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 – Houston
1181 Brittmoore Road, Suite 600
Houston, TX 77043

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-2489.02
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)

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CALIBRATION

Valid to: **September 7, 2019** Certificate Number: **AC-2489.02**

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measuring and Measuring Equipment [1]	0 µA to 220 µA		Fluke 5720A
	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 % + 110 nA	
	5 kHz to 10 kHz	0.11 % + 650 nA	
	2.2 mA to 22 mA		
	10 Hz to 20 Hz	0.039 % + 400 nA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measuring and Measuring Equipment [1]	20 Hz to 40 Hz	0.019 % + 350 nA	Fluke 5720A
	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	0.033 % + 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	0.021 % + 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	0.046 % + 80 µA	
	5 kHz to 10 kHz	0.7 % + 160 µA	
	2.2 A to 11 A		Fluke 5720A w/5725A
	40 Hz to 1 kHz	0.048 % + 170 µA	
	1 kHz to 5 kHz	0.096 % + 380 µA	
	5 kHz to 10 kHz	0.36 % + 750 µA	
	11 A to 20.5 A		Fluke 5520A
	45 Hz to 100 Hz	0.097 % + 3.8 mA	
	100 Hz to 1 kHz	0.12 % + 3.8 mA	
	1 kHz to 5 kHz	2.3 % + 3.8 mA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Extended Frequency Ranges	29 µA to 330 µA 10 kHz to 30 kHz	1.2 % + 0.31 µA	Fluke 5520A
	0.33 mA 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	0.3 % + 26 mA	Fluke 5520A, 1 kA 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, 1 kA Coil
	20 A to 150 A 65 Hz to 440 Hz	1 % + 0.25 A	
	150 A to 1000 A 45 Hz to 65 Hz	0.6 % + 0.9 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 65 Hz to 440 Hz	1.3 % + 0.92 A	Fluke 5520A, 1 kA Coil
	1 000 A to 6 000 A 10 Hz to 300 Hz	0.62 %	Fluke 52120A, 5520A, 6 kA Coil
	1000 A to 2000A 300 Hz to 440 Hz	0.8 %	
	2000A to 6000 A 300 Hz to 440 Hz	0.66 %	
AC Current – Measure [1]	0 µA to 100 µA 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 5 kHz	 0.46 % + 35 nA 0.18 % + 35 nA 0.072 % + 35 nA	Agilent 3458A opt 2
	0.1 mA 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 % + 0.23 µA 0.17 % + 0.23 µA 0.071 % + 0.23 µA 0.038 % + 0.23 µA	
	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 % + 2.3 µA 0.17 % + 2.3 µA 0.071 % + 2.3 µA 0.038 % + 2.3 µA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current – Measure [1]	10 mA to 100 mA		Agilent 3458A opt 2
	10 Hz to 20 Hz	0.46 % + 23 µA	
	20 Hz to 45 Hz	0.17 % + 23 µA	
	45 Hz to 100 Hz	0.071 % + 23 µA	
	100 Hz to 5 kHz	0.037 % + 23 µA	
	0.1 A to 1 A		
	10 Hz to 20 Hz	0.46 % + 0.23 mA	
	20 Hz to 45 Hz	0.19 % + 0.23 mA	
	45 Hz to 100 Hz	0.097 % + 0.23 mA	
	100 Hz to 5 kHz	0.12 % + 0.23 mA	
	1 A to 3 A		Fluke 8846A
	3 Hz to 5 Hz	1.3 % + 2 mA	
	5 Hz to 10 Hz	0.41 % + 2 mA	
	10 Hz to 5 kHz	0.18 % + 2 mA	
	5 kHz to 10 kHz	0.41 % + 24 mA	
	3 A to 10 A		
	3 Hz to 5 Hz	1.1 % + 13 mA	
	5 Hz to 10 Hz	0.41 % + 7 mA	
	10 Hz to 5 kHz	0.18 % + 7 mA	
	5 kHz to 10 kHz	0.42 % + 81 mA	
	10 A to 100 A		Shunt
	10 Hz to 1 kHz	0.12 % + 1mA	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Resistance – Measuring Equipment and Measure	0 Ω (floor) to < 100 µΩ	0.63 nΩ	Standard Resistors with Current Source and DMM
	100 µΩ to < 1 mΩ	9.2 µΩ/Ω	
	1 mΩ to < 10 mΩ	3.6 µΩ/Ω	
	10 mΩ to < 100 mΩ	3.3 µΩ/Ω	
	0.1 Ω to < 1 Ω	5.2 µΩ/Ω	
	1 Ω to < 10 Ω	0.17 µΩ/Ω	Standard Resistors with MI 6242B Bridge
	10 Ω to < 100 Ω	0.22 µΩ/Ω	
	100 Ω to < 1 kΩ	0.32 µΩ/Ω	
	1 kΩ to < 10 kΩ	0.64 µΩ/Ω	
	10 kΩ to < 100 kΩ	0.19 µΩ/Ω	
	100 kΩ to < 1 MΩ	0.69 µΩ/Ω	
	1 MΩ to < 10 MΩ	2.8 µΩ/Ω	
	10 MΩ to < 100 MΩ	6.3 µΩ/Ω	
DC Resistance – Measure	100 MΩ to < 1 GΩ	20 µΩ/Ω	Standard Resistors with 8508 (Double Substitution)
	1 GΩ to < 20 GΩ	140 µΩ/Ω	
DC Resistance – Measuring Equipment	10 MΩ	3.9 µΩ/Ω	Standard Resistor
	100 MΩ	15 µΩ/Ω	
	1 GΩ	39 µΩ/Ω	
Resistance Ratio	1 Ω to 1 kΩ	0.2 µΩ/Ω	MI 6242B Bridge
DC Resistance – Measuring Equipment and Measure [1]	0 mΩ to 10 Ω	18 µΩ/Ω + 50 µΩ	HP3458A with Decade Resistor
	10 Ω to 100 Ω	15 µΩ/Ω + 500 µΩ	
	100 Ω to 1 kΩ	12 µΩ/Ω + 500 µΩ	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Resistance – Measuring Equipment and Measure [1]	1 kΩ to 10 kΩ	12 μΩ/Ω + 5 mΩ	HP3458A with Decade Resistor
	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	
DC Resistance – Measuring Equipment and Measure [1]	10 MΩ to 100 MΩ	0.08 %	IET HRRS-B-7-100k-5kV
	100 MΩ to 1 GΩ	0.25 %	
	1 GΩ to 10 GΩ	0.41 %	
	10 GΩ to 100 GΩ	0.84 %	
	100 GΩ to 1 TΩ	2.5 %	
DC Current – Measuring Equipment and Measure	0 A (floor) ≤ I < 100nA	1.5 pA	Standard Shunts with Current Source
	100 nA ≤ I < 1μA	22 μA/A	
	1 μA ≤ I < 10 μA	7.3 μA/A	
	10 μA ≤ I < 100 μA	6.7 μA/A	
	100 μA ≤ I < 1 mA	2 μA/A	
	1 mA ≤ I < 10 mA	2 μA/A	
	10 mA ≤ I < 100 mA	1.9 μA/A	
	100 mA ≤ I < 1 A	2.1 μA/A	
	1 A ≤ I < 10 A	6.0 μA/A	
	10 A ≤ I < 20 A	5.2 μA/A	
	20 A ≤ I ≤ 30 A	7.8 μA/A	
	30 A < I ≤ 100 A	26 μA/A	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Current – Measuring Equipment and Measure [1]	0 µA to 100 µA	26 µA/A + 0.92 nA	HP3458A with Current Source
	100 µA to 1 mA	26 µA/A + 5.8 nA	
	1 mA to 10 mA	26 µA/A + 58 nA	
	10 mA to 100 mA	43 µA/A + 0.58 µA	
	100 mA to 1 A	130 µA/A + 12 µA	
DC Current – Measure [1]	1 A to 3 A	0.14 %	Fluke 8846A
	3 to 10	0.18 % + 0.8mA	
	10 A to 20 A	0.023 % + 0.9mA	Current Shunt
	20 A to 25 A	5.5 mA	
	25 A to 100 A	0.012 %	
Clamp-on Ammeter Non-Toroidal Type [1]	20 A to 150 A	0.51 % + 0.14 A	Fluke 5520A, 55120A 1 kA and 6 kA Coils
	150 A to 1000 A	0.51 % + 0.5 A	
	1000 A to 5000 A	0.58 %	
DC Voltage – Fixed Points Measuring Equipment and Measure	0 V (floor)	59 nV	Ratio Metric with Zener
	100 mV	0.80 µV/V	
	1 V	0.29 µV/V	
	10 V	0.2 µV/V	
	19 V	0.46 µV/V	
	100 V	0.28 µV/V	
	1000 V	0.54 µV/V	
	1 mV ≤ V < 10mV	110 µV/V	Fluke 8508
	10 mV	13 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
DC Voltage – Fixed Points Measuring Equipment and Measure	10 mV < V < 100 mV	8.6 µV/V	Fluke 8508
	100 mV < V ≤ 1 kV	0.61 µV/V + 0.059 µV	
DC Voltage – Measuring Equipment and Measure [1]	0 V to 100 mV	7.1 µV/V + 0.58 µV	HP3458A opt 2 with 5720A
	100 mV to 10 V	5.1 µV/V + 0.58 µV	
	10 V to 100 V	7.6 µV/V + 35 µV	
	100 V to 500 V	11 µV/V + 120 µV	
	500 V to 800 V	16 µV/V + 120 µV	
	800 V to 1100 V	21 µV/V + 120 µV	
DC Voltage- Measure [1]	1 kV to 10 kV	0.049% + 0.62 V	Vitrek 4700
	10 kV to 20 kV	0.08% + 0.35 V	4700A w/HVP-35
	20 kV to 35 kV	0.14% + 1 V	
	15 kV to 30 kV	0.065% + 1 V	4700A w/HVL-70
	30 kV to 45 kV	0.09% + 3 V	
	45 kV to 70 kV	0.17% + 1 V	
	25 kV to 100 kV	0.11% + 0.5 V	4700 w/HVL-100
AC Voltage – Measure [1]	0 mV to 10 mV		Agilent 3458A opt 2
	1 Hz to 40 Hz	0.039 % + 3.5 µV	
	40 Hz to 1 kHz	0.028 % + 1.2 µV	
	1 kHz to 20 kHz	0.038 % + 1.2 µV	
	20 kHz to 50 kHz	0.15 % + 1.2 µV	
	50 kHz to 100 kHz	0.59 % + 1.2 µV	
	100 kHz to 300 kHz	4.6 % + 2.3 µV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	10 mV to 100 mV		Agilent 3458A opt 2
	1 Hz to 40 Hz	0.013 % + 4.6 µV	
	40 Hz to 1 kHz	0.009 5 % + 2.3 µV	
	1 kHz to 20 kHz	0.017 % + 2.3 µV	
	20 kHz to 50 kHz	0.037 % + 2.3 µV	
	50 kHz to 100 kHz	0.093 % + 2.3 µV	
	100 kHz to 300 kHz	0.36 % + 12 µV	
	300 kHz to 1 MHz	1.2 % + 12 µV	
	100 mV to 1 V		
	1 Hz to 40 Hz	0.009 8 % + 46 µV	
	40 Hz to 1 kHz	0.009 5 % + 23 µV	
	1 kHz to 20 kHz	0.017 % + 23 µV	
	20 kHz to 50 kHz	0.036 % + 23 µV	
	50 kHz to 100 kHz	0.093 % + 23 µV	
	100 kHz to 300 kHz	0.35 % + 0.12 mV	
	300 kHz to 1 MHz	1.2 % + 0.12 mV	
	1 V to 10 V		
	1 Hz to 40 Hz	0.009 5 % + 0.46 mV	
	40 Hz to 1 kHz	0.009 5 % + 0.23 mV	
	1 kHz to 20 kHz	0.017 % + 0.23 mV	
	20 kHz to 50 kHz	0.036 % + 0.23 mV	
	50 kHz to 100 kHz	0.093 % + 0.23 mV	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	100 kHz to 300 kHz	0.35 % + 1.2 mV	Agilent 3458A opt 2
	300 kHz to 1 MHz	1.2 % + 1.2 mV	
	10 V to 100 V		
	1 Hz to 40 Hz	0.024 % + 4.6 mV	
	40 Hz to 1 kHz	0.024 % + 2.3 mV	
	1 kHz to 20 kHz	0.024 % + 2.3 mV	
	20 kHz to 50 kHz	0.041 % + 2.3 mV	
	50 kHz to 100 kHz	0.14 % + 2.3 mV	
	100 kHz to 300 kHz	0.46 % + 12 mV	
	300 kHz to 1 MHz	1.7 % + 12 mV	
	100 V to 700 V		
	1 Hz to 40 Hz	0.047 % + 46 mV	
	40 Hz to 1 kHz	0.047 % + 23 mV	
	1 kHz to 20 kHz	0.071 % + 23 mV	
	20 kHz to 50 kHz	0.14 % + 23 mV	
	50 kHz to 100 kHz	0.35 % + 23 mV	
	700 V to 10 kV		Vitrek 4700A
	60 Hz	0.17 % + 0.16 V	
	10 kV to 20 kV		4700A w/HVP-35
	60 Hz	0.17 % + 0.6V	
	20 kV to 35 kV		
	60 Hz	0.23 % + 3.5 V	
	12.5 kV to 25 kV		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measure [1]	60 Hz	0.15 % + 1.4 V	4700A w/HVL-70
	25 kV to 37.5 kV 60 Hz	0.16 % + 2.8 V	
	37.5 kV to 50 kV 60 Hz	0.2 % + 0.2 V	
	25 kV to 75 kV 60 Hz	0.19 % + 3.5 V	4700A w/HVL-100
AC Voltage – Measuring Equipment and Measure [1]	0 mV to 2.2 mV		Fluke 5720A
	10 Hz to 20 Hz	0.16 % + 4 µV	
	20 Hz to 40 Hz	0.1 % + 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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment and Measure [1]	100 kHz to 300 kHz	0.12 % + 10 µV	Fluke 5720A
	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 5 % + 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	
	220 mV to 2.2 V		
	10 Hz to 20 Hz	0.027 % + 40 µV	
	20 Hz to 40 Hz	0.01 % + 15 µV	
	40 Hz to 20 kHz	0.004 8 % + 8.0 µV	
	20 kHz to 50 kHz	0.008 % + 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 % + 200 µV	
	500 kHz to 1 MHz	0.18 % + 300 µV	
	2.2 V to 22 V		

