



CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board

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

This is to certify that

Keysight Technologies, Inc. Service Center

904 South Taft Avenue, Suite 100

Loveland, CO 80537

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

ISO/IEC 17025:2005

and national standards

ANSI/NCSL Z540-1-1994 (R2002) and

ANSI/NCSL Z540.3-2006 (R2013)

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-1498.03

Certificate Number



ANAB Approval

Certificate Valid: 12/14/2017-11/16/2018
Version No. 002 Issued: 12/14/2017



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).



**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005,
ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)**

Keysight Technologies, Inc. Service Center

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CALIBRATION

Valid to: **November 16, 2018**

Certificate Number: **AC-1498.03**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure	0 V 1 V, 1.018 V 10 V	35 nV 42 nV 40 nV	Josephson Junction Array
DC Voltage – Source & Measure ¹	Up to 0.1 V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	0.53 μ V/V 0.11 μ V/V 0.054 μ V/V 0.43 μ V/V 0.46 μ V/V	Fluke 732A Fixed Oil Resistors Datron 4700 Keysight 3458A
DC Current – Source & Measure ¹	100 nA 1 μ A 10 μ A 100 μ A 1 mA 10 mA 100 mA 1 A 3 A 5 A 10 A	12 μ A/A 5.2 μ A/A 5.1 μ A/A 1 μ A/A 1 μ A/A 1 μ A/A 1 μ A/A 1.7 μ A/A 0.12 mA 0.15 mA 0.45 mA	Fixed Resistors in Air / Oil Keysight 3458A



