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

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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	**Fields of Calibration** 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 2.4 µin 3.0 µin 4.5 µin 5.1 µin 6.4 µin 9.0 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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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) 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	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	0.00046 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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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) 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 0.25 in 1.0 in 4.0 in	6.4 µin 5.7 µin 4.7 µin 5.1 µin 8.8 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 0.186 in >0.186 in to 0.25 in >0.25 in to 0.628 in >0.628 in to 1.0 in >1.0 in to 1.628 in >1.628 in to 4.0 in >4.0 in to 12 in	1100 µin/in - 33 µin 21 µin - 110 µin/in 99 µin/in - 5 µin 34 µin - 110 µin/in 1.4 µin + 19 µin/in 23 µin – 15 µin/in 12 µin/in – 4.2 µin 16 µin – 0.17 µin/in 5 µin + 2.6 µin/in	Comparison to master gages
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	0.0062 in + 0.00040 in/ft	Tape-to-tape method

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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) Note 3	Remarks
THREADED PLUG/RINGS (20/D14)			
Thread Plugs – Pitch Diameter			Thread wires/ Supermicrometer
6 TPI to 120 TPI	0.01 in to 5 in	89 µin	
0.20 mm to 10 mm (Pitch)	0.1 mm to 127 mm	2.3 µm	
Adjustable Threaded Rings, Straight Thread – Pitch Diameter			
6 TPI to 120 TPI	0.01 in to 5 in	89 µin	Ring is sized to a setting plug with plug's uncert. given
0.20 mm to 10 mm (Pitch)		2.3 µm	

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
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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) 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

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		

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

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	0.18 %	Agilent 16074A
		> 1 MHz to 13 MHz	0.27 %	
	1 Ω	> 0.1 Hz to 1 MHz	0.12 %	
		> 1 MHz to 13 MHz	0.12 %	
	10 Ω	> 0.1 Hz to 1 MHz	0.036 %	
		> 1 MHz to 13 MHz	0.036 %	
	100 Ω	> 0.1 Hz to 1 MHz	0.035 %	
		> 1 MHz to 13 MHz	0.036 %	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) Note 3	Remarks
	1 kΩ	> 0.1 Hz to 1 MHz	0.035 %	
		> 1 MHz to 13 MHz	0.035 %	
	10 kΩ	> 0.1 Hz to 1 MHz	0.040 %	
		> 1 MHz to 13 MHz	0.14 %	
	100 kΩ	> 0.1 Hz to 1 MHz	0.099 %	
		> 1 MHz to 13 MHz	0.62 %	
AC Resistance – Measure	0 Ω to 15 Ω	50 Hz to 1 MHz	0.14 %	Agilent 4284A
	15 Ω to 320 kΩ	100 Hz to 100 kHz	0.08 %	
	> 320 kΩ to 10 MΩ	100 Hz to 100 kHz	0.26 %	

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	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	
	> 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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
	> 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 fA/A + 13 fA	Keithley 617
	> 2 pA to 20 pA	14 fA/A + 110 fA	
	> 20 pA to 200 pA	18 fA/A + 110 fA	
	> 200 pA to 2 nA	2.6 pA/A + 1.3 pA	
	> 2 nA to 20 nA	2.8 pA/A + 5.3 pA	
	> 20 nA to 100 nA	34 µA/A + 47 pA	HP 3458A/002
	> 100 nA to 1 µA	17 µA/A	
	1 µA to 20 µA	3.2 µA/A + 41 pA	Fluke 8508A With Standard Resistors
	20 µA to 200 µA	4.9 µA/A + 84 pA	
	200 µA to 2 mA	4.7 µA/A + 790 pA	
	2 mA to 20 mA	4.6 µA/A + 8 nA	
	20 mA to 100 mA	5.9 µA/A + 71 nA	
	100 mA to 200 mA	6.1 µA/A + 56 nA	
	0.2 A to 7.5 A	13 µA/A + 0.38 µA	
	7.5 A to 50 A	24 µA/A + 1.4 µA	
	50 A to 200 A	8.9 µA/A + 53 µA	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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	28 μΩ/Ω	Fluke 5730A Characterized
	1.9 Ω	21 μΩ/Ω	
	10 Ω	5.6 μΩ/Ω	
	19 Ω	5.0 μΩ/Ω	
	100 Ω	3.1 μΩ/Ω	
	190 Ω	3.1 μΩ/Ω	
	1 kΩ	2.6 μΩ/Ω	
	1.9 kΩ	2.6 μΩ/Ω	
	10 kΩ	2.0 μΩ/Ω	
	19 kΩ	2.0 μΩ/Ω	
	100 kΩ	4.3 μΩ/Ω	
	190 kΩ	4.3 μΩ/Ω	
	1 MΩ	4.0 μΩ/Ω	
	1.9 MΩ	4.1 μΩ/Ω	
	10 MΩ	14 μΩ/Ω	
	19 MΩ	19 μΩ/Ω	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