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment and Measure [1]	10 Hz to 20 Hz	0.028 % + 0.4 mV	Fluke 5720A
	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	0.1 % + 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 % + 40 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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Voltage – Measuring Equipment [1]	220 V to 750 V 30 kHz to 50 kHz 50 kHz to 100 kHz	0.061 % + 11 mV 0.23 % + 45 mV	Fluke 5720A/5725A
Capacitance – Measure: 10 Hz to 1 MHz	0.33 mF	0.048 %	Time/Charge Method with HP3458A
	0.8 mF	0.027 %	
	1 mF	0.024 %	
	1.2 mF	0.023 %	
	3 mF	0.018 %	
	3.3 mF	0.017 %	
	8 mF	0.016 %	
	10 mF	0.016 %	
	12 mF	0.016 %	
	30 mF	0.015 %	
	80 mF	0.014 %	
	100 mF	0.014 %	
Capacitance – Measure	0.1 pF 100 kHz 1 MHz	 1.4 % 1.8 %	Agilent E4980A LCR
	1 pF 10 kHz 100 kHz 1 MHz 2 MHz	 1.4 % 0.37 % 0.44 % 1.1 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance – Measure	10 pF		Agilent E4980A LCR
	1 kHz	1.4 %	
	10 kHz	0.28 %	
	100 kHz	0.28 %	
	1 MHz	0.3 %	
	2 MHz	0.75 %	
	100 pF		
	100 Hz	2.1 %	
	1 kHz	0.23 %	
	10 kHz	0.17 %	
	100 kHz	0.21 %	
	1 MHz	0.23 %	
	2 MHz	0.3 %	
	1 nF		
	20 Hz	1.8 %	
	100 Hz	0.3 %	
	1 kHz	0.1 %	
	10 kHz	0.1 %	
	100 kHz	0.1 %	
	1 MHz	0.14 %	
	2 MHz	0.53 %	
	10 nF		
	20 Hz	0.31 %	
	100 Hz	0.12 %	
	1 kHz	0.092 %	
	10 kHz	0.092 %	
	100 kHz	0.092 %	
	1 MHz	0.25 %	
	2 MHz	0.67 %	
	100 nF		
	20 Hz	0.16 %	
	100 Hz	0.092 %	
	1 kHz	0.092 %	
	10 kHz	0.092 %	
	100 kHz	0.18 %	
	1 MHz	0.33 %	
	2 MHz	0.97 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance – Measure	1 µF 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	 0.15 % 0.092 % 0.092 % 0.18 % 0.25 % 0.79 %	Agilent E4980A LCR
	10 µF 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	 0.15 % 0.092 % 0.16 % 0.28 % 0.73 %	
	100 µF 20 Hz 100 Hz 1 kHz 10 kHz	 0.16 % 0.17 % 0.29 % 0.8 %	
Capacitance – Source [1]	0.19 nF to 3.3 nF 10 Hz to 10 kHz	0.39 % + 7.8 pF	Fluke 5520A
	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	
	110 nF to 330 nF 10 Hz to 1 kHz	0.21 % + 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	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Capacitance – Source [1]	3.3 µF to 11 µF 10 Hz to 150 Hz	0.2 % + 7.8 nF	Fluke 5520A
	11 µF to 33 µF 10 Hz to 120 Hz	0.31 % + 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	0.35 % + 0.23 µF	
	0.33 mF to 1.1 mF DC to 20 Hz	0.35 % + 0.78 µF	
	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 – Source [1]	100 mH 1 kHz	0.02 %	Fixed Inductor
Inductance – Measure [3]	1 µH 10 kHz 100 kHz 1 MHz 2 MHz	 1.6 % 0.36 % 0.27 % 0.66 %	Agilent E4980A LCR