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure ¹	1 mV		Datron 4700, AC Divider Fluke 5790A
	10 Hz to 1 kHz	0.12 mV/V	
	(1 to 20) kHz	0.16 mV/V	
	(20 to 100) kHz	0.25 mV/V	
	(100 to 300) kHz	0.33 mV/V	
	(300 to 500) kHz	0.53 mV/V	
	500 kHz to 1 MHz	1 mV/V	
	3 mV		
	10 Hz to 1 kHz	36 μ V/V	
	(1 to 20) kHz	52 μ V/V	
	(20 to 100) kHz	0.1 mV/V	
	(100 to 300) kHz	0.15 mV/V	
	(300 to 500) kHz	0.26 mV/V	
	500 kHz to 1 MHz	0.52 mV/V	
	10 mV		
	10 Hz to 1 kHz	21 μ V/V	
	(1 to 20) kHz	32 μ V/V	
	(20 to 100) kHz	52 μ V/V	
	(100 to 300) kHz	0.1 mV/V	
	(300 to 500) kHz	0.21 mV/V	
500 kHz to 4 MHz	0.42 mV/V		
30 mV			
10 Hz to 100 kHz	30 μ V/V		
(100 to 300) kHz	55 μ V/V		
(300 to 500) kHz	55 μ V/V		
500 kHz to 1 MHz	0.21 mV/V		
100 mV			
10 Hz to 100 kHz	27 μ V/V		
(100 to 300) kHz	34 μ V/V		
(300 to 500) kHz	60 μ V/V		
500 kHz to 1 MHz	0.12 mV/V		
(1 to 4) MHz	0.37 mV/V		
(4 to 8) MHz	0.47 mV/V		
(8 to 10) MHz	0.56 mV/V		
AC Voltage – Source & Measure ¹	300 mV		Fluke A55 0.5 TVC, Nanovoltmeter Fluke 5790A
	(10 to 20) Hz	18 μ V/V	
	(20 to 100) Hz	13 μ V/V	
	100 Hz to 100 kHz	12 μ V/V	
	(100 to 500) kHz	30 μ V/V	
500 kHz to 1 MHz	43 μ V/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure ¹	500 mV		Holt 11, Nanovoltmeter Fluke 5790A
	1 kHz	7.1 μ V/V	
	1 V		
	(10 to 20) Hz	9.5 μ V/V	
	20 Hz to 30 kHz	5 μ V/V	
	(30 to 200) kHz	9.1 μ V/V	
	(200 to 500) kHz	17 μ V/V	
	500 kHz to 1 MHz	29 μ V/V	
	(1 to 8) MHz	0.33 mV/V	
	(8 to 10) MHz	0.36 mV/V	
	3 V		
	1 kHz	5.9 μ V/V	
	(1 to 100) kHz	4.9 μ V/V	
	100 kHz to 2 MHz	0.21 mV/V	
	(2 to 4) MHz	0.33 mV/V	
	(4 to 8) MHz	0.34 mV/V	
	(8 to 10) MHz	0.37 mV/V	
	6 V		
	1 kHz	4.5 μ V/V	
	10 V		
	(10 to 20) Hz	6.6 μ V/V	
	20 Hz to 1 kHz	3.5 μ V/V	
	(1 to 20) kHz	4.9 μ V/V	
	(20 to 100) kHz	7.0 μ V/V	
	(100 to 300) kHz	8.5 μ V/V	
	(300 to 500) kHz	12 μ V/V	
	500 kHz to 1 MHz	21 μ V/V	
70 V			
300 kHz	19 μ V/V		
100 V			
10 Hz to 30 kHz	6.5 μ V/V		
(30 to 50) kHz	12 μ V/V		
(50 to 200) kHz	23 μ V/V		
300 V			
(40 to 100) Hz	8.1 μ V/V		
100 Hz to 50 kHz	11 μ V/V		
(50 to 100) kHz	15 μ V/V		
500 V			
40 Hz to 50 kHz	14 μ V/V		
(50 to 100) kHz	27 μ V/V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source & Measure ¹	700 V		Holt 11, Nanovoltmeter Fluke 5790A
	40 Hz to 1 kHz	10 μ V/V	
	(1 to 20) kHz	12 μ V/V	
	(20 to 50) kHz	18 μ V/V	
	(50 to 100) kHz	53 μ V/V	
	1 000 V		
(40 to 100) Hz	11 μ V/V		
100 Hz to 10 kHz	16 μ V/V		
(10 to 20) kHz	20 μ V/V		
(20 to 30) kHz	32 μ V/V		
AC DC Difference	300 mV		Fluke A55 0.5 TVC, Nanovoltmeter
	(10 to 20) Hz	18 μ V/V	
	(20 to 100) Hz	13 μ V/V	
	100 Hz to 100 kHz	12 μ V/V	
	(100 to 500) kHz	30 μ V/V	
	500 kHz to 1 MHz	43 μ V/V	
	500 mV		Holt 11, Nanovoltmeter
	1 kHz	7.1 μ V/V	
	1 V		
	(10 to 20) Hz	9.5 μ V/V	
	20 Hz to 30 kHz	5 μ V/V	
	(30 to 200) kHz	9.1 μ V/V	
	(200 to 500) kHz	17 μ V/V	
	500 kHz to 1 MHz	29 μ V/V	
	(1 to 8) MHz	0.33 mV/V	
	(8 to 10) MHz	0.36 mV/V	
	3 V		
	1 kHz	5.9 μ V/V	
(1 to 100) kHz	4.9 μ V/V		
100 kHz to 2 MHz	0.21 mV/V		
(2 to 4) MHz	0.33 mV/V		
(4 to 8) MHz	0.34 mV/V		
(8 to 10) MHz	0.37 mV/V		
6 V			
1 kHz	4.5 μ V/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC DC Difference	10 V		Holt 11, Nanovoltmeter
	(10 to 20) Hz	6.6 μ V/V	
	20 Hz to 1 kHz	3.5 μ V/V	
	(1 to 20) kHz	4.9 μ V/V	
	(20 to 100) kHz	7 μ V/V	
	(100 to 300) kHz	8.5 μ V/V	
	(300 to 500) kHz	12 μ V/V	
	500 kHz to 1 MHz	21 μ V/V	
	70 V		
