



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:

November 15, 2012

Issue Date:

April 17, 2017

Expiration Date:

April 17, 2019

Revision Date.:

September 30, 2017

Accreditation No.:

15639

Certificate No.:

L17-160-R1

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.pjilabs.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 (\pm)	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 (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Conductivity Meter ^{FO}	10 μ S/cm	0.037 μ S	Conductivity Solutions
	100 μ S/cm	0.64 μ S	
	1 000 μ S/cm	5.9 μ S	
	1 400 μ S/cm	5.9 μ S	
	10 000 μ S/cm	38 μ S	
	100 000 μ S/cm	380 μ S	
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 (\pm)	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) μ in	Grade 2 gage blocks
Cylindrical Gage, ID ^{FO}	0.125 in to 19 in	(15 + 9.7L) μ in	Grade 2 gage blocks with ID comparator
Cylindrical Gage, OD ^{FO}	0.01 in to 27 in	(13 + 18.8L) μ in	Grade 2 gage blocks with OD comparator
	0.01 in to 1.2 in	(23 + 3.8L) μ in	Laser Mic
Gage Blocks ^{FO}	0.05 in to 4 in	(2 + 3.3L) μ in	Grade 1 Blocks w/gage comparator
	4 in to 24 in	(3 + 3.3L) μ in	
Height Gage ^{FO}	0.05 in to 48 in	900 μ in	Grade 2 gage blocks
Indicator, Plunger ^{FO}	Up to 4 in	300 μ in	
Indicator, Test ^{FO}	Up to 0.125 in	100 μ in	
Length Standards ^{FO}	0.05 in to 27 in	(20 + 18.8L) μ in	Grade 2 gage blocks w/comparator
Micrometer, Depth ^{FO}	0.05 in to 12 in	650 μ in	Grade 2 gage blocks
Micrometer, Inside ^{FO}	1.5 in to 24 in	1 300 μ in	



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Micrometer, Outside ^{FO}	0.05 in to 24 in	(29+ 30L) μ m	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) μ m	Grade 2 gage blocks
Thickness, Ultrasonic ^{FO}	Up to 20 in	(4 000 + 18L) μ m	
Thread Ring Gage Pitch Diameter 60° ^{FO}	1/2-80 to 16-6	(100 + 19.8L) μ m	Grade 2 gage blocks w/comparator and spheres
Thread Plug Gage Pitch Diameter 60° ^{FO}	0-80 to 20-6	(90 + 18.8L) μ m	Grade 2 gage blocks w/comparator and wires
CMM Axis Length ^{FO}	12 in to 96 in	(70 + 7.4L) μ m	Ball Bar & Gage Blocks - ASME B89.4.10360.2-2008
CMM Repeatability ^{FO}	1 in	66 μ m	Ball Bar & Gage Blocks Standard
CMM Squareness ^{FO}	12 in to 24 in	(40 + 11L) μ m	Ball Bar
CMM Volumetric ^{FO}	12 in to 96 in	(65 + 6.6L) μ m	
V Block -Angle ^{FO}	5° to 60°	57 μ m	Gage Blocks, Sine Bar & Surface Plate
V Block - Parallelism ^{FO}	1 in to 8 in	170 μ m	Gage Blocks, Sine Bar, LVDT & Surface Plate
V Block-Perpendicularity ^{FO}	1 in to 8 in	180 μ m	LVDT, Square and Surface Plate
Bore Gage(Indicator) ^{FO}	0.07 in to 12 in	(15 + 1.4L) μ m	Gage Blocks
Tri-Micrometer ^{FO}	0.28 in to 12 in	(50 + 11L) μ m	Ring Gages
Surface Plate Flatness ^{FO}	12 in to 160 in	(25 + 0.6D) μ m	Auto Collimator
Surface Plate Repeat reading ^{FO}	0.002 in	25 μ m	Repeat-O-Meter
Optical Comparator Axis Linearity ^{FO}	304.8 mm Maximum (12 in Maximum)	(1.7 + 0.2L) μ m [(65 + 7L) μ m]	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 μ m (57 μ m)	
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 %		
	Optical Comparator Magnification ^{FO}	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) μ in	Glass Master	
OMS Linear Z Axis ^{FO}	1 in to 8 in	(65 + 5.2L) μ in	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 μ m (57 μ in)		
Optical Flat ^{FO}	0.5 in to 12 in	0.5 μ in	3 Flat Method	
Protractor ^{FO}	0° to 90°	0.021°	Sine Bar, Gage Blocks & Surface Plate	
Flatness ^{FO}	4 μ in to 40 μ in	1.2 μ in	Optical Flat	
Radius Gages ^{FO}	0.01 in to 8 in	(75 + 9.2L) μ in	Optical Comparator	
Thickness Gage Ferrous Nonferrous Ultrasonic ^{FO}	25 μ m to 500 μ m	1.1 μ m	Thickness Standards and Gauge Blocks	
	800 μ m to 0.06 in	43 μ m		
	0.8 mils to 59 mils	0.043 mils		



