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The ANSI National Accreditation Board

Hereby attests that

Transcat – Denver
3251 Lewiston St, Suite 12
Aurora, CO 80011

Fulfills the requirements of

ISO/IEC 17025:2017

and the national standards

ANSI/NCSL Z540-1-1994 (R2002) AND
ANSI/NCSL Z540.3-2006 (R2013)

In the fields of

CALIBRATION & DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 September 2021
Certificate Number: AC-2489.10

This laboratory 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 (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017, ANSI/NCSL Z540-1-1994 (R2002), AND ANSI/NCSL Z540.3-2006 (R2013)

Transcat – Denver
3251 Lewiston St, Suite 12
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Ryan Gohl
303-364-8325

CALIBRATION & DIMENSIONAL MEASUREMENT

Valid to: **September 7, 2021** Certificate Number: **AC-2489.10**

Acoustics and Vibration

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Acceleration	5 Hz to 9 Hz	1.7%	Standard Accelerometer
	10 Hz to 99 Hz	1.2%	
	100 Hz	0.75%	
	101 Hz to 920 Hz	1%	
	921 Hz to 5 000 Hz	1.4%	
	5 001 Hz to 10 kHz	1.8%	
	10 kHz to 15 kHz	2.2%	
	15 kHz to 20 kHz	2.8%	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Sinewave Flatness [1]	0.3 V to 3 V		Thermal Converter/HP3458A
	10 Hz to 1 MHz	0.06%	
	1 MHz to 10 MHz	0.1%	
	10 MHz to 30 MHz	0.18%	
	30 MHz to 50 M Hz	0.41%	
	50 MHz to 80 MHz	0.71%	
	80 MHz to 100 MHz	0.84%	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
ACI Measuring Equipment [1]	0 µA to 220 µA		Fluke 5700A/EP
	10 Hz to 20 Hz	0.031 % + 16 nA	
	20 Hz to 40 Hz	0.019 % + 10 nA	
	40 Hz to 1 kHz	0.015 % + 8 nA	
	1 kHz to 5 kHz	0.03 % + 12 nA	
	5 kHz to 10 kHz	0.11 % + 65 nA	
	0.22 mA to 2.2 mA		
	10 Hz to 20 Hz	0.03 % + 40 nA	
	20 Hz to 40 Hz	0.018 % + 35 nA	
	40 Hz to 1 kHz	0.014 % + 35 nA	
	1 kHz to 5 kHz	0.021 % + 0.11 µA	
	5 kHz to 10 kHz	0.11 % + 0.65 µA	
	2.2 mA to 22 mA		
	10 Hz to 20 Hz	0.039 % + 0.4 µA	
	20 Hz to 40 Hz	0.019 % + 0.35 µA	
	40 Hz to 1 kHz	0.014 % + 0.35 µA	
	1 kHz to 5 kHz	0.022 % + 0.55 µA	
	5 kHz to 10 kHz	0.12 % + 5 µA	
	22 mA to 220 mA		
	10 Hz to 20 Hz	0.033 % + 4 µA	
	20 Hz to 40 Hz	0.018 % + 3.5 µA	
	40 Hz to 1 kHz	0.015 % + 2.5 µA	
	1 kHz to 5 kHz	0.021 % + 3.5 µA	
	5 kHz to 10 kHz	0.12 % + 10 µA	
ACI Measuring Equipment [1]	0.22 A to 2.2 A		Fluke 5700A/EP
	20 Hz to 1 kHz	0.027 % + 35 µA	
	1 kHz to 5 kHz	0.046 % + 80 µA	
	5 kHz to 10 kHz	0.7 % + 0.16 mA	
	2.2 A to 11 A		Fluke 5700A/EP with 5725
	40 Hz to 1 kHz	0.048 % + 0.17 mA	
	1 kHz to 5 kHz	0.096 % + 0.38 mA	
	5 kHz to 10 kHz	0.036 % + 0.75 mA	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Extended Frequency Ranges [1]	29 µA to 330 µA 10 kHz to 30 kHz	1.2 % + 0.4 µA	Fluke 5520A
	0.33 mA to 3.3 mA 10 kHz to 30 kHz	0.78 % + 0.6 µA	
	3.3 mA to 33 mA 10 kHz to 30 kHz	0.31 % + 4 µA	
	33 mA to 330 mA 10 kHz to 30 kHz	0.31 % + 0.2 mA	
Clamp-on Ammeter Toroidal Type [1] Transformer Type	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.3 % + 0.026 A 0.83 % + 0.047 A	Fluke 5520A with 5500A/Coil
	150 A to 1000 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.35 % + 0.12 A 1.1 % + 0.22 A	
Clamp-on Ammeter Non-Toroidal Type [1] Hall Effect Sensor	20 A to 150 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.57 % + 0.25 A 1 % + 0.25 A	Fluke 5520A with 5500A/Coil
	150 A to 1000 A 45 Hz to 65 Hz 65 Hz to 440 Hz	0.6 % + 0.9 A 1.3 % + 0.92 A	
AC Current – Measure [1]	0 µA to 100 µA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 1 kHz	0.4 % + 30 nA 0.15 % + 30 nA 0.063 % + 30 nA 0.063 % + 30 nA	Agilent 3458A /002
	100 µA to 1 mA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	0.4 % + 0.2 µA 0.15 % + 0.2 µA 0.062 % + 0.2 µA 0.034 % + 0.2 µA	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measure [1]	1 mA to 10 mA		Agilent 3458A /002
	10 Hz to 20 Hz	0.4 % + 2 µA	
	20 Hz to 45 Hz	0.15 % + 2 µA	
	45 Hz to 100 Hz	0.062 % + 2 µA	
	100 Hz to 5 kHz	0.034 % + 2 µA	
	10 mA to 100 mA		
	10 Hz to 20 Hz	0.4 % + 20 µA	
	20 Hz to 45 Hz	0.15 % + 20 µA	
	45 Hz to 100 Hz	0.061 % + 20 µA	
	100 Hz to 5 kHz	0.033 % + 20 µA	
	100 mA to 1 A		
	10 Hz to 20 Hz	0.40 % + 0.2 mA	
	20 Hz to 45 Hz	0.16 % + 0.2 mA	
	45 Hz to 100 Hz	0.085 % + 0.2 mA	
	100 Hz to 5 kHz	0.10 % + 0.2 mA	
	1 A to 20 A		Fluke Y5020
	50 Hz to 100 Hz	0.02%	
	100 Hz to 300 Hz	0.03%	
	300 Hz to 1 kHz	0.03%	
	1 kHz to 3 kHz	0.06%	
	3 kHz to 4 kHz	0.07%	
	4 kHz to 5 kHz	0.09%	
	20 A to 100 A		Agilent 3458A opt 002 w/ 100 Amp shunt
	10 Hz to 1 kHz	0.12%	
AC Resistance – Measure [1]	20 Ω to 100 kΩ		Gen Rad 1689
	1 kHz	0.039 % + 0.01 Ω	
	0.1 Ω to 15 Ω		Agilent 4284A
	50 Hz to 100 kHz	0.12%	
	15 Ω to 420 Ω		
	100 Hz to 100 kHz	0.06%	
	420 Ω to 32 kΩ		
	100 Hz to 10 kHz	0.06%	
	32 kΩ to 320 kΩ		
	100 Hz to 100 kHz	0.06%	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Resistance – Measure [1]	320 kΩ to 10 MΩ 100 Hz to 100 kHz	0.12%	
AC Resistance-Measuring Equipment	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.17% 0.12% 0.12% 0.05% 0.05% 0.13% 0.26%	Impedance Standards
	0 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ 1 MΩ to 10 MΩ 10 MΩ to 100 MΩ 100 MΩ to 1 GΩ	20 μΩ/Ω + 50 μΩ 15 μΩ/Ω + 0.50 mΩ 13 μΩ/Ω + 0.50 mΩ 12 μΩ/Ω + 5 mΩ 13 μΩ/Ω + 50 mΩ 19 μΩ/Ω + 2 Ω 62 μΩ/Ω + 100 Ω 0.059 % + 1 kΩ 0.58 % + 10 kΩ	HP3458A w/Resistors
	1 GΩ to 2 GΩ 2 GΩ to 20 GΩ 20 GΩ to 200 GΩ	1.7% + 100 kΩ 1.7% + 1 MΩ 1.8% + 10 MΩ	Keithley 617
Resistance - Measuring Equipment [1]	333 μΩ 1 mΩ 10 mΩ 100 mΩ	0.12% 0.06% 0.01% 0.01%	Guildline 9211
	1 Ω 10 kΩ	10 μΩ 54 mΩ	Fluke 742A
	1 GΩ 10 GΩ 100 GΩ 1 TΩ	0.20% 0.50% 0.55% 0.56%	IET HRRS-Q-8-100k-10kV

