Generate, Fixed <small>Note 4</small>	0.4 nF to 1.1 nF	10 Hz to 10 kHz	5.8 pF/nF + 12 pF	GenRad 1404 & 1409
	1.1 nF to 3.3 nF	10 Hz to 3 kHz	5.8 pF/nF + 12 pF	
	3.3 nF to 11 nF	10 Hz to 1 kHz	2.9 pF/nF + 12 pF	
	11 nF to 33 nF	10 Hz to 1 kHz	2.9 pF/nF + 120 pF	
	33 nF to 110 nF	10 Hz to 1 kHz	2.9 pF/nF + 120 pF	
	110 nF to 330 nF	10 Hz to 1 kHz	2.9 pF/nF + 350 pF	
	0.33 μF to 1.1 μF	10 Hz to 600 Hz	2.9 nF/μF + 1.2 nF	
	1.1 μF to 3.3 μF	10 Hz to 300 Hz	2.9 nF/μF + 3.5 nF	
	3.3 μF to 11 μF	10 Hz to 150 Hz	2.9 nF/μF + 11 nF	
	11 μF to 33 μF	10 Hz to 120 Hz	4.7 nF/μF + 35 nF	
	33 μF to 110 μF	10 Hz to 80 Hz	5.2 nF/μF + 110 nF	
	110 μF to 330 μF	DC to 50 Hz	5.2 nF/μF + 350 nF	
	0.33 mF to 1.1 mF	DC to 20 Hz	5.2 μF/mF + 1.2 μF	
	1.1 mF to 3.3 mF	DC to 6 Hz	5.2 μF/mF + 3.5 μF	
	3.3 mF to 11 mF	DC to 2 Hz	5.2 μF/mF + 12 μF	
	11 mF to 33 mF	DC to 0.6 Hz	8.7 μF/mF + 35 μF	
	33 mF to 110 mF	DC to 0.2 Hz	13 μF/mF + 120 μF	
	1 pF	100 Hz, 120 Hz, or 1 kHz	3.9 fF	GenRad 1417
	10 pF		12 fF	
	100 pF		6.1 fF	
	1000 pF		24 fF	
	0.001 μF		0.60 pF	
	0.002 μF		1.2 pF	
	0.005 μF		3.0 pF	
	0.01 μF		6.0 pF	
	0.1 μF		410 pF	
	1 μF		600 pF	
	10 μF	100 Hz, 120 Hz, or 1 kHz	0.034 μF	GenRad 1417
100 μF	0.34 μF			
1 mF	3.6 μF			



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	10 mF 100 mF 1 F	100 Hz, 120 Hz	52 µF 0.41 mF 5.8 mF	
	10 nF 100 nF 1 µF	120 Hz to 100 kHz	3.5 pF 35 pF 0.36 nF	HP 16385A HP 16386A HP 16387A
	1 pF	1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.083 fF 0.11 fF 0.24 fF 0.42 fF 0.63 fF 0.88 fF 2.5 fF 3.7 fF	HP 16381A
	10 pF	1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.70 fF 0.70 fF 0.70 fF 0.72 fF 0.75 fF 0.79 fF 1.3 fF 1.7 fF	HP 16382A
	100 pF	1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	7.0 fF 7.1 fF 7.6 fF 8.9 fF 11 fF 14 fF 34 fF 49 fF	HP 16383A

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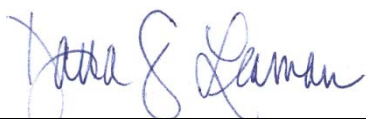
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	1000 pF	1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	4.0 nF 86 nF 0.16 pF 0.29 pF 0.44 pF 0.62 pF 1.9 pF 2.8 pF	HP 16384A
INDUCTANCE (20/E11)				
Inductance – Measure	10 µH to 10 H	100 Hz or 1 kHz	1.5 mH/H + 0.12 µH	HP 4284A
	0.1 mH to 0.5 mH 0.5 mH to 2 mH 2 mH to 10 mH 10 mH to 50 mH 50 mH to 200 mH 200 mH to 1 H 1 H to 5 H 5 H to 10 H	100 Hz to 1 kHz	49 µH/H + 0.49 µH 0.14 mH/H + 0.44 µH 0.24 mH/H + 0.24 µH 0.26 mH/H + 69 nH 0.26 mH/H + 1.8 nH 0.27 mH/H - 1.2 µH 0.37 mH/H - 0.11 mH 0.59 mH/H - 0.62 mH	ESI LCR Bridge w/ DT72A Transformer
Inductance – Generate <small>Note 4</small>	50 µH 100 µH 1 mH 10 mH 100 mH 1 H 10 H	100 Hz or 1 kHz	0.17 µH 0.12 µH 0.46 µH 1.7 µH 26 µH 0.99 mH 19 mH	GenRad 1482 Set

