CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Transcat – Charlotte
8334 Arrowridge Blvd., Suite B
Charlotte, NC 28273

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

while demonstrating technical competence in the field of

CALIBRATION

Refer to the accompanying Scope of Accreditation for information regarding the types of calibrations to which this accreditation applies.

AC-2489.07
Certificate Number

ANAB Approval

Certificate Valid: 09/29/17-09/07/19
Version No. 001 Issued: 09/29/17

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

ANSI-ASQ National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 AND ANSI/NCSL Z540-1-1994 (R2002)

Transcat – Charlotte
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CALIBRATION

Valid to: **September 7, 2019** Certificate Number: **AC-2489.07**

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measuring Equipment [1]	0 µA to 220 µA		Fluke 5700A-EP
	10 Hz to 20 Hz	0.028 % + 16 nA	
	20 Hz to 40 Hz	0.019 % + 10 nA	
	40 Hz to 1 kHz	0.014 % + 8.0 nA	
	1 kHz to 5 kHz	0.030 % + 12 nA	
	5 kHz to 10 kHz	0.11 % + 65 nA	
	0.22 mA to 2.2 mA		
	10 Hz to 20 Hz	0.027 % + 40 nA	
	20 Hz to 40 Hz	0.017 % + 35 nA	
	40 Hz to 1 kHz	0.014 % + 35 nA	
	1 kHz to 5 kHz	0.021 % + 110 nA	
	5 kHz to 10 kHz	0.11 % + 650 nA	
	2.2 mA to 22 mA		
	10 Hz to 20 Hz	0.028 % + 400 nA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measuring Equipment [1]	20 Hz to 40 Hz	0.018 % + 350 nA	Fluke 5700A-EP
	40 Hz to 1 kHz	0.014 % + 350 nA	
	1 kHz to 5 kHz	0.021 % + 550 nA	
	5 kHz to 10 kHz	0.11 % + 5 µA	
	22 mA to 220 mA		
	10 Hz to 20 Hz	0.028 % + 4 µA	
	20 Hz to 40 Hz	0.018 % + 3.5 µA	
	40 Hz to 1 kHz	0.014 % + 2.5 µA	
	1 kHz to 5 kHz	0.022 % + 3.5 µA	
	5 kHz to 10 kHz	0.11 % + 10 µA	
	0.22 A to 2.2 A		
	20 Hz to 1 kHz	0.027 % + 35 µA	
	1 kHz to 5 kHz	0.047 % + 80 µA	
	5 kHz to 10 kHz	0.71 % + 160 µA	
	2.2 A to 11 A		Fluke 5700A-EP with 5725A
	20 Hz to 1 kHz	0.027 % + 170 µA	
	1 kHz to 5 kHz	0.098 % + 380 µA	
	5 kHz to 10 kHz	0.37 % + 750 µA	
	11 A to 20.5 A		Fluke 5520A
	45 Hz to 100 Hz	0.095 % + 3.9 mA	
	100 Hz to 1 kHz	0.12 % + 3.9 mA	
	1 kHz to 5 kHz	2.3% + 3.9 mA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measuring Equipment [1]	20 A to 100 A 0.05 kHz to 1 kHz	0.12% + 300 µA	Fluke 5520A Ballantine 1625A with Agilent 3458A
Extended Frequency Ranges [1]	29 µA to 330 µA 10 kHz to 30 kHz	1.2 % + 0.31 µA	Fluke 5520A
	330 µA to 3.3 mA 10 kHz to 30 kHz	0.78 % + 0.47 µA	
	3.3 mA to 33 mA 10 kHz to 30 kHz	0.31 % + 3.1 µA	
	33 mA to 330 mA 10 kHz to 30 kHz	0.31 % + 0.16 mA	
Clamp-on Ammeter Toroidal Type [1] Transformer Type	20 A to 150 A 45 Hz to 65 Hz	0.30 % + 26 mA	Fluke 5520A with 5500A/Coil
	20 A to 150 A 65 Hz to 440 Hz	0.83 % + 47 mA	
	150 A to 1000 A 45 Hz to 65 Hz	0.35 % + 0.12 A	
