

CALIBRATION LABORATORIES

NVLAP LAB CODE 200972-0

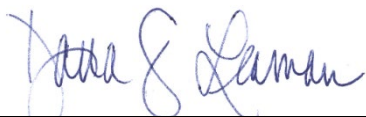
SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

<p>ESSCO CALIBRATION LABORATORY 27 Industrial Avenue, Unit #9 Chelmsford, MA 01824-3618 Mr. James Murphy Phone: 800-325-2201 Ext:156 Fax 978-256-1331 E-mail: jmurphy@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 0.5 in > 0.5 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	2.8 µin 2.4 µin 2.9 µin 4.3 µin 5.1 µin 6.4 µin 8.8 µin 9.5 µin 11 µin 13 µin 15 µin 17 µin 22 µin	Comparison to master blocks
LENGTH & DIAMETER (20/D05)			
Length Standards, Rods	0.1 in to 40 in	1.9 µin/in + 9.6 µin	Comparison to gage blocks
Calipers ^{Note 4}	0 in to 120 in	9.6 µin/in + 290 µin	Comparison to gage blocks
Thickness Setting Discs	0.01 in to 0.24 in	21 µin	Comparison to gage blocks

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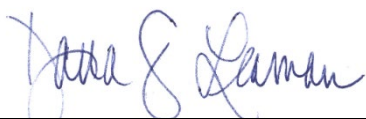
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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
Micrometer ^{Note 4}	0 in to 40 in	2.1 μin/in + 28 μin	Comparison to gage blocks
Supermicrometer	0 in to 1 in	12 μin	Comparison to gage blocks
Anvil Parallelism ^{Note 4}	0 μin nominal	13 μin	Optical flat
Anvil Flatness ^{Note 4}	0 μin nominal	5.4 μin	Optical flat
Optical Flats & Parallels			
Flatness	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 μin/in + 47 μin	Comparison to master rings
Dial/Test Indicator ^{Note 4}	0 in to 12 in	1.7 μin/in + 6.7 μin	Gage blocks or Micrometer head
Height Gages ^{Note 4}	0 in to 40 in	1.3 μin/in + 17 μin	Comparison to gage blocks
Depth Gages ^{Note 4}	0 in to 12 in	1.8 μin/in + 29 μin	Comparison to gage blocks
Durometer (Indentor Length)	0.05 in 0.10 in 0.20 in	0.00019 in 0.00019 in 0.00022 in	Comparison to gage blocks (Note: Spring force component listed in mechanical section)
Electronic Gage Amplifier	0 in to 1 in	8.2 μin	Comparison to gage blocks
Crimp Tools – Crimp Height	0.011 to 1 in	0.00046 in	Indirect comparison to crimp micrometer
MEASURING WIRES (20/D07)			
Thread Wires	4 threads/in to 120 threads/in	9.2 μin	Labmaster, gage blocks
OPTICAL REFERENCE PLANES (20/D08)			
Glass Reticules, Stage Micrometers	0 in to 1 in 1 in to 2 in	0.00021 in 0.00043 in	Microscope w/micrometer head

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty ($k=2$) ^{Note 3}	Remarks
SPHERICAL DIAMETER, PLAIN PLUG/RINGS (20/D11)			
Pin Gages ^{Note 4}	0.004 in to 1 in	60 μ in	Supermicrometer
Plain Plugs	0 in to 12 in	2.9 μ in/in + 3.1 μ in	Labmaster
Plain Ring Gages Discrete sizes	0.04 in 0.125 in 0.25 in 1.0 in 4.0 in	6.4 μ in 5.7 μ in 4.7 μ in 5.1 μ in 8.8 μ in	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 μ in 15 μ in 1.5 μ in/in + 15 μ in	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 > 120 in to 160 in	4.9 μ in/in + 170 μ in 4.9 μ in/in + 340 μ in 4.9 μ in/in + 500 μ in 4.9 μ in/in + 670 μ in	P & W LMU1000A with digital microscope
Tape Measures	0 ft to 100 ft	0.0063 in + 0.00025 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 μ in 2.4 μ m	Thread wires/ Supermicrometer
Thread Rings, Straight Thread – Pitch Diameter 6 TPI to 80 TPI 0.25 mm to 10 mm Pitch	0.01 in to 5 in	96 μ in 2.4 μ m	Ring is sized to a setting plug with plug's uncert. given

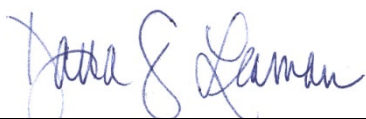
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
ELECTROMAGNETICS – DC/LOW FREQUENCY				
AC RESISTANCE and CURRENT (20/E02)				
Alternating Current– Generate ^{Note 4}	0 μ A to 220 μ A	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	283 μ A/A + 19 nA 0.16 mA/A + 10 nA 0.12 mA/A + 10 nA 0.25 mA/A + 12 nA 0.83 mA/A + 65 nA	Fluke 5730A
	>220 μ A to 2.2 mA	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.20 mA/A + 0.14 μ A 0.16 mA/A + 32 nA 0.15 mA/A + 44 nA 0.23 mA/A + 130 nA 1.2 mA/A + 0.94 μ A	
	> 2.2 mA to 22 mA	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.25 mA/A + 1.2 μ A 0.11 mA/A + 1.0 μ A 0.10 mA/A + 0.35 μ A 0.18 mA/A + 0.55 μ A 0.80 mA/A + 5.0 μ A	
	> 22 mA to 220 mA	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.24 mA/A + 3.9 μ A 0.14 mA/A + 3.4 μ A 0.099 mA/A + 2.5 μ A 0.17 mA/A + 3.5 μ A 0.79 mA/A + 12 μ A	
	> 220 mA to 2.2 A	40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.24 mA/A + 34 μ A 0.35 mA/A + 79 μ A 6.0 mA/A + 160 μ A	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
(no field capability)	> 2.2 A to 11 A	40 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	0.54 mA/A + 0.19 mA 1.1 mA/A + 0.48 mA 4.2 mA/A + 0.89 mA	Fluke 5730A w/5725A
	> 11 A to 20.5 A	45 Hz to 100 Hz > 100 Hz to 1 kHz > 1 kHz to 5 kHz	1.4 mA/A + 5.7 mA 1.8 mA/A + 5.7 mA 35 mA/A + 5.8 mA	Fluke 5522A
	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 µA	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 µA 0.39 mA/A + 0.023 µA 0.84 mA/A + 0.023 µA 4.6 mA/A + 0.023 µA	Fluke 8508A DMM



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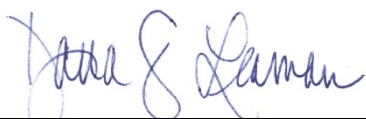
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	> 200 μ A to 2 mA	1 Hz to 10 Hz	0.36 mA/A + 0.23 μ A	
		> 10 Hz to 10 kHz	0.35 mA/A + 0.23 μ A	
		> 10 kHz to 30 kHz	0.82 mA/A + 0.23 μ A	
		> 30 kHz to 100 kHz	4.6 mA/A + 0.23 μ A	
	> 2 mA to 20 mA	1 Hz to 10 Hz	0.37 mA/A + 2.3 μ A	
		> 10 Hz to 10 kHz	0.36 mA/A + 2.3 μ A	
		> 10 kHz to 30 kHz	0.83 mA/A + 2.3 μ A	
		> 30 kHz to 100 kHz	4.6 mA/A + 2.3 μ A	
	> 20 mA to 200 mA	1 Hz to 10 Hz	0.37 mA/A + 23 μ A	
		> 10 Hz to 10 kHz	0.34 mA/A + 23 μ A	
		> 10 kHz 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	Fluke 5790B and A40B Shunts	
	> 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		