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
LF POWER & ENERGY (20/E12)			
DC Power – Generate ^{Note 4} 0.33 mA to 330 mA	11 μ W to 1.1 mW 1.1 mW to 110 mW 0.11W to 110 W 110 W to 330 W	0.024 % 0.027 % 0.024 % 0.018 %	Fluke 5520A
0.33 A to 3 A	11 W to 110 mW 0.11 W to 990 W 1 W to 3 kW	0.044 % 0.053 % 0.0096 %	
3 A to 20.5 A	0.099 W to 0.99 W 0.99 W to 6.8 kW 6.8 W to 20.5 kW	0.088 % 0.070 % 0.040 %	
AC Power – Generate ^{Notes 4,7} (PF = 1, $\Phi = 0^\circ$ at 10 Hz to 65 Hz)			Fluke 5520A
3.3 mA to 9 mA	0.11 mW to 3.0 mW 3.0 mW to 9 W	0.13% 0.077 %	
9 mA to 33 mA	0.3 mW to 10 mW 10 mW to 33 W	0.089 % 0.077 %	
33 mA to 90 mA	1 mW to 30 mW 30 mW to 90 W	0.071 % 0.057 %	
90 mA to 330 mA	3.0 mW to 100 mW 100 mW to 300 W	0.089 % 0.078 %	
0.33 A to 0.9 A	11 mW to 300 mW 300 mW to 900 W	0.071 % 0.058 %	
0.9 A to 2.2 A	30 mW to 720 mW	0.089 %	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
2.2 A to 4.5 A	720 mW to 2 kW	0.079 %	
	80 mW to 1.4 W	0.088 %	
	1.4 W to 4.5 kW	0.05 %	
4.5 A to 20.5 A	150 mW to 6.7 W	0.17 %	
	6.7 W to 20 kW	0.17 %	
PHASE (20/E15)			
Phase – Measure (10 mV to 630 V)	5 Hz to 2 kHz 2 kHz to 5 kHz 5 kHz to 10 kHz 10 kHz to 50 kHz 50 kHz to 1 MHz	0.032° 0.042° 0.058° 0.068° 0.0012°/kHz + 0.015°	Clark Hess 6000A
Phase – Generate ^{Note 4}	10 Hz to 65 Hz 65 Hz to 500 Hz 500 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz 10 kHz to 30 kHz	0.14° 0.30° 0.58° 2.9° 5.8° 12°	Fluke 5520A
OSCILLOSCOPES (20/E20)			
Leveled Sine Amplitude	50 kHz reference 0.1 Hz to 6.4 GHz	17.3 μ V/mV + 1.9 nV 17.3 μ V/mV + 1.9 nV	Fluke 9500B / 9560
Leveled Sine Flatness ^{Note 4} 50 kHz – 10 MHz Reference	0.1 Hz to 300 MHz 300 MHz to 550 MHz 550 MHz to 3 GHz 3 GHz to 6 GHz	0.20 dB 0.25 dB 0.30 dB 0.40 dB	Fluke 9500B/9560
Time Marker, 50 Ω ^{Note 4}	500 ps to 901 ns 901 ns to 55 s	0.50 μ s/s 0.29 ns/ms + 47 ns	Fluke 5820A Fluke 9500B /9560