	150 A to 1000 A 65 Hz to 440 Hz	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	0.57 % + 0.25 A	Fluke 5520A with 5500A/Coil
	20 A to 150 A 65 Hz to 440 Hz	1 % + 0.25 A	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Clamp-on Ammeter Non-Toroidal Type [1] Hall Effect Sensor	150 A to 1000 A 45 Hz to 65 Hz	0.60 % + 0.90 A	Fluke 5520A with 5500A/Coil
	150 A to 1000 A 65 Hz to 440 Hz	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 5 kHz	 0.46 % + 30 nA 0.17 % + 30 nA 0.072 % + 30 nA 0.072 % + 30 nA	Agilent 3458A opt 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	 0.46 % + 200 nA 0.17 % + 200 nA 0.071 % + 200 nA 0.038 % + 200 nA	
	1 mA to 10 mA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 5 kHz	 0.46 % + 2 µA 0.17 % + 2 µA 0.071 % + 2 µA 0.038 % + 2 µA	
	10 mA to 100 mA 10 Hz to 20 Hz 20 Hz to 45 Hz	 0.46 % + 20 µA 0.17 % + 20 µA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measure [1]	45 Hz to 100 Hz	0.071 % + 20 µA	Agilent 3458A opt 002
	100 Hz to 5 kHz	0.037 % + 20 µA	
	100 mA to 1 A 10 Hz to 20 Hz	0.46 % + 200 µA	
	20 Hz to 45 Hz	0.19 % + 200 µA	
	45 Hz to 100 Hz	0.097 % + 200 µA	
	100 Hz to 5 kHz	0.12 % + 200 µA	
	1 A to 2 A 50 Hz to 1 kHz	0.12 % + 200 µA	Ballantine 1625A with Agilent 3458A
	2 A to 20 A 50 Hz to 1 kHz	0.12 % + 300 µA	
	20 A to 100 A 50 Hz to 1 kHz	0.12% + 300 µA	
DC Resistance – Measuring Equipment and Measure [1]	0 Ω to 10 Ω	18 µΩ/Ω + 50 µΩ	HP 3458A with Decade Resistor
	10 Ω to 100 Ω	15 µΩ/Ω + 500 µΩ	
	100 Ω to 1 kΩ	12 µΩ/Ω + 500 µΩ	
	1 kΩ to 10 kΩ	12 µΩ/Ω + 5 mΩ	
	10 kΩ to 100 kΩ	12 µΩ/Ω + 50 mΩ	
	100 kΩ to 1 MΩ	19 µΩ/Ω + 2 Ω	
	1 MΩ to 10 MΩ	62 µΩ/Ω + 100 Ω	
	10 MΩ to 100 MΩ	590 µΩ/Ω + 1 kΩ	
	100 MΩ to 1 GΩ	0.58 % + 10 kΩ	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Resistance – Measuring Equipment [1]	100 µΩ	810 µΩ/Ω	Fixed Resistors
	1 mΩ	500 µΩ/Ω	
	10 mΩ	200 µΩ/Ω	
	100 mΩ	86 µΩ/Ω	
	1 Ω	100 µΩ/Ω	
	10 MΩ to 100 MΩ	0.08 %	IET HRRS-B-7-100k-5kV
	100 MΩ to 1 GΩ	0.24 %	
	1 GΩ to 10 GΩ	0.42 %	
	10 GΩ to 100 GΩ	0.83 %	
	100 GΩ to 1 TΩ	2.4 %	
DC Current – Measuring Equipment and Measure [1]	0 µA to 100 µA	26 µA/A + 0.8 nA	Agilent 3458A with Current Source
	100 µA to 1 mA	26 µA/A + 5 nA	
	1 mA to 10 mA	26 µA/A + 50 nA	
	10 mA to 100 mA	41 µA/A + 500 nA	
	100 mA to 1 A	130 µA/A + 10 µA	
DC Current – Measure [1]	1 A to 300 A	0.058 %	L&N 4363 shunt with DMM
DC Current – Measuring Equipment [1]	0.22 A to 2.2 A	92 µA/A + 12 µA	Fluke 5700A-EP With 5725A
	2.2 A to 11 A	280 µA/A + 480 µA	
	11 A to 20.5 A	780 µA/A + 750 µA	Fluke 5520A
Clamp-on Ammeter Non-Toroidal Type [1]	20 A to 150 A	0.50 % + 0.14 A	Fluke 5520A with 5500A/Coil
	150 A to 1000 A	0.51 % + 0.5 A	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Voltage – Measure [1]	50 kV to 120 kV	0.083 %	High Voltage Divider
	0 V to 0.22 V 0.22 V to 2.2V	8.1 µV/V+ 0.4 µV 5.5 µV/V+ 0.7 µV	Fluke 5700A-EP
DC Voltage – Measuring Equipment	2.2 V to 11 V	4.1 µV/V+ 2.5 µV	
