

## PERRY JOHNSON LABORATORY ACCREDITATION, INC.

# Certificate of Accreditation

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

## **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382

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

## ISO/IEC 17025:2017

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 April 2017):

Calibration of Chemical, Dimensional, Electrical, Pressure, Mechanical, Temperature, Thermodynamic Measuring and Test Equipment, Weights and Scales (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

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

Initial Accreditation Date: Issue Date: June 6, 2008 January 30, 2021 Accreditation No.: 62582

Expiration Date: February 28, 2023

Certificate No.: L21-77

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



#### **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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

Chemical MEASURED INSTRUMENT, RANGE OR NOMINAL CALIBRATION AND CALIBRATION QUANTITY OR GAUGE DEVICE SIZE AS MEASUREMENT EQUIPMENT APPROPRIATE CAPABILITY EXPRESSED AND REFERENCE AS AN UNCERTAINTY (±) STANDARDS USED Conductivity FO 100 µS/cm 2.9 µS/cm **Conductivity Solutions** QAI-A02 1 413 µS/cm 10.5 µS/cm 5 000 µS/cm 35.9 µS/cm 10 000 µS/cm 56.4 µS/cm 100 000 µS/cm 726 µS/cm

#### 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
Outside Micrometers FO	0.05 in to 4 in	(60 + 0.052L) µin	Gage Blocks
	4 in to 40 in	(730 + 0.018L) µin	QAI-MXX procedures
Height Gages FO	0.05 in to 4 in	(86 + 0.052L) µin	
	4 in to 40 in	(360 + 0.18L) µin	
Depth Gages FO	0.05 in to 4 in	(180 + 0.052L) µin	
Calipers <sup>FO</sup>	0.05 in to 4 in	(310 + 0.052L) µin	
	4 in to 40 in	(730 + 0.018L) µin	
Dial Indicators FO	0.000 5 in to 4 in	(36 + 0.052L) µin	
Length – Inside Diameter <sup>F</sup>	0.65 in to 1.2 in	(8.2 + 0.007 6L) µin	Ring Gages
			P&W Labmaster
			OEM manual
Length – Outside Diameter <sup>F</sup>	0.05 in to 4 in	(3.7 + 0.000 13L) µin	Gage Blocks
	4 in to 8 in	(13 + 0.000 13L) µin	P&W Labmaster



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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	-250 °C to -100 °C	0.56 °C	Fluke 5520A
	-100 °C to -25 °C	0.19 °C	Electrical Simulation of Thermocouple Output GIDEP procedures OEM procedures
Thermocouple Type E FO	-25 °C to 350 °C	0.17 °C	
	350 °C to 650 °C	0.19 °C	
	650 °C to 1 000 °C	0.24 °C	
Temperature Calibration,	-210 °C to -100 °C	0.31 °C	
Indication, and Control	-100 °C to -30 °C	0.19 °C	
Equipment used with Thermocouple Type J <sup>FO</sup>	-30 °C to 150 °C	0.17 °C	
	150 °C to 760 °C	0.20 °C	
	760 °C to 1 200 °C	0.26 °C	
Temperature Calibration,	-200 °C to -100 °C	0.37 °C	
Indication, and Control	-100 °C to -25 °C	0.21 °C	
Equipment used with Thermocouple Type K <sup>FO</sup>	-25 °C to 120 °C	0.19 °C	
Thermocoupie Type R	120 °C to 1 000 °C	0.29 °C	
	1 000 °C to 1 372 °C	0.45 °C	
Temperature Calibration,	-200 °C to -100 °C	0.45 °C	
Indication, and Control	-100 °C to -25 °C	0.25 °C	
Thermocouple Type N <sup>FO</sup>	-25 °C to 120 °C	0.22 °C	
	120 °C to 410 °C	0.21 °C	
	410 °C to 1 300 °C	0.31 °C	
Temperature Calibration,	0 °C to 250 °C	0.63 °C	
Indication, and Control	250 °C to 400 °C	0.39 °C	
Thermocouple Type R <sup>FO</sup>	400 °C to 1 000 °C	0.37 °C	
incrinocoupie i ype K	1 000 °C to 1 767 °C	0.45 °C	
Temperature Calibration,	0 °C to 250 °C	0.52 °C	
Indication, and Control Equipment used with Thermocouple Type S <sup>FO</sup>	250 °C to 1 000 °C	0.40 °C	
	1 000 °C to 1 400 °C	0.41 °C	
	1 400 °C to 1 767 °C	0.51 °C	
Temperature Calibration,	-250 °C to -150 °C	0.7 °C	
Indication, and Control	-150 °C to 0 °C	0.27 °C	
Equipment used with Thermocouple Type T <sup>FO</sup>	0 °C to 120 °C	0.19 °C	
	120 °C to 400 °C	0.17 °C	



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Temperature Calibration,	-200 °C to -80 °C	0.05 °C	Fluke 5520A Electrical Simulation of RTD Output GIDEP procedures OEM procedures
Indication and Control Equipment used with RTD Pt 385, 100 O FO	-80 °C to 0 °C	0.05 °C	
	0 °C to 100 °C	0.04 °C	
1112 11 202, 100 11	100 °C to 300 °C	0.08 °C	
	300 °C to 400 °C	0.09 °C	
	400 °C to 630 °C	0.11 °C	
	630 °C to 800 °C	0.19 °C	
Temperature Calibration,	-200 °C to -80 °C	0.04 °C	
Indication and Control	-80 °C to 0 °C	0.04 °C	
RTD Pt 385 200 Q FO	0 °C to 100 °C	0.04 °C	
1112 11 2003, 200 44	100 °C to 260 °C	0.05 °C	
	260 °C to 300 °C	0.1 °C	
	300 °C to 400 °C	0.1 °C	-
	400 °C to 600 °C	0.12 °C	
	600 °C to 630 °C	0.13 °C	
Temperature Calibration,	-200 °C to -80 °C	0.04 °C	
Indication and Control	-80 °C to 0 °C	0.05 °C	
Equipment used with RTD Pt 385, 500 $\Omega$ FO	0 °C to 100 °C	0.05 °C	
1112 11 202, 200 11	100 °C to 260 °C	0.06 °C	
	260 °C to 300 °C	0.07 °C	
	300 °C to 400 °C	0.07 °C	
	400 °C to 600 °C	0.08 °C	
	600 °C to 630 °C	0.1 °C	
Temperature Calibration,	-200 °C to -80 °C	0.03 °C	
Indication and Control Equipment used with RTD Pt 385, 1 k $\Omega$ <sup>FO</sup>	-80 °C to 0 °C	0.03 °C	
	0 °C to 100 °C	0.04 °C	
	100 °C to 260 °C	0.05 °C	1
	260 °C to 300 °C	0.06 °C	
	300 °C to 400 °C	0.06 °C	1
	400 °C to 600 °C	0.07 °C	
	600 °C to 630 °C	0.19 °C	