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	100 MΩ	42 μΩ/Ω	
	10 GΩ	35 mΩ/Ω	Keithley 263
	100 GΩ	35 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	2.1 mΩ/Ω	IET VRS-100-10-1K-BP
	100 GΩ	0.99 mΩ/Ω	
	1 TΩ	5.0 mΩ/Ω	
Resistance – Measure Note 4	0 Ω to 2 Ω	5.1 μΩ/Ω + 3.1 μΩ	Fluke 8508 transfer accuracy
	> 2 Ω to 20 Ω	3.1 μΩ/Ω + 7.6 μΩ	
	> 20 Ω to 200 Ω	2.6 μΩ/Ω + 6.7 μΩ	
	> 200 Ω to 2 kΩ	1.9 μΩ/Ω + 85 μΩ	
	> 2 kΩ to 20 kΩ	1.1 μΩ/Ω + 1.3 mΩ	
	> 20 kΩ to 200 kΩ	4.0 μΩ/Ω + 4.5 mΩ	
	> 200 kΩ to 2 MΩ	3.0 μΩ/Ω + 0.46 Ω	
	> 2 MΩ to 20 MΩ	11 μΩ/Ω + 1.7 Ω	
	> 20 MΩ to 200 MΩ	13 μΩ/Ω + 21 Ω	
	> 0.2 GΩ to 2 GΩ	70 μΩ/Ω + 68 kΩ	
	> 2 GΩ to 20 GΩ	0.69 mΩ/Ω + 9.5 MΩ	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
(No field capability above 20 GΩ)	> 20 GΩ to 200 GΩ > 200 GΩ to 2 TΩ > 2 TΩ to 20 TΩ > 20 TΩ to 200 TΩ	0.93 mΩ/Ω 1.4 mΩ/Ω 4.0 mΩ/Ω 6.9 mΩ/Ω	Guildline 6530B
DC VOLTAGE (20/E06)			
DC Voltage – Variable Generate [Note 4]	0 V to 220 mV > 0.22 V to 2.2 V > 2.2 V to 11 V > 11 V to 22 V > 22 V to 220 V > 220 V to 1.1 kV 1 kV to 50 kV > 50 kV to 70 kV	0.58 µV/V + 330 nV 0.43 µV/V + 1.3 µV 0.29 µV/V + 3.7 µV 0.57 µV/V + 3.2 µV 0.54 µV/V + 89 µV 0.24 µV/V + 760 µV 0.49 mV/V + 0.21 V 0.47 mV/V + 1.4 V	Characterized Fluke 5730A Hipotronics Source and Vitrek
DC Voltage – Fixed Generate	10 V 100 mV 1 V 10 V 100 V 1000 V	0.43 µV/V 2.8 µV/V 1.1 µV/V 0.62 µV/V 0.88 µV/V 0.92 µV/V	Fluke 732A Characterized Fluke 5730A
DC Voltage – Fixed Measure [Note 4]	100 mV 1 V 10 V 100 V 1000 V	1.2 µV/V 0.52 µV/V 0.44 µV/V 0.53 µV/V 0.74 µV/V	Agilent 34420A, Fluke 732A, 752A
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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

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						

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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			

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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		