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
CONDUCTANCE (20/E21)			
Conductivity ^{Note 4}	10 μ S/cm 100 μ S/cm 1000 μ S/cm 10 000 μ S/cm 100 000 μ S/cm	0.65 μ S/cm 1.3 μ S/cm 4.2 μ S/cm 36 μ S/cm 0.33 mS/cm	Conductivity solutions
TIME and FREQUENCY			
FREQUENCY DISSEMINATION (20/F01)			
Frequency – Measure ^{Note 4}	100 μ Hz to 10 Hz 10 Hz to 3 GHz 3 GHz to 26.5 GHz 26.5 GHz to 110 GHz	50 μ Hz 7.7 pHz/Hz 7.7 pHz/Hz 5.2 pHz/Hz	HP 58503A/53132A HP 58503A/53132A HP 58503A/53151A HP 58503A/EIP 578/EIP 590
Frequency – Generate ^{Note 4}	100 μ Hz to 10 Hz 10 Hz to 50 GHz	6.5 pHz/Hz 6.5 pHz/Hz	HP 58503A/HP3325B & Agilent 83650B
OSCILLATOR CHARACTERIZATION (20/F03)			
Harmonics ^{Note 4} 0 dBc to 80 dBc	20 Hz to 50 kHz 50 kHz to 10 MHz 10 MHz to 3.6 GHz 3.6 GHz to 26.5 GHz	0.50 dB 0.45 dB 0.39 dB 1.7 dB	R & S FSQ26
Amplitude Modulation -- Measure & Generate ^{Note 4}	100 kHz to 3.6 GHz 3.6 GHz to 13.6 GHz 13.6 GHz to 17.1 GHz 17.1 GHz to 26.5 GHz 26.5 GHz to 34.5 GHz	1 % to 99 % 5 % to 99 % 5 % to 99 % 5 % to 99 % 5 % to 99 %	Keysight N5531X

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
34.5 GHz to 50 GHz	5 % to 99 %	0.46 %	Keysight N5531X
Frequency Modulation -- Generate and measure ^{Notes 4,8}			
100 kHz to 3.6 GHz	0.2 < β ≤ 100 β > 100	0.004 <i>FM</i> 0.0092 <i>FM</i>	
3.6 GHz to 8.4 GHz	0.2 < β ≤ 100 β > 100	0.0081 <i>FM</i> 0.023 <i>FM</i>	
8.4 GHz to 17.1 GHz	0.2 < β ≤ 100 β > 100	0.0081 <i>FM</i> 0.029 <i>FM</i>	
17.1 GHz to 34.5 GHz	0.2 < β ≤ 100 β > 100	0.0092 <i>FM</i> 0.035 <i>FM</i>	
34.5 GHz to 50 GHz	0.2 < β ≤ 100 β > 100	0.016 <i>FM</i> 0.046 <i>FM</i>	Keysight N5531X
Phase Modulation – Measure & Generate ^{Note 4}			
	100 kHz to 3.6 GHz	0.014 rad	
	3.6 GHz to 13.6 GHz	0.015 rad	
	13.6 GHz to 17.1 GHz	0.018 rad	
	17.1 GHz to 26.5 GHz	0.021 rad	
	26.5 GHz to 34.5 GHz	0.025 rad	
	34.5 GHz to 50 GHz	0.027 rad	
PULSE WAVEFORM (20/F04)			
Rise Time – Generate	> 150 ps 30 ps	33 ps 18 ps	Fluke 5820A Tek 067-1338-00



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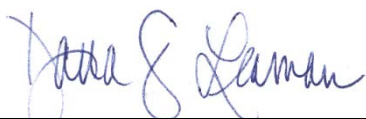
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
Rise Time – Measure	> 10 ps	24 ps	HP 54750A/54751A
STOPWATCHES & TIMERS (20/F05)			
Time – Measure ^{Note 4}	15 s to 24 hr	0.059 s/day	Vibrograf 4500 Timometer
MECHANICAL			
AIRSPPEED (20/M03)			
Air Velocity – Measure	400 ft/min to 800 ft/min 800 ft/min to 9000 ft/min	24ft/min - 1.4 % of reading 5.7 ft/min + 0.94 % of reading	Comparison of Pitot Tube with UUT using Wind Tunnel
FLOW RATE (20/M05)			
Gas Flow	0.5 SCCM to 5 SCCM 5 SCCM to 50 SCCM 50 SCCM to 500 SCCM 500 SCCM to 5 SLPM 5 SLPM to 50 SLPM 50 SLPM to 100 SLPM	0.61 % 0.30% + 0.012 SCCM 0.25% + 0.12 SCCM 0.30% + 1.2 SCCM 0.24% + 12 SCCM 0.42% + 24 SCCM	DHI Molbloc & Molbox
FORCE (20/M06)			
Crimp Tool – Pull Force	0 lbf to 100 lbf	7.8 % of rdg. + 2.6 lbf	Crimp pull tester
Durometer – Spring Force	78 gf 113 gf 821 gf 4533 gf	3.1 gf 0.84 gf 4.8 gf 13 gf	Electronic balance
Gaging Force	2 ozf 4 ozf 8 ozf 16 ozf 40 ozf	0.090 ozf 0.22 ozf 0.22 ozf 0.97 ozf 2.5 ozf	Gram gage Force gage