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Current – Measuring Equipment [1]	0 pA to 2 pA	0.80 % + 10 fA	Keithley 263
	2 pA to 20 pA	0.44 % + 10 fA	
	20 pA to 200 pA	0.30 % + 30 fA	
	200 pA to 2 nA	0.077 % + 100 fA	
	2 nA to 20 nA	0.076 % + 1 pA	
	20 nA to 200 nA	0.041 % + 10 pA	
	200 nA to 2 µA	0.029 % + 100 pA	
DC Current – Measuring Equipment [1]	2 µA to 220 µA	41 µA/A + 6.0 nA	Fluke 5700A/EP
	220 µA to 2.2 mA	36 µA/A + 7.0 nA	
	2.2 mA to 22 mA	36 µA/A + 40 nA	
	22 mA to 220 mA	49 µA/A + 0.7 µA	
	220 mA to 2.2 A	0.02 % + 12 µA	
	2.2 A to 11 A	0.04 % + 0.48 mA	Fluke 5700A/EP w/5725A
	11 A to 20.5 A	0.082 % + 0.75 mA	Fluke 5520A
	1 A to 10 A	0.01%	Guildline 9211 with source
	10 A to 100 A	0.06%	
	100 A to 300 A	0.12%	
DC Current – Measure [1]	0 to 2 pA	2.1 % + 6.6 fA	Keithley 617
	2 pA to 20 pA	1.9 % + 7 fA	
	20 pA to 200 pA	1.9 % + 10 fA	
	200 pA to 2 nA	0.3 % + 500 fA	
	2 nA to 20 nA	0.3 % + 1 pA	
	20 nA to 200nA	0.3 % + 10 pA	
	200 nA to 1 µA	26 µA/A + 0.4 pA	HP 3458A Opt 002
	1 µA to 10 µA	26 µA/A + 0.1 nA	
DC Current – Measure [1]	10 µA to 100 µA	28 µA/A + 0.8 nA	HP 3458A Opt 002
	100 µA to 1 mA	29 µA/A + 5 nA	
	1 mA to 10 mA	29 µA/A + 50 nA	
	10 mA to 100 mA	47 µA/A + 0.5 µA	
	100 mA to 1 A	0.11 % + 10 µA	
	1 A to 10 A	0.01%	Guildline 9211 with meter
	10 A to 100 A	0.06%	
	100 A to 300 A	0.12%	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Clamp-on Ammeter Non-Toroidal Type [1] Hall Effect Sensor	20 A to 150 A 150 A to 1000 A	0.50 % + 0.14 A 0.51 % + 0.5 A	Fluke 5520A with 5500A/Coil
DC Voltage – Measure [1]	0 mV to 100 mV 100 mV to 10 V 10 V to 100 V 100 V to 500 V 500 V to 800 V 800 V to 1 kV 1 kV to 5 kV 5 kV to 10 kV 10 kV to 20 kV 20 kV to 50 kV 50 kV to 70 kV 70 kV to 100 kV	10 µV/V + 0.5 µV 5.2 µV/V + 0.5 µV 7.9 µV/V + 30 µV 12 µV/V + 0.1 mV 15 µV/V + 0.1 mV 21 µV/V + 0.1 mV 0.04 % + 0.26 V 0.04 % + 1.7 V 0.065 % + 1.1 V 0.066 % + 10 V 0.067 % + 28 V 0.069 % + 81 V	3458A Opt 002 Vitrek 4700 / HVL-35 / HVL-70 / HVL-100
DC Voltage - Measuring Equipment [1]	0 V to 220 mV 220 mV to 2.2 V 2.2 V to 11 V 11 V to 22 V 22 V to 220 V 220 V to 1100 V	8.5 µV/V + 0.5 µV 5.1 µV/V + 0.7 µV 4.0 µV/V + 2.5 µV 4.0 µV/V + 4 µV 6.2 µV/V + 40 µV 7.6 µV/V + 500 µV	Fluke 5700A/EP Fluke 5700A/EP w/5725A
AC Voltage – Measure [1]	0 mV to 1 mV 0.1 MHz to 1 MHz 1 MHz to 3 MHz 3 MHz to 10 MHz 10 MHz to 20 MHz 1 mV to 3 mV 0.1 MHz to 1 MHz 1 MHz to 3 MHz 3 MHz to 10 MHz 10 MHz to 20 MHz	 1.8 % + 2.4 µV 3.5 % + 2.4 µV 9.3 % + 2.4 µV 23 % + 2.4 µV 0.97 % + 2 µV 3.5 % + 2 µV 9.3 % + 2 µV 23 % + 2 µV	R&S URE3