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Equipment to Measure DC Voltage ^{FO}	10 V Fixed Point	2 μ V/V	Fluke 732A	
	2 μ V to 220 mV	8 μ V/V + 0.6 μ V	Fluke 5700A	
	220 mV to 2.2 V	7 μ V/V + 1 μ V		
	2.2 V to 11 V	7 μ V/V + 3.5 μ V		
	11 V to 22 V	7 μ V/V + 6.5 μ V		
	22 V to 220 V	8 μ V/V + 80 μ V		
	220 V to 1.1 kV	9 μ V/V + 500 μ V		
		60 nV to 1 mV	50 μ V/V + 20 nV	Agilent 34420A
		1 mV to 10 mV	50 μ V/V + 30 nV	Agilent 3458A
	1 μ V to 100 mV	10 μ V/V + 0.3 μ V		
	100 mV to 1 V	9 μ V/V + 0.3 μ V		
	1 V to 10 V	9 μ V/V + 0.5 μ V		
	10 V to 100 V	10 μ V/V + 350 μ V		
	100 V to 1 kV	10 μ V/V + 1.3 mV		
Equipment to Measure DC Voltage ^{FO}	1 kV to 40 kV	2 μ V/V	Divider w/DMM	
Equipment to Measure DC Current ^{FO}	24 nA to 2.2 mA	50 μ A/A + 8 nA	Fluke 5700A	
	2.2 mA to 22 mA	50 μ A/A + 80 nA		
	22 mA to 220 mA	60 μ A/A + 0.8 μ A		
	220 mA to 2.2 A	80 μ A/A + 25 μ A	Agilent 34420A	
	1 μ A to 100 μ A	4 μ A/A + 0.6 nA		
	100 μ A to 1 mA	30 μ A/A + 0.6 nA	Agilent 3458A	
	1 mA to 10 mA	30 μ A/A + 0.1 nA		
	10 mA to 100 mA	0.4 μ A/A + 0.6 μ A		
	100 mA to 1 A	130 μ A/A + 12 μ A		
	1 A to 2 A	190 μ A/A + 16 μ A		
	2 A to 20 A	400 μ A/A + 40 μ A	Fluke 8508A	
Equipment to Measure Resistance ^{FO}	0.1 Ω to 1 Ω	95 $\mu\Omega/\Omega$	Fluke 5700A	
	1 Ω to 1.9 Ω	95 $\mu\Omega/\Omega$		
	1.9 Ω to 10 Ω	28 $\mu\Omega/\Omega$		
	10 Ω to 19 Ω	27 $\mu\Omega/\Omega$		
	19 Ω to 100 Ω	17 $\mu\Omega/\Omega$		
	100 Ω to 190 Ω	17 $\mu\Omega/\Omega$		
	190 Ω to 1 k Ω	13 $\mu\Omega/\Omega$		
	1 k Ω to 1.9 k Ω	13 $\mu\Omega/\Omega$		