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Inductance – Measure [3]	10 µH		Agilent E4980A LCR
	10 kHz	0.37 %	
	100 kHz	0.2 %	
	1 MHz	0.2 %	
	2 MHz	0.3 %	
	100 µH		
	1 kHz	0.4 %	
	10 kHz	0.2 %	
	100 kHz	0.12 %	
	1 MHz	0.14 %	
	2 MHz	0.72 %	
	1 mH		
	100 Hz	0.55 %	
	1 kHz	0.18 %	
	10 kHz	0.12 %	
	100 kHz	0.092 %	
	1 MHz	0.23 %	
	2 MHz	0.88 %	
	10 mH		
	20 Hz	0.85 %	
	100 Hz	0.22 %	
	1 kHz	0.092 %	
	10 kHz	0.092 %	
	100 kHz	0.1 %	
	1 MHz	0.35 %	
	2 MHz	1.3 %	
	100 mH		
	20 Hz	0.28 %	
	100 Hz	0.1 %	
	1 kHz	0.092 %	
	10 kHz	0.092 %	
	100 kHz	0.21 %	
	1 MHz	0.88 %	
	1 H		
	20 Hz	0.16 %	
	100 Hz	0.092 %	
	1 kHz	0.092 %	
	10 kHz	0.1 %	
	100 kHz	0.31 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Inductance – Measure [3]	10 H 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	 0.15 % 0.092 % 0.1 % 0.21 % 0.69 %	Agilent E4980A LCR
	100 H 20 Hz 100 Hz 1 kHz 10 kHz	 0.15 % 0.1 % 0.15 % 0.62 %	
DC Volts – Measuring Equipment	1 mV	2.6024 %	Fluke 9500B with Fluke 9530 head
	10 mV	0.68377 %	
	100 mV	0.051867 %	
	1 V	0.0064 %	
	10 V	0.026 7 %	
	100 V	0.026 4 %	
Flatness Relative to 1 kHz	7 V / 3.2 V 10 Hz	0.007 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	20 Hz	0.008%	
	50 Hz	0.005 %	
	105 Hz	0.008 %	
	200 Hz	0.005 %	
	2 kHz	0.006 %	
	10 kHz	0.007 %	
	20 kHz	0.007%	
	50 kHz	0.006 %	
	100 kHz	0.005 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	200 kHz	0.007 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	500 kHz	0.006 %	
	700 kHz	0.011 %	
	1 MHz	0.012 %	
	1.2 MHz	0.012 %	
	2 MHz	0.015 %	
	3 MHz	0.019 %	
	4 MHz	0.019%	
	6 MHz	0.024 %	
	8 MHz	0.029 %	
	9 MHz	0.027 %	
	10 MHz	0.028 %	
	12 MHz	0.041 %	
	15 MHz	0.042%	
	17 MHz	0.048 %	
	20 MHz	0.052 %	
	23 MHz	0.072 %	
	26 MHz	0.085 %	
	28 MHz	0.094 %	
	30 MHz	0.11 %	
	2.2 V / 2 V 10 Hz	0.011 %	
	20 Hz	0.01 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	50 Hz	0.006 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	105 Hz	0.009 %	
	200 Hz	0.006 %	
	2 kHz	0.006 %	
	10 kHz	0.007 %	
	20 kHz	0.007 %	
	50 kHz	0.007%	
	100 kHz	0.006 %	
	200 kHz	0.007 %	
	500 kHz	0.007 %	
	700 kHz	0.012 %	
	1 MHz	0.013 %	
	1.2 MHz	0.013 %	
	2 MHz	0.016 %	
	3 MHz	0.021 %	
	4 MHz	0.022 %	
	6 MHz	0.026 %	
	8 MHz	0.031 %	
	9 MHz	0.03 %	
	10 MHz	0.033 %	
	12 MHz	0.044 %	
	15 MHz	0.046 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	17 MHz	0.054 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	20 MHz	0.057 %	
	23 MHz	0.075%	
	26 MHz	0.087 %	
	28 MHz	0.096 %	
	30 MHz	0.11 %	
	2.2 V / 1 V 10 Hz	0.011 %	
	20 Hz	0.012 %	
	50 Hz	0.006 %	
	105 Hz	0.008 %	
	200 Hz	0.006 %	
	2 kHz	0.006 %	
	10 kHz	0.007 %	
	20 kHz	0.007 %	
	50 kHz	0.007 %	
	100 kHz	0.007 %	
	200 kHz	0.008 %	
	500 kHz	0.007 %	
	700 kHz	0.013 %	
	1 MHz	0.013 %	
	1.2 MHz	0.013 %	
	2 MHz	0.016 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	3 MHz	0.02 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	4 MHz	0.021 %	
	6 MHz	0.026 %	
	8 MHz	0.03 %	
	9 MHz	0.029 %	
	10 MHz	0.03 %	
	12 MHz	0.043 %	
	15 MHz	0.044 %	
	17 MHz	0.051 %	
	20 MHz	0.056 %	
	23 MHz	0.074 %	
	26 MHz	0.087 %	
	28 MHz	0.097 %	
	30 MHz	0.11 %	
	0.7 V / 0.64 V 10 Hz	0.014 %	
	20 Hz	0.013 %	
	50 Hz	0.007 %	
	105 Hz	0.009 %	
	200 Hz	0.006 %	
	2 kHz	0.007 %	
	10 kHz	0.008 %	
	20 kHz	0.008 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	50 kHz	0.007 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	100 kHz	0.007 %	
	200 kHz	0.008 %	
	500 kHz	0.007 %	
	700 kHz	0.013 %	
	1 MHz	0.014 %	
	1.2 MHz	0.014 %	
	2 MHz	0.017 %	
	3 MHz	0.022 %	
	4 MHz	0.023 %	
	6 MHz	0.028 %	
	8 MHz	0.033 %	
	9 MHz	0.032 %	
	10 MHz	0.035 %	
	12 MHz	0.047 %	
	15 MHz	0.049 %	
	17 MHz	0.057 %	
	20 MHz	0.062 %	
	23 MHz	0.079 %	
	26 MHz	0.091 %	
	28 MHz	0.1 %	
	30 MHz	0.11 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	0.7 V / 0.32 V 10 Hz	0.015 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	20 Hz	0.014 %	
	50 Hz	0.008 %	
	105 Hz	0.009 %	
	200 Hz	0.007 %	
	2 kHz	0.008 %	
	10 kHz	0.008 %	
	20 kHz	0.008 %	
	50 kHz	0.007 %	
	100 kHz	0.007 %	
	200 kHz	0.008 %	
	500 kHz	0.009 %	
	700 kHz	0.014 %	
	1 MHz	0.017 %	
	1.2 MHz	0.016 %	
	2 MHz	0.017 %	
	3 MHz	0.023 %	
	4 MHz	0.022 %	
	6 MHz	0.028 %	
	8 MHz	0.035 %	
	9 MHz	0.034 %	
	10 MHz	0.035 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	12 MHz	0.049 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	15 MHz	0.050 %	
	17 MHz	0.057 %	
	20 MHz	0.067 %	
	23 MHz	0.084 %	
	26 MHz	0.097 %	
	28 MHz	0.11 %	
	30 MHz	0.12 %	
	0.22 V / 0.1 V 10 Hz	0.017 %	
	20 Hz	0.017 %	
	50 Hz	0.008 %	
	105 Hz	0.009 %	
	200 Hz	0.007 %	
	2 kHz	0.008 %	
	10 kHz	0.008 %	
	20 kHz	0.009 %	
	50 kHz	0.008 %	
	100 kHz	0.008 %	
	200 kHz	0.009 %	
	500 kHz	0.009 %	
	700 kHz	0.015 %	
	1 MHz	0.018 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	1.2 MHz	0.017 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	2 MHz	0.018 %	
	3 MHz	0.024 %	
	4 MHz	0.023 %	
	6 MHz	0.03 %	
	8 MHz	0.037 %	
	9 MHz	0.035 %	
	10 MHz	0.037 %	
	12 MHz	0.052 %	
	15 MHz	0.053 %	
	17 MHz	0.059 %	
	20 MHz	0.071 %	
	23 MHz	0.087 %	
	26 MHz	0.1 %	
	28 MHz	0.11 %	
	30 MHz	0.12 %	
	0.07 V / 32 mV 10 Hz	0.019 %	
	20 Hz	0.018 %	
	50 Hz	0.009 %	
	105 Hz	0.01 %	
	200 Hz	0.008 %	
	2 kHz	0.009 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	10 kHz	0.009 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	20 kHz	0.009 %	
	50 kHz	0.009 %	
	100 kHz	0.009 %	
	200 kHz	0.01 %	
	500 kHz	0.01 %	
	700 kHz	0.016 %	
	1 MHz	0.018 %	
	1.2 MHz	0.017 %	
	2 MHz	0.018 %	
	3 MHz	0.025 %	
	4 MHz	0.024 %	
	6 MHz	0.031 %	
	8 MHz	0.037 %	
	9 MHz	0.036 %	
	10 MHz	0.037 %	
	12 MHz	0.052 %	
	15 MHz	0.053 %	
	17 MHz	0.059 %	
	20 MHz	0.071 %	
	23 MHz	0.088 %	
	26 MHz	0.1 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	28 MHz	0.12 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	30 MHz	0.12 %	
	22 mV / 10 mV 10 Hz	0.021 %	
	20 Hz	0.02 %	
	50 Hz	0.01 %	
	105 Hz	0.01 %	
	200 Hz	0.008 %	
	2 kHz	0.009 %	
	10 kHz	0.009 %	
	20 kHz	0.01 %	
	50 kHz	0.009 %	
	100 kHz	0.01 %	
	200 kHz	0.01 %	
	500 kHz	0.011 %	
	700 kHz	0.017 %	
	1 MHz	0.019 %	
	1.2 MHz	0.018 %	
	2 MHz	0.019 %	
	3 MHz	0.026 %	
	4 MHz	0.025 %	
	6 MHz	0.032 %	
	8 MHz	0.039 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	9 MHz	0.038 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	10 MHz	0.039 %	
	12 MHz	0.055 %	
	15 MHz	0.056 %	
	17 MHz	0.062 %	
	20 MHz	0.074 %	
	23 MHz	0.092 %	
	26 MHz	0.11 %	
	28 MHz	0.12 %	
	30 MHz	0.13 %	
	7 mV / 3.2 mV 10 Hz	0.022 %	
	20 Hz	0.022 %	
	50 Hz	0.011 %	
	105 Hz	0.011 %	
	200 Hz	0.009 %	
	2 kHz	0.01 %	
	10 kHz	0.01 %	
	20 kHz	0.01 %	
	50 kHz	0.009 %	
	100 kHz	0.01 %	
	200 kHz	0.011 %	
	500 kHz	0.011 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	700 kHz	0.018 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	1 MHz	0.02 %	
	1.2 MHz	0.019 %	
	2 MHz	0.019 %	
	3 MHz	0.027 %	
	4 MHz	0.026 %	
	6 MHz	0.034 %	
	8 MHz	0.041 %	
	9 MHz	0.04 %	
	10 MHz	0.041	
	12 MHz	0.057 %	
	15 MHz	0.06 %	
	17 MHz	0.065 %	
	20 MHz	0.079 %	
	23 MHz	0.097 %	
	26 MHz	0.11 %	
	28 MHz	0.13 %	
	30 MHz	0.13 %	
	2.2 mV / 1 mV 10 Hz	0.024 %	
	20 Hz	0.023 %	
	50 Hz	0.011 %	
	105 Hz	0.011 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	200 Hz	0.009 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	2 kHz	0.01 %	
	10 kHz	0.01 %	
	20 kHz	0.011 %	
	50 kHz	0.01 %	
	100 kHz	0.01 %	
	200 kHz	0.011 %	
	500 kHz	0.012 %	
	700 kHz	0.019 %	
	1 MHz	0.021 %	
	1.2 MHz	0.02 %	
	2 MHz	0.02 %	
	3 MHz	0.028 %	
	4 MHz	0.027 %	
	6 MHz	0.035 %	
	8 MHz	0.042 %	
	9 MHz	0.042 %	
	10 MHz	0.043 %	
	12 MHz	0.059 %	
	15 MHz	0.062 %	
	17 MHz	0.067 %	
	20 MHz	0.082 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Flatness Relative to 1 kHz	23 MHz	0.1 %	Fluke 5790, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, with source (5720A)
	26 MHz	0.12 %	
	28 MHz	0.13 %	
	30 MHz	0.14 %	
LF AC-DC Difference 2 mV	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	570 µV/V 350 µV/V 490 µV/V 410 µV/V 350 µV/V 320 µV/V 320 µV/V 360 µV/V 450 µV/V 510 µV/V 610 µV/V 760 µV/V 780 µV/V	Fluke 792A
6 mV	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	220 µV/V 230 µV/V 250 µV/V 190 µV/V 180 µV/V 170 µV/V 200 µV/V 220 µV/V 300 µV/V 410 µV/V 490 µV/V 580 µV/V 640 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
10 mV	10 Hz	110 µV/V	Fluke 792A
	20 Hz	120 µV/V	
	40 Hz	92 µV/V	
	100 Hz	160 µV/V	
	1 kHz	87 µV/V	
	10 kHz	110 µV/V	
	20 kHz	82 µV/V	
	50 kHz	110 µV/V	
	100 kHz	160 µV/V	
	300 kHz	220 µV/V	
	500 kHz	310 µV/V	
	800 kHz	330 µV/V	
	1 MHz	440 µV/V	
20 mV	10 Hz	79 µV/V	
	20 Hz	66 µV/V	
	40 Hz	63 µV/V	
	100 Hz	120 µV/V	
	1 kHz	67 µV/V	
	10 kHz	83 µV/V	
	20 kHz	62 µV/V	
	50 kHz	120 µV/V	
	100 kHz	160 µV/V	
	300 kHz	220 µV/V	
	500 kHz	320 µV/V	
	800 kHz	380 µV/V	
	1 MHz	380 µV/V	
60 mV	10 Hz	81 µV/V	
	20 Hz	40 µV/V	
	40 Hz	34 µV/V	
	100 Hz	31 µV/V	
	1 kHz	32 µV/V	
	10 kHz	28 µV/V	
	20 kHz	28 µV/V	
	50 kHz	39 µV/V	
	100 kHz	75 µV/V	
	300 kHz	140 µV/V	
	500 kHz	220 µV/V	
	800 kHz	290 µV/V	
	1 MHz	300 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 mV	10 Hz	44 µV/V	Fluke 792A
	20 Hz	36 µV/V	
	40 Hz	32 µV/V	
	100 Hz	27 µV/V	
	1 kHz	18 µV/V	
	10 kHz	27 µV/V	
	20 kHz	32 µV/V	
	50 kHz	27 µV/V	
	100 kHz	42 µV/V	
	300 kHz	87 µV/V	
	500 kHz	130 µV/V	
	800 kHz	180 µV/V	
	1 MHz	200 µV/V	
200 mV	10 Hz	34 µV/V	
	20 Hz	22 µV/V	
	40 Hz	30 µV/V	
	100 Hz	17 µV/V	
	1 kHz	14 µV/V	
	10 kHz	20 µV/V	
	20 kHz	15 µV/V	
	50 kHz	27 µV/V	
	100 kHz	50 µV/V	
	300 kHz	76 µV/V	
	500 kHz	110 µV/V	
	800 kHz	160 µV/V	
	1 MHz	190 µV/V	
600 mV	10 Hz	28 µV/V	
	20 Hz	24 µV/V	
	40 Hz	18 µV/V	
	100 Hz	8.3 µV/V	
	1 kHz	8.7 µV/V	
	10 kHz	7.5 µV/V	
	20 kHz	10 µV/V	
	50 kHz	8.9 µV/V	
	100 kHz	32 µV/V	
	300 kHz	15 µV/V	
	500 kHz	52 µV/V	
	800 kHz	59 µV/V	
	1 MHz	83 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
1 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	30 µV/V 23 µV/V 18 µV/V 8.8 µV/V 6.1 µV/V 6.1 µV/V 5.7 µV/V 8.3 µV/V 12 µV/V 21 µV/V 38 µV/V 33 µV/V 44 µV/V	Fluke 792A
2 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	25 µV/V 20 µV/V 17 µV/V 8 µV/V 6.6 µV/V 6.2 µV/V 6.9 µV/V 8.2 µV/V 13 µV/V 37 µV/V 37 µV/V 32 µV/V 44 µV/V	
6 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	33 µV/V 21 µV/V 17 µV/V 7.9 µV/V 5.8 µV/V 6.3 µV/V 5.9 µV/V 6.5 µV/V 9.5 µV/V 21 µV/V 27 µV/V 34 µV/V 42 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
10 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	25 µV/V 20 µV/V 17 µV/V 8.1 µV/V 5.8 µV/V 5.5 µV/V 5.4 µV/V 7.1 µV/V 8.8 µV/V 20 µV/V 38 µV/V 61 µV/V 89 µV/V	Fluke 792A
20 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	37 µV/V 22 µV/V 18 µV/V 8.7 µV/V 7.6 µV/V 8.0 µV/V 7.9 µV/V 9.1 µV/V 11 µV/V 22 µV/V 29 µV/V 38 µV/V 57 µV/V	
60 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz	38 µV/V 22 µV/V 18 µV/V 7.8 µV/V 7.2 µV/V 7 µV/V 7.7 µV/V 16 µV/V 11 µV/V 34 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	27 µV/V 20 µV/V 18 µV/V 7.9 µV/V 7 µV/V 7.3 µV/V 8.2 µV/V 12 µV/V 17 µV/V	Fluke 792A
200 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	45 µV/V 23 µV/V 20 µV/V 11 µV/V 9.6 µV/V 9.8 µV/V 10 µV/V 12 µV/V 18 µV/V	
600 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kH	54 µV/V 29 µV/V 23 µV/V 19 µV/V 13 µV/V 17 µV/V 19 µV/V 35 µV/V 63 µV/V	
1000 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	54 µV/V 22 µV/V 22 µV/V 20 µV/V 19 µV/V 20 µV/V 25 µV/V 47 µV/V 67 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
AC Current 100 µA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	75 µV/V 70 µV/V 61 µV/V 59 µV/V 56 µV/V 73 µV/V 83 µV/V 120 µV/V 160 µV/V	Fluke A40 Shunts with 792A
200 µA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	95 µV/V 56 µV/V 59 µV/V 45 µV/V 43 µV/V 69 µV/V 81 µV/V 120 µV/V 190 µV/V	
300 µA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	71 µV/V 70 µV/V 49 µV/V 47 µV/V 47 µV/V 47 µV/V 49 µV/V 68 µV/V 120 µV/V	
1 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	56 µV/V 47 µV/V 41 µV/V 34 µV/V 30 µV/V 34 µV/V 37 µV/V 43 µV/V 36 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
2 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	54 µV/V 42 µV/V 46 µV/V 38 µV/V 38 µV/V 39 µV/V 41 µV/V 41 µV/V 48 µV/V	Fluke A40 Shunts with 792A
3 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	51 µV/V 40 µV/V 35 µV/V 33 µV/V 33 µV/V 32 µV/V 32 µV/V 38 µV/V 44 µV/V	
10 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	100 µV/V 53 µV/V 38 µV/V 37 µV/V 32 µV/V 31 µV/V 32 µV/V 42 µV/V 63 µV/V	
20 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	140 µV/V 84 µV/V 78 µV/V 77 µV/V 76 µV/V 76 µV/V 76 µV/V 78 µV/V 93 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
30 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	280 µV/V 92 µV/V 72 µV/V 66 µV/V 66 µV/V 67 µV/V 73 µV/V 85 µV/V 110 µV/V	Fluke A40 Shunts with 792A
100 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	140 µV/V 64 µV/V 53 µV/V 51 µV/V 48 µV/V 48 µV/V 49 µV/V 61 µV/V 78 µV/V	
200 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	150 µV/V 58 µV/V 39 µV/V 37 µV/V 40 µV/V 34 µV/V 33 µV/V 49 µV/V 68 µV/V	
300 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	120 µV/V 56 µV/V 43 µV/V 33 µV/V 32 µV/V 31 µV/V 36 µV/V 43 µV/V 72 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
500 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	260 µV/V 51 µV/V 75 µV/V 50 µV/V 45 µV/V 37 µV/V 29 µV/V 47 µV/V 79 µV/V	Fluke A40 Shunts with 792A
1A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	98 µV/V 50 µV/V 38 µV/V 39 µV/V 35 µV/V 39 µV/V 48 µV/V 80 µV/V 120 µV/V	
2A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	110 µV/V 56 µV/V 42 µV/V 37 µV/V 35 µV/V 42 µV/V 43 µV/V 55 µV/V 110 µV/V	
3 A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	130 µV/V 66 µV/V 57 µV/V 56 µV/V 55 µV/V 61 µV/V 63 µV/V 83 µV/V 140 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
5 A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	130 µV/V 67 µV/V 56 µV/V 61 µV/V 53 µV/V 58 µV/V 69 µV/V 88 µV/V 180 µV/V	
10A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	150 µV/V 84 µV/V 65 µV/V 64 µV/V 62 µV/V 62 µV/V 62 µV/V 100 µV/V 150 µV/V	
20A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz 20 kHz 30 kHz	150 µV/V 120 µV/V 81 µV/V 81 µV/V 77 µV/V 77 µV/V 77 µV/V 130 µV/V 180 µV/V	
100A	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz	160 µV/V 160 µV/V 96 µV/V 86 µV/V 86 µV/V 120 µV/V	
Impedance Measure [3] 0.1 Ω	1 kHz 10 kHz 100 kHz 1 MHz	1.8 % 1.6 % 1 % 1.5 %	Agilent E4980A LCR