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
		> 50 kHz to 100 kHz	110 µA/A	
	> 1 mA to 10 mA	10 Hz to 20 Hz	160 µA/A	
		> 20 Hz to 40 Hz	57 µA/A	
		> 40 Hz to 20 kHz	27 µA/A	
		> 20 kHz to 50 kHz	41 µA/A	
		> 50 kHz to 100 kHz	61 µA/A	
	> 10 mA to 20 mA	10 Hz to 20 Hz	160 µA/A	
		> 20 Hz to 40 Hz	57 µA/A	
		> 40 Hz to 20 kHz	27 µA/A	
		> 20 kHz to 50 kHz	41 µA/A	
		> 50 kHz to 100 kHz	61 µA/A	
	> 20 mA to 50 mA	10 Hz to 20 Hz	160 µA/A	
		> 20 Hz to 40 Hz	57 µA/A	
		> 40 Hz to 20 kHz	28 µA/A	
		> 20 kHz to 50 kHz	44 µA/A	
		> 50 kHz to 100 kHz	62 µA/A	
	> 50 mA to 100 mA	10 Hz to 20 Hz	160 µA/A	
		> 20 Hz to 40 Hz	57 µA/A	
		> 40 Hz to 20 kHz	27 µA/A	
		> 20 kHz to 50 kHz	42 µA/A	
		> 50 kHz to 100 kHz	59 µA/A	

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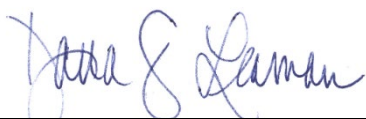
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	> 100 mA to 200 mA	10 Hz to 20 Hz > 20 Hz to 40 Hz > 40 Hz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz	160 µA/A 57 µA/A 28 µA/A 42 µA/A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

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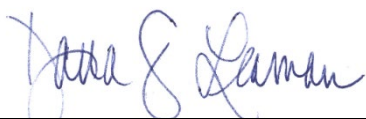
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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
	> 5 A to 10 A	> 20 Hz to 40 Hz	60 μ A/A	
		> 40 Hz to 20 kHz	34 μ A/A	
		> 20 kHz to 50 kHz	53 μ A/A	
		> 50 kHz to 100 kHz	95 μ A/A	
	> 10 A to 20 A	10 Hz to 20 Hz	160 μ A/A	
		> 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	
	> 20 A to 50 A	> 50 kHz to 100 kHz	110 μ A/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	
	> 50 A to 100 A	> 20 kHz to 50 kHz	86 μ A/A	
		> 50 kHz to 100 kHz	140 μ A/A	
		10 Hz to 20 Hz	160 μ A/A	
		> 20 Hz to 40 Hz	75 μ A/A	
> 50 A to 100 A	> 40 Hz to 20 kHz	74 μ A/A		
	> 20 kHz to 50 kHz	96 μ A/A		
> 50 A to 100 A	> 50 kHz to 100 kHz	170 μ A/A		
	10 Hz to 20 Hz	170 μ A/A		
> 50 A to 100 A	> 20 Hz to 40 Hz	82 μ A/A		

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Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Note 3}	Remarks
AC Resistance – Generate	0.1 Ω	> 40 Hz to 20 kHz	93 μA/A	Agilent 16074A
		> 20 kHz to 50 kHz	110 μA/A	
		> 50 kHz to 100 kHz	200 μA/A	
	1 Ω	> 0.1 Hz to 1 MHz	0.18 %	
		> 1 MHz to 13 MHz	0.27 %	
	10 Ω	> 0.1 Hz to 1 MHz	0.12 %	
		> 1 MHz to 13 MHz	0.12 %	
	100 Ω	> 0.1 Hz to 1 MHz	0.036 %	
		> 1 MHz to 13 MHz	0.036 %	
	1 kΩ	> 0.1 Hz to 1 MHz	0.035 %	
		> 1 MHz to 13 MHz	0.036 %	
	10 kΩ	> 0.1 Hz to 1 MHz	0.035 %	
> 1 MHz to 13 MHz		0.035 %		
100 kΩ	> 0.1 Hz to 1 MHz	0.040 %		
	> 1 MHz to 13 MHz	0.14 %		
AC Resistance – Measure	0 Ω to 15 Ω	> 0.1 Hz to 1 MHz	0.099 %	Agilent 4284A
		> 1 MHz to 13 MHz	0.62 %	
	15 Ω to 320 kΩ	50 Hz to 1 MHz	0.14 %	
		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	
	> 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 22 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	Fluke 5730A with 5725A Fluke 5522A Fluke 52120A	
> 11 A to 20 A	0.77 mA/A + 0.77 mA		
> 20 A to 100 A	0.43 mA/A		
Current Clamp – Non-Toroidal ^{Note 4}	20 A to 1000 A	5.8 mA/A + 0.58 A	Fluke 5522A 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	



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Resistance – Variable Generate ^{Note 4}	> 20 nA to 100 nA	34 μ A/A + 47 pA	HP 3458A/002
	> 100 nA to 1 μ A	17 μ A/A	
	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	
	> 20 A to 100 A	0.23 mA/A	Guildline 9230/ Fluke 8508A
	Resistance – Fixed Generate Instrument-Based ^{Note 4}	0 Ω to 11 Ω	47 $\mu\Omega/\Omega$ + 1.2 m Ω
> 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	
> 330 k Ω to 1.1 M Ω		40 $\mu\Omega/\Omega$ + 3.0 Ω	
> 1.1 M Ω to 3.3 M Ω		0.12 m Ω/Ω	
> 3.3 M Ω to 11 M Ω		0.16 m Ω/Ω + 86 Ω	
> 11 M Ω to 33 M Ω		0.70 m Ω/Ω + 2.5 k Ω	
> 33 M Ω to 110 M Ω		0.76 m Ω/Ω + 3.5 k Ω	
> 110 M Ω to 330 M Ω		0.65 m Ω/Ω	
> 330 M Ω to 1100 M Ω	15 m Ω/Ω + 730 k Ω		
Resistance – Fixed Generate Instrument-Based ^{Note 4}	1 Ω	37 $\mu\Omega$	Fluke 5730A
	1.9 Ω	54 $\mu\Omega$	



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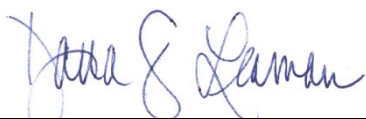
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Fixed Resistor-Based	10 Ω	0.11 m Ω	Keithley 263
	19 Ω	0.13 m Ω	
	100 Ω	0.55 m Ω	
	190 Ω	0.90 m Ω	
	1 k Ω	5.9 m Ω	
	1.9 k Ω	7.4 m Ω	
	10 k Ω	44 m Ω	
	19 k Ω	0.074 Ω	
	100 k Ω	0.71 Ω	
	190 k Ω	0.75 Ω	
	1 M Ω	10 Ω	
	1.9 M Ω	13 Ω	
	10 M Ω	0.22 k Ω	
	19 M Ω	0.49 k Ω	
	100 M Ω	6.4 k Ω	
	10 G Ω	0.35 G Ω	L & N 4333 Guildline 9230/100 Guildline 9230/15 Fluke 742A-1 Fluke 742A-1.9 Guildline 9334-10 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
	100 G Ω	3.6 G Ω	
	0.001 Ω	0.12 $\mu\Omega$	
	0.01 Ω	0.14 $\mu\Omega$	
	0.1 Ω	0.78 $\mu\Omega$	
	1 Ω	2.1 $\mu\Omega$	
	1.9 Ω	1.8 $\mu\Omega$	
	10 Ω	11 $\mu\Omega$	
	100 Ω	0.18 m Ω	
	1 k Ω	3.5 m Ω	
	10 k Ω	25 m Ω	
	19 k Ω	49 m Ω	
	100 k Ω	0.28 Ω	
	1 M Ω	2.3 Ω	
	10 M Ω	110 Ω	
	19 M Ω	0.38 k Ω	
	100 M Ω	8.4 k Ω	
1 G Ω	38 k Ω		
10 G Ω	21 M Ω		

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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
Resistance – Measure ^{Note 4} (No field capability above 20 GΩ)	100 GΩ 1 TΩ	99 MΩ 5.0 GΩ	Fluke 8508 transfer accuracy Guildline 6530B
	0 Ω to 2 Ω	3.5 μΩ/Ω + 1.1 μΩ	
	> 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		
> 20 GΩ to 200 GΩ	0.93 mΩ/Ω		
> 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	2.2 μV/V + 0.39 μV	Fluke 5730A Hipotronics Source and Vitrek 4700 w/HLV70
	> 0.22 V to 2.2 V	2.0 μV/V + 0.62 μV	
	> 2.2 V to 11 V	1.2 μV/V + 2.3 μV	
	> 11 V to 22 V	1.3 μV/V + 3.2 μV	
	> 22 V to 220 V	2.0 μV/V + 38 μV	
	> 220 V to 1.1 kV	2.4 μV/V + 0.31 mV	
	1.0 kV to 50 kV	0.49 mV/V + 0.21 V	
DC Voltage – Fixed Generate	10 V	3.8 μV	Fluke 732A