	11 V to 22 V	4.0 µV/V+ 4.0 µV	
	22 V to 220 V	6.3 µV/V+ 40 µV	
	220 V to 1100 V	7.7 µV/V+ 400 µV	
DC Voltage – Measure [1]	0 V to 100 mV	7.1 µV/V + 0.5 µV	HP 3458A opt 002
	100 mV to 10 V	5.0 µV/V + 0.5 µV	
	10 V to 100 V	7.6 µV/V + 30 µV	
	100 V to 500 V	11 µV/V + 100 µV	
	500 V to 800 V	14 µV/V + 100 µV	
	800 V to 1000 V	21 µV/V + 100 µV	
	1 kV to 2 kV	0.051 % + 0.4 V	Vitrek 4600A with source
	2 kV to 20 kV	0.049 % + 4.0 V	
	20 kV to 50 kV	0.082 %	HV Divider with source
AC High Voltage – Measure [1]	700 V to 2 kV 20 Hz to 100 Hz	0.086 % + 2 V	Vitrek 4600A
	700 V to 2 kV 100 Hz to 400 Hz	0.53 % + 2 V	
	2 kV to 20 kV 20 Hz to 100 Hz	0.34 % + 20 V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC High Voltage – Measure [1]	20 kV to 85 kV 60 Hz	0.48 %	HV Voltage Divider
AC Voltage – Measure [1]	0 mV to 10 mV		Agilent 3458A opt 002
	1 Hz to 40 Hz	0.035 % + 3 µV	
	40 Hz to 1 kHz	0.026 % + 1.1 µV	
	1 kHz to 20 kHz	0.034 % + 1.1 µV	
	20 kHz to 50 kHz	0.1 % + 1.1 µV	
	50 kHz to 100 kHz	0.51 % + 1.1 µV	
	100 kHz to 300 kHz	4 % + 2 µV	
	10 mV to 100 mV		
	1 Hz to 40 Hz	0.012 % + 4 µV	
	40 Hz to 1 kHz	0.008 5 % + 2 µV	
	1 kHz to 20 kHz	0.015 % + 2 µV	
	20 kHz to 50 kHz	0.03 % + 2 µV	
	50 kHz to 100 kHz	0.081 % + 2 µV	
	100 kHz to 300 kHz	0.31 % + 10 µV	
	300 kHz to 1 MHz	1 % + 10 µV	
	100 mV to 1 V		
	1 Hz to 40 Hz	0.008 9 % + 40 µV	
	40 Hz to 1 kHz	0.008 5 % + 20 µV	
	1 kHz to 20 kHz	0.015 % + 20 µV	
	20 kHz to 50 kHz	0.031 % + 20 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	50 kHz to 100 kHz	0.081 % + 20 µV	Agilent 3458A opt 002
	100 kHz to 300 kHz	0.30 % + 100 µV	
	300 kHz to 1 MHz	1.0 % + 100 µV	
	1 V to 10 V		
	1 Hz to 40 Hz	0.008 5 % + 0.4 mV	
	40 Hz to 1 kHz	0.008 6 % + 0.2 mV	
	1 kHz to 20 kHz	0.015 % + 0.2 mV	
	20 kHz to 50 kHz	0.031 % + 0.2 mV	
	50 kHz to 100 kHz	0.081 % + 0.2 mV	
	100 kHz to 300 kHz	0.3 % + 1 mV	
	300 kHz to 1 MHz	1.0 % + 1 mV	
	10 V to 100 V		
	1 Hz to 40 Hz	0.021 % + 4 mV	
	40 Hz to 1 kHz	0.021 % + 2 mV	
	1 kHz to 20 kHz	0.021 % + 2 mV	
	20 kHz to 50 kHz	0.036 % + 2 mV	
	50 kHz to 100 kHz	0.12 % + 2 mV	
	100 kHz to 300 kHz	0.40 % + 10 mV	
	300 kHz to 1 MHz	1.5 % + 10 mV	
	100 V to 700 V		
	1 Hz to 40 Hz	0.041 % + 40 mV	
	40 Hz to 1 kHz	0.041 % + 20 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	1 kHz to 20 kHz	0.061 % + 20 mV	Agilent 3458A opt 002
	20 kHz to 50 kHz	0.12 % + 20 mV	
	50 kHz to 100 kHz	0.35 % + 20 mV	
AC Voltage – Measuring Equipment [1]	0 mV to 2.2 mV		
	10 Hz to 20 Hz	0.036 % + 4 µV	
	20 Hz to 40 Hz	0.033 % + 4 µV	
	40 Hz to 20 kHz	0.033 % + 4 µV	
	20 kHz to 50 kHz	0.033 % + 4 µV	
	50 kHz to 100 kHz	0.057 % + 5 µV	
	100 kHz to 300 kHz	0.13 % + 10 µV	
	300 kHz to 500 kHz	0.20 % + 20 µV	
	500 kHz to 1 MHz	0.31 % + 20 µV	
	2.2 mV to 22 mV		
	10 Hz to 20 Hz	0.044 % + 4 µV	
	20 Hz to 40 Hz	0.031 % + 4 µV	
