CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

The Standards Institution of Israel
Electrical and Electronics Laboratory
Calibration Center

42 Chaim Levanon Street
Tel Aviv, 6997701 Israel

Fulfills the requirements of

ISO/IEC 17025:2017

In the field of

CALIBRATION AND DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
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R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 14 May 2024
Certificate Number: AC-2699

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **May 14, 2024** Certificate Number: **AC-2699**

CALIBRATION

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage, Measuring Instruments [1,2]	0 mV	904 nV	Short measurement
	(0.1 to 190] μV	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(904\,nV)^2}+0.93\,nV$	Calibrator Datron 4708
	(0.19 to 1.9] mV	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(904\,nV)^2}+9.76\,nV$	
	(1.9 to 19] mV	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(905\,nV)^2}+92.3\,nV$	
	(19 to 190] mV	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(1.03\,\mu V)^2}+4.33\,nV$	
	(0.19 to 1.9] V	$\sqrt{\left(5.8\,\frac{\mu V}{V}\cdot OR\right)^2+(2.91\,\mu V)^2}+994\,nV$	
	(1.9 to 19] V	$\sqrt{\left(3.5\,\frac{\mu V}{V}\cdot OR\right)^2+(21.3\,\mu V)^2}+2.57\,\mu V$	
DC Voltage, Measuring Instruments [1,2]	(19 to 190] V	$\sqrt{\left(5.8\,\frac{\mu V}{V}\cdot OR\right)^2+(296\,\mu V)^2}+49.5\,\mu V$	Calibrator Datron 4708
	(190 to 1 000] V	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(2.92\,mV)^2}+271\,\mu V$	
DC Voltage, Measuring Instruments [1,2]	(1 000 to 2 000] V	$\sqrt{\left(463\,\frac{\mu V}{V}\cdot OR\right)^2+(1.15\,V)^2}+263\,mV$	DC High Voltage Calibrator PINTEK HVC-801

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage, Measuring Instruments [1,2]	(2 000 to 20 000] V	$\sqrt{\left(463\,\frac{\mu V}{V}\cdot OR\right)^2+(11.5\,V)^2}+2.63\,V$	Precision High Voltage Meter VITREK 4700A
DC Voltage, Measuring Instruments [1,2]	(20 to 40] kV	24 V/kV	High Voltage Probe: FLUKE 80K-40
DC Voltage, Sources [1,2]	0 mV	1.7 µV	Calibrator Datron 4708
	(0.1 µV to 190] µV (0.19 mV to 1.9] mV (1.9 mV to 19] mV (19 mV to 190] mV (0.19 V to 1.9] V (1.9 V to 19] V	$\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(905\,nV)^2}+1.34\,nV$ $\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(906\,nV)^2}+10.0\,nV$ $\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(1.03\,\mu V)^2}+86.7\,nV$ $\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(1.03\,\mu V)^2}+433\,nV$ $\sqrt{\left(5.8\,\frac{\mu V}{V}\cdot OR\right)^2+(2.91\,\mu V)^2}+994\,nV$ $\sqrt{\left(3.5\,\frac{\mu V}{V}\cdot OR\right)^2+(21.3\,\mu V)^2}+2.57\,\mu V$	DMM Datron 1281
DC Voltage, Sources [1,2]	(19 to 190] V (190 to 1 000] V (1 000 to 2 000] V	$\sqrt{\left(5.8\,\frac{\mu V}{V}\cdot OR\right)^2+(296\,\mu V)^2}+49.5\,\mu V$ $\sqrt{\left(8.1\,\frac{\mu V}{V}\cdot OR\right)^2+(2.92\,mV)^2}+271\,\mu V$ $\sqrt{\left(463\,\frac{\mu V}{V}\cdot OR\right)^2+(1.15\,V)^2}+263\,mV$	Precision High Voltage Meter VITREK 4700A
DC Voltage, Sources [1,2]	(2 000 to 20 000] V	$\sqrt{\left(463\,\frac{\mu V}{V}\cdot OR\right)^2+(11.5\,V)^2}+2.63\,V$	High Voltage Probe: FLUKE 80K-40
	(20 to 30] kV	24 V/kV	
DC Current, Measuring Instruments [1,2]	0 pA	810 fA	Open measurement
DC Current, Measuring Instruments [1,2]	(0 to 2] pA (2 to 20] pA (20 to 200] pA	$\sqrt{(0.49\,\%\cdot OR)^2+(810\,fA)^2}+1.58\,fA$ $\sqrt{(0.43\,\%\cdot OR)^2+(810\,fA)^2}+12.4\,fA$ $\sqrt{(0.29\,\%\cdot OR)^2+(8.02\,pA)^2}+9.81\,fA$	Calibrator KEITHLEY 263

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Measuring Instruments [1,2]	(0.2 to 2] nA (2 to 20] nA (20 to 200] nA (0.2 to 2] µA	$\sqrt{\left(752\,\frac{\mu A}{A}\cdot OR\right)^2+(20\,pA)^2}+65.1\,fA$ $\sqrt{\left(752\,\frac{\mu A}{A}\cdot OR\right)^2+(200\,pA)^2}+554\,fA$ $\sqrt{\left(405\,\frac{\mu A}{A}\cdot OR\right)^2+(2.0\,nA)^2}+5.12\,pA$ $\sqrt{\left(289\,\frac{\mu A}{A}\cdot OR\right)^2+(117\,pA)^2}+104\,pA$	Calibrator KEITHLEY 263
DC Current Measuring Instruments [1,2]	(2 to 19] µA (19 to 190] µA (0.19 to 1.9] mA (1.9 to 19] mA (19 to 190] mA (0.19 to 1.9] A	$\sqrt{\left(116\,\frac{\mu A}{A}\cdot OR\right)^2+(3.06\,nA)^2}+1.12\,nA$ $\sqrt{\left(116\,\frac{\mu A}{A}\cdot OR\right)^2+(3.06\,nA)^2}+2.09\,nA$ $\sqrt{\left(46.3\,\frac{\mu A}{A}\cdot OR\right)^2+(167\,nA)^2}+45.5\,nA$ $\sqrt{\left(46.3\,\frac{\mu A}{A}\cdot OR\right)^2+(1.96\,\mu A)^2}+412\,nA$ $\sqrt{\left(46.3\,\frac{\mu A}{A}\cdot OR\right)^2+(1.96\,\mu A)^2}+1.02\,\mu A$ $\sqrt{\left(116\,\frac{\mu A}{A}\cdot OR\right)^2+(36\,\mu A)^2}+20.8\,\mu A$	Calibrator DATRON 4708
DC Current, Measuring Instruments [1,2]	(1.9 to 3] A (3 to 10] A (10 to 20] A (20 to 32] A (32 to 105] A (105 to 160] A (160 to 525] A (525 to 1 000] A	$\sqrt{\left(440\,\frac{\mu A}{A}\cdot OR\right)^2+(783\,\mu A)^2}+39.4\,\mu A$ $\sqrt{\left(579\,\frac{\mu A}{A}\cdot OR\right)^2+(3.56\,mA)^2}+474\,\mu A$ $\sqrt{\left(637\,\frac{\mu A}{A}\cdot OR\right)^2+(8.74\,mA)^2}+3.82\,mA$ $\sqrt{(0.30\,\%\cdot OR)^2+(7.94\,mA)^2}+57.3\,mA$ $\sqrt{(0.30\,\%\cdot OR)^2+(27\,mA)^2}+194\,mA$ $\sqrt{(0.30\,\%\cdot OR)^2+(39.9\,mA)^2}+350\,mA$ $\sqrt{(0.30\,\%\cdot OR)^2+(134\,mA)^2}+1.18\,A$ $\sqrt{(0.30\,\%\cdot OR)^2+(350\,mA)^2}+2.33\,A$	Calibrator FLUKE 5520A
DC Current Sources [1,2]	0 nA	2 nA	Open measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Sources [1,2]	(0 to 120] nA	$\sqrt{\left(34.7\,\frac{\mu A}{A}\cdot OR\right)^2+(2.01\ nA)^2}$ – 4.44 pA	DMM HP 3458A
DC Current Sources [1,2]	(0.12 to 1.2] µA (1.2 to 12] µA (12 to 120] µA (0.12 to 1.2] mA (1.2 to 12] mA (12 to 120] mA	$\sqrt{\left(23.1\frac{\mu A}{A}\cdot OR\right)^2+(411\,pA)^2}+80.5\,fA$ $\sqrt{\left(23.1\frac{\mu A}{A}\cdot OR\right)^2+(4.11\,nA)^2}-406\,fA$ $\sqrt{\left(23.1\frac{\mu A}{A}\cdot OR\right)^2+(14.0\,nA)^2}+33.4\,pA$ $\sqrt{\left(23.1\frac{\mu A}{A}\cdot OR\right)^2+(591\,nA)^2}+460\,pA$ $\sqrt{\left(23.1\frac{\mu A}{A}\cdot OR\right)^2+(591\,nA)^2}+658\,pA$ $\sqrt{\left(40.5\frac{\mu A}{A}\cdot OR\right)^2+(6.01\,\mu A)^2}+4.38\,nA$	DMM HP 3458A
DC Current Sources [1,2]	(0.12 to 1.05] A (1.05 to 20] A	$\sqrt{\left(127\frac{\mu A}{A}\cdot OR\right)^2+(141\,\mu A)^2}+8.1\,\mu A$ 230 µA/A	Shunt: FLUKE A40A-20A
DC Current Sources [1,2]	(20 to 1 000] A	8 mA/A	Calibrator, FLUKE 5520A +DC Clamp meter used as Transfer Standard
AC Voltage, Measuring Instruments [1,2]	[0.1 to 1.9] mV [10 to 31] Hz (31 to 330] Hz (0.33 to 10] kHz (10 to 33] kHz (33 to 100] kHz (100 to 330] kHz (033 to 1] MHz	 $\sqrt{\left(139\frac{\mu V}{V}\cdot OR\right)^2+(6.26\,\mu V)^2}+244\,nV$ $\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(6.26\,\mu V)^2}+137\,nV$ $\sqrt{\left(69.4\frac{\mu V}{V}\cdot OR\right)^2+(6.26\,\mu V)^2}+124\,nV$ $\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(6.30\,\mu V)^2}+143\,nV$ $\sqrt{\left(347\frac{\mu V}{V}\cdot OR\right)^2+(6.39\,\mu V)^2}+578\,nV$ $\sqrt{(0.12\,\%\cdot OR)^2+(12.0\,\mu V)^2}+1.95\,\mu V$ $\sqrt{(0.23\,\%\cdot OR)^2+(24.3\,\mu V)^2}+3.96\,\mu V$	IEC 60051-9; IEC 60044 Calibrator Datron 4709