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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 – 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	
	1 kV to 50 kV	0.49 mV/V + 0.21 V	Vitretek 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	0.24 mV/V + 4.3 μ V	Fluke 5730A	
		> 20 Hz to 40 Hz	0.11 mV/V + 4.3 μ V		
		> 40 Hz to 20 kHz	0.051 mV/V + 4.3 μ V		
		> 20 kHz to 50 kHz	0.068 mV/V + 4.7 μ V		
		> 50 kHz to 100 kHz	0.16 mV/V + 5.9 μ V		
		> 100 kHz to 300 kHz	0.29 mV/V + 11 μ V		
		> 300 kHz to 500 kHz	0.71 mV/V + 23 μ V		
		> 500 kHz to 1 MHz	2.0 mV/V + 25 μ V		
		> 2.2 mV to 22 mV	10 Hz to 20 Hz		0.20 mV/V + 4.8 μ V
			20 Hz to 40 Hz		0.077 mV/V + 4.7 μ V
	40 Hz to 20 kHz		51 μ V/V + 4.4 μ V		
	20 kHz to 50 kHz		0.065 mV/V + 5.3 μ V		
		50 kHz to 100 kHz	0.15 mV/V + 6.7 μ V		
		100 kHz to 300 kHz	0.29 mV/V + 12 μ 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 mV to 220 mV	> 300 kHz to 500 kHz	0.68 mV/V + 27 μV	
		> 500 kHz to 1 MHz	1.8 mV/V + 46 μV	
		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	
	> 220 mV to 2.2 V	> 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	
		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	
	> 2.2 V to 22 V	> 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	
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	



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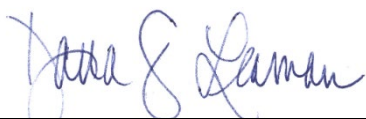
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
		> 20 kHz to 50 kHz	67 μ V/V + 93 μ V	
		> 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	
	> 22 V to 220 V	10 Hz to 20 Hz	0.22 mV/V + 4 mV	
		> 20 Hz to 40 Hz	87 μ V/V + 1.4 mV	
		> 40 Hz to 20 kHz	51 μ V/V + 0.52 mV	
		> 20 kHz to 50 kHz	77 μ V/V + 0.94 mV	
		> 50 kHz to 100 kHz	0.15 mV/V + 2.3 mV	
		> 100 kHz to 300 kHz	0.63 mV/V + 16 mV	limits on voltage
		> 300 kHz to 500 kHz	3.8 mV/V + 38 mV	versus frequency
		> 500 kHz to 1 MHz	7.1 mV/V + 79 mV	
	> 220 V to 750 V	15 Hz to 50 Hz	0.26 mV/V + 16 mV	
		> 50 Hz to 1 kHz	58 μ V/V + 3.0 mV	
		> 30 kHz to 50 kHz	0.34 mV/V + 11 mV	Fluke 5730A w/5725A
		> 50 kHz to 100 kHz	1.3 mV/V + 43 mV	
	220 V to 1100 V	40 Hz to 1 kHz	0.070 mV/V + 4.3 mV	
		> 1 kHz to 20 kHz	0.11 mV/V + 5.8 mV	
		> 20 kHz to 30 kHz	0.34 mV/V + 11 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
	1.1 kV to 5 kV > 5 kV to 44 kV	50 Hz to 60 Hz 50 Hz to 60 Hz	2.5 mV/V + 1.5 V 1.4 mV/V + 27 V	Quadtech Sentry 20 w/Vitrek 4700 & HLV70

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	0.13 mV/V + 0.98 μV 0.10 mV/V + 0.98 μV 99 $\mu\text{V/V}$ + 0.98 μV	Fluke 5790B/05



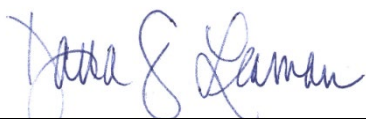
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	> 2.2 mV to 7 mV	> 20 kHz to 50 kHz	89 μ V/V + 1.5 μ V	
		> 50 kHz to 100 kHz	0.10 mV/V + 1.9 μ V	
		> 100 kHz to 300 kHz	0.21 mV/V + 3.1 μ V	
		> 300 kHz to 500 kHz	0.60 mV/V + 6.2 μ V	
		> 500 kHz to 1 MHz	2.2 mV/V + 6.1 μ V	
		10 Hz to 20 Hz	84 μ V/V + 0.99 μ V	
		> 20 Hz to 40 Hz	53 μ V/V + 0.98 μ V	
	> 7 mV to 22 mV	> 40 Hz to 20 kHz	51 μ V/V + 1.0 μ V	
		> 20 kHz to 50 kHz	21 μ V/V + 1.6 μ V	
		> 50 kHz to 100 kHz	60 μ V/V + 1.9 μ V	
		> 100 kHz to 300 kHz	0.15 mV/V + 3.0 μ V	
		> 300 kHz to 500 kHz	0.38 mV/V + 6.2 μ V	
		> 500 kHz to 1 MHz	1.6 mV/V + 6.1 μ V	
		10 Hz to 20 Hz	81 μ V/V + 0.82 μ V	
> 20 Hz to 40 Hz	49 μ V/V + 0.93 μ V			
> 40 Hz to 20 kHz	41 μ V/V + 0.95 μ V			
> 20 kHz to 50 kHz	49 μ V/V + 1.5 μ V			
> 50 kHz to 100 kHz	76 μ V/V + 1.8 μ V			
> 100 kHz to 300 kHz	0.18 mV/V + 2.7 μ V			
> 300 kHz to 500 kHz	0.37 mV/V + 5.9 μ 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 mV to 70 mV	> 500 kHz to 1 MHz	0.80 mV/V + 6.1 μV	
		10 Hz to 20 Hz	63 μV/V + 1.1 μV	
		> 20 Hz to 40 Hz	40 μV/V + 0.97 μV	
		> 40 Hz to 20 kHz	32 μV/V + 1.2 μV	
		> 20 kHz to 50 kHz	48 μV/V + 1.3 μV	
		> 50 kHz to 100 kHz	90 μV/V + 1.4 μV	
		> 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 μV/V + 38 μV	
		> 20 Hz to 40 Hz	24 μV/V + 1.9 μV	
		> 40 Hz to 20 kHz	2.8 μV/V + 36 μV	
		> 20 kHz to 50 kHz	30 μV/V + 1.3 μV	
		> 50 kHz to 100 kHz	62 μV/V + 0.85 μV	
		> 100 kHz to 300 kHz	125 μV/V + 2.6 μV	
		> 300 kHz to 500 kHz	259 μV/V + 5.7 μV	
		> 500 kHz to 1 MHz	772 μV/V + 6.1 μV	
	> 220 mV to 700 mV	10 Hz to 20 Hz	54 μV/V + 1.2 μV	
		> 20 Hz to 40 Hz	24 μV/V + 1.2 μV	
		> 40 Hz to 20 kHz	22 μV/V + 1.0 μV	



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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
	> 700 mV to 2.2 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 $\mu\text{V/V} + 7.9 \mu\text{V}$	
		10 Hz to 20 Hz	50 $\mu\text{V/V} + 1.1 \mu\text{V}$	
	> 2.2 V to 7 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 $\mu\text{V/V} + 7.5 \mu\text{V}$	
		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 $\mu\text{V/V} - 15 \mu\text{V}$			