	40 Hz to 20 kHz	0.015% + 4 µV	
	20 kHz to 50 kHz	0.032 % + 4 µV	
	50 kHz to 100 kHz	0.060 % + 5 µV	
	100 kHz to 300 kHz	0.066 % + 10 µV	
	300 kHz to 500 kHz	0.17 % + 20 µV	
	500 kHz to 1 MHz	0.31 % + 20 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment [1]	22 mV to 220 mV		Agilent 3458A opt 002
	10 Hz to 20 Hz	0.029 % + 12 µV	
	20 Hz to 40 Hz	0.011 % + 7 µV	
	40 Hz to 20 kHz	0.0087 % + 7 µV	
	20 kHz to 50 kHz	0.021 % + 7 µV	
	50 kHz to 100 kHz	0.048 % + 17 µV	
	100 kHz to 300 kHz	0.094 % + 20 µV	
	300 kHz to 500 kHz	0.15 % + 25 µV	
	500 kHz to 1 MHz	0.28 % + 45 µV	
	220 mV to 2.2 V		
	10 Hz to 20 Hz	0.028 % + 40 µV	
	20 Hz to 40 Hz	0.01 % + 15 µV	
	40 Hz to 20 kHz	0.004 9 % + 8 µV	
	20 kHz to 50 kHz	0.008 3 % + 10 µV	
	50 kHz to 100 kHz	0.012 % + 30 µV	
	100 kHz to 300 kHz	0.044 % + 80 µV	
	300 kHz to 500 kHz	0.01 % + 200 µV	
	500 kHz to 1 MHz	0.18 % + 300 µV	
	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	0.005 % + 50 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment [1]	20 kHz to 50 kHz	0.0084 % + 0.1 mV	Agilent 3458A opt 002
	50 kHz to 100 kHz	0.012 % + 0.2 mV	
	100 kHz to 300 kHz	0.031 % + 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 7 % + 0.6 mV	
	20 kHz to 50 kHz	0.009 4 % + 1 mV	
	50 kHz to 100 kHz	0.017 % + 2.5 mV	
	100 kHz to 300 kHz	0.092 % + 16 mV	
	300 kHz to 500 kHz	0.45 % + 40 mV	
	500 kHz to 1 MHz	0.82 % + 80 mV	
	220 V to 1100 V		Fluke 5720A/5725A
	40 Hz to 1 kHz	0.011 % + 4 mV	
	1 kHz to 20 kHz	0.017 % + 6 mV	
	20 kHz to 30 kHz	0.061 % + 11 mV	
	220 V to 750 V		
	30 kHz to 50 kHz	0.062 % + 11 mV	
	50 kHz to 100 kHz	0.24 % + 45 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance – Measure [1]	0 pF to 10 pF 60 Hz to 1 kHz	0.47 % + 0.014 pF	GenRad 1689M
	10 pF to 100 pF 60 Hz to 1 kHz	0.062 % + 0.014 pF	
	100 pF to 1 µF 60 Hz to 1 kHz	0.027 % + 0.014pF	
	1 µF to 100 µF 60 Hz to 1 kHz	0.035 % + 0.018pF	
	100 µF to 1000 µF 60 Hz to 1 kHz	0.24 % + 0.018pF	
Capacitance - Measuring Equipment [1]	0.1 nF to 0.5 nF 100 Hz to 1 kHz	0.65 pF	Arco SS32
	0.5 nF to 1400 nF 100 Hz to 1 kHz	0.13 pF	
	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	0.21 % + 7.8 pF	
	11 nF to < 110 nF 10 Hz to 1 kHz	0.21 % + 78 pF	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment [1]	110 nF to < 330 nF 10 Hz to 1 kHz	0.21 % + 0.23 nF	5520A
	0.33 µF to < 1.1 µF 10 Hz to 600 Hz	0.21 % + 0.78 nF	
	1.1 µF to < 3.3 µF 10 Hz to 300 Hz	0.21 % + 2.3 nF	
	3.3 µF to < 11 µF 10 Hz to 150 Hz	0.21 % + 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	0.36 % + 78 nF	
	110 µF to < 330 µF DC to 50 Hz	0.36 % + 0.23 µF	
	0.33 mF to < 1.1 mF DC to 20 Hz	0.36 % + 0.78 µF	
	1.1 mF to < 3.3 mF DC to 2 Hz	0.36 % + 2.3 µF	
	3.3 mF to < 11 mF DC to 6 Hz	0.36 % + 7.8 µF	
	11 mF to < 33 mF DC to 0.6 Hz	0.61 % + 23 µF	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance - Measuring Equipment [1]	33 mF to < 110 mF DC to 0.2 Hz	0.90 % + 78 µF	5520A
