CALIBRATION LABORATORIES **NVLAP LAB CODE 200972-0**

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

ESSCO CALIBRATION LABORATORY	Fields of Calibration
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	Dimensional Electromagnetics – DC/Low Frequency Time and Frequency Mechanical Electromagnetics – RF/Microwave Thermodynamic This laboratory is compliant to ANSI/NCSL Z540-1-1994; Part 1. (NVLAP Code: 20/A01)

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 2.5 µin 3.1 µin 4.6 µin 5.3 µin 6.8 µin 9.2 µin 10 µin 11 µin 13 µin 15 µin 18 µin 22 µin	Comparison to master blocks
LENGTH & DIAMETER (20/D05)			
Length Standards, Rods	0.1 in to 40 in	2.0 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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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

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	1.5 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	2.3 µin/in + 29 µin	Comparison to gage blocks
Feeler Gage	Up to 0.2 in	32 µin	Supermicrometer
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	0.00048 in	Indirect comparison to crimp micrometer
MEASURING WIRES (20/D07)			
Thread Wires	4 threads/in to 120 threads/in	8.9 µin	Labmaster, gage blocks

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Note 3	Remarks
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
SPHERICAL DIAMETER, PLAIN PLUG/RINGS (20/D11)			
Pin Gages (Class Z & ZZ)Note 4	0.004 in to 1 in 0.004 in to 1 in	60 µin 36 µin/in + 7.9 µin	Supermicrometer Laser Micrometer
Plain Plugs (Class Y to XXX)	0 in to 12 in	2.9 µin/in + 3.1 µin	Labmaster
Plain Ring Gages			
Discrete sizes	0.04 in 0.125 in 0.1875 in 0.25 in 0. 50 in 1.0 in 2.0 in 4.0 in	6.8 µin 6.1 µin 6.1 µin 5.3 µin 5.3 µin 5.5 µin 6.3 µin 8.7 µin	Comparison to master gages
Variable Range	0.040 in to 0.044 in > 0.044 in to 0.125 in >0.125 in to 0.1562 in >0.1562 in to 0.186 in >0.186 in to 0.2166 in >0.2166 in to 0.25 in >0.25 in to 0.375 in >0.375 in to 0.50 in >0.50 in to 0.752 in >0.752 in to 1.0 in >1.0 in to 1.32 in >1.32 in to 2.0 in >2.0 in to 3.47 in >3.47 in to 4.0 in >4.0 in to 12 in	1400 µin/in - 49 µin 18 µin - 89 µin/in 64 µin/in - 1 µin 20 µin/in - 69 µin/in 63 µin - 5 µin 25 µin/in - 77 µin/in 3.7 µin + 9.9 µin/in 10 µin - 7.3 µin/in 14 µin - 0.72 µin/in 21 µin – 14 µin/in 12 µin/in - 5.7 µin 16 µin/in - 4.0 µin/in 3.0 µin/in + 2.6 µin/in 8.1 µin + 1.1 µin/in 4 µin + 2.1 µin/in	Comparison to master gages

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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
Crimp Tools – Die Dimension	0.005 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 µin/in + 170 µin 4.9 µin/in + 340 µin 4.9 µin/in + 500 µin 4.9 µin/in + 670 µin	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 120 TPI 0.20 mm to 10 mm (Pitch)	 0.01 in to 5 in 0.1 mm to 127 mm	 89 µin 2.3 µm	Thread wires/ Supermicrometer
Adjustable Threaded Rings, Straight Thread – Pitch Diameter 6 TPI to 120 TPI 0.20 mm to 10 mm (Pitch)	 0.01 in to 5 in	 89 µin 2.3 µm	 Ring is sized to a setting plug with plug's uncert. given

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

ELECTROMAGNETICS – DC/LOW FREQUENCY					
AC RESISTANCE and CURRENT (20/E02)					
AC Current – Generate					
Fluke 5730B/05 and 5725A Characterized With Fluke 5790B and A40Bs					
Range	**10 to 20 Hz**	**20 to 40 Hz**	**0.040 to 1 kHz**	**1 to 5 kHz**	**5 to 10 kHz**
0 to 220 µA	130 µA/A + 3.9 nA	72 µA/A + 3.9 nA	41 µA/A + 2.4 nA	46 µA/A + 16 nA	310 µA/A + 78 nA
0.22 to 1 mA	130 µA/A + 4.1 nA	74 µA/A + 4.4 nA	44 µA/A + 3.1 nA	53 µA/A + 15 nA	310 µA/A + 78 nA
1 to 2.2 mA	130 µA/A	71 µA/A + 3.7 nA	40 µA/A + 2.0 nA	50 µA/A + 13 nA	310 µA/A + 77 nA
2.2 to 10 mA	130 µA/A + 42 nA	71 µA/A + 45 nA	38 µA/A + 34 nA	46 µA/A + 380 nA	310 µA/A + 780 nA
10 to 20 mA	130 µA/A	71 µA/A + 37 nA	40 µA/A + 20 nA	50 µA/A + 350 nA	310 µA/A + 770 nA
20 to 22 mA	130 µA/A	72 µA/A	41 µA/A	50 µA/A + 340 nA	310 µA/A
22 to50 mA	130 µA/A + 430 nA	70 µA/A + 470 nA	38 µA/A + 370 nA	47 µA/A + 2.3 µA	310 µA/A + 3.9 µA
50 to 100 mA	130 µA/A + 390 nA	71 µA/A + 410 nA	39 µA/A + 260 nA	48 µA/A + 2.2 µA	310 µA/A + 3.9 µA
100 to 200 mA	130 µA/A	71 µA/A + 370 nA	40 µA/A + 200 nA	50 µA/A + 2.1 µA	310 µA/A + 3.9 µA

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AC Current – Generate					
Fluke 5730B/05 and 5725A Characterized With Fluke 5790B and A40Bs					
Range	**10 to 20 Hz**	**20 to 40 Hz**	**0.040 to 1 kHz**	**1 to 5 kHz**	**5 to 10 kHz**
200 to 220 mA	130 µA/A	72 µA/A	41 µA/A	51 µA/A + 2.0 µA	310 µA/A
220 to 500 mA			49 µA/A + 4.8 µA	68 µA/A + 16 µA	620 µA/A + 39 µA
0.5 to 1 A			51 µA/A + 3.9 µA	69 µA/A + 15 µA	620 µA/A + 39 µA
1 to 2 A			51 µA/A + 3.5 µA	72 µA/A + 14 µA	620 µA/A + 39 µA
2 to 5 A			54 µA/A + 3.1 µA	72 µA/A + 14 µA	620 µA/A
5 to 10 A			67 µA/A + 81 µA	84 µA/A + 120 µA	160 µA/A + 230 µA
10 to 11 A			70 µA/A + 73 µA	86 µA/A + 110 µA	160 µA/A + 230 µA

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) [Note 3]	Remarks
AC Current – Generate	> 11 A to 20.5 A	45 Hz to 100 Hz > 100 Hz to 1 kHz > 1 kHz to 5 kHz	0.93 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Fluke 5522A
(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 5730A
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 5522A with 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	Fluke 5522A with 5500A/COIL
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 5730A with Fluke 52120A, Fluke 52120A/Coil3kA