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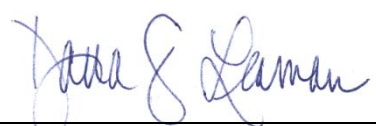

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) <small>Notes 3,5</small>	Remarks
Force Gages	0.03125 ozf to 8 ozf 0.5 lbf to 500 lbf 3.2 lbf to 300 lbf > 300 lbf to 1000 lbf > 1000 lbf to 10 000 lbf	0.054 % + 0.000066 ozf 0.055 % + 0.000022 lbf 0.010 % + 0.0064 lbf 0.012 % + 0.0012 lbf 0.010 % + 0.16 lbf	Class 6 Weights Class 7 Weights Morehouse M4215A-300LBF Morehouse M4215A- 1000LBF Morehouse M4215A-10000LBF
MASS DISSEMINATION (20/M08)			
Mass – Measure	1 mg to 10 g > 10 g to 30 g > 30 g to 100 g > 100 g to 210 g > 210 g to 300 g > 300 g to 5000 g > 5000 g to 34 000 g	0.15 mg 0.18 mg 0.21 mg 0.24 mg 0.34 mg 0.75 mg + 0.43 µg/g 270 mg	Weights, RC210S Balance Weights, 1773MP8 Balance Weights, Sartorius CCEE 5004 Comparator Weights, Sartorius CPA 34001S Balance
VIBRATION (20/M11)			
Accelerometers			
Voltage sensitivity	5 Hz – 10 Hz 10 Hz – 100 Hz 100 Hz – 2 kHz 2 kHz – 8 kHz 8 kHz – 10 kHz	3.3 % 2.2 % 1.9 % 3.1 % 3.3 %	Vibration Research VR9500
Charge sensitivity	5 Hz – 10 Hz 10 Hz – 100 Hz 100 Hz – 2 kHz 2 kHz – 8 kHz 8 kHz – 10 kHz	3.5 % 2.5 % 2.2 % 3.3 % 3.5 %	
VOLUME & DENSITY (20/M12)			
Viscosity	100 cps 1000 cps 5000 cps	0.33 % 0.50 % 0.45 %	Viscosity solutions



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	100 000 cps	0.60 %	
SPEED INDICATORS (20/M14)			
Photo ^{Note 4}	1 rpm to 100 000 rpm	8.6E-6 rpm/rpm + 0.0058 rpm	Signal generator
Contact	10 rpm to 50 000 rpm	5.9 E-5 rpm/rpm + 0.012 rpm	Ideal Aerosmith 1921
TORQUE (20/M15)			
Torque – Generate	0.25 ozf-in to 40 ozf-in > 40 ozf-in to 20 lbf-in 0.035 Nm to 0.45 Nm 0.45 Nm to 3.3 Nm 3.3 Nm to 339 Nm 339 Nm to 2712 Nm	0.13 % 0.073 % 0.077 % 0.070 % 0.065 % 0.070 %	Torque wheel or arm with Class 6 weights
Torque – Measure	0.5 ozf-in to 2.5 ozf-in > 2.5 ozf-in to 10 ozf-in > 10 ozf-in to 15 ozf-in > 15 ozf-in to 200 ozf-in > 200 ozf-in to 50 lbf-in > 50 lbf-in to 150 lbf-in > 150 lbf-in to 400 lbf-in > 400 lbf-in to 1000 lbf-in > 1000 lbf-in to 125 lbf-ft > 125 lbf-ft to 250 lbf-ft > 250 lbf-ft to 600 lbf-ft > 600 lbf-ft to 1000 lbf-ft > 1000 lbf-ft to 2000 lbf-ft	0.51 % + 0.0022 ozf-in 0.51 % + 0.0086 ozf-in 0.58 % + 0.0032 lbf-in 0.29 % + 0.035 lbf-in 0.30 % + 0.0031 lbf-in 0.30 % + 0.0057 lbf-in 0.30 % + 0.017 lbf-in 0.30 % + 0.038 lbf-in 0.27 % + 0.037 lbf-ft 0.30 % + 0.0084 lbf-ft 0.30 % + 0.031 lbf-ft 0.30 % + 0.083 lbf-ft 0.30 % + 0.042 lbf-ft	Waters 6500T4 Waters 6500T4 CDI 2000-4-02 CDI 2000-5-02 CDI 2000-6-02 CDI 2000-65-02 CDI 2000-7-02 CDI 2000-8-02 CDI 2000-10-02 CDI 2000-11-02 CDI 2000-12-02 CDI 2000-13-02 CDI 2000-14-02