Inductance – Measure 60 Hz to 1 kHz	1 mH to 10 mH	0.034 % + 0.1 µH	GenRad 1689M
	10 mH to 10 H	0.034 % + 1.4 µH	
Inductance – Measuring Equipment [1] 1 kHz	1 mH	0.12 %	Standard Inductor
	10 mH	0.12 %	
	100 mH	0.12 %	
Electrical Simulation of Thermocouple Devices [1] Type B	250°C to 350°C	1.0°C	Ectron 1140A
	350°C to 445°C	0.77°C	
	445°C to 580°C	0.61°C	
	580°C to 750°C	0.47°C	
	750°C to 1000°C	0.39°C	
	1000°C to 1820°C	0.31°C	
Type E	-270°C to -245°C	2.1°C	
	-245°C to -195°C	0.20°C	
	-195°C to -155°C	0.11°C	
	-155°C to -90°C	0.09°C	
	-90°C to 0°C	0.08°C	
	0°C to 15°C	0.08°C	
	15°C to 890°C	0.07°C	
	890°C to 1000°C	0.08°C	
Type J	-210 °C to -180 °C	0.13 °C	
	-180 °C to -120 °C	0.11 °C	
	-120 °C to -50 °C	0.09 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type J	-50 °C to 990 °C	0.08 °C	Ectron 1140A
	990 °C to 1200 °C	0.08 °C	
Type K	-270°C to -255°C	2.3°C	Ectron 1140A
	-255 °C to -195 °C	0.73 °C	
	-195 °C to -115 °C	0.14 °C	
	-115 °C to -55 °C	0.10 °C	
	-55 °C to 1000 °C	0.08 °C	
	1000 °C to 1372 °C	0.09 °C	
Type N	-270°C to -260°C	5.1°C	
	-260°C to -200°C	1.1°C	
	-200°C to -140°C	0.25°C	
	-140 °C to -70 °C	0.16 °C	
	-70 °C to 25°C	0.13 °C	
	25°C to 160 °C	0.11 °C	
	160 °C to 1300 °C	0.10 °C	
Type R	-50°C to -30°C	0.68°C	
	-30°C to -45°C	0.58°C	
	-45°C to 160 °C	0.42 °C	
	160°C to 380 °C	0.31 °C	
	380 °C to 775 °C	0.28 °C	
	775 °C to 1768 °C	0.23 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type S	-50°C to -30°C	0.65°C	Ectron 1140A
	-30°C to 45°C	0.59°C	
	45°C to 105 °C	0.42 °C	
	105°C to 310 °C	0.35 °C	
	310 °C to 615 °C	0.31 °C	
	615 °C to 1768 °C	0.27 °C	
Type N	-270°C to -255°C	1.8°C	
	-255°C to -240°C	0.51°C	
	-240°C to -210°C	0.32°C	
	-210 °C to -150 °C	0.19°C	
	-150 °C to -40 °C	0.13 °C	
	-40°C to 100 °C	0.09 °C	
	100 °C to 400 °C	0.08 °C	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Power – Measuring Equipment (for current range listed below) DC Power [1] 0.33 mA to 330 mA	11 µW to 1.1 mW	0.024 %	Fluke 5520A
	1.1 mW to 110 mW	0.027 %	
	0.11W to 110 W	0.024 %	
	110 W to 330 W	0.018 %	
0.33 A to 3 A	11 W to 110 mW	0.044 %	
	0.11 W to 990 W	0.053 %	
	1 W to 3 kW	0.009 6 %	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
3 A to 20.5 A	0.099 W to 0.99 W	0.088 %	Fluke 5520A
	0.99 W to 6.8 kW	0.07 %	
	6.8 W to 20.5 kW	0.04 %	
AC Power [3] (PF = 1) 3.3 mA to 9 mA	0.11 mW to 3 mW 10 Hz to 65 Hz	0.13 %	
	3 mW to 9 W 10 Hz to 65 Hz	0.077 %	
9 mA to 33 mA	0.3 mW to 10 mW 10 Hz to 65 Hz	0.089 %	
	10 mW to 33W 10 Hz to 65 Hz	0.077 %	
33 mA to 90 mA	1 mW to 30 mW 10 Hz to 65 Hz	0.071 %	
	30 mW to 90 W 10 Hz to 65 Hz	0.057 %	
90 mA to 330 mA	3 mW to 100 mW 10 Hz to 65 Hz	0.089 %	
	100 mW to 300 W 10 Hz to 65 Hz	0.078 %	
0.33 A to 0.9 A	11 mW to 300 mW 10 Hz to 65 Hz	0.071 %	
	300 mW to 900 W		