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Current – Measure				
Fluke 8508A				
Range	**1 to 10 Hz**	**0.010 to 10 kHz**	**10 to 30 kHz**	**30 to 100 kHz**
0 to 200 µA	0.25 mA/A + 20 nA	0.25 mA/A + 25 nA	0.60 mA/A + 78 nA	3.9 mA/A + 53 nA
0.200 to 2 mA	0.25 mA/A + 0.20 µA	0.25 mA/A + 0.20 µA	0.68 mA/A + 0.21 µA	4.0 mA/A + 0.21 µA
2 to 20 mA	0.25 mA/A + 2.0 µA	0.25 mA/A + 2.0 µA	0.68 mA/A + 2.1 µA	4.0 mA/A + 2.1 µA
20 to 200 mA	0.25 mA/A + 20 µA	0.25 mA/A + 20 µA	0.67 mA/A + 20 µA	
0.200 to 2 A	0.60 mA/A + 0.20 mA	0.70 mA/A + 0.20 mA	3.1 mA/A + 0.20 mA	
2 to 20 A	0.80 mA/A + 2.0 mA	2.5 mA/A + 2.0 mA		

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Current –Measure											
Fluke 5790B/05 With Fluke A40B Shunts											
Expanded uncertainties are in µA/A for the level shown at left at indicated frequencies below											
Range	**10 to 20Hz**	**20 to 40Hz**	**40 to 55Hz**	**55 to 400Hz**	**0.4 to 1kHz**	**1 to 10kHz**	**10 to 20kHz**	**20 to 30kHz**	**30 to 50kHz**	**50 to 70kHz**	**70 to 100kHz**
0 to 1 mA	61	42	39	39	39	39	39	40	49	60	64
1 to 10 mA	56	35	32	32	32	32	33	33	37	51	55
10 to 20 mA	56	35	32	32	32	33	33	33	37	51	53
20 to 50 mA	57	36	33	33	33	33	37	37	37	51	55
50 to 100 mA	56	35	32	32	32	32	33	33	33	49	51
100 to 200 mA	56	35	32	32	32	32	33	33	33	49	50
200 to 500 mA	57	36	33	34	33	33	34	34	36	50	53
0.5 to 1 A	57	36	33	33	33	32	35	35	35	50	53
1 to 2 A	56	35	32	33	33	36	39	40	45	57	67
2 to 5 A	59	40	37	37	37	36	42	42	53	64	80
5 to 10 A	61	43	40	40	40	39	61	62	71	79	99
10 to 20 A	66	49	47	48	48	56	74	74	95	100	130
20 to 50 A	72	57	56	56	55	63	82	82	100	110	160
50 to 100 A	78	65	63	63	62	80	90	90	140	150	180

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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	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.18 % 0.27 %	Agilent 16074A
	1 Ω	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.12 % 0.12 %	
	10 Ω	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.036 % 0.036 %	
	100 Ω	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.035 % 0.036 %	
	1 kΩ	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.035 % 0.035 %	
	10 kΩ	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.040 % 0.14 %	
	100 kΩ	> 0.1 Hz to 1 MHz > 1 MHz to 13 MHz	0.099 % 0.62 %	
AC Resistance – Measure	0 Ω to 15 Ω 15 Ω to 320 kΩ > 320 kΩ to 10 MΩ	50 Hz to 1 MHz 100 Hz to 100 kHz 100 Hz to 100 kHz	0.14 % 0.08 % 0.26 %	Agilent 4284A

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

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 > 2 pA to 20 pA > 20 pA to 200 pA > 0.2 nA to 2 nA	4.9 fA/pA + 12 fA 4.1 fA/pA + 17 fA 2.9 fA/pA + 42 fA 0.76 pA/nA + 0.12 pA	Keithley 263

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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 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	
	> 0 µA to 20 µA	6 µA/A + 1.2 nA	Characterized Fluke 5730A and Fluke 5725A
	> 20 µA to 220 µA	7 µA/A + 1.1 nA	
	> 220 µA to 2.2 mA	9.6 µA/A + 0.97 nA	
	> 2.2 mA to 22 mA	9.8 µA/A + 4.9 nA	
	> 22 mA to 220 mA	13 µA/A	
	> 220 mA to 2.2 A	19 µA/A - 220 nA	
	> 2.2 A to 7.5 A	56 µA/A - 73 µA	
	> 7.5 A to 11 A	37 µA/A + 100 µA	
	> 11 A to 20 A	0.77 mA/A + 0.77 mA	Fluke 5522A
	> 20 A to 100 A	0.43 mA/A	Fluke 5730A with Fluke 52120A
Current Clamp – Non-Toroidal [Note 4]	20 A to 1000 A	5.8 mA/A + 0.58 A	Fluke 5522A w/ 5500A/COIL
	1000 A to 2500 A	4.9 mA/A	Fluke 5730A with Fluke 52120A, Fluke 52120A/Coil3kA
Direct Current – Measure [Note 4]	0 pA to 2 pA	16 µA/A + 13 fA	Keithley 617
	> 2 pA to 20 pA	14 µA/A + 110 fA	
	> 20 pA to 200 pA	18 µA/A + 110 fA	
	> 200 pA to 2 nA	2.6 µA/A + 1.3 pA	
	> 2 nA to 20 nA	2.8 µA/A + 5.3 pA	
	> 20 nA to 200 nA	8.7 µA/A + 0.32 pA	Fluke 8508A With Standard Resistors
	> 200 nA to 2 µA	4.1 µA/A + 0.29 pA	
	2 µA to 20 µA	1.7 µA/A + 82 pA	
	20 µA to 200 µA	3.1 µA/A + 39 pA	
	200 µA to 2 mA	3.6 µA/A + 0.23 nA	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
	2 mA to 20 mA	3.2 µA/A + 2.5 nA	
	20 mA to 100 mA	3.6 µA/A + 22 nA	
	100 mA to 200 mA	5.0 µA/A + 65 nA	
	0.2 A to 7.5 A	11 µA/A + 0.45 µA	
	7.5 A to 50 A	22 µA/A	
	50 A to 200 A	13 µA/A + 38 µA	
Resistance – Variable Generate Note 4	0 Ω to 11 Ω	47 µΩ/Ω + 1.2 mΩ	Fluke 5522A
	> 11 Ω to 33 Ω	40 µΩ/Ω + 1.7 mΩ	
	> 33 Ω to 110 Ω	34 µΩ/Ω + 1.8 mΩ	
	> 110 Ω to 330 Ω	34 µΩ/Ω + 2.4 mΩ	
	> 330 Ω to 1.1 kΩ	34 µΩ/Ω + 2.4 mΩ	
	> 1.1 kΩ to 3.3 kΩ	34 µΩ/Ω + 22 mΩ	
	> 3.3 kΩ to 11 kΩ	34 µΩ/Ω + 23 mΩ	
	> 11 kΩ to 33 kΩ	34 µΩ/Ω + 0.22 Ω	
	> 33 kΩ to 110 kΩ	34 µΩ/Ω + 0.24 Ω	
	> 110 kΩ to 330 kΩ	44 µΩ/Ω + 1.6 Ω	
	> 330 kΩ to 1.1 MΩ	40 µΩ/Ω + 3.0 Ω	
	> 1.1 MΩ to 3.3 MΩ	0.12 mΩ/Ω	
	> 3.3 MΩ to 11 MΩ	0.16 mΩ/Ω + 86 Ω	
Resistance – Variable Generate Note 4	> 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	
Resistance – Fixed Generate Instrument-Based Note 4	1 Ω	22 µΩ/Ω	Fluke 5730A Characterized
	1.9 Ω	17 µΩ/Ω	
	10 Ω	4.5 µΩ/Ω	
	19 Ω	3.9 µΩ/Ω	
	100 Ω	1.8 µΩ/Ω	
	190 Ω	1.7 µΩ/Ω	
	1 kΩ	2.4 µΩ/Ω	
	1.9 kΩ	2.4 µΩ/Ω	
	10 kΩ	1.8 µΩ/Ω	