### **Precision Measurements**

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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	-200 °C to -190 °C	0.2 °C	Fluke 5520A
	-190 °C to -80 °C	0.05 °C	Electrical Simulation of
Equipment used with RTD Pt 3916 100 FO	-80 °C to 0 °C	0.05 °C	RID Output GIDEP procedures
	0 °C to 100 °C	0.07 °C	OEM procedures
	100 °C to 260 °C	0.07 °C	-
	260 °C to 300 °C	0.08 °C	
	300 °C to 400 °C	0.09 °C	
	400 °C to 600 °C	0.1 °C	
	600 °C to 630 °C	0.2 °C	
Temperature Calibration,	-200 °C to -80 °C	0.06 °C	
Indication and Control	-80 °C to 0 °C	0.06 °C	
Equipment used with RTD Pt 3926, 100 O FO	0 °C to 100 °C	0.07 °C	
K1D1(3)20, 100 32	100 °C to 300 °C	0.09 °C	
	300 °C to 400 °C	0.09 °C	
	400 °C to 630 °C	0.11 °C	
Temperature calibration,	-80 °C to 0 °C	0.07 °C	
Indication and Control	0 °C to 100 °C	0.07 °C	
Equipment used with RTD Ni 385, 120 $\Omega$ F <sup>O</sup>	100 °C to 260 °C	0.12 °C	
Temperature calibration,	-100 °C to 260 °C	0.4 °C	
Indication and Control			
Equipment used with RTD Cii 427, 10 O FO			
Equipment to Measure	0 mV to 330 mV	20 μV/V + 1.8 μV	Fluke 5520A
DC Voltage <sup>FO</sup>	330 mV to 3.3 V	11 μV/V + 11 μV	QAI-EXX procedures
	3.3 V to 33 V	11 μV/V + 23 μV	OEM procedures
	33 V to 330 V	$18 \mu V/V + 1.1 m V$	
	330 V to 1 000 V	$18 \mu V/V + 4 m V$	
Equipment to Output	0 mV to 200 mV	6.3 μV/V + 0.5 μV	Fluke 8508A
DC Voltage <sup>FO</sup>	200 mV to 2 V	$3.7 \mu V/V + 0.3 \mu V$	QAI-EXX procedures
	2 V to 20 V	$3.7 \mu \text{V/V} + 1 \mu \text{V}$	OEM procedures
	20 V to 200 V	5.8 μV/V + 10 μV	
	200 V to 1 000 V	$5.9 \mu V/V + 0.1 mV$	
	1 kV to 10 kV	0.4  mV/V + 40  mV	Vitrek 4700 QAI-EXX procedures OEM procedures
	10 kV to 40 kV	27 mV/V + 0.1 V	Fluke 80K-40 with Fluke 87 V QAI-EXX procedures OEM procedures

This supplement is in conjunction with certificate #L21-77



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Electrical	1	T	
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	0 μA to 330 μA	120 µA/A + 16 nA	Fluke 5520A
DC Current <sup>FO</sup>	330 µA to 3.3 mA	78 μA/A + 60 nA	QAI-EXX procedures
	3.3 mA to 33 mA	78 μA/A + 0.5 μA	OEM procedures
	33 mA to 330 mA	78 μA/A + 10 μA	
	330 mA to 1.1 A	160 μA/A + 40 μA	
	1.1 A to 3 A	300 µA/A + 0.23 mA	
	3 A to 11 A	390 µA/A + 0.9 mA	
	11 A to 20.5 A	780 µA/A + 2.5 mA	
Equipment to Output	0 nA to 100 nA	43 μA/A + 48 pA	HP 3458A
DC Current <sup>FO</sup>	100 nA to 1 µA	32 μA/A + 48 pA	QAI-EXX procedures
	1 µA to 10 µA	30 µA/A + 0.12 nA	OEM procedures
	10 µA to 100 µA	30 µA/A + 0.96 nA	
	100 µA to 2 mA	14 μA/A + 4.1 nA	Fluke 8508A
	2 mA to 20 mA	15 μA/A + 41 nA	QAI-EXX procedures
	20 mA to 200 mA	52 μA/A + 0.81 μA	OEM procedures
	200 mA to 2 A	190 μA/A + 17 μA	
	2 A to 20 A	410 µA/A + 0.4 mA	
Equipment to Measure	$0 \Omega$ to $11 \Omega$	$32 \mu\Omega/\Omega + 0.8 \mathrm{m}\Omega$	Fluke 5520A
Resistance <sup>FO</sup>	11 Ω to 33 Ω	$24 \ \mu\Omega/\Omega + 1.3 \ m\Omega$	QAI-EXX procedures
	33 Ω to 110 Ω	$22 \ \mu\Omega/\Omega + 1.3 \ m\Omega$	OEM procedures
	110 $\Omega$ to 330 $\Omega$	$22 \ \mu\Omega/\Omega + 2.9 \ m\Omega$	
	330 $\Omega$ to 1.1 k $\Omega$	$22 \ \mu\Omega/\Omega + 7 \ m\Omega$	
	1.1 k $\Omega$ to 3.3 k $\Omega$	$22 \ \mu\Omega/\Omega + 42 \ m\Omega$	
	3.3 k $\Omega$ to 11 k $\Omega$	$22 \ \mu\Omega/\Omega + 0.12 \ \Omega$	
	11 k $\Omega$ to 33 k $\Omega$	$22 \ \mu\Omega/\Omega + 0.42 \ \Omega$	
	33 k $\Omega$ to 110 k $\Omega$	$22 \ \mu\Omega/\Omega + 1.2 \ \Omega$	
	110 k $\Omega$ to 330 k $\Omega$	$25 \ \mu\Omega/\Omega + 3.3 \ \Omega$	
	330 k $\Omega$ to 1.1 M $\Omega$	25 μΩ/Ω + 11 Ω	
	1.1 MΩ to 3.3 MΩ	47 μΩ/Ω + $48$ Ω	
	$3.3 \text{ M}\Omega$ to $11 \text{ M}\Omega$	110 μ $\Omega/\Omega$ + 0.27 k $\Omega$	
	11 MΩ to 33 MΩ	$200 \ \mu\Omega/\Omega + 3.2 \ k\Omega$	
	33 MΩ to 110 MΩ	390 μΩ/Ω + 19 kΩ	
	110 MΩ to 330 MΩ	$2.4 \text{ m}\Omega/\Omega + 0.11 \text{ M}\Omega$	
	330 M $\Omega$ to 1.1 G $\Omega$	$12 \text{ m}\Omega/\Omega + 1.1 \text{ M}\Omega$	