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	3 mV to 100 mV		R & S URE3
	0.1 MHz to 1 MHz	0.91 % + 3 µV	
	1 MHz to 3 MHz	1.8 % + 3 µV	
	3 MHz to 10 MHz	2.9 % + 3 µV	
	10 MHz to 20 MHz	6.9 % + 3 µV	
	20 MHz to 30 MHz	14 % + 3 µV	
AC Voltage – Measure [1]	0 mV to 10 mV		Agilent 3458A/002
	1 Hz to 40 Hz	0.039 % + 3 µV	
	40 Hz to 1 kHz	0.028 % + 1 µV	
	1 kHz to 20 kHz	0.038 % + 1 µV	
	20 kHz to 50 kHz	0.15 % + 1 µV	
	50 kHz to 100 kHz	0.59 % + 1 µV	
	100 kHz to 300 kHz	4.6 % + 2 µV	
	10 mV to 100 mV		
	1 Hz to 40 Hz	0.013 % + 4 µV	
	40 Hz to 1 kHz	0.0095 % + 2 µV	
	1 kHz to 20 kHz	0.017 % + 2 µV	
	20 kHz to 50 kHz	0.037 % + 2 µV	
	50 kHz to 100 kHz	0.093 % + 2 µV	
	100 kHz to 300 kHz	0.36 % + 10 µV	
	300 kHz to 1 MHz	1.2 % + 10 µV	
	100 mV to 1 V		
	1 Hz to 40 Hz	0.009 8 % + 40 µV	
	40 Hz to 1 kHz	0.009 4 % + 20 µV	
	1 kHz to 20 kHz	0.017 % + 20 µV	
	20 kHz to 50 kHz	0.036 % + 20 µV	
	50 kHz to 100 kHz	0.093 % + 20 µV	
	100 kHz to 300 kHz	0.35 % + 0.1 mV	
	300 kHz to 1 MHz	1.2 % + 0.1 mV	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	1 V to 10 V		Agilent 3458A/002
	1 Hz to 40 Hz	0.009 5 % + 0.4 mV	
	40 Hz to 1 kHz	0.009 5 % + 0.2 mV	
	1 kHz to 20 kHz	0.017 % + 0.2 mV	
	20 kHz to 50 kHz	0.036 % + 0.2 mV	
	50 kHz to 100 kHz	0.093 % + 0.2 mV	
	100 kHz to 300 kHz	0.35 % + 1 mV	
	300 kHz to 1 MHz	1.2 % + 1 mV	
	10 V to 100 V		
	1 Hz to 40 Hz	0.024 % + 4 mV	
	40 Hz to 1 kHz	0.024 % + 2 mV	
	1 kHz to 20 kHz	0.024 % + 2 mV	
	20 kHz to 50 kHz	0.041 % + 2 mV	
	50 kHz to 100 kHz	0.14 % + 2 mV	
	100 kHz to 300 kHz	0.46 % + 10 mV	
	300 kHz to 1 MHz	1.7 % + 10 mV	
	100 V to 700 V		
	1 Hz to 40 Hz	0.047 % + 40 mV	
	40 Hz to 1 kHz	0.047 % + 20 mV	
	1 kHz to 20 kHz	0.071 % + 20 mV	
	20 kHz to 50 kHz	0.14 % + 20 mV	
	50 kHz to 100 kHz	0.35 % + 20 mV	
	(0.7 to 5) kV (10 to 200) Hz	0.14 % + 0.34 V	Vitrek 4700
	(0 to 5) kV (200 to 450) Hz	0.47 % + 0.34 V	
	5 kV to 10 kV		
	10 Hz to 200 Hz	0.16 % + 1.9 V	
	200 Hz to 450 Hz	0.47 % + 1.9 V	
	10 kV to 20 kV		Vitrek 4700 / HVL-35 / HVL-70 / HVL-100
	30 Hz to 70 Hz	0.16 % + 1.4 V	
	70 Hz to 200 Hz	1.2 % 1.4 V	
	200 Hz to 450 Hz	2.9 % + 1.8 V	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	20 kV to 50 kV		Vitrek 4700 / HVL-35 / HVL-70 / HVL-100
	30 Hz to 70 Hz	0.16 % + 11 V	
	70 Hz to 200 Hz	1.2 % + 11 V	
	200 Hz to 450 Hz	2.9 % + 21 V	
	50 kV to 70 kV		
	30 Hz to 70 Hz	0.16 % + 28 V	
	70 Hz to 200 Hz	1.2 % + 28 V	
AC Voltage Measuring Equipment [1]	0 mV to 2.2 mV		5700A/EP
	10 Hz to 20 Hz	0.16 % + 4 µV	
	20 Hz to 40 Hz	0.10 % + 4 µV	
	40 Hz to 20 kHz	0.078 % + 4 µV	
	20 kHz to 50 kHz	0.13 % + 4 µV	
	50 kHz to 100 kHz	0.17 % + 5 µV	
	100 kHz to 300 kHz	0.33 % + 10 µV	
	300 kHz to 500 kHz	0.47 % + 20 µV	
	500 kHz to 1 MHz	0.58 % + 20 µV	
	2.2 mV to 22 mV		
	10 Hz to 20 Hz	0.042 % + 4 µV	
	20 Hz to 40 Hz	0.03 % + 4 µV	
	40 Hz to 20 kHz	0.014 % + 4 µV	
	20 kHz to 50 kHz	0.03 % + 4 µV	
	50 kHz to 100 kHz	0.058 % + 5 µV	
	100 kHz to 300 kHz	0.12 % + 10 µV	
	300 kHz to 500 kHz	0.16 % + 20 µV	
	500 kHz to 1 MHz	0.27 % + 20 µV	
	22 mV to 220 mV		
	10 Hz to 20 Hz	0.028 % + 12 µV	
	20 Hz to 40 Hz	0.011 % + 7 µV	
	40 Hz to 20 kHz	0.008 % + 7 µV	
	20 kHz to 50 kHz	0.021 % + 7 µV	
	50 kHz to 100 kHz	0.047 % + 17 µV	
	100 kHz to 300 kHz	0.091 % + 20 µV	
	300 kHz to 500 kHz	0.14 % + 25 µV	
	500 kHz to 1 MHz	0.28 % + 45 µV	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage Measuring Equipment [1]	220 mV to 2.2 V		5700A/EP
	10 Hz to 20 Hz	0.027 % + 40 µV	
	20 Hz to 40 Hz	0.011 % + 15 µV	
	40 Hz to 20 kHz	0.004 8 % + 8 µV	
	20 kHz to 50 kHz	0.008 4 % + 10 µV	
	50 kHz to 100 kHz	0.012 % + 30 µV	
	100 kHz to 300 kHz	0.043 % + 80 µV	
	300 kHz to 500 kHz	0.1 % + 0.2 mV	
	500 kHz to 1 MHz	0.18 % + 0.3 mV	
	2.2 V to 22 V		
	10 Hz to 20 Hz	0.028 % + 0.4 mV	
	20 Hz to 40 Hz	0.01 % + 0.15 mV	
	40 Hz to 20 kHz	0.004 9 % + 50 µV	
	20 kHz to 50 kHz	0.008 3 % + 0.1 mV	
	50 kHz to 100 kHz	0.012 % + 0.2 mV	
	100 kHz to 300 kHz	0.03 % + 0.6 mV	
	300 kHz to 500 kHz	0.11 % + 2 mV	
	500 kHz to 1 MHz	0.17 % + 3.2 mV	
	22 V to 220 V		
	10 Hz to 20 Hz	0.028 % + 4 mV	
	20 Hz to 40 Hz	0.01 % + 1.5 mV	
	40 Hz to 20 kHz	0.005 6 % + 0.6 mV	
	20 kHz to 50 kHz	0.009 3 % + 1 mV	
	50 kHz to 100 kHz	0.016 % + 2.5 mV	
	100 kHz to 300 kHz	0.09 % + 16 mV	
	300 kHz to 500 kHz	0.44 % + 40 mV	
	500 kHz to 1 MHz	0.8 % + 80 mV	
	220 V to 750 V		5700A/EP with 5725A
	30 kHz to 50 kHz	0.061 % + 11 mV	
	50 kHz to 100 kHz	0.23 % + 45 mV	
	220 V to 1100 V		
	40 Hz to 1 kHz	0.011 % + 4 mV	
	1 kHz to 20 kHz	0.017 % + 6 mV	
	20 kHz to 30 kHz	0.067 % + 11 mV	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance – Measure [1] 1 kHz	Up to 10 pF 10 pF to 100 pF 100 pF to 1 µF 1 µF to 100 µF 100 µF to 1 mF	0.47 % + 0.05 pF 0.058 % + 0.05 pF 0.024 % + 0.05 pF 0.04% 0.24%	GenRad 1689
Capacitance – Measure [1]	10 nF to 100 µF 100 Hz to 120 Hz	0.06%	Agilent 4284A
	100 µF to 12 mF 100 Hz to 120 Hz	0.12%	
	10 nF to 10 µF 400 Hz	0.06%	
	10 µF to 80 pF 10 kHz	0.12%	
	80 pF to 1 µF 10 kHz	0.06%	
	12 pF to 90 pF 100 kHz	0.12%	
	90 pF to 100 nF 100 kHz	0.06%	
	100 nF to 100 µF 100 kHz	0.12%	
	10 pF to 90 pF 1 MHz	0.12%	
	90 pF to 10 nF 1 MHz	0.06%	
Capacitance - Measuring Equipment [1]	0.1 nF to 0.5 nF 1 kHz	0.59 pF	Arco SS32
	0.5 nF to 1.4 µF 1 kHz	0.12 % + 0.018 pF	
	1 pF 1 kHz to 1 MHz	0.06%	HP16381A
	10 pF 1 kHz to 1 MHz	0.004%	HP16382A

