PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:

Tool Testing Lab, Inc.

11601 North Dixie Drive, Tipp City, OH 45371

(Hereinafter called the Organization) and hereby declares that Organization is accredited in accordance with the recognized International Standard:

ISO/IEC 17025:2005

This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (as outlined by the joint ISO-ILAC-IAF Communiqué dated January 2009):

Dimensional, Electrical, Mass Force and Weighing, Mechanical, Optical, Time & Frequency, Thermodynamic and Acoustic Calibration

(As detailed in the supplement)

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body's duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen
President/Operations Manager

Initial Accreditation Date:	*Issue Date:*	*Expiration Date:*
November 15, 2012	April 17, 2017	April 17, 2019

Accreditation No.:	*Certificate No.:*
15639	L17-160

Perry Johnson Laboratory Accreditation, Inc. (PJLA)
755 W. Big Beaver, Suite 1325
Troy, Michigan 48084

The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: www.pjlabs.com

Certificate of Accreditation: Supplement

Tool Testing Lab, Inc.
11601 North Dixie Drive, Tipp City, OH 45371
Contact Name: Rob Thomas Phone: 937-898-5696

Accreditation is granted to the facility to perform the following calibrations:

Acoustic

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Acoustic Measurement Devices[FO]	94 dB @ 1 kHz	0.14 dB	Acoustic Calibrator
	114 dB @ 1 kHz		
Acoustic Generation Devices[FO]	94 dB @ 1 kHz	0.14 dB	Acoustic Calibrator /Meter
	114 dB @ 1 kHz		

Chemical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Conductivity Meter [FO]	10 µS/cm	0.037 µS	Conductivity Solutions
	100 µS/cm	0.64 µS	
	1 000 µS/cm	5.9 µS	
	1 400 µS/cm	5.9 µS	
	10 000 µS/cm	38 µS	
	100 000 µS/cm	380 µS	
pH Meter [FO]	4 pH	0.02 pH	Buffer Solutions
	7 pH	0.02 pH	
	10 pH	0.02 pH	

Dimensional

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Angle Blocks[FO]	Up to 90°	0.12°	CMM
Calipers[FO]	0.05 in to 80 in	(450 + 22L) µin	Grade 2 gage blocks
Cylindrical Gage, ID[FO]	0.125 in to 19 in	(15 + 9.7L) µin	Grade 2 gage blocks with ID comparator
Cylindrical Gage, OD[FO]	0.01 in to 27 in	(13 + 18.8L) µin	Grade 2 gage blocks with OD comparator
	0.01 in to 1.2 in	(23 + 3.8L) µin	Laser Mic
Gage Blocks[FO]	0.05 in to 4 in	(2 + 3.3L) µin	Grade 1 Blocks w/gage comparator
	4 in to 24 in	(3 + 3.3L) µin	
Height Gage[FO]	0.05 in to 48 in	900 µin	Grade 2 gage blocks
Indicator, Plunger[FO]	Up to 4 in	300 µin	
Indicator, Test[FO]	Up to 0.125 in	100 µin	
Length Standards[FO]	0.05 in to 27 in	(20 + 18.8L) µin	Grade 2 gage blocks w/comparator
Micrometer, Depth[FO]	0.05 in to 12 in	650 µin	Grade 2 gage blocks
Micrometer, Inside[FO]	1.5 in to 24 in	1 300 µin	

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Micrometer, Outside[FO]	0.05 in to 24 in	(29+ 30L) µin	Grade 2 gage blocks
Protractor[FO]	Up to 90°	0.01°	Grade 2 gage blocks w/sine bar
Ruler[FO]	Up to 36 in	(8 000 + 22L) µin	Grade 2 gage blocks
Thickness, Ultrasonic[FO]	Up to 20 in	(4 000 + 18L) µin	
Thread Ring Gage Pitch Diameter 60°[FO]	1/2-80 to 16-6	(100 + 19.8L) µin	Grade 2 gage blocks w/comparator and spheres
Thread Plug Gage Pitch Diameter 60° [FO]	0-80 to 20-6	(90 + 18.8L) µin	Grade 2 gage blocks w/comparator and wires
CMM Axis Length[FO]	12 in to 96 in	(70 + 7.4L) µin	Ball Bar & Gage Blocks - ASME B89.4.10360.2-2008
CMM Repeatability[FO]	1 in	66 µin	Ball Bar & Gage Blocks Standard
CMM Squareness[FO]	12 in to 24 in	(40 + 11L) µin	Ball Bar
CMM Volumetric[FO]	12 in to 96 in	(65 + 6.6L) µin	
V Block -Angle[FO]	5° to 60°	57 µin	Gage Blocks, Sine Bar & Surface Plate
V Block - Parallelism[FO]	1 in to 8 in	170 µin	Gage Blocks, Sine Bar, LVDT & Surface Plate
V Block- Perpendicularity[FO]	1 in to 8 in	180 µin	LVDT, Square and Surface Plate
Bore Gage(Indicator) [FO]	0.07 in to 12 in	(15 + 1.4L) µin	Gage Blocks
Tri-Micrometer[FO]	0.28 in to 12 in	(50 + 11L) µin	Ring Gages
Surface Plate Flatness[FO]	12 in to 160 in	(25 + 0.6D) µin	Auto Collimator
Surface Plate Repeat reading[FO]	0.002 in	25 µin	Repeat-O-Meter
Optical Comparator Axis Linearity[FO]	304.8 mm Maximum (12 in Maximum)	(1.7 + 0.2L) µm [(65 + 7L) µin]	Gage Blocks Glass Master Glass Scale
Optical Comparator Axial Squareness[FO]	(101.6 mm of Y axis travel or maximum Y axis travel is less than 101.6 mm)(4 in of Y axis travel or maximum Y axis travel is less than 4 in)	1.4 µm (57 µin)	Glass Master
Optical Comparator Chart Angularity[FO]	0° to 90°	0.027°	

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Optical Comparator Magnification[FO]	5X	0.021 %	Ball Check Gage, 10 in Glass Magnification Scale
	10X	0.026 %	
	20X	0.026 %	
	31.25X	0.033 %	
	50X	0.028 %	
	62.5X	0.044 %	
	100X	0.028 %	
	5X	0.03 %	Template 18 in to 30 in
	10X	0.015 %	
	20X	0.015 %	
	31.25X	0.019 %	
	50X	0.016 %	
	62.5X	0.019 %	
	100X	0.016 %	
Optical/Video Measuring System (O/VMS) Linear X/Y Axis[FO]	0.001 in to 24 in	(65 + 6.1L) µin	Glass Master
OMS Linear Z Axis[FO]	1 in to 8 in	(65 + 5.2L) µin	Gage Blocks
OMS Axial Squareness[FO]	(101.6 mm of Y axis travel or maximum Y axis travel is less than 101.6 mm) (4 in of Y axis travel or maximum Y axis travel is less than 4 in)	1.4 µm (57 µin)	
Optical Flat[FO]	0.5 in to 12 in	0.5 µin	3 Flat Method
Protractor[FO]	0° to 90°	0.021°	Sine Bar, Gage Blocks & Surface Plate
Flatness[FO]	4 µin to 40 µin	1.2 µin	Optical Flat
Radius Gages[FO]	0.01 in to 8 in	(75 + 9.2L) µin	Optical Comparator

Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Measure DC Voltage[FO]	10 V Fixed Point	2 µV/V	Fluke 732A
	2 µV to 220 mV	8 µV/V + 0.6 µV	Fluke 5700A
	220 mV to 2.2 V	7 µV/V + 1 µV	
	2.2 V to 11 V	7 µV/V + 3.5 µV	
	11 V to 22 V	7 µV/V + 6.5 µV	