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Measuring Instruments [1,2]	(1.9 to 19] mV		IEC 60051-9; IEC 60044 Calibrator Datron 4709
	[10 to 31] Hz	$\sqrt{\left(139\frac{\mu V}{V}\cdot OR\right)^2+(7.18\,\mu V)^2}+1.91\,\mu V$	
	(31 to 330] Hz	$\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(7.09\,\mu V)^2}+1.22\,\mu V$	
	(0.33 to 10] kHz	$\sqrt{\left(69.4\frac{\mu V}{V}\cdot OR\right)^2+(7.18\,\mu V)^2}+1.05\,\mu V$	
	(10 to 33] kHz	$\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(7.63\,\mu V)^2}+1.15\,\mu V$	
	(33 to 100] kHz	$\sqrt{\left(347\frac{\mu V}{V}\cdot OR\right)^2+(8.70\,\mu V)^2}+3.27\,\mu V$	
	(100 to 330] kHz	$\sqrt{(0.12\,\%\cdot OR)^2+(14.9\,\mu V)^2}+8.99\,\mu V$	
	(0.33 to 1] MHz	$\sqrt{(0.23\,\%\cdot OR)^2+(36.2\,\mu V)^2}+22.1\,\mu V$	
AC Voltage, Measuring Instruments [1,2]	[19 to 190] mV		IEC 60051-9; IEC 60044 Calibrator Datron 4709
	[10 to 31] Hz	$\sqrt{\left(139\frac{\mu V}{V}\cdot OR\right)^2+(17.3\,\mu V)^2}+7.58\,\mu V$	
	(31 to 330] Hz	$\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(15.1\,\mu V)^2}+6.33\,\mu V$	
	(0.33 to 10] kHz	$\sqrt{\left(69.4\frac{\mu V}{V}\cdot OR\right)^2+(16.1\,\mu V)^2}+5.71\,\mu V$	
	(10 to 33] kHz	$\sqrt{\left(81\frac{\mu V}{V}\cdot OR\right)^2+(23.5\,\mu V)^2}+5.10\,\mu V$	
	(33 to 100] kHz	$\sqrt{\left(347\frac{\mu V}{V}\cdot OR\right)^2+(39.3\,\mu V)^2}+8.32\,\mu V$	
	(100 to 330] kHz	$\sqrt{(0.12\,\%\cdot OR)^2+(65.1\,\mu V)^2}+20.7\,\mu V$	
	(0.33 to 1] MHz	$\sqrt{(0.23\,\%\cdot OR)^2+(167\,\mu V)^2}+111\,\mu V$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Measuring Instruments [1,2]	(190 mV to 1.90 V]		IEC 60051-9; IEC 60044 Calibrator Datron 4709
	[10 to 31] Hz	$\sqrt{\left(104\,\frac{\mu V}{V}\cdot OR\right)^2+(50.4\,\mu V)^2}+29.7\,\mu V$	
	(31 to 330] Hz	$\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2+(34.1\,\mu V)^2}+19.3\,\mu V$	
	(0.33 to 33] kHz	$\sqrt{\left(46.3\,\frac{\mu V}{V}\cdot OR\right)^2+(28.3\,\mu V)^2}+9.92\,\mu V$	
	(33 to 100] kHz	$\sqrt{\left(92.6\,\frac{\mu V}{V}\cdot OR\right)^2+(52.0\,\mu V)^2}+20.0\,\mu V$	
	(100 to 330] kHz	$\sqrt{\left(289\,\frac{\mu V}{V}\cdot OR\right)^2+(162\,\mu V)^2}+97.4\,\mu V$	
	(0.33 to 1] MHz	$\sqrt{(0.17\,\%\cdot OR)^2+(738\,\mu V)^2}+405\,\mu V$	
AC Voltage, Measuring Instruments [1,2]	(1.9 to 19] V		IEC 60051-9; IEC 60044 Calibrator Datron 4709
	[10 to 31] Hz	$\sqrt{\left(104\,\frac{\mu V}{V}\cdot OR\right)^2+(504\,\mu V)^2}+297\,\mu V$	
	(31 to 330] Hz	$\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2+(341\,\mu V)^2}+193\,\mu V$	
	(0.33 to 10] kHz	$\sqrt{\left(46.3\,\frac{\mu V}{V}\cdot OR\right)^2+(283\,\mu V)^2}+992\,\mu V$	
	(10 to 33] kHz	$\sqrt{\left(46.3\,\frac{\mu V}{V}\cdot OR\right)^2+(301\,\mu V)^2}+988\,\mu V$	
	(33 to 100] kHz	$\sqrt{\left(92.6\,\frac{\mu V}{V}\cdot OR\right)^2+(457\,\mu V)^2}+202\,\mu V$	
	(33 to 100] kHz	$\sqrt{\left(92.6\,\frac{\mu V}{V}\cdot OR\right)^2+(457\,\mu V)^2}+202\,\mu V$	
	(100 to 330] kHz	$\sqrt{\left(289\,\frac{\mu V}{V}\cdot OR\right)^2+(1.55\,mV)^2}+976\,\mu V$	
	(0.33 to 1] MHz	$\sqrt{(0.17\,\%\cdot OR)^2+(7.14\,mV)^2}+4.05\,mV$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Measuring Instruments [1,2]	(19 to 190] V [10 to 31] Hz	$\sqrt{\left(116\,\frac{\mu V}{V}\cdot OR\right)^2+\left(5.35\,mV\right)^2}+3.01\,mV$	IEC 60051-9; IEC 60044 Calibrator Datron 4709
	(31 to 330] Hz	$\sqrt{\left(69.4\,\frac{\mu V}{V}\cdot OR\right)^2+\left(3.57\,mV\right)^2}+1.99\,mV$	
	(0.33 to 10] kHz	$\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2+\left(3.01\,mV\right)^2}+1.0\,mV$	
	(10 to 33] kHz	$\sqrt{\left(69.4\,\frac{\mu V}{V}\cdot OR\right)^2+\left(3.81\,mV\right)^2}+1.98\,mV$	
	(33 to 100] kHz	$\sqrt{\left(139\,\frac{\mu V}{V}\cdot OR\right)^2+\left(7.84\,mV\right)^2}+3.00\,mV$	
	(100 to 200] kHz	$\sqrt{\left(463\,\frac{\mu V}{V}\cdot OR\right)^2+\left(26.8\,mV\right)^2}+9.97\,mV$	
AC Voltage, Measuring Instruments [1,2]	(190 to 1 000] V [50 to 330] Hz	$\sqrt{\left(162\,\frac{\mu V}{V}\cdot OR\right)^2+\left(41.7\,mV\right)^2}+10.9\,mV$	IEC 60051-9; IEC 60044 Calibrator Datron 4709
	(0.33 to 10] kHz	$\sqrt{\left(116\,\frac{\mu V}{V}\cdot OR\right)^2+\left(45.6\,mV\right)^2}+10.4\,mV$	
	(10 to 33] kHz	$\sqrt{\left(162\,\frac{\mu V}{V}\cdot OR\right)^2+\left(76.1\,mV\right)^2}+10.2\,mV$	
	(33 to 100] kHz	$\sqrt{\left(0.12\,\%\cdot OR\right)^2+\left(350\,mV\right)^2}+21.8\,mV$	
AC Voltage, Measuring Instruments [1,2]	(1 to 1.5) kV [40 to 60] Hz	$\sqrt{\left(810\,\frac{\mu V}{V}\cdot OR\right)^2+\left(2.1\,V\right)^2}+7.54\,V$	Potential Transformer TETTEX 7823, Precision High Voltage Meter
AC Voltage, Measuring Instruments [1,2]	(1.5 to 10] kV [40 to 60] Hz	$\sqrt{\left(0.23\,\%\cdot OR\right)^2+\left(23.0\,V\right)^2}+10.6\,V$	VITREK VITREK 4600A 4600A
AC Voltage, Sources [1,2]	[1 to 3] mV [10 to 100] Hz	$\sqrt{\left(0.15\,\%\cdot OR\right)^2+\left(1.06\,\mu V\right)^2}+38.5\,nV$	AV Measurement, Standard, Datron 4920
	(100 Hz to 30 kHz]	$\sqrt{\left(0.13\,\%\cdot OR\right)^2+\left(1.06\,\mu V\right)^2}+37.1\,nV$	
	(30 to 200] kHz	$\sqrt{\left(0.19\,\%\cdot OR\right)^2+\left(1.11\,\mu V\right)^2}-8.6\,nV$	
	(200 to 500] kHz	$\sqrt{\left(0.36\,\%\cdot OR\right)^2+\left(1.11\,\mu V\right)^2}+45.4\,nV$	
	(500 to 1 000] kHz	$\sqrt{\left(0.75\,\%\cdot OR\right)^2+\left(1.31\,\mu V\right)^2}+50.0\,nV$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Sources [1,2]	(3 to 10] mV [10 to 100] Hz (100 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 kHz to 1 MHz]	 $\sqrt{\left(509\,\frac{\mu V}{V}\cdot OR\right)^2+(1.12\,\mu V)^2}-10.9\,nV$ $\sqrt{\left(312\,\frac{\mu V}{V}\cdot OR\right)^2+(1.12\,\mu V)^2}-16.5\,nV$ $\sqrt{\left(729\,\frac{\mu V}{V}\cdot OR\right)^2+(1.56\,\mu V)^2}-641\,pV$ $\sqrt{\left(2.1\,\frac{mV}{V}\cdot OR\right)^2+(1.56\,\mu V)^2}+49.8\,nV$ $\sqrt{\left(5.2\,\frac{mV}{V}\cdot OR\right)^2+(3.00\,\mu V)^2}+50.4\,nV$	AV Measurement, Standard, Datron 4920
AC Voltage, Sources [1,2]	(10 to 30] mV [10 to 100] Hz (100 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(1.16\,\mu V)^2}+45.1\,nV$ $\sqrt{\left(243\,\frac{\mu V}{V}\cdot OR\right)^2+(1.16\,\mu V)^2}+41.1\,nV$ $\sqrt{\left(521\,\frac{\mu V}{V}\cdot OR\right)^2+(1.52\,\mu V)^2}+50.7\,nV$ $\sqrt{\left(1.6\,\frac{mV}{V}\cdot OR\right)^2+(2.94\,\mu V)^2}+51.4\,nV$ $\sqrt{\left(3.9\,\frac{mV}{V}\cdot OR\right)^2+(8.54\,\mu V)^2}+50.5\,nV$	AV Measurement, Standard, Datron 4920
AC Voltage, Sources [1,2]	(30 to 100] mV [10 to 100] Hz (100 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(301\,\frac{\mu V}{V}\cdot OR\right)^2+(1.89\,\mu V)^2}+52.2\,nV$ $\sqrt{\left(150\,\frac{\mu V}{V}\cdot OR\right)^2+(1.89\,\mu V)^2}+46.2\,nV$ $\sqrt{\left(289\,\frac{\mu V}{V}\cdot OR\right)^2+(3.94\,\mu V)^2}+4.51\,nV$ $\sqrt{\left(868\,\frac{\mu V}{V}\cdot OR\right)^2+(9.28\,\mu V)^2}+53.6\,nV$ $\sqrt{\left(2.3\,\frac{mV}{V}\cdot OR\right)^2+(24.1\,\mu V)^2}+45.2\,nV$	Standard, Datron 4920

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Sources [1,2]	(100 to 300] mV [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2+(30.1\,\mu V)^2}+2.94\text{ nV}$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2+(10.5\,\mu V)^2}-8.65\text{ nV}$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(6.62\,\mu V)^2}+404\text{ pV}$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(11.1\,\mu V)^2}+19.6\text{ nV}$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2+(35.8\,\mu V)^2}-17.1\text{ nV}$ $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(35.8\,\mu V)^2}-8.85\text{ nV}$ $\sqrt{\left(1.1\,\frac{mV}{V}\cdot OR\right)^2+(84.8\,\mu V)^2}+4.59\text{ nV}$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(0.3 to 1] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2+(50.1\,\mu V)^2}+86.3\text{ nV}$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2+(27.1\,\mu V)^2}+3.80\text{ nV}$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(16.1\,\mu V)^2}-3.61\text{ nV}$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(18.1\,\mu V)^2}-4.48\text{ nV}$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2+(41.1\,\mu V)^2}-17.4\text{ nV}$ $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(118\,\mu V)^2}+64.4\text{ nV}$ $\sqrt{(0.11\,\%\cdot OR)^2+(283\,\mu V)^2}-67.4\text{ nV}$	Standard, Datron 4920

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage, Sources [1,2]	(1 to 3] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2+(160\,\mu V)^2}+196\,nV$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2+(81.2\,\mu V)^2}-81.7\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(42.1\,\mu V)^2}+27.5\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(48.1\,\mu V)^2}+32.1\,nV$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2+(114\,\mu V)^2}+35.6\,nV$ $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(277\,\mu V)^2}-121\,nV$ $\sqrt{\left(1.1\,\frac{mV}{V}\cdot OR\right)^2+(722\,\mu V)^2}-15.3\,nV$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(3 to 10] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2+(53.1\,\mu V)^2}+835\,nV$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2+(271\,\mu V)^2}+38.0\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(141\,\mu V)^2}-22.6\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(161\,\mu V)^2}-36.1\,nV$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2+(381\,\mu V)^2}-199\,nV$ $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(922\,\mu V)^2}-95.7\,nV$ $\sqrt{\left(1.1\,\frac{mV}{V}\cdot OR\right)^2+(2.83\,mV)^2}-674\,nV$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(10 to 30] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz (200 to 500] kHz (500 to 1 000] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2+(1.60\,mV)^2}+1.96\,\mu V$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2+(812\,\mu V)^2}-817\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(812\,\mu V)^2}+184\,nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2+(481\,\mu V)^2}+321\,nV$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2+(1.14\,mV)^2}+356\,nV$ $\sqrt{\left(405\,\frac{\mu V}{V}\cdot OR\right)^2+(2.77\,mV)^2}-1.21\,\mu V$ $\sqrt{\left(1.1\,\frac{mV}{V}\cdot OR\right)^2+(7.22\,mV)^2}-153\,nV$	Standard, Datron 4920

