



# CERTIFICATE OF ACCREDITATION

## The ANSI National Accreditation Board

Hereby attests that

**Transmile Calibration**  
**158 Brentwood Drive, Unit 4**  
**Colchester, VT 05446**

Fulfills the requirements of

**ISO/IEC 17025:2017**

In the field of

**CALIBRATION**

This certificate is valid only when accompanied by a current scope of accreditation document.  
The current scope of accreditation can be verified at [www.anab.org](http://www.anab.org).

A handwritten signature in black ink, appearing to read 'R.D.L.', is positioned above a horizontal line.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 17 July 2023

Certificate Number: AC-2691



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**

**Transmille Calibration**  
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 Colchester, VT 05446  
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**CALIBRATION**

Valid to: **July 17, 2023**

Certificate Number: **AC-2691**

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source Fixed Values	1.018 V 10.000 V	2.6 $\mu$ V 25 $\mu$ V	Transmille 3000ZR Zener Voltage Standard
DC Voltage – Source	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.6 $\mu$ V/V + 1.4 $\mu$ V 5.3 $\mu$ V/V + 1.6 $\mu$ V 4.8 $\mu$ V/V + 11 $\mu$ V 7.3 $\mu$ V/V + 15 $\mu$ V 8.3 $\mu$ V/V + 1.3 mV	Transmille 4010 Reference Calibrator
DC Voltage – Measure	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	2.8 $\mu$ V/V + 0.8 $\mu$ V 4.7 $\mu$ V/V + 0.9 $\mu$ V 5.3 $\mu$ V/V + 7.5 $\mu$ V 7.3 $\mu$ V/V + 15 $\mu$ V 7.2 $\mu$ V/V + 1.4 mV	Transmille 8091 Multimeter
DC Current – Source	(0 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 10) A (10 to 30) A	5.6 $\mu$ A/A + 0.28 nA 5.9 $\mu$ A/A + 2.5 nA 6.3 $\mu$ A/A + 32 nA 18 $\mu$ A/A + 0.36 $\mu$ A 87 $\mu$ A/A + 7.0 $\mu$ A 210 $\mu$ A/A + 210 $\mu$ A 290 $\mu$ A/A + 510 $\mu$ A	Transmille 4010 Reference Calibrator
DC Current Source For Clamp Meters	(10 to 1 500) A	0.46 % of reading + 0.42 A	Transmille 4010 Reference Calibrator, Transmille EA002 Coil