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	19 kΩ	1.7 μΩ/Ω	
	100 kΩ	4.5 μΩ/Ω	
	190 kΩ	4.5 μΩ/Ω	
	1 MΩ	3.8 μΩ/Ω	
	1.9 MΩ	3.7 μΩ/Ω	
	10 MΩ	12 μΩ/Ω	
	19 MΩ	16 μΩ/Ω	
	100 MΩ	1.8 μΩ/Ω	
	10 GΩ	1.7 mΩ/Ω	Keithley 263
	100 GΩ	4.5 mΩ/Ω	
Fixed Resistor-Based	0.001 Ω	0.01 %	Ohms-Lab CS-200
	0.01 Ω	23 μΩ/Ω	Guildline 9230-100
	0.1 Ω	12 μΩ/Ω	Guildline 9230-15
	1 Ω	3.6 μΩ/Ω	Fluke 742A-1
	1.9 Ω	1.1 μΩ/Ω	Fluke 742A-1.9
	10 Ω	2.8 μΩ/Ω	Guildline 9334-10
	100 Ω	2.6 μΩ/Ω	Guildline 9334-100
	1 kΩ	1.9 μΩ/Ω	Fluke 742A-1k
	10 kΩ	1.1 μΩ/Ω	Fluke 742A-10k
	100 kΩ	4.0 μΩ/Ω	Fluke 742A-100k
	1 MΩ	2.9 μΩ/Ω	Fluke 742A-1M
	10 MΩ	11 μΩ/Ω	Guildline 9334-10M
	100 MΩ	13 μΩ/Ω	Guildline 9330-100M
	1 GΩ	20 μΩ/Ω	Guildline 9334-1G
	10 GΩ	100 μΩ/Ω	Ohm-Labs 110
	100 GΩ	0.99 mΩ/Ω	IET VRS-100-10-1K-BP
	1 TΩ	5.0 mΩ/Ω	
Resistance – Measure [Note 4]	0 Ω to 2 Ω	4.9 μΩ/Ω + 3.1 μΩ	Fluke 8508 transfer accuracy
	> 2 Ω to 20 Ω	2.4 μΩ/Ω + 8.3 μΩ	
	> 20 Ω to 200 Ω	1.1 μΩ/Ω + 13 μΩ	
	> 200 Ω to 2 kΩ	2.0 μΩ/Ω + 83 μΩ	
	> 2 kΩ to 20 kΩ	1.1 μΩ/Ω + 1.3 mΩ	
	> 20 kΩ to 200 kΩ	4.3 μΩ/Ω + 4.2 mΩ	
	> 200 kΩ to 2 MΩ	3.0 μΩ/Ω + 0.46 Ω	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) [Notes 3,5]	Remarks
	> 2 MΩ to 20 MΩ	9.8 μΩ/Ω + 1.9 Ω	
	> 20 MΩ to 200 MΩ	9.5 μΩ/Ω + 28 Ω	
	> 0.2 GΩ to 2 GΩ	70 μΩ/Ω + 68 kΩ	
	> 2 GΩ to 20 GΩ	0.74 mΩ/Ω + 6.8 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	0.58 μV/V + 330 nV	Characterized Fluke 5730A
	> 0.22 V to 2.2 V	0.43 μV/V + 1.3 μV	
	> 2.2 V to 11 V	0.29 μV/V + 3.7 μV	
	> 11 V to 22 V	0.57 μV/V + 3.2 μV	
	> 22 V to 220 V	0.54 μV/V + 89 μV	
	> 220 V to 1.1 kV	0.24 μV/V + 760 μV	
	1 kV to 50 kV	0.49 mV/V + 0.21 V	Hipotronics Source and Vitrek
	> 50 kV to 70 kV	0.47 mV/V + 1.4 V	
DC Voltage – Fixed Generate	10 V	0.43 μV/V	Fluke 732A
	100 mV	2.8 μV/V	Characterized Fluke 5730A
	1 V	1.1 μV/V	
	10 V	0.62 μV/V	
	100 V	0.88 μV/V	
	1000 V	0.92 μV/V	
DC Voltage – Fixed Measure [Note 4]	100 mV	1.2 μV/V	Agilent 34420A, Fluke 732A, 752A
	1 V	0.52 μV/V	
	10 V	0.44 μV/V	
	100 V	0.53 μV/V	
	1000 V	0.74 μV/V	

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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 – Variable Measure Note 4	0 V to 200 mV > 200 mV to 2 V > 2 V to 20 V > 20 V to 200 V > 200 V to 1000 V	1.3 µV/V + 23 nV 0.56 µV/V + 0.15 µV 0.80 µV/V + 1.3 µV 0.49 µV/V + 1.9 µV 0.71 µV/V + 13 µV	Fluke 8508A w/732A,752A

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AC VOLTAGE (20/E09)

AC Voltage – Source/Measure

Fluke 792A, Fluke 732A, Fluke 752A, Fluke 8508, Fluke 5730A/05, Fluke 5725A

Expanded uncertainties are in µV/V for the level shown at left at indicated frequencies below

Range	Level	10 Hz	20 Hz	40 Hz	100 Hz	1k Hz	10 kHz	20 kHz	30 kHz	50 kHz	100 kHz	300 kHz	500 kHz	800 kHz	1 MHz
22 mV	**2 mV**	460	460	460	460	460	460	460		460	530	610	700	800	810
22 mV	**6 mV**	240	240	210	200	200	200	200		240	300	420	480	590	630
22 mV	**10 mV**	110	100	99	99	100	99	99		110	160	220	290	350	400
22 mV	**20 mV**	88	71	70	71	70	70	69		90	150	220	310	400	420
220 mV	**20 mV**	94	84	85	71	70	71	70		89	150	210	280	320	370
220 mV	**50 mV**	65	39	35	34	33	36	34		38	76	140	210	280	290
220 mV	**100 mV**	45	28	17	16	14	14	14		25	42	80	120	190	190
220 mV	**200 mV**	31	22	14	15	11	13	14		22	41	76	110	160	190
700 mV	**200 mV**	30	21	13	14	12	12	12		21	41	76	110	160	190
700 mV	**600 mV**	28	20	11	11	11	12	11		12	16	26	31	53	71
2.2 V	**600 mV**	26	16	6.9	6.9	6.8	6.9	7.7		8.3	11	22	26	32	42
2.2 V	**1 V**	25	15	7.2	5.6	5.7	5.7	5.9		7.7	11	21	25	31	41
2.2 V	**2 V**	26	15	7.7	5.8	5.5	5.5	5.6		5.5	10	20	25	31	42
7 V	**2 V**	25	16	8.4	5.5	5.6	5.8	5.9		6.7	11	21	26	30	41
7 V	**6 V**	25	15	5.8	5.7	5.5	5.5	5.4		6.3	7.4	20	25	31	41
22 V	**6 V**	29	17	5.9	5.4	5.3	5.8	5.4		6.3	7.5	20	25	30	40
22 V	**10 V**	29	17	5.8	5.5	5.3	5.6	5.7		6.2	8.3	20	25	30	40
22 V	**20 V**	29	17	6.7	6.2	6.2	6.5	6.3		7.2	10	20	25	31	42
70 V	**20 V**	26	16	6.5	7.2	6.5	6.7	6.5		7.5	10	25			
70 V	**60 V**	26	16	6.9	6.9	6.8	6.8	6.9		8.6	11	25			
220 V	**60 V**	25	16	7.3	7.2	7.1	7.3	7.3		9.4	11	30			
220 V	**100 V**	31	16	7.4	7.8	6.7	6.6	6.6		9.4	16				
220 V	**200 V**	40	16	9.1	9.6	8.6	8.5	8.4		11	16				
1000 V	**200 V**	40	16	9.4	9.1	8.4	8.9	8.9		12	31				
1000 V	**600 V**			12	12	11	12	12		17	42				
1000 V	**1000 V**			12	12	11	12	12	13						