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	**Expanded Uncertainty of Measurement (+/-)**	**Reference Standard, Method, and/or Equipment**
AC Voltage, Sources [1,2]	(30 to 100] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 30 kHz] (30 to 200] kHz	 $\sqrt{\left(428\,\frac{\mu V}{V}\cdot OR\right)^2 + (5.81\ mV)^2} + 8.90\ \mu V$ $\sqrt{\left(197\,\frac{\mu V}{V}\cdot OR\right)^2 + (2.91\ mV)^2} - 4.58\ \mu V$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2 + (2.91\ mV)^2} - 189\ nV$ $\sqrt{\left(40.5\,\frac{\mu V}{V}\cdot OR\right)^2 + (1.61\ mV)^2} - 361\ nV$ $\sqrt{\left(98.4\,\frac{\mu V}{V}\cdot OR\right)^2 + (5.01\ mV)^2} - 765\ nV$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(100 to 300] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 20 kHz] (20 to 100] kHz	 $\sqrt{\left(475\,\frac{\mu V}{V}\cdot OR\right)^2 + (69.2\ mV)^2} - 9.38\ \mu V$ $\sqrt{\left(243\,\frac{\mu V}{V}\cdot OR\right)^2 + (10.0\ mV)^2} - 6.20\ \mu V$ $\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2 + (6.92\ mV)^2} - 9.72\ \mu V$ $\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2 + (7.22\ mV)^2} - 9.46\ \mu V$ $\sqrt{\left(151\,\frac{\mu V}{V}\cdot OR\right)^2 + (39.7\ mV)^2} - 14.0\ \mu V$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(300 to 1 000] V [1 to 2] Hz (2 to 10] Hz (10 to 40] Hz (40 Hz to 20 kHz] (20 to 100] kHz	 $\sqrt{\left(475\,\frac{\mu V}{V}\cdot OR\right)^2 + (301\ mV)^2} - 136\ \mu V$ $\sqrt{\left(243\,\frac{\mu V}{V}\cdot OR\right)^2 + (27.1\ mV)^2} - 326\ nV$ $\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2 + (27.1\ mV)^2} - 35.6\ \mu V$ $\sqrt{\left(57.9\,\frac{\mu V}{V}\cdot OR\right)^2 + (52.1\ mV)^2} - 2.22\ \mu V$ $\sqrt{\left(151\,\frac{\mu V}{V}\cdot OR\right)^2 + (132\ mV)^2} + 175\ \mu V$	Standard, Datron 4920
AC Voltage, Sources [1,2]	(1 000 to 1 500] V [50 to 60] Hz (1.5 to 15] kV [50 to 60] Hz	$\sqrt{\left(810\,\frac{\mu V}{V}\cdot OR\right)^2 + (2.10\ V)^2} + 754\ mV$ $\sqrt{\left(2.3\,\frac{mV}{V}\cdot OR\right)^2 + (23\ V)^2} + 12.6\ V$	Precision High Voltage Meter VITREK 4700A
AC Voltage, Sources [1,2]	(15 to 28] kV [50 to 60] Hz	58 V/kV	High Voltage Probe FLUKE 80K-40

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current, Measuring Instruments	(0 to 190] µA (0.01 to 1] kHz (1 to 5] kHz	$\sqrt{(174\frac{\mu A}{A}OR)^2+(17nA)^2}+3.1nA$ $\sqrt{(347\frac{\mu A}{A}OR)^2+(22nA)^2}+2.6nA$	IEC 60051-9; IEC 60044 Calibrator DATRON 4708
AC Current, Measuring Instruments	(0 to 330] µA (0.01 to 10] kHz (10 to 30] kHz	$\sqrt{(0.93\%OR)^2+239nA^2}-22nA$ $\sqrt{(1.85\%OR)^2+467nA^2}-435nA$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(0.33 to 3.3] mA (0.01 to 10] kHz (10 to 30] kHz	$\sqrt{(0.85\%OR)^2+688\mu A^2}-2.3\mu A$ $\sqrt{(1.16\%OR)^2+91.3\mu A^2}-4.5\mu A$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(1.9 to 19 mA] (0.01 to 1] kHz (1 to 5] kHz	$\sqrt{(0.02\%OR)^2+1.7\mu A^2}+2.2\mu A$ $\sqrt{(116\frac{\mu A}{A}OR)^2+(16nA)^2}+15nA$	Calibrator DATRON 4708
AC Current, Measuring Instruments	(3.3 to 33 mA] (0.01 to 10] kHz (10 to 30] kHz	$\sqrt{(0.23\%OR)^2+6.9\mu A^2}-7.3\mu A$ $\sqrt{(0.46\%OR)^2+7.5\mu A^2}-16.5\mu A$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(19 to 190 mA] (0.01 to 1] kHz (1 to 5] kHz	$\sqrt{(116\frac{\mu A}{A}OR)^2+(16nA)^2}+3.6nA$ $\sqrt{(232\frac{\mu A}{A}OR)^2+(17nA)^2}+2.2nA$	Calibrator DATRON 47 08
AC Current, Measuring Instruments	(33 to 330 mA] (0.01 to 10] kHz (10 to 30] kHz	$\sqrt{(0.23\frac{\mu A}{A}OR)^2+(130nA)^2}+12nA$ $\sqrt{(0.46\%OR)^2+239\mu A^2}-22\mu A$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(0.5 to 1] A [44 to 65] Hz (65 to 850] Hz	$\sqrt{(151\frac{\mu A}{A}OR)^2+(38.1\mu A)^2}+1.3\mu A$ $\sqrt{(161\frac{\mu A}{A}OR)^2+(38.8nA)^2}+97nA$	Calibrator FLUKE 6100B

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current, Measuring Instruments	(1.1to 1.9] A (0.85 to 1] kHz (1 to 5] kHz	$\sqrt{(347\frac{\mu A}{A}OR)^2+(203\mu A)^2}-2.2\mu A$ $\sqrt{(521\frac{\mu A}{A}OR)^2+(271\mu A)^2}-11\mu A$	Calibrator DATRON 4708
AC Current, Measuring Instruments	(1.9 to 2] A [44 to 65] Hz (65 to 850] Hz	$\sqrt{(151\frac{\mu A}{A}OR)^2+(76.2\mu A)^2}+2.6\mu A$ $\sqrt{(161\frac{\mu A}{A}OR)^2+(77.6\mu A)^2}+19.6\mu A$	Calibrator FLUKE 6100B
AC Current, Measuring Instruments	(2 to 3] A [44 to 65] Hz (0.65 to 5] kHz (5 to 10] kHz	$\sqrt{(161\frac{\mu A}{A}OR)^2+(216\mu A)^2}+34.3\mu A$ $\sqrt{(0.12\%OR)^2+4.0mA^2}+683\mu A$ $\sqrt{(3.47\%OR)^2+4.0mA^2}-12mA$	Calibrator FLUKE 6100B Calibrator FLUKE 5520A Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(3 to 5] A [44 to 65] Hz (65 to 850] Hz	$\sqrt{(151\frac{\mu A}{A}OR)^2+(21\mu A)^2}+6.5\mu A$ $\sqrt{(161\frac{\mu A}{A}OR)^2+(22\mu A)^2}+486nA$	Calibrator FLUKE 6100B
AC Current, Measuring Instruments	(5 to 10] A [44 to 65] Hz (65 to 850] Hz	$\sqrt{(190\frac{\mu A}{A}OR)^2+(43.2mA)^2}-33\mu A$ $\sqrt{(221\frac{\mu A}{A}OR)^2+(45.5mA)^2}-73\mu A$	Calibrator FLUKE 6100B
AC Current, Measuring Instruments	(3 to 11] A (65 to100] Hz (0.85 to 1] kHz (1 to 5] kHz	$\sqrt{(0.07\%OR)^2+9mA^2}+4.4mA$ $\sqrt{(0.12\%OR)^2+9mA^2}+750\mu A$ $\sqrt{(3.47\%OR)^2+9mA^2}-4.9mA$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(10 to 20] A [44 to 850] Hz	$\sqrt{(247\frac{\mu A}{A}OR)^2+(1.2mA)^2}-8.2\mu A$	Calibrator FLUKE 6100B
AC Current, Measuring Instruments	(11 to 20.5] A (0.1 to 1] kHz (1 to 5] kHz	$\sqrt{(0.17\%OR)^2+17mA^2}-21mA$ $\sqrt{(3.47\%OR)^2+17mA^2}-9mA$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(80 to 205] A (0.65 to 100] Hz (100 to 440] Hz	$\sqrt{(0.16\%OR)^2+170mA^2}+559mA$ $\sqrt{(3.47\%OR)^2+170mA^2}-903mA$	Calibrator FLUKE 5520A
AC Current, Measuring Instruments	(205 to 1000] A (0.65 to 100] Hz	$\sqrt{(0.16\%OR)^2+852mA^2}+7.2mA$	Calibrator FLUKE 5520A

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current, Sources [1,2]	(0 to 120] µA		DMM HP 3458A
	(10 to 20] Hz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (31\,\mathrm{nA})^2} + 44\,\mathrm{pA}$	
	(20 to 45] Hz	$\sqrt{(0.17\,\% \cdot \mathrm{OR})^2 + (42\,\mathrm{nA})^2} + 26\,\mathrm{nA}$	
	(45 to 1 000] Hz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (42\,\mathrm{nA})^2} + 22\,\mathrm{nA}$	
AC Current, Sources [1,2]	(120 µA to 1.2 mA]		DMM HP 3458A
	(10 to 20] Hz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (381\,\mathrm{nA})^2} + 271\,\mathrm{nA}$	
	(20 to 45] Hz	$\sqrt{(0.17\,\% \cdot \mathrm{OR})^2 + (381\,\mathrm{nA})^2} + 258\,\mathrm{nA}$	
	(45 to 100] Hz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (381\,\mathrm{nA})^2} + 225\,\mathrm{nA}$	
	(100 Hz to 5 kHz]	$\sqrt{\left(347\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (371\,\mathrm{nA})^2} + 13\,\mathrm{pA}$	
	(5 to 20] kHz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (521\,\mathrm{nA})^2} + 196\,\mathrm{pA}$	
	(20 to 50] kHz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (1.3\,\mu\mathrm{A})^2} + 642\,\mathrm{pA}$	
	(50 to 100] kHz	$\sqrt{(0.64\,\% \cdot \mathrm{OR})^2 + (5.4\,\mu\mathrm{A})^2} + 1.5\,\mathrm{nA}$	
AC Current, Sources [1,2]	(1.2 to 12] mA		DMM HP 3458A
	(10 to 20] Hz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (3.8\,\mu\mathrm{A})^2} + 2.7\,\mu\mathrm{A}$	
	(20 to 45] Hz	$\sqrt{(0.17\,\% \cdot \mathrm{OR})^2 + (3.8\,\mu\mathrm{A})^2} + 2.6\,\mu\mathrm{A}$	
	(45 to 100] Hz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (3.8\,\mu\mathrm{A})^2} + 2.3\,\mu\mathrm{A}$	
	(100 Hz to 5 kHz]	$\sqrt{\left(347\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (3.7\,\mu\mathrm{A})^2} + 126\,\mathrm{pA}$	
	(5 to 20] kHz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (5.2\,\mu\mathrm{A})^2} + 2.0\,\mathrm{nA}$	
	(20 to 50] kHz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (14\,\mu\mathrm{A})^2} + 5.1\,\mu\mathrm{A}$	
	(50 to 100] kHz	$\sqrt{(0.64\,\% \cdot \mathrm{OR})^2 + (58\,\mu\mathrm{A})^2} + 15\,\mu\mathrm{A}$	
AC Current, Sources [1,2]	(12 to 120] mA		DMM HP 3458A
	(10 to 20] Hz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (38\,\mu\mathrm{A})^2} + 27\,\mu\mathrm{A}$	
	(20 to 45] Hz	$\sqrt{(0.17\,\% \cdot \mathrm{OR})^2 + (38\,\mu\mathrm{A})^2} + 26\,\mu\mathrm{A}$	
	(45 to 100] Hz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (38\,\mu\mathrm{A})^2} + 23\,\mu\mathrm{A}$	
	(100 Hz to 5 kHz]	$\sqrt{\left(347\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (37\,\mu\mathrm{A})^2} + 1.3\,\mathrm{nA}$	
	(5 to 20] kHz	$\sqrt{\left(694\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (52\,\mu\mathrm{A})^2} + 20\,\mathrm{nA}$	
	(20 to 50] kHz	$\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (142\,\mu\mathrm{A})^2} + 51\,\mu\mathrm{A}$	
	(50 to 100] kHz	$\sqrt{(0.64\,\% \cdot \mathrm{OR})^2 + (541\,\mu\mathrm{A})^2} + 152\,\mathrm{nA}$	

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current, Sources [1,2]	(120 mA to 1.05 A] (10 to 20] Hz (20 to 45] Hz (45 to 100] Hz (100 Hz to 5 kHz] (5 to 20] kHz (20 to 50] kHz	 $\sqrt{(0.46\,\% \cdot \mathrm{OR})^2 + (548\ \mu\mathrm{A})^2} + 236\ \mu\mathrm{A}$ $\sqrt{(0.19\,\% \cdot \mathrm{OR})^2 + (548\ \mu\mathrm{A})^2} + 222\ \mu\mathrm{A}$ $\sqrt{\left(926\,\frac{\mu\mathrm{A}}{\mathrm{A}} \cdot \mathrm{OR}\right)^2 + (491\ \mu\mathrm{A})^2} + 119\ \mathrm{nA}$ $\sqrt{(0.12\,\% \cdot \mathrm{OR})^2 + (752\ \mu\mathrm{A})^2} + 194\ \mu\mathrm{A}$ $\sqrt{(0.35\,\% \cdot \mathrm{OR})^2 + (1.0\ \mathrm{mA})^2} + 228\ \mu\mathrm{A}$ $\sqrt{(1.16\,\% \cdot \mathrm{OR})^2 + (3.5\ \mathrm{mA})^2} + 459\ \mu\mathrm{A}$	DMM HP 3458A
AC Current, Sources [1,2]	(1.05 to 20] A (10 to 1 000] Hz (1 000 Hz to 5 kHz]	 690 µA/A 870 µA/A	Shunt FLUKE A40A-20A
AC Current, Sources [1,2]	(20 to 100] A (10 to 100] Hz (100 to 400] Hz	 8.4 mA/A OR 15 mA/A OR	Calibrator FLUKE 5520A, AC Clamp meter used as transfer standard
AC Current, Sources [1,2]	(100 to 1 000] A (10 to 50] Hz (50 to 100] Hz	 8.0 mA/A OR 7.9 mA/A OR	Calibrator FLUKE 5520A, AC Clamp meter used as transfer standard
DC Resistance Measuring Instruments [1]	0 mΩ 100 µΩ 1 mΩ 10 mΩ	4.6 µΩ 38 µΩ/Ω 34 µΩ/Ω 56 µΩ/Ω	IEC 60051-9 IEC 60477 IEC 60564 Short measurement
DC Resistance Measuring Instruments [1]	100 mΩ 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ	824 µΩ/Ω 9.3 µΩ/Ω 15 µΩ/Ω 9.3 µΩ/Ω 37 µΩ/Ω 12 µΩ/Ω 24 µΩ/Ω 11 µΩ/Ω 18 µΩ/Ω 11 µΩ/Ω	Standard Resistors: Tettex 3200, Tettex 3201 Tettex 3202, Tettex 3203 Tettex 3274, Tettex 3275 Calibrator Datron 4708 Calibrator Fluke 5700A Calibrator Keithley 263
DC Resistance Measuring Instruments [1]	19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ 1 GΩ	17 µΩ/Ω 14 µΩ/Ω 20 µΩ/Ω 32 µΩ/Ω 30 µΩ/Ω 63 µΩ/Ω 67 µΩ/Ω 214 µΩ/Ω 5.1 mΩ/Ω	Standard Resistors: Tettex 3200, Tettex 3201 Tettex 3202, Tettex 3203 Tettex 3274, Tettex 3275 Calibrator Datron 4708 Calibrator Fluke 5700A Calibrator Keithley 263