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure	1 pA to 10 nA	0.54 % of reading + 13 pA	Transmille 8091 Multimeter, AC-DC Current Shunts
	(10 to 100) nA	0.19 % of reading + 22 pA	
	100 nA to 1 µA	0.02 % of reading + 33 pA	
	(1 to 10) µA	38 µA/A + 120 pA	
	(10 to 100) µA	9.1 µA/A + 470 pA	
	(100 to 200) µA	9.1 µA/A + 4.7 nA	
	200 µA to 1 mA	14 µA/A	
	(1 to 2) mA	11 µA/A + 51 nA	
	(2 to 10) mA	13 µA/A	
	(10 to 20) mA	35 µA/A + 0.7 µA	
	20 to 100 mA	19 µA/A	
	(100 to 200) mA	0.17 mA/A + 15 µA	
	200 mA to 1 A	30 µA/A	
	(1 to 2) A	26 µA/A	
2 to 5) A	20 µA/A		
(5 to 30) A	69 µA/A		
AC Voltage – Source	(0 to 100) mV		Transmille 4010 Reference Calibrator
	(10 to 45) Hz	640 µV/V + 12 µV	
	45 Hz to 1 kHz	130 µV/V + 12 µV	
	(1 to 20) kHz	170 µV/V + 18 µV	
	(20 to 50) kHz	980 µV/V + 25 µV	
	(50 to 100) kHz	1.3 mV/V + 25 µV	
	(100 to 300) kHz	4.6 mV/V + 59 µV	
	(300 to 500) kHz	12 mV/V + 65 µV	
	(100 to 300) mV		
	(10 to 23) Hz	780 µV/V + 89 µV	
	(23 to 45) Hz	480 µV/V + 100 µV	
	45 to 1 kHz	160 µV/V + 70 µV	
	(1 to 20) kHz	170 µV/V + 100 µV	
	(20 to 100) kHz	730 µV/V + 170 µV	
	(100 to 200) kHz	2.6 mV/V + 260 µV	
	(200 to 500) kHz	2.7 mV/V + 260 µV	
	300 mV to 1 V		
	(10 to 23) Hz	510 µV/V + 100 µV	
	(23 to 45) Hz	470 µV/V + 110 µV	
	45 Hz to 1 kHz	150 µV/V + 75 µV	
	(1 to 20) kHz	170 µV/V + 110 µV	
	(20 to 100) kHz	620 µV/V + 170 µV	
	(100 to 200) kHz	2.6 mV/V + 260 µV	
	(200 to 500) kHz	2.7 mV/V + 260 µV	
500 kHz to 1 MHz	2.8 mV/V + 250 µV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	(1 to 3) V		Transmille 4010 Reference Calibrator
	(10 to 23) Hz	490 $\mu$ V/V + 910 $\mu$ V	
	(23 to 45) Hz	450 $\mu$ V/V + 930 $\mu$ V	
	45 Hz to 1 kHz	140 $\mu$ V/V + 580 $\mu$ V	
	(1 to 20) kHz	170 $\mu$ V/V + 0.93 mV	
	(20 to 100) kHz	550 $\mu$ V/V + 1.7 mV	
	(3 to 10) V		
	(10 to 23) Hz	500 $\mu$ V/V + 880 $\mu$ V	
	(23 to 45) Hz	450 $\mu$ V/V + 920 $\mu$ V	
	45 Hz to 1 kHz	140 $\mu$ V/V + 580 $\mu$ V	
	(1 to 20) kHz	170 $\mu$ V/V + 920 $\mu$ V	
	(20 to 100) kHz	560 $\mu$ V/V + 1.7 mV	
	(10 to 30) V		
	(30 to 45) Hz	450 $\mu$ V/V + 12 mV	
	45 Hz to 1 kHz	140 $\mu$ V/V + 7 mV	
	(1 to 10) kHz	170 $\mu$ V/V + 9.3 mV	
	(10 to 20) kHz	250 $\mu$ V/V + 17 mV	
	(20 to 40) kHz	260 $\mu$ V/V + 17 mV	
	(40 to 100) kHz	2.1 mV/V + 29 mV	
	(30 to 100) V		
	(30 to 45) Hz	450 $\mu$ V/V + 12 mV	
	45 Hz to 1 kHz	140 $\mu$ V/V + 7.9 mV	
	(1 to 10) kHz	170 $\mu$ V/V + 10 mV	
	(10 to 20) kHz	250 $\mu$ V/V + 18 mV	
(20 to 40) kHz	280 $\mu$ V/V + 17 mV		
(40 to 100) kHz	2.1 mV/V + 29 mV		
(100 to 300) V			
(30 to 45) Hz	520 $\mu$ V/V + 120 mV		
45 Hz to 1 kHz	160 $\mu$ V/V + 36 mV		
(1 to 10) kHz	210 $\mu$ V/V + 70 mV		
300 V to 1 kV			
(30 to 45) Hz	520 $\mu$ V/V + 120 mV		
45 Hz to 1 kHz	170 $\mu$ V/V + 35 mV		
(1 to 10) kHz	220 $\mu$ V/V + 70 mV		
(10 to 20) kHz	270 $\mu$ V/V + 120 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(0 to 100) mV		Transmille 8091 Multimeter
	(10 to 40) Hz	360 $\mu$ V/V + 11 $\mu$ V	