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Equipment to Measure Resistance ^{FO}	1.9 k Ω to 10 k Ω	12 $\mu\Omega/\Omega$	Fluke 5700A
	10 k Ω to 19 k Ω	12 $\mu\Omega/\Omega$	
	19 k Ω to 100 k Ω	14 $\mu\Omega/\Omega$	
	100 k Ω to 190 k Ω	14 $\mu\Omega/\Omega$	
	190 k Ω to 1 M Ω	20 $\mu\Omega/\Omega$	
	1 M Ω to 1.9 M Ω	21 $\mu\Omega/\Omega$	
	1.9 M Ω to 10 M Ω	40 $\mu\Omega/\Omega$	
	10 M Ω to 19 M Ω	47 $\mu\Omega/\Omega$	
Equipment to Output Resistance ^{FO}	100 $\mu\Omega$ to 2 Ω	17 $\mu\Omega/\Omega$ + 4 $\mu\Omega$	Fluke 8508A
	2 Ω to 20 Ω	9.5 $\mu\Omega/\Omega$ + 14 $\mu\Omega$	
	20 Ω to 200 Ω	8 $\mu\Omega/\Omega$ + 50 $\mu\Omega$	
	200 Ω to 2 k Ω	8 $\mu\Omega/\Omega$ + 0.5 m Ω	
	2 k Ω to 20 k Ω	8 $\mu\Omega/\Omega$ + 5 m Ω	
	20 k Ω to 200 k Ω	8 $\mu\Omega/\Omega$ + 50 m Ω	
	200 k Ω to 2 M Ω	9 $\mu\Omega/\Omega$ + 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 μ F	0.25 % of Reading + 3 nF	
	3.3 μ F to 33 μ F	0.4 % of Reading + 30 nF	
	33 μ F to 330 μ F	0.45 % of Reading + 300 nF	
	330 μ F to 3.3 mF	0.45 % of Reading + 3 μ F	
	3.3 mF to 33 mF	0.75 % of Reading + 30 μ F	
	33 mF to 110 mF	1.1 % of Reading + 100 μ F	
Equipment to Measure AC Voltage At the Listed Frequencies ^{FO}			Fluke 5700A
10 Hz to 20 Hz	15 μ V to 2.2 mV	550 μ V/V + 4.5 μ V	
20 Hz to 40 Hz	15 μ V to 2.2 mV	210 μ V/V + 4.5 μ V	
40 Hz to 20 kHz	15 μ V to 2.2 mV	100 μ V/V + 4.5 μ V	
20 kHz to 50 kHz	15 μ V to 2.2 mV	370 μ V/V + 4.5 μ V	
50 kHz to 100 kHz	21 μ V to 2.2 mV	850 μ V/V + 7 μ V	
100 kHz to 300 kHz	39 μ V to 2.2 mV	1 100 μ V/V + 13 μ V	
300 kHz to 500 kHz	75 μ V to 2.2 mV	1 700 μ V/V + 25 μ V	
500 kHz to 1 MHz	75 μ V to 2.2 mV	3 400 μ V/V + 25 μ V	



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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 μ V/V + 5 μ V	
20 Hz to 40 Hz	2.2 mV to 22 mV	210 μ V/V + 5 μ V	
40 Hz to 20 kHz	2.2 mV to 22 mV	100 μ V/V + 5 μ V	
20 kHz to 50 kHz	2.2 mV to 22 mV	370 μ V/V + 5 μ V	
50 kHz to 100 kHz	2.2 mV to 22 mV	850 μ V/V + 7 μ V	
100 kHz to 300 kHz	2.2 mV to 22 mV	1 100 μ V/V + 25 μ V	
300 kHz to 500 kHz	2.2 mV to 22 mV	1 700 μ V/V + 35 μ V	
500 kHz to 1 MHz	2.2 mV to 22 mV	3 400 μ V/V + 80 μ V	
Equipment to Measure AC Voltage At the Listed Frequencies ^{FO}			
10 Hz to 20 Hz	22 mV to 220 mV	550 μ V/V + 13 μ V	
20 Hz to 40 Hz	22 mV to 220 mV	210 μ V/V + 8 μ V	
40 Hz to 20 kHz	22 mV to 220 mV	110 μ V/V + 8 μ V	
20 kHz to 50 kHz	22 mV to 220 mV	320 μ V/V + 8 μ V	
50 kHz to 100 kHz	22 mV to 220 mV	850 μ V/V + 25 μ V	
100 kHz to 300 kHz	22 mV to 220 mV	1 100 μ V/V + 25 μ V	
300 kHz to 500 kHz	22 mV to 220 mV	1 700 μ V/V + 35 μ V	
500 kHz to 1 MHz	22 mV to 220 mV	3 400 μ V/V + 80 μ V	
Equipment to Measure AC Voltage At the Listed Frequencies ^{FO}			
10 Hz to 20 Hz	220 mV to 2.2 V	500 μ V/V + 80 μ V	
20 Hz to 40 Hz	220 mV to 2.2 V	160 μ V/V + 25 μ V	
40 Hz to 20 kHz	220 mV to 2.2 V	75 μ V/V + 6 μ V	
20 kHz to 50 kHz	220 mV to 2.2 V	120 μ V/V + 16 μ V	
50 kHz to 100 kHz	220 mV to 2.2 V	250 μ V/V + 70 μ V	
100 kHz to 300 kHz	220 mV to 2.2 V	430 μ V/V + 130 μ V	
300 kHz to 500 kHz	220 mV to 2.2 V	1 100 μ V/V + 350 μ V	
500 kHz to 1 MHz	220 mV to 2.2 V	2 200 μ V/V + 850 μ V	