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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 V to 22 V	> 500 kHz to 1 MHz	958 $\mu\text{V/V} + 44 \mu\text{V}$	
		10 Hz to 20 Hz	50 $\mu\text{V/V} + 8.7 \mu\text{V}$	
		> 20 Hz to 40 Hz	53 $\mu\text{V/V} + 0.58 \mu\text{V}$	
		> 40 Hz to 20 kHz	19 $\mu\text{V/V} + 1.8 \mu\text{V}$	
		> 20 kHz to 50 kHz	22 $\mu\text{V/V} + 1.3 \mu\text{V}$	
		> 50 kHz to 100 kHz	51 $\mu\text{V/V} + 1.6 \mu\text{V}$	
		> 100 kHz to 300 kHz	119 $\mu\text{V/V} + 5.2 \mu\text{V}$	
		> 300 kHz to 500 kHz	296 $\mu\text{V/V} + 18 \mu\text{V}$	
		> 500 kHz to 1 MHz	960 $\mu\text{V/V} + 51 \mu\text{V}$	
	> 22 V to 70 V	10 Hz to 20 Hz	51 $\mu\text{V/V} + 6.3 \mu\text{V}$	
		> 20 Hz to 40 Hz	25 $\mu\text{V/V} + 24 \mu\text{V}$	
		> 40 Hz to 20 kHz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
		> 20 kHz to 50 kHz	22 $\mu\text{V/V} + 71 \mu\text{V}$	
		> 50 kHz to 100 kHz	53 $\mu\text{V/V} + 110 \mu\text{V}$	
		> 100 kHz to 300 kHz	120 $\mu\text{V/V} + 50 \mu\text{V}$	
> 70 V to 220 V	> 300 kHz to 500 kHz	304 $\mu\text{V/V} + 20 \mu\text{V}$		
	> 500 kHz to 1 MHz	962 $\mu\text{V/V} + 6.3 \mu\text{V}$		
	10 Hz to 20 Hz	51 $\mu\text{V/V} + 27 \mu\text{V}$		
	> 20 Hz to 40 Hz	27 $\mu\text{V/V} + 51 \mu\text{V}$		
	> 40 Hz to 20 kHz	22 $\mu\text{V/V} + 8.8 \mu\text{V}$		
	> 20 kHz to 50 kHz	29 $\mu\text{V/V} + 24 \mu\text{V}$		

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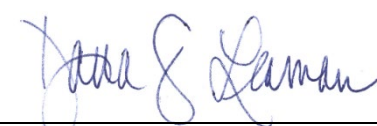


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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	> 220 V to 700 V	> 50 kHz to 100 kHz	57 μ V/V + 57 μ 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	
	> 700 V to 1100 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	
	1 mV to 10 mV	> 20 kHz to 50 kHz	87 μ V/V + 0.69 mV	
		> 50 kHz to 100 kHz	390 μ V/V + 0.16 mV	
	> 10 mV to 100 mV	1 MHz to 4 MHz	54 mV/V + 11 μ V	
		> 4 MHz to 8 MHz	155 mV/V + 8.2 μ V	
1 MHz to 2 MHz		11.5 mV/V + 19 μ V		
> 2 MHz to 4 MHz		30.4 mV/V + 130 μ V		
> 0.1 V to 1 V	> 4 MHz to 8 MHz	30 mV/V + 220 μ V		
	> 8 MHz to 10 MHz	116 mV/V + 160 μ V		
	1 MHz to 2 MHz	11.6 mV/V + 110 μ V		
	> 2 MHz to 4 MHz	30.4 mV/V + 1.3 mV		
		> 4 MHz to 8 MHz	30 mV/V + 2.2 mV	
		> 8 MHz to 10 MHz	116 mV/V + 1.6 mV	

HP 3458A



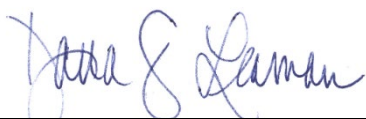
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
AC Voltage – Wideband Generate <small>Note 4</small>	> 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	Vitretek 4700 w/HLV70
	1.1 kV to 5 kV	50 Hz to 60 Hz	2.5 mV/V + 1.5 V	
	> 5 kV to 50 kV	50 Hz to 60 Hz	1.4 mV/V + 27 V	
	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 %	Fluke 5730A / 05
			0.085 %	
			0.39 %	
			0.55 %	
			0.71 %	
			2.3 %	
			3.6 %	
3.6 %				
> 1.1 mV to 3.3 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	0.24 %		
		0.08 %		
		0.16 %		
		0.31 %		
		0.47 %		
		1.3 %		
		1.3 %		
		1.3 %		

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NVLAP LAB CODE 200972-0

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

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	> 3.3 mV to 11 mV	> 30 MHz to 50 MHz	2.5 %	
		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	0.30 %
	> 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 %	
	> 33 mV to 110 mV	10 Hz to 30 Hz	0.23 %	
> 30 Hz to 2 MHz		0.083 %		
> 2 MHz to 10 MHz		0.16 %		



2023-06-06 through 2024-06-30

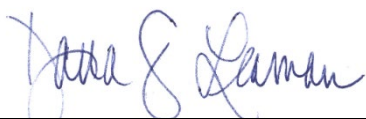
Effective dates

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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
	> 110 mV to 330 mV	> 10 MHz to 20 MHz	0.33 %	
		> 20 MHz to 30 MHz	0.80 %	
		> 30 MHz to 50 MHz	1.7 %	
		10 Hz to 30 Hz	0.23 %	
		> 30 Hz to 2 MHz	0.082 %	
		> 2 MHz to 10 MHz	0.16 %	
	> 0.33 V to 1.1 V	> 10 MHz to 20 MHz	0.32 %	
		> 20 MHz to 30 MHz	0.79 %	
		> 30 MHz to 50 MHz	1.7 %	
		10 Hz to 30 Hz	0.23 %	
		> 30 Hz to 2 MHz	0.081 %	
		> 2 MHz to 10 MHz	0.16 %	
> 1.1 V to 3.5 V	> 10 MHz to 20 MHz	0.32 %		
	> 20 MHz to 30 MHz	0.79 %		
	> 30 MHz to 50 MHz	1.7 %		
	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 %	

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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 Measure	0.1 mV to 2.2 mV	> 20 MHz to 30 MHz	0.79 %	Fluke 5790B/05
		> 30 MHz to 50 MHz	1.7 %	
		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 %	
	> 2.2 mV to 7 mV	> 10 MHz to 20 MHz	0.32 %	
		> 20 MHz to 30 MHz	0.71 %	
		> 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 %	
	> 7 mV to 22 mV	> 500 kHz to 2 MHz	0.080 %	
		> 2 MHz to 10 MHz	0.11 %	
> 10 MHz to 20 MHz		0.17 %		
> 20 MHz to 30 MHz		0.42 %		
> 30 MHz to 50 MHz		0.46 %		
10 Hz to 30 Hz		0.081 %		
	> 30 Hz to 120 kHz	0.040 %		

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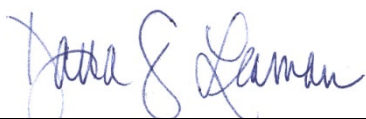
CALIBRATION LABORATORIES

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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 mV to 70 mV	> 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 %	
		> 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 %	
	> 70 mV to 220 mV	> 500 kHz to 2 MHz	0.042 %	
		> 2 MHz to 10 MHz	0.084 %	
		> 10 MHz to 20 MHz	0.12 %	
		> 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 %	
		> 500 kHz to 2 MHz	0.041 %	

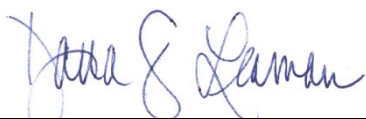
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	> 220 mV to 700 mV	> 2 MHz to 10 MHz	0.083 %	
		> 10 MHz to 20 MHz	0.13 %	
		> 20 MHz to 30 MHz	0.28 %	
		> 30 MHz to 50 MHz	0.51 %	
		10 Hz to 30 Hz	0.079 %	
	> 0.7 V to 2.2 V	> 30 Hz to 120 kHz	0.025 %	
		> 120 kHz to 500 kHz	0.025 %	
		> 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 %	
> 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 %			