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Equipment to Measure DC Voltage[FO]	22 V to 220 V	8 µV/V + 80 µV	Fluke 5700A
	220 V to 1.1 kV	9 µV/V + 500 µV	
	60 nV to 1 mV	50 µV/V + 20 nV	Agilent 34420A
	1 mV to 10 mV	50 µV/V + 30 nV	
	1 µV to 100 mV	10 µV/V + 0.3 µV	Agilent 3458A
	100 mV to 1 V	9 µV/V + 0.3 µV	
	1 V to 10 V	9 µV/V + 0.5 µV	
	10 V to 100 V	10 µV/V + 350 µV	
	100 V to 1 kV	10 µV/V + 1.3 mV	
Equipment to Measure DC Voltage[FO]	1 kV to 40 kV	2 µV/V	Divider w/DMM
Equipment to Measure DC Current[FO]	24 nA to 2.2 mA	50 µA/A + 8 nA	Fluke 5700A
	2.2 mA to 22 mA	50 µA/A + 80 nA	
	22 mA to 220 mA	60 µA/A + 0.8 µA	
	220 mA to 2.2 A	80 µA/A + 25 µA	
	1 µA to 100 µA	4 µA/A + 0.6 nA	Agilent 34420A
	100 µA to 1 mA	30 µA/A + 0.6 nA	
	1 mA to 10 mA	30 µA/A + 0.1 nA	Agilent 3458A
	10 mA to 100 mA	0.4 µA/A + 0.6 µA	
	100 mA to 1 A	130 µA/A + 12 µA	
	1 A to 2 A	190 µA/A + 16 µA	Fluke 8508A
	2 A to 20 A	400 µA/A + 40 µA	
Equipment to Measure Resistance[FO]	0.1 Ω to 1 Ω	95 µΩ/Ω	Fluke 5700A
	1 Ω to 1.9 Ω	95 µΩ/Ω	
	1.9 Ω to 10 Ω	28 µΩ/Ω	
	10 Ω to 19 Ω	27 µΩ/Ω	
	19 Ω to 100 Ω	17 µΩ/Ω	
	100 Ω to 190 Ω	17 µΩ/Ω	
	190 Ω to 1 kΩ	13 µΩ/Ω	
	1 kΩ to 1.9 kΩ	13 µΩ/Ω	
Equipment to Measure Resistance[FO]	1.9 kΩ to 10 kΩ	12 µΩ/Ω	
	10 kΩ to 19 kΩ	12 µΩ/Ω	
	19 kΩ to 100 kΩ	14 µΩ/Ω	
	100 kΩ to 190 kΩ	14 µΩ/Ω	
	190 kΩ to 1 MΩ	20 µΩ/Ω	
	1 MΩ to 1.9 MΩ	21 µΩ/Ω	

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Equipment to Measure Resistance[FO]	1.9 MΩ to 10 MΩ	40 μΩ/Ω	Fluke 5700A
	10 MΩ to 19 MΩ	47 μΩ/Ω	
	19 MΩ to 100 Ω	110 μΩ/Ω	
Equipment to Output Resistance[FO]	100 μΩ to 2 Ω	17 μΩ/Ω + 4 μΩ	Fluke 8508A
	2 Ω to 20 Ω	9.5 μΩ/Ω + 14 μΩ	
	20 Ω to 200 Ω	8 μΩ/Ω + 50 μΩ	
	200 Ω to 2 kΩ	8 μΩ/Ω + 0.5 mΩ	
	2 kΩ to 20 kΩ	8 μΩ/Ω + 5 mΩ	
	20 kΩ to 200 kΩ	8 μΩ/Ω + 50 mΩ	
	200 kΩ to 2 MΩ	9 μΩ/Ω + 1 Ω	
Equipment to Measure Capacitance[FO]	0.19 nF to 3.3 nF	0.5 % of Reading + 0.01 nF	Fluke 5520A
	3.3 nF to 330 nF	0.25 % of Reading + 0.3 nF	
	330 nF to 3.3 μF	0.25 % of Reading + 3 nF	
	3.3 μF to 33 μF	0.4 % of Reading + 30 nF	
	33 μF to 330 μF	0.45 % of Reading + 300 nF	
	330 μF to 3.3 mF	0.45 % of Reading + 3 μF	
	3.3 mF to 33 mF	0.75 % of Reading + 30 μF	
	33 mF to 110 mF	1.1 % of Reading + 100 μF	
Equipment to Measure AC Voltage At the Listed Frequencies[FO]			Fluke 5700A
10 Hz to 20 Hz	15 μV to 2.2 mV	550 μV/V + 4.5 μV	
20 Hz to 40 Hz	15 μV to 2.2 mV	210 μV/V + 4.5 μV	
40 Hz to 20 kHz	15 μV to 2.2 mV	100 μV/V + 4.5 μV	
20 kHz to 50 kHz	15 μV to 2.2 mV	370 μV/V + 4.5 μV	
50 kHz to 100 kHz	21 μV to 2.2 mV	850 μV/V + 7 μV	
100 kHz to 300 kHz	39 μV to 2.2 mV	1 100 μV/V + 13 μV	
300 kHz to 500 kHz	75 μV to 2.2 mV	1 700 μV/V + 25 μV	
500 kHz to 1 MHz	75 μV to 2.2 mV	3 400 μV/V + 25 μV	

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Equipment to Measure AC Voltage At the Listed Frequencies[FO]			Fluke 5700A
10 Hz to 20 Hz	2.2 mV to 22 mV	550 µV/V + 5 µV	
20 Hz to 40 Hz	2.2 mV to 22 mV	210 µV/V + 5 µV	
40 Hz to 20 kHz	2.2 mV to 22 mV	100 µV/V + 5 µV	
20 kHz to 50 kHz	2.2 mV to 22 mV	370 µV/V + 5 µV	
50 kHz to 100 kHz	2.2 mV to 22 mV	850 µV/V + 7 µV	
100 kHz to 300 kHz	2.2 mV to 22 mV	1 100 µV/V + 25 µV	
300 kHz to 500 kHz	2.2 mV to 22 mV	1 700 µV/V + 35 µV	
500 kHz to 1 MHz	2.2 mV to 22 mV	3 400 µV/V + 80 µV	
Equipment to Measure AC Voltage At the Listed Frequencies[FO]			
10 Hz to 20 Hz	22 mV to 220 mV	550 µV/V + 13 µV	
20 Hz to 40 Hz	22 mV to 220 mV	210 µV/V + 8 µV	
40 Hz to 20 kHz	22 mV to 220 mV	110 µV/V + 8 µV	
20 kHz to 50 kHz	22 mV to 220 mV	320 µV/V + 8 µV	
50 kHz to 100 kHz	22 mV to 220 mV	850 µV/V + 25 µV	
100 kHz to 300 kHz	22 mV to 220 mV	0.11 % of Reading + 25 µV	
300 kHz to 500 kHz	22 mV to 220 mV	0.17 % of Reading + 35 µV	
500 kHz to 1 MHz	22 mV to 220 mV	0.34 % of Reading + 80 µV	
Equipment to Measure AC Voltage At the Listed Frequencies[FO]			
10 Hz to 20 Hz	220 mV to 2.2 V	500 µV/V + 80 µV	
20 Hz to 40 Hz	220 mV to 2.2 V	160 µV/V + 25 µV	
40 Hz to 20 kHz	220 mV to 2.2 V	75 µV/V + 6 µV	
20 kHz to 50 kHz	220 mV to 2.2 V	120 µV/V + 16 µV	
50 kHz to 100 kHz	220 mV to 2.2 V	250 µV/V + 70 µV	
100 kHz to 300 kHz	220 mV to 2.2 V	430 µV/V + 130 µV	
300 kHz to 500 kHz	220 mV to 2.2 V	1 100 µV/V + 350 µV	
500 kHz to 1 MHz	220 mV to 2.2 V	2 200 µV/V + 850 µV	