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Voltage –Measure								
Fluke 5790B/05								
Range	**10 to 20 Hz**	**20 to 40 Hz**	**0.040 to 20 kHz**	**20 to 50 kHz**	**50 to 100 kHz**	**100 to 300 kHz**	**300 to 500 kHz**	**0.500 to 1 MHz**
0.6 to 2.2 mV	130 µV/V + 0.99 µV	95 µV/V + 0.99 µV	91 µV/V + 0.99 µV	82 µV/V + 1.5 µV	92 µV/V + 1.9 µV	200 µV/V + 3.1 µV	600 µV/V + 6.2 µV	2200 µV/V + 6.1 µV
2.2 to 7 mV	84 µV/V + 0.99 µV	50 µV/V + 0.98 µV	49 µV/V + 0.98 µV	48 µV/V + 1.5 µV	58 µV/V + 1.9 µV	150 µV/V + 3 µV	380 µV/V + 6.2 µV	1600 µV/V + 6.1 µV
7 to 22 mV	87 µV/V + 0.88 µV	49 µV/V + 0.94 µV	40 µV/V + 0.96 µV	48 µV/V + 1.5 µV	74 µV/V + 1.8 µV	170 µV/V + 2.8 µV	370 µV/V + 5.9 µV	1200 µV/V + 6.1 µV
22 to 70 mV	64 µV/V + 0.98 µV	39 µV/V + 1 µV	35 µV/V + 1 µV	43 µV/V + 1.4 µV	80 µV/V + 1.6 µV	160 µV/V + 2.5 µV	300 µV/V + 5.6 µV	800 µV/V + 6.1 µV
70 to 220 mV	68 µV/V + 0.14 µV	26 µV/V + 1.1 µV	23 µV/V + 1.1 µV	28 µV/V + 1.3 µV	57 µV/V + 1.6 µV	120 µV/V + 2.7 µV	250 µV/V + 5.8 µV	760 µV/V + 6 µV
220 to 700 mV	57 µV/V	25 µV/V + 1.1 µV	22 µV/V + 1.1 µV	22 µV/V + 1.4 µV	44 µV/V + 1.8 µV	97 µV/V + 3 µV	210 µV/V + 6.2 µV	740 µV/V + 6.2 µV
0.7 to 2.2 V	67 µV/V - 10 µV	23 µV/V	18 µV/V	19 µV/V	40 µV/V	88 µV/V	180 µV/V	690 µV/V
2.2 to 7 V	56 µV/V - 11 µV	23 µV/V	18 µV/V	21 µV/V	50 µV/V	120 µV/V	300 µV/V	930 µV/V
7 to 22 V	70 µV/V - 120 µV	25 µV/V	18 µV/V	21 µV/V	51 µV/V	120 µV/V	300 µV/V	930 µV/V
22 to 70 V	55 µV/V - 73 µV	25 µV/V	21 µV/V	23 µV/V	54 µV/V	120 µV/V	300 µV/V	930 µV/V
70 to 220 V	68 µV/V - 1000 µV	27 µV/V	21 µV/V	29 µV/V	56 µV/V	130 µV/V	370 µV/V	
220 to 700 V	50 µV/V + 200 µV	29 µV/V	23 µV/V	87 µV/V	390 µV/V			
700 to 1100 V	50 µV/V	29 µV/V	24 µV/V	87 µV/V	390 µV/V			

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Voltage – Source								
Fluke 5730A/05 and Fluke 5725A Characterized with Fluke 5790B/05								
Range	**10 to 20 Hz**	**20 to 40 Hz**	**0.040 to 20 kHz**	**20 to 50 kHz**	**50 to 100 kHz**	**100 to 300 kHz**	**300 to 500 kHz**	**0.500 to 1 MHz**
0 to 2.2 mV	26 µV/V + 5.9 µV	18 µV/V + 5.9 µV	40 µV/V + 2.5 µV	46 µV/V + 2.8 µV	47 µV/V + 4 µV	140 µV/V + 4.6 µV	470 µV/V + 8.5 µV	1800 µV/V + 8.3 µV
2.2 to 22 mV	27 µV/V + 5.9 µV	11 µV/V + 5.9 µV	17 µV/V + 2.6 µV	29 µV/V + 2.8 µV	40 µV/V + 4 µV	96 µV/V + 6.6 µV	220 µV/V + 13 µV	800 µV/V + 19 µV
22 to 220 mV	180 µV/V + 23 µV	95 µV/V + 17 µV	25 µV/V + 2.6 µV	26 µV/V + 3 µV	54 µV/V + 3.1 µV	110 µV/V + 5.8 µV	260 µV/V + 14 µV	730 µV/V + 26 µV
0.22 to 2.2 V	190 µV/V + 22 µV	95 µV/V + 17 µV	22 µV/V + 5 µV	25 µV/V + 6.6 µV	41 µV/V + 7.7 µV	90 µV/V + 15 µV	190 µV/V + 31 µV	700 µV/V + 44 µV
2.2 to 22 V	190 µV/V + 19 µV	96 µV/V + 16 µV	23 µV/V + 6.2 µV	27 µV/V + 5.2 µV	55 µV/V - 17 µV	130 µV/V - 60 µV	320 µV/V - 190 µV	970 µV/V - 490 µV
22 to 220 V	190 µV/V + 230 µV	96 µV/V + 160 µV	26 µV/V	35 µV/V - 64 µV	59 µV/V - 63 µV	140 µV/V	370 µV/V + 7700 µV	840 µV/V + 17 mV

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Voltage – Source						
Fluke 5730A Characterized with Fluke 5790B Continued						
Range	**15 to 40 Hz**	**0.040 to 1 kHz**	**1 to 20 kHz**	**20 to 30 kHz**	**30 to 50 kHz**	**50 to 100 kHz**
220 to 750 V					120 µV/V - 11 mV	540 µV/V - 74 mV
220 to 1100 V	180 µV/V	27 µV/V - 310 µV	30 µV/V + 1200 µV	100 µV/V - 12 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 – Measure Note 4	1 mV to 10 mV	1 MHz to 4 MHz > 4 MHz to 8 MHz	54 mV/V + 11 µV 160 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	12 mV/V + 19 µV 30 mV/V + 130 µV 30 mV/V + 220 µV 120 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	12 mV/V + 110 µV 30 mV/V + 1.3 mV 30 mV/V + 2.2 mV 120 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	12 mV/V + 1.2 mV 31 mV/V + 6.2 mV 31 mV/V +7.9 mV 120 mV/V + 8.5 mV	
	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
	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