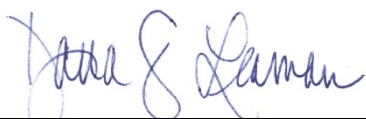
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) <small>Notes 3,5</small>	Remarks
	> 2.2 V to 7 V	> 20 MHz to 30 MHz	0.30 %	
		> 30 MHz to 50 MHz	0.50 %	
		10 Hz to 30 Hz	0.080 %	
		> 30 Hz to 120 kHz	0.024 %	
		> 120 kHz to 500 kHz	0.024 %	
		> 500 kHz 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	0.50 %	
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		1.3 nF/μF	HP 4284A
	> 800 μF to 100 mF		1.7 μF/mF + 4.3 nF	
	> 100 mF to 1000 mF		3.1 μF/mF + 57 μF	
	0.01 fF to 10 pF	20 Hz to 12.5 kHz	3.8 fF/pF + 3.1 aF	HP 4284A
		> 12.5 kHz to 48 kHz	3.0 fF/pf + 3.5 aF	
		> 48 kHz to 96 kHz	3.4 fF/pF + 3.3 aF	
		> 96 kHz to 1 MHz	3.1 fF/pF + 3.5 aF	

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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 pF to 100 pF	20 Hz to 500 Hz	3.5 fF/pF + 38 fF	
		> 500 Hz to 1 kHz	3.4 fF/pF + 38 fF	
		> 1 kHz to 12.5 kHz	1.7 fF/pF + 19 fF	
		>12.5 kHz to 48 kHz	2.0 fF/pF + 22 fF	
		> 48 kHz to 96 kHz	1.6 fF/pF + 18 fF	
		> 96 kHz to 1 MHz	1.5 fF/pF + 16 fF	
	> 100 pF to 1000 pF	20 Hz to 50 Hz	33 fF/pF + 3.7 pF	
		> 50 Hz to 500 Hz	3.3 fF/pF + 0.37 pF	
		> 500 Hz to 1 kHz	1.5 fF/pF + 0.17 pF	
		> 1 kHz to 12.5 kHz	1.6 fF/pF + 0.18 pF	
> 12.5 kHz to 48 kHz		1.6 fF/pF + 0.18 pF		
> 48 kHz to 96 kHz		1.7 fF/pF + 0.19 pF		
1 fF to 110 pF	> 96 kHz to 1 MHz	1.9 fF/pF + 0.21 pF		
	50 Hz to 0.5 kHz	3.9 aF/pF + 2.0 aF	AH2700A	
	> 0.5 kHz to 1.5 kHz	3.7 aF/pF + 1.3 aF		
	> 1.5 kHz to 10 kHz	4.8 aF/pF + 7.1 aF		
> 10 kHz to 20 kHz	14 aF/pF + 0.21 fF			
> 110 pF to 1 nF	50 Hz to 0.5 kHz	3.9 aF/pF + 4.2 aF		
	> 0.5 kHz to 1.5 kHz	3.9 aF/pF – 4.0 aF		
	> 1.5 kHz to 10 kHz	8.2 aF/pF – 0.33 fF		
	> 10 kHz to 20 kHz	7.8 aF/pF + 0.13 fF		
> 1 nF to 10 nF	50 Hz to 0.5 kHz	3.7 fF/nF + 1.5 fF		
	> 0.5 kHz to 1.5 kHz	4.8 fF/nF + 0.16 fF		
	> 1.5 kHz to 10 kHz	5.7 fF/nF – 51 aF		



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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, Variable <small>Note 4</small>	> 10 nF to 100 nF	> 10 kHz to 20 kHz	70 fF/nF – 0.71 fF	Fluke 5522A
		50 Hz to 0.5 kHz	7.8 fF/nF – 0.64 fF	
		> 0.5 kHz to 1.5 kHz	9.6 fF/nF – 7.4 fF	
		> 1.5 kHz to 10 kHz	9.9 fF/nF – 7.5 fF	
		> 10 kHz to 20 kHz	0.22 pF/nF – 0.32 pF	
	> 100 nF to 1.2 µF	50 Hz to 0.5 kHz	13 fF/nF – 0.56 pF	
		> 0.5 kHz to 1.5 kHz	15 fF/nF – 0.38 pF	
		> 1.5 kHz to 10 kHz	23 fF/nF – 0.79 pF	
		> 10 kHz to 20 kHz	0.74 pF/nF – 34 pF	
		10 Hz to 10 kHz	5.8 pF/nF + 12 pF	
	0.19 nF to 0.39 nF	10 Hz to 10 kHz	5.8 pF/nF + 12 pF	
	0.4 nF to 1.1 nF	10 Hz to 10 kHz	5.8 pF/nF + 12 pF	
	> 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		



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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
Capacitance – Generate, Fixed ^{Note 4}	> 3.3 mF to 11 mF	DC to 2 Hz	5.2 μF/mF + 12 μF	AH1100 GenRad 1404 & 1409 GenRad 1417 HP 16385A HP 16386A HP 16387A HP 16381A
	> 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	1 kHz or 1.6 kHz	2.0 aF	
	10 pF		16 aF	
	100 pF	100 Hz, 120 Hz, or 1 kHz	0.15 fF	
	1 pF		3.9 fF	
	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		
100 μF		0.34 μF		
1 mF	100 Hz, 120 Hz	3.6 μF		
10 mF		52 μF		
100 mF		0.41 mF		
1 F		5.8 mF		
10 nF	120 Hz to 100 kHz	3.5 pF		
100 nF		35 pF		
1 μF		0.36 nF		
1 pF	1 kHz	0.083 fF		

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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 pF	1 MHz	0.11 fF	HP 16382A
		2 MHz	0.24 fF	
		3 MHz	0.42 fF	
		4 MHz	0.63 fF	
		5 MHz	0.88 fF	
		10 MHz	2.5 fF	
		13 MHz	3.7 fF	
	100 pF	1 kHz	0.70 fF	
		1 MHz	0.70 fF	
		2 MHz	0.70 fF	
		3 MHz	0.72 fF	
		4 MHz	0.75 fF	
		5 MHz	0.79 fF	
		10 MHz	1.3 fF	
	1000 pF	13 MHz	1.7 fF	
		1 kHz	7.0 fF	
		1 MHz	7.1 fF	
		2 MHz	7.6 fF	
		3 MHz	8.9 fF	
		4 MHz	11 fF	
		5 MHz	14 fF	
HP 16383A	10 MHz	34 fF		
	13 MHz	49 fF		
	1 kHz	4.0 nF		
	1 MHz	86 nF		
	2 MHz	0.16 pF		
	3 MHz	0.29 pF		
	4 MHz	0.44 pF		
HP 16384A	5 MHz	0.62 pF		
	10 MHz	1.9 pF		
	13 MHz	2.8 pF		

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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
INDUCTANCE (20/E11)				
Inductance – Measure	10 nH to 10 H	12 Hz to 100 kHz	2.2 mH/H + 4.8 nH	GenRad 1693
	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	100 Hz to 1 kHz	49 µH/H + 0.49 µH	ESI LCR Bridge w/ DT72A Transformer
	> 0.5 mH to 2 mH		0.14 mH/H + 0.44 µH	
> 2 mH to 10 mH	0.24 mH/H + 0.24 µH			
> 10 mH to 50 mH		0.26 mH/H + 69 nH		
> 50 mH to 200 mH		0.26 mH/H + 1.8 nH		
> 200 mH to 1 H		0.27 mH/H - 1.2 µH		
> 1 H to 5 H		0.37 mH/H - 0.11 mH		
5 H to 10 H		0.59 mH/H - 0.62 mH		
Inductance – Generate ^{Note 4}	50 µH	100 Hz or 1 kHz	0.17 µH	GenRad 1482 Set
	100 µH		0.12 µH	
	1 mH		0.46 µH	
	10 mH		1.7 µH	
	100 mH		26 µH	
	1 H		0.99 mH	
	10 H		19 mH	

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 µW to 1.1 mW	0.024 %	Fluke 5522A
	> 1.1 mW to 110 mW	0.027 %	
	> 0.11W to 110 W	0.024 %	