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Equipment to Measure AC Voltage At the Listed Frequencies[FO]			Fluke 5700A
10 Hz to 20 Hz	2.2 V to 22 V	500 µV/V + 800 µV	
20 Hz to 40 Hz	2.2 V to 22 V	160 µV/V + 250 µV	
40 Hz to 20 kHz	2.2 V to 22 V	750 µV/V + 60 µV	
20 kHz to 50 kHz	2.2 V to 22 V	120 µV/V + 160 µV	
50 kHz to 100 kHz	2.2 V to 22 V	250 µV/V + 350 µV	
100 kHz to 300 kHz	2.2 V to 22 V	500 µV/V + 1.5 mV	
300 kHz to 500 kHz	2.2 V to 22 V	1 300 µV/V + 4.3 mV	
500 kHz to 1 MHz	2.2 V to 22 V	2 700 µV/V + 8.5 mV	
Equipment to Measure AC Voltage At the Listed Frequencies[FO]			
10 Hz to 20 Hz	22 V to 220 V	500 µV/V + 8 mV	
20 Hz to 40 Hz	22 V to 220 V	160 µV/V + 2.5 mV	
40 Hz to 20 kHz	22 V to 220 V	80 µV/V + 0.8 mV	
20 kHz to 50 kHz	22 V to 220 V	220 µV/V + 3.5 mV	
50 kHz to 100 kHz	22 V to 220 V	500 µV/V + 8 mV	
100 kHz to 300 kHz	22 V to 220 V	1 500 µV/V + 90 mV	
300 kHz to 500 kHz	22 V to 220 V	4 700 µV/V + 90 mV	
500 kHz to 1 MHz	22 V to 220 V	11 000 µV/V + 190 mV	
Equipment to Measure AC Voltage At the Listed Frequencies[FO]			
15 Hz to 50 Hz	220 V to 1.1 kV	400 µV/V + 16 mV	
50 Hz to 1 kHz	220 V to 1.1 kV	80 µV/V + 3.5 mV	
Equipment to Output AC Voltage At the Listed Frequencies[FO]			Agilent 3458A
1 Hz to 40 Hz	1 mV to 10 mV	0.03 % of Reading + 4 µV	
40 Hz to 1 kHz	1 mV to 10 mV	0.02 % of Reading + 2 µV	
1 kHz to 20 kHz	1 mV to 10 mV	0.03 % of Reading + 2 µV	
20 kHz to 50 kHz	1 mV to 10 mV	0.1 % of Reading + 2 µV	
50 kHz to 100 kHz	1 mV to 10 mV	0.5 % of Reading + 2 µV	
100 kHz to 300 kHz	1 mV to 10 mV	4 % of Reading + 3 µV	

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Equipment to Output AC Voltage At the Listed Frequencies[FO]			Agilent 3458A
1 Hz to 40 Hz	10 mV to 10 V	70 µV/V + 450 µV	
40 Hz to 1 kHz	10 mV to 10 V	70 µV/V + 250 µV	
1 kHz to 20 kHz	10 mV to 10 V	140 µV/V + 250 µV	
20 kHz to 50 kHz	10 mV to 10 V	300 µV/V + 250 µV	
50 kHz to 100 kHz	10 mV to 10 V	800 µV/V + 250 µV	
100 kHz to 300 kHz	10 mV to 10 V	300 µV/V + 1 mV	
300 kHz to 1 MHz	10 mV to 10 V	1 000 µV/V + 1 mV	
1 MHz to 2 MHz	10 mV to 10 V	15 000 µV/V + 1 mV	
Equipment to Output AC Voltage At the Listed Frequencies[FO]			
1 Hz to 40 Hz	10 V to 100 V	200 µV/V + 4 mV	
40 Hz to 1 kHz	10 V to 100 V	200 µV/V + 2 mV	
1 kHz to 20 kHz	10 V to 100 V	200 µV/V + 2 mV	
20 kHz to 50 kHz	10 V to 100 V	350 µV/V + 2 mV	
50 kHz to 100 kHz	10 V to 100 V	1 200 µV/V + 2 mV	
100 kHz to 300 kHz	10 V to 100 V	4 000 µV/V + 10 mV	
300 kHz to 1 MHz	10 V to 100 V	15 000 µV/V + 10 mV	
Equipment to Output AC Voltage At the Listed Frequencies[FO]			
1 Hz to 40 Hz	100 V to 1 kV	400 µV/V + 40 mV	
40 Hz to 1 kHz	100 V to 1 kV	400 µV/V + 20 mV	
1 kHz to 20 kHz	100 V to 1 kV	600 µV/V + 20 mV	
20 kHz to 50 kHz	100 V to 1 kV	1 200 µV/V + 20 mV	
50 kHz to 100 kHz	100 V to 1 kV	3 000 µV/V + 20 mV	
Equipment to Measure AC Current At the Listed Frequencies[FO]			Fluke 5700A
10 Hz to 20 Hz	550 nA to 220 µA	180 nA	
20 Hz to 40 Hz	300 nA to 220 µA	97 nA	
40 Hz to 1 kHz	150 nA to 220 µA	47 nA	
1 kHz to 5 kHz	550 nA to 220 µA	170 nA	
5 kHz to 10 kHz	1.3 µA to 220 µA	430 nA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			
10 Hz to 20 Hz	220 µA to 2.2 mA	1.6 µA	
20 Hz to 40 Hz	220 µA to 2.2 mA	800 nA	
40 Hz to 1 kHz	220 µA to 2.2 mA	350 nA	
1 kHz to 5 kHz	220 µA to 2.2 mA	1.7 µA	
5 kHz to 10 kHz	220 µA to 2.2 mA	4.4 µA	

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Equipment to Measure AC Current At the Listed Frequencies[FO]			Fluke 5700A
10 Hz to 20 Hz	2.2 mA to 22 mA	16 µA	
20 Hz to 40 Hz	2.2 mA to 22 mA	8.1 µA	
40 Hz to 1 kHz	2.2 mA to 22 mA	3.5 µA	
1 kHz to 5 kHz	2.2 mA to 22 mA	18 µA	
5 kHz to 10 kHz	2.2 mA to 22 mA	43 µA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			
10 Hz to 20 Hz	22 mA to 220 mA	160 µA	
20 Hz to 40 Hz	22 mA to 220 mA	81 µA	
40 Hz to 1 kHz	22 mA to 220 mA	35 µA	
1 kHz to 5 kHz	22 mA to 220 mA	180 µA	
5 kHz to 10 kHz	22 mA to 220 mA	430 µA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			
20 Hz to 1 kHz	220 mA to 2.2 A	1.5 mA	
1 kHz to 5 kHz	220 mA to 2.2 A	1.8 mA	
5 kHz to 10 kHz	220 mA to 2.2 A	19 mA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			Fluke 5520A
10 Hz to 45 Hz	2.2 A to 3 A	180 µA/A + 0.2 mA	
45 Hz to 1 kHz	2.2 A to 3 A	60 µA/A + 0.1 mA	
1 kHz to 5 kHz	2.2 A to 3 A	600 µA/A + 1 mA	
5 kHz to 10 kHz	2.2 A to 3 A	25 000 µA/A + 5 mA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			
45 Hz to 100 Hz	3 A to 11 A	100 µA/A + 2 mA	
100 Hz to 1 kHz	3 A to 11 A	1 000 µA/A + 5 mA	
1 kHz to 5 kHz	3 A to 11 A	30 000 µA/A + 2 mA	
Equipment to Measure AC Current At the Listed Frequencies[FO]			
45 Hz to 100 Hz	11 A to 20.5 A	120 µA/A + 5 mA	
100 Hz to 1 kHz	11 A to 20.5 A	150 µA/A + 5 mA	
1 kHz to 5 kHz	11 A to 20.5 A	30 000 µA/A + 5 mA	
Equipment to Output AC Current At the Listed Frequencies[FO]			Agilent 3458A
10 Hz to 20 Hz	5 µA to 100 µA	4 000 µA/A + 30 nA	
20 Hz to 45 Hz	5 µA to 100 µA	1 500 µA/A + 30 nA	
45 Hz to 5 kHz	5 µA to 100 µA	600 µA/A + 30 nA	