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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 μ V/V + 800 μ V	
20 Hz to 40 Hz	2.2 V to 22 V	160 μ V/V + 250 μ V	
40 Hz to 20 kHz	2.2 V to 22 V	750 μ V/V + 60 μ V	
20 kHz to 50 kHz	2.2 V to 22 V	120 μ V/V + 160 μ V	
50 kHz to 100 kHz	2.2 V to 22 V	250 μ V/V + 350 μ V	
100 kHz to 300 kHz	2.2 V to 22 V	500 μ V/V + 1.5 mV	
300 kHz to 500 kHz	2.2 V to 22 V	1 300 μ V/V + 4.3 mV	
500 kHz to 1 MHz	2.2 V to 22 V	2 700 μ V/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 μ V/V + 8 mV	
20 Hz to 40 Hz	22 V to 220 V	160 μ V/V + 2.5 mV	
40 Hz to 20 kHz	22 V to 220 V	80 μ V/V + 0.8 mV	
20 kHz to 50 kHz	22 V to 220 V	220 μ V/V + 3.5 mV	
50 kHz to 100 kHz	22 V to 220 V	500 μ V/V + 8 mV	
100 kHz to 300 kHz	22 V to 220 V	1 500 μ V/V + 90 mV	
300 kHz to 500 kHz	22 V to 220 V	4 700 μ V/V + 90 mV	
500 kHz to 1 MHz	22 V to 220 V	11 000 μ V/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 μ V/V + 16 mV	
50 Hz to 1 kHz	220 V to 1.1 kV	80 μ V/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 μ V	
40 Hz to 1 kHz	1 mV to 10 mV	0.02 % of Reading + 2 μ V	
1 kHz to 20 kHz	1 mV to 10 mV	0.03 % of Reading + 2 μ V	
20 kHz to 50 kHz	1 mV to 10 mV	0.1 % of Reading + 2 μ V	
50 kHz to 100 kHz	1 mV to 10 mV	0.5 % of Reading + 2 μ V	
100 kHz to 300 kHz	1 mV to 10 mV	4 % of Reading + 3 μ V	