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance Measuring Instruments [1,2]	(1 to 20] mΩ (20 to 200] mΩ (200 mΩ to 2 Ω] (2 to 19] Ω (19 to 190] Ω 90) Ω to 1.9 kΩ] (1.9 to 19] kΩ (19 to 190] kΩ (190 k Ω to 1.9 MΩ] (1.9 to 19] MΩ (19 to 190] MΩ	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(10.8\,\mu\Omega)^2}+830\,n\Omega$ $\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(108\,\mu\Omega)^2}+8.3\,\mu\Omega$ $\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.08\,m\Omega)^2}+83\,\mu\Omega$ $\sqrt{\left(17.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(302\,\mu\Omega)^2}+15.2\,\mu\Omega$ $\sqrt{\left(12.7\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.2\,m\Omega)^2}+65.8\,\mu\Omega$ $\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(11\,m\Omega)^2}+619\,\mu\Omega$ $\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(110\,m\Omega)^2}+6.19\,m\Omega$ $\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.4\,\Omega)^2}+58.6\,m\Omega$ $\sqrt{\left(16.2\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(32.1\,\Omega)^2}+1.07\,\Omega$ $\sqrt{\left(34.7\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(638\,\Omega)^2}+61.2\,\Omega$ $\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(23.3\,k\Omega)^2}+8.78\,k\Omega$	Resistance decades, micro-ommeter Tettex 2226 or DMM Datron 1281 used as transfer standards
DC Resistance Measuring Instruments [1,2]	(190 MΩ to 1.9 GΩ] (1.9 to 10] GΩ	$\sqrt{(0.35\%\,OR)^2+(1.01\,M\Omega)^2}+916\,k\Omega$ 12 mΩ/Ω	Resistance decades, micro-ommeter Tettex 2226 or DMM Datron 1281 used as transfer standards
DC Resistance Measuring Instruments [1,2]	(10 to 90] GΩ	58 mΩ/Ω	Resistance decades, micro-ommeter Tettex 2226 or DMM Datron 1281 used as transfer standards

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance, Resistors [1,2]	0 mΩ	290 nΩ	Micro-ommeter Tettex 2226 DMM Datron 1281 OR – Of Reading
	(100 µΩ to 2 mΩ]	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.08\,\mu\Omega)^2}+83\,n\Omega$	
	(2 to 20] mΩ	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(10.8\,\mu\Omega)^2}+830\,n\Omega$	
	(20 to 200] mΩ	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(108\,\mu\Omega)^2}+8.3\,\mu\Omega$	
	(200 mΩ to 2 Ω]	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.08\,m\Omega)^2}+83\,\mu\Omega$	
	(2 to 19] Ω	$\sqrt{\left(17.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(302\,\mu\Omega)^2}+15.2\,\mu\Omega$	
	(19 to 190] Ω	$\sqrt{\left(12.7\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.2\,m\Omega)^2}+65.8\,\mu\Omega$	
	(190 Ω to 1.9 kΩ]	$\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(11\,m\Omega)^2}+619\,\mu\Omega$	
	(1.9 to 19] kΩ	$\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(110\,m\Omega)^2}+6.19\,m\Omega$	
	(19 to 190] kΩ	$\sqrt{\left(10.4\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(1.4\,\Omega)^2}+58.6\,m\Omega$	
	(190 kΩ to 1.9 MΩ]	$\sqrt{\left(16.2\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(32.1\,\Omega)^2}+1.07\,\Omega$	
	(1.9 to 19] MΩ	$\sqrt{\left(34.7\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(638\,\Omega)^2}+61.2\,\Omega$	
	(19 to 190] MΩ	$\sqrt{\left(347\,\frac{\mu\Omega}{\Omega}\cdot OR\right)^2+(23.3\,k\Omega)^2}+8.78\,k\Omega$	
	(190 MΩ to 1.9 GΩ]	$\sqrt{(0.35\,\%\cdot OR)^2+(1.01\,M\Omega)^2}+916\,k\Omega$	
AC Resistance. Measuring Instruments [1,2]	[1 to 6.25) Ω [12 to 30) Hz [30 to 100) Hz	 $\sqrt{(0.59\,\%\cdot OR)^2+(1.42\,m\Omega)^2}$ $\sqrt{(0.30\,\%\cdot OR)^2+(1.42\,m\Omega)^2}$	Resistance decades GENRAD 1433-F; 1433-H Digibridge GENRAD 1689M used as transfer standard
AC Resistance. Measuring Instruments [1,2]	[1 to 6.25) Ω [100 to 250) Hz [250 to 1 000) Hz	 $\sqrt{(0.23\,\%\cdot OR)^2+(1.42\,m\Omega)^2}$ $\sqrt{(0.16\,\%\cdot OR)^2+(1.42\,m\Omega)^2}$	Resistance decades GENRAD 1433-F; 1433-H

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance. Measuring Instruments [1,2]	[1 to 6.25) Ω		Digibridge GENRAD 1689M used as transfer standard
	1 kHz	$\sqrt{(0.08\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(1 to 3] kHz	$\sqrt{(0.16\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(3 to 6] kHz	$\sqrt{(0.23\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(6 to 10] kHz	$\sqrt{(0.30\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(10 to 20] kHz	$\sqrt{(0.45\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(20 to 50] kHz	$\sqrt{(1.21\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(50 to 100] kHz	$\sqrt{(2.39\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
AC Resistance. Measuring Instruments [1,2]	[6.25 to 100) Ω		Resistance decades GENRAD 1433-F; 1433-H Digibridge GENRAD 1689M used as transfer standard
	[12 to 30) Hz	$\sqrt{(0.10\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	[30 to 100) Hz	$\sqrt{(0.06\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	[100 to 250) Hz	$\sqrt{(0.05\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	[250 to 1 000) Hz	$\sqrt{(0.03\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	1 kHz	$\sqrt{(0.02\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(1 to 3] kHz	$\sqrt{(0.03\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(3 to 6] kHz	$\sqrt{(0.05\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(6 to 10] kHz	$\sqrt{(0.06\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(10 to 20] kHz	$\sqrt{(0.08\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(20 to 50] kHz	$\sqrt{(0.20\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
	(50 to 100] kHz	$\sqrt{(037\,\% \cdot \mathrm{OR})^2 + (1.42\ \mathrm{m}\Omega)^2}$	
AC Resistance. Measuring Instruments [1,2]	[100 Ω to 1.6 k Ω)		Resistance decades GENRAD 1433-F; 1433-H Digibridge GENRAD 1689M used as transfer standard
	[12 to 30) Hz	$\sqrt{(0.10\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	[30 to 100) Hz	$\sqrt{(0.06\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	[100 to 250) Hz	$\sqrt{(0.05\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	]250 to 1 000) Hz	$\sqrt{(0.03\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	1 kHz	$\sqrt{(0.02\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(1 to 3] kHz	$\sqrt{(0.03\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(3 to 6] kHz	$\sqrt{(0.05\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(6 to 10)] kHz	$\sqrt{(0.06\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(10 to 20] kHz	$\sqrt{(0.10\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(20 to 50] kHz	$\sqrt{(0.20\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	
	(50 to 100] kHz	$\sqrt{(037\,\% \cdot \mathrm{OR})^2 + (1.02\ \Omega)^2}$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance. Measuring Instruments [1,2]	(1.6 to 25.6] kΩ		Resistance decades GENRAD 1433-F; 1433-H Digibridge GENRAD 1689M used as transfer standard
	[12 to 30) Hz	$\sqrt{(0.10\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	[30 to 100) Hz	$\sqrt{(0.06\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	[100 to 250) Hz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	[250 to 1 000) Hz	$\sqrt{(0.03\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	1 kHz	$\sqrt{(0.02\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(1 to 3] kHz	$\sqrt{(0.03\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(3 to 6] kHz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(6 to 10] kHz	$\sqrt{(0.06\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(10 to 20] kHz	$\sqrt{(0.08\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(20 to 50] kHz	$\sqrt{(0.20\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
	(50 to 100] kHz	$\sqrt{(037\,\%\cdot\mathrm{OR})^2+(11.7\,\Omega)^2}$	
AC Resistance. Measuring Instruments [1,2]	(25.6 to 410] kΩ		Resistance decades GENRAD 1433-F; 1433-H Digibridge GENRAD 1689M used as transfer standard
	[12 to 30) Hz	$\sqrt{(0.10\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	[30 to 100) Hz	$\sqrt{(0.06\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	[100 to 250) Hz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	[250 to 1 000) Hz	$\sqrt{(0.03\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	1 kHz	$\sqrt{(0.02\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	(1 to 3] kHz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	(3 to 6] kHz	$\sqrt{(0.09\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	(6 to 10] kHz	$\sqrt{(0.20\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	
	(10 to 20] kHz	$\sqrt{(0.60\,\%\cdot\mathrm{OR})^2+(102\,\Omega)^2}$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance, Resistors [1,2]	(1 to 6.25] Ω		Digibridge Genrad 1689M Resistors that have a serial inductance not exceeding 10 µH. The uncertainties will be increased for resistors with higher inductance.
	[12 to 30) Hz	$\sqrt{(0.59\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[30 to 100) Hz	$\sqrt{(0.30\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[100 to 250) Hz	$\sqrt{(0.23\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[250 to 1 000) Hz	$\sqrt{(0.16\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	1 kHz	$\sqrt{(0.08\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(1 to 3] kHz	$\sqrt{(0.16\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(3 to 6] kHz	$\sqrt{(0.23\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(6 to 10] kHz	$\sqrt{(0.30\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(10 to 20] kHz	$\sqrt{(0.45\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(20 to 50] kHz	$\sqrt{(1.21\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(50 to 100] kHz	$\sqrt{(2.39\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
AC Resistance, Resistors [1,2]	(6.25 to 100] Ω		Digibridge Genrad 1689M Resistors that have a serial inductance not exceeding 10 µH. The uncertainties will be increased for resistors with higher inductance.
	[12 to 30) Hz	$\sqrt{(0.10\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[30 to 100) Hz	$\sqrt{(0.06\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[100 to 250) Hz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	[250 to 1 000) Hz	$\sqrt{(0.03\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	1 kHz	$\sqrt{(0.02\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(1 to 3] kHz	$\sqrt{(0.03\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(3 to 6] kHz	$\sqrt{(0.05\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(6 to 10] kHz	$\sqrt{(0.06\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(10 to 20] kHz	$\sqrt{(0.08\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(20 to 50] kHz	$\sqrt{(0.20\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	
	(50 to 100] kHz	$\sqrt{(037\,\%\cdot\mathrm{OR})^2+(1.42\ \mathrm{m\Omega})^2}$	