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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
AC Voltage – Measure Note 4	1 mV to 10 mV	1 MHz to 4 MHz	54 mV/V + 11 µV	HP 3458A
		> 4 MHz to 8 MHz	160 mV/V + 8.2 µV	
	> 10 mV to 100 mV	1 MHz to 2 MHz	12 mV/V + 19 µV	
		> 2 MHz to 4 MHz	30 mV/V + 130 µV	
		> 4 MHz to 8 MHz	30 mV/V + 220 µV	
		> 8 MHz to 10 MHz	120 mV/V + 160 µV	
	> 0.1 V to 1 V	1 MHz to 2 MHz	12 mV/V + 110 µV	
		> 2 MHz to 4 MHz	30 mV/V + 1.3 mV	
		> 4 MHz to 8 MHz	30 mV/V + 2.2 mV	
		> 8 MHz to 10 MHz	120 mV/V + 1.6 mV	
	> 1 V to 10 V	1 MHz to 2 MHz	12 mV/V + 1.2 mV	
		> 2 MHz to 4 MHz	31 mV/V + 6.2 mV	
		> 4 MHz to 8 MHz	31 mV/V +7.9 mV	
		> 8 MHz to 10 MHz	120 mV/V + 8.5 mV	
	1.1 kV to 5 kV	50 Hz to 60 Hz	2.5 mV/V + 1.5 V	Quadtech Sentry 20 w/Vitrek 4700 & HLV70
	> 5 kV to 44 kV	50 Hz to 60 Hz	1.4 mV/V + 27 V	
	1.1 kV to 5 kV	50 Hz to 60 Hz	2.5 mV/V + 1.5 V	Vitrek 4700 w/HLV70
	> 5 kV to 50 kV	50 Hz to 60 Hz	1.4 mV/V + 27 V	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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 %

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) 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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) 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	
	> 33 nF to 110 nF	10 Hz to 1 kHz	2.9 pF/nF + 120 pF	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) Note 3	Remarks
	> 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	2.0 aF	Andeen-Hagerling AH1100
	10 pF		16 aF	
	100 pF		0.15 fF	
	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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) 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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **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) 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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
LF POWER & ENERGY (20/E12)			
DC Power – Generate [Note 4]			
0.33 mA to 330 mA	11 µW to 1.1 mW > 1.1 mW to 110 mW > 0.11W to 110 W > 110 W to 330 W	0.024 % 0.027 % 0.024 % 0.018 %	Fluke 5522A
> 0.33 A to 3 A	11 W to 110 mW > 0.11 W to 990 W > 0.99 kW to 3 kW	0.044 % 0.053 % 0.0096 %	
> 3 A to 20.5 A	0.099 W to 0.99 W > 0.99 W to 6.8 kW > 6.8 kW to 20.5 kW	0.088 % 0.070 % 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 > 3.0 mW to 9 W	0.13% 0.077 %	Fluke 5522A
> 9 mA to 33 mA	0.3 mW to 10 mW > 10 mW to 33 W	0.089 % 0.077 %	
> 33 mA to 90 mA	1 mW to 30 mW > 30 mW to 90 W	0.071 % 0.057 %	
> 90 mA to 330 mA	3.0 mW to 100 mW > 100 mW to 300 W	0.089 % 0.078 %	
> 0.33 A to 0.9 A	11 mW to 300 mW > 300 mW to 900 W	0.071 % 0.058 %	
> 0.9 A to 2.2 A	30 mW to 720 mW > 720 mW to 2 kW	0.089 % 0.079 %	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
> 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	0.032º 0.042º 0.058º 0.068º 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 1.3 µS/cm 4.2 µS/cm	Conductivity solutions

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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	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 %	
> 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 %	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
Frequency Modulation – Generate and measure [Notes 4,8]			
100 kHz to 3.6 GHz	0.2 < β ≤ 100 β > 100	0.004 *FM* 0.0092 *FM*	Keysight N5531X
> 3.6 GHz to 8.4 GHz	0.2 < β ≤ 100 β > 100	0.0081 *FM* 0.023 *FM*	
> 8.4 GHz to 17.1 GHz	0.2 < β ≤ 100 β > 100	0.0081 *FM* 0.029 *FM*	
> 17.1 GHz to 34.5 GHz	0.2 < β ≤ 100 β > 100	0.0092 *FM* 0.035 *FM*	
> 34.5 GHz to 50 GHz	0.2 < β ≤ 100 β > 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	
PULSE WAVEFORM (20/F04)			
Rise Time – Generate	30 ps 500 ps 150 ps 70 ps	18 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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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	24 ft/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	Up to 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 & 3E4 Molbloc Molbox1 & 1E5Molbloc
FORCE (20/M06)			
Crimp Tool – Pull Force	Up 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 0.91 gf 5.4 gf 14 gf	Electronic balance
Supermicrometer Gaging Force	2 ozf 4 ozf 8 ozf 16 ozf 40 ozf	0.090 ozf 0.22 ozf 0.22 ozf 0.88 ozf 2.5 ozf	Gram gage Force gage