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



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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 μ A		
20 Hz to 40 Hz	2.2 mA to 22 mA	8.1 μ A		
40 Hz to 1 kHz	2.2 mA to 22 mA	3.5 μ A		
1 kHz to 5 kHz	2.2 mA to 22 mA	18 μ A		
5 kHz to 10 kHz	2.2 mA to 22 mA	43 μ A		
Equipment to Measure AC Current At the Listed Frequencies ^{FO}				
10 Hz to 20 Hz	22 mA to 220 mA	160 μ A		
20 Hz to 40 Hz	22 mA to 220 mA	81 μ A		
40 Hz to 1 kHz	22 mA to 220 mA	35 μ A		
1 kHz to 5 kHz	22 mA to 220 mA	180 μ A		
5 kHz to 10 kHz	22 mA to 220 mA	430 μ A		
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 μ A/A + 0.2 mA		
45 Hz to 1 kHz	2.2 A to 3 A	60 μ A/A + 0.1 mA		
1 kHz to 5 kHz	2.2 A to 3 A	600 μ A/A + 1 mA		
5 kHz to 10 kHz	2.2 A to 3 A	25 000 μ A/A + 5 mA		
Equipment to Measure AC Current At the Listed Frequencies ^{FO}				
45 Hz to 100 Hz	3 A to 11 A	100 μ A/A + 2 mA		
100 Hz to 1 kHz	3 A to 11 A	1 000 μ A/A + 5 mA		
1 kHz to 5 kHz	3 A to 11 A	30 000 μ A/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 μ A/A + 5 mA		
100 Hz to 1 kHz	11 A to 20.5 A	150 μ A/A + 5 mA		
1 kHz to 5 kHz	11 A to 20.5 A	30 000 μ A/A + 5 mA		
Equipment to Output AC Current At the Listed Frequencies ^{FO}				Agilent 3458A
10 Hz to 20 Hz	5 μ A to 100 μ A	4 000 μ A/A + 30 nA		
20 Hz to 45 Hz	5 μ A to 100 μ A	1 500 μ A/A + 30 nA		
45 Hz to 5 kHz	5 μ A to 100 μ A	600 μ A/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 μ A/A + 200 nA	
20 Hz to 45 Hz	0.1 mA to 1 mA	1 500 μ A/A + 200 nA	
45 Hz to 100 Hz	0.1 mA to 1 mA	600 μ A/A + 200 nA	
100 Hz to 5 kHz	0.1 mA to 1 mA	300 μ A/A + 200 nA	
5 kHz to 20 kHz	0.1 mA to 1 mA	600 μ A/A + 200 nA	
20 kHz to 50 kHz	0.1 mA to 1 mA	4 000 μ A/A + 400 nA	
50 kHz to 100 kHz	0.1 mA to 1 mA	5 500 μ A/A + 1.5 μ A	
Equipment to Output AC Current At the Listed Frequencies ^{FO}			
10 Hz to 20 Hz	1 mA to 10 mA	4 000 μ A/A + 2 μ A	
20 Hz to 45 Hz	1 mA to 10 mA	1 500 μ A/A + 2 μ A	
45 Hz to 100 Hz	1 mA to 10 mA	600 μ A/A + 2 μ A	
100 Hz to 5 kHz	1 mA to 10 mA	300 μ A/A + 2 μ A	
5 kHz to 20 kHz	1 mA to 10 mA	600 μ A/A + 2 μ A	
20 kHz to 50 kHz	1 mA to 10 mA	4 000 μ A/A + 4 μ A	
50 kHz to 100 kHz	1 mA to 10 mA	5 500 μ A/A + 15 μ A	
Equipment to Output AC Current At the Listed Frequencies ^{FO}			
10 Hz to 20 Hz	10 mA to 100 mA	4 000 μ A/A + 20 μ A	
20 Hz to 45 Hz	10 mA to 100 mA	1 500 μ A/A + 20 μ A	
45 Hz to 100 Hz	10 mA to 100 mA	600 μ A/A + 20 μ A	
100 Hz to 5 kHz	10 mA to 100 mA	300 μ A/A + 20 μ A	
5 kHz to 20 kHz	10 mA to 100 mA	600 μ A/A + 20 μ A	
20 kHz to 50 kHz	10 mA to 100 mA	4 000 μ A/A + 40 μ A	
50 kHz to 100 kHz	10 mA to 100 mA	5 500 μ A/A + 150 μ A	
Equipment to Output AC Current At the Listed Frequencies ^{FO}			
10 Hz to 20 Hz	100 mA to 1 A	4 000 μ A/A + 200 μ A	
20 Hz to 45 Hz	100 mA to 1 A	1 600 μ A/A + 200 μ A	
45 Hz to 100 Hz	100 mA to 1 A	800 μ A/A + 200 μ A	
100 Hz to 5 kHz	100 mA to 1 A	1 000 μ A/A + 200 μ A	
5 kHz to 20 kHz	100 mA to 1 A	3 000 μ A/A + 200 μ A	
20 kHz to 50 kHz	100 mA to 1 A	10 000 μ A/A + 400 μ A	