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Equipment to Output AC Current At the Listed Frequencies[FO]			Agilent 3458A
10 Hz to 20 Hz	0.1 mA to 1 mA	4 000 µA/A + 200 nA	
20 Hz to 45 Hz	0.1 mA to 1 mA	1 500 µA/A + 200 nA	
45 Hz to 100 Hz	0.1 mA to 1 mA	600 µA/A+ 200 nA	
100 Hz to 5 kHz	0.1 mA to 1 mA	300 µA/A+ 200 nA	
5 kHz to 20 kHz	0.1 mA to 1 mA	600 µA/A+ 200 nA	
20 kHz to 50 kHz	0.1 mA to 1 mA	4 000 µA/A + 400 nA	
50 kHz to 100 kHz	0.1 mA to 1 mA	5 500 µA/A + 1.5 µA	
Equipment to Output AC Current At the Listed Frequencies[FO]			
10 Hz to 20 Hz	1 mA to 10 mA	4 000 µA/A + 2 µA	
20 Hz to 45 Hz	1 mA to 10 mA	1 500 µA/A + 2 µA	
45 Hz to 100 Hz	1 mA to 10 mA	600 µA/A+ 2 µA	
100 Hz to 5 kHz	1 mA to 10 mA	300 µA/A+ 2 µA	
5 kHz to 20 kHz	1 mA to 10 mA	600 µA/A+ 2 µA	
20 kHz to 50 kHz	1 mA to 10 mA	4 000 µA/A + 4 µA	
50 kHz to 100 kHz	1 mA to 10 mA	5 500 µA/A + 15 µA	
Equipment to Output AC Current At the Listed Frequencies[FO]			
10 Hz to 20 Hz	10 mA to 100 mA	4 000 µA/A + 20 µA	
20 Hz to 45 Hz	10 mA to 100 mA	1 500 µA/A + 20 µA	
45 Hz to 100 Hz	10 mA to 100 mA	600 µA/A+ 20 µA	
100 Hz to 5 kHz	10 mA to 100 mA	300 µA/A+ 20 µA	
5 kHz to 20 kHz	10 mA to 100 mA	600 µA/A+ 20 µA	
20 kHz to 50 kHz	10 mA to 100 mA	4 000 µA/A + 40 µA	
50 kHz to 100 kHz	10 mA to 100 mA	5 500 µA/A + 150 µA	
Equipment to Output AC Current At the Listed Frequencies[FO]			
10 Hz to 20 Hz	100 mA to 1 A	4 000 µA/A + 200 µA	
20 Hz to 45 Hz	100 mA to 1 A	1 600 µA/A + 200 µA	
45 Hz to 100 Hz	100 mA to 1 A	800 µA/A + 200 µA	
100 Hz to 5 kHz	100 mA to 1 A	1 000 µA/A + 200 µA	
5 kHz to 20 kHz	100 mA to 1 A	3 000 µA/A + 200 µA	
20 kHz to 50 kHz	100 mA to 1 A	10 000 µA/A + 400 µA	

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Equipment to Output AC Current At the Listed Frequencies[FO]			Fluke 8508A
10 Hz to 2 kHz	200 mA to 2 A	620 µA/A + 200 µA	
2 kHz to 10 kHz	200 mA to 2 A	740 µA/A + 200 µA	
10 kHz to 30 kHz	200 mA to 2 A	30 000 µA/A + 200 µA	
Equipment to Output AC Current At the Listed Frequencies[FO]			
10 Hz to 2 kHz	2 A to 20 A	820 µA/A + 200 µA	
2 kHz to 10 kHz	2 A to 20 A	25 000 µA/A + 200 µA	
Oscilloscope – Leveled Sine Wave Flatness[FO] (Relative to 10 MHz) 50 kHz to 100 MHz	5 mV to 5.5 V	1.5 % of Reading + 100 µV	Fluke 5520A/SC300 Fluke 9500B/9530
Oscilloscope – Leveled Sine Wave Flatness[FO] (Relative to 10 MHz) 100 MHz to 300 MHz	5 mV to 5.5 V	2 % of Reading + 100 µV	
Oscilloscope – Leveled Sine Wave Flatness[FO] (Relative to 10 MHz) 0.3 GHz to 3.2 GHz	5 mV to 5.5 V	7 % of Reading + 100 µV	
Oscilloscope - Square Wave DC Signal[FO] 50Ω load	-6.6 V to 6.6 V	0.25 % of Reading + 40 µV	Fluke 5520A/SC300
Oscilloscope - Square Wave DC Signal[FO] 1 MΩ load	-130 V to 130 V	0.05 % of Reading + 40 µV	
Oscilloscope - Time Marker[FO] 50Ω load	5 s to 50 ms	(20 + 1 000t) µs/s	
	20 ms to 1 ns	2.5 µs/s	
Equipment to Measure DC Voltage[FO]	0.1 mV to 330 mV	20 µV /V + 2 µV	Fluke 5520A
	330 mV to 3.3 V	11 µV /V + 2 µV	
	3.3 V to 33 V	10 µV /V + 1 µV	
	33 V to 330 V	10 µV /V + 100 µV	
	330 V to 1 020 V	10 µV /V + 1.2 mV	

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Equipment to Output DC Voltage[FO]	Up to 100 mV	10 µV/V + 0.6 µV	Fluke 3458A
	100 mV to 1 V	9 µV/V + 0.6 µV	
	1 V to 10 V	8 µV/V + 20 µv	
	10 V to 100 V	10 µV/V + 350 µV	
	100 V to 1 000 V	10 µV/V + 1.3 mV	
	1 kV to 40 kV	2 % of Reading	DMM w/Divider
Equipment to Measure DC Current[FO]	30 µA to 3.3 mA	0.000 4 µA/mA + 0.06 µA	Fluke 5520A
	3.3 mA to 33 mA	0.000 4 µA/mA + 0.6 µA	
	33 mA to 330 mA	0.001 µA/mA + 0.009 µA	
	330 A to 1.1 A	0.3 mA/A + 45 µA	
	1.1 A to 3.0 A	4 mA/A + 120 µA	
	3.0 A to 11 A	0.5 mA/A + 6 mA	
	11 A to 20.5 A	1 mA/A + 16 mA	
	20 A to 1 000 A	0.5 % of Reading + 0.5 A	Fluke 5520A w/Coil
Equipment to Output DC Current[FO]	10 µA to 100 µA	0.004 nA/µA + 0.6 nA	Fluke 3458A
	100 µA to 1 mA	0.03 nA/mA + 0.6 nA	
	1 mA to 10 mA	0.03 nA/mA + 0.1 nA	
	10 mA to 100 mA	0.4 µA/mA + 0.6 µA	
	100 mA to 1 A	130 µA/A + 12 µA	
Equipment to Measure Resistance[FO]	1 Ω to 11 Ω	2 mΩ	Fluke 5520A
	11 Ω to 33 Ω	30 µΩ/Ω + 2 mΩ	
	33 Ω to 110 Ω	15 µΩ/Ω + 2 mΩ	
	110 Ω to 330 Ω	0.04 mΩ/Ω + 2 mΩ	
	330 Ω to 1.1 kΩ	0.04 mΩ/Ω + 2 mΩ	
	1.1 kΩ to 11 kΩ	35 mΩ/kΩ + 25 mΩ	
	11 kΩ to 110 kΩ	35 mΩ/kΩ + 250 mΩ	
	110 kΩ to 1.1 MΩ	36 mΩ/kΩ + 35 Ω	
	1.1 MΩ to 3.3 MΩ	135 Ω/MΩ + 55 Ω	
	3.3 MΩ to 11 MΩ	320 Ω/MΩ + 55 Ω	
	11 MΩ to 33 MΩ	0.2kΩ/MΩ + 3kΩ	
	33 MΩ to 110 MΩ	0.5kΩ/MΩ + 3.5kΩ	
	110 MΩ to 330 MΩ	3 kΩ/MΩ + 0.1 MΩ	
	330 MΩ to 1 100 MΩ	15kΩ/MΩ + 5 MΩ	