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
Force Gages	0.03125 ozf to 8 ozf 0.5 lbf to 500 lbf 3.2 lbf to 300 lbf > 300 lbf to 1000 lbf > 1000 lbf to 10 000 lbf	0.056 % + 0.000024 ozf 0.055 % + 0.000023 lbf 0.010 % + 0.0064 lbf 0.012 % + 0.0012 lbf 0.010 % + 0.16 lbf	Class 6 Weights 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 610 g > 610 g to 5 kg > 5 kg to 34 kg	3.1 µg + 2.4 µg/g 6.7 µg + 0.59 µg/g 7.3 µg + 0.53 µg/g 9.6 µg + 0.64 µg/g 0.23 mg + 0.53 µg/g 130 mg	Weights, MCM36 Balance Weights, MCM36 Balance Weights, MCM36 Balance Weights, MCM605 Balance Weights, CCE5004 Balance Weights, CPA34001S Balance
VIBRATION (20/M11)			
Accelerometers			
Voltage sensitivity Up to 1000 mV/g	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, PCB 301A11, and ET-126-1HF
Charge sensitivity Up to 1000 pC/g	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 %	VR9500, 301A11, ET-126-1HF, and PCB 422E53
VOLUME & DENSITY (20/M12)			
Viscosity	100 cps 1000 cps 5000 cps 100 000 cps	0.33 % 0.50 % 0.45 % 0.60 %	Viscosity solutions

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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	0.25 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 % 0.066 % 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 > 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 % + 0.0035 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 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 20 mg > 20 mg to 500 mg > 500 mg to 5 g > 5 g to 10 g	0.0023 mg 0.0030 mg 0.0081 mg 0.012 mg	Class 1 Weights

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Expanded Uncertainty (k=2) Notes 3,5	Remarks
	> 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	0.010 mg + 0.57 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	
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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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
100 kHz 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	
	-102 dBm to -110 dBm	0.32 dB	
	-110 dBm to -120 dBm	0.37 dB	
	-120 dBm to -127 dBm	0.43 dB	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
Tuned RF Power – Relative Measure Note 4			HP 8902 w/11722A or 11792A sensor
100kHz 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	(-35 to -24) dBm	1.1 dB	Signal Generator
	(>-24 to -8) dBm	0.42 dB	
	(>-8 to 20) dBm	0.23 dB	
	(-35 to -24) dBm	1.1 dB	
	(>-24 to -8) dBm	0.49 dB	
	(>-8 to 20) dBm	0.35 dB	
	(-35 to -24) dBm	1.2 dB	
	(>-24 to -8) dBm	0.61 dB	
	(>-8 to 20) dBm	0.50 dB	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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 > 25 MHz to 80 MHz 200 Hz to 25 MHz > 25 MHz to 80 MHz 200 Hz to 25 MHz > 25 MHz to 80 MHz	0 dB to 18 dB 20 dB to 58 dB 60 dB to 98 dB	0.28 dB 0.40 dB 0.39 dB 0.52 dB 0.47 dB 0.81 dB	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
DC to 18 GHz (Fixed Value)	3 dB 6 dB 10 dB 20 dB	0.46 dB 0.46 dB 0.65 dB 0.65 dB	Weinschel 44 Series
Attenuation – Generate Note 4 30 MHz	0 dB 10 dB 20 dB 30 dB 40 dB 50 dB	0.0040 dB 0.0083 dB 0.019 dB 0.020 dB 0.033 dB 0.022 dB	Agilent 11812A
Attenuation – Measure Note 4 2.5 MHz to 26.5 GHz	0 dB to 2 dB > 2 dB to -12 dB > -12 dB to -22 dB > -22 dB to -31 dB > -31 dB to -40 dB > -40 dB to -50 dB > -50 dB to -61 dB > -61 dB to -71 dB > -71 dB to -80 dB > -80 dB to -90 dB > -90 dB to -100 dB > -100 dB to -110 dB > -110 dB to -120 dB > -120 dB to -127 dB	0.081 dB 0.070 dB 0.081 dB 0.081 dB 0.093 dB 0.10 dB 0.11 dB 0.12 dB 0.15 dB 0.16 dB 0.16 dB 0.20 dB 0.22 dB 0.34 dB	HP8902 with 11722A or 11792A sensor
THERMODYNAMIC			
HUMIDITY (20/T02)			
Relative Humidity Note 4	10 % RH to 95 % RH	0.15 % RH + 0.29 % rdg.	Thunder Scientific 2500