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment [1]	100 pF 1 kHz to 1 MHz	0.004%	HP16383A
	1000 pF 1 kHz to 1 MHz	0.007%	HP16384A
	10 nF 120 Hz to 100 kHz	0.007%	HP 16385A
	100 nF 120 Hz to 100 kHz	0.007%	HP 16386A
	1 µF 120 Hz to 100 kHz	0.007%	HP 16387A
	0.19 nF to 1.1 nF 10 Hz to 10 kHz	0.39 % + 7.8 pF	5520A
	1.1 nF to 3.3 nF 10 Hz to 3 kHz	0.39 % + 7.8 pF	
	3.3 nF to 11 nF 10 Hz to 1 kHz	0.2 % + 7.8 pF	
	11 nF to 110 nF 10 Hz to 1 kHz	0.2 % + 78 pF	
	110 nF to 330 nF 10 Hz to 1 kHz	0.2 % + 0.23 nF	
	0.33 µF to 1.1 µF 10 Hz to 600 Hz	0.2 % + 0.78 nF	
	1.1 µF to 3.3 µF 10 Hz to 300 Hz	0.2 % + 2.3 nF	
	3.3 µF to 11 µF 10 Hz to 150 Hz	0.2 % + 7.8 nF	
	11 µF to 33 µF 10 Hz to 120 Hz	0.32 % + 23 nF	
	33 µF to 110 µF 10 Hz to 80 Hz	0.35 % + 78 nF	
	110 µF to 330 µF DC to 50 Hz	0.37 % + 0.23 µF	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment [1]	0.33 mF to 1.1 mF DC to 20 Hz	0.37 % + 0.78 µF	5520A
	1.1 mF to 3.3 mF DC to 6 Hz	0.35 % + 2.3 µF	
	3.3 mF to 11 mF DC to 2 Hz	0.35 % + 7.8 µF	
	11 mF to 33 mF DC to 0.6 Hz	0.58 % + 23 µF	
	33 mF to 110 mF DC to 0.2 Hz	0.85 % + 78 µF	
Inductance – Measure [1]	1 mH to 100 mH 0.1 kHz to 1 kHz	0.04 % + 0.1 µH	GenRad 1689
	100 mH to 10 H 0.1 kHz to 1 kHz	0.057 % + 1.4 µH	
	5 µH to 5 mH 400 Hz	0.12%	Agilent 4284A
	5 mH to 10 H 400 Hz	0.06%	
	120 µH to 20 mH 100 Hz to 120 Hz	0.12%	
	20 mH to 10 H 100 Hz to 120 Hz	0.06%	
	1 µH to 1 mH 1 kHz	0.12%	
	5 nH to 120 µH 10 kHz	0.12%	
	120 µH to 100 mH 10 kHz	0.06%	
Inductance – Measuring Equipment [1]	100 mH 1 kHz	0.14%	Standard Inductor