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Equipment to Output Resistance[FO]	0.01 Ω to 10 Ω	0.1 mΩ/Ω + 1 mΩ	Fluke 3458A
	10 Ω to 100 Ω	0.02 mΩ/Ω + 5.5 mΩ	
	0.1 kΩ to 100 kΩ	15 mΩ/kΩ + 50 mΩ	
	100 kΩ to 1 MΩ	16 Ω/MΩ + 2.2 Ω	
	1 MΩ to 10 MΩ	52 Ω/MΩ + 100 Ω	
	10 MΩ to 100 MΩ	522 Ω/MΩ + 1.52 kΩ	
	100 MΩ to 1 GΩ	5 kΩ/MΩ + 11 kΩ	
Equipment to Measure Capacitance[FO]	0.19 nF to 3.3 nF	0.5 % of Reading + 0.01 nF	Fluke 5520A
	3.3 nF to 330 nF	0.25 % of Reading + 0.3 nF	
	330 nF to 3.3 µF	0.25 % of Reading + 3 nF	
	3.3 µF to 33 µF	0.40 % of Reading + 30 nF	
	33 µF to 330 µF	0.45 % of Reading + 300 nF	
	330 µF to 3.3 mF	0.45 % of Reading + 3 µF	
	3.3 mF to 33 mF	0.75 % of Reading + 30 µF	
	33 mF to 110 mF	1.1 % of Reading + 100 µF	
Equipment to Measure RF Power At the listed frequencies [FO]			Fluke 9640A W = Reference power from source in watts
10 Hz to 12.5 MHz	1×10^{-16} W to 2.5×10^{-1} W (24 dBm to -130 dBm)	0.05 dB	
12.5 MHz to 4 GHz	1×10^{-16} W to 2.5×10^{-2} W (14 dBm to -130 dBm)	0.06 dB	
Equipment to Measure AC Voltage At the listed Frequencies[FO]			Fluke 5520A
10 Hz to 45 Hz	1 mV to 33 mV	15 µV/mV + 0.8 µV	
45 Hz to 10 kHz	1 mV to 33 mV	0.2 µV/mV + 6 µV	
10 kHz to 20 kHz	1 mV to 33 mV	0.3 µV/mV + 6 µV	
20 kHz to 50 kHz	1 mV to 33 mV	1.1 µV/mV + 6 µV	
50 kHz to 100 kHz	1 mV to 33 mV	4.3 µV/mV + 12 µV	
100 kHz to 500 kHz	1 mV to 33 mV	7.1 µV/mV + 55 µV	
Equipment to Measure AC Voltage At the listed frequencies[FO]			
10 Hz to 45 Hz	33 mV to 330 mV	0.35 µV /mV + 9 µV	
45 Hz to 10 kHz	33 mV to 330 mV	0.16 µV /mV + 9 µV	
10 kHz to 20 kHz	33 mV to 330 mV	0.17 µV /mV + 9 µV	
20 kHz to 50 kHz	33 mV to 330 mV	0.4 µV /mV + 9 µV	
50 kHz to 100 kHz	33 mV to 330 mV	1.1 µV /mV + 35 µV	
100 kHz to 500 kHz	33 mV to 330 mV	1.8 µV /mV + 75 µV	

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Equipment to Measure AC Voltage At the listed frequencies[FO]			Fluke 5520A
10 Hz to 45 Hz	0.33 V to 3.3 V	0.7 mV/V + 55 µV	
45 Hz to 10 kHz	0.33 V to 3.3 V	0.2 mV/V + 65 µV	
10 kHz to 20 kHz	0.33 V to 3.3 V	0.3 mV/V + 65 µV	
20 kHz to 50 kHz	0.33 V to 3.3 V	0.35 mV/V + 55 µV	
50 kHz to 100 kHz	0.33 V to 3.3 V	0.77 mV/V + 65 µV	
100 kHz to 500 kHz	0.33 V to 3.3 V	2.3 mV/V + 75 µV	
Equipment to Measure AC Voltage At the listed frequencies[FO]			
10 Hz to 45 Hz	3.3 V to 33 V	0.63 mV/V + 0.7 mV	
45 Hz to 10 kHz	3.3 V to 33 V	0.16 mV/V + 0.7 mV	
10 kHz to 20 kHz	3.3 V to 33 V	0.2 mV/V + 0.7 mV	
20 kHz to 50 kHz	3.3 V to 33 V	0.35 mV/V + 0.7 mV	
50 kHz to 100 kHz	3.3 V to 33 V	10 mV/V + 1.7 mV	
Equipment to Measure AC Voltage At the listed frequencies[FO]			
45 Hz to 1 kHz	33 V to 330 V	0.2 mV/V + 2.1 mV	
1 Hz to 10 kHz	33 V to 330 V	0.2 mV/V + 6.2 mV	
10 kHz to 20 kHz	33 V to 330 V	0.3 mV/V + 6.2 mV	
20 kHz to 50 kHz	33 V to 330 V	0.3 mV/V + 6.2 mV	
50 kHz to 100 kHz	33 V to 330 V	2.2 mV/V + 62 mV	
Equipment to Measure AC Voltage At the listed frequencies[FO]			
45 Hz to 1 kHz	330 V to 1 020 V	0.3 mV/V + 11 mV	
1 kHz to 10 kHz	330 V to 1 020 V	0.3 mV/V + 11 mV	
10 kHz to 20 kHz	330 V to 1 020 V	0.32 mV/V + 11 mV	
Equipment to Measure AC Voltage At the listed frequencies[FO]			Fluke 3458A
1 Hz to 40 Hz	1 V to 10 mV	0.4 µV /mV + 0.4 µV	
40 Hz to 1 kHz	1 V to 10 mV	0.5 µV /mV + 0.21 µV	
1 kHz to 20 kHz	1 V to 10 mV	0.64 µV /mV + 0.21 µV	
20 kHz to 50 kHz	1 V to 10 mV	1.2 µV /mV + 0.21 µV	
50 kHz to 100 kHz	1 V to 10 mV	2.6 µV /mV + 2.2 µV	
100 kHz to 300 kHz	1 V to 10 mV	76 µV /mV + 4 µV	

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Equipment to Output AC Voltage At the listed frequencies[FO]			Fluke 3458A
1 Hz to 40 Hz	10 mV to 10 V	85 µV /V + 750 µV	
40 Hz to 1 kHz	10 mV to 10 V	60 µV /V + 400 µV	
1 kHz to 20 kHz	10 mV to 10 V	9 mV/V + 400 µV	
20 kHz to 50 kHz	10 mV to 10 V	13 mV/V + 400 µV	
50 kHz to 100 kHz	10 mV to 10 V	89 mV/V + 400 µV	
100 kHz to 300 kHz	10 mV to 10 V	100 mV/V + 1.2 mV	
300 kHz to 1 MHz	10 mV to 10 V	230 mV/V + 750 µV	
1 MHz to 2 MHz	10 mV to 10 V	0.5 V/V + 12 mV	
Equipment to Output AC Voltage At the listed frequencies[FO]			
1 Hz to 40 Hz	10 V to 100 V	0.2 mV/V + 5 mV	
40 Hz to 1 kHz	10 V to 100 V	0.2 mV/V + 2.5 mV	
1 kHz to 20 kHz	10 V to 100 V	0.5 mV/V + 2.5 mV	
20 kHz to 50 kHz	10 V to 100 V	1.9 mV/V + 2.5 mV	
50 kHz to 100 kHz	10 V to 100 V	52 mV/V + 2.5 mV	
100 kHz to 300 kHz	10 V to 100 V	110 mV/V + 12 mV	
300 kHz to 1 MHz	10 V to 100 V	230 mV/V + 12 mV	
Equipment to Output AC Voltage At the listed frequencies[FO]			
1 Hz to 40 Hz	100 V to 1 000 V	0.4 mV/V + 50 mV	
40 Hz to 1 kHz	100 V to 1 000 V	0.43 mV/V + 25 mV	
1 kHz to 20 kHz	100 V to 1 000 V	330 mV/V + 25 mV	
20 kHz to 50 kHz	100 V to 1 000 V	2 V/V + 25 mV	
50 kHz to 100 kHz	100 V to 1 000 V	3.5 V/V + 25 mV	
Equipment to Measure AC Current At the listed frequencies[FO]			Fluke 5520A
10 Hz to 20 Hz	29 µA to 330 µA	1.7 nA/µA + 0.12 µA	
20 Hz to 45 Hz	29 µA to 330 µA	0.9 nA/µA + 0.12 µA	
45 Hz to 1 kHz	29 µA to 330 µA	1.1 nA/µA + 0.12 µA	
1 kHz to 5 kHz	29 µA to 330 µA	1.6 nA/µA + 0.3 µA	
5 kHz to 10 kHz	29 µA to 330 µA	9 nA/µA + 0.5 µA	
10 kHz to 30 kHz	29 µA to 330 µA	0.2 µA /µA + 0.6 µA	