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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 Output	15 $\mu\Omega$ to 2 $\Omega$	$20 \ \mu\Omega/\Omega + 4 \ \mu\Omega$	Fluke 8508A
Resistance <sup>FO</sup>	2 Ω to 20 Ω	11 μ $\Omega$ / $\Omega$ + 15 μ $\Omega$	QAI-EXX procedures
	20 Ω to 200 Ω	8.5 μΩ/Ω + 51 μΩ	OEM procedures
	$200 \Omega$ to $2 k\Omega$	8.3 μΩ/Ω + 510 μΩ	
	$2 \text{ k}\Omega$ to $20 \text{ k}\Omega$	$8.2 \ \mu\Omega/\Omega + 5.1 \ m\Omega$	
	$20 \text{ k}\Omega$ to $200 \text{ k}\Omega$	8.6 μ $\Omega/\Omega$ + 51 m $\Omega$	
	$200 \text{ k}\Omega$ to $2 \text{ M}\Omega$	11 μΩ/Ω + 1 Ω	
	$2 \text{ M}\Omega$ to $20 \text{ M}\Omega$	$20 \ \mu\Omega/\Omega + 10 \ \Omega$	
	20 MΩ to 200 MΩ	66 μΩ/Ω + 1 kΩ	
	200 MΩ to 2 GΩ	190 μ $\Omega/\Omega$ + 0.1 M $\Omega$	
	$2 G\Omega$ to $20 G\Omega$	$1.6 \text{ m}\Omega/\Omega + 1 \text{ M}\Omega$	
Equipment to Measure	0.19 nF to 0.4 nF	3.9 mF/F + 8.1 pF	Fluke 5520A
Capacitance FO	0.4 nF to 1.1 nF	3.9 mF/F + 8.2 pF	QAI-EXX procedures
	1.1 nF to 3.3 nF	3.9 mF/F + 8.7 pF	OEM procedures
	3.3 nF to 11 nF	2 mF/F + 11 pF	
	11 nF to 33 nF	2 mF/F + 81 pF	
	33 nF to 110 nF	2 mF/F + 0.11 nF	
	110 nF to 330 nF	2 mF/F + 0.32 nF	
	330 nF to 1.1 µF	2 mF/F + 1.1 nF	
	1.1 μF to 3.3 μF	2 mF/F + 3.2 nF	
	3.3 µF to 11 µF	2 mF/F + 13 nF	
	11 µF to 33 µF	3.2 mF/F + 37 nF	
	33 µF to 110 µF	3.5 mF/F + 0.16 μF	
	110 µF to 330 µF	3.5 mF/F + 0.45 μF	
	330 µF to 1.1 mF	3.5 mF/F + 1.1 μF	
	1.1 mF to 3.3 mF	3.5 mF/F + 2.6 μF	
	3.3 mF to 11 mF	3.5 mF/F + 8.3 μF	
	11 mF to 33 mF	5.9 mF/F + 25 μF	
	33 mF to 110 mF	8.6 mF/F + 90 μF	



**Precision Measurements** 

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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 Output	1 pF to 10 pF	1 mF/F + 7.8 fF	Fluke PM6304
Capacitance FO	10 pF to 100 pF	1 mF/F + 95 fF	QAI-EXX procedures
	0.1 nF to 1 nF	1 mF/F + 0.6 pF	OEM procedures
	1 nF to 10 nF	1 mF/F + 7.7 pF	
	10 nF to 100 nF	1 mF/F + 77 pF	
	0.1 µF to 1 µF	1 mF/F + 1.3 nF	
	1 μF to 10 μF	1 mF/F + 13 nF	
	10 μF to 100 μF	1 mF/F + 0.13 μF	
	0.1 mF to 1 mF	1 mF/F + 1.3 μF	
Equipment to Output	0.1 mH to 1 mH	1 mH/H + 1.5 μH	-
Inductance FO	1 mH to 10 mH	1 mH/H + 15 μH	
	10 H to 100 H	1 mH/H + 0.15 mH	
	0.1 H to 1 H	1 mH/H + 1.4 mH	
	1 H to 10 H	1 mH/H + 15 mH	
	10 H to 100 H	1 mH/H + 0.17 H	-
	0.1 H to 1 kH	5 mH/H + 1.9 H	
Equipment to Output AC Voltage (at the listed free	equencies) <sup>FO</sup>		HP 3458A OAI-EXX procedures
1 Hz to 40 Hz	0.1 mV to 10 mV	350 μV/V + 3.5 μV	OEM procedures
40 Hz to 1 kHz	0.1 mV to 10 mV	$240 \mu V/V + 1.3 \mu V$	-
1 kHz to 20 kHz	0.1 mV to 10 mV	350 μV/V + 1.3 μV	-
20 kHz to 50 kHz	0.1 mV to 10 mV	1.2 mV/V + 1.3 μV	
50 kHz to 100 kHz	0.1 mV to 10 mV	5.8 mV/V + 16 μV	
100 kHz to 300 kHz	0.1 mV to 10 mV	47 mV/V + 25 μV	
Equipment to Output	1		
AC Voltage (at the listed fre	equencies) <sup>FO</sup>		_
1 Hz to 40 Hz	10 mV to 100 mV	$81 \mu V/V + 4.8 \mu V$	_
40 Hz to 1 kHz	10 mV to 100 mV	$81 \mu V/V + 2.6 \mu V$	
1 kHz to 20 kHz	10 mV to 100 mV	$170 \mu V/V + 2.5 \mu V$	
20 kHz to 50 kHz	10 mV to 100 mV	350 μV/V + 2.5 μV	
50 kHz to 100 kHz	10 mV to 100 mV	930 μV/V + 2.5 μV	
100 kHz to 300 kHz	10 mV to 100 mV	$3.5 \text{ mV/V} + 12 \mu \text{V}$	
300 kHz to 1 MHz	10 mV to 100 mV	$12 \text{ mV/V} + 390 \mu \text{V}$	



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Equipment to Output	HP 3458A		
AC Voltage (at the listed fre	equencies) FO		QAI-EXX procedures
1 Hz to 40 Hz	100 mV to 1 V	$81 \mu V/V + 47 \mu V$	OEM procedures
40 Hz to 1 kHz	100 mV to 1 V	81 μV/V + 24 μV	
1 kHz to 20 kHz	100 mV to 1 V	170 μV/V + 77 μV	
20 kHz to 50 kHz	100 mV to 1 V	$350 \mu V/V + 140 \mu V$	
50 kHz to 100 kHz	100 mV to 1 V	930 μV/V + 300 μV	
100 kHz to 300 kHz	100 mV to 1 V	$3.5 \text{ mV/V} + 540 \mu \text{V}$	
300 kHz to 1 MHz	100 mV to 1 V	12 mV/V + 1.4 mV	
Equipment to Output AC Voltage (at the listed free	equencies) <sup>FO</sup>		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	200 mV to 2 V	160 μV/V + 121 μV	OEM procedures
10 Hz to 40 Hz	200 mV to 2 V	130 μV/V + 21 μV	
40 Hz to 100 Hz	200 mV to 2 V	110 μV/V + 21 μV	
100 Hz to 2 kHz	200 mV to 2 V	$80 \mu V/V + 21 \mu V$	
2 kHz to 10 kHz	200 mV to 2 V	$120 \mu V/V + 21 \mu V$	
10 kHz to 30 kHz	200 mV to 2 V	$230 \mu V/V + 41 \mu V$	
30 kHz to 100 kHz	200 mV to 2 V	$600 \mu V/V + 210 \mu V$	
100 kHz to 300 kHz	200 mV to 2 V	3.1  mV/V + 2.1  mV	
300 kHz to 1 MHz	200 mV to 2 V	11  mV/V + 20  mV	
Equipment to Output AC Voltage (at the listed free	equencies) <sup>FO</sup>		HP 3458A QAI-EXX procedures
1 Hz to 40 Hz	0.1 V to 1 V	$70 \mu V/V + 40 \mu V$	OEM procedures
40 Hz to 1 kHz	0.1 V to 1 V	$70 \mu V/V + 20 \mu V$	
1 kHz to 20 kHz	0.1 V to 1 V	140 μV/V + 20 μV	
20 kHz to 50 kHz	0.1 V to 1 V	$300 \mu V/V + 20 \mu V$	
50 kHz to 100 kHz	0.1 V to 1 V	$800 \ \mu V/V + 20 \ \mu V$	
100 kHz to 300 kHz	0.1 V to 1 V	3  mV/V + 0.1  mV	
300 kHz to 1 MHz	0.1 V to 1 V	10  mV/V + 0.1  mV	
1 MHz to 2 MHz	0.1 V to 1 V	15 mV/V + 0.1 mV	