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Power Measuring Equipment[1] DC Power 0.33 mA to 330 mA	11 µW to 1.1 mW 1.1 mW to 110 mW 0.11W to 110 W 110 W to 330 W	0.024 % 0.027 % 0.024 % 0.018 %	Fluke 5520A
0.33 A to 3 A 3 A to 20.5 A	11 W to 110 mW 0.11 W to 990 W 1 W to 3 kW 0.099 W to 0.99 W	0.044 % 0.053 % 0.009 6 % 0.088 %	
AC Power [3] (PF=1) (10 to 65) Hz (3.3 to 9.0) mA	0.99 W to 6.8 kW 6.8 W to 20.5 kW 0.11 mW to 3.0 mW 3.0 mW to 9.0 W	0.07 % 0.04 % 0.13% 0.077%	
(9.0 to 33) mA	0.3 mW to 10 mW	0.089 %	
(33 to 90) mA	10 mW to 33W 1 mW to 30 mW 30 mW to 90 W	0.077% 0.071 % 0.057 %	
(90 to 330) mA (0.33 to 0.9) A	3 mW to 100 mW 100 mW to 300 W 11 mW to 300 mW 300 mW to 900 W	0.089 % 0.078 % 0.071 % 0.081 %	
(0.9 to 2.2) A	30 mW to 720 mW 720 mW to 2 kW	0.089 % 0.079 %	Fluke 5520A
(2.2 to 4.5) A	80 mW to 1.4 W 1.4 W to 4.5 kW	0.088 % 0.18 %	Fluke 5520A

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
(4.5 to 20.5) A	150 mW to 6.7 W 6.7 W to 20 kW	0.17 % 0.17 %	Fluke 5520A
Phase Meters – Measure Equipment [1]	0° to 180° 10 Hz to 65 Hz 65 Hz to 500 Hz 500 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz 10 kHz to 20 kHz	 0.11° 0.20° 0.40° 1.9° 3.9° 7.8°	Fluke 5520A
Oscilloscopes[1] Amplitude DC[1] into 50 Ω Load into 1 MΩ Load	 (-5.0 to 5.0) V (-200 to 200) V	 0.023% + 19 µV 0.023% + 19 µV	Fluke 9500B
Amplitude Square Wave[1] into 50 Ω Load Rate: 10 Hz to 10 kHz Rate: 10 Hz to 100 kHz	 40 $\mu V_{(pk-pk)}$ to 1.0 $mV_{(pk-pk)}$ 1.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$ 1.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	 0.78% + 7.8 µV 0.078% + 7.8 µV 0.16% + 7.8 µV	 Fluke 9500B, 9530 Fluke 9500B, 9560
into 1 MΩ Load Rate: 10 Hz to 10 kHz Rate: 10 Hz to 100 kHz	 40 $\mu V_{(pk-pk)}$ to 1.0 $mV_{(pk-pk)}$ 1.0 $mV_{(pk-pk)}$ to 200 $V_{(pk-pk)}$	 0.78% + 7.8 µV 0.078% + 7.8 µV	 Fluke 9500B, 9530
Timing - Generate[1] 100 $mV_{(pk-pk)}$ to 1.0 $V_{(pk-pk)}$ Square Wave	 9.0091 ns to 83 µs 83 µs to 55 s	 0.19 µs/s 2.3 µs/s	 Fluke 9500B
Sine Wave	909.1 ps to 9.009 ns 450.5 ps to 9.009 ns 450.5 ps to 9.009 ns 180.19 ps to 9.009 ns	0.19 µs/s 0.19 µs/s 0.19 µs/s 0.19 µs/s	Fluke 9500B/600 Fluke 9500B/1100 Fluke 9500B/3200 Fluke 9500B/3200, 9560
Pulse	900.91 ns to 83 µs 83 µs to 55 s	0.19 µs/s 2.3 µs/s	Fluke 9500B
Timing - Generate[1]			