	40 Hz to 1 kHz	110 $\mu$ V/V + 10 $\mu$ V	
	(1 to 20) kHz	140 $\mu$ V/V + 14 $\mu$ V	
	(20 to 50) kHz	510 $\mu$ V/V + 18 $\mu$ V	
	(50 to 100) kHz	940 $\mu$ V/V + 18 $\mu$ V	
	(100 to 300) kHz	3.8 mV/V + 48 $\mu$ V	
	(300 to 500) kHz	12 mV/V + 55 $\mu$ V	
	(100 to 300) mV		
	(10 to 23) Hz	760 $\mu$ V/V + 4.6 $\mu$ V	
	(23 to 40) Hz	320 $\mu$ V/V + 6.7 $\mu$ V	
	40 Hz to 1 kHz	98 $\mu$ V/V + 7.2 $\mu$ V	
	(1 to 20) kHz	110 $\mu$ V/V + 12 $\mu$ V	
	(20 to 100) kHz	640 $\mu$ V/V + 13 $\mu$ V	
	100 kHz to 1 MHz	2 mV/V + 43 $\mu$ V	
	300 mV to 1 V		
	(10 to 23) Hz	280 $\mu$ V/V + 62 $\mu$ V	
	(23 to 40) Hz	190 $\mu$ V/V + 73 $\mu$ V	
	40 kHz to 1 kHz	72 $\mu$ V/V + 53 $\mu$ V	
	(1 to 20) kHz	88 $\mu$ V/V + 74 $\mu$ V	
	(20 to 100) kHz	290 $\mu$ V/V + 110 $\mu$ V	
	100 kHz to 1 MHz	1.6 mV/V + 140 $\mu$ V	
	(1 to 3) V		
	(10 to 23) Hz	290 $\mu$ V/V + 51 $\mu$ V	
	(23 to 40) Hz	200 $\mu$ V/V + 69 $\mu$ V	
	40 Hz to 1 kHz	85 $\mu$ V/V + 45 $\mu$ V	
	(1 to 20) kHz	120 $\mu$ V/V + 82 $\mu$ V	
	(20 to 100) kHz	290 $\mu$ V/V + 110 $\mu$ V	
	100 kHz to 1 MHz	1.6 mV/V + 130 $\mu$ V	
	(3 to 10) V		
(10 to 23) Hz	290 $\mu$ V/V + 500 $\mu$ V		
(23 to 40) Hz	200 $\mu$ V/V + 600 $\mu$ V		
40 Hz to 1 kHz	79 $\mu$ V/V + 390 $\mu$ V		
(1 to 20) kHz	93 $\mu$ V/V + 610 $\mu$ V		
(20 to 100) kHz	280 $\mu$ V/V + 1.1 mV		
(100 to 200) kHz	1.2 mV/V + 1.7 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(10 to 30) V		Transmille 8091 Multimeter
	(10 to 23) Hz	290 $\mu$ V/V + 430 $\mu$ V	
	(23 to 40) Hz	200 $\mu$ V/V + 580 $\mu$ V	
	40 Hz to 1 kHz	80 $\mu$ V/V + 370 $\mu$ V	
	(1 to 20) kHz	94 $\mu$ V/V + 580 $\mu$ V	
	(20 to 100) kHz	260 $\mu$ V/V + 1.1 mV	
	(30 to 100) V		
	(10 to 40) Hz	190 $\mu$ V/V + 8.3 mV	
	40 Hz to 1 kHz	67 $\mu$ V/V + 5.9 mV	
	(1 to 20) kHz	77 $\mu$ V/V + 7.4 mV	
	(20 to 50) kHz	170 $\mu$ V/V + 11 mV	
	(50 to 100) kHz	710 $\mu$ V/V + 19 mV	
	(100 to 300) V		
	(10 to 40) Hz	190 $\mu$ V/V + 7.8 mV	
	40 Hz to 1 kHz	76 $\mu$ V/V + 5.0 mV	
(1 to 10) kHz	76 $\mu$ V/V + 63 mV		
(10 to 40) kHz	140 $\mu$ V/V + 110 mV		
AC Voltage – Measure	300 V to 1 kV		5790B AC Measurement Standard
	40 Hz to 1 kHz	93 $\mu$ V/V + 21 mV	
	(1 to 10) kHz	110 $\mu$ V/V + 44 mV	
	(2.2 to 7) mV		
	(10 to 20) Hz	1.8 mV/V + 1.9 $\mu$ V	
	(20 to 40) Hz	430 $\mu$ V/V + 1.9 $\mu$ V	
	40 Hz to 20 kHz	430 $\mu$ V/V + 1.9 $\mu$ V	
	(20 to 50) kHz	910 $\mu$ V/V + 2.6 $\mu$ V	
	(50 to 100) kHz	1.3 mV/V + 3.1 $\mu$ V	
	(100 to 300) kHz	2.6 mV/V + 4.8 $\mu$ V	
	(300 to 500) kHz	3 mV/V + 9.3 $\mu$ V	
	(500 to 1 000) kHz	5.8 mV/V + 9.3 $\mu$ V	
	(2.2 to 7) mV		
	(10 to 20) Hz	964 $\mu$ V/V + 1.7 $\mu$ V	
	(20 to 40) Hz	409 $\mu$ V/V + 1.8 $\mu$ V	
40 Hz to 20 kHz	229 $\mu$ V/V + 1.8 $\mu$ V		
(20 to 50) kHz	462 $\mu$ V/V + 2.5 $\mu$ V		
(50 to 100) kHz	695 $\mu$ V/V + 3.1 $\mu$ V		
(100 to 300) kHz	1.4 mV/V + 4.7 $\mu$ V		
(300 to 500) kHz	1.6 mV/V + 9.3 $\mu$ V		
(500 to 1 000) kHz	4.2 mV/V + 9.3 $\mu$ V		