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Voltage – Wideband Generate							
Fluke 5730A/05							
Range	**10 to 30 Hz**	**0.030 to 120 kHz**	**0.120 to 2 MHz**	**2 to 10 MHz**	**10 to 20 MHz**	**20 to 30 MHz**	**30 to 50 MHz**
0.3 to 1.1 mV	0.24 %	0.085 %	0.39 %	0.55 %	0.71 %	2.3 %	3.6 %
1.1 to 3.3 mV	0.24 %	0.080 %	0.16 %	0.31 %	0.47 %	1.3 %	2.5 %
3.3 to 11 mV	0.23 %	0.079 %	0.10 %	0.18 %	0.35 %	0.82 %	1.7 %
11 to 33 mV	0.30 %	0.079 %	0.089 %	0.17 %	0.33 %	0.80 %	1.7 %
33 to 110 mV	0.23 %	0.083 %	0.083 %	0.16 %	0.33 %	0.80 %	1.7 %
110 to 330 mV	0.23 %	0.082 %	0.082 %	0.16 %	0.32 %	0.79 %	1.7 %
0.33 to 1.1 V	0.23 %	0.081 %	0.081 %	0.16 %	0.32 %	0.79 %	1.7 %
1.1 to 3.5 V	0.23 %	0.081 %	0.081 %	0.16 %	0.32 %	0.79 %	1.7 %

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

AC Voltage – Wideband Measure								
Fluke 5790B/05								
Range	**10 to 30 Hz**	**0.030 to 120 kHz**	**120 to 500 kHz**	**0.5 to 2 MHz**	**2 to 10 MHz**	**10 to 20 MHz**	**20 to 30 MHz**	**30 to 50 MHz**
0.1 to 2.2 mV	0.088 %	0.050 %	0.13 %	0.13 %	0.21 %	0.32 %	0.71 %	0.88 %
2.2 to 7 mV	0.082 %	0.051 %	0.079 %	0.080 %	0.11 %	0.17 %	0.42 %	0.46 %
7 to 22 mV	0.081 %	0.040 %	0.055 %	0.056 %	0.084 %	0.15 %	0.32 %	0.52 %
22 to 70 mV	0.10 %	0.040 %	0.040 %	0.042 %	0.084 %	0.12 %	0.31 %	0.51 %
70 to 220 mV	0.080 %	0.032 %	0.032 %	0.041 %	0.083 %	0.13 %	0.28 %	0.51 %
220 to 700 mV	0.079 %	0.025 %	0.025 %	0.041 %	0.083 %	0.13 %	0.30 %	0.51 %
0.7 to 2.2 V	0.080 %	0.025 %	0.025 %	0.041 %	0.10 %	0.13 %	0.30 %	0.50 %
2.2 to 7 V	0.080 %	0.024 %	0.024 %	0.041 %	0.083 %	0.13 %	0.30 %	0.50 %

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

AC Voltage – Source								
Fluke 5730A/05 Characterized with EL1100 and JFW Attenuators								
Expanded uncertainties are in μV/V for the frequencies shown at left at indicated levels below								
Frequency	**3.2 V**	**1 V**	**320 mV**	**100 mV**	**32 mV**	**10 mV**	**3.2 mV**	**10 mV**
10 Hz	480	510	620	620	620	740	810	810
20 Hz	160	240	290	340	380	420	480	560
50 Hz	160	170	180	190	210	210	270	340
100 Hz	170	170	190	200	210	230	270	350
200 Hz	160	170	180	190	200	230	250	390
2 kHz	160	170	180	190	200	210	230	390
10 kHz	160	170	180	190	200	220	240	380
20 kHz	160	170	180	190	210	210	230	360
50 kHz	160	170	180	190	200	210	230	340
100 kHz	160	180	190	200	220	230	240	400
200 kHz	160	170	180	190	200	210	260	280
500 kHz	220	240	250	270	280	300	320	380
700 kHz	230	250	270	290	300	320	340	440
1 MHz	230	260	270	290	300	320	340	500
1.2 MHz	230	260	280	300	320	340	370	510
2 MHz	370	400	440	460	490	520	560	630
3 MHz	400	430	470	500	530	560	590	670
4 MHz	450	500	520	560	590	620	650	720
6 MHz	510	560	580	620	640	680	700	770
8 MHz	530	570	590	630	650	690	710	770
9 MHz	530	570	590	630	650	690	720	800
10 MHz	530	570	590	630	650	690	720	800
12 MHz	770	830	880	930	980	1000	1100	1100
15 MHz	770	830	880	930	980	1000	1100	1200
17 MHz	900	960	1000	1000	1100	1100	1200	1200
20 MHz	950	1000	1100	1200	1200	1300	1300	1400
23 MHz	1500	1500	1600	1600	1700	1700	1800	1900
26 MHz	1800	1900	1900	2000	2100	2100	2200	2300
28 MHz	2000	2100	2200	2300	2400	2500	2500	2600
30 MHz	2200	2300	2400	2500	2600	2700	2700	2800
35 MHz	2500	2600	2700	2800	2800	2900	3000	3100
40 MHz	2700	2800	2900	3000	3100	3200	3300	3400
45 MHz	2900	3000	3200	3300	3400	3500	3600	3700
50 MHz	3100	3300	3400	3600	3700	3800	3900	4100

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) [Note 3]	Remarks
CAPACITANCE (20/E10)				
Capacitance – Measure	0.001 nF to 1.2 µF	100 Hz to 10 kHz	8 µF/F	ESI 701B with GenRad 1404-A
	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 kH	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 kH	3.4 fF/pF + 3.3 aF	
		> 96 kHz to 1 MHz	3.1 fF/pF +3.5 aF	
	> 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	
		> 96 kHz to 1 MHz	1.9 fF/pF + 0.21 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) Note 3	Remarks
	1 fF to 110 pF	50 Hz to 0.5 kHz	3.9 aF/pF + 2.0 aF	Andeen-Hagerling AH2700A OPT. E
		> 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	
		> 10 kHz to 20 kHz	70 fF/nF – 0.71 fF	
	> 10 nF to 100 nF	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	
Capacitance – Generate Variable Note 4	0.19 nF to 0.39 nF	10 Hz to 10 kHz	5.8 pF/nF + 12 pF	Fluke 5522A
	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	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Expanded Uncertainty (k=2) Note 3	Remarks
	> 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	
Capacitance – Generate, Fixed Note 4	1 pF	1 kHz	1.2 µF/F	Andeen-Hagerling AH1100
	10 pF		0.35 µF/F	
	100 pF		0.35 µF/F	
	1000 pF	1 kHz	24 fF	GenRad 1404-A
	0.001 µF	1 kHz	0.60 pF	GenRad 1409
	0.01 µF		6.0 pF	
	0.1 µF		410 pF	
	1 µF		600 pF	
	10 µF	100 Hz	4.6 nF	
	10 µF	1 kHz	3.1 nF	
	100 µF	100 Hz	76 nF	
	100 µF	1 kHz	70 nF	
	10 µF	100 Hz, 120 Hz, or 1 kHz	0.034 µF	GenRad 1417
	100 µF		0.34 µF	
	1 mF		3.6 µF	
	10 mF		52 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) Note 3	Remarks
	100 mF	100 Hz, 120 Hz	0.41 mF	
	1 F		5.8 mF	
	10 nF	120 Hz to 100 kHz	3.5 pF	HP 16385A
	100 nF		35 pF	HP 16386A
	1 µF		0.36 nF	HP 16387A
	1 pF	1 kHz	0.083 fF	HP 16381A
		1 MHz	0.11 fF	
		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	
	10 pF	1 kHz	0.70 fF	HP 16382A
		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	
		13 MHz	1.7 fF	
	100 pF	1 kHz	7.0 fF	HP 16383A
		1 MHz	7.1 fF	
		2 MHz	7.6 fF	
		3 MHz	8.9 fF	
		4 MHz	11 fF	
		5 MHz	14 fF	
		10 MHz	34 fF	
		13 MHz	49 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) Note 3	Remarks
	1000 pF	1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	71 fF 86 fF 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 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 > 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 Note 4	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 µW to 1.1 mW	0.024 %	Fluke 5522A
	> 1.1 mW to 110 mW	0.027 %	
	> 0.11W to 110 W	0.024 %	
	> 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, Φ = 0º 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 %	