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
1 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.67 % 0.43 % 0.33 % 0.32 % 0.31 % 0.38 % 0.92 %	Agilent E4980A LCR
10 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.29 % 0.2 % 0.17 % 0.19 % 0.19 % 0.27 % 0.67 %	
100 Ω	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.16 % 0.092 % 0.092 % 0.12 % 0.12 % 0.2 % 0.53 %	
1 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.15 % 0.092 % 0.092 % 0.092 % 0.092 % 0.14 % 0.3 %	
10 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.15 % 0.092 % 0.092 % 0.092 % 0.1 % 0.29 0.87	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 kΩ	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.17 % 0.1 % 0.1 % 0.17 % 0.28 % 0.38 % 1.3 %	Agilent E4980A LCR
AC Voltage – Measure 2 mV	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	610 µV/V 400 µV/V 520 µV/V 460 µV/V 400 µV/V 380 µV/V 380 µV/V 410 µV/V 490 µV/V 550 µV/V 640 µV/V 780 µV/V 800 µV/V	Fluke 792A
6 mV	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	250 µV/V 260 µV/V 270 µV/V 220 µV/V 220 µV/V 210 µV/V 240 µV/V 250 µV/V 320 µV/V 420 µV/V 510 µV/V 590 µV/V 650 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
10 mV	10 Hz	110 µV/V	Fluke 792A
	20 Hz	120 µV/V	
	40 Hz	99 µV/V	
	100 Hz	160 µV/V	
	1 kHz	94 µV/V	
	10 kHz	120 µV/V	
	20 kHz	90 µV/V	
	50 kHz	110 µV/V	
	100 kHz	160 µV/V	
	300 kHz	220 µV/V	
	500 kHz	310 µV/V	
	800 kHz	340 µV/V	
	1 MHz	440 µV/V	
20 mV	10 Hz	81 µV/V	
	20 Hz	69 µV/V	
	40 Hz	66 µV/V	
	100 Hz	120 µV/V	
	1 kHz	70 µV/V	
	10 kHz	85 µV/V	
	20 kHz	64 µV/V	
	50 kHz	120 µV/V	
	100 kHz	160 µV/V	
	300 kHz	230 µV/V	
	500 kHz	320 µV/V	
	800 kHz	380 µV/V	
	1 MHz	380 µV/V	
60 mV	10 Hz	81 µV/V	
	20 Hz	42 µV/V	
	40 Hz	35 µV/V	
	100 Hz	33 µV/V	
	1 kHz	34 µV/V	
	10 kHz	30 µV/V	
	20 kHz	30 µV/V	
	50 kHz	40 µV/V	
	100 kHz	76 µV/V	
	300 kHz	140 µV/V	
	500 kHz	220 µV/V	
	800 kHz	290 µV/V	
	1 MHz	300 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 mV	10 Hz	44 µV/V	Fluke 792A
	20 Hz	37 µV/V	
	40 Hz	32 µV/V	
	100 Hz	27 µV/V	
	1 kHz	18 µV/V	
	10 kHz	27 µV/V	
	20 kHz	32 µV/V	
	50 kHz	27 µV/V	
	100 kHz	42 µV/V	
	300 kHz	87 µV/V	
	500 kHz	130 µV/V	
	800 kHz	180 µV/V	
	1 MHz	200 µV/V	
200 mV	10 Hz	34 µV/V	
	20 Hz	22 µV/V	
	40 Hz	30 µV/V	
	100 Hz	17 µV/V	
	1 kHz	14 µV/V	
	10 kHz	20 µV/V	
	20 kHz	15 µV/V	
	50 kHz	27 µV/V	
	100 kHz	49 µV/V	
	300 kHz	76 µV/V	
	500 kHz	110 µV/V	
	800 kHz	160 µV/V	
	1 MHz	190 µV/V	
600 mV	10 Hz	29 µV/V	
	20 Hz	25 µV/V	
	40 Hz	19 µV/V	
	100 Hz	11 µV/V	
	1 kHz	12 µV/V	
	10 kHz	11 µV/V	
	20 kHz	13 µV/V	
	50 kHz	12 µV/V	
	100 kHz	33 µV/V	
	300 kHz	17 µV/V	
	500 kHz	52 µV/V	
	800 kHz	60 µV/V	
	1 MHz	84 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
1 V	10 Hz	30 µV/V	Fluke 792A
	20 Hz	23 µV/V	
	40 Hz	18 µV/V	
	100 Hz	8.7 µV/V	
	1 kHz	6 µV/V	
	10 kHz	6 µV/V	
	20 kHz	5.6 µV/V	
	50 kHz	8.2 µV/V	
	100 kHz	12 µV/V	
	300 kHz	21 µV/V	
	500 kHz	38 µV/V	
	800 kHz	33 µV/V	
	1 MHz	44 µV/V	
2 V	10 Hz	26 µV/V	
	20 Hz	21 µV/V	
	40 Hz	19 µV/V	
	100 Hz	10 µV/V	
	1 kHz	9.4 µV/V	
	10 kHz	9.1 µV/V	
	20 kHz	9.6 µV/V	
	50 kHz	11 µV/V	
	100 kHz	15 µV/V	
	300 kHz	38 µV/V	
	500 kHz	38 µV/V	
	800 kHz	33 µV/V	
	1 MHz	44 µV/V	
6 V	10 Hz	33 µV/V	
	20 Hz	22 µV/V	
	40 Hz	19 µV/V	
	100 Hz	11 µV/V	
	1 kHz	9.2 µV/V	
	10 kHz	9.5 µV/V	
	20 kHz	9.3 µV/V	
	50 kHz	9.7 µV/V	
	100 kHz	12 µV/V	
	300 kHz	22 µV/V	
	500 kHz	28 µV/V	
	800 kHz	34 µV/V	
	1 MHz	43 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
10 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	25 µV/V 20 µV/V 17 µV/V 7.9 µV/V 5.5 µV/V 5.2 µV/V 5.2 µV/V 6.9 µV/V 8.7 µV/V 20 µV/V 38 µV/V 61 µV/V 89 µV/V	Fluke 792A
20 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 800 kHz 1 MHz	38 µV/V 22 µV/V 19 µV/V 11 µV/V 9.6 µV/V 9.9 µV/V 9.8 µV/V 11 µV/V 13 µV/V 23 µV/V 29 µV/V 39 µV/V 57 µV/V	
60 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz	38 µV/V 23 µV/V 20 µV/V 10 µV/V 9.9 µV/V 9.7 µV/V 10 µV/V 17 µV/V 13 µV/V 35 µV/V	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
100 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	27 µV/V 20 µV/V 18 µV/V 7.3 µV/V 6.4 µV/V 6.7 µV/V 7.7 µV/V 12 µV/V 17 µV/V	Fluke 792A
200 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	44 µV/V 22 µV/V 19 µV/V 9 µV/V 8.1 µV/V 8.3 µV/V 9 µV/V 11 µV/V 17 µV/V	
600 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	54 µV/V 29 µV/V 24 µV/V 20 µV/V 15 µV/V 19 µV/V 20 µV/V 36 µV/V 64 µV/V	
1000 V	10 Hz 20 Hz 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz	53 µV/V 22 µV/V 22 µV/V 19 µV/V 19 µV/V 20 µV/V 25 µV/V 47 µV/V 67 µV/V	
Inductance Measure [3] 1 µH	10 kHz 100 kHz 1 MHz 2 MHz	1.6 % 0.36 % 0.27 % 0.66 %	Agilent E4980A LCR