	300 kHz	19 μ V/V	
	100 V		
	10 Hz to 30 kHz	6.5 μ V/V	
	(30 to 50) kHz	12 μ V/V	
	(50 to 200) kHz	23 μ V/V	
	300 V		
	(40 to 100) Hz	8.1 μ V/V	
	100 Hz to 50 kHz	11 μ V/V	
	(50 to 100) kHz	15 μ V/V	
	500 V		
	40 Hz to 50 kHz	14 μ V/V	
(50 to 100) kHz	27 μ V/V		
700 V			
40 Hz to 1 kHz	10 μ V/V		
(1 to 20) kHz	12 μ V/V		
(20 to 50) kHz	18 μ V/V		
(50 to 100) kHz	53 μ V/V		
1 000 V			
(40 to 100) Hz	11 μ V/V		
100 Hz to 10 kHz	16 μ V/V		
(10 to 20) kHz	20 μ V/V		
(20 to 30) kHz	32 μ V/V		
AC Voltage Flatness	1 mV		TVC, Attenuators Fluke 5790A
	(10 to 50) Hz	0.013 % of reading	
	50 Hz to 100 kHz	0.009 3 % of reading	
	100 kHz to 1 MHz	0.014 % of reading	
	(1 to 3) MHz	0.035 % of reading	
	(3 to 4) MHz	0.049 % of reading	
	(4 to 8) MHz	0.079 % of reading	
	(8 to 10) MHz	0.096 % of reading	
(10 to 30) MHz	0.12 % of reading		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness	3 mV		TVC, Attenuators Fluke 5790A
	(10 to 100) Hz	0.009 5 % of reading	
	100 Hz to 100 kHz	0.005 2 % of reading	
	(100 to 300) kHz	0.006 7 % of reading	
	300 kHz to 1 MHz	0.012 % of reading	
	(1 to 3) MHz	0.033 % of reading	
	(3 to 4) MHz	0.047 % of reading	
	(4 to 8) MHz	0.075 % of reading	
	(8 to 20) MHz	0.1 % of reading	
	(20 to 30) MHz	0.12 % of reading	
	10 mV		
	(10 to 50) Hz	0.008 4 % of reading	
	50 Hz to 300 kHz	0.006 5 % of reading	
	300 kHz to 1 MHz	0.01 % of reading	
	(1 to 3) MHz	0.028 % of reading	
	(3 to 10) MHz	0.069 % of reading	
	(10 to 20) MHz	0.084 % of reading	
	(20 to 30) MHz	0.1 % of reading	
	30 mV		
	(10 to 50) Hz	0.007 8 % of reading	
	50 Hz to 100 kHz	0.005 3 % of reading	
	(100 to 300) kHz	0.006 4 % of reading	
	300 kHz to 1 MHz	0.009 8 % of reading	
	(1 to 3) MHz	0.026 % of reading	
(3 to 10) MHz	0.062 % of reading		
(10 to 20) MHz	0.08 % of reading		
(20 to 30) MHz	0.099 % of reading		
100 mV			
(10 to 50) Hz	0.007 8 % of reading		
50 Hz to 50 kHz	0.004 4 % of reading		
(50 to 300) kHz	0.006 4 % of reading		
300 kHz to 1 MHz	0.009 5 % of reading		
(1 to 3) MHz	0.025 % of reading		
(3 to 10) MHz	0.056 % of reading		
(10 to 20) MHz	0.073 % of reading		
(20 to 30) MHz	0.094 % of reading		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness	300 mV		TVC, Attenuators, Fluke 5790A
	(10 to 50) Hz	0.007 6 % of reading	
	50 Hz to 50 kHz	0.004 5 % of reading	
	(50 to 300) kHz	0.006 2% of reading	
	300 kHz to 1 MHz	0.008 6 % of reading	
	(1 to 3) MHz	0.023 % of reading	
	(3 to 10) MHz	0.046 % of reading	
	(10 to 20) MHz	0.067 % of reading	
	(20 to 30) MHz	0.088 % of reading	
	1 V		
	(10 to 50) Hz	0.007 6 % of reading	
	50 Hz to 50 kHz	0.004 1 % of reading	
	(50 to 300) kHz	0.006 1 % of reading	
	300 kHz to 1 MHz	0.008 2 % of reading	
	(1 to 3) MHz	0.021 % of reading	
	(3 to 10) MHz	0.036 % of reading	
	(10 to 20) MHz	0.061 % of reading	
	(20 to 30) MHz	0.084 % of reading	
3V			
(10 to 50) Hz	0.007 3 % of reading		
50 Hz to 50 kHz	0.004 3 % of reading		
(50 to 300) kHz	0.006 3 % of reading		
300 kHz to 1 MHz	0.009 % of reading		
(1 to 3) MHz	0.021 % of reading		
(3 to 10) MHz	0.037 % of reading		
(10 to 20) MHz	0.061 % of reading		
(20 to 30) MHz	0.084 % of reading		
AC Current – Source & Measure ¹	40 Hz to 10 kHz		Fluke 5720A Holt HCS-1 84506
	10 mA	11 μA/A	
	50 mA	13 μA/A	
	100 mA	12 μA/A	
	0.5 A, 1 A	17 μA/A	
	5 A	38 μA/A	
	10 A		
	40 Hz to 1 kHz	53 μA/A	
	(1 to 5) kHz	64 μA/A	
	(5 to 10) kHz	73 μA/A	