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Electrical	DANCE OF NOT STATE		
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Equipment to Output	·		HP 3458A
AC Voltage (at the listed fre	equencies) <sup>FO</sup>		QAI-EXX procedures
1 Hz to 40 Hz	1 V to 10 V	$70 \mu V/V + 400 \mu V$	OEM procedures
40 Hz to 1 kHz	1 V to 10 V	$70 \mu V/V + 200 \mu V$	
1 kHz to 20 kHz	1 V to 10 V	$140 \ \mu V/V + 200 \ \mu V$	
20 kHz to 50 kHz	1 V to 10 V	$300 \mu V/V + 200 \mu V$	
50 kHz to 100 kHz	1 V to 10 V	$800 \ \mu V/V + 200 \ \mu V$	
100 kHz to 300 kHz	1 V to 10 V	3 mV/V + 1 mV	
300 kHz to 1 MHz	1 V to 10 V	10 mV/V + 1 mV	
1 MHz to 2 MHz	1 V to 10 V	15 mV/V + 1 mV	7
Equipment to Output AC Voltage (at the listed free	equencies) <sup>FO</sup>		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	2 V to 20 V	$160 \mu V/V + 1.3 m V$	OEM procedures
10 Hz to 40 Hz	2 V to 20 V	$130 \mu V/V + 210 \mu V$	
40 Hz to 100 Hz	2 V to 20 V	$97 \mu V/V + 210 \mu V$	
100 Hz to 2 kHz	2 V to 20 V	81 μV/V + 210 μV	
2 kHz to 10 kHz	2 V to 20 V	120 μV/V + 210 μV	
10 kHz to 30 kHz	2 V to 20 V	230 μV/V + 410 μV	
30 kHz to 100 kHz	2 V to 20 V	580 μV/V + 2.1 mV	
100 kHz to 300 kHz	2 V to 20 V	3.1 mV/V + 20 mV	
300 kHz to 1 MHz	2 V to 20 V	11 mV/V + 0.2 V	
Equipment to Output AC Voltage (at the listed free	equencies) FO		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	20 V to 200 V	$160 \mu V/V + 13 m V$	OEM procedures
10 Hz to 40 Hz	20 V to 200 V	130 μV/V + 2.1 mV	-
40 Hz to 100 Hz	20 V to 200 V	$97 \mu V/V + 2.1 mV$	-
100 Hz to 2 kHz	20 V to 200 V	$79 \mu V/V + 2.1 mV$	
2 kHz to 10 kHz	20 V to 200 V	$120 \mu V/V + 2.1 mV$	
10 kHz to 30 kHz	20 V to 200 V	230 µV/V + 4.1 mV	
30 kHz to 100 kHz	20 V to 200 V	$580 \mu V/V + 21 m V$	
100 kHz to 300 kHz	20 V to 200 V	3.1 mV/V + 200 mV	
300 kHz to 1 MHz	20 V to 200 V	11 mV/V + 2 V	



## **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVIC SIZE AS APPROPRIATE	E CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Output	50		HP 3458A
AC Voltage (at the listed fre	equencies) <sup>FO</sup>		QAI-EXX procedures
1 Hz to 40 Hz	10 V to 100 V	0.2  mV/V + 4  mV	OEM procedures
40 Hz to 1 kHz	10 V to 100 V	0.2  mV/V + 2  mV	
1 kHz to 20 kHz	10 V to 100 V	0.2  mV/V + 2  mV	
20 kHz to 50 kHz	10 V to 100 V	0.35  mV/V + 2  mV	
50 kHz to 100 kHz	10 V to 100 V	1.2  mV/V + 2  mV	
100 kHz to 300 kHz	10 V to 100 V	4  mV/V + 10  mV	
300 kHz to 1 MHz	10 V to 100 V	15 mV/V + 10 mV	
Equipment to Output AC Voltage (at the listed fre	equencies) <sup>FO</sup>		
1 Hz to 40 Hz	100 V to 1 000 V	0.4  mV/V + 40  mV	
40 Hz to 1 kHz	100 V to 1 000 V	0.4 mV/V + 20 mV	_
1 kHz to 20 kHz	100 V to 1 000 V	0.6 mV/V + 0.2 V	
20 kHz to 50 kHz	100 V to 1 000 V	1.2  mV/V + 20  mV	
50 kHz to 100 kHz	100 V to 1 000 V	3  mV/V + 20  mV	
Equipment to Output AC Voltage (at the listed free	equencies) <sup>FO</sup>		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	200 V to 1 000 V	1.6 mV/V + 71 mV	OEM procedures
10 Hz to 40 Hz	200 V to 1 000 V	$130 \mu V/V + 21 m V$	
40 Hz to 10 kHz	200 V to 1 000 V	170 μV/V + 21 mV	
10 kHz to 30 kHz	200 V to 1 000 V	$400 \ \mu V/V + 41 \ mV$	
30 kHz to 100 kHz	200 V to 1 000 V	670 μV/V + 0.2 V	
Equipment to Output	50		Vitrek 4700
AC Voltage (at the listed fre	equencies) <sup>FO</sup>		QAI-EXX procedures
10 mHz to 10 Hz	1 kV to 10 kV	1.4  mV/V + 0.2  V	OEM procedures
10 Hz to 65 Hz	1 kV to 10 kV	1.4 mV/V + 0.2 V	
65 Hz to 200 Hz	1 kV to 10 kV	1.4 mV/V + 0.2 V	
200 Hz to 450 Hz	1 kV to 10 kV	4.7 mV/V + 0.2 V	