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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
	> 110 W to 330 W	0.018 %	
> 0.33 A to 3 A	11 W to 110 mW	0.044 %	
	> 0.11 W to 990 W	0.053 %	
	> 0.99 kW to 3 kW	0.0096 %	
> 3 A to 20.5 A	0.099 W to 0.99 W	0.088 %	
	> 0.99 W to 6.8 kW	0.070 %	
	> 6.8 kW to 20.5 kW	0.040 %	
AC Power – Generate ^{Notes 4,7} (PF = 1, $\Phi = 0^\circ$ at 10 Hz to 65 Hz)			
3.3 mA to 9 mA	0.11 mW to 3.0 mW	0.13%	Fluke 5522A
	> 3.0 mW to 9 W	0.077 %	
> 9 mA to 33 mA	0.3 mW to 10 mW	0.089 %	
	> 10 mW to 33 W	0.077 %	
> 33 mA to 90 mA	1 mW to 30 mW	0.071 %	
	> 30 mW to 90 W	0.057 %	
> 90 mA to 330 mA	3.0 mW to 100 mW	0.089 %	
	> 100 mW to 300 W	0.078 %	
> 0.33 A to 0.9 A	11 mW to 300 mW	0.071 %	
	> 300 mW to 900 W	0.058 %	
> 0.9 A to 2.2 A	30 mW to 720 mW	0.089 %	
	> 720 mW to 2 kW	0.079 %	
> 2.2 A to 4.5 A	80 mW to 1.4 W	0.088 %	
	> 1.4 W to 4.5 kW	0.05 %	



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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
> 4.5 A to 20.5 A	150 mW to 6.7 W > 6.7 W to 20 kW	0.17 % 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 5522A
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}	180.19 ps to 9.009 ns 9.0091 ns to 55 s	0.29 as/ns + 1.1 as 0.29 ns/ms – 1.7 as	Fluke 9500B /9560
CONDUCTANCE (20/E21)			
Conductivity ^{Note 4}	10 μ S/cm 100 μ S/cm 1000 μ S/cm	0.65 μ S/cm 1.3 μ S/cm 4.2 μ S/cm	Conductivity solutions

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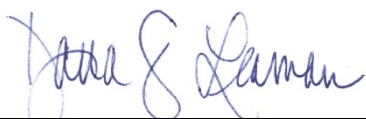
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
	10 000 µS/cm 100 000 µS/cm	36 µS/cm 0.33 mS/cm	
TIME and FREQUENCY			
FREQUENCY DISSEMINATION (20/F01)			
Frequency – Measure ^{Note 4}	100 µHz to 10 Hz > 10 Hz to 3 GHz > 3 GHz to 26.5 GHz > 26.5 GHz to 110 GHz	50 µHz 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 µHz 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}			Keysight N5531X
100 kHz to 3.6 GHz	1 % to 99 %	0.12 %	
> 3.6 GHz to 13.6 GHz	5 % to 99 %	0.15 %	
> 13.6 GHz to 17.1 GHz	5 % to 99 %	0.17 %	
> 17.1 GHz to 26.5 GHz	5 % to 99 %	0.19 %	
> 26.5 GHz to 34.5 GHz	5 % to 99 %	0.24 %	
> 34.5 GHz to 50 GHz	5 % to 99 %	0.46 %	

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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
Frequency Modulation -- Generate and measure ^{Notes 4,8} 100 kHz to 3.6 GHz	0.2 < β ≤ 100	0.004 FM	Keysight N5531X
	β > 100	0.0092 FM	
	> 3.6 GHz to 8.4 GHz	0.0081 FM	
	β > 100	0.023 FM	
	> 8.4 GHz to 17.1 GHz	0.0081 FM	
> 17.1 GHz to 34.5 GHz	0.2 < β ≤ 100	0.0081 FM	
	β > 100	0.029 FM	
> 34.5 GHz to 50 GHz	0.2 < β ≤ 100	0.0092 FM	
	β > 100	0.035 FM	
Phase Modulation – Measure & Generate ^{Note 4}	100 kHz to 3.6 GHz	0.014 rad	Keysight N5531X
	> 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	30 ps	18 ps	Tek 067-1338-00
	500 ps	49 ps	
	150 ps	20 ps	Fluke 9500A/9560
	70 ps	16 ps	



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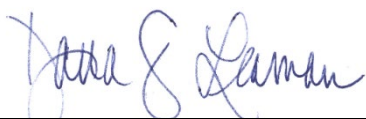
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

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			
AIRSPEED (20/M03)			
Air Velocity – Measure	0 ft/min 400 ft/min to 800 ft/min 800 ft/min to 9000 ft/min	1.3 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 SCCM to 50 SCCM 50 SCCM to 500 SCCM 500 SCCM to 5 SLPM 5 SLPM to 50 SLPM 50 SLPM to 100 SLPM	0.26 % + 0.012 SCCM 0.26 % + 0.12 SCCM 0.26 % + 1.2 SCCM 0.26 % + 12 SCCM 0.52 % + 140 SCCM	Molbox1 & 5E1 Molbloc Molbox1 & 5E2 Molbloc Molbox1 & 5E3 Molbloc Molbox1 & 5E4 Molbloc Molbox1 & 1E5Molbloc
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
Force Gages	0.03125 ozf to 8 ozf	0.056 % + 0.000024 ozf	Class 6 Weights

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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
	0.5 lbf to 500 lbf 3.2 lbf to 300 lbf > 300 lbf to 1000 lbf > 1000 lbf to 10 000 lbf	0.055 % + 0.000022 lbf 0.010 % + 0.0064 lbf 0.012 % + 0.0012 lbf 0.010 % + 0.16 lbf	Class 7 Weights Morehouse HADI 300LBF Morehouse M4215A- 1000LBF Morehouse M4215A-10000LBF
MASS DISSEMINATION (20/M08)			
Mass – Measure	1 mg to 2 g > 2 g to 10 g > 10 g to 31 g > 31 g to 210 g > 210 g to 300 g > 300 g to 5 kg > 5 kg to 34 kg	3.0 µg + 2.2 µg/g 4.7 µg + 1.4 µg/g 12 µg + 0.63 µg/g 55 µg + 0.56 µg/g 0.34 mg 0.75 mg + 0.43 µg/g 270 mg	Weights, MCM36 Balance Weights, MCM36 Balance Weights, MCM36 Balance Weights, RC210S Balance Weights, 1773MP8 Balance Weights, CCE5004 Balance Weights, CPA34001S 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 100 000 cps	0.33 % 0.50 % 0.45 % 0.60 %	Viscosity solutions

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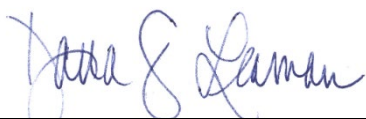
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
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
WEIGHING INSTRUMENTS (20/M16)			
Scales & Balances ^{Note 4}	1 mg to 500 mg > 500 mg to 5 g > 5 g to 10 g > 10 g to 20 g	0.0064 mg 0.0095 mg 0.020 mg 0.031 mg	Class 1 Weights

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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 g to 50 g > 50 g to 300 g > 300 g to 500 g > 500 g to 1 kg > 1 kg to 2 kg > 2 kg to 5 kg > 5 kg to 10 kg > 10 kg to 30 kg > 30 kg to 50 kg > 50 kg to 250 kg	0.13 mg 0.21 mg 0.31 mg 0.85 mg 1.1 mg 3.7 mg 5.9 mg 22 mg 28 mg 3.8 µg/g + 400 mg	Class F Weights
ELECTROMAGNETICS – RF/MICROWAVE			
RF/MICROWAVE POWER (20/R17)			
RF Absolute Power – Measure ^{Note 4}			
100 kHz to 2.6 GHz	-20 dBm to 30 dBm	0.15 dB	HP 8902A w/ 11722A
50 MHz to 1.3 GHz	-20 dBm to 30 dBm	0.15 dB	HP 8902A w/ 11792A
1.3 GHz to 18 GHz		0.25 dB	
18 GHz to 26.5 GHz		0.31 dB	
50 MHz to 100 MHz	-30 dBm to 20 dBm	0.14 dB	HP E4419B w/ HP N8487A
100 MHz to 2 GHz		0.12 dB	
2 GHz to 12.4 GHz		0.14 dB	
12.4 GHz to 18 GHz		0.15 dB	
18 GHz to 26.5 GHz		0.18 dB	
26.5 GHz to 40 GHz		0.22 dB	
40 GHz to 50 GHz		0.31 dB	
50 MHz to 100 MHz	-70 dBm to -20 dBm	0.15 dB	HP E4419B w/ HP 8487D
100 MHz to 2 GHz		0.16 dB	
2 GHz to 12.4 GHz		0.17 dB	
12.4 GHz to 18 GHz		0.20 dB	
18 GHz to 34 GHz		0.23 dB	
34 GHz to 40 GHz		0.29 dB	