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
10 µH	10 kHz 100 kHz 1 MHz 2 MHz	0.37 % 0.2 % 0.2 % 0.3 %	Agilent E4980A LCR
100 µH	1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.4 % 0.2 % 0.12 % 0.14 % 0.72 %	
1 mH	100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.55 % 0.18 % 0.12 % 0.092 % 0.23 % 0.88 %	
10 mH	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	0.85 % 0.22 % 0.092 % 0.092 % 0.1 % 0.35 % 1.3 %	
100 mH	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	0.28 % 0.1 % 0.092 % 0.092 % 0.21 % 0.88 %	
1 H	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	0.16 % 0.092 % 0.092 % 0.1 % 0.31 %	
10 H	20 Hz 100 Hz 1 kHz 10 kHz 100 kHz	0.15 % 0.092 % 0.1 % 0.21 % 0.69 %	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Fast Edge Pulse – Measuring Equipment	5 mV to 3 V 10Hz to 2MHz	3.8595 %	Fluke 9500B with Fluke 9530 head
High Edge Pulse – Measuring Equipment	1 mV to 200 V 10 Hz to 100 KHz	3.8595 %	Fluke 9500B with Fluke 9530 head
Impedance - Measuring Equipment	10 Ω to 12 MΩ	0.5157 %	
Level Sinewave - Measuring Equipment	5mV to 2V 0.1Hz to 3.2GHz	6.0398 %	
Timing Markers – Measuring Equipment	10 nSec to 55 Sec	0.000 025 776 %	
Oscillpscopes Capacitance - Measure	10pF to 95pF	2 % + 2.5 pF	Fluke 9500B with Fluke 9530 head
Risetime – Measuring Equipment	< 20pS	12.5 %	Tektronix 067-1330-00
Electrical Simulation of Thermocouples – Measure and Measuring Equipment [1] Type J	-210 °C to -180 °C	0.13 °C	Ectron 1140A
	-180 °C to -120 °C	0.11 °C	
	-120 °C to -50 °C	0.09 °C	
	-50 °C to 1200 °C	0.08 °C	
Type K	-270 °C to -255 °C	2.3 °C	
	-255 °C to -195 °C	0.73 °C	
	-195 °C to -115 °C	0.14 °C	
	-115 °C to -55 °C	0.1 °C	
	-55 °C to 1 000 °C	0.08 °C	
	1 000 °C to 1 372 °C	0.09 °C	
Type T	-270 °C to -250 °C	1.8 °C	
	-250 °C to -240 °C	0.52 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type T	-240 °C to -210 °C	0.32 °C	Ectron 1140A
	-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	
Type E	-270 °C to -245 °C	2.1 °C	
	-245 °C to -195 °C	2 °C	
	-195 °C to -155 °C	1.1 °C	
	-155 °C to -90 °C	0.93 °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 1 000 °C	0.08 °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 1 768.1 °C	0.23 °C	
Type S	-50 °C to -30 °C	0.65 °C	
	-30 °C to 45 °C	0.59 °C	
	45 °C to 105 °C	0.42 °C	