## **Precision Measurements**

20 Hagerty Road, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVIC SIZE AS APPROPRIATE	E CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	CALIBRATION EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Output		HP 3458A	
AC Current (at the listed fre	1  uncles	$4 \pm 1/4 \pm 30$ mÅ	QAI-EXX procedures
20 H= 40 45 H=	1 μΑ το 100 μΑ	$+\mu A/A + 30 \pi A$	
20 HZ 10 45 HZ	1 μΑ το 100 μΑ	1.5 μA/A + 30 hA	_
45 Hz to 100 Hz	1 μA to 100 μA	$0.6 \mu A/A + 30 nA$	_
100 Hz to 1 kHz	1 μA to 100 μA	0.6 μA/A + 30 nA	
Equipment to Output AC Current (at the listed fre	quencies) <sup>FO</sup>		Agilent 34401A QAI-EXX procedures
3 Hz to 5 kHz	100 µA to 3 A	2 mA/A + 1.2 mA	OEM procedures
5 kHz to 10 kHz	100 µA to 3 A	2 mA/A + 1.2 mA	-
Equipment to Output AC Current (at the listed fre	quencies) <sup>FO</sup>		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	20 µA to 200 µA	510 μA/A + 20 nA	OEM procedures
10 Hz to 10 kHz	20 µA to 200 µA	560 μA/A + 20 nA	-
10 kHz to 30 kHz	20 µA to 200 µA	750 μA/A + 20 nA	
30 kHz to 100 kHz	20 µA to 200 µA	4.1 mA/A + 20 nA	
Equipment to Output AC Current (at the listed fre	quencies) <sup>FO</sup>		
1 Hz to 10 Hz	200 µA to 2 mA	340 μA/A + 0.2 μA	
10 Hz to 10 kHz	200 µA to 2 mA	320 μA/A + 0.2 μA	
10 kHz to 30 kHz	200 µA to 2 mA	720 μΑ/Α + 0.2 μΑ	
30 kHz to 100 kHz	200 µA to 2 mA	4.1 mA/A + 0.2 μA	
Equipment to Output AC Current (at the listed fre	quencies) <sup>FO</sup>		HP 3458A QAI-EXX procedures
10 Hz to 20 Hz	0.1 mA to 1 mA	4 mA/A + 0.2 μA	OEM procedures
20 Hz to 45 Hz	0.1 mA to 1 mA	1.5 mA/A + 0.2 μA	
45 Hz to 100 Hz	0.1 mA to 1 mA	0.6 mA/A + 0.2 μA	
100 Hz to 5 kHz	0.1 mA to 1 mA	0.3 mA/A + 0.2 μA	
5 kHz to 20 kHz	0.1 mA to 1 mA	0.6 mA/A + 0.2 μA	
20 kHz to 50 kHz	0.1 mA to 1 mA	4 mA/A + 0.4 µA	
50 kHz to 100 kHz	0.1 mA to 1 mA	5.5 mA/A + 1.5 μA	



**Precision Measurements** 

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

Electrical MEASURED INSTRUMENT	RANGE OR NOMINAL	CALIBRATION AND	CALIBRATION
QUANTITY OR GAUGE	DEVICE SIZE AS APPROPRIATE	MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)	EQUIPMENT AND REFERENCE STANDARDS USED
Equipment to Output AC Cu	urrent		HP 3458A
(at the listed frequencies) FO	1  m  A to $10  m  A$	$4 m \Delta / \Delta + 2 m \Delta$	QAI-EXX procedures
		$4 \operatorname{IIIA/A} + 2 \mu A$	OEM procedures
20 HZ to 45 HZ	1 mA to 10 mA	$1.5 \text{ mA/A} + 2 \mu \text{A}$	
45 Hz to 100 Hz	1 mA to 10 mA	$0.6 \text{ mA/A} + 2 \mu \text{A}$	
100 Hz to 5 kHz	1 mA to 10 mA	0.3 mA/A + 2 μA	
5 kHz to 20 kHz	1 mA to 10 mA	0.6 mA/A + 2 μA	
20 kHz to 50 kHz	1 mA to 10 mA	4 mA/A + 4 μA	
50 kHz to 100 kHz	1 mA to 10 mA	5.5 mA/A + 15 μA	
Equipment to Output AC Cu (at the listed frequencies) <sup>FO</sup>	urrent		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	2 mA to 20 mA	340 μA/A + 2 μA	OEM procedures
10 Hz to 10 kHz	2 mA to 20 mA	340 μA/A + 2 μA	
10 kHz to 30 kHz	2 mA to 20 mA	730 μΑ/Α + 2 μΑ	
30 kHz to 100 kHz	2 mA to 20 mA	4.1 mA/A + 2 μA	
Equipment to Output AC Current (at the listed frequencies) <sup>FO</sup>			HP 3458A QAI-EXX procedures
10 Hz to 20 Hz	10 mA to 100 mA	4 mA/A + 20 μA	OEM procedures
20 Hz to 45 Hz	10 mA to 100 mA	1.5 mA/A + 20 μA	
45 Hz to 100 Hz	10 mA to 100 mA	0.6 mA/A + 20 μA	
100 Hz to 5 kHz	10 mA to 100 mA	0.3 mA/A + 20 μA	
5 kHz to 20 kHz	10 mA to 100 mA	0.6 mA/A + 20 μA	
20 kHz to 50 kHz	10 mA to 100 mA	4 mA/A + 40 μA	
50 kHz to 100 kHz	10 mA to 100 mA	5.5 mA/A + 150 μA	
Equipment to Output AC Cu (at the listed frequencies) <sup>FO</sup>	irrent		Fluke 8508A QAI-EXX procedures
1 Hz to 10 Hz	20 mA to 200 mA	340 μA/A + 20 μA	OEM procedures
10 Hz to 10 kHz	20 mA to 200 mA	320 μA/A + 20 μA	
10 kHz to 30 kHz	20 mA to 200 mA	640 μA/A + 20 μA	
Equipment to Output AC Cu (at the listed frequencies) <sup>FO</sup>	irrent		
10 Hz to 2 kHz	200 mA to 2 A	630 µA/A + 0.2 mA	
2 kHz to 10 kHz	200 mA to 2 A	940 µA/A + 0.2 mA	
10 kHz to 30 kHz	200 mA to 2 A	3.1 mA/A + 0.2 mA	1



## **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

MEASURED INSTRUMENT, QUANTITY OR GAUGE	RANGE OR NOMINAL DEVICE SIZE AS APPROPRIATE	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED	CALIBRATION EQUIPMENT AND REFERENCE
		AS AN UNCERTAINTY (±)	STANDARDS USED
Equipment to Output AC Curre	ent		HP 3458A
(at the listed frequencies) <sup>10</sup>	OFM procedures		
		$4 \operatorname{IIIA/A} + 0.2 \operatorname{IIIA}$	OEWI procedures
20 Hz to 45 Hz	0.1 A to 1 A	1.6  mA/A + 0.2  mA	
45 Hz to 100 Hz	0.1 A to 1 A	0.8 mA/A + 0.2 mA	
100 Hz to 5 kHz	0.1 A to 1 A	1  mA/A + 0.2  mA	
5 kHz to 20 kHz	0.1 A to 1 A	3 mA/A + 0.2 mA	
20 kHz to 50 kHz	0.1 A to 1 A	10 mA/A + 0.4 mA	
Equipment to Output AC Curre (at the listed frequencies) <sup>FO</sup>	ent		Fluke 45 QAI-EXX procedures
20 Hz to 50 Hz	1 A to 10 A	10 mA/A + 10 mA	OEM procedures
50 Hz to 2 kHz	1 A to 10 A	20 mA/A + 10 mA	
Equipment to Output AC Curre (at the listed frequencies) <sup>FO</sup>	Fluke 8508A OAI-EXX procedures		
10 Hz to 2 kHz	2 A to 20 A	830 μA/A + 2 mA	OEM procedures
2 kHz to 10 kHz	2 A to 20 A	2.7 mA/A + 2 mA	
Equipment to Measure AC Cur (at the listed frequencies) <sup>FO</sup>		Fluke 5520A QAI-EXX procedures	
10 Hz to 20 Hz	29 µA to 330 µA	1.6 mA/A + 90 nA	OEM procedures
20 Hz to 45 Hz	29 µA to 330 µA	1.2 mA/A + 90 nA	•
45 Hz to 1 kHz	29 µA to 330 µA	980 µA/A + 90 nA	
1 kHz to 5 kHz	29 µA to 330 µA	2.4 mA/A + 140 nA	
5 kHz to 10 kHz	29 µA to 330 µA	6.3 mA/A + 180 nA	
10 kHz to 30 kHz	29 µA to 330 µA	13 mA/A + 370 nA	
Equipment to Measure AC Cur (at the listed frequencies) <sup>FO</sup>			
10 Hz to 20 Hz	330 µA to 3.3 mA	1.6 mA/A + 0.4 μA	
20 Hz to 45 Hz	330 µA to 3.3 mA	980 μA/A + 0.4 μA	
45 Hz to 1 kHz	330 µA to 3.3 mA	780 μA/A + 0.3 μA	
1 kHz to 5 kHz	330 µA to 3.3 mA	1.6 mA/A + 0.4 μA	
5 kHz to 10 kHz	330 µA to 3.3 mA	3.9 mA/A + 0.5 μA	
10 kHz to 30 kHz	330 µA to 3.3 mA	7.8 mA/A + 0.8 μA	1