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
	10 Hz to 65 Hz	0.081 %	Fluke 5520A
0.9 A to 2.2 A	30 mW to 720 mW 10 Hz to 65 Hz	0.089 %	
	720 mW to 2 kW 10 Hz to 65 Hz	0.079 %	
2.2 A to 4.5 A	80 mW to 1.4 W 10 Hz to 65 Hz	0.088 %	
	1.4 W to 4.5 kW 10 Hz to 65 Hz	0.18 %	
4.5 A to 20.5 A	150 mW to 6.7 W 10 Hz to 65 Hz	0.17 %	
	6.7 W to 20 kW 10 Hz to 65 Hz	0.17 %	
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
Sine Wave Flatness [1]	10 Hz to 1 MHz 1 MHz to 10 MHz	0.052 % 0.095 %	Ballantine 1395B

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Sine Wave Flatness [1]	10 MHz to 30 MHz	0.18 %	Ballantine 1395B
	30 MHz to 50 MHz	0.41 %	
	50 MHz to 80 MHz	0.71 %	
	80 MHz to 100 MHz	0.84 %	
Absolute RF Power- 30 dBm to 20 dBmThis will become relative move to R18	100 kHz to 4.2 GHz	1.7 %	Agilent 437 with 8482A

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Angles	0° to 75°	5.3”	Angle Blocks
	90°	1.2”	Master Square
Gage Blocks English	0.05 in to 1 in	(1.5 + 1.4*L*) µin	Federal Comparator and Fed GGG-G15c Grade 1 Blocks
	1 in to 4 in	(0.7 + 1.9*L*) µin	
Metric	1 mm to 10 mm	(0.032 + 3*X*) µm	
	10 mm to 100 mm	(0.07 + 1.5*X*) µm	
Micrometers and Calipers – Outside, Inside, Depth, Step [1]	0 in to 8 in	(20 + 5*L*) µin	Comparison to Gage Blocks
	8 in to 48 in	(13 + 7*L*) µin	
Anvil Flatness [1]	0 in to 3 in	6.7 µin	Optical Flats
Length Measurement – Single Axis	0 in to 6 in	(9 + 4*L*) µin	Supermicrometer and Gage Blocks
	6 in to 10 in	(2 + 5*L*) µin	
Digital and Dial Indicators [1]	0 in to 6 in	(4 + 7*L*) µin	Comparison to Gage Blocks, or to Supermicrometer

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [4]	Reference Standard, Method and/or Equipment
Height Measuring Equipment [1]	0 in to 8 in	(30 + 2*L*) µin	Comparison to Gage Blocks
	8 in to 44 in	(10 + 4*L*) µin	
Height – Measure [1]	0 in to 8 in	(37 + 2*L*) µin	Comparison to Gage Blocks using Test Indicator and Electronic Amplifier
	8 in to 44 in	(11 + 4*L*) µin	
Parallelism & Straightness	0 in to 3 in	(20 + 3.2*L*) µin	Gage Amp & Surface Plate
	3 in to 24 in	(30 + 3.2*L*) µin	
2D Length - Measure	X Axis: 0 in to 9 in	290 µin	Optical Comparator
	Y Axis: 0 in to 4 in	290 µin	
Optical Comparator X Axis	0.05 in to 12 in	200 µin	Glass Grid
Y Axis	0.05 in to 12 in	200 µin	
X-Y Axis	0.05 in to 12 in	260 µin	Cylindrical Square
Outside Diameter – Plug/Pin Gages	0 in to 1 in	33 µin	Laser Micrometer and Master Pins/Plugs
Laser Micrometers	0 in to 1 in	(13 + 3.2*L*) µin	Master Pins
Tapes and Rulers [1]	(0 to 96) in	0.006 in + 14 µin/in	Glass Scale