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Type S	105 °C to 310 °C	0.33 °C	Ectron 1140A
	310 °C to 615 °C	0.31 °C	
	615 °C to 1 768.1 °C	0.27 °C	
Type N	-270 °C to -260 °C	0.41 °C	
	-260 °C to -200 °C	0.24 °C	
	-200 °C to -140 °C	0.22 °C	
	-140 °C to -70 °C	0.21 °C	
	-70 °C to 25 °C	0.13 °C	
	25 °C to 160 °C	0.11 °C	
	160 °C to 1 300 °C	0.1 °C	
Type B	250 °C to 350 °C	1 °C	
	350 °C to 450 °C	0.77 ºC	
	450 °C to 580 °C	0.61 ºC	
	580 °C to 750 °C	0.47 ºC	
	750 °C to 1 000 °C	0.39 ºC	
	1 000 °C to 1 820 °C	0.31 °C	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Power – Measuring Equipment AC Power [4] (PF = 1) 3.3 mA to 9 mA	0.11 mW to 3 mW 10 Hz to 65 Hz	0.13 %	Fluke 5520A

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Power – Measuring Equipment AC Power [4] (PF = 1) 3.3 mA to 9 mA	3 mW to 9 W 10 Hz to 65 Hz	0.077 %	Fluke 5520A
9 mA to 33 mA	0.3 mW to 10 mW 10 Hz to 65 Hz	0.089 %	
	10 mW to 33 W 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 10 Hz to 65 Hz	0.081 %	
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 %	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
2.2 A to 4.5 A	80 mW to 1.4 W 10 Hz to 65 Hz	0.088 %	Fluke 5520A
	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 %	
0.5 A to 20 A	46 to 650 V 16 Hz to 850 Hz	0.0239 %	Fluke 6105A
Phase – Measure	0° to 360° 1 Hz ≤ f ≤ 10 kHz 10 kHz ≤ f ≤ 50 kHz 50 kHz < f ≤ 100 kHz 100 kHz < f ≤ 200 kHz	 0.002 3° 0.002 7° 0.01° 0.012°	Phase Verification Bridge Set (1:1)
Phase – Measuring Equipment 5 V, equal Amplitude	0° to 360° 1 Hz ≤ f ≤ 5 kHz 5 kHz < f ≤ 50 kHz 50 kHz < f ≤ 200 kHz	 0.006 6° 0.013° 0.052°	Clark-Hess 5002 Bridge Set (equal amplitude)
50 mV ≤ V ≤ 100 V	0° to 360° 1 Hz ≤ f ≤ 1 kHz 1 kHz ≤ f ≤ 5 kHz	 0.006 6° 0.013°	Clark-Hess 5500-2 Phase Standard (Ratio Independent)

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
50 mV ≤ V ≤ 100 V	5 kHz < f ≤ 50 kHz	0.019°	Clark-Hess 5500-2 Phase Standard (Ratio Independent)
	50 kHz < f ≤ 200 kHz	0.05°	
100 V < V < 120 V	0° to 360°		
	1 Hz ≤ f ≤ 1 kHz	0.012°	
	1 kHz ≤ f ≤ 5 kHz	0.024°	
	5 kHz < f ≤ 50 kHz	0.036°	
	50 kHz < f ≤ 200 kHz	0.094°	
Dips and Interrupts –Measure	0% to 100% Ratio, 0° to 360°	1.304 %	Agilent Infinity Oscilloscope
Electrical Fast Transients - Measure	0.25 kV to 4 kV	2.626 1 %	Agilent Infinity Oscilloscope and Haefely HV Attenuators
Electrostatic Discharge – Measure	0.1 to 15 kV	2.509 4 %	Tektronix TDS7404 Oscilloscope, KeyTech CTC-3 Target, Barth HV Attenuators
Harmonic Flicker - Measure	100 V to 230V 50 Hz to 400 Hz	3.570 5 %	Tektronix TDS1012B Oscilloscope, Keysight DMM, CNS HFC-II Load, Ohms Lab CS100 Shunt
Surge – Open - Measure	0.25 to 4 kV	1.253 %	Agilent Infinity Oscilloscope, Tektronix 6015A HV Probe
Surge – Short - Measure	0.25 to 4 kV	1.377 1 %	Agilent Infinity Oscilloscope, Tegam RF Current Probe
Impulse - Source	60 dBuV Nominal 10 KHz to 150 KHz (Band A) 150 KHz to 30 MHz (Band B) 30 MHz to 1 GHz (Band C & D)	12.678 9 % 12.678 9 % 20.443 4 %	Schwarzbeck IGLK 2914