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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	80 mW to 1.4 W > 1.4 W to 4.5 kW	0.088 % 0.05 %	
> 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	0.038º 0.053º 0.069º 0.085º 0.0012º/kHz + 0.015º	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	0.14º 0.30º 0.58º 2.9º 5.8º 12º	Fluke 5522A
OSCILLOSCOPES (20/E20)			
Leveled Sine Amplitude	50 kHz reference 0.1 Hz to 6.4 GHz	17 µV/mV + 1.9 nV 17 µV/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 µS/cm 100 µS/cm 1000 µS/cm	0.65 µS/cm 2.1 µS/cm 4.6 µS/cm	Conductivity 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
	10 000 µS/cm 100 000 µS/cm	40 µS/cm 0.36 mS/cm	
TIME and FREQUENCY			
FREQUENCY DISSEMINATION (20/F01)			
Frequency – Measure Note 4	10 mHz to 1 Hz 1 Hz to 10 Hz 10 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 10 kHz 10 kHz to 100 kHz 100 kHz to 1 MHz 1 MHz to 10 MHz 10 MHz to 100 MHz 100 MHz to 350 MHz 350 MHz to 1 GHz 1 GHz to 10 GHz 10 GHz to 46 GHz	45 µHz -0.21 µHz/Hz + 4.7 µHz -12 nHz/Hz + 2.7 µHz -0.79 nHz/Hz + 1.6 µHz 0.23 pHz/Hz + 0.78 µHz 31 pHz/Hz + 0.47 µHz -1.4 pHz/Hz + 3.7 µHz 1.7 pHz/Hz + 0.61 µHz 1.9 pHz/Hz + 1.7 µHz 1.8 pHz/Hz + 7.2 µHz -3.8 nHz/Hz + 4.8 Hz 46 pHz/Hz + 0.95 Hz 20 pHz/Hz + 1.2 Hz	Keysight 53230A & HP 58503A Agilent 53152A & HP 58503A
Frequency – Generate Note 4	1 µHz to 20 MHz > 20 MHz to 50 GHz	6.7 pHz/Hz 6.7 pHz/Hz	HP 58503A/Keysight 33600A & 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	0.043 dB 0.043 dB 0.42 dB 1.5 dB	Keysight N9030B
Amplitude Modulation -- Measure & Generate Note 4			
100 kHz to 3.6 GHz	1 % to 99 %	0.12 %	Keysight N5531X
> 3.6 GHz to 13.6 GHz	5 % to 99 %	0.15 %	
> 13.6 GHz to 17.1 GHz	5 % to 99 %	0.17 %	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
> 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 %	
Frequency Modulation – Generate and measure Notes 4,8			
100 kHz to 3.6 GHz	$0.2 < \beta \leq 100$ $\beta > 100$	0.004 *FM* 0.0092 *FM*	Keysight N5531X
> 3.6 GHz to 8.4 GHz	$0.2 < \beta \leq 100$ $\beta > 100$	0.0081 *FM* 0.023 *FM*	
> 8.4 GHz to 17.1 GHz	$0.2 < \beta \leq 100$ $\beta > 100$	0.0081 *FM* 0.029 *FM*	
> 17.1 GHz to 34.5 GHz	$0.2 < \beta \leq 100$ $\beta > 100$	0.0092 *FM* 0.035 *FM*	
> 34.5 GHz to 50 GHz	$0.2 < \beta \leq 100$ $\beta > 100$	0.016 *FM* 0.046 *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	

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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
PULSE WAVEFORM (20/F04)			
Rise Time – Generate	14 ps 500 ps 150 ps 70 ps	4.0 ps 49 ps 20 ps 16 ps	Tek 067-1338-00 Fluke 9500B/9530 Fluke 9500B/9560
Rise Time – Measure	> 30 ps and <500 ps	24 ps	HP 54750A/54751A
STOPWATCHES & TIMERS (20/F05)			
Time – Measure [Note 4]	Up to 19.99 s/day	0.059 s/day	Helmut Klein Timometer 4500
MECHANICAL			
AIRSPEED (20/M03)			
Air Velocity – Measure	400 ft/min to 800 ft/min 800 ft/min to 9000 ft/min	21 ft/min - 1.6 % of reading 5.0 ft/min + 0.43 % of reading	Comparison of Pitot tube with UUT using wind tunnel
FLOW RATE (20/M05)			
Gas Flow	Up 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 & 3E4 Molbloc Molbox1 & 1E5Molbloc Nitrogen under measurement at laboratory pressure & temperature. Standardized to 0 ºC & 101.325 kPa.
FORCE (20/M06)			
Crimp Tool – Pull Force	Up to 100 lbf	7.8 % of rdg. + 2.6 lbf	Crimp pull tester