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks	
8.4 GHz to 12 GHz	3 dB	0.044		
	4 dB	0.037		
	5 dB	0.031		
	6 dB	0.027		
	7 dB	0.026		
	8 dB	0.022		
	9 dB	0.022		
	10 dB	0.022		
	11 dB	0.021		
	12 dB	0.021		
	20 dB	0.022		
	30 dB	0.017		
	40 dB	0.091		
	12 GHz to 20 GHz	1 dB	0.16	
		2 dB	0.13	
		3 dB	0.10	
		4 dB	0.084	
5 dB		0.068		
6 dB		0.055		
7 dB		0.047		
8 dB		0.039		
9 dB		0.034		
10 dB		0.030		
11 dB		0.028		
12 dB		0.026		
20 dB		0.045		
30 dB	0.068			
40 dB	0.11			

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
20 GHz to 26.5 GHz	5 dB	0.034	
	6 dB	0.030	
	7 dB	0.032	
	8 dB	0.031	
	9 dB	0.030	
	10 dB	0.029	
	11 dB	0.029	
	12 dB	0.028	
	20 dB	0.042	
	30 dB	0.10	
	40 dB	0.037	
	1 dB	0.027	
	2 dB	0.022	
	3 dB	0.018	
4 dB	0.015		
5 dB	0.12		
6 dB	0.11		
7 dB	0.11		
8 dB	0.097		
9 dB	0.092		
10 dB	0.089		
11 dB	0.086		
12 dB	0.085		
20 dB	0.16		
30 dB	0.44		
40 dB	0.31		
Attenuation – Generate ^{Note 4} (50 Ω) 200 Hz to 80 MHz	0 dB to 38 dB	0.26 dB	HP 3335A (BNC F)
	40 dB to 58 dB	0.32 dB	
	60 dB to 98 dB	0.51 dB	



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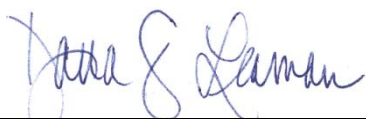
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (<i>k</i>=2) ^{Notes 3,5}	Remarks
Attenuation – Generate ^{Note 4} (75 Ω) 200 Hz to 25 MHz 25 MHz to 80 MHz 200 Hz to 25 MHz 25 MHz to 80 MHz 200 Hz to 25 MHz 25 MHz to 80 MHz	0 dB to 18 dB 20 dB to 58 dB 60 dB to 98 dB	0.28 dB 0.40 dB 0.39 dB 0.52 dB 0.47 dB 0.81 dB	
DC to 18 GHz (Fixed Value)	3 dB 6 dB 10 dB 20 dB	0.46 dB 0.46 dB 0.65 dB 0.65 dB	Weinschel 44 Series
Attenuation – Generate ^{Note 4} 30 MHz	0 dB 10 dB 20 dB 30 dB 40 dB 50 dB	0.0040 dB 0.0083 dB 0.019 dB 0.020 dB 0.033 dB 0.022 dB	Agilent 11812A
Attenuation – Measure ^{Note 4} 2.5 MHz to 26.5 GHz	0 dB to 2 dB 2 dB to -12 dB -12 dB to -22 dB -22 dB to -31 dB -31 dB to -40 dB -40 dB to -50 dB -50 dB to -61 dB -61 dB to -71 dB	0.081 dB 0.070 dB 0.081 dB 0.081 dB 0.093 dB 0.10 dB 0.11 dB 0.12 dB	HP8902 with 11722A or 11792A sensor