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 $mV_{(pk-pk)}$ to 1.0 $V_{(pk-pk)}$	900.91 ns to 83 µs	0.19 µs/s	Fluke 9500B
Triangle Wave	83 µs to 55 s	2.3 µs/s	
Rise Time – Generate[1,7]			
50 Ω Load			
5.0 $mV_{(pk-pk)}$ to 3.0 $V_{(pk-pk)}$			
Rate: 10 Hz to 2 MHz	500 ps (nominal)	290 ps	Fluke 9500B/ 9530
	150 ps (nominal)	34 ps	
25 $mV_{(pk-pk)}$ to 2.0 $V_{(pk-pk)}$			
Rate: 10 Hz to 1 MHz	70 ps (nominal)	21 ps	Fluke 9500B/ 9560
425 $mV_{(pk-pk)}$ to 575 $mV_{(pk-pk)}$			
Rate: 10 Hz to 1 MHz	25 ps (nominal)	5.7 ps	Fluke 9500B/ 9550
Leveled Sine Wave Generate[1]			
50 Ω Load			
Reference Frequency			
5.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	50 kHz to 10 MHz	1.2 %	Fluke 9500B/ 9530
Bandwidth/Flatness Measure[1]			
(wrt Reference Frequency)			
Into VSWR (1.2:1)			
5.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	0.10 Hz to 300 MHz	1.6 %	9500B/3200, 9530
	300 MHz to 550 MHz	1.9 %	
5.0 $mV_{(pk-pk)}$ to 3.0 $V_{(pk-pk)}$	550 MHz to 1.1 GHz	2.7 %	
	1.1 GHz to 2.5 GHz	3.1 %	
5.0 $mV_{(pk-pk)}$ to 2.0 $V_{(pk-pk)}$	2.5 GHz to 3.2 GHz	3.1 %	
Into VSWR (1.2:1)			
5.0 $mV_{(pk-pk)}$ to 5.0 $V_{(pk-pk)}$	0.10 Hz to 300 MHz	1.6 %	9500B/1100, 9560
	300 MHz to 550 MHz	1.9 %	
5.0 $mV_{(pk-pk)}$ to 3.0 $V_{(pk-pk)}$	550 MHz to 1.1 GHz	2.3 %	
	1.1 GHz to 2.5 GHz	2.3 %	
5.0 $mV_{(pk-pk)}$ to 2.0 $V_{(pk-pk)}$	2.5 GHz to 3.0 GHz	2.3 %	
25 $mV_{(pk-pk)}$ to 2.0 $V_{(pk-pk)}$	3.0 GHz to 6.0 GHz	3.1 %	
	10 Ω to 40 Ω	0.39 %	
	40 Ω to 90 Ω	0.083 %	
Input Impedance Measure[1]	90 Ω to 150 Ω	0.39 %	Fluke 9500B
	50 kΩ to 800 kΩ	0.39 %	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
	800 kΩ to 1.2 MΩ 1.2 MΩ to 12 MΩ	0.083 % 0.39 %	
Input Capacitance Measure[1]	1.0 pF to 35 pF	1.6 % + 0.19 pF	Fluke 9500B
	35 pF to 95 pF	2.3 % + 0.19 pF	
Electrical Simulation of Thermocouples [1]			Ectron 1140A
Type B	(250 to 350) °C (350 to 445) °C (445 to 580) °C (580 to 750) °C (750 to 1 000) °C (1 000 to 1 820) °C	1.2 °C 0.90 °C 0.71 °C 0.55 °C 0.45 °C 0.35 °C	
Type E	(-270 to -245) °C (-245 to -195) °C (-195 to -155) °C (-155 to -90) °C (-90 to 0) °C (0 to 15) °C (15 to 890) °C (890 to 1 000) °C	1.6 °C 0.24 °C 0.12 °C 0.095 °C 0.080 °C 0.076 °C 0.064 °C 0.074 °C	
Type J	(-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 990) °C (990 to 1 200) °C	0.15 °C 0.12 °C 0.093 °C 0.080 °C 0.094 °C	
Type K	(-270 to -255) °C (-255 to -195) °C (-195 to -115) °C (-115 to -55) °C (-55 to 1 000) °C (1 000 to 1 372) °C	2.5 °C 0.85 °C 0.16 °C 0.12 °C 0.087 °C 0.096 °C	
Type N	(-270 to -260) °C (-260 to -200) °C (-200 to -140) °C (-140 to -70) °C (-70 to 25) °C	5.4 °C 1.5 °C 0.29 °C 0.18 °C 0.14 °C	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
	(25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.11 °C	
Electrical Simulation of Thermocouples [1]	(-50 to -30) °C	0.80 °C	Ectron 1140A
	(-30 to 45) °C	0.69 °C	
Type R	(45 to 160) °C	0.49 °C	
	(160 to 380) °C	0.35 °C	
	(380 to 775) °C	0.30 °C	
	(775 to 1 768) °C	0.26 °C	
	(-50 to -30) °C	0.76 °C	
	(-30 to 45) °C	0.68 °C	
Type S	(45 to 105) °C	0.49 °C	
	(105 to 310) °C	0.41 °C	
	(310 to 615) °C	0.35 °C	
	(615 to 1 768) °C	0.31 °C	
	(-270 to -255) °C	1.9 °C	
	(-255 to -240) °C	0.60 °C	
	(-240 to -210) °C	0.36 °C	
Type T	(-210 to -150) °C	0.22 °C	
	(-180 to -40) °C	0.15 °C	
	(-40 to 100) °C	0.095 °C	
	(100 to 400) °C	0.080 °C	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Frequency - Source and Measure			Fluke 910R
In-Lab	10 MHz	3.7×10^{-12}	
Field Service [1]	10 MHz	3.8×10^{-9}	HP 53132A Counter
AM Depth – Measure [1]	5 % to 40 %		Agilent 8902A with 11722A
50 Hz to 10 kHz	150 kHz to 10 MHz	$(0.021AM + 0.014)$ %	
	40 % to 99 %		
	150 kHz to 10 MHz	$(0.021AM + 0.14)$ %	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
20 Hz to <50 Hz	5 % to 40 % 150 kHz to 10 MHz	(0.031*AM* + 0.014) %	
	40 % to 99 % 150 kHz to 10 MHz	(0.031*AM* + 0.14) %	
50 Hz to 50 kHz	5 % to 40 % 10 MHz to 1.3 GHz	(0.011*AM* + 0.014) %	
	40 % to 99 % 10 MHz to 1.3 GHz	(0.011*AM* + 0.14) %	
50 Hz to 50 kHz	5 % to 40 % 1.3 GHz to 26.5 GHz	(0.016*AM* + 0.014) %	Agilent 8902A with 11722A, 11792A, and11793A
	40 % to 99 % 1.3 GHz to 26.5 GHz	(0.016*AM* + 0.14) %	
(20 Hz to 50 Hz) or (50 kHz to 100 kHz)	5 % to 40 % 10 MHz to 26.5 GHz	(0.031*AM* + 0.014) %	Agilent 8902A with 11722A, 11792A, and11793A
	40 % to 99 % 10 MHz to 26.5 GHz	(0.031*AM* + 0.14) %	
FM Modulation – Measure [1] 20 Hz to 10 kHz	0 kHz to 4 kHz 250 kHz to 10 MHz 4 kHz to 40 kHz 40 kHz to 400 kHz	(0.021*FM* + 20) Hz (0.021*FM* + 22) Hz (0.021*FM* + 100) Hz	Agilent 8902A with 11722A
50 Hz to 100 kHz	0 kHz to 4 kHz 100 MHz to 26.5 GHz	(0.011*FM* + 20) Hz	Agilent 8902A with 11722A, 11792A, and 11793A
	4 kHz to 40 kHz 100 MHz to 26.5 GHz	(0.011*FM* + 22) Hz	
	40 kHz to 400 kHz 100 MHz to 26.5 GHz	(0.011*FM* + 100) Hz	
20 Hz to <50 Hz	0 kHz to 4 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 20) Hz	
	4 kHz to 40 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 22) Hz	
	40 kHz to 400 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 100) Hz	

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
>100 kHz to 200 kHz	0 kHz to 4 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 100) Hz	
	4 kHz to 40 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 100) Hz	
	40 kHz to 400 kHz 100 MHz to 26.5 GHz	(0.05*FM* + 100) Hz	
Phase Modulation – Measure [1] 200 Hz to 10 kHz	0 rad to < 4 rad 150 kHz to 10 MHz	(0.042*PM* + 0.03) rad	Agilent 8902A with 11722A
	4 rad to < 40 rad 150 kHz to 10 MHz	(0.042*PM* + 0.03) rad	
Phase Modulation – Measure [1] 200 Hz to 10 kHz	40 rad to 400 rad 150 kHz to 10 MHz	(0.042*PM* + 0.1) rad	
200 Hz to 20 kHz	0 rad to < 4 rad 10 MHz to 26.5 GHz	(0.036*PM* + 0.03) rad	Agilent 8902A with 11722A, 11792A, and 11793A
	4 rad to < 40 rad 10 MHz to 26.5 GHz	(0.036*PM* + 0.03) rad	
	40 rad to 400 rad 10 MHz to 26.5 GHz	(0.036*PM* + 0.1) rad	
Harmonic Distortion [1]	0 dBc to -80 dBc 30 Hz to 6.5 GHz 6.5 GHz to 22 GHz 22 GHz to 26.5 GHz	 1.7 dB 2.6 dB 3.4 dB	Agilent 8563E
Total Harmonic Distortion [1]	0 dB to -80 dB 20 Hz to 20 kHz 20 kHz to 100 kHz	 1.2 dB 2.3 dB	Agilent 8903B
AM Total Harmonic Distortion [1]	0 dB to -80 dB 20 Hz to 100 kHz	 2.7 dB	
Total Harmonic Distortion [1] Input Voltage Range 5 Hz to 1.2 MHz < 30 V 100 % to 0.3 %	10 Hz to 1 MHz 1 MHz to 3 MHz 10 Hz to 20 Hz 20 Hz to 30 Hz 30 Hz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1.2 MHz	3% 6% 12% 6% 3% 6% 12%	Agilent 334A