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	**Expanded Uncertainty of Measurement (+/-)**	**Reference Standard, Method, and/or Equipment**
AC Resistance, Resistors [1,2]	(100 Ω to 1.6 k Ω] [12 to 30) Hz [30 to 100) Hz [100 to 250) Hz [250 to 1 000) Hz 1 kHz (1 to 3] kHz (3 to 6] kHz (6 to 10] kHz (10 to 20] kHz (20 to 50] kHz (50 to 100] kHz	 $\sqrt{(0.10\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.06\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.03\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.02\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.03\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.06\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.10\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(0.20\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$ $\sqrt{(037\,\% \cdot OR)^2 + (1.02\,\Omega)^2}$	Digibridge Genrad 1689M Resistors that have a serial inductance not exceeding 10 µH. The uncertainties will be increased for resistors with higher inductance
AC Resistance, Resistors [1,2]	(1.6 Ω to 25.6 k Ω] [12 to 30) Hz [30 to 100) Hz [100 to 250) Hz [250 to 1000) Hz 1 kHz (1 to 3] kHz (3 to 6] kHz (6 to10] kHz (10 to 20] kHz (20 to 50] kHz (50 to 100] kHz	 $\sqrt{(0.10\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.06\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.03\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.02\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.03\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.06\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.08\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(0.20\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$ $\sqrt{(037\,\% \cdot OR)^2 + (11.7\,\Omega)^2}$	Digibridge Genrad 1689M Resistors that have a serial inductance not exceeding 10 µH. The uncertainties will be increased for resistors with higher inductance
AC Resistance, Resistors [1,2]	(25.6 Ω to 410 kΩ] [12 to 30) Hz [30 to 100) Hz [100 to 250) Hz [250 to 1 000) Hz 1 kHz (1 to 3] kHz (3 to 6] kHz (6 to 10] kHz (10 to 20] kHz	 $\sqrt{(0.10\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.06\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.03\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.02\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.05\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.09\,\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.20\% \cdot OR)^2 + (102\,\Omega)^2}$ $\sqrt{(0.60\,\% \cdot OR)^2 + (102\,\Omega)^2}$	Digibridge Genrad 1689M Resistors that have a serial inductance not exceeding 10 µH. The uncertainties will be increased for resistors with higher inductance

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance, Measuring Instruments [1,2]	1kHz		IEC 60477 IEC 60564 HP 16381A, HP 16382A HP 16383A, HP 16384A St. Capacitors Genrad 1409 Y, Genrad 1409 L, Genrad 1409 T, Capacitance Decades + Digibridge Genrad 1689M used as a transfer standard
	1 pF	0.19 fF	
	10 pF	1.3 fF	
	100 pF	11 fF	
	1000 pF	110 fF	
	10 nF	1.5 pF	
	100 nF	15 pF	
	1 µF	150 pF	
	[1 to 10) pF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(2.2\ \mathrm{fF})^2}$	
	(10 to 1 000] pF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(7.4\ \mathrm{fF})^2}$	
	(1 to 1.5] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(240\ \mathrm{fF})^2}$	
	(1.5 to 6.4] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(680\ \mathrm{fF})^2}$	
	(6.4 to 10] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(740\ \mathrm{fF})^2}$	
	(10 to 25] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(3.3\ \mathrm{pF})^2}$	
	(25 to 100] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(11\ \mathrm{pF})^2}$	
	(100 to 200] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(29\ \mathrm{pF})^2}$	
	(200 to 400] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(46\ \mathrm{pF})^2}$	
	(400 to 1 000) nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(102\ \mathrm{pF})^2}$	
Capacitance, Capacitors [1,2]	1 kHz		Digibridge Genrad 1689M The uncertainties measurement of capacitors that have a dissipation factor ≤ 1% of a lossless capacitor
	[1 to 10] pF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(2.2\ \mathrm{fF})^2}$	
	(10 to 1 000] pF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(7.4\ \mathrm{fF})^2}$	
	(1 to 1.5] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(240\ \mathrm{fF})^2}$	
	(1.5 to 6.4] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(680\ \mathrm{fF})^2}$	
	(6.4 to 10] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(740\ \mathrm{fF})^2}$	
	(10 to 25] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(3.3\ \mathrm{pF})^2}$	
	(25 to 100] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(11\ \mathrm{pF})^2}$	
	(100 to 200] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(29\ \mathrm{pF})^2}$	
	(200 to 400] nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(46\ \mathrm{pF})^2}$	
	(400 to 1 000) nF	$\sqrt{(0.02\,\%\cdot \mathrm{OR})^2+(102\ \mathrm{pF})^2}$	

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance Measuring Instruments [1,2]	100 µH 100 Hz 400 Hz 1 kHz 1 mH 100 Hz 400 Hz 1 kHz 10 mH 100 Hz 400 Hz 1kHz 100 mH 100 Hz 400 Hz 1 kHz 1 H 100 Hz 400 Hz 10 H 100 Hz	1.1 µH 1.2 µH 11 µH 33 µH 1.2 mH 1.3 mH 13 mH	IEC 60477 IEC 60 564 St. Inductors Genrad 1482- B, Genrad 1482-E, Genrad 1482-H, Genrad 1482-L, Genrad 1482-P, Genrad 1482-T, +Digibridge Genrad 1689M Used as a transfer standard
Inductance Measuring Instruments [1,2]	100 Hz [10 µH to 1 mH] (1 to 9] mH (9 to 90] mH (90 to 900] mH (0.9 to 9] H (9 to 10] H	 $\sqrt{(9.10\,\% \cdot \mathrm{OR})^2 + (5.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.07\,\% \cdot \mathrm{OR})^2 + (5.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.11\,\% \cdot \mathrm{OR})^2 + (3.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.17\,\% \cdot \mathrm{OR})^2 + (55\,\mu\mathrm{H})^2}$ $\sqrt{(0.05\,\% \cdot \mathrm{OR})^2 + (11\,\mathrm{mH})^2}$ $\sqrt{(0.06\,\% \cdot \mathrm{OR})^2 + (24\,\mathrm{mH})^2}$	IEC 60477 IEC 60 564 St. Inductors Genrad 1482- B, Genrad 1482-E, Genrad 1482-H, Genrad 1482-L, Genrad 1482-P, Genrad 1482-T, Inductance Decade +Digibridge Genrad 1689M Used as a transfer standard

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance, Inductors [1,2]	100 Hz [10 µH to 1 mH] (1 to 9] mH (9 to 90] mH (90 to 900] mH (0.9 to 9] H (9 to 90] H (90 to 900] H	 $\sqrt{(9.10\,\%\cdot \mathrm{OR})^2+(5.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.07\,\%\cdot \mathrm{OR})^2+(5.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.11\,\%\cdot \mathrm{OR})^2+(3.1\,\mu\mathrm{H})^2}$ $\sqrt{(0.17\,\%\cdot \mathrm{OR})^2+(55\,\mu\mathrm{H})^2}$ $\sqrt{(0.05\,\%\cdot \mathrm{OR})^2+(11\,\mathrm{mH})^2}$ $\sqrt{(0.06\,\%\cdot \mathrm{OR})^2+(24\,\mathrm{mH})^2}$ $\sqrt{(0.49\,\%\cdot \mathrm{OR})^2+(21\,\mathrm{mH})^2}$	Digibridge Genrad 1689M The uncertainties apply to the measurement of inductors that have a quality factor ≤ 1% of series impedance of an ideal inductor
AC Power, Measuring Instruments [1,2]	[1 to 1 008] V, (0 to 40] Hz, [0 to 20] A [0.00 to 20 160.00] VA PF = 1 20160.00 W PF = 0.8 8 064.00 W 6 048.00 VAR PF = 0.5 5 040.00 W 8 729.54 VAR PF = 0.2 2 016.00 W 19 752.69 VAR	 0.06 % OR 0.08 % OR 0.09 % OR 0.05 % OR 0.13 % OR 0.06 % OR 0.32 % OR 0.04 % OR	Calibrator FLUKE 6100B
AC Power, Measuring Instruments [1,2]	(40 to 65] Hz, [0 to 5] A (0.00 to 5 040.00] VA PF = 1 5 040.00 W	 0.04 % OR 0.07 % OR	Calibrator FLUKE 6100B
AC Power, Measuring Instruments [1,2]	(0 to 40] Hz, [0 to 20] A PF = 0.8 4 032.00 W 3 024.00 VAR PF = 0.5 2520.00 W 3 117.69 VAR PF = 0.2 720.00 W / 3 527.27 VAR	 0.09 % OR 0.05 % OR 0.13 % OR 0.04 % OR 0.32 % OR 0.04 % OR	Calibrator FLUKE 6100B

Electrical – DC/Low Frequency

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power, Measuring Instruments [1,2]	(40 to 65] Hz, (5 to 80] A (5 040.00 to 80 640.0] VA PF = 1 80 640.00 W PF = 0.8 64 512.00 W/ 48 384.00 VAR PF = 0.5 40 320.00 W/ 698.29 VAR	0.05 % OR 0.07 % OR 0.09 % OR 0.05 % OR 0.13 % OR 0.05 % OR	Calibrator FLUKE 6100B
AC Power, AC current Measuring Instruments [1,2]	(65 to 850] Hz, (20 to 80] A (20 160.0 to 80 640.0] VA PF = 1 8 0640.00 W PF = 0.8 64 512.00 W 48 384.00 VAR PF = 0.5 4 0320.00 W 6 9836.29 VAR PF = 0.2 16 128.00 W 79 010.74 VAR	0.06 % OR 0.08 % OR 0.13 % OR 0.18 % OR 0.24 % OR 0.09 % OR 0.65 % OR 0.06 % OR	Calibrator FLUKE 6100B
AC Power, Measuring Instruments [1,2]	(65 to 850] Hz (20 to 800 A (20 160.0 to 80 640.0] VA PF = 1 8 0640.00 W	0.06 % OR 0.08 % OR	Calibrator FLUKE 6100B
AC Power, Generating instruments [1]	(45 to 1 000] Hz [11 to 749] V PF range [(0.1 to 1] [1 to 4) W (4 W to 1.42 kW] (1.42 to 75] kW	2.3 mW/W 1 mW/W 3.5 mW/W	DMM DATRON 1281 DMM DATRON 1271 CLAPMETER FLUKE 801-1000S

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power factor (PF) Measurement Instruments [1,2,4]	[1 to 1008] V [16 to 850) Hz [0.01 to 80] A PF = 1 PF = 0.9 PF = 0.8 PF = 0.7 PF = 0.6 PF = 0.5 PF = 0.4 PF = 0.3 PF = 0.2 PF = 0.1	 0.005 5 0.006 7 0.007 9 0.008 9 0.009 6 0.01 0.011 0.011 0.011 0.011	Calibrator FLUKE 6100B
Power factor Generating Instruments [1,2,4]	[45 to75] Hz Up to 500 V] Up to 10 A] PF range [0.1 to 1]	0.03	IEC 60051-9
AC Energy, Single phase Measuring Instruments [1,2]	[1 to 1 008] V [0.01 to 80] A [16 to 850] Hz Max: 1 000 h	0.08 % OR	Calibrator FLUKE 6100B
Temperature, Temperature indicators and simulators for Noble metal thermocouples [1]	[-200 to 500) °C (500 to 1 800] °C	0.5 °C 0.3 °C	Euramet cg11 Calibration by means of electrical simulation Including cold junction compensation
Temperature, Temperature indicators and simulators for Base metal thermocouples [1]	[-200 to 1 380] °C	0.15 °C	Euramet cg11 Calibration by means of electrical simulation Including cold junction compensation

Electrical – DC/Low Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature, Temperature indicators and simulators for Base metal thermocouples [2]	Type E [-250 to -100) °C (-100 to 1 000] °C Type J [-210 to -100) °C (-100 to -1 200] °C Type K [-200 to 1 000) °C (1 000 to 1 372] °C Type N [-200 to -100) °C (-100 to 1 300) °C Type T [-250 to -150) °C (-150 to 0] °C (0 to 400] °C	 0.6 °C 0.3 °C 0.4 °C 0.3 °C 0.3 °C 0.5 °C 0.5 °C 0.3 °C 0.7 °C 0.3 °C 0.2 °C	Euramet cg11 Calibration by means of electrical simulation Including cold junction compensation
Temperature, Temperature indicators and simulators for Noble metal thermocouples [2]	Type R, S [-200 to 1 800) °C	0.8 °C	Euramet cg11
Temperature, Temperature indicators and simulators for Resistance sensors [1]	[-200 to 100] °C (100 to 300] °C (300 to 500] °C (500 to 850] °C	0.01 °C 0.02 °C 0.03 °C 0.04 °C	Euramet cg11

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calibration Factor for Power Sensors [1,2]	[100 to 150) kHz [0.15 to 1) MHz [1 to 10) MHz	1.7 % 1.6 % 1.3 %	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calibration Factor for Power Sensors [1,2,4]	[10 to 499) MHz [499 to 580) MHz [580 to 820) MHz (0.82 to 2.6] GHz (2.6 to 3.3] GHz (3.3 to 4.0] GHz (4.0 to 4.5] GHz (4.5 to 5.0] GHz (5.0 to 6.0] GHz	1.1 % 1.2 % 1.3 % 1.4 % 1.5 % 1.6 % 1.7 % 1.8 % 1.9 %	RF REFERENCE SOURCE FLOUKE 96270A With Power Sensors: R & S Z55-1
Calibration Factor for Power Sensors [1,2,4]	(6 to 8] GHz (8 to 10] GHz (10 to 12] GHz (12 to 15] GHz (15 to 18] GHz	2.0 % 2.1 % 2.2 % 2.3 % 2.4 %	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1
RF Attenuation [1,2]	(0 to 4) dB [300 kHz to 3 GHz] (3 to 6] GHz (6 to 18] GHz (4 to 6) dB [300 kHz to 3 GHz] (3 to 6] GHz (6 to 18] GHz	 0.09 dB 0.1 dB 0.27 dB 0.1 dB 0.12 dB 0.27 dB	The uncertainties apply to the measurements of devices fitted with connectors that have input/ output VSWR not exceeding 1.1 The uncertainties will be increased for devices with higher VSWR Network analyzers: HP 8757A, HP 8753C