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Modulation – AM - Measure	50 Hz-50 KHz	1.268 1 %	Keysight 8902A Receiver
Modulation – FM - Measure	50 Hz-100 KHz	1.622 7 %	Keysight 8902A Receiver
Modulation – PM - Measure	150 KHz-1300 MHz	4.268 1 %	Keysight 8902A Receiver
RF Power – Noise Figure - Measure	0 to -40dB 10 MHz-26.5 GHz	0.404 1 dB	Keysight PSA (E4440A) w/ Opt 219 Personality Module and 346C Noise Source
RF Power – Transfer - Measure	+10 dBm to -20 dbm 9 KHz to 18 GHz	1.257 5 %	Tegam 2510A Power Standard, Tegam 1803A Power Meter
	+10 dBm to -20 dbm 10 MHz-26.5 GHz	2.589 6 %	
	+10 dBm to -20 dbm 26.5 GHz-50 GHz	4.815 %	
RF Power [1]	+20 dBm to -60 dBm 9 KHz to 18 GHz	2.633 3 %	Agilent E9304A H18 Power Sensor, E4419B Power Meter
	+20 dBm to -70 dBm 26.5 GHz to 40 GHz	3.805 5 %	Agilent 8487A Power Sensor, E4419B Power Meter
	+20 dBm to -70 dBm 40GHz to 50GHz	5.074 3 %	
	+30 dBm to +10 dBm 30MHz to 26.5 GHz	5.671 %	Agilent E4440, E4419B Power Meter, N5532A Power Sensor
	+10 dBm to -30 dBm 30MHz to 26.5 GHz	3.29 %	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
RF Power - Tuned RF	0 dBm to -58 dBm 30MHz to 26.5 GHz	3.4594 4 %	Agilent E4440, E4419B Power Meter, N5532A Power Sensor
	-58 dBm to -78 dBm 30MHz to 26.5 GH	4.019 9 %	
	-78 dBm to -114 dBm 30MHz to 26.5GHz	4.751 2 %	
Relative RF Power - Tuned RF	0 dBm to – 58 dBm 30MHz to 26.5 GHz	1.070 5 %	Agilent E4440, E4419B Power Meter, N5532A Power Sensor
	-58 dBm to -78 dBm 30MHz to 26.5 GHz	2.310 3 %	
	-78 dBm to -114 dBm 30 MHz to 26.5 GHz	3.428 2 %	
Sine Flatness (RF)	9 kHz to 6 GHz	0.073 dB	Agilent E4418B w/ E9304A
Attenuation - Source	0 dB to 50dB 30 MHz	1.630 8 %	Agilent 11812A Verification Kit
SSB Phase Noise/RMS Noise/RMSJitter - Measure	+20 dBm to -50 dBm 1 MHz to 3 GHz	0.622 8 dBm	Keysight PSA (E4440A) w/ Opt 226 Personality Module
	+20 dBm to -50 dBm 3 GHz to 6.6 GHz	0.922 9 dBm	
	+20 dBm to -50 dBm 6.6 GHz to 13.2 GHz	1.305 8 dBm	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
SSB Phase Noise/RMS Noise/RMSJitter - Measure	+20 dBm to -50 dBm 13.2 GHz to 22 GHz	1.204 9 dBm	Keysight PSA (E4440A) w/ Opt 226 Personality Module
	+20 dBm to -50 dBm 22 GHz to 26.5 GHz	1.620 2 dBm	
Spectral Analysis (Amplitude) - Measure	+30 dBm to -127 dBm (w/o pre-amp) 3 Hz to 3 GHz	0.898 2 dBm	Keysight: PSA (E4440A)
	+30 dBm to -127 dBm (w/o pre-amp) 3 GHz to 6.6 GHz	1.127 2 dBm	
	+30 dBm to -127 dBm (w/o pre-amp) 6.6 GHz to 13.2 GHz	1.457 4 dBm	
	+30 dBm to -127 dBm (w/o pre-amp) 13.2 GHz to 22 GHz	1.367 7 dBm	
	+30 dBm to -127 dBm (w/o pre-amp) 22 GHz to 26.5 GHz	1.744 7 dBm	
	+30 dBm to -127 dBm (w/o pre-amp) 26.5 GHz to 40 GHz	3.631 9 dBm	Keysight PSA (E4440A) and 11970A Mixer
	+30 dBm to -127 dBm (w/o pre-amp)		Keysight PSA (E4440A) and 11970Q Mixer
	33 GHz to 50 GHz	3.631 9 dBm	
Attenuation – Measure or Tuned RF Relative Power 2.5 MHz to 26.5 GHz	0 dB to -10 dB	0.026 dB	Agilent 8902 with 11793A sensor
	-10 dB to -20 dB	0.038 dB	
	-20 dB to -30 dB	0.048 dB	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Attenuation – Measure or Tuned RF Relative Power 2.5 MHz to 26.5 GHz	-30 dB to -40 dB	0.056 dB	Agilent 8902 with 11793A sensor
	-40 dB to -50 dB	0.060 dB	
	-50 dB to -60 dB	0.069 dB	
	-60 dB to -70 dB	0.077 dB	
	-70 dB to -80 dB	0.082 dB	
	-80 dB to -90 dB	0.09 dB	
	-90 dB to -100 dB	0.099 dB	
	-100 dB to -110 dB	0.1 dB	
	-110 dB to -120 dB	0.12 dB	
Impedance – Measure	1 Ω to 2 kΩ 5 Hz to 3 GHz	3.009 9 %	Keysight E5061B VNA
RF Current - Insertion Loss - Measure	10dB to -90dB 10KHz to 400MHz	2.918 dB	Keysight E5061B VNA, FCC BCICF-1 Cal Fixture
RF Current - Transfer Z - Measure	10dB to -90dB 10KHz to 400MHz	2.194 6 dB	
Transmission - Longitudinal Conversion Loss	10dB to -90dB 10KHz to 100MHz	5.619 2 %	Schaffner BCS-1000 Bridge, Agilent E5061B VNA
S-Parameter S11-S22 – BNC - Measure	0 to 1 LinMag, +10 dB to -90 dB 10 Hz to 100 KHz	0.029 85 LinMag	E5061B with 8550CK Cal Kit
	0 to 1 LinMag, +10 dB to -90 dB 100 KHz to 10 MHz	0.029 92 LinMag	E5061B with 8550CK Cal Kit

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
S-Parameter S11-S22 - 7mm - Measure	0 to 1 LinMag, +10 dB to -90 dB 300 KHz to 1.3 GHz	0.005 78 LinMag	8753ES with 85050C Cal Kit
	0 to 1 LinMag, +10 dB to -90 dB 1.3 GHz to 3 GHz	0.006 89 LinMag	
	0 to 1 LinMag, +10 dB to -90 dB 3 GHz to 6 GHz	0.012 78 LinMag	
S-Parameter S11-S22 N-Type - Measure	0 to 1 LinMag, +10 dB to -90 dB 10 MHz to 500 MHz	0.024 64 LinMag	N5230A with N4690C Ecal Cal Kit
	0 to 1 LinMag, +10 dB to -90 dB 500 MHz to 2 GHz	0.017 02 LinMag	
S-Parameter S11-S22 - 3.5mm or 2.9mm - Measure	0 to 1 LinMag, +10 dB to -90 dB 10 MHz to 500 MHz	0.026 4 LinMag	N5230A with N4692A Ecal Cal Kit
	0 to 1 LinMag, +10 dB to -90 dB 500 MHz to 2 GHz	0.024 67 LinMag	
	0 to 1 LinMag, +10 dB to -90 dB 2 GHz to 26.5 GHz	0.076 45 LinMag	
S-Parameter S11-S22 - 2.4mm- Measure	0 to 1 LinMag, +10 dB to -90 dB 50 MHz to 50 GHz	0.218 32 LinMag	N5225A with 85056D Calibration Kit
S-Parameter S21-S12 – BNC - Measure	+10 dB to -50dB 10 Hz to 100 KHz	0.57 dB	E5061B with 8550CK Cal Kit

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
S-Parameter S21-S12 – BNC - Measure	+10 dB to -50dB 100 KHz to 10 MHz	0.365 dB	E5061B with 8550CK Cal Kit
	+10 dB to -50dB 10 MHz to 500 MHz	0.359 dB	
S-Parameter S21-S12 - 7mm - Measure	+10 dB to -50dB 300 KHz to 1.3 GHz	0.244 dB	8753ES with 85050C Cal Kit
	+10 dB to -50dB 1.3 GHz to 3 GHz	0.246 dB	
S-Parameter S21-S12 N-Type - Measure	+10 dB to -30 dB 10 MHz to 500 MHz	0.426 dB	N5230A with N4690C Ecal Cal Kit
	-30 dB to -50 dB 10 MHz to 500 MHz	2.639 dB	
	+10 dB to -50 dB 500 MHz to 2 GHz	0.172 dB	
	+10 dB to -50 dB 2 GHz to 18 GHz	0.39 dB	
S-Parameter S21-S12 - 3.5mm or 2.9mm - Measure	+10 dB to -30 dB 10 MHz to 500 MHz	0.494 dB	N5230A with N4692A Ecal Cal Kit
	-30 dB to -50 dB 10 MHz to 500 MHz	2.647 dB	
	+10 dB to -50 dB 500 MHz to 2 GHz	0.284 dB	

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
S-Parameter S21-S12 - 3.5mm or 2.9mm - Measure	+10 dB to -50 dB 2 GHz to 26.5 GHz	0.787 dB	N5230A with N4692A Ecal Cal Kit
S-Parameter S21-S12 - 2.9mm – Measure	+10 dB to -50 dB		N5230A with N4692A Ecal Cal Kit
	26.5 GHz to 40GHz	0.822 dB	
S-Parameter S21-S12 - 2.4mm - Measure	+10 dB to -30 dB 50 MHz to 500 MHz	0.241 dB	N5225A with 85056D Calibration Kit
	-30 dB to -50 dB 50 MHz to 500 MHz	0.932 dB	
	+10 dB to -50 dB 500 MHz to 2 GHz	0.138 dB	
	+10 dB to -50 dB 2 GHz to 26.5 GHz	0.559 dB	
	+10 dB to -50 dB 26.5 GHz to 50 GHz	0.855 dB	

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [6]	Reference Standard, Method and/or Equipment
Angles	0° to 60°	8.3 arc seconds	Sine Bar
	90°	2.8 arc seconds	Master Square
Micrometers & Calipers - Outside, Inside, Depth [1]	0.01 in to 0.5 in	13 µin	Comparison to Gage Blocks
	0.5 in to 1 in	14 µin	
	1 in to 4 in	(3.5 + 10*L*) µin	
	4 in to 15 in	(4.3 + 11*L*) µin	
	15 in to 40 in	(4.4 + 11*L*) µin	
Anvil Flatness [1]	0 in to 1 in Diameter	6.1 µin	Optical Flats
Dial Indicators [1]	0 in to 6 in	(1.5 + 21*L*) µin	Comparison to Gage Blocks

Length – Dimensional Metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [6]	Reference Standard, Method and/or Equipment
Single Axis – Outside	0 in to 1 in	(3.6 + 2*L*) µin	P & W Labmaster
	1 in to 6 in	(3.6 + 3*L*) µin	
	6 in to 21 in	(1.2 + 4*L*) µin	
Length Measurement – Single Axis – Inside	0 in to 1 in	10 µin	P & W Labmaster
	1 in to 12 in	(8 + 3.5*L*) µin	
Height Gages	0 in to 24 in	(60 + 0.7*L*) µin	Comparison to Gage Blocks
Length Measure Equipment – Linear Displacement	0 ft to 12 ft	(1+ 2.1*L*) µin	Laser Interferometer
Thread Wires	2 TPI to 120 TPI	14 µin	P & W Labmaster
Plug Gage - Outer Spherical Diameter	0 in to 3 in	(11 + 2*L*) µin	P & W Labmaster
	3 in to 6 in	(7 + 3.5*L*) µin	
Ring Gage - Inner Spherical Diameter	0 in to 1 in	10 µin	P & W Labmaster
	1 in to 12 in	(8 + 3.5*L*) µin	
Threaded Plugs Pitch Diameter 60° Thread Plug	0 in to 1 in	79 µin	Comparator/Thread Wires
	1 in to 3 in	80 µin	
	3 in to 6 in	82 µin	
Major Diameter	0 in to 3 in	3 µin/in	Comparator
	3 in to 6 in	(7 + 3.5*L*) µin	
Standoff	0 in to 1 in	31 µin	Gage Blocks and Amplifier
Thread Ring	0 in to 7 in	130 µin	Setting Plug