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Equipment to Measure AC Current At the listed frequencies[FO]			Fluke 5520A
10 Hz to 20 Hz	330 µA to 3.3 mA	2 µA /mA + 0.5 µA	
20 Hz to 45 Hz	330 µA to 3.3 mA	0.9 µA /mA + 0.5 µA	
45 Hz to 1 kHz	330 µA to 3.3 mA	2 µA /mA + 0.5 µA	
1 kHz to 5 kHz	330 µA to 3.3 mA	2 µA /mA + 1.8 µA	
5 kHz to 10 kHz	330 µA to 3.3 mA	2.2 µA /mA + 1.8 µA	
10 kHz to 30 kHz	330 µA to 3.3 mA	9 µA /mA + 10.6 µA	
Equipment to Measure AC Current At the listed frequencies[FO]			
10 Hz to 20 Hz	3.3 mA to 33 mA	20 µA /mA + 3 µA	
20 Hz to 45 Hz	3.3 mA to 33 mA	11 µA /mA + 3 µA	
45 Hz to 1 kHz	3.3 mA to 33 mA	6 µA /mA + 3 µA	
1 kHz to 5 kHz	3.3 mA to 33 mA	9 µA /mA + 5 µA	
5 kHz to 10 kHz	3.3 mA to 33 mA	9 µA /mA + 7 µA	
10 kHz to 30 kHz	3.3 mA to 33 mA	50 µA /mA + 15 µA	
Equipment to Measure AC Current At the listed frequencies[FO]			
10 Hz to 20 Hz	33 mA to 330 mA	2 µA/mA + 21 µA	
20 Hz to 45 Hz	33 mA to 330 mA	1 µA/mA + 20 µA	
45 Hz to 1 kHz	33 mA to 330 mA	0.8 µA/mA + 20 µA	
1 kHz to 5 kHz	33 mA to 330 mA	1 µA/mA + 55 µA	
5 kHz to 10 kHz	33 mA to 330 mA	2 µA/mA + 0.11 mA	
10 kHz to 30 kHz	33 mA to 330 mA	5 µA/mA + 0.21 mA	
Equipment to Measure AC Current At the listed frequencies[FO]			
10 Hz to 45 Hz	330 mA to 1.1 A	1.6 mA/A + 0.6 mA	
45 Hz to 1 kHz	330 mA to 1.1 A	0.6 mA/A + 0.6 mA	
1 kHz to 5 kHz	330 mA to 1.1 A	6 mA/A + 1.6 mA	
5 kHz to 10 kHz	330 mA to 1.1 A	23 mA/A + 5.5 mA	
Equipment to Measure AC Current At the listed frequencies[FO]			
10 Hz to 45 Hz	1.1 A to 3 A	6 mA/A + 0.6 mA	
45 Hz to 1 kHz	1.1 A to 3 A	2 mA/A + 0.6 mA	
1 kHz to 5 kHz	1.1 A to 3 A	23 mA/A + 1.6 mA	
5 kHz to 10 kHz	1.1 A to 3 A	85 mA/A + 5.6 mA	
Equipment to Measure AC Current At the listed frequencies[FO]			
45 Hz to 100 Hz	3 A to 11 A	1.3 mA/A + 5 mA	
100 Hz to 1 kHz	3 A to 11 A	1 mA/A + 5 mA	
1 kHz to 5 kHz	3 A to 11 A	30 mA/A + 5 mA	

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Equipment to Measure AC Current (Clamp) At the listed frequencies[FO]			Fluke 5520A w/coil
45 Hz to 65 Hz	20.5 A to 1 025 A	1 % of Reading	
65 Hz to 440 Hz	20.5 A to 1 025 A	1.2 % of Reading	
Equipment to Output AC Current At the listed frequencies[FO]			Fluke 3458A
10 Hz to 20 Hz	5 µA to 100 µA	0.004 3 µA/A + 0.03 mA	
20 Hz to 45 Hz	5 µA to 100 µA	0.002 µA/A + 0.03 mA	
45 Hz to 5 kHz	5 µA to 100 µA	0.000 7 µA/A + 0.03 mA	
Equipment to Output AC Current At the listed frequencies[FO]			
10 Hz to 20 Hz	0.1 mA to 100 mA	4 µA/mA + 23 µA	
20 Hz to 45 Hz	0.1 mA to 100 mA	2 µA/mA + 23 µA	
45 Hz to 100 Hz	0.1 mA to 100 mA	1 µA/mA + 23 µA	
100 Hz to 5kHz	0.1 mA to 100 mA	0.4 µA/mA + 23 µA	
5 kHz to 20 kHz	0.1 mA to 100 mA	1 µA/mA + 23 µA	
20 kHz to 50 kHz	0.1 mA to 100 mA	4 µA/mA + 45 µA	
50 kHz to 100 kHz	0.1 mA to 100 mA	6 mA/mA + 160 µA	
Equipment to Output AC Current At the listed frequencies[FO]			
10 Hz to 20 Hz	100 mA to 1 A	2 mA/A + 0.2 mA	
20 Hz to 45 Hz	100 mA to 1 A	1 mA/A + 0.2 mA	
45 Hz to 100 Hz	100 mA to 1 A	1.3 mA/A + 0.2 mA	
100 Hz to 5kHz	100 mA to 1 A	1.2 mA/A + 0.2 mA	
5 kHz to 20 kHz	100 mA to 1 A	3 mA/A + 0.2 mA	
20 kHz to 50 kHz	100 mA to 1 A	11 mA/A + 0.4 mA	

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Temperature Calibration, Indication and Control Equipment used with Thermocouple Type B[FO]	600 °C to 800 °C	0.44 °C	Fluke 5520A Electrical Simulation of Thermocouple Output
	800 °C to 1 000 °C	0.34 °C	
	1 000 °C to 1 550 °C	0.3 °C	
	1 550 °C to 1 800 °C	0.33 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type C[FO]	0 °C to 150 °C	0.3 °C	
	1 000 °C to 1 800 °C	0.5 °C	
	1 800 °C to 2 316 °C	0.84 °C	
	150 °C to 650 °C	0.26 °C	
	650 °C to 1 000 °C	0.31 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type E[FO]	-250 °C to -100 °C	0.5 °C	
	-100 °C to -25 °C	0.16 °C	
	-25 °C to 350 °C	0.14 °C	
	350 °C to 650 °C	0.16 °C	
	650 °C to 1 000 °C	0.21 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type J[FO]	-210 °C to -100 °C	0.27 °C	
	-100 °C to -30 °C	0.16 °C	
	-30 °C to 150 °C	0.14 °C	
	150 °C to 760 °C	0.17 °C	
	760 °C to 1 200 °C	0.23 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type K[FO]	-210 °C to -100 °C	0.33 °C	
	-100 °C to -25 °C	0.18 °C	
	-25 °C to 120 °C	0.16 °C	
	120 °C to 1 000 °C	0.26 °C	
	1 000 °C to 1 372 °C	0.4 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type L[FO]	-200 °C to -100 °C	0.37 °C	
	-100 °C to 800 °C	0.26 °C	
	800 °C to 900 °C	0.17 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type N[FO]	-200 °C to -100 °C	0.4 °C	
	-100 °C to -25 °C	0.22 °C	
	-25 °C to 120 °C	0.19 °C	
	120 °C to 410 °C	0.18 °C	
	410 °C to 1 300 °C	0.27 °C	