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source & Measure ¹	10 μ A		Characterized Shunt Ratio Transformer Fluke 5720A
	>0 Hz to 10 Hz	58 μ A/A	
	> 10 Hz to 20 Hz	59 μ A/A	
	> 20 Hz to 50 Hz	58 μ A/A	
	> 50 Hz to 1 kHz	55 μ A/A	
	>1 kHz to 5 kHz	55 μ A/A	
	> 5 kHz to 10 kHz	56 μ A/A	
	100 μ A		
	>0 Hz to 10 Hz	19 μ A/A	
	> 10 Hz to 20 Hz	44 μ A/A	
	> 20 Hz to 50 Hz	42 μ A/A	
	> 50 Hz to 1 kHz	42 μ A/A	
	>1 kHz to 5 kHz	42 μ A/A	
	> 5 kHz to 10 kHz	42 μ A/A	
	1 mA		
	>0 Hz to 10 Hz	16 μ A/A	
	> 10 Hz to 20 Hz	37 μ A/A	
	> 20 Hz to 50 Hz	35 μ A/A	
	> 50 Hz to 1 kHz	36 μ A/A	
	>1 kHz to 5 kHz	35 μ A/A	
	> 5 kHz to 10 kHz	34 μ A/A	
	10 mA		
	>0 Hz to 10 Hz	28 μ A/A	
	> 10 Hz to 20 Hz	39 μ A/A	
> 20 Hz to 50 Hz	36 μ A/A		
> 50 Hz to 1 kHz	36 μ A/A		
>1 kHz to 5 kHz	36 μ A/A		
> 5 kHz to 10 kHz	39 μ A/A		
100 mA			
>0 Hz to 10 Hz	24 μ A/A		
> 10 Hz to 20 Hz	49 μ A/A		
> 20 Hz to 50 Hz	44 μ A/A		
> 50 Hz to 1 kHz	44 μ A/A		
>1 kHz to 5 kHz	44 μ A/A		
> 5 kHz to 10 kHz	36 μ A/A		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source & Measure ¹	1 A >0 Hz to 10 Hz > 10 Hz to 20 Hz > 20 Hz to 50 Hz > 50 Hz to 1 kHz >1 kHz to 5 kHz > 5 kHz to 10 kHz	23 μ A/A 40 μ A/A 33 μ A/A 33 μ A/A 33 μ A/A 44 μ A/A	Characterized Shunt Ratio Transformer Fluke 5720A
AC Current – Source and Measure ¹	10 A >0 Hz to 40 Hz > 40 Hz to 1 kHz > 1 kHz to 3 kHz > 3 kHz to 5 kHz > 5 kHz to 10 kHz	56 μ A/A 55 μ A/A 76 μ A/A 66 μ A/A 56 μ A/A	HP 3458A with Holt HCS-1 84506 0.01 Ω Resistor
LF Resistance – Source and Measure ¹	0.001 Ω > 0 Hz to 1 kHz > 1 kHz to 3 kHz > 3 kHz to 10 kHz 0.004 Ω > 0 Hz to 40 Hz > 40 Hz to 400 Hz > 400 Hz to 1 kHz > 1 kHz to 3 kHz > 3 kHz to 5 kHz > 5 kHz to 10 kHz 0.01 Ω > 0 Hz to 40 Hz > 40 Hz to 400 Hz > 400 Hz to 1 kHz > 1 kHz to 10 kHz 0.1 Ω 10 Hz to 5 kHz >5 kHz to 10 kHz 1 Ω 10 Hz to 5 kHz >5 kHz to 10 kHz	0.029 % of reading 0.028 % of reading 0.029 % of reading 0.013 % of reading 0.012 % of reading 0.011 % of reading 0.012 % of reading 0.011 % of reading 0.01 % of reading 0.014 % of reading 0.012 % of reading 0.01 % of reading 0.009 % of reading 32 $\mu\Omega$ / Ω 37 $\mu\Omega$ / Ω 43 $\mu\Omega$ / Ω 38 $\mu\Omega$ / Ω	Holt HCS-1 85046 Resistor Fluke 5790A