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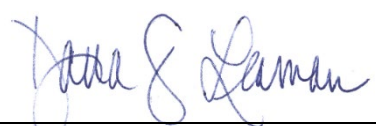
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
40 GHz to 50 GHz		0.37 dB	
30 MHz to 4 GHz	-70 dBm to -20 dBm	0.15 dB	HP E4419B w/ HP 8481D
4 GHz to 10 GHz		0.16 dB	
10 GHz to 15 GHz		0.19 dB	
15 GHz to 18 GHz		0.21 dB	
18 GHz to 30 GHz		0.22 dB	
RF Absolute Power – Measure ^{Note 4}			
9 kHz to 2 GHz	-60 dBm to 20 dBm	0.15 dB	HP E4419B w/ HP E9304A
2 GHz to 6 GHz		0.16 dB	
50 MHz to 100 MHz	-70 dBm to 20 dBm	0.21 dB	HP E4419B w/ HP E4413A
100 MHz to 8 GHz		0.21 dB	
8 GHz to 18 GHz		0.22 dB	
18 GHz to 26.5 GHz		0.23 dB	
50 MHz	1 mW	0.0033 mW	Tegam 1830A w/HP 478A-H76
Tuned RF Power – Absolute Measure ^{Note 4}			HP 8902 w/11722A or 11792A sensor
	10 dBm to -22 dBm	0.14 dB	
	-22 dBm to -42 dBm	0.15 dB	
	-42 dBm to -50 dBm	0.17 dB	
	-50 dBm to -60 dBm	0.17 dB	
	-60 dBm to -72 dBm	0.19 dB	
	-72 dBm to -80 dBm	0.20 dB	
	-80 dBm to -92 dBm	0.21 dB	
	-92 dBm to -102 dBm	0.27 dB	
	-102 dBm to -110 dBm	0.32 dB	
	-110 dBm to -120 dBm	0.37 dB	
	-120 dBm to -127 dBm	0.43 dB	



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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
Tuned RF Power – Relative Measure ^{Note 4} 2.5 MHz to 26.5 GHz	10 dB to 2 dB	0.087 dB	HP 8902 w/11722A or 11792A sensor
	2 dB to -12 dB	0.099 dB	
	-12 dB to -22 dB	0.11 dB	
	-22 dB to -31 dB	0.11 dB	
	-31 dB to -40 dB	0.093 dB	
	-40 dB to -50 dB	0.10 dB	
	-50 dB to -61 dB	0.11 dB	
	-61 dB to -71 dB	0.12 dB	
	-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		
SCATTERING PARAMETERS (20/R18)			
S ₁₁ , S ₂₂ Parameters Reflection Coefficient (0 to 1) 10 MHz to 8.4 GHz	At return loss of:		HP 8757A w/85027B
	1 dB	0.067	
	2 dB	0.054	
	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		

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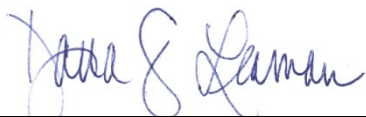
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
> 8.4 GHz to 12 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		
> 12 GHz to 20 GHz	1 dB	0.069	
	2 dB	0.056	
	3 dB	0.047	
	4 dB	0.039	
	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		

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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 GHz to 26.5 GHz	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	
Attenuation – Generate ^{Note 4} (75 Ω) 200 Hz to 25 MHz	0 dB to 18 dB	0.28 dB	
> 25 MHz to 80 MHz		0.40 dB	
200 Hz to 25 MHz	20 dB to 58 dB	0.39 dB	
> 25 MHz to 80 MHz		0.52 dB	
200 Hz to 25 MHz	60 dB to 98 dB	0.47 dB	
> 25 MHz to 80 MHz		0.81 dB	
DC to 18 GHz (Fixed Value)	3 dB	0.46 dB	Weinschel 44 Series
	6 dB	0.46 dB	
	10 dB	0.65 dB	



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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
Attenuation – Generate <small>Note 4</small> 30 MHz	20 dB	0.65 dB	Agilent 11812A
	0 dB	0.0040 dB	
	10 dB	0.0083 dB	
	20 dB	0.019 dB	
	30 dB	0.020 dB	
	40 dB	0.033 dB	
	50 dB	0.022 dB	
Attenuation – Measure <small>Note 4</small> 2.5 MHz to 26.5 GHz	0 dB to 2 dB	0.081 dB	HP8902 with 11722A or 11792A sensor
	> 2 dB to -12 dB	0.070 dB	
	> -12 dB to -22 dB	0.081 dB	
	> -22 dB to -31 dB	0.081 dB	
	> -31 dB to -40 dB	0.093 dB	
	> -40 dB to -50 dB	0.10 dB	
	> -50 dB to -61 dB	0.11 dB	
	> -61 dB to -71 dB	0.12 dB	
	> -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 <small>Note 4</small>	10 % RH to 95 % RH	0.15 % RH + 0.29 % rdg.	Humidity probe/indicator Thunder Scientific
LABORATORY THERMOMETERS (20/T03)			
Temperature – Generate & Measure	-197 °C -95 °C to -80 °C	6.4 mK 13 mK	Additel ADT286 w/AccuMac 1960A or Fixed Point



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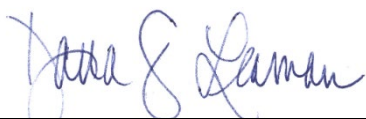
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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) ^{Notes 1,2}

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
Thermistor	$\geq -80\text{ }^{\circ}\text{C}$ to $0\text{ }^{\circ}\text{C}$ $0.01\text{ }^{\circ}\text{C}$ $> 0\text{ }^{\circ}\text{C}$ to $100\text{ }^{\circ}\text{C}$ $\geq 100\text{ }^{\circ}\text{C}$ to $250\text{ }^{\circ}\text{C}$ $> 250\text{ }^{\circ}\text{C}$ to $660\text{ }^{\circ}\text{C}$ $> 660\text{ }^{\circ}\text{C}$ to $700\text{ }^{\circ}\text{C}$	$7.2\text{ mK} + 0.014\text{ mK}/^{\circ}\text{C}$ 4.4 mK $7.6\text{ mK} + 0.018\text{ mK}/^{\circ}\text{C}$ $6.3\text{ mK} + 0.029\text{ mK}/^{\circ}\text{C}$ $20\text{ mK} + 0.079\text{ mK}/^{\circ}\text{C}$ $0.47\text{ }^{\circ}\text{C} + 1.2\text{ E-}04\text{ }^{\circ}\text{C}/^{\circ}\text{C}$	TPW Fluke 9118A w/AccuMac AM1210-20
	$> 700\text{ }^{\circ}\text{C}$ to $1000\text{ }^{\circ}\text{C}$ $> 1000\text{ }^{\circ}\text{C}$ to $1200\text{ }^{\circ}\text{C}$	$1.2\text{ }^{\circ}\text{C}$ $0.85\text{ }^{\circ}\text{C} + 7.6\text{ E-}04\text{ }^{\circ}\text{C}/^{\circ}\text{C}$	Fluke 5644S w/Additel ADT286
PRESSURE (20/T05)			
Pressure – Generate & Measure ^{Note 4}	0 Pa to 746 Pa $> 746\text{ Pa}$ to 7460 Pa	$0.0048\% + 0.045\text{ Pa}$ $0.011\% - 0.00015\text{ Pa}$	Fluke 7250 LP
	1245 Pa to 10 kPa $> 10\text{ kPa}$ to 62 kPa $> 62\text{ kPa}$ to 689 kPa $> 689\text{ kPa}$ to 6.89 MPa $> 6.89\text{ MPa}$ to 20 MPa $> 20\text{ MPa}$ to 68.9 MPa	1.2 Pa 0.012% $0.0098\% + 0.64\text{ Pa}$ $0.0098\% + 1.8\text{ Pa}$ $0.016\% + 1.4\text{ Pa}$ $0.017\% + 3.0\text{ Pa}$	Pressurements T3500/3 DHI RPM4-A700kp DHI RPM4-A7mp DHI RPM4-A2Ms DHI RPM4-A70Ms
	69 MPa to 207 MPa	$0.025\% + 17\text{ Pa}$	Fluke/DHI E-DWT-H-A200Me-L
RADIATION THERMOMETRY (20/T06)			
Source ^{Note 4}	$-15\text{ }^{\circ}\text{C}$ to $120\text{ }^{\circ}\text{C}$ $120\text{ }^{\circ}\text{C}$ to $200\text{ }^{\circ}\text{C}$ $200\text{ }^{\circ}\text{C}$ to $500\text{ }^{\circ}\text{C}$	$0.0012\text{ }^{\circ}\text{C}/^{\circ}\text{C} + 0.33\text{ }^{\circ}\text{C}$ $0.0023\text{ }^{\circ}\text{C}/^{\circ}\text{C} + 0.17\text{ }^{\circ}\text{C}$ $0.0028\text{ }^{\circ}\text{C}/^{\circ}\text{C} + 0.065\text{ }^{\circ}\text{C}$	Fluke 4180 infrared source Fluke 4181 infrared source