### **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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 AC Cu	Equipment to Measure AC Current			
(at the listed frequencies) <sup>ro</sup>	2.2		QAI-EXX procedures	
10 Hz to 20 Hz	3.3 mA to 33 mA	$1.4 \text{ mA/A} + 6 \mu \text{A}$	OEM procedures	
20 Hz to 45 Hz	3.3 mA to 33 mA	0.7 mA/A + 6 μA		
45 Hz to 1 kHz	3.3 mA to 33 mA	320 µA/A + 4 µA		
1 kHz to 5 kHz	3.3 mA to 33 mA	630 μA/A + 4 μA		
5 kHz to 10 kHz	3.3 mA to 33 mA	1.6 mA/A + 5 μA		
10 kHz to 30 kHz	3.3 mA to 33 mA	3.2 mA/A + 7 μA		
Equipment to Measure AC Cu (at the listed frequencies) <sup>FO</sup>	rrent	• •		
10 Hz to 20 Hz	33 mA to 330 mA	1.4 mA/A + 50 μA		
20 Hz to 45 Hz	33 mA to 330 mA	0.7 mA/A + 50 μA		
45 Hz to 1 kHz	33 mA to 330 mA	320 mA/A + 30 μA		
1 kHz to 5 kHz	33 mA to 330 mA	770 mA/A + 50 μA	_	
5 kHz to 10 kHz	33 mA to 330 mA	1.6 mA/A + 90 μA		
10 kHz to 30 kHz	33 mA to 330 mA	2.4 mA/A + 170 μA		
Equipment to Measure AC Cu (at the listed frequencies) <sup>FO</sup>	rrent			
10 Hz to 45 Hz	330 mA to 1.1 A	1.4 mA/A + 170 μA		
45 Hz to 1 kHz	330 mA to 1.1 A	390 μA/A + 120 μA		
1 kHz to 5 kHz	330 mA to 1.1 A	4.7 μΑ/Α + 820 μΑ		
5 kHz to 10 kHz	330 mA to 1.1 A	20 mA/A + 4 mA		
Equipment to Measure AC Cu (at the listed frequencies) <sup>FO</sup>	rrent			
10 Hz to 45 Hz	1.1 A to 3 A	1.4 mA/A + 450 μA		
45 Hz to 1 kHz	1.1 A to 3 A	470 μA/A + 280 μA		
1 kHz to 5 kHz	1.1 A to 3 A	4.7 μA/A + 830 μA		
5 kHz to 10 kHz	1.1 A to 3 A	20 mA/A + 3.9 mA		
Equipment to Measure AC Cu (at the listed frequencies) <sup>FO</sup>	rrent	•		
45 Hz to 100 Hz	3 A to 11 A	470 μA/A + 2.5 mA		
100 Hz to 1 kHz	3 A to 11 A	780 µA/A + 2 mA		
1 kHz to 5 kHz	3 A to 11 A	24 mA/A + 7.3 mA		



## **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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 AC C	Fluke 5520A		
(at the listed frequencies) FO	1	1	QAI-EXX procedures
45 Hz to 100 Hz	11 A to 20 A	940 µA/A + 5.9 mA	OEM procedures
100 Hz to 1 kHz	11 A to 20 A	1.2 mA/A + 5.9 mA	
1 kHz to 5 kHz	11 A to 20 A	24 mA/A + 28 mA	
Equipment to Measure	monoios) FO		HP 3325B opt 001
RF Power (at the listed freq	4  nW to $100  mW$	48  mW/W	GIDEP procedures
100 kHz to 10 MHz	4  nW to $100  mW$	150 mW/W	
Fauinment to Measure REP	Power	150 11 107 10	Agilent F8257D
(at the listed frequencies) $^{FO}$	ower		Opt 1E1, 532, UNT
10 MHz to 2 GHz	1 pW to 10 mW	210 mW/W	GIDEP procedures
2 GHz to 20 GHz	100 µW to 100 mW	210 mW/W	
	100 pW to 100 µW	231 mW/W	
	1 pW to 100 pW	260 mW/W	
20 GHz to 31.8 GHz	100 pW to 100 mW	260 mW/W	
	1 pW to 100 pW	590 mW/W	
Equipment to Output RF Po	Agilent E4416A		
(at the listed frequencies) FO			Agilent N8482A
100 kHz to 26.5 GHz	10 µW to 1 W	35 mW/W	HP N8481A
10 MHz to 18 GHz	100 pW to 10 µW	46 mW/W	HP 8485A
			GIDEP procedures
			I I I I I I I I I I I I I I I I I I I
Equipment to Output RF Att	tenuation - TRFL		HP 8902A
(at the listed frequencies) <sup>10</sup>	100W to 1W	12	GIDEP procedures
2.5 MHZ to 1.3 GHZ (200 Hz BW) <sup>FO</sup>	$100 \mu$ W to 1 mW	12 mW/W	•
	$\frac{10\mu\text{W}}{10\mu\text{W}} = \frac{10\mu\text{W}}{10\mu\text{W}}$	1/ mw/w	•
	$1 \mu w$ to $10 \mu w$	21 mW/W	-
	$100 \text{ nW}$ to $1 \mu \text{W}$	26 mW/W	
	10 nW to 100 nW	40 mW/W	
	1 nW to 10 nW	45 mW/W	
	100 pW to 1 nW	50 mW/W	
	10 pW to 100 pW	55 mW/W	
	1 pW to 10 pW	70 mW/W	
	100 fW to 1 pW	74 mW/W	