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Force Measuring Equipment – Tension and Compression [1]	0 lbf to 500 lbf	0.027 % + 0.001 lbf	Dead Weight – NIST Class F Weights
	50 lbf to 500 lbf	0.31 lbf	Interface Gold System
	500 lbf to 2 000 lbf	0.45 lbf	
	2 000 lbf to 5 000 lbf	1.9 lbf	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Force Measuring Equipment – Tension and Compression [1]	5000 lbf to 10 000 lbf	1.5 lbf	Interface Gold System
	10 000 lbf to 25 000 lbf	3.9 lbf	
Mass - Metric	30 kg	33 mg	Echelon III
	25 kg	33 mg	
	20 kg	19 mg	
	10 kg	9.0 mg	
	5 kg	3.7 mg	
	2 kg	3.3 mg	
	1 kg	1.1 mg	
	500 g	0.37 mg	
	200 g	0.18 mg	
	100 g	0.23 mg	
	50 g	97 µg	
	20 g	70 µg	
	10 g	35 µg	
	5 g	21 µg	
	2 g	27 µg	
	1 g	29 µg	
	500 mg	17 µg	
	200 mg	17 µg	
	100 mg	16 µg	
	50 mg	16 µg	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Mass - Metric	20 mg	16 µg	Echelon III
	10 mg	16 µg	
	5 mg	16 µg	
	2 mg	16 µg	
	1 mg	16 µg	
Mass - Avoirdupois	50 lb	110 µlb	Echelon III
	30 lb	100 µlb	
	20 lb	100 µlb	
	10 lb	18 µlb	
	5 lb	18 µlb	
	3 lb	16 µlb	
	2 lb	15 µlb	
	1 lb	15 µlb	
	8 oz	15 µlb	
	4 oz	5.1 µlb	
	2 oz	5.1 µlb	
	1 oz	5.1 µlb	
	0.5 oz	5.1 µlb	
Rockwell Hardness Measuring Equipment [1]	HRC High Middle Low	 0.53 HRC 0.73 HRC 0.92 HRC	Hardness Blocks

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Rockwell Hardness Measuring Equipment [1]	HRBw High Middle Low	 1.2 HRBw 1.2 HRBw 1.3 HRBw	Hardness Blocks
Durometer [1]	Type A, B, O	0.31 durometer units	Duro Calibrator ASTM D2240
	Type D, C, DO	0.16 durometer units	
Torque – Measure [1]	2.5 ozf·in to 1 000 lbf·ft	0.50 %	CDI 2000 Torque System
	1 000 lbf·ft to 2 000 lbf·ft	0.39 %	
Torque – Measuring Equipment [1]	2.5 ozf·in to 500 lbf·ft	0.055 %	Wheels/Arms & NIST Class F Weights
	500 lbf·in to 1 000 lbf·ft	0.074 %	
Balances & Scales – Metric [1]	30 kg	30 mg	Characterized ASTM Class1 Mass Standards
	25 kg	27 mg	
	20 kg	24 mg	
	10 kg	8.8 mg	
	5 kg	3.4 mg	
	2 kg	2.0 mg	
	1 kg	1.2 mg	
	500 g	0.38 mg	
	200 g	0.18 mg	
	100 g	0.12 mg	
	50 g	0.10 mg	
	20 g	81 µg	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Balances & Scales – Metric [1]	10 g	77 µg	Characterized ASTM Class1 Mass Standards
	5 g	32 µg	
	2 g	16 µg	
	1 g	16 µg	
	500 mg	16 µg	
	200 mg	18 µg	
	100 mg	17 µg	
	50 mg	16 µg	
	20 mg	16 µg	
	10 mg	16 µg	
	5 mg	16 µg	
	2 mg	16 µg	
	1 mg	16 µg	
Avoirdupois	1 lb to 500 lb	0.013 %	NIST Class F Weights
Absolute Pressure Source – Pneumatic	0 psia to 30 psia	0.002 4 psia	DHI PPC4 w/ RPM4 Indicator
	30 psia to 1 000 psia	0.006 7 % + 0.000 48 psia	
Gage Pressure Pneumatic [1]	-15 psig to 30 psig	0.002 psi	
	30 psi to 1 000 psi	0.006 7 % + 0.000 1 psi	
	-2 inH_2O to 2 inH_2O	0.000 61 inH_2O	Dwyer 1430 Microtetor
	-36 inH_2O to -22 inH_2O	0.009 % + 150 µinH_2O	DHI PPC 4 Controller
	-22 inH_2O to 22 inH_2O	0.002 2 inH_2O	
	22 inH_2O to 60 inH_2O	0.009 5 % + 150 µinH_2O	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Gage Pressure Pneumatic [1]	60 inH_2O to 72 inH_2O	0.006 6 inH_2O	DHI PPC 4 Controller
	72 inH_2O to 804 inH_2O	0.009 5 % + 150 µinH_2O	
	0.14 psig to 25 psig	0.018 % + 44 µpsi	Ametek RK-1100 WC
Gage Pressure, Hydraulic [1]	10 psig to 16 000 psig	0.012 %	Pressurements P3125-3