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
	-71 dB to -80 dB	0.15 dB	
	-80 dB to -90 dB	0.16 dB	
	-90 dB to -100 dB	0.16 dB	
	-100 dB to -110 dB	0.20 dB	
	-110 dB to -120 dB	0.22 dB	
	-120 dB to -127 dB	0.34 dB	

THERMODYNAMIC

HUMIDITY (20/T02)

Relative Humidity ^{Note 4}	10 % RH to 95 % RH	0.15 % RH + 0.29 % rdg.	Humidity probe/indicator Thunder Scientific
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LABORATORY THERMOMETERS (20/T03)

Temperature – Generate & Measure	-200 °C to 0.01 °C >0.01 °C to 300 °C > 300 °C to 660 °C > 660 °C to 700 °C > 700 °C to 1200 °C	0.010 °C + 1.2 E-05 °C/°C 0.010 °C + 4.1 E-05 °C/°C 0.024 °C + 1.3 E-04 °C/°C 0.47 °C + 1.2 E-04 °C/°C 0.85 °C + 7.6 E-04 °C/°C	Fluke 5628 PRT w/Fluke 2560 Fluke 9173 Fluke 9118 w/Omega NB1-CAXL-14LL-18
Thermistor	0 °C to 100 °C	6.7 E-03 °C + 1.8 E-05 °C/°C	Fluke 5644S / 2564

PRESSURE (20/T05)

Pressure – Generate & Measure ^{Note 4}	0 Pa to 746 Pa > 746 Pa to 7460 Pa 1245 Pa to 10 kPa > 10 kPa to 62 kPa > 62 kPa to 689 kPa > 689 kPa to 6.89 MPa > 6.89 MPa to 20 MPa	0.0039 % + 0.057 Pa 0.010 % + 0.0077 Pa 1.2 Pa 0.012 % 0.0094 % + 0.24 Pa 0.0094 % + 4.4 Pa 0.015 % + 12 Pa	Fluke 7250 LP Pressurements T3500/3 DHI RPM4-A700kp DHI RPM4-A7mp DHI RPM4-A2-Ms
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CALIBRATION LABORATORIES

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Notes 3,5}	Remarks
	> 20 MPa to 68.9 MPa	0.016 % + 6.3 Pa	DHI RPM4-A70Ms
	69 MPa to 207 MPa	0.025 % + 5.1 Pa	Fluke/DHI E-DWT-H-A200Me-L
RADIATION THERMOMETRY (20/T06)			
Source ^{Note 4}	-15 °C to 120 °C 120 °C to 200 °C 200 °C to 500 °C	0.0012 °C /°C + 0.33 °C 0.0023 °C /°C + 0.17 °C 0.0028 °C /°C + 0.065 °C	Fluke 4180 infrared source Fluke 4181 infrared source
TEMPERATURE INDICATORS (20/T08)			
Thermocouple Simulation ^{Note 4}			
Type B	600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1550 °C 1550 °C to 1820 °C	0.50 °C 0.41 °C 0.36 °C 0.40 °C	Fluke 5520A
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 1000 °C to 1800 °C 1800 °C to 2316 °C	0.36 °C 0.32 °C 0.37 °C 0.59 °C 0.98 °C	
Type E	-250 °C to -100 °C -100 °C to -25 °C -25 °C to 350 °C 350 °C to 650 °C 650 °C to 1000 °C	0.59 °C 0.22 °C 0.20 °C 0.22 °C 0.27 °C	
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.33 °C 0.22 °C 0.20 °C 0.23 °C 0.29 °C	