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Mass – Metric [1]	32 kg	210 mg	Echelon III
	16 kg	98 mg	
	8 kg	18 mg	
	7 kg	16 mg	
	6 kg	15 mg	
	5 kg	13 mg	
	4 kg	12 mg	
	2 kg	10 mg	
	1 kg	1.6 mg	
	500 g	1 mg	
	200 g	0.39 mg	
	100 g	0.35 mg	
	50 g	0.11 mg	
	20 g	0.16 mg	
	10 g	0.14 mg	
	5 g	0.13 mg	
	2 g	0.16 mg	
	1 g	0.083 mg	
	500 mg	0.078 mg	
	200 mg	0.076 mg	
	100 mg	0.065 mg	
	50 mg	0.064 mg	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Mass – Metric [1]	20 mg	0.073 mg	Echelon III
	10 mg	0.084 mg	
	5 mg	0.097 mg	
	2 mg	0.064 mg	
	1 mg	0.064 mg	
Torque - Measure [1]	2 lbf·in to 811 lbf·ft	1.2 %	Torque Calibrator
Balance and Scale [1]	114 kg	0.6 g	ASTM Class 1 and Class 2 Mass Standards
	64 kg	0.45 g	
	32 kg	0.21 g	
	16 kg	98 mg	
	8 kg	18 mg	
	7 kg	16 mg	
	6 kg	15 mg	
	5 kg	13 mg	
	4 kg	12 mg	
	2 kg	10 mg	
	1 kg	1.6 mg	
	500 g	1 mg	
	200 g	0.39 mg	
	100 g	0.35 mg	
	50 g	0.11 mg	
	20 g	0.16 mg	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Balance and Scale [1]	10 g	0.14 mg	ASTM Class 1 and Class 2 Mass Standards
	5 g	0.13 mg	
	2 g	0.16 mg	
	1 g	0.083 mg	
	500 mg	0.078 mg	
	200 mg	0.076 mg	
	100 mg	0.065 mg	
	50 mg	0.064 mg	
	20 mg	0.073 mg	
	10 mg	0.084 mg	
	5 mg	0.097 mg	
	2 mg	0.064 mg	
	1 mg	0.064 mg	
Absolute Pressure Source – Pneumatic	0.2 psi to 1.45 psi	0.001 3 % + 0.29 mpsi	Ruska 2465
	1.45 psi to 50 psi	0.001 5 % + 14 µpsi	DHI FPG 7601
	50 psi to 1 000 psi	0.001 9 %	
Gage Pressure Source – Pneumatic	-14.7 psi to -0.2 psi	0.001 3 % + 8 µpsi	Ruska 2465
	-60 inH_2O to +60 inH_2O	0.002 8 % + 22 µinH_2O	DHI FPG 8601
	0.2 psi to 100 psi	0.001 3 % + 8 µpsi	Ruska 2465
	100 psi to 1 000 psi	0.001 9 %	
Gage Pressure Source – Hydraulic	72.5 psi to 7 250 psi	0.002 % + 2.9 mpsi	DHI PG7000
	200 psi to 20 000 psi	0.003 5 % + 7.3 mpsi	
	20 000 psi to 72 500 psi	0.005 5 % + 15 mpsi	

Mass

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Determination of Piston Area	0.2 psi to 100 psi	0.001 1 %	Ruska 2465
	100 psi to 1 000 psi	0.001 7 %	
	72.5 psi to 7 250 psi	0.001 7 %	DHI PG7000 (Gas to 6 kpsi)
	200 psi to 20 000 psi	0.002 6 %	
	725 psi to 72 500 psi	0.005 1 %	
Pressure Source Pneumatic [1]	-14.7 psi to -0.2 psi	0.001 3% + 8 µpsi	Ruska 2465 gauge mode
	0.2 psi to 100 psi	0.001 3% + 8 µpsi	
	0.2 psi to 100 psi	0.001 1% + 0.29 mpsi	Ruska 2465 absolute mode
	100 psi to 1000 psi	0.001 9 %	Ruska 2465 gauge or absolute
Hydraulic [1]	50 psi to 15 000 psi	0.011 % + 0.17 psi	Ametek T-150
Absolute Pressure Source - Pneumatic	0.000 7 to 0.14 Pascal	50 %	Ion Gauge
	0.14 to 2 500 Pascal	0.05 % + 0.07 Pa	CDG

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Humidity – Measure [1]	0 % RH to 90 % RH	2.2 % RH	Vaisala M170 & HMP76
	90 % RH to 100 % RH	2.7 % RH	
Temperature - Measuring Equipment	-20 ºC to 100 ºC	0.011 ºC	PRT with Liquid Baths
	100 ºC to 150 ºC	0.013 °C	
	150 °C to 230 °C	0.016 °C	
	230 °C to 300 °C	0.018 °C	
	300 °C to 420 °C	0.074 °C	PRT with Metrology Well

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature - Measuring Equipment	420 °C to 660 °C	0.12 °C	PRT with Metrology Well
Measuring Equipment [1]	50 °C to 100 °C	0.056 °C	PRT with Metrology Well
	100 ºC to 150 ºC	0.059 °C	
	150 °C to 230 °C	0.064 °C	
	230 °C to 300 °C	0.071 °C	
	300 °C to 420 °C	0.074 °C	
	420 °C to 500 °C	0.090 °C	
	500 °C to 660 °C	0.12 °C	
Temperature - Measure [1]	-195 ºC to 0 ºC	0.012 ºC	Hart 5628 w/Black Stack
	0 ºC to 420 °C	0.025 ºC	
	420 °C to 660 °C	0.036 ºC	
	660 °C to 750° C	1.3 °C	Type S Probe and Readout
	750 °C to 1200 °C	1.8 °C	
Infrared Temperature Measuring Equipment	-15 °C to 0 °C	0.79 °C	Fluke Black Body
	0 °C to 50 °C	0.65 °C	
	50 °C to 100 °C	0.7 °C	
	100 °C to 120 °C	0.75 °C	
	120 °C to 200 °C	0.93 °C	
	200 °C to 350 °C	1.58 °C	
	350 °C to 500 °C	2.1 °C	
Isothermal Block Verification [1]	Ambient (~ 23 ºC)	0.02 ºC	Thermocouple Half Junction

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Frequency – Source and Measure [5]	10 MHz	6.4 x 10^{-10} Hz/Hz	Fluke 910R
Harmonic Distortion - Measure	10 Hz to 100 kHz	0.7 dB	Agilent U8903A Audio Analyzer
Frequency Comparison-Measure	+30 dbm to -20 dBm 10 MHz Reference	8.2075 E-10 Hz	Fluke PM6681R Rubidium Counter
Frequency Drift - Measure	+30 dbm to -20 dBm 10 MHz Reference	8.1928 E-10 Hz	
Frequency - Measure	+30 dBm to -127 dBm (w/o pre-amp) 3 Hz to 10 MHz	2.0210 E-2 Hz	Keysight PSA E4440A
	+30 dBm to -127 dBm (w/o pre-amp) 10 MHz to 1 GHz	1.1834 E-1 Hz	
	+30 dBm to -127 dBm (w/o pre-amp) 1 GHz to 10 GHz	1.1561 Hz	
	+30 dBm to -127 dBm (w/o pre-amp) 10 GHz to 26.5 GHz	3.0613 Hz	
	+30 dBm to -127 dBm (w/o pre-amp)		
	26.5 GHz to 50 GHz	3.2718 Hz	
Time Interval / Duty Cycle – Measure	10s Interval	8.5387 [E-10] Hz	Fluke PM6681R Rubidium Counter
Risetime – Measure	<= 500pS	2.519 pSec	Agilent 83484A, 86100C Oscilloscope Mainframe
Total Harmonic Distortion: CW, Modulation	5 Hz to 500 kHz	1.4 dB	Krohn-Hite 6900B
	500 kHz to 1 MHz	2.3 dB	

Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-) [2]	Reference Standard, Method and/or Equipment
Harmonic Distortion	100 kHz to 2.9 GHz	1.7 dB	Spectrum Analyzer
	2.9 GHz to 6.5 GHz	1.9 dB	
	6.5 GHz to 13.2 GHz	2.6 dB	
	13.2 GHz to 22 GHz	2.9 dB	
	22 GHz to 26.5 GHz	3.7 dB	
Rise time (Generate)	≥ 14 ps	2.4 ps	Pulser
Rise time (Measure)	28 ps to 300 ps	14 %	Sampling System
	300 ps to 5 ns	4.7 %	
	5 ns to 100 ns	1.4 %	
	100 ns	0.73 %	

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. As frequency & amplitude deviate from the listed values, uncertainty may be higher than stated. If needed, contact laboratory for more information regarding uncertainties at frequency and range combinations other than the ones shown.
4. 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.
5. Uncertainty values of derivatives of 10 MHz will differ due to resolution, noise and gating errors.
6. L = Length in inches.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.03.

Vice President