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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 69 MPa to 207 MPa	0.0048 % + 0.045 Pa 0.011 % - 0.00015 Pa 1.2 Pa 0.012 % 0.0098 % + 0.064 Pa 0.0098 % + 1.8 Pa 0.016 % + 1.4 Pa 0.017 % + 3.0 Pa 0.025 % + 17 Pa	Fluke 7250 LP Pressurements T3500/3 DHI RPM4-A700kp DHI RPM4-A7Mp DHI RPM4-A2Ms DHI RPM4-A70Ms 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

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
RESISTANCE THERMOMETRY (20/T07)			
Comparison – RTDs	-197 °C	6.4 mK	Additel ADT286 w/AccuMac
	-95 °C to -80 °C	13 mK	1960A or Fixed Point
	≥ -80 °C to 0 °C	7.2 mK+ 0.014 mK/°C	
	0.01 °C	4.4 mK	TPW
	> 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	470 mK + 0.12 mK/°C	
	> 700 °C to 1000 °C	1.2 °C	Fluke 9118A w/AccuMac
	> 1000 °C to 1200 °C	850 mK + 0.76 mK /°C	AM1210-20
TEMPERATURE INDICATORS (20/T08)			
Thermocouple Simulation Note 4			
Type B	600 °C to 800 °C	0.33 °C	Fluke 5522A
	> 800 °C to 1000 °C	0.26 °C	
	> 1000 °C to 1550 °C	0.23 °C	
	> 1550 °C to 1820 °C	0.20 °C	
Type C	0 °C to 150 °C	0.18 °C	
	> 150 °C to 650 °C	0.15 °C	
	> 650 °C to 1000 °C	0.18 °C	
	> 1000 °C to 1800 °C	0.30 °C	
	> 1800 °C to 2316 °C	0.49 °C	
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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
	> 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	
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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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 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	
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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
	> 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	
Pt 385, 1000 Ω	-200 °C to -80 °C	0.023 °C	
	> -80 °C to 0 °C	0.023 °C	
	> 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	
PtNi, 120 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	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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
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	
Type K	-196°C > -95 °C to 50 °C > 50°C to 700°C > 700°C to 1093°C > 1093°C to 1200°C	0.15 °C 0.16 °C 0.18 °C + 0.077 mK/°C 1.2 °C 2.2 °C	
Type N	-196°C > -95 °C to 50 °C > 50°C to 700°C > 700°C to 1093°C > 1093°C to 1200°C	0.15 °C 0.16 °C 0.18 °C + 0.077 mK/°C 1.2 °C 2.2 °C	
Type R	> -50 °C to 50 °C > 50°C to 700°C > 700°C to 1093°C > 1093°C to 1200°C	0.29°C – 1.3 mK/°C 0.23 °C 1.3 °C 2.2 °C	

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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 S	> -50 °C to 50 °C > 50°C to 700°C > 700°C to 1093°C > 1093°C to 1200°C	0.28°C – 1.1 mK/°C 0.24 °C 1.3 °C 2.2 °C	
Type T	-196°C > -95 °C to 50 °C > 50°C to 400°C	0.15 °C 0.16 °C 0.18°C + 0.057 mK/°C	
END			

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program

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

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, Φ = 0º 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.

2025-03-19 through 2025-06-30
Effective dates

For the National Voluntary Laboratory Accreditation Program