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
LF Resistance – Source and Measure ¹	10 Ω		Holt HCS-1 85046 Resistor Fluke 5790A
	10 Hz to 5 kHz	35 μΩ /Ω	
	>5 kHz to 10 kHz	33 μΩ /Ω	
	100 Ω		
	10 Hz to 5 kHz	34 μΩ /Ω	
	>5 kHz to 10 kHz	33 μΩ /Ω	
Thermal Voltage Converters	1 000 Ω		Holt 11, Nanovoltmeter
	10 Hz to 5 kHz	41 μΩ /Ω	
	>5 kHz to 10 kHz	41 μΩ /Ω	
	0.5 V		
	10 Hz	15 μV/V	
	1 kHz	4.6 μV/V	
	(10 to 100) Hz	12 μV/V	
	100 Hz to 10 kHz	6 μV/V	
	(10 to 100) kHz	9.4 μV/V	
	(100 to 300) kHz	21 μV/V	
	(300 to 500) kHz	25 μV/V	
	500 kHz to 1 MHz	34 μV/V	
	1 V		
	10 Hz	6.3 μV/V	
	1 kHz	3.1 μV/V	
	(10 to 20) Hz	4.5 μV/V	
	20 Hz to 20 kHz	3.8 μV/V	
	(20 to 100) kHz	5 μV/V	
	(100 to 500) kHz	10 μV/V	
	500 kHz to 1 MHz	18 μV/V	
	3 V		
10 Hz	8.2 μV/V		
1 kHz	3.8 μV/V		
10 Hz to 100 kHz	4.7 μV/V		
(100 to 300) kHz	7.5 μV/V		
300 kHz to 1 MHz	16 μV/V		
6 V			
1 kHz	2.9 μV/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermal Voltage Converters	10 V		Holt 11, Nanovoltmeter
	10 Hz	5.9 μ V/V	
	1 kHz	3.4 μ V/V	
	10 Hz to 50 kHz	4.8 μ V/V	
	(50 to 300) kHz	7.6 μ V/V	
	(300 to 500) kHz	10 μ V/V	
	500 kHz to 1 MHz	18 μ V/V	
	20V		
	1 kHz	3.5 μ V/V	
	100 V		
	1 kHz	4 μ V/V	
	(10 to 20) Hz	5.6 μ V/V	
	20 Hz to 30 kHz	4.3 μ V/V	
	(30 to 100) kHz	7.3 μ V/V	
	(100 to 200) kHz	10 μ V/V	
	300 V		
	1 kHz	5.7 μ V/V	
	40 Hz to 20 kHz	6.1 μ V/V	
	(20 to 50) kHz	8.7 μ V/V	
	(50 to 100) kHz	15 μ V/V	
	500 V		
	1 kHz	9.2 μ V/V	
	40 Hz to 1 kHz	9.2 μ V/V	
	(1 to 30) kHz	11 μ V/V	
(30 to 50) kHz	14 μ V/V		
(50 to 100) kHz	23 μ V/V		
700 V			
1 kHz	9.9 μ V/V		
40 Hz to 20 kHz	10 μ V/V		
(20 to 30) kHz	12 μ V/V		
(30 to 50) kHz	16 μ V/V		
(50 to 100) kHz	21 μ V/V		
1 000 V			
1 kHz	11 μ V/V		
40 Hz to 30 kHz	12 μ V/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermal Voltage Converters	(0.5 to 3) V		Ballantine 1395A TVC
	3 MHz	0.02 % of reading	
	8 MHz	0.03 % of reading	
	10 MHz	0.04 % of reading	
	20 MHz	0.06 % of reading	
	30 MHz	0.08 % of reading	
	50 MHz	0.17 % of reading	
	70 MHz	0.29 % of reading	
	80 MHz	0.31 % of reading	
100 MHz	0.37 % of reading		
Ratio Transformer – Magnitude Only	(1 to 100) V input, 1 kHz	0.48×10^{-6}	ESI-DT72A Ratio Transformer
Inductance (Series) - Measure	4 Terminal Pair Resistors		HP 4284A, 16074A
	1 MHz	1 nH	
	0.1 Ω	0.3 nH	
	1 Ω	1 nH	
	10 Ω	7 nH	
Capacitance (Parallel) - Measure	4 Terminal Pair Resistors		HP 4284A, 16074A, 16380A