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation [1,2]	(6 to 40) dB [300 kHz to 10 MHz) (40 to 45) dB [300 kHz to 10 MHz) (45 to 50) dB [300 kHz to 10 MHz) (50 to 55) dB [300 kHz to 10 MHz) (55 to 60) dB [300 kHz to 10 MHz) (60 to 65) dB [300 kHz to 10 MHz) (65 to 70) dB [300 kHz to 10 MHz) (70 to 75) dB [300 kHz to 10 MHz) (75 to 80) dB [300 kHz to 10 MHz) (80 to 85) dB [300 kHz to 10 MHz) (85 to 90) dB [300 kHz to 10 MHz)	 0.13 dB 0.2 dB 0.41 dB 0.51 dB 0.54 dB 0.56 dB 0.64 dB 0.86 dB 1.4 dB 2.1 dB 3.4 dB	Spectrum analyzer Agilent N9030A
RF Attenuation [1,2]	(6 to 25) dB [10 MHz to 3.6 GHz] (3.6 to 8.4] GHz (8.4 to 17.1] GHz (17.1 to 18] GHz [25 to 40) dB [10 MHz to 3.6 GHz] (3.6 to 8.4] GHz (8.4 to 17.1] GHz (17.1 to 18] GHz [40 to 80] dB [10 MHz to 3.6 GHz] (3.6 to 8.4] GHz (8.4 to 13.6] GHz (13.6 to 17.1] GHz (17.1 to 18] GHz	 0.13 dB 0.14 dB 0.16 dB 0.17 dB 0.1 dB 0.12 dB 0.16 dB 0.17 dB 0.1 dB 0.12 dB 0.13 dB 0.14 dB 0.15 dB	Spectrum analyzer Agilent N9030A

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power Source [1,2]	[-100 to -35) dBm) (100 kHz to 60 MHz] (60 MHz to 16 GHz] (8 to 16] GHz (16 to 26.5] GHz	0.16 dB 0.3 dB 0.41 dB 0.52 dB	RF Reference Source FLUKE 96270A for absolute power offset measurement + Spectrum analyzer Agilent N9030A for power measurement exceeding 1.1 The uncertainties will be increased for devices with higher VSWR
Power Source [1,2]	(-35 to 20) dBm [100 kHz to 26.5 GHz]	0.078 dB	RF Reference Source FLUKE 96270A
Power Source [1,2]	(20 to 44) dBm [10 MHz- 2 GHz] (2 to 6] GHz (6 to 9] GHz (9 to 13] GHz (13 to 16] GHz (16 to 18] GHz	0.23 dB 0.24 dB 0.25 dB 0.27 dB 0.31 dB 0.39 dB	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1
Power, Measuring Instruments [1,2]	[-130 to -110) dBm [10 to 240) MHz [240 MHz to 3 GHz]	0.92 dB 2 dB	RF Reference Source FLUKE 96270A
Power, Measuring Instruments [1,2]	[-110 to -35) dBm [100 to 300) kHz [300 kHz to 4] GHz] (4 to 26.5] GHz	0.054 dB 0.049 dB 0.1 dB	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1 with automatic dynamic attenuator and generator error correction
Power, Measuring Instruments [1,2]	[-35 to 20) dBm [100 kHz to 14 GHz] (14 to 26.5] GHz	0.02 dB 0.026 dB	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1

Electrical – RF/Microwave

Parameter/Equipment	**Range** [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power, Measuring Instruments [1,2]	20 dBm [100 kHz to 18 GHz] (20 to 44] dBm (10 MHz to 6 GHz] (2 to 6] GHz (6 to 9] GHz (9 to 13] GHz (13 to 16] GHz (16 to 18] GHz	 0.026 dB 0.23 dB 0.24 dB 0.25 dB 0.27 dB 0.3 dB 0.38 dB	Power sensor HP 8481B, HP 8482A, HP 8485A
Relative Power Sources [1,2]	[-80 to -35] dB [100 kHz to 3.6 GHz) (3.6 to 8.4) GHz (8.4 to 13.6) GHz (13.6 to 26.5] GHz	 0.15 dB 0.27 dB 0.35 dB 0.41 dB	Spectrum Analyzer Agilent N9030A
Relative Power Sources [1,2]	[-35 to 20) dB [100 kHz to 26.5 GHz]	0.08 dB	RF Reference Source FLUKE 96270A Power sensor R & S
	(20 to 44] dB [10 MHz to 18 GHz] (6 to 9] GHz (9 to 13] GHz (13 to 16] GHz (16 to 26.5] GHz	 0.08 dB 0.09 dB 0.01 dB 0.11 dB 0.12 dB	High Frequency Power sensor HP 8481B
Relative Power Measuring Instruments [1,2]	[-110 to -35) dBm (100 kHz to 10 MHz) [10 MHz to 4 GHz] (4 to 18] GHz (18 to 26.5] GHz	 0.054 dB 0.044 dB 0.098 dB 0.1 dB	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1 with automatic dynamic attenuator and generator error correction
Relative Power Measuring Instruments [1,2]	(-35 to 20) dB [100 kHz to 26.5 GHz]	0.014 dB	RF Reference Source Fluke 96270A With Power Sensors: R&S Z55-1
Relative Power Measuring Instruments [1,2]	(20 to 44) dB [10 MHz to 18 GHz]	0.08 dB	High Frequency Power sensor HP 8481B

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation, Sources [1,2]	carrier: [1 MHz to 26.5 GHz] modulation rate: [50 Hz to 10 kHz] modulation depth: [1 to 99] %	0.00164 x MODULATION DEPTH + 0.022	Spectrum Analyzer Agilent N9030A
Frequency Modulation, Sources [1,2]	carrier: [1 MHz to 26.5 GHz] modulation rate: [20 Hz to 20 kHz) frequency deviation: 200 Hz to 4 kHz	$\sqrt{1.57\% \text{ of rdg.}^2 + 3\text{Hz}^2}$	Spectrum Analyzer Agilent N9030A
Frequency Modulation, Sources [1,2]	carrier: [1 MHz to 26.5 GHz] modulation rate: [20 to 50] kHz frequency deviation: [4 to 40] kHz	$\sqrt{3.30\% \text{ of rdg.}^2 + 30\text{Hz}^2}$	Spectrum Analyzer Agilent N9030A
Frequency Modulation, Sources [1,2]	carrier: [1 MHz to 26.5 GHz] modulation rate: [20 to 50] kHz frequency deviation: [40 to 400] kHz	$\sqrt{0.69\% \text{ of rdg.}^2 + 210\text{Hz}^2}$	Spectrum Analyzer Agilent N9030A
Phase Modulation Sources [1,2]	carrier: [1 MHz to 26.5 GHz] modulation rate: [50 Hz to 50 kHz] phase deviation: [0.2 to 100] rad	$0.12\ \%\text{of rdg.} + 0.02\ \text{rad}$	Spectrum Analyzer Agilent N9030A
Distortion, Sources	[0.001 to 100] %: [20 Hz to 20 kHz] (20 to 100] kHz	$\sqrt{(13.9\%\ \text{OR})^2 + (0.00058\ \%)^2}$ $\sqrt{(29.0\%\ \text{OR})^2 + (0.00058\ \%)^2}$	HP 8903 Audio Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Voltage reflection coefficient (VRC) [1,2,4]	[300 kHz to 3 GHz] (0 to 0.01) (0.01 to 0.1) (0.1 to 0.2) (0.2 to 0.3) (0.3 to 0.4) (0.4 to 0.5) (0.5 to 0.6) (0.6 to 0.7) (0.7 to 0.8) (0.4 to 0.5) (0.5 to 0.6) (0.6 to 0.7) (0.7 to 0.8) (0.8 to 0.9) (0.9 to 1.0)	 0.008 0.009 0.01 0.012 0.014 0.016 0.019 0.023 0.026 0.016 0.019 0.023 0.026 0.03 0.034	The results may also be expressed in terms of VSWR or Return Loss (dB) with uncertainties stated in the appropriated units. Network Analyzer HP 8753C The uncertainties are for one-port or two - port device with greater than 25 dB transmission loss.
Voltage reflection coefficient (VRC) [1,2,4]	(3 to 6] GHz (0 to 0.01) (0.01 to 0.1) (0.1 to 0.2) (0.2 to 0.3) (0.3 to 0.4) (0.4 to 0.5) (0.5 to 0.6) (0.6 to 0.7) (0.7 to 0.8) (0.8 to 0.9) (0.9 to 1.0)	 0.012 0.013 0.015 0.018 0.022 0.025 0.03 0.035 0.04 0.046 0.052	The results may also be expressed in terms of VSWR or Return Loss (dB) with uncertainties stated in the appropriated units. Network Analyzer HP 8753C The uncertainties are for one-port or tow - port device with greater than 25 dB transmission loss.
Voltage reflection coefficient (VRC) [1,2,4]	(6 to 12] GHz (0.00 to 1.00] (12 to 18] GHz (0.01 to 1.00] GHz	 0.034 0.042	Network Analyzer HP 8757A

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length, Dimensions of Traffic Camera's Loop Field [2,3]	[1 to 5] m	(1 + L/2) mm	Reference Measuring Tape

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Traffic Speed, Gatso Loop Detector Traffic Cameras [1,2]	[20 to 250] km/h	1 km/h	Calibration of Gatso loop detector traffic speed cameras by means of 4 lanes simulator. The scope of accreditation comprises conducting camera self-tests and speed limit accuracy tests. The results of these tests may be included in the calibration certificates.
Distance- Calibration of City Train Tachograph [2]	(875 to 885) m	2 m	Reference Measuring Tape CP 25.240
Speed -Calibration of City Train Tachograph [2]	(10 to 70) km/h	0.45 km/h	GPS Standard Instrument The scope of accreditation comprises tests hereafter. The results may be included in the certificates. Tachograph, Functional tests according regulator's specification Functional tests will cover items (a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), (l), (m). Chapter 5 paragraph 20(5) of Railroad Regulations.
Perpendicularity, Height Gauge [1]	(-1 to 1) mm (gauge height up to 600 mm)	5 µm	JIS B7517; BS 1643 Gauge blocks, Angle Plate WYLER
Perpendicularity, Squares [1]	[0 to 300] mm (300 to 600] mm	3 µm 5 µm	JIS B 7526; DIN 875 Height up to 600 mm Grade "00" Standard Angle plate WYLER, Gauge blocks.
Angle, Sine Bars [1]	[0 to 45]°	22 µrad	DIN 2273; JIS B 7523 BS 3064 Base length up to 200 mm Grade "1" Gauge blocks, Angle gauges
Angle, Bevel protractors [1]	(-90 to 90)°	0.6 mrad	BS 1685; GGG-P-676b Angle gauges TSUGAMI Scale interval 5´

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle, Levels [1]	Up to ± 3’ ± (3 to ±10]’ ± (10 to ±20]’ ± (20 to ±30]’	0.5" 1" 2" 3"	JIS B 7510; DIN 877; BS 958; BS 3509 Small angles generator, 1 µm/m sensitivity
Form, Flatness, Surface Plates, Granite [1,2,3]	ISO 8512-2, BS 817, DIN 876 Grades	(2 + 0.5×L) µm	Surface Plate 250 x 250 mm minimum size up to 4 m in diagonal Grade “0” Electronic level WYLER
Gauge Blocks [1,3]	[0.5 to 100] mm	(0.1 + L) µm	ISO 3650; DIN 861; BS 888; ISO 3650; BS 4311 Gauge blocks, Comparator Tesa, The calibration method is the comparison
Length Bars [1,3]	[1 to 1 000] mm	(1+5×L) µm	BS 870; JIS B 7502; DIN 863-1 Gauge blocks, Comparator (Dial indicator MAHR, length measuring instrument MAHR) The calibration method is the comparison
Caliper [1,2,3]	[0.5 to 1 000] mm	(15+20×L) µm	ISO 6906; ISO 3599; DIN 862; JIS B 7507 Gauge blocks, CMC stands for caliper resolution 0.01 mm.
Depth Caliper [1,2,3]	Up to 200 mm	(10+10×L) µm	DIN 862 CMC stands for caliper resolution 0.01 mm. Gauge blocks, Depth micro checker
Micrometer External [1,2,3]	Up to 100 mm[1] Up to 100 mm[2] (100 to 1 000] mm[1]	2 µm 3 µm (2+8×L) µm	IS0 3611; DIN 863; JIS B 7502 Gauge blocks CMC stands for resolution 0.001 mm
Micrometer Internal, Duo-bore [1]	[30 to 100] mm	3 µm	DIN 863 Standard Plain rings