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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
Durometer – Spring Force	78 gf	1.1 gf	Electronic balance
	113 gf	0.91 gf	
	821 gf	5.4 gf	
	4533 gf	14 gf	
Supermicrometer Gaging Force	2 ozf	0.090 ozf	Gram gage
	4 ozf	0.22 ozf	
	8 ozf	0.22 ozf	
	16 ozf	0.88 ozf	Force gage
	40 ozf	2.5 ozf	
Force Gages	0.03125 ozf to 8 ozf	0.056 % + 0.000024 ozf	Class 6 Weights
	0.5 lbf to 500 lbf	0.055 % + 0.000023 lbf	Class 7 Weights
	3.2 lbf to 300 lbf	0.010 % + 0.0064 lbf	Morehouse HADI 300LBF
	> 300 lbf to 1000 lbf	0.012 % + 0.0012 lbf	Morehouse M4215A- 1000LBF
	> 1000 lbf to 10 000 lbf	0.010 % + 0.16 lbf	Morehouse M4215A-10000LBF
MASS DISSEMINATION (20/M08)			
Mass – Measure	1 mg to 2 g	3.1 µg + 2.4 µg/g	Weights, MCM36 Balance
	> 2 g to 10 g	6.7 µg + 0.59 µg/g	Weights, MCM36 Balance
	> 10 g to 31 g	7.3 µg + 0.53 µg/g	Weights, MCM36 Balance
	> 31 g to 610 g	9.6 µg + 0.64 µg/g	Weights, MCM605 Balance
	> 610 g to 5 kg	0.23 mg + 0.53 µg/g	Weights, CCE5004 Balance
	> 5 kg to 34 kg	130 mg	Weights, CPA34001S Balance
VIBRATION (20/M11)			
Accelerometers			
Voltage Charge			TMS9155D Air Bearing
Sensitivity	(5 - 9) Hz	1.7 % of reading	Shaker System
	(10 - 99) Hz	1.2 % of reading	
(0.2 to 1000) mV/g	100 Hz	0.75 % of reading	
	(101 - 920) Hz	1.0 % of reading	
	(921 - 5000) Hz	1.4 % of reading	
	(>5 - 10) kHz	1.9 % of reading	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
	(>10 - 15) kHz (>15 - 20) kHz	2.2 % of reading 2.8 % of reading	
VOLUME & DENSITY (20/M12)			
Viscosity	100 cps 1000 cps 5000 cps 100 000 cps	0.33 % 0.50 % 0.45 % 0.60 %	Viscosity solutions
SPEED INDICATORS (20/M14)			
Photo Note 4	1 rpm to 100 000 rpm	8.6 E-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	0.088 cNm to 0.35 cNm 0.35 cNm to 2.82 cNm 0.282 Nm to 3.39 Nm 3.39 Nm to 339 Nm 339 Nm to 2712 Nm	0.13 % 0.074 % 0.070 % 0.066 % 0.071 %	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	0.51 % + 0.0022 ozf-in 0.51 % + 0.0086 ozf-in 0.58 % + 0.0035 ozf-in 0.29 % + 0.029 ozf-in 0.30 % + 0.0028 lbf-in 0.30 % + 0.0067 lbf-in 0.30 % + 0.026 lbf-in 0.30 % + 0.084 lbf-in 0.27 % + 0.036 lbf-ft 0.30 % + 0.013 lbf-ft 0.30 % + 0.031 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

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
	> 600 lbf-ft to 1000 lbf-ft	0.30 % + 0.083 lbf-ft	CDI 2000-13-02
	> 1000 lbf-ft to 2000 lbf-ft	0.30 % + 0.042 lbf-ft	CDI 2000-14-02
WEIGHING INSTRUMENTS (20/M16)			
Scales & Balances Note 4	1 mg to 20 mg	0.0023 mg	Class 1 Weights
	> 20 mg to 500 mg	0.0030 mg	
	> 500 mg to 5 g	0.0081 mg	
	> 5 g to 10 g	0.012 mg	
	> 10 g to 20 g	0.017 mg	
	> 20 g to 50 g	0.034 mg	
	> 50 g to 100 g	0.068 mg	
	> 100 g to 5 kg	0.17 µg + 0.58 µg/g	
	> 5 kg to 20 kg	0.59 µg/g	
	> 20 kg to 30 kg	13 mg	
	> 30 kg to 50 kg	18 mg	
	> 50 kg to 250 kg	4.4 µg/g + 470 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	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
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	
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	
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
2.5 MHz to 26.5 GHz	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	

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Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
	-102 dBm to -110 dBm	0.32 dB	
	-110 dBm to -120 dBm	0.37 dB	
	-120 dBm to -127 dBm	0.43 dB	
Tuned RF Power – Relative Measure Note 4			HP 8902 w/11722A or 11792A sensor
2.5 MHz to 26.5 GHz	10 dB to 2 dB	0.087 dB	
	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	
RF Power –Flatness Note 4			
9kHz to 6 GHz	-60 to 20 dBm	0.041 dB	Agilent E4419B, Agilent E9304A
RF Power – Generate			Signal Generator
1 Hz to 10 MHz	(-35 to -24) dBm	1.1 dB	
	(>-24 to -8) dBm	0.42 dB	
	(>-8 to 20) dBm	0.23 dB	
10 MHz to 50 MHz	(-35 to -24) dBm	1.1 dB	
	(>-24 to -8) dBm	0.49 dB	
	(>-8 to 20) dBm	0.35 dB	
50 MHz to 80 MHz	(-35 to -24) dBm	1.2 dB	
	(>-24 to -8) dBm	0.61 dB	
	(>-8 to 20) dBm	0.50 dB	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

SCATTERING PARAMETERS (20/R18)				
S_{11}, S_{22} Parameters, Reflection Coefficient (0 to 1)				
HP 8757A w/85027B				
Return Loss	**10 MHz to 8.4 GHz**	**8.4 GHz to 12 GHz**	**12 GHz to 20 GHz**	**20 GHz to 26.5 GHz**
1 dB	0.067	0.16	0.069	0.027
2 dB	0.054	0.13	0.056	0.022
3 dB	0.044	0.10	0.047	0.018
4 dB	0.037	0.084	0.039	0.015
5 dB	0.031	0.068	0.034	0.12
6 dB	0.027	0.055	0.030	0.11
7 dB	0.026	0.047	0.032	0.11
8 dB	0.022	0.039	0.031	0.097
9 dB	0.022	0.034	0.030	0.092
10 dB	0.022	0.030	0.029	0.089
11 dB	0.021	0.028	0.029	0.086
12 dB	0.021	0.026	0.028	0.085
20 dB	0.022	0.045	0.042	0.16
30 dB	0.017	0.068	0.10	0.44
40 dB	0.091	0.11	0.037	0.31

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	**Range**	**Expanded Uncertainty (k=2)** Notes 3,5	**Remarks**
Attenuation – Generate Note 4 (50 Ω)			
200 Hz to 80 MHz	0 dB to 38 dB 40 dB to 58 dB 60 dB to 98 dB	0.26 dB 0.32 dB 0.51 dB	HP 3335A (BNC F)
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	

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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 to 18 GHz			
(Fixed Value)	3 dB	0.46 dB	Weinschel 44 Series
	6 dB	0.46 dB	
	10 dB	0.65 dB	
	20 dB	0.65 dB	
Attenuation – Generate Note 4			
30 MHz	0 dB	0.0040 dB	Agilent 11812A
	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 Note 4			HP8902 with 11722A or
2.5 MHz to 26.5 GHz	0 dB to 2 dB	0.081 dB	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	

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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
THERMODYNAMIC			
HUMIDITY (20/T02)			
Relative Humidity Generate/ Measure Note 4	10 % RH to 95 % RH	0.15 % RH + 0.29 % rdg.	Thunder Scientific 2500
Relative Humidity Measure	10 % RH to 95 % RH	1.6 %RH	Rotronics HydroPalm & HC2A-S
Dew Point Measure	10 % RH to 95 % RH	0.16 °C	RH Systems 473
LABORATORY THERMOMETERS (20/T03)			
Temperature – Generate & Measure	-197 °C -95 °C to -80 °C ≥ -80 °C to 0 °C 0.01 °C > 0 °C to 100 °C ≥ 100 °C to 250 °C > 250 °C to 660 °C > 660 °C to 700 °C > 700 °C to 1000 °C > 1000 °C to 1200 °C	6.4 mK 13 mK 7.2 mK+ 0.014 mK/°C 4.4 mK 7.6 mK+ 0.018 mK/°C 6.3 mK+ 0.029 mK/°C 20 mK+ 0.079 mK/°C 0.47 °C + 1.2 E-04 °C/°C 1.2 °C 0.85 °C + 7.6 E-04 °C/°C	Additel ADT286 w/AccuMac 1960A or Fixed Point TPW Fluke 9118A w/AccuMac AM1210-20
Thermistor	0 °C to 100 °C	5.8 mK + 0.036 mK/°C	Fluke 5644S w/Additel ADT286
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 > 20 MPa to 68.9 MPa	0.0048 % + 0.045 Pa 0.011 % - 0.00015 Pa 1.2 Pa 0.012 % 0.0098 % + 0.068 Pa 0.0098 % + 1.8 Pa 0.016 % + 1.4 Pa 0.017 % + 3.0 Pa	Fluke 7250 LP Pressurements T3500/3 DHI RPM4-A700kp DHI RPM4-A7Mp DHI RPM4-A20Ms DHI RPM4-A70Ms