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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 μ A/A + 200 μ A	
2 kHz to 10 kHz	200 mA to 2 A	740 μ A/A + 200 μ A	
10 kHz to 30 kHz	200 mA to 2 A	30 000 μ A/A + 200 μ A	
Equipment to Output AC Current At the Listed Frequencies ^{FO}			
10 Hz to 2 kHz	2 A to 20 A	820 μ A/A + 200 μ A	
2 kHz to 10 kHz	2 A to 20 A	25 000 μ A/A + 200 μ A	Fluke 5520A/SC300 Fluke 9500B/9530
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 μ V	
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 μ V	
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 μ V	
Oscilloscope - Square Wave DC Signal ^{FO} 50 Ω load	-6.6 V to 6.6 V	0.25 % of Reading + 40 μ V	
Oscilloscope - Square Wave DC Signal ^{FO} 1 M Ω load	-130 V to 130 V	0.05 % of Reading + 40 μ V	
Oscilloscope - Time Marker ^{FO} 50 Ω load	5 s to 50 ms	(20 + 1 000t) μ s/s	Fluke 5520A/SC300
	20 ms to 1 ns	2.5 μ s/s	
Equipment to Measure DC Voltage ^{FO}	0.1 mV to 330 mV	20 μ V /V + 2 μ V	Fluke 5520A
	330 mV to 3.3 V	11 μ V /V + 2 μ V	
	3.3 V to 33 V	10 μ V /V + 1 μ V	
	33 V to 330 V	10 μ V /V + 100 μ V	
	330 V to 1 020 V	10 μ V /V + 1.2 mV	



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



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Equipment to Output Resistance ^{FO}	0.01 Ω to 10 Ω	0.1 m Ω / Ω + 1 m Ω	Fluke 3458A
	10 Ω to 100 Ω	0.02 m Ω / Ω + 5.5 m Ω	
	0.1 k Ω to 100 k Ω	15 m Ω /k Ω + 50 m Ω	
	100 k Ω to 1 M Ω	16 Ω /M Ω + 2.2 Ω	
	1 M Ω to 10 M Ω	52 Ω /M Ω + 100 Ω	
	10 M Ω to 100 M Ω	522 Ω /M Ω + 1.52 k Ω	
	100 M Ω to 1 G Ω	5 k Ω /M Ω + 11 k 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 μ F	0.25 % of Reading + 3 nF	
	3.3 μ F to 33 μ F	0.40 % of Reading + 30 nF	
	33 μ F to 330 μ F	0.45 % of Reading + 300 nF	
	330 μ F to 3.3 mF	0.45 % of Reading + 3 μ F	
	3.3 mF to 33 mF	0.75 % of Reading + 30 μ F	
	33 mF to 110 mF	1.1 % of Reading + 100 μ F	
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 x 10 ⁻¹⁶ W to 2.5 x 10 ⁻¹ W (24 dBm to -130 dBm)	0.05 dB	
12.5 MHz to 4 GHz	1 x 10 ⁻¹⁶ W to 2.5 x 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 μ V/mV + 0.8 μ V	
45 Hz to 10 kHz	1 mV to 33 mV	0.2 μ V/mV + 6 μ V	
10 kHz to 20 kHz	1 mV to 33 mV	0.3 μ V/mV + 6 μ V	
20 kHz to 50 kHz	1 mV to 33 mV	1.1 μ V/mV + 6 μ V	
50 kHz to 100 kHz	1 mV to 33 mV	4.3 μ V/mV + 12 μ V	
100 kHz to 500 kHz	1 mV to 33 mV	7.1 μ V/mV + 55 μ V	
Equipment to Measure AC Voltage At the listed frequencies ^{FO}			
10 Hz to 45 Hz	33 mV to 330 mV	0.35 μ V /mV + 9 μ V	
45 Hz to 10 kHz	33 mV to 330 mV	0.16 μ V /mV + 9 μ V	
10 kHz to 20 kHz	33 mV to 330 mV	0.17 μ V /mV + 9 μ V	
20 kHz to 50 kHz	33 mV to 330 mV	0.4 μ V /mV + 9 μ V	
50 kHz to 100 kHz	33 mV to 330 mV	1.1 μ V /mV + 35 μ V	
100 kHz to 500 kHz	33 mV to 330 mV	1.8 μ V /mV + 75 μ V	