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Relative Humidity – Measuring Equipment (0°C to 70°C)	10 % RH to 90 % RH	0.5 % RH	Thunder Scientific 2500
Relative Humidity – Measure [1] (10°C to 30°C)	20 % RH to 80 % RH	1.3 % RH	Vaisala HMI41/HMP46
Temperature Measuring Equipment	-80 °C to 100 °C	0.022 °C	Liquid Bath/Hart 5628
	100 °C to 200 °C	0.023 °C	
	200 °C to 300 °C	0.070 °C	Dry Block/Hart 5628
	300 °C to 600 °C	0.085 °C	
Temperature Measure [1]	-195 °C to 0 °C	0.012 °C + 0.001 %	Hart 5628
	0 °C to 420 °C	0.026 °C + 0.001 %	
	420°C to 600 °C	0.036 °C + 0.001 %	
Infrared Temperature Measuring Equipment	-15 °C to 0 °C	0.79 °C	Fluke Black Body
	0 °C to 50 °C	0.53 °C	
	50 °C to 100 °C	0.68 °C	
	100 °C to 120 °C	0.75 °C	

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Infrared Temperature Measuring Equipment	120 °C to 200 °C	0.98 °C	Fluke Black Body
	200 °C to 350 °C	1.7 °C	
	350 °C to 500 °C	2.3 °C	

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Frequency – Source and Measure In-Lab	10 MHz	5.9×10^{-10}	Rubidium Oscillator
Field [1]	10 MHz	2.9×10^{-9}	HP 5328A Counter
Total Harmonic Distortion 5 Hz to 600 kHz Fundamental Input Voltage Range < 30 V			Agilent 334A
100 % to 0.3 %	10 Hz to 1 MHz	3.5 %	
	1 MHz to 3 MHz	6.9 %	
0.1 %	10 Hz to 20 Hz	14 %	
	20 Hz to 30 Hz	6.9 %	
	30 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
	500 kHz to 1.2 MHz	14 %	
Input Voltage Range > 30 V	10 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
100 % to 0.3 %	500 kHz to 3 MHz	14 %	

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Input Voltage Range > 30 V 0.1 %	10 Hz to 20 Hz	14 %	Agilent 334A
	20 Hz to 30 Hz	6.9 %	
	30 Hz to 300 kHz	3.5 %	
	300 kHz to 500 kHz	6.9 %	
	500 kHz to 1.2 MHz	14 %	
Total Harmonic Distortion	0 dBc to -80 dBc 10 Hz to 2 GHz	1.8 dB	Agilent 8563E and 8903B
Rise Time – Generate	≥ 150 ps	42 ps	Fluke 9500B
Rise Time – Measure	≥ 800 ps	930 ps	TDS 5054 Oscilloscope

Acoustics and Vibration

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Measuring Equipment Harmonic Frequency Range 125 Hz to 2 kHz	74 dB to 104 dB	0.46 dB	GenRad 1986
4 kHz		0.73 dB	
125 Hz to 2 kHz	114 dB	0.37 dB	
4 kHz		0.62 dB	

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. L = Length in inches; X = Length in millimeters.
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.07.

Vice President