	1 MHz	0.7 pF	
	100 Ω	0.07 pF	
	1 k Ω	0.02 pF	
	10 k Ω	0.004 pF	
DC Resistance – Measure and Source ¹	Short	0.02 $\mu\Omega$	Resistance Bridge Resistance Shunts in Air / Oil, Keysight 3458A, Keysight 4339B
	1 m Ω	2 $\mu\Omega/\Omega$	
	10 m Ω	2 $\mu\Omega/\Omega$	
	100 m Ω	0.95 $\mu\Omega/\Omega$	
	1 Ω	0.25 $\mu\Omega/\Omega$	
	10 Ω	0.21 $\mu\Omega/\Omega$	
	100 Ω	0.3 $\mu\Omega/\Omega$	
	1 k Ω	0.44 $\mu\Omega/\Omega$	
	10 k Ω	0.19 $\mu\Omega/\Omega$	
	100 k Ω	0.46 $\mu\Omega/\Omega$	
	1 M Ω	1.4 $\mu\Omega/\Omega$	
	10 M Ω	4.9 $\mu\Omega/\Omega$	
	100 M Ω	24 $\mu\Omega/\Omega$	
	1 G Ω	77 $\mu\Omega/\Omega$	
	10 G Ω	0.20 m Ω/Ω	
100 G Ω	0.17 m Ω/Ω		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Measure and Source ¹	1.9 Ω	0.49 μΩ/Ω	Resistance Bridge Resistors in Oil
	19 Ω	1.2 μΩ/Ω	
	190 Ω	0.47 μΩ/Ω	
	1.9 kΩ	1.1 μΩ/Ω	
	19 kΩ	1.3 μΩ/Ω	
	190 kΩ	0.84 μΩ/Ω	
	1.9 MΩ	2.0 μΩ/Ω	
	19 MΩ	11 μΩ/Ω	
Capacitance - Measure	2/3 Terminal Pair @ 1 kHz		AH2500a Bridge
	1 pF to 40 nF	3 μF/F	
	(40 to 100) nF	4 μF/F	
	(100 to 400) nF	5 μF/F	
	400 nF to 1.2 μF	8 μF/F	
	Dissipation Factor @ 1kHz		
	1 pF to 1 nF	0.000 003	
	(1 to 10) nF	0.000 005	
	(10 to 40) nF	0.000 01	
	(40 to 70) nF	0.000 015	
	(70 to 100) nF	0.000 02	
	(100 to 200) nF	0.000 04	
	(200 to 300) nF	0.000 055	
	(300 to 400) nF	0.000 075	
	(400 to 500) nF	0.000 095	
	(500 to 600) nF	0.000 11	
	(600 to 700) nF	0.000 125	
	(700 to 800) nF	0.000 145	
	(800 to 900) nF	0.000 16	
	900 nF to 1 μF	0.000 175	
(1 to 1.1) μF	0.000 195		
(1.1 to 1.2) μF	0.000 21		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Capacitance - Measure	4 Terminal Pair			
	Dissipation Factor, Freq			
	1 pF			
		0.000 02, 1 kHz	44 μ F/F	AH2500a Bridge, HP8753C, 85046A, 85031B
		0.000 03, 1 MHz	90 μ F/F	
		0.000 06, 2 MHz	0.23 mF/F	
		0.000 09, 3 MHz	0.41 mF/F	
		0.000 14, 4 MHz	0.63 mF/F	
		0.000 2, 5 MHz	0.88 mF/F	
		0.000 57, 10 MHz	2.5. mF/F	
		0.000 83, 13 MHz	3.7 mF/F	
		10 pF		
		0.000 02, 1 kHz	39 μ F/F	
		0.000 02, 1 MHz	39 μ F/F	
		0.000 02, 2 MHz	40 μ F/F	
		0.000 02, 3 MHz	43 μ F/F	
		0.000 02, 4 MHz	47 μ F/F	
		0.000 03, 5 MHz	54 μ F/F	
		0.000 07, 10 MHz	0.12 mF/F	
		0.000 09, 13 MHz	0.16 mF/F	
		100 pF		
		0.000 02, 1 kHz	38 μ F/F	
		0.000 02, 1 MHz	40 μ F/F	
		0.000 02., 2 MHz	48 μ F/F	
		0.000 03, 3 MHz	66 μ F/F	
		0.000 05, 4 MHz	91 μ F/F	
		0.000 06, 5 MHz	0.13 mF/F	