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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
	69 MPa to 207 MPa	0.025 % + 9.6 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	0.00071 °C /°C + 0.28 °C 0.0025 °C /°C + 0.11 °C 0.0026 °C /°C + 0.096 °C	Fluke 4180 infrared source Fluke 4181 infrared source
RESISTANCE THERMOMETRY (20/T07)			
Comparison – RTDs	-197 °C -95 °C to -80 °C ≥ -80 °C to 0 °C 0.01 °C > 0 °C to 100 °C ≥ 100 °C to 250 °C > 250 °C to 660 °C > 660 °C to 700 °C > 700 °C to 1000 °C > 1000 °C to 1200 °C	6.4 mK 13 mK 7.2 mK+ 0.014 mK/°C 4.4 mK 7.6 mK+ 0.018 mK/°C 6.3 mK+ 0.029 mK/°C 20 mK+ 0.079 mK/°C 470 mK + 0.12 mK/°C 1.2 °C 850 mK + 0.76 mK /°C	Additel ADT286 w/AccuMac 1960A or Fixed Point TPW Fluke 9118A w/AccuMac AM1210-20
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	0.33 °C 0.26 °C 0.23 °C 0.20 °C	Fluke 5522A
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	0.18 °C 0.15 °C 0.18 °C 0.30 °C 0.49 °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 E	-250 °C to -100 °C	0.30 °C	
	> -100 °C to -25 °C	0.093 °C	
	> -25 °C to 350 °C	0.078 °C	
	> 350 °C to 650 °C	0.093 °C	
	> 650 °C to 1000 °C	0.12 °C	
Type J	-210 °C to -100 °C	0.16 °C	
	> -100 °C to -30 °C	0.093 °C	
	> -30 °C to 150 °C	0.078 °C	
	> 150 °C to 760 °C	0.10 °C	
	> 760 °C to 1200 °C	0.14 °C	
Type K	-210 °C to -100 °C	0.19 °C	
	> -100 °C to -25 °C	0.11 °C	
	> -25 °C to 120 °C	0.093 °C	
	> 120 °C to 1000 °C	0.15°C	
	> 1000 °C to 1372 °C	0.23 °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	0.23 °C	
	> -100 °C to -25 °C	0.13 °C	
	> -25 °C to 120 °C	0.12 °C	
	> 120 °C to 410 °C	0.11 °C	
	> 410 °C to 1300 °C	0.16 °C	
Type R	0 °C to 250 °C	0.37 °C	
	> 250 °C to 400 °C	0.22 °C	
	> 400 °C to 1000°C	0.20 °C	
	> 1000 °C to 1767 °C	0.23 °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 S	0 °C to 250 °C	0.36 °C	
	> 250 °C to 1000 °C	0.23 °C	
	> 1000 °C to 1400 °C	0.23 °C	
	> 1400 °C to 1767 °C	0.26 °C	
Type T	-250 °C to -150 °C	0.37 °C	
	> -150 °C to 0 °C	0.14 °C	
	> 0 °C to 120 °C	0.093 °C	
	> 120 °C to 400 °C	0.078 °C	
Type U	-200 °C to 0 °C	0.43 °C	
	> 0 °C to 600 °C	0.21 °C	
Half Junction Simulation			
Type E	-200 °C to 1000 °C	0.045 °C	
Type J	-210 °C to 1200 °C	0.093 °C	
Type K	-270 °C to 1373 °C	0.11 °C	
Type N	-270 °C to 1260 °C	0.092 °C	
Type S	-50 °C to 1480 °C	0.15 °C	
Type T	-200 °C to 400 °C	0.082 °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	

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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 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	
	> 300 °C to 400 °C	0.078 °C	
	> 400 °C to 630 °C	0.093 °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	
	> 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	0.031 °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	
	> 600 °C to 630 °C	0.12 °C	
Pt 385, 500 Ω	-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	
	> 600 °C to 630 °C	0.085 °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 385, 1000 Ω	-200 °C to -80 °C > -80 °C to 0 °C > 0 °C to 100 °C > 100 °C to 260 °C > 260 °C to 300 °C > 300 °C to 400 °C > 400 °C to 600 °C > 600 °C to 630 °C	0.023 °C 0.023 °C 0.031 °C 0.039 °C 0.047 °C 0.054 °C 0.055 °C 0.18 °C	
PtNi, 120 Ω	-80 °C to 0 °C > 0 °C to 100 °C > 100 °C to 260 °C	0.062 °C 0.062 °C 0.11 °C	
Cu 427, 10 Ω	-100 °C to 260 °C	0.23 °C	
VACUUM & LOW PRESSURE GAGES (20/T09)			
Vacuum – 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 E	-196°C > -95 °C to 50 °C > 50°C to 700°C > 700°C to 1000°C	0.14 °C 0.15 °C 0.17 °C + 0.092 mK/°C 1.2°C	Additel ADT286 w/ Fluke 5628 Accumac AM1210-20
Type J	-196°C > -95 °C to 50 °C > 50°C to 700°C > 700°C to 1093°C > 1093°C to 1200°C	0.14 °C 0.16 °C 0.18 °C + 0.077 mK/°C 1.2 °C 2.2 °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	-196°C	0.15 °C	
	> -95 °C to 50 °C	0.16 °C	
	> 50°C to 700°C	0.18 °C + 0.077 mK/°C	
	> 700°C to 1093°C	1.2 °C	
	> 1093°C to 1200°C	2.2 °C	
Type N	-196°C	0.15 °C	
	> -95 °C to 50 °C	0.16 °C	
	> 50°C to 700°C	0.18 °C + 0.077 mK/°C	
	> 700°C to 1093°C	1.2 °C	
	> 1093°C to 1200°C	2.2 °C	
Type R	> -50 °C to 50 °C	0.29°C – 1.3 mK/°C	
	> 50°C to 700°C	0.23 °C	
	> 700°C to 1093°C	1.3 °C	
	> 1093°C to 1200°C	2.2 °C	
Type S	> -50 °C to 50 °C	0.28°C – 1.1 mK/°C	
	> 50°C to 700°C	0.24 °C	
	> 700°C to 1093°C	1.3 °C	
	> 1093°C to 1200°C	2.2 °C	
Type T	-196°C	0.15 °C	
	> -95 °C to 50 °C	0.16 °C	
	> 50°C to 400°C	0.18°C + 0.057 mK/°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.

Note 7: Uncertainties are listed at optimal conditions (PF = 1, $\Phi = 0^{o}$ 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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