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Total Harmonic Distortion [1] Input Voltage Range > 30 V 100 % to 0.3 % 0.10%	10 Hz to 300 kHz 300 kHz to 500 kHz 500 kHz to 3 MHz 20 Hz to 30 Hz 30 Hz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1.2 MHz	3% 6% 12% 12% 3% 6% 12%	
Rise time (Generate) [1]	≥ 14 ps	2.4 ps	Pulser
Rise Time (Measure)	≥ 17 ps	3.9 ps	Sampling System
Absolute RF Power [1] 50 MHz	1 mW Reference	0.63 % (0.03 dB)	Agilent 478A- H75, 432A, and 3458A
100 kHz to 2.6 GHz	30 dBm to 20 dBm 20 dBm to 10 dBm 10 dBm to 0 dBm 0 dBm to -10 dBm -10 dBm to -20 dBm	0.12 dB 0.12 dB 0.12 dB 0.12 dB 0.15 dB	Agilent 8902A with 11722A
2.6 GHz to 12 GHz	30 dBm to 20 dBm 20 dBm to 10 dBm 10 dBm to 0 dBm 0 dBm to -10 dBm -10 dBm to -20 dBm	0.13 dB 0.13 dB 0.13 dB 0.13 dB 0.14 dB	Agilent 8902A w/ 11722A, 11792A & 11793A
12 GHz to 18 GHz	30 dBm to 20 dBm 20 dBm to 10 dBm 10 dBm to 0 dBm 0 dBm to -10 dBm -10 dBm to -20 dBm	0.13 dB 0.13 dB 0.13 dB 0.13 dB 0.15 dB	
18 GHz to 26.5 GHz	5 dBm to 0 dBm 0 dBm to -10 dBm -10 dBm to -20 dBm	0.16 dB 0.15 dB 0.15 dB	
Reflection (VSWR) [1] 10 MHz to 18 GHz	(Rho) 0.022 to 0.1 0.1 to 0.2 0.2 to 0.3 0.3 to 0.4	(Rho) 0.022 0.027 0.033 0.042	VSWR Bridge

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Relative Tuned RF Power [1] 2.5 MHz to 18 GHz	0 dB to -20 dB -20 dB to -40 dB -40 dB to -60 dB -60 dB to -80 dB -80 dB to -100 dB -100 dB to -120 dB	0.12 dB 0.14 dB 0.18 dB 0.23 dB 0.34 dB 0.37 dB	Agilent 8902A with 11722A, 11793A
Relative Tuned RF Power [1] 18 GHz to 26 GHz	0 dB to -20 dB -20 dB to -40 dB -40 dB to -60 dB -60 dB to -80 dB	0.13 dB 0.15 dB 0.18 dB 0.22 dB	Agilent 8902A with 11722A, 11793A

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Angle Angle Measuring Devices (Protractors, Inclinometers, Squares, Angle Gages)	0º to 85º 90º	0° 00’ 01.5” 0° 00’ 01.9”	Master Angle Blocks Master Square
Measure 0° to 360°	Up to 2 in (2 to16) in	0.072° (0.0005 *L*) + 0.062°	Non-Contact Vision System
Micrometers & Calipers – Outside, Inside, Depth [1]	0.05 in to 48 in	(8+ 8*L*) µin	Comparison to Gage Blocks
Anvil Flatness [1]	0 in to 1 in	4.5 µin	Optical Flats
Digital & Dial Indicators [1]	0 in to 0.05 in	28 µin	Dial Indicator Calibrator
	0.05 in to 5 in	(44 + 4*L*) µin	Horizontal Comparator
Length Single Axis Outside Dimension Inside Dimension	0 in to 5 in 0 in to 5 in	(6 + 8*L*) µin (22 + 3*L*) µin	Horizontal Comparator Horizontal Comparator

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Height Measuring Equipment [1]	0.4 in to 8 in 8 in to 48 in	(29 + 6*L*) µin (12 + 8*L*) µin	Gage Blocks
Plug Gages Outside Diameter	0 in to 5 in	(6 + 8*L*) µin	Horizontal Comparator
Ring Gages Inside Diameter	0 in to 5 in	(22 + 3*L*) µin	Horizontal Comparator
Rulers, Tape Measures	Up to 16 in	(120 +10*L*) µin	Vision System
Thread Plug Gages Pitch Diameter 60°	0 in to 1 in 1 in to 3 in 3 in to 5 in	79 µin 84 µin 94 µin	ULM w/Thread Wires
Major Diameter	0 in to 5 in	(6 + 8*L*) µin	Horizontal Comparator
Thread Ring Gages Pitch Diameter	0 in to 1 in 1 in to 3 in 3 in to 5 in	79 µin 84 µin 94 µin	Master Plug Uncertainty

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Force Measuring Equipment	1 lbf to 200 lbf	0.06%	Deadweight
Torque – Measure [1]	0.5 ozf·in to 15 ozf·in 15 ozf·in to 200 ozf·in 4 lbf·in to 80 lbf·in 80 lbf·in to 1 000 lbf·in 20 lbf·ft to 2 000 lbf·ft 1 000 lbf·ft to 5 000 lbf·ft	0.83% 0.4% 0.43% 0.4% 0.4% 1%	Wheel w/ weight Torque Calibrator