		0.000 16, 10 MHz	0.33 mF/F	
		0.000 24, 13 MHz	0.49 mF/F	
		1 000 pF		
		0.000 02, 1 kHz	41 μ F/F	
		0.000 03, 1 MHz	64 μ F/F	
		0.000 06, 2 MHz	0.15 mF/F	
	0.000 1, 3 MHz	0.28 mF/F		
	0.000 15, 4 MHz	0.44 mF/F		
	0.000 21, 5 MHz	0.62 mF/F		
	0.000 58 10 MHz	1.9 mF/F		
	0.000 85 13 MHz	2.8 mF/F		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance - Measure	4 Terminal Pair Dissipation Factor, Freq		AH2500a Bridge, HP8753C, 85046A, 85031B
	0.01 μ F		
	0.000 02, 120 Hz	40 μ F/F	
	1 kHz, 10 kHz		
	0.000 02, 100 kHz	40 μ F/F	
	0.1 μ F		
	0.000 03, 120 Hz	40 μ F/F	
	0.000 02, 1 kHz,	40 μ F/F	
	10 kHz		
	0.000 03, 100 kHz	40 μ F/F	
	1 μ F		
	0.000 04, 120 Hz	50 μ F/F	
	0.000 02, 1 kHz	40 μ F/F	
	0.000 03, 10 kHz	40 μ F/F	
0.000 04, 100 kHz	70 μ F/F		
10 μ F			
0.000 04, 120 Hz	50 μ F/F		
0.000 03, 1 kHz	50 μ F/F		
0.000 28, 10 kHz	0.16 mF/F		
0.000 7, 100 kHz	0.7 mF/F		
HF Resistance - Measure	4 Terminal Pair		HP 4285A, 16074A, 16380A
	10 Ω		
	1 MHz	0.3 m Ω / Ω	
	2 MHz	0.5 m Ω / Ω	
	3 MHz	0.6 m Ω / Ω	
	4 MHz	0.7 m Ω / Ω	
	5 MHz	1 m Ω / Ω	
	10 MHz	4 m Ω / Ω	
	13 MHz	6 m Ω / Ω	
	100 Ω		
	1 MHz	0.3 m Ω / Ω	
	2 MHz	0.3 m Ω / Ω	
	(3, 4, 5) MHz	0.5 m Ω / Ω	
	10 MHz	2 m Ω / Ω	
13 MHz	3 m Ω / Ω		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
HF Resistance - Measure	4 Terminal Pair		HP 4285A, 16074A, 16380A
	1 kΩ		
	100 kHz	0.3 mΩ/Ω	
	(1, 2, 3) MHz	0.3 mΩ/Ω	
	4 MHz	0.4 mΩ/Ω	
	5 MHz	0.5 mΩ/Ω	
	10 MHz	2 mΩ/Ω	
	13 MHz	3 mΩ/Ω	
	10 kΩ		
	100 kHz	0.2 mΩ/Ω	
	1 MHz	0.3 mΩ/Ω	
	100 kΩ		
100 kHz	0.3 mΩ/Ω		
1 MHz	0.3 mΩ/Ω		
HF Reactance - Measure	4 Terminal Pair		HP 4285A, 16074A, 16380A
	10 Ω		
	1 MHz	4 mΩ	
	(2, 3) MHz	5 mΩ	
	4 MHz	6 mΩ	
	5 MHz	7 mΩ	
	10 MHz	20 mΩ	
	13 MHz	40 mΩ	
	100 Ω		
	(1, 2, 3, 4, 5) MHz	40 mΩ	
	10 MHz	80 mΩ	
	13 MHz	90 mΩ	
HF Susceptance - Measure	4 Terminal Pair		HP 4285A, 16074A, 16380A
	1 kΩ		
	100 kHz	0.4 μs	
	(1, 2, 3, 4, 5) MHz	0.4 μs	
	(10, 13) MHz	0.7 μs	
	10 kΩ		
	100 kHz	0.04 μs	
	1 MHz	0.04 μs	
	100 kΩ		
	100 kHz	4 ns	
	1 MHz	4 ns	



Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency	10 MHz	1.2×10^{-12}	58503 GPS Receiver (signal tracked and compared with NIST)

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. The Source and Measure capabilities are defined protocols that utilize characterized instrumentation.
2. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1498.03.



Vice President