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
Type K	-210 °C to -100 °C	0.40 °C	
	-100 °C to -25 °C	0.24 °C	
	-25 °C to 120 °C	0.22 °C	
	120 °C to 1000 °C	0.32 °C	
	1000 °C to 1372 °C	0.47 °C	
Type L	-200 °C to -100 °C	0.44 °C	
	-100 °C to 800 °C	0.32 °C	
	800 °C to 900 °C	0.23 °C	
Type N	-200 °C to -100 °C	0.47 °C	
	-100 °C to -25 °C	0.28 °C	
	-25 °C to 120 °C	0.25 °C	
	120 °C to 410 °C	0.24 °C	
	410 °C to 1300 °C	0.33 °C	
Type R	0 °C to 250 °C	0.67 °C	
	250 °C to 400 °C	0.42 °C	
	400 °C to 1000 °C	0.40 °C	
	100 °C to 1767 °C	0.47 °C	
Type S	0 °C to 250 °C	0.55 °C	
	250 °C to 1000 °C	0.43 °C	
	1000 °C to 1400 °C	0.44 °C	
	1400 °C to 1767 °C	0.54 °C	
Type T	-250 °C to -150 °C	0.74 °C	
	-150 °C to 0 °C	0.30 °C	
	0 °C to 120 °C	0.22 °C	
	120 °C to 400 °C	0.20 °C	
Type U	-200 °C to 0 °C	0.66 °C	
	0 °C to 600 °C	0.33 °C	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
Half Junction Simulation			
Type E	-200 °C to 1000 °C	0.074 °C	
Type J	-210 °C to 1200 °C	0.14 °C	
Type K	-270 °C to 1373 °C	0.14 °C	
Type N	-270 °C to 1260 °C	0.12 °C	
Type S	-50 °C to 1480 °C	0.15 °C	
Type T	-200 °C to 400 °C	0.11 °C	
RTD Simulation ^{Note 4}			
Pt 385, 100 Ω	-200 °C to -80 °C	0.058 °C	
	-80 °C to 0 °C	0.058 °C	
	0 °C to 100 °C	0.081 °C	
	100 °C to 300 °C	0.10 °C	
	300 °C to 400 °C	0.12 °C	
	400 °C to 630 °C	0.14 °C	
	630 °C to 800 °C	0.27 °C	
Pt 3926, 100 Ω	-200 °C to -80 °C	0.058 °C	
	-80 °C to 0 °C	0.058 °C	
	0 °C to 100 °C	0.081 °C	
	100 °C to 300 °C	0.1 °C	
	300 °C to 400 °C	0.12 °C	
	400 °C to 630 °C	0.14 °C	
Pt 3916, 100 Ω	-200 °C to -190 °C	0.29 °C	
	-190 °C to -80 °C	0.046 °C	
	-80 °C to 0 °C	0.058 °C	
	0 °C to 100 °C	0.069 °C	
	100 °C to 260 °C	0.081 °C	



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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	260 °C to 300 °C	0.092 °C	
	300 °C to 400 °C	0.10 °C	
	400 °C to 600 °C	0.12 °C	
	600 °C to 630 °C	0.27 °C	
Pt 385, 200 Ω	-200 °C to -80 °C	0.046 °C	
	-80 °C to 0 °C	0.046 °C	
	0 °C to 100 °C	0.046 °C	
	100 °C to 260 °C	0.058 °C	
	260 °C to 300 °C	0.14 °C	
Pt 385, 200 Ω	300 °C to 400 °C	0.15 °C	
	400 °C to 600 °C	0.16 °C	
	600 °C to 630 °C	0.18 °C	
Pt 385, 500 Ω	-200 °C to -80 °C	0.058 °C	
	-80 °C to 0 °C	0.046 °C	
	0 °C to 100 °C	0.058 °C	
	100 °C to 260 °C	0.069 °C	
	260 °C to 300 °C	0.092 °C	
	300 °C to 400 °C	0.092 °C	
	400 °C to 600 °C	0.10 °C	
	600 °C to 630 °C	0.13 °C	
Pt 385, 1000 Ω	-200 °C to -80 °C	0.035 °C	
	-80 °C to 0 °C	0.035 °C	
	0 °C to 100 °C	0.046 °C	
	100 °C to 260 °C	0.058 °C	
	260 °C to 300 °C	0.069 °C	
	300 °C to 400 °C	0.081 °C	
	400 °C to 600 °C	0.081 °C	
	600 °C to 630 °C	0.27 °C	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
PtNi, 120 Ω	-80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C	0.092 °C 0.092 °C 0.16 °C	
Cu 427, 10 Ω	-100 °C to 260 °C	0.35 °C	
VACUUM & LOW PRESSURE GAGES (20/T09)			
Measure ^{Note 4}	0 mTorr to 1000 mTorr > 1 Torr to 10 Torr	0.14 mTorr + 1.3 % 0.0013 Torr + 1.3 %	MKS 390411-0-YE-T with: MKS 660B20/626C01TDE MKS660B10/626C11TQD
THERMOCOUPLES (20/T11)			
Type K	-200 °C to 0.01 °C > 0.01 °C to 660 °C	0.18 °C – 1.6E-03 °C/°C 0.18 °C + 3.7E-04 °C/°C	Comparison to Fluke SPRT
Type J	-200 °C to 0.01 °C > 0.01 °C to 660 °C	0.16 °C – 1.5E-03 °C/°C 0.16 °C + 3.8E-04 °C/°C	
Type T	-200 °C to 0.01 °C > 0.01 °C to 420 °C	0.18 °C – 1.7E-03 °C/°C 0.18 °C + 2.4E-04 °C/°C	
END			