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometer Depth [1]	Up to 200 mm	2 µm	DIN 863 Depth micro checker, Mitutoyo, Measuring machine
Micrometers, Indicating, Main Scale [1]	Up to 100 mm	2 µm	JIS B 7520 Gauge blocks CMC stands for resolution 0.001 mm
Micrometers, Indicating Indicator Scale [1]	± 0.06 mm	1 µm	JIS B 7520
Micrometer Internal, Tri-o- Bore[1]	[5 to 100] mm	2 µm	DIN 863 Standard Plain Rings
Height Gauge [1,2,3]	Up to 1 000 mm	$(2+4\times L)$ µm	JIS B7517; BS 1643 Gauge blocks CMC stands for resolution 0.001 mm
Dial Gauge [1]	Up to 100 mm	1 µm	DIN 878; JIS B7503; ANSI/ASME B89.1.10M XPE-11-056 Calibration Testers Mitutoyo, Measuring machine, CMC stands for resolution 0.1 µm
Dial Gauge Lever [1]	(-0.1 to 0.1) mm	1.5 µm	DIN 2270; JIS B 7533 Calibration Testers Mitutoyo, Measuring machine CMC stands for resolution of 0.2 µm
Dial Indicator Symmetric Scale [1]	(-0.25 to 0.25) mm	1 µm	DIN 879 Calibration testers Mitutoyo, Plain Rings CMC stands for resolution of 0.1 µm
Bore Gauges [1]	[3.6 to 100] mm	2 µm	JIS B 7515 Calibration Testers Mitutoyo, Plain rings CMC stands for resolution of 0.5 µm
Extensometer [1,2]	Up to 5 mm	3.5 µm	ISO 9513; JIS B 7741; ASTME B3; BS 3846 Standard Extensometer Standard Dial Gauge

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Measuring table scale, Microscope [1,2]	Up to 275 mm	5 µm	JIS B 7153 Standard Glass Scale CMC stands for magnification of x50 and resolution of 1 µm
Comparator- Tesa Modul UPC [1]	(-0.01 to 0.01) mm	0.05 µm	EURAMET/ cg-02 Gauge blocks, CMC stands for max. nom. Length for comparison 100 mm.
Horizontal Measuring Machine [1,3]	Up to 250 mm	(0.12+3×L) µm	Gauge blocks CMC stands for resolution of 0.1 µm
Depth Microchecker [1,3]	Up to 300 mm	(1+3×L) µm	Gauge blocks
Length, Electrical Comparator [1]	(-1 to 1) mm	0.3 µm	Gauge blocks CMC stands for resolution of 0.1 µm
Length, Calibration Testers For Dial Gauges [1]	Up to 25 mm	0.8 µm	Gauge blocks Electrical Comparator L-in meters CMC stands for resolution of 0.5 µm
Length, Calibration Testers For Precision Dial Gauges [1]	Up to 5 mm	0.4 µm	Gauge blocks Electrical Comparator L-in meters CMC stands for resolution of 0.1 µm
Length, Metal Rules [1]	Up to 1 m (1 to 2] m	0.2 mm 0.3mm	Standard 1 m long Engineering Metal Rule JIS B 7516-1987
Metal Rules [1] Straightness, Squareness	Up to 1 mm	0.04 mm 0.003 mm	Standard 1 m long Engineering Metal Rule JIS B 7516-1987
Length, Steel Tape Measures [1,3]	Up to 4 m (4 to 50] m	0.4mm (0.4 + 0.3xL/4) mm	Standard 4 m long Metal Rule OIML R 35-1
Length, Non-metallic Tape Measures [1,3]	Up to 4 m (4 to 50] m	1.4 mm (1 + 0.35xL) mm	Standard 4 m long Metal Rule OIML R 35-1
Length Laser Distance Measurer [1]	Up to 4 m 24 m	1 mm 3 mm	Standard 4 m long rule Standard 24 m long set up
Thickness, Feeler Gauge [1]	[0.01 to 2] mm	1 µm	JIS B 7524; DIN 2275 Measuring machine Standard Gauge Block

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Diameter Plain Plug Gauges [1,3]	[0.5 to 150] mm	$(1+3 \times D)$ µm	BS 969; ISO/R 1938; DIN 7150; DIN 7162; DIN 2269 Measuring machine Standard Plugs
Major Diameter, Thread Plug Gauges, Parallel [1]	[0.5 to 150] mm	2 µm	ISO 965; ISO 724; ISO 1502; FED - STD H28/6A; ANSI/ASME B1.2; ISO 5864; ISO 228/1; ISO 228/2; ANSI/ASME B1.20.1; FED-STD H28/7A; BS 84; BS 919; MIL-ST-21309E; BS 3409; BS 2710; Measuring Machine, Standard Plugs
Simple Pitch Diameter, Thread Plug Gauges, Parallel [1]	[0.5 to 150] mm	3 µm	ISO 965; ISO 724; ISO 1502; FED - STD H28/6A; ANSI/ASME B1.2; ISO 5864; ISO 228/1; ISO 228/2; ANSI/ASME B1.20.1; FED-STD H28/7A; BS 84; BS 919; MIL-ST-21309E; BS 3409; BS 2710 Measuring machine, Wires for screw thread measuring, Standard Plugs
Pitch Diameter, Thread Plug Gauges, Tapered [1]	[1.5 to 150] mm	5 µm	ANSI/ASME B1.20.1; BS 21; ISO 7; DIN 2999; ASME B1.20.5; AS 2710 Measuring machine, Wires for screw thread measuring Standard Plugs

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Major Diameter, Thread Plug Gauges, Tapered [1]	[1.5 to 150] mm	3 µm	ANSI/ASME B1.20.1; BS 21; ISO 7; DIN 2999; ASME B1.20.5; AS 2710 Measuring machine, Standard Plugs
Stand off from Reference Plane Thread Ring Gauges, Tapered sizes 1/16" to 3" [1]	[-5 to 5] mm	20 µm	ISO 7-2; ANSI/ASME B1.20.1 Standard Check Plug Gauges
Dimension Thread Ring Gauges, Tapered sizes 1/16" to 6" [1]	[1 to 50] mm	4 µm	ISO 7-2; ANSI/ASME B1.20.1 Length dimensions
Diameter, Plain Ring Gauges, Parallel [1]	[2.5 to 200] mm	1.5 µm	BS 969; ISO/R 1938; DIN 7150; DIN 7162; BS 4064; ANSI/ASME B89. 1.6 M Standard Ring Gauges, Measuring machine
Diameter, Thread Measuring, Wires [1]	[0.15 to 4] mm	0.6 µm	JIS B 0271; BS 5590 Measuring machine, Standard Wires
Simple Pitch Diameter, Minor Diameter Thread Ring Gauges, Parallel [1]	[4 to 200] mm	3 µm	ISO 965; ISO 724; ISO 1502; ANSI/ASME B.1.2; ISO 5864; ISO 228/1; ISO 228/2; ANSI/ASME B.1.20.1; FED-STD H28/7A; BS 919; AS 2710 Measuring machine, Standard Feelers for the thread measurement Standard Ring Gauge Parallel
Measuring table scale, Profile Projector [1,2]	Up to 275 mm	5 µm	JIS B 7153; JIS B 7184 Standard Glass Scale CMC stands for magnification of x50 and resolution of 1 µm

Length – Dimensional Metrology

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Opening size, Test sieves [1,2]	[20 µm to 5.6. mm] [1] [6.3 mm to 125 mm] [1,2]	4 µm or ¼ of Y whichever greater 0.5 mm or ¼ of Y whichever lower	BS 410-1; BS410-2; ASTM E11; ASTM E323-09 Y – tolerance of average opening size for wire test sieves or individual hole size tolerance for perforated sieve. Caliper Optical projector

Mass and Mass Related

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Torque Wrenches and Drivers [1]	[0.05 to 1 000) N·m	0.75 % of Readings of Standard Instrument	Standard BS EN ISO 6789; ASME B107.300 Transducer
Torque Torque Wrenches and Drivers [2]	[0.05 to 50] N·m	1 % of Readings of Standard Instrument	Standard BS EN ISO 6789; ASME B107.300 Transducer
Torque Mechanical and Electronic Torque Calibration Equipment [1]	[0.05 to 1 000] N·m	0.1 % of Readings	Standard BS 7882; ASME B107.300; Euramet cg-14 Mass and Lever
Force Compression [1,2] Tension [1,2]	(0 to 1.5] kN	0.03 % of Readings of Standard Instrument	Standard ISO 376 Standard ISO 7500-1 Standard weights
Force Compression [1,2] Tension[1,2]	[1.5 to 100] kN	0.15 % of Readings of Standard Instrument	Standard ISO 376 Standard ISO 7500-1 Standard load Cell
Force Compression [1,2] Tension[1,2]	[100 to 400] kN	0.08 % of Readings of Standard Instrument	Standard ISO 376 Standard ISO 7500-1 Standard load Cell
Force Compression [1,2] Tension [2]	[400 to 1 000] kN	0.08 % of Readings of Standard Instrument	Standard ISO 376 Standard ISO 7500-1 Standard load Cell

Mass and Mass Related

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Compression [1,2]	(1 000 to 2 000] kN	0.08 % of Readings	Standard ISO 376 Standard ISO 7500-1 Standard load Cell
Force Compression [2]	(2 000 to 5 000] kN	0.33 % of Readings	Standard ISO 376 Standard ISO 7500-1 Standard load Cell
Mass, Weights [1]	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g	0.003 3 mg 0.003 3 mg 0.003 3 mg 0.003 3 mg 0.003 3 mg 0.004 mg 0.005 mg 0.006 mg 0.007 mg 0.007 mg 0.01 mg 0.01 mg	OIML R111-1; OIML R52; Standard Weights Class E1, Standard Comparator, Comparison.
Mass, Weights [1]	10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg	0.012 mg 0.026 mg 0.05 mg 0.06 mg 0.07 mg 0.17 mg 1.6 mg 2.0 mg 2.6 mg 150 mg 150 mg	OIML R111-1; OIML R52; Standard Weights Class E1, Standard Comparator, Comparison.

Mass and Mass Related

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Non-automatic Weighing Instruments [1,2]	Up to 5 000 kg	$2 \times \sqrt{\left(\frac{res}{3.4}\right)^2 + \left(\frac{mpe}{1.7}\right)^2}$	OIML R 76-1 Euramet cg 18 res: the resolution of the balances at the calibration point mpe: maximum permissible error of the weights as defined in Table 1, OIML R 111-1 Available standard weights are: E1 from 1 mg to 5 kg, E2 from 1 mg to 5 kg, F1 from 1 mg to 10 kg F2 from 1 mg to10 kg M1 from 100 g to 10 kg M2 10 kg (100 pieces)
Pneumatic Pressure - Gauge Pressure measuring instruments [1]	[-98 to -20) kPa [-20 to -7) kPa [-7 to -2.5) kPa [-2.5 to 2.5] kPa (2.5 to 7] kPa (7 to 10) kPa [10 kPa to 7 MPa] (7 to 10] MPa	10 Pa +0.2 Pa/kPa 15 Pa 3 Pa 1 Pa 3 Pa 15 Pa 0.25 Pa/kPa 1 Pa/kPa	OIML R 101; OIML R 109; ASME B40.100; EURAMET cg 17; BS EN 837; BS EN ISO 5171 Gas Dead Weight Tester
Pneumatic Pressure - Gauge Pressure measuring instruments [2]	[-95 to -20) kPa [-20 to -7) kPa [-7 to -2.5) kPa [-2.5 to 2.5] kPa (2.5 to 7] kPa (7 to 20] kPa (20 kPa to 6 MPa] (6 to 70] MPa	20 Pa +0.1 Pa/kPa 15 Pa 3 Pa 1 Pa 3 Pa 15 Pa 1 Pa/kPa 1 Pa/kPa	Pressure in 6 MPa to 70 MPa range generated by customer IDOS UPMP Transducer Standard Pressure Gauge
Pneumatic Pressure - Absolute. Pressure measuring instruments [1]	[2 to 80] kPa (80 to 115] kPa (115 kPa to 7.1 MPa]	35 Pa 20 Pa $\sqrt{[0.00025 * (P_i - P_{barometric})]^2 + 20^2}$ Pa	P_i – measured value of absolute pressure $P_{barometric}$ – ambient barometric pressure during the P_i measurement.