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Tool Testing Lab, Inc.
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Accreditation is granted to the facility to perform the following calibrations:

Electrical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type R[FO]	0 °C to 250 °C	0.57 °C	Fluke 5520A Electrical Simulation of Thermocouple Output
	250 °C to 400 °C	0.35 °C	
	400 °C to 1 000 °C	0.33 °C	
	1 000 °C to 1 767 °C	0.4 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type S[FO]	0 °C to 250 °C	0.47 °C	
	250 °C to 1 000 °C	0.36 °C	
	1 000 °C to 1 400 °C	0.37 °C	
	1 400 °C to 1 767 °C	0.46 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type T[FO]	-250 °C to -150 °C	0.63 °C	
	-150 °C to 0 °C	0.24 °C	
	0 °C to 120 °C	0.16 °C	
	120 °C to 400 °C	0.14 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type U[FO]	-200 °C to 0 °C	0.56 °C	
	0 °C to 600 °C	0.27 °C	
Temperature Calibration, Indication and Control Equipment used with Thermocouple RTDs Pt 385, 100 Ω[FO]	-200 °C to 0 °C	0.05 °C	Fluke 5520A
	0 °C to 100 °C	0.07 °C	
	100 °C to 300 °C	0.09 °C	
	300 °C to 400 °C	0.1 °C	
	400 °C to 630 °C	0.12 °C	
	630 °C to 800 °C	0.23 °C	

Mass, Force and Weighing Devices

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Weighing Device[FO]	135 mg to 220 g	44 mg	Comparison to F Class Weights
	220 g to 32 kg	(50 + 2Wt) mg	
	1 lb to 1 000 lb	(0.06 + 1 x 10^{-6}Wt) lb	
Force- Compression and Tension- Source and Measure[FO]	100 lb to 5 000 lb	10 lb	Comparison to Load Cell
	5 000 lb to 25 000 lb	50 lb	
	25 000 lb to 100 000 lb	200 lb	

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Accreditation is granted to the facility to perform the following calibrations:

Mass Force and Weighing

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Mass Standards	100 mg	390 µg	SG204 & ASTM Class 0 Weights
	200 mg		
	300 mg		
	500 mg		
	1g		
	3 g		
	5 g		
	10 g		
	20 g		
	30 g		
	50 g		
	100 g		
	200 g		
	300 g	1.2 mg	EX1103 & ASTM Class 0 Weights
	500 g		
	1 kg		
	2 kg	5.8 mg	PR5002 & ASTM Class 0 Weights
	3 kg		
	5 kg		
	5 kg	58 mg	SG32001 & ASTM Class 0 Weights
	10 kg		
	20 kg		
	30 kg		
Accelerometers & Vibration Meters[F]	5 m/s^2 to 10 m/s^2 (30 Hz to 2 kHz)	1.5 % of Reading	Comparison to 9100D Calibrator
Micropipettes[FO]	100 µL to 1 000 µL	1.5 µL	SG204
Beakers[FO]	25 mL	0.29 mL	BG204, SOP14
	50 mL	0.58 mL	
	100 mL	1.2 mL	
	150 mL	1.7 mL	
	250 mL	2.9 mL	EX1103, SOP14
	400 mL	4.6 mL	
	600 mL	6.9 mL	
	800 mL	9.2 mL	

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Accreditation is granted to the facility to perform the following calibrations:

Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Beakers[FO]	1 L	12 mL	EX1103, SOP14, Gravimetric Method
	2 L	23 mL	SG32001, SOP14
Burettes[FO]	10 mL	0.012 mL	SG204, SOP14, Gravimetric Method
	25 mL	0.024 mL	
	50 mL	0.024 mL	
	100 mL	0.059 mL	
Flasks[FO]	1 mL	4.8 µL	SG204, SOP14, Gravimetric Method
	2 mL	6.4 µL	
	5 mL	14 µL	
	10 mL	27 µL	
	20 mL	49 µL	
	25 mL	60 µL	EX1103, SOP14, Gravimetric Method
	50 mL	130 µL	
	100 mL	130 µL	
	200 mL	180 µL	
	250 mL	270 µL	
	500 mL	590 µL	
	1 L	1.4 mL	
	2 L	3.4 mL	SG32001, SOP14, Gravimetric Method
Graduated Cylinders[FO]	10 mL	27 µL	SG204, SOP14, Gravimetric Method
	25 mL	60 µL	
	50 mL	130 µL	
	100 mL	130 µL	
	250 mL	270 µL	EX1103, SOP14, Gravimetric Method
	500 mL	590 µL	
	1 L	1.4 mL	
	2 L	3.4 mL	SG32001, SOP14, Gravimetric Method
Test Tubes[FO]	3 mL	10 µL	SG204, Gravimetric Method
	5 mL	14 µL	
	10 mL	27 µL	
	20 mL	49 µL	
	25 mL	60 µL	
	50 mL	130 µL	
	100 mL	130 µL	

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Mechanical

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Test Tubes[FO]	500 mL	590 µL	EX1103, Gravimetric Method
	1 L	1.4 mL	
	2 L	3.4 mL	SG32001, Gravimetric Method
Pressure Measurement Device[FO]	Up to 2.5 psig	0.000 7 psi	APC/CPC/PCS
	Up to 5 psig	0.000 9 psi	
	Up to 15 psig	0.002 psi	
	Up to 30 psig	0.003 psi	
	Up to 50 psig	0.006 psi	
	Up to 100 psig	0.013 psi	
	Up to 1 000 psig	0.12 psi	
	Up to 6 000 psig	0.7 psi	
Pressure Measurement Device[FO]	Up to 100 psig	0.01 % of Reading + 0.003 psi	PPC
Pressure Measurement Device[FO]	Up to 1 000 psig	0.01 % of Reading + 0.03 psi	
Pressure Transducer[FO]	58 psig to 16 000 psig	0.007 5 % Reading	DHI Piston Gauge
	0.3 psig to 500 psig		C-1, P2 Piston Gauge
Torque Transducer[FO]	0.16 ozf•in to 4 000 ozf•in	0.05 % Reading	Wheel w/Weights Bar w/Weights Torque Calibrator
	2.5 lbf•ft to 2 500 lbf•ft	0.05 % Reading	
	0.01 lbf•ft to 2 500 lbf•ft	0.1 % Reading	
Torque Wrench[FO]	160 ozf•in to 1 600 ozf•in	1 % Reading + 4.8 ozf•in	1600 Calibrator
	10 lbf•ft to 100 lbf•ft	0.3 % Reading + 0.02 lbf•ft	100 Calibrator
	100 lbf•ft to 500 lbf•ft	0.2 % Reading + 3.6 lbf•ft	500 Calibrator
	500 lbf•ft to 2 500 lbf•ft	12 lbf•ft	2500 Calibrator
Indirect Verification of Rockwell Hardness Tester HRBW[FO]	40 HRBW to 59 HRBW	0.7 HRBW	Rockwell Hardness Test Block
	59 HRBW to 79 HRBW	0.71 HRBW	
	79 HRBW to 100 HRBW	0.6 HRBW	