## **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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
1.3 GHz to 26.5 GHz	100 µW to 1 mW	12 mW/W	HP 8902A
(200 Hz BW) <sup>FO</sup>	10 μW to 100 μW	17 mW/W	HP 11793A
	1 μW to 10 μW	21 mW/W	GIDEP procedures
	100 nW to 1 µW	26 mW/W	
	10 nW to 100 nW	40 mW/W	
	1 nW to 10 nW	45 mW/W	
	100 pW to 1 nW	50 mW/W	
	10 pW to 100 pW	55 mW/W	
	1 pW to 10 pW	115 mW/W	
	100 fW to 1 pW	120 mW/W	
Oscilloscopes Leveled Sine Wave			Fluke 5520A-SC1100 OAI-E04
Amplitude 5 mVp-p to 5 Vp-p <sup>FO</sup>	50 kHz	20 mV/V + 0.3 mV	
Flatness	50 kHz to 100 MHz	15 mV/V + 0.1 mV	
(relative to 50 kHz,	100 MHz to 300 MHz	20  mV/V + 0.1  mV	
5 mVn-n to 5 Vn-n <sup>FO</sup>	300 MHz to 600 MHz	40 mV/V + 0.1 mV	
5 11 ( ) ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) (	600 MHz to 1.1 GHz	76 mV/V + 440 μV	
Square, Sine & Triangle Wa Frequency Range 10 Hz to 1	ve 00 kHz <sup>FO</sup>		
Terminated into 1 M $\Omega$	1.8 mV to 5.5 Vp-p	30  mV/V + 0.1  mV	
Terminated into 50 Ω	1.8 mV to 2.5 Vp-p	30  mV/V + 0.1  mV	
Time Marker Output	2 ns to 20 ms	2.5 μs/s	
Equipment to Measure AC V (at the listed frequencies) <sup>FO</sup>	Fluke 5520A GIDEP procedures		
10 Hz to 45 Hz	1 mV to 33 mV	$630 \mu V/V + 10 \mu V$	OEM procedures
45 Hz to 10 kHz	1 mV to 33 mV	120 μV/V + 6 μV	
10 kHz to 20 kHz	1 mV to 33 mV	160 μV/V + 6 μV	
20 kHz to 50 kHz	1 mV to 33 mV	780 μV/V + 8 μV	
50 kHz to 100 kHz	1 mV to 33 mV	2.8 mV/V + 14 μV	
100 kHz to 500 kHz	1 mV to 33 mV	6.3 mV/V + 48 μV	



### **Precision Measurements**

20 Hagerty Boulevard, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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 AC	Voltage		Fluke 5520A
10 Hz to 45 Hz	33 mV to 330 mV	240  uV/V + 59  uV	OFM procedures
45 Hz to 10 kHz	33 mV to 330 mV	$120 \mu V/V + 13 \mu V$	
10 kHz to 20 kHz	33 mV to 330 mV	$130 \mu V/V + 13 \mu V$	
20 kHz to 50 kHz	33 mV to 330 mV	$280 \mu \text{V/V} + 18 \mu \text{V}$	
50 kHz to 100 kHz	33 mV to 330 mV	$630 \mu \text{V/V} + 35 \mu \text{V}$	
100 kHz to 500 kHz	33 mV to 330 mV	$1.6 \text{ mV/V} + 110 \mu \text{V}$	
Equipment to Measure AC V (at the listed frequencies) <sup>FO</sup>	Voltage		
10 Hz to 45 Hz	330 mV to 3.3 V	$240 \mu V/V + 550 \mu V$	
45 Hz to 10kHz	330 mV to 3.3 V	120 μV/V + 90 μV	
10 kHz to 20 kHz	330 mV to 3.3 V	150 μV/V + 90 μV	
20 kHz to 50 kHz	330 mV to 3.3 V	240 μV/V + 170 μV	
50 kHz to 100kHz	330 mV to 3.3 V	550 μV/V + 270 μV	
100 kHz to 500kHz	330 mV to 3.3 V	1.9 mV/V + 1.3 mV	
Equipment to Measure AC V (at the listed frequencies) <sup>FO</sup>	Voltage		
10 Hz to 45 Hz	3.3 V to 33 V	$240 \mu V/V + 5.5 mV$	
45 Hz to 10 kHz	3.3 V to 33 V	$120 \mu V/V + 1 mV$	
10 kHz to 20 kHz	3.3 V to 33 V	$190 \mu V/V + 1 mV$	
20 kHz to 50 kHz	3.3 V to 33 V	280 μV/V + 1.7 mV	
50 kHz to 100 kHz	3.3 V to 33 V	0.7  mV/V + 3  mV	
Equipment to Measure AC (at the listed frequencies) FO	Voltage		
45 Hz to 1 kHz	33 V to 330 V	$150 \mu V/V + 12 m V$	
1 kHz to 10 kHz	33 V to 330 V	160 μV/V + 13 mV	
10 kHz to 20 kHz	33 V to 330 V	0.2 mV/V + 13 mV	
20 kHz to 50 kHz	33 V to 330 V	$240 \mu V/V + 35 mV$	
50 kHz to 100 kHz	33 V to 330 V	1.6 mV/V + 144 mV	
Equipment to Measure AC V (at the listed frequencies) <sup>FO</sup>	Voltage		
45 Hz to 1 kHz	330 V to 1 020 V	$240 \mu V/V + 40 m V$	
1 kHz to 5 kHz	330 V to 1 020 V	$200 \mu V/V + 40 mV$	
5 kHz to 10 kHz	330 V to 1 020 V	$240 \mu V/V + 40 mV$	



## **Precision Measurements**

20 Hagerty Road, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

Mass, Force and Weighin	g 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
Scales and Balances FO	1 mg to 500 mg	5.8 μg/g + 5.9 μg	Class 1 Weights
	1 g to 1 kg	2.1 μg/g + 64 μg	QAI-A04
	1 kg to 10 kg	3.3 μg/g + 23 mg	
Load Cells/Force Gauges FO	1 lbf to 600 lbf	0.001 3 % of reading + 0.006 6 lbf	Class F Weights QAI-M11
Load Cells <sup>FO</sup>	500 N to 5 000 N	2.4 mN/N	Deadweights Class F
(Tension, Compression)	200 N to 2 N	5 mN/N	QAI-M11
	20 N to 1 779 N	5 mN/N	
Weights <sup>F</sup>	1 mg to 500 mg	3.4 µg	Class 0 Weights
	500 mg to 5 g	3.4 µg	Sartorius
	10 g	6.8 μg	CCE1004
	20 g	8.7 µg	OIML R111 ABBA
	50 g	16 µg	
	100 g	31 µg	
	200 g	150 µg	
	500 g	220 µg	
	1 kg	330 µg	