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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 μ V	
45 Hz to 10 kHz	0.33 V to 3.3 V	0.2 mV/V + 65 μ V	
10 kHz to 20 kHz	0.33 V to 3.3 V	0.3 mV/V + 65 μ V	
20 kHz to 50 kHz	0.33 V to 3.3 V	0.35 mV/V + 55 μ V	
50 kHz to 100 kHz	0.33 V to 3.3 V	0.77 mV/V + 65 μ V	
100 kHz to 500 kHz	0.33 V to 3.3 V	2.3 mV/V + 75 μ V	
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 μ V /mV + 0.4 μ V	
40 Hz to 1 kHz	1 V to 10 mV	0.5 μ V /mV + 0.21 μ V	
1 kHz to 20 kHz	1 V to 10 mV	0.64 μ V /mV + 0.21 μ V	
20 kHz to 50 kHz	1 V to 10 mV	1.2 μ V /mV + 0.21 μ V	
50 kHz to 100 kHz	1 V to 10 mV	2.6 μ V /mV + 2.2 μ V	
100 kHz to 300 kHz	1 V to 10 mV	76 μ V /mV + 4 μ V	



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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 μ V/V + 750 μ V	
40 Hz to 1 kHz	10 mV to 10 V	60 μ V/V + 400 μ V	
1 kHz to 20 kHz	10 mV to 10 V	9 mV/V + 400 μ V	
20 kHz to 50 kHz	10 mV to 10 V	13 mV/V + 400 μ V	
50 kHz to 100 kHz	10 mV to 10 V	89 mV/V + 400 μ V	
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 μ V	
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 μ A to 330 μ A	1.7 nA/ μ A + 0.12 μ A	
20 Hz to 45 Hz	29 μ A to 330 μ A	0.9 nA/ μ A + 0.12 μ A	
45 Hz to 1 kHz	29 μ A to 330 μ A	1.1 nA/ μ A + 0.12 μ A	
1 kHz to 5 kHz	29 μ A to 330 μ A	1.6 nA/ μ A + 0.3 μ A	
5 kHz to 10 kHz	29 μ A to 330 μ A	9 nA/ μ A + 0.5 μ A	
10 kHz to 30 kHz	29 μ A to 330 μ A	0.2 μ A / μ A + 0.6 μ A	



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Equipment to Measure AC Current At the listed frequencies ^{FO}			Fluke 5520A
10 Hz to 20 Hz	330 μ A to 3.3 mA	2 μ A /mA + 0.5 μ A	
20 Hz to 45 Hz	330 μ A to 3.3 mA	0.9 μ A /mA + 0.5 μ A	
45 Hz to 1 kHz	330 μ A to 3.3 mA	2 μ A /mA + 0.5 μ A	
1 kHz to 5 kHz	330 μ A to 3.3 mA	2 μ A /mA + 1.8 μ A	
5 kHz to 10 kHz	330 μ A to 3.3 mA	2.2 μ A /mA + 1.8 μ A	
10 kHz to 30 kHz	330 μ A to 3.3 mA	9 μ A /mA + 10.6 μ A	
Equipment to Measure AC Current At the listed frequencies ^{FO}			
10 Hz to 20 Hz	3.3 mA to 33 mA	20 μ A /mA + 3 μ A	
20 Hz to 45 Hz	3.3 mA to 33 mA	11 μ A /mA + 3 μ A	
45 Hz to 1 kHz	3.3 mA to 33 mA	6 μ A /mA + 3 μ A	
1 kHz to 5 kHz	3.3 mA to 33 mA	9 μ A /mA + 5 μ A	
5 kHz to 10 kHz	3.3 mA to 33 mA	9 μ A /mA + 7 μ A	
10 kHz to 30 kHz	3.3 mA to 33 mA	50 μ A /mA + 15 μ A	
Equipment to Measure AC Current At the listed frequencies ^{FO}			
10 Hz to 20 Hz	33 mA to 330 mA	2 μ A/mA + 21 μ A	
20 Hz to 45 Hz	33 mA to 330 mA	1 μ A/mA + 20 μ A	
45 Hz to 1 kHz	33 mA to 330 mA	0.8 μ A/mA + 20 μ A	
1 kHz to 5 kHz	33 mA to 330 mA	1 μ A/mA + 55 μ A	
5 kHz to 10 kHz	33 mA to 330 mA	2 μ A/mA + 0.11 mA	
10 kHz to 30 kHz	33 mA to 330 mA	5 μ A/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 μ A to 100 μ A	0.004 3 μ A/A + 0.03 mA	
20 Hz to 45 Hz	5 μ A to 100 μ A	0.002 μ A/A + 0.03 mA	
45 Hz to 5 kHz	5 μ A to 100 μ A	0.000 7 μ A/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 μ A/mA + 23 μ A	
20 Hz to 45 Hz	0.1 mA to 100 mA	2 μ A/mA + 23 μ A	
45 Hz to 100 Hz	0.1 mA to 100 mA	1 μ A/mA + 23 μ A	
100 Hz to 5kHz	0.1 mA to 100 mA	0.4 μ A/mA + 23 μ A	
5 kHz to 20 kHz	0.1 mA to 100 mA	1 μ A/mA + 23 μ A	
20 kHz to 50 kHz	0.1 mA to 100 mA	4 μ A/mA + 45 μ A	
50 kHz to 100 kHz	0.1 mA to 100 mA	6 mA/mA + 160 μ A	
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	
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	