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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
RESISTANCE THERMOMETRY (20/T07)			
Comparison - RTDs	-197 °C	6.4 mK	Additel ADT286 w/AccuMac 1960A or Fixed Point
	-95 °C to -80 °C	13 mK	
	≥ -80 °C to 0 °C	7.2 mK+ 0.014 mK/°C	TPW
	0.01 °C	4.4 mK	
	> 0 °C to 100 °C	7.6 mK+ 0.018 mK/°C	
	≥ 100 °C to 250 °C	6.3 mK+ 0.029 mK/°C	
	> 250 °C to 660 °C	20 mK+ 0.079 mK/°C	
	> 660 °C to 700 °C	0.47 °C + 1.2 E-04 °C/°C	
	> 700 °C to 1000 °C	1.2 °C	Fluke 9118A w/AccuMac AM1210-20
	> 1000 °C to 1200 °C	0.85 °C + 7.6 E-04 °C/°C	
TEMPERATURE INDICATORS (20/T08)			
Thermocouple Simulation ^{Note 4} Type B	600 °C to 800 °C	0.34 °C	Fluke 5522A
	> 800 °C to 1000 °C	0.27 °C	
	> 1000 °C to 1550 °C	0.23 °C	
	> 1550 °C to 1820 °C	0.26 °C	
	Type C	0 °C to 150 °C	
	> 150 °C to 650 °C	0.20 °C	
	> 650 °C to 1000 °C	0.24 °C	
	> 1000 °C to 1800 °C	0.39 °C	
	> 1800 °C to 2316 °C	0.65 °C	
Type E	-250 °C to -100 °C	0.39 °C	
	> -100 °C to -25 °C	0.13 °C	
	> -25 °C to 350 °C	0.11 °C	
	> 350 °C to 650 °C	0.13 °C	
	> 650 °C to 1000 °C	0.16 °C	



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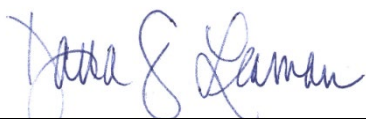
CALIBRATION LABORATORIES

NVLAP LAB CODE 200972-0

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

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) ^{Notes 3,5}	Remarks
Type J	-210 °C to -100 °C	0.21 °C	
	> -100 °C to -30 °C	0.13 °C	
	> -30 °C to 150 °C	0.11 °C	
	> 150 °C to 760 °C	0.13 °C	
	> 760 °C to 1200 °C	0.18 °C	
Type K	-210 °C to -100 °C	0.26 °C	
	> -100 °C to -25 °C	0.14 °C	
	> -25 °C to 120 °C	0.13 °C	
	> 120 °C to 1000 °C	0.20 °C	
	> 1000 °C to 1372 °C	0.31 °C	
Type L	-200 °C to -100 °C	0.29 °C	
	> -100 °C to 800 °C	0.20 °C	
	> 800 °C to 900 °C	0.13 °C	
Type N	-200 °C to -100 °C	0.31 °C	
	> -100 °C to -25 °C	0.17 °C	
	> -25 °C to 120 °C	0.15 °C	
	> 120 °C to 410 °C	0.14 °C	
	> 410 °C to 1300 °C	0.21 °C	
Type R	0 °C to 250 °C	0.44 °C	
	> 250 °C to 400 °C	0.27 °C	
	> 400 °C to 1000 °C	0.26 °C	
	> 1000 °C to 1767 °C	0.31 °C	
Type S	0 °C to 250 °C	0.37 °C	
	> 250 °C to 1000 °C	0.28 °C	
	> 1000 °C to 1400 °C	0.29 °C	
	> 1400 °C to 1767 °C	0.36 °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 T	-250 °C to -150 °C	0.49 °C	
	> -150 °C to 0 °C	0.19 °C	
	> 0 °C to 120 °C	0.13 °C	
	> 120 °C to 400 °C	0.11 °C	
Type U	-200 °C to 0 °C	0.44 °C	
	> 0 °C to 600 °C	0.22 °C	
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	0.039 °C	
	> -80 °C to 0 °C	0.039 °C	
	> 0 °C to 100 °C	0.054 °C	
	> 100 °C to 300 °C	0.070 °C	
	> 300 °C to 400 °C	0.078 °C	
	> 400 °C to 630 °C	0.093 °C	
	> 630 °C to 800 °C	0.18 °C	
Pt 3926, 100 Ω	-200 °C to -80 °C	0.039 °C	
	> -80 °C to 0 °C	0.039 °C	
	> 0 °C to 100 °C	0.054 °C	
	> 100 °C to 300 °C	0.070 °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
Pt 3916, 100 Ω	> 300 °C to 400 °C	0.078 °C	
	> 400 °C to 630 °C	0.093 °C	
	-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	
	> 260 °C to 300 °C	0.092 °C	
	> 300 °C to 400 °C	0.10 °C	
	> 400 °C to 600 °C	0.12 °C	
Pt 385, 200 Ω	> 600 °C to 630 °C	0.27 °C	
	-200 °C to -80 °C	0.031 °C	
	> -80 °C to 0 °C	0.031 °C	
	> 0 °C to 100 °C	0.031 °C	
	> 100 °C to 260 °C	0.039 °C	
	> 260 °C to 300 °C	0.093 °C	
	> 300 °C to 400 °C	0.10 °C	
	> 400 °C to 600 °C	0.11 °C	
Pt 385, 500 Ω	> 600 °C to 630 °C	0.12 °C	
	-200 °C to -80 °C	0.039 °C	
	> -80 °C to 0 °C	0.031 °C	
	> 0 °C to 100 °C	0.039 °C	
	> 100 °C to 260 °C	0.047 °C	
	> 260 °C to 300 °C	0.062 °C	
	> 300 °C to 400 °C	0.062 °C	
	> 400 °C to 600 °C	0.070 °C	
Pt 385, 1000 Ω	> 600 °C to 630 °C	0.085 °C	
	-200 °C to -80 °C	0.023 °C	
	> -80 °C to 0 °C	0.023 °C	



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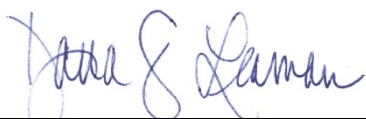
CALIBRATION LABORATORIES

NVLAP LAB CODE 200972-0

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	> 0 °C to 100 °C	0.031 °C	
	> 100 °C to 260 °C	0.039 °C	
	> 260 °C to 300 °C	0.047 °C	
	> 300 °C to 400 °C	0.054 °C	
	> 400 °C to 600 °C	0.055 °C	
	> 600 °C to 630 °C	0.18 °C	
Cu 427, 10 Ω	-80 °C to 0 °C	0.062 °C	
	> 0 °C to 100 °C	0.062 °C	
	> 100 °C to 260 °C	0.11 °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	0.14 °C – 3.5E-04 °C/°C 0.14 °C + 1.3E-04 °C/°C	Comparison to Fluke SPRT
Type J	-200 °C to 0.01 °C > 0.01 °C to 660 °C	0.14 °C – 3.0E-04 °C/°C 0.14 °C + 1.3E-04 °C/°C	
Type T	-200 °C to 0.01 °C > 0.01 °C to 420 °C	0.14 °C – 3.4E-04 °C/°C 0.14 °C + 1.1E-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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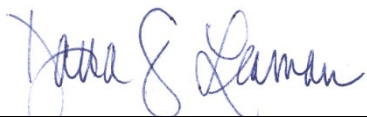
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Notes

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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