Mass and Mass Related

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pneumatic Pressure - Absolute. Pressure measuring instruments [2]	[5 to 200) kPa [200 kPa to 6.1 MPa]	120 Pa $\sqrt{[0.001 * (P_i - P_{barometric})]^2 + 130^2}$ Pa	P_i – measured value of absolute pressure $P_{barometric}$ – ambient barometric pressure during the P_i measurement
Hydraulic pressure - Gauge Pressure measuring instruments [1]	[0.1 to 0.16) MPa [0.16 to 120] MPa	0. 3 Pa/kPa 0. 25 Pa/kPa	Oil Dead Weight Tester
Hydraulic pressure - Gauge Pressure measuring instruments [2]	[0.1 to 70] MPa (70 to 120] MPa	1 Pa/kPa 0.5 MPa	Pressure Gauge

Thermodynamic

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature, Liquid in Glass Thermometers [1]	[-60 to 250] °C (250 to 500] °C	0.03 °C 0.095 °C	ASTM E1; ASTM E77; SPRT set, HART 1595A Superthermometer
Temperature, Thermocouples, Base Metal Type K, N, thermocouples [1,2]	[-100 to -60) °C [1] [-60 to 0] °C [1] [0 to 50] °C [1] (50 to 100] °C [1] [100 to 250] °C [1] (250 to 500] °C [1] (500 to 600] °C [1] (600 to 1 100] °C [1] (1 100 to 1 300] °C [1] [-100 to 600] °C [2]	0.3 °C 0.1 °C 0.05 °C 0.1 ° C 0.15 °C 0.2 °C 0.4 °C 1.4 °C 2.3 °C 0.5 °C	ASTM E220; ASTM E230 SPRT set HART 1595A Superthermometer Type R standard thermocouple
Temperature, Thermocouples, Noble Metal Type S, R thermocouples [1,2]	[0 to 500] °C [1] (500 to 600] 0C [1] (600 to 1 100] 0C [1] (1 100 to 1 300] °C [1] [0 to 600] °C [2]	0.4 °C 1 °C 1.4 °C 2.3 °C 1°C	ASTM E220; ASTM E230 SPRT set, HART 1595A Superthermometer Type R standard thermocouple
Temperature, Extension cables [1]	[-100 to 1 300] °C	As for thermocouples of the same type	ASTM E220; ASTM E230 Extension cables calibrated at room temperatures
Temperature, Resistance thermometers [1]	0.01 °C	0.003 °C	WTP Standard cell

Thermodynamic

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature, Resistance thermometers [1,2]	[-100 to -60] °C [1] (-60 to 230] °C [1] (230 to 500] °C [1] (500 to 600] °C [1] (600 to 960] °C [1] [-100 to 600] °C [2]	0.13 °C 0.023 °C 0.06 °C 0.3 °C 1.3 °C 0.3 °C	ASTM E1137; ASTM E644 SPRT set, HART 1595A Superthermometer
Temperature, Infrared Thermometers [1,6]	-15 °C 0 °C 15 °C 100 °C 120 °C 200 °C 300 °C 400 °C 500 °C	0.8 °C 0.8 °C 0.8 °C 0.9 °C 1 °C 1.2 °C 1.5 °C 2 °C 2.5 °C	Infrared Calibrator Fluke 4180, 4181 $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm
Temperature, Block Calibrators [1]	[-100 to 100] °C (100 to 250] °C (250 to 660] °C (660 to 1 100] °C (1 100 to 1 300] °C	0.07 °C 0.1 °C 0.17 °C 1.3 °C 3 °C	Euramet cg13
Temperature, Block Calibrators Stability test [1]	[-100 to 250] °C (250 to 660] °C (660 to 1 300] °C	0.01 °C 0.03 °C 0.2 °C	Euramet cg13
Temperature Block Calibrators Uniformity test [1]	[-100 to 250] °C (250 to 660] °C (660 to 1 300] °C	0.0 3°C 0.06 °C 0.4 °C	Euramet cg13
Temperature, Liquid baths [1,2]	[-100 to 250] °C (250 to 500] °C	0.032 °C 0.07 °C	SPRT Type 5699
Temperature Liquid baths Stability test [1]	[-100 to 550] °C	0.001 °C	SPRT Type 5699
Temperature uniformity test, Baths [1]	[-100 to 550] °C	0.01 °C	Standard Thermometer
Temperature, Temperature indicators and controllers in Furnaces, Freezers, Climatic Rooms/ Cells [1,2]	[-60 to 90] °C (90 to 120] °C (120 to 370] °C (370 to 800] °C (800 to 1 300] °C	0.5 °C 0.9 °C 1.8 °C 3.8 °C 6 °C	IEC 60397; IEC 60398 Secondary Standard Thermometer sets

Thermodynamic

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature uniformity test, Furnaces, Freezers, Climatic Rooms/ Cells [1,2]	[-60 to 90] °C (90 to 120] °C (120 to 370] °C (370 to 800] °C (800 to 1 300] °C	0.5 °C 0.9 °C 1.8 °C 3.8 °C 6 °C	IEC 60397; IEC 60398 Secondary Standard Thermometer sets
Relative Humidity, Hygrometers, Humidity Recorders [1]	23 °C ± 4 °C ambient [10 to 80] %RH)	0.8 %RH	Comparison to Standard humidity probe in Humidity Generator
Relative Humidity, Hygrometers, Humidity Recorders [1]	23 °C ± 4 °C ambient [4 to 95) %RH	0.5 %RH+ 2 % OR	Comparison to Standard GE Dew point humidity monitor with optical sensor in Humidity Generator
Relative Humidity, Hygrometers, Humidity Recorders [1]	(25 to 60) °C [35 to 95] %RH	0.5 %RH+ 2 % OR	Comparison to Standard GE Dew point humidity monitor with optical sensor in Temp & Humidity chamber.
Dew Point [1]	[-30 to 60] °C	0.3 °C	Standard GE Dew point humidity monitor with optical sensor
Relative Humidity, Indicators and controllers, Humidity Rooms/ Cells, Uniformity test [1,2]	23 °C ± 4 °C [10 to 80] %RH [19 to 60] °C (4 to 95] %RH	1.5 %RH 2 %RH + 1.5 % OR	Temperature and humidity sensors

Time and Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Time Interval, Measuring instruments [1]	[150 ns to 10 s] (10 to 100] s (100 s to 2 h] (2 to 20] h (20 to 27] h	2×10^{-9} s 2.3×10^{-10} s 3.7×10^{-11} s 6.5×10^{-12} s 9.3×10^{-13} s	Counter HP 53131 A locked to GPS
Time Interval, Mechanical Stopwatch [1]	[10 s- 24 h]	0.5 s	Clock locked to GPS
Time Interval, Source instruments [1]	[150 ns to 100 s]	2×10^{-9} s	Counter HP 53131A locked to GPS

Time and Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes Horizontal Sensitivity [1,2]	1 ns/div 2 ns/div 5 ns/div 10 ns/div 20 ns/div 50 ns/div 100 ns/div 200 ns/div 500 ns/div 1 µs/div 2 µs/div 5 µs/div 10 µs/div 20 µs/div 50 µs/div 100 µs/div 200 µs/div 500 µs/div 1 ms/div 2 ms/div	0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR 0.18 % OR 0.18 % OR	Fluke 5522A Multiproduct Calibrator
Oscilloscopes Horizontal Sensitivity [1,2]	5 ms/div 10 ms/div 20 ms/div 50 ms/div	0.15 % OR 0.18 % OR 0.18 % OR 0.15 % OR	Fluke 5522A Multiproduct Calibrator
Oscilloscopes Vertical Sensitivity [1,2]	50 V/div 20 V/div 10 V/div 2 V/div 1 V/div 5 V/div 500 mV/div 200 mV/div 100 mV/div 50 mV/div 20 mV/div 10 mV/div 5 mV/div 2 mV/div 1 mV/div	0.33 % OR 0.29 % OR 0.29 % OR 0.29 % OR 0.29 % OR 0.29 % OR 0.29 % OR 0.29 % OR 0.3 % OR 0.31 % OR 0.33 % OR 0.37 % OR 0.45 % OR 0.76 % OR 1.1 % OR	Fluke 5522A Multiproduct Calibrator
Oscilloscopes Bandwidth [1,2]	[50 kHz to 100 MHz] Level= 4.0 %	1.2 minor divisions for a major graticule divided in 5 minor divisions	Uncertainties are for RF voltage displayed

Time and Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(100 MHz to 300 MHz] Level= 4.3 %	1.3 minor divisions for a major graticule divided in 5 minor divisions	relative to a reference voltage level at 50 kHz, /6 graticules (=30 minor divisions).
	(300 MHz to 500 MHz] Level= 5.9 %	1.8 minor divisions for a major graticule divided in 5 minor divisions	
Oscilloscopes Bandwidth [1,2]	(500 MHz to 1100 MHz] Level= 6.8 %	2.0 minor divisions for a major graticule divided in 5 minor divisions	Uncertainties are for RF voltage displayed relative to a reference voltage level at 50 kHz, /6 graticules (=30 minor divisions).
Frequency, Measuring Instruments [1]	100 µHz to 26 GHz	$2.8x 10^{-11}$ OR	IEC 60351; IEC 60548: IEC 60 624 Function Generator HP 33120A, Signal Generator HP 4432B, HP 8673B with the time base locked to GPS, Phase Comparator locked to GPS
Frequency Measuring Instruments [2]	100 µHz to 26 GHz	5×10^{-10} OR	Function Generator HP 33120A, Signal Generator HP 4432B, HP 8673B with the time base locked to the Fluke 910R
Frequency Sources [1] 24 h average	0.01 Hz 0.01 Hz 0.025 Hz 0.05 Hz 0.1 Hz 0.25 Hz 0.5 Hz 1 Hz 2.5 Hz 5 Hz	9.6×10^{-6} OR 9.6×10^{-6} OR 9.6×10^{-6} OR 9.6×10^{-7} OR 9.6×10^{-7} OR 9.6×10^{-7} OR 9.6×10^{-8} OR 9.6×10^{-8} OR 9.6×10^{-8} OR 9.6×10^{-8} OR	The CMC is based on square wave. Phase comparator STANFORD RESEARCH FS 700, Counter HP 53131A and counter HP 5351B locked to GPS

Time and Frequency

Parameter/Equipment	Range [5] [including end point] (does not include end point)	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Sources [1] 24 h average	10 Hz 25 Hz 50 Hz 100 Hz 250 Hz 500 Hz 1 kHz 2.5 kHz 5 kHz 10 kHz 25 kHz 50 kHz 100 kHz 250 kHz 500 kHz 1 MHz	9.6×10^{-9} OR 9.6×10^{-9} OR 9.6×10^{-10} OR 9.6×10^{-10} OR 9.6×10^{-10} OR 9.6×10^{-10} OR 9.6×10^{-11} OR 9.6×10^{-11} OR 9.6×10^{-11} OR 1×10^{-11} OR 1×10^{-11} OR 1×10^{-11} OR 0.18×10^{-12} OR 1×10^{-12} OR 1×10^{-12} OR 1×10^{-12} OR	The CMC is based on square wave. Phase comparator STANFORD RESEARCH FS 700, Counter HP 53131A and counter HP 5351B locked to GPS and Fluke 910R
Frequency Sources [1] 24 h average	2.5 MHz 5 MHz 10 MHz [0.1 to 1] Hz (1 to 10] Hz (10 to 100] Hz (100 Hz to 1 kHz] (1 to 10] kHz (10 to 100] kHz (100 kHz to 3 GHz] (3 to 5] GHz (5 to 10] GHz (10 to 15] GHz (15 to 20] GHz (20 to 26] GHz	1×10^{-12} OR 1×10^{-12} OR 1×10^{-12} OR 4.4×10^{-10} OR 1.7×10^{-10} OR 8.3×10^{-11} OR 5.5×10^{-11} OR 4.7×10^{-11} OR 4.4×10^{-11} OR 4.3×10^{-11} OR 3.6×10^{-10} OR 2.3×10^{-10} OR 1.3×10^{-10} OR 9.4×10^{-11} OR 7.7×10^{-11} OR	The CMC is based on square wave. Phase comparator STANFORD RESEARCH FS 700, Counter HP 53131A and counter HP 5351B locked to GPS and Fluke 910R
Frequency Sources [2] 24 h average	[10 Hz to 1 GHz) [1 to 10) GHz [10 to 15) GHz [15 to 20) GHz [20 to 26.5] GHz	5.8×10^{-10} OR 8.1×10^{-10} OR 6.9×10^{-10} OR 6.6×10^{-10} OR 6.4×10^{-10} OR	Counter HP 53151A locked to Fluke 910R GPS Frequency Standard

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DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length Linear Dimensions Special Gauges [1]	(Up to 150 mm]	3 µm	Length Meas. Machine SIP-302M Procedure 25.190
Length Linear Dimensions Special Gauges [1]	(Up to 150 mm]	0.01 mm	Optical Comparator Procedure 25.190
Length Linear Dimensions Special Gauges [1,3]	(Up to 500 mm]	(2 + 20xL) µm	Length Gauge Block by Comparison Procedure 25.190
Length Linear Dimensions Special Gauges [1,3]	(Up to 500 mm]	(5 + 20xL) µm	Height Gauge Trimos Vertical 3 Procedure 25.190
Length Linear Dimensions Special Gauges [1,3]	(Up to 1 000 mm]	(0.03 + 0.1xL) mm	Calipers Procedure 25.190
Length Linear Dimensions Special Gauges [1,3]	(Up to 1 000 mm]	(0.5 + 2xL) mm	Metal Rules Procedure 25.190
Length Linear Dimensions Distance [2,3]	(5 to 1 000 m]	0.1 % OR	Steel Measuring Tape 50 m Procedure 25.190

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Special Gauges [1]	(Up to 360°]	10 '	Optical Comparator Angle Protractor Procedure 25.190
Radius Special Gauges [1]	(Up to 20 mm]	0.01 mm	Optical Comparator Procedure 25.190

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. Available ranges and uncertainty for calibrations being performed on Permanent Site.
2. Available ranges and uncertainty for calibrations being performed on Temporary Site.
3. D = diameter in meters, L = length in meters, OR = "of reading"
4. Unitless linear measure.
5. The use of brackets "[]" indicate that the endpoints of the range are included within the range for the uncertainty of measurement listed and the use of parenthesis "()" indicate the endpoints are not included within the range for the uncertainty of measurement listed.
6. Intermediate measurement points are available for this parameter and will be estimated at time of service.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2699.

R. Douglas Leonard Jr., VP, PILR SBU