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Mechanical

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Indirect Verification of Rockwell Hardness Tester HRC[FO]	20 HRC to 35 HRC	0.45 HRC	Rockwell Hardness Test Block
	35 HRC to 55 HRC	0.44 HRC	
	55 HRC to 65 HRC	0.38 HRC	
Indirect Verification of Rockwell Hardness Tester HRA[FO]	20 HRA to 65 HRA	0.46 HRA	
	65 HRA to 78 HRA	0.23 HRA	
	78 HRA to 84 HRA	0.24 HRA	
Indirect Verification of Rockwell Superficial Hardness Tester HR15N[FO]	70 HR15N to 77 HR15N	0.4 HR15N	
	77 HR15N to 88 HR15N	0.33 HR15N	
	88 HR15N to 92 HR15N	0.27 HR15N	
Indirect Verification of Rockwell Superficial Hardness Tester HR30N[FO]	40 HR30N to 54 HR30N	0.45 HR30N	Rockwell Hardness Test Block
	54 HR30N to 76 HR30N	0.39 HR30N	
	76 HR30N to 86 HR30N	0.35 HR30N	
Indirect Verification of Rockwell Superficial Hardness Tester HR45N[FO]	19 HR45N to 36 HR45N	0.53 HR45N	
	36 HR45N to 65 HR45N	0.45 HR45N	
	65 HR45N to 78 HR45N	0.45 HR45N	
Indirect Verification of Rockwell Superficial Hardness Tester HR15TW[FO]	60 HR15TW to 80 HR15TW	0.6 HR15TW	
	80 HR15TW to 86 HR15TW	0.45 HR15TW	
	86 HR15TW to 93 HR15TW	0.37 HR15TW	
Indirect Verification of Rockwell Superficial Hardness Tester HR30TW[FO]	15 HR30TW to 56 HR30TW	0.56 HR30TW	
	56 HR30TW to 69 HR30TW	0.45 HR30TW	
	69 HR30TW to 83 HR30TW	0.38 HR30TW	
Indirect Verification of Rockwell Superficial Hardness Tester HR45TW[FO]	1 HR45TW to 32 HR45TW	0.55 HR45TW	
	32 HR45TW to 52 HR45TW	0.5 HR45TW	
	52 HR45TW to 73 HR45TW	0.47 HR45TW	
Indentor Diameter[FO]	1.25 mm to 50 mm	$(3.6 \times 10^{-6} + 7.0 \times 10^{-6}L)$m	Optical Comparator ASTM D 2240-05 5.1.1
Indentor Tip Diameter [FO]	1.27 mm to 12 mm	$(3.6 \times 10^{-6} + 7.0 \times 10^{-6}L)$m	
Indentor Tip Radius [FO]	0.1 mm to 11 mm	$(3.6 \times 10^{-6} + 7.0 \times 10^{-6}L)$m	
Indentor Tip Angle [FO]	30° to 35°	0.027°	
Direct Verification of Durometer Hardness Tester Types A, B, C, D, DO, E, M, O, OO, OOO, OOO-S. Indentor Extension Indicator[FO]	1 µm to 5 mm	3.6 µm	Gage Blocks ASTM D 2240-05 5.1.1.8
Durometer Indentor Spring Force Types A, B, C, D, DO, E, M, O, OO, OOO, OOO-S[FO]	0 g to 4.53 kg	1.3 g	Balance ASTM D 2240-05 5.1.1.13

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Accreditation is granted to the facility to perform the following calibrations:

Optical

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Illuminance Response[FO]	100 cd to 10 000 cd	1.3 % of Reading	Standard of Illuminance
Spectral Irradiance[FO]	100 µW/cm^2 to 5 mW/cm^2 @ 365 nm	1.3 % of Reading	Radiometer & Lamp
Wavelength[FO]	253 nm to 579 nm	0.01 nm	Spectral Lamps
	200 nm to 1 100 nm	0.02 nm	Spectral Radiometer

Thermodynamic

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Humidity Meters[FO]	5 % RH to 95 % RH	3 % RH	Vaisala w/Salts Chamber
	25 °C	0.05 °C	SPRT w/salts Chamber
IR Temperature Devices[FO]	35 °C to 350 °C	3 °C	IR Calibrator
Equipment to Output Temperature[FO]	-20 °C to 420 °C	0.16 °C	SPRT w/display
Equipment to Measure Temperature[FO]	-20 °C to 150 °C	0.02 °C	SPRT w/bath
	-25 °C to 150 °C	0.16 °C	SPRT w/9142
	50 °C to 650 °C	0.16 °C	SPRT w/9141
Flow Meter N2/air[FO]	1 mL/min to 700 mL/min	1 % of Reading + 0.15 mL/min	DC-1LC
	0.1 L/min to 30 L/min	0.2 % of Reading + 0.01 L/min	Molbox/Molbloc
	30 L/min to 50 L/min	0.2 % of Reading + 0.02 L/min	
	50 L/min to 3200 L/min	0.3 % of Reading + 0.3 L/min	N2 Flow Bench
Flow Meter H2O[FO]	1 L/min to 60 L/min	0.3 % of Reading + 0.03 L/min	H2O Flow Bench
Flow Meter Hydraulic Fluid[FO]	1.9 L/min to 230 L/min	0.3 % of Reading + 0.03 L/min	Hydraulic Flow Bench
Humidity Meters[FO]	5 % RH to 95 % RH	1.1 % RH	Vaisala w/Chamber
IR Temperature Devices[FO]	35 °C to 350 °C	0.34 % of Reading + 0.38 °C	IR Calibrator

Time and Frequency

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Measure Frequency[FO]	10 MHz Fixed Point	2 µHz	GPSDO
Equipment to Generate Frequency[FO]	10 MHz Fixed Point	2 µHz	GPSDO
Equipment to Measure Frequency[FO]	10 Hz to 22.6 GHz	20 pHz/HZ	Generator w/GPSDO

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Time and Frequency

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Generate Frequency[FO]	10 Hz to 3 GHz	20 pHz/Hz	Counter w/GPSDO
Time Intervals, Timers[FO]	6×10^{-9} s to 1×10^{6} s	0.1 µHz/Hz	Counter
Stop Watches[FO]	7.2×10^{3} s to 8.7×10^{4} s	0.68 s	Direct Comparison, Stop Watch or Universal Counter
	1 s to 1.8×10^{3} s	6 ms	Time Base Method Universal Counter

1. The CMC (Calibration and Measurement Capability) stated for calibrations included on this scope of accreditation represents the smallest measurement uncertainty attainable by the laboratory when performing a more or less routine calibration of a nearly ideal device under nearly ideal conditions. It is typically expressed at a confidence level of 95 % using a coverage factor *k* (usually equal to 2). The actual measurement uncertainty associated with a specific calibration performed by the laboratory will typically be larger than the CMC for the same calibration since capability and performance of the device being calibrated and the conditions related to the calibration may reasonably be expected to deviate from ideal to some degree.

2. The laboratories range of calibration capability for all disciplines for which they are accredited is the interval from the smallest calibrated standard to the largest calibrated standard used in performing the calibration. The low end of this range must be an attainable value for which the laboratory has or has access to the standard referenced. Verification of an indicated value of zero in the absence of a standard is common practice in the procedure for many calibrations but by its definition it does not constitute calibration of zero capacity.

3. The presence of a superscript FO means that the laboratory performs calibration of the indicated parameter both at its fixed location and onsite at customer locations. Example: Outside Micrometer[FO] would mean that the laboratory performs this calibration at its fixed location and onsite at customer locations.

4. Measurement uncertainties obtained for calibrations performed at customer sites can be expected to be larger than the measurement uncertainties obtained at the laboratories fixed location for similar calibrations. This is due to the effects of transportation of the standards and equipment and upon environmental conditions at the customer site which are typically not controlled as closely as at the laboratories fixed location.

5. The term L represents length in inches or millimeters appropriate to the uncertainty statement.

6. The term Wt represents weight in pounds or grams (including SI multiple and submultiple units) appropriate to the uncertainty statement.