## **Precision Measurements**

20 Hagerty Road, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

Mechanical			1
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
Pressure <sup>FO</sup>	-15 psig to 25 psig	0.008 % of reading + 0.001 6 psig	Ruska 7250-xi
	25 psig to 500 psig	0.01 % of reading + 0.000 9 psig	QAI-P01
	0 psia to 40 psia	0.008 % of reading + 0.001 6 psia	
	40 psia to 515 psia	0.01 % of reading + 0.000 9 psia	
	100 psig to 2 000 psig	0.008 % of reading + 0.064 psig	Ruska 7250 QAI-P01
Pressure <sup>FO</sup>	200 psig to 10 000 psig	0.000 83 % of reading + 0.006 psig	GE 3100 DWT QAI-P01
	-1 inH <sub>2</sub> O to 1 inH <sub>2</sub> O	0.001 6 inH <sub>2</sub> O	Additel ADT761-LLP
	-10 inH <sub>2</sub> O to 10 inH <sub>2</sub> O	0.012 inH <sub>2</sub> O	QAI-P01
Torque Transducers FO	1 lbf·in to 100 lbf·in	0.011 % of reading +0.000 58 lbf·in	Class F Weights/Torque
	0.2 lbf·ft to 1 000 lbf·ft	0.011 % of reading + 0.005 8 lbf·ft	Arm NAVAIR 17-20MU- 52
Torque <sup>FO</sup>	2 ozf·in to 20 ozf·in	0.63 % of reading + 0.001 ozf·in	Mountz BMX20Z QAI –M04
	1 lbf·in to 10 lbf·in	0.63 % of reading + 0.001 lbf·in	Mountz BMX10i QAI –M04
	25 lbf·in to 250 lbf·in	0.6 % of reading + 0.01 lbf $\cdot$ in	Mountz BMX250i QAI –M04
	10 lbf·ft to 100 lbf·ft	0.63 % of reading + 0.005 8 lbf · ft	Mountz BMX100F QAI –M04
	25 lbf·ft to 250 lbf·ft	0.7 % of reading + 0.01 lbf·ft	Mountz BMX 250F QAI –M04
Torque <sup>F</sup>	10 lbf·in to 100 lbf·in	0.12 % of reading + 0.02 lbf·in	AKO TDS
_	100 lbf·ft to 1 000 lbf·ft	0.12 % of reading + 0.2 lbf ft	QAI –M04
Mass Flow, Liquids <sup>FO</sup>	0.3 kg/m to 1 000 kg/m	0.05 % of reading + 0.005 8 kg/min	Rosemount D100 Flow Sensor Endress Hauser 83F
Gas Flow <sup>F</sup>	1 SCCM to 10 SCCM	0.4 % of reading + 0.000 58 SCCM	MolBloc System
	10 SCCM to 100 SCCM	0.4 % of reading + 0.005 8 SCCM	GIDEP Procedures
	100 SCCM to 1 000 SCCM	0.4 % of reading + 0.058 SCCM	OEM Procedures
	1 SLPM to 10 SLPM	0.4 % of reading + 0.58 SCCM	1
	2.5 SLPM to 25 SLPM	0.47 % of reading + 5.8 SCCM	
	10 SLPM to 100 SLPM	0.5 % of reading + 5.8 SCCM	
	50 SLPM to 500 SLPM	0.47 % of reading + 15 SCCM	1



## **Precision Measurements**

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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	-196 °C	0.04 °C	Kaye IRTD
measurement with RTD FO			Liquid Nitrogen
	-80 °C	0.04 °C	Dry Ice
	-40 °C to 125 °C	0.04 °C	CALTO1
	125 °C to 300 °C	0.04 °C	
Relative Humidity FO	0 % RH to 25 % RH	1.3 % RH	Edgetech RH-Cal
	25 % RH to 75 % RH	0.77 % RH	QAI-T08
	75 % RH to 95 % RH	1.3 % RH	
Liquid-In-Glass	-40 °C to 125 °C	0.07 °C	Kaye IRTD
Thermometers <sup>FO</sup>	125 °C to 300 °C	0.07 °C	Temperature Bath QAI-T02
Infrared Temperature FO	20 °C to 500 °C	0.55 % of reading + 0.074 °C	Fluke 4181
			QAI-T07
Time and Frequency			7
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	10 mHz to 120 Hz	2.5 µHz/Hz + 10 mHz	Fluke 5520A
Frequency FO	120 Hz to 1.2 kHz	2.5 µHz/Hz + 0.1 Hz	GIDEP procedures
	1.2 kHz to 12 kHz	2.5 µHz/Hz + 1 Hz	OEM procedures
	12 kHz to 120 kHz	2.5 μHz/Hz + 10 Hz	
	120 kHz to 1.2 MHz	2.5 µHz/Hz + 0.1 kHz	
	1.2 MHz to 2 MHz	$2.5 \mu\text{Hz/Hz} + 1 \text{kHz}$	
Equipment to Output	1 Hz to 100 Hz	0.6 nHz	Agilent 53132A
Frequency <sup>FO</sup>	100 Hz to 1 kHz	51 nHz	GIDEP procedures
	1 kHz to 10 kHz	760 nHz	OEM procedures
	10 kHz to 100 kHz	5.01 µHz	
	100 kHz to 1 MHz	50.1 µHz	
	1 MHz to 10 MHz	510 µHz	
	10 MHz to 100 MHz	5.01 mHz	
	100 MHz to 1 GHz	50.1 mHz	
	1 GHz to 3 GHz	101 mHz	
Stopwatch / Period measuring devices <sup>FO</sup>	Up to 100 sec/day	0.051 sec/day	Timometer QAI-K01



## **Precision Measurements**

20 Hagerty Road, Suite #1, West Chester, PA 19382 Contact Name: Jackie Perry Phone: 610-436-9703

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
Phase Modulation <sup>F</sup>	150 kHz to 10 MHz	4 % of reading $+ 0.5$ rad	HP 8902A
	10 MHz to 1.3 GHz	3 % of reading + 0.5 rad	GIDEP procedures
	1.3 GHz to 26.5 GHz	4 % of reading + 0.5 rad	OEM procedures
Amplitude Modulation <sup>F</sup> Depths: 5 % to 99 %	150 kHz to 10 MHz	2.1 % of reading + 0.012 % AM	
Amplitude Modulation <sup>F</sup> Depths: to 99 %	150 kHz to 10 MHz	3.1 % of reading + 0.012 % AM	
Amplitude Modulation <sup>F</sup> Depths: 5 % to 99 %	10 MHz to 1.3 GHz	1.1 % + 0.012 % AM	
Amplitude Modulation <sup>F</sup> Depths: to 99 %	10 MHz to 1.3 GHz	3.1 % + 0.012 % AM	
Amplitude Modulation <sup>F</sup> Depths: 5 % to 99 %	1.3 GHz to 26.5 GHz	2.1 % + 0.012 % AM	
Amplitude Modulation <sup>F</sup> Depths: to 99 %	1.3 GHz to 26.5 GHz	3.1 % + 0.012 % AM	
Frequency Modulation <sup>F</sup>	250 kHz to 10 MHz	20 mHz/Hz + 0.12 kHz	
Rate: 20 Hz to 200 kHz	10 MHz to 1.3 GHz	51 mHz/Hz + 20 Hz	
Frequency Modulation <sup>F</sup> Rate: 50 Hz to 100 kHz	10 MHz to 1.3 GHz	11 mHz/Hz + 20 Hz	
Frequency Modulation <sup>F</sup> Rate: 20 Hz to 200 kHz	1.3 GHz to 26.5 GHz	51 mHz/Hz + 20 Hz	
Frequency Modulation <sup>F</sup> Rate: 50 Hz to 100 kHz	1.3 GHz to 26.5 GHz	11 mHz/Hz + 20 Hz	
Rotating Motion <sup>FO</sup>	9 rpm to 90 000 rpm	0.000 6 % of reading + 0.000 07 rpm	HP 3325B GIDEP procedures OEM procedures
Period Totalization <sup>FO</sup>	0 to 3600 s	11 μs/s + 8.2 ms	Stop Watch Control Company GIDEP procedures OEM procedures



**Precision Measurements** 

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- 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 F means that the laboratory performs calibration of the indicated parameter at its fixed location. Example: Outside Micrometer <sup>F</sup> would mean that the laboratory performs this calibration at its fixed location.
- 4. 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 <sup>FO</sup> would mean that the laboratory performs this calibration at its fixed location and onsite at customer locations.
- 5. 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.
- 6. The term L represents length in inches or millimeters as appropriate to the uncertainty statement.