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Torque – Measuring Equipment Wrenches, Transducers	0.5 ozf·in to 16 ozf·in	0.83%	Torque Wheel with Weights
	1 lbf·in to 40 lbf·in	0.08%	
	40 lbf·in to 260 lbf·in	0.07%	
	260 lbf·in to 3 000 lbf·in	0.07%	Torque Arm with Weights
Torque Multipliers	150 Nm to 2 700 Nm	1.1%	Torque Calibration System
	110 lbf·ft to 2 000 lbf·ft	1.1%	
	2 700 Nm to 4 000 Nm	1.3%	
	2 000 lbf·ft to 3 000 lbf·ft	1.3%	
	4 000 Nm to 27 000 Nm	1.4%	
	3 000 lbf·ft to 20 000 lbf·ft	1.4%	
Hydraulic Devices	150 Nm to 2 700 Nm	1.1%	Torque Calibration System
	110 lbf·ft to 2 000 lbf·ft	1.1%	
	2 700 Nm to 4 000 Nm	1.3%	
	2 000 lbf·ft to 3 000 lbf·ft	1.3%	
	4 000 Nm to 27 000 Nm	1.3%	
	3 000 lbf·ft to 20 000 lbf·ft	1.3%	
Balances & Scales [1,8]	5 mg to 500 mg	0.012 mg	ASTM Class 1 Weights
	500 mg to 5 g	0.040 mg	
	5 g to 10 g	0.058 mg	
	10 g to 30 g	0.089 mg	
	30 g to 9 kg	0.000 32 %	
	9 kg to 15 kg	0.000 34 %	
Balances & Scales [1,8]	Up to 100 mg	0.016 mg	ASTM Class 2 Weights
	100 mg to 500 mg	0.029 mg	
	500 mg to 5 g	0.058 mg	
	5 g to 10 g	0.082 mg	
	10 g to 20 g	0.12 mg	
	20 g to 30 g	0.18 mg	
	30 g to 100 g	0.35 mg	
	100 g to 20 kg	0.005 9 %	
	Up to 0.02 lb	2.3 mg	NIST Class F Weights
	(0.02 to 1) lb	0.041%	
	(1 to 5) lb	0.038%	
	(5 to 977) lb	0.036%	

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Absolute Pressure Measure & Measuring Equipment	25 to 500 psia 0 to 25 psia	0.006 7 % + 0.001 psia 0.0019 psia	Ruska 7250xi
Gage Pressure Measure & Measuring Equipment – Pneumatic	-36 in H_2O to -22 in H_2O -22 in H_2O to 22 in H_2O 22 in H_2O to 60 in H_2O	0.009% + 150 µin H_2O 0.002 in H_2O 0.009% + 150 µin H_2O	DHI PPC4-ui
Gage Pressure Measure & Measuring Equipment – Pneumatic	60 in H_2O to 72 in H_2O 72 in H_2O to 804 in H_2O -14.7 psig to 25 psig 25 psig to 500 psig 10 psig to 3 000 psig 3 000 psig to 30 000 psig	0.006 5 in H_2O 0.009% + 150 µin H_2O 0.001 6 psig 0.0076% 0.38 psig 0.01%	DHI PPC4-ui Ruska 7250xi Fluke RPM 4
Pressure Measuring Equipment – Hydraulic	5 psig to 15 000 psig	0.02%	Fluke P3125-PSI

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Relative Humidity [1] Measure (10 °C to 30 °C)	10 % to 90 %	1.3%	Vaisala HMI70/HMP76
Generate (10 °C to 30 °C)	10 % to 90 %	1.3%	Vaisala HMI70/HMP76 with Source
Temperature – Measure [1]	-195 °C to 0 °C 0 °C to 420 °C 420 °C to 660 °C	0.011 °C + 0.001 % 0.025 °C + 0.001 % 0.037 °C + 0.001 %	AccuMac AM1760 w/Black Stack
	-195 °C to 0 °C 0 °C to 420 °C 420 °C to 660 °C	0.01 °C + 0.001 % 0.02 °C + 0.001 % 0.031 °C + 0.001 %	AccuMac AM1760 w/ Hart 1575
Temperature – Measuring Equipment [1]	-25 °C to 140 ºC 140 °C to 600 ºC	0.06 ºC 0.03 ºC	AccuMac AM1760 w/Hart 1575 & Hart Well

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Infrared Temperature – Measuring Equipment [1] λ = (8 to 14) µm	-15 °C to 0 °C 0 °C to 50 °C 50 °C to 100 °C 100 °C to 120 °C 120 °C to 200 °C 200 °C to 350 °C 350 °C to 500 °C	0.80 °C 0.65 °C 0.70 °C 0.76 °C 0.95 °C 1.6 °C 2.1 °C	Blackbody Sources (Plate) Ɛ = (0.9 to 1.0)

DIMENSIONAL MEASUREMENT

2 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Measurement 2D (X – Y)	Up to 16 in	(120 + 10*L*) µin	Vision System

3 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Measurement 3D	X = Up to 1 in Y = Up to 1 in Z = Up to 1 in	99 µin	Coordinate Measurement Machine utilized for Dimensional Measurement
	X = Up to 3 in Y = Up to 3 in Z = Up to 3 in	114 µin	
Dimensional Measurement 3D	X = Up to 6 in Y = Up to 6 in Z = Up to 6 in	137 µin	Coordinate Measurement Machine utilized for Dimensional Measurement
	X = Up to 12 in Y = Up to 12 in Z = Up to 12 in	188 µin	
	X = Up to 18 in Y = Up to 18 in Z = Up to 18 in	242 µin	

3 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Measurement 3D	X = Up to 24 in Y = Up to 24 in Z = Up to 24 in	295 µin	Coordinate Measurement Machine utilized for Dimensional Measurement
	X = Up to 30 in Y = Up to 30 in Z = Up to 24 in	334 µin	
	X = Up to 39 in Y = Up to 36 in Z = Up to 24 in	386 µin	
	X = Up to 39 in Y = Up to 48 in Z = Up to 24 in	430 µin	
	X = Up to 39 in Y = Up to 54 in Z = Up to 24 in	454 µin	
Dimensional Measurement 3D	X = Up to 39 in Y = Up to 63 in Z = Up to 24 in	492 µin	Coordinate Measurement Machine utilized for Dimensional Measurement

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 (k=2), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. Values listed with percent (%) are percent of reading or generated value unless otherwise noted.
3. The uncertainties shown are for the most favorable conditions. There is an increase in uncertainty that corresponds to the laboratory's AC voltage and current uncertainties at different frequencies other than the ones shown. Power factors (PF) other than the one shown contribute to the power uncertainty. PF is related to the cosine of phase. Therefore, uncertainties track the laboratory's phase uncertainty closely at PF near one, but are magnified heavily as PF approaches zero. The lab may also report reactive power, apparent power, and power factor under this accreditation. If needed, contact laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
4. Where AM, FM, and PM is the value of the respective modulation measured. AM uncertainty is expressed in percent of modulation depth.
5. L = length in inches.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.10.
7. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 150 ps, 70 ps, or 25 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the UUT. The known source rise time is mathematically removed from the total observed UUT rise time.
8. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.

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