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Temperature Calibration, Indication and Control Equipment used with Thermocouple Type E ^{FO}	-250 °C to -100 °C	0.5 °C	Fluke 5520A Electrical Simulation of Thermocouple Output
	-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	
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	



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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 (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Temperature Calibration, Indication and Control Equipment used with Thermocouple Type T ^{FO}	-250 °C to -150 °C	0.63 °C	Fluke 5520A Electrical Simulation of Thermocouple Output
	-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 (\pm)	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	
Mass Standards ^{FO}	100 mg	390 μ g	SG204 & ASTM Class 0 Weights
	200 mg		
	300 mg		
	500 mg		
	1g		
	3 g		
	5 g		
	10 g		
	20 g		
	30 g		
50 g			



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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 (\pm)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Mass Standards ^{FO}	100 g	390 μ g	SG204 & ASTM Class 0 Weights
	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 μ L to 1 000 μ L	1.5 μ L	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	

Mechanical

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (\pm)	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	0.02 mL	SG204, SOP14, Gravimetric Method
	25 mL	0.03 mL	
	50 mL	0.03 mL	
	100 mL	0.06 mL	



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Mechanical

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Flasks ^{FO}	1 mL	4.8 μ L	SG204, SOP14, Gravimetric Method
	2 mL	6.4 μ L	
	5 mL	14 μ L	
	10 mL	27 μ L	
	20 mL	49 μ L	
	25 mL	60 μ L	EX1103, SOP14, Gravimetric Method
	50 mL	130 μ L	
	100 mL	130 μ L	
	200 mL	180 μ L	
	250 mL	270 μ L	
	500 mL	590 μ L	
	1 L	1.4 mL	SG32001, SOP14, Gravimetric Method
	2 L	3.4 mL	
Graduated Cylinders ^{FO}	10 mL	27 μ L	SG204, SOP14, Gravimetric Method
	25 mL	60 μ L	
	50 mL	130 μ L	
	100 mL	130 μ L	EX1103, SOP14, Gravimetric Method
	250 mL	270 μ L	
	500 mL	590 μ L	
	1 L	1.4 mL	
	2 L	3.4 mL	
Test Tubes ^{FO}	3 mL	10 μ L	SG204, Gravimetric Method
	5 mL	14 μ L	
	10 mL	27 μ L	
	20 mL	49 μ L	
	25 mL	60 μ L	
	50 mL	130 μ L	
	100 mL	130 μ L	



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Test Tubes ^{FO}	500 mL	590 μ L	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	
Indenter 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
Indenter Tip Diameter ^{FO}	1.27 mm to 12 mm	$(3.6 \times 10^{-6} + 7.0 \times 10^{-6}L)m$	
Indenter Tip Radius ^{FO}	0.1 mm to 11 mm	$(3.6 \times 10^{-6} + 7.0 \times 10^{-6}L)m$	
Indenter 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. Indenter Extension Indicator ^{FO}	1 μ m to 5 mm	3.6 μ m	Gage Blocks ASTM D 2240-05 5.1.1.8
Durometer Indenter Spring Force Types A, B, C, D, DO, E, M, O, OO, OOO, OOO-	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:

S ^{FO}			
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Optical

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
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

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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 μ Hz/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

- 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.
- 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.
- 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.
- 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.
- The term L represents length in inches or millimeters appropriate to the uncertainty statement.
- The term Wt represents weight in pounds or grams (including SI multiple and submultiple units) appropriate to the uncertainty statement.
- W represent reference power from source in watts