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Notes

Note 1: A Calibration and Measurement Capability (CMC) is a description of the best result of a calibration or measurement (result with the smallest uncertainty of measurement) that is available to the laboratory's customers under normal conditions, when performing more or less routine calibrations of nearly ideal measurement standards or instruments. The CMC is described in the laboratory's scope of accreditation by: the measurement parameter/device being calibrated, the measurement range, the uncertainty associated with that range (see note 3), and remarks on additional parameters, if applicable.

Note 2: Calibration and Measurement Capabilities are traceable to the national measurement standards of the U.S. or to the national measurement standards of other countries and are thus traceable to the internationally accepted representation of the appropriate SI (Système International) unit.

Note 3: The uncertainty associated with a measurement in a CMC is an expanded uncertainty with a level of confidence of approximately 95 %, typically using a coverage factor of $k = 2$. However, laboratories may report a coverage factor different than $k = 2$ to achieve the 95 % level of confidence. Units for the measurand and its uncertainty are to match. Exceptions to this occur when marketplace practice employs mixed units, such as when the artifact to be measured is labeled in non-SI units and the uncertainty is given in SI units (Example: 5 lb weight with uncertainty given in mg).

Note 3a: The uncertainty of a specific calibration by the laboratory may be greater than the uncertainty in the CMC due to the condition and behavior of the customer's device and specific circumstances of the calibration. The uncertainties quoted do not include possible effects on the calibrated device of transportation, long term stability, or intended use.

Note 3b: As the CMC represents the best measurement results achievable under normal conditions, the accredited calibration laboratory shall not report smaller uncertainty of measurement than that given in a CMC for calibrations or measurements covered by that CMC.

Note 3c: As described in Note 1, CMCs cover calibrations and measurements that are available to the laboratory's customers under *normal conditions*. However, the laboratory may have the capability to offer special tests, employing special conditions, which yield calibration or measurement results with lower uncertainties. Such special tests are not covered by the CMCs and are outside the laboratory's scope of accreditation. In this case, NVLAP requirements for the labeling, on calibration reports, of results outside the laboratory's scope of accreditation apply. These requirements are set out in Annex A.5 of NIST Handbook 150, Procedures and General Requirements.

Note 4: Uncertainties associated with field service calibration may be greater as they incorporate on-site environmental contributions, transportation effects, or other factors that affect the measurements. (This note applies only if marked in the body of the scope.)

Note 5: Values listed with percent (%) are percent of reading or generated value unless otherwise noted.

Note 6: NVLAP accreditation is the formal recognition of specific calibration capabilities. Neither NVLAP nor NIST guarantee the accuracy of individual calibrations made by accredited laboratories.

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Notes

Note 7: Uncertainties are listed at optimal conditions ($PF = 1, \Phi = 0^\circ$ at 10 Hz - 65 Hz). Under different conditions, the uncertainty of the power measurement will vary based on the laboratory's AC voltage and current measurement uncertainties. PFs of less than one will increase the uncertainty of the power measurement, ramping up as PF approaches zero. Essco may also report reactive power, apparent power, and power factor under this accreditation. Uncertainties at other conditions can be obtained from the laboratory.

Note 8: Where *FM* is measured peak expressed in Hertz.

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