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(7 to 22) mV		5790B AC Measurement Standard
	(10 to 20) Hz	330 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(20 to 40) Hz	220 $\mu\text{V/V} + 1.8 \mu\text{V}$	
	40 Hz to 20 kHz	120 $\mu\text{V/V} + 1.8 \mu\text{V}$	
	(20 to 50) kHz	240 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(50 to 100) kHz	360 $\mu\text{V/V} + 3 \mu\text{V}$	
	(100 to 300) kHz	960 $\mu\text{V/V} + 4.6 \mu\text{V}$	
	(300 to 500) kHz	1.2 mV/V + 9.2 $\mu\text{V}$	
	(500 to 1 000) kHz	3 mV/V + 9.2 $\mu\text{V}$	
	(22 to 70) mV		
	(10 to 20) Hz	290 $\mu\text{V/V} + 1.8 \mu\text{V}$	
	(20 to 40) Hz	150 $\mu\text{V/V} + 1.9 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 1.9 \mu\text{V}$	
	(20 to 50) kHz	160 $\mu\text{V/V} + 2.4 \mu\text{V}$	
	(50 to 100) kHz	310 $\mu\text{V/V} + 2.9 \mu\text{V}$	
	(100 to 300) kHz	630 $\mu\text{V/V} + 4.6 \mu\text{V}$	
	(300 to 500) kHz	820 $\mu\text{V/V} + 9 \mu\text{V}$	
	(500 to 1 000) kHz	1.5 mV/V + 9.1 $\mu\text{V}$	
	(70 to 220) mV		
	(10 to 20) Hz	250 $\mu\text{V/V} + 1.8 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 1.8 \mu\text{V}$	
	40 Hz to 20 kHz	50 $\mu\text{V/V} + 1.9 \mu\text{V}$	
	(20 to 50) kHz	90 $\mu\text{V/V} + 2.4 \mu\text{V}$	
	(50 to 100) kHz	190 $\mu\text{V/V} + 2.9 \mu\text{V}$	
	(100 to 300) kHz	330 $\mu\text{V/V} + 4.5 \mu\text{V}$	
	(300 to 500) kHz	480 $\mu\text{V/V} + 9.0 \mu\text{V}$	
	(500 to 1 000) kHz	1.4 mV/V + 9.1 $\mu\text{V}$	
	(220 to 700) mV		
(10Hz to 20) Hz	240 $\mu\text{V/V} + 2.1 \mu\text{V}$		
(20Hz to 40) Hz	90 $\mu\text{V/V} + 2.7 \mu\text{V}$		
40 Hz to 20 kHz	40 $\mu\text{V/V} + 3.5 \mu\text{V}$		
(20z to 50) kHz	60 $\mu\text{V/V} + 3.6 \mu\text{V}$		
(50 to 100) kHz	100 $\mu\text{V/V} + 3.7 \mu\text{V}$		
(100 to 300) kHz	250 $\mu\text{V/V} + 4.9 \mu\text{V}$		
(300 to 500) kHz	400 $\mu\text{V/V} + 9.4 \mu\text{V}$		
(500 to 1 000) kHz	1.4 mV/V + 9.3 $\mu\text{V}$		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	700 mV to 2.2 V		5790B AC Measurement Standard
	(10 to 20) Hz	230 $\mu$ V/V	
	(20 to 40) Hz	80 $\mu$ V/V	
	40 Hz to 20 kHz	34 $\mu$ V/V	
	(20 to 50) kHz	61 $\mu$ V/V	
	(50 to 100) kHz	91 $\mu$ V/V	
	(100 to 300) kHz	240 $\mu$ V/V	
	(300 to 500) kHz	360 $\mu$ V/V	
	(500 to 1 000) kHz	1.4 mV/V	
	(2.2 to 7) V		
	(10 to 20) Hz	230 $\mu$ V/V	
	(20 to 40) Hz	80 $\mu$ V/V	
	40 Hz to 20 kHz	32 $\mu$ V/V	
	(20 to 50) kHz	61 $\mu$ V/V	
	(50 to 100) kHz	100 $\mu$ V/V	
	(100 to 300) kHz	260 $\mu$ V/V	
	(300 to 500) kHz	540 $\mu$ V/V	
	(500 to 1 000) kHz	1.7 mV/V	
	(7 to 22) V		
	(10 to 20) Hz	230 $\mu$ V/V	
	(20 to 40) Hz	81 $\mu$ V/V	
	40 Hz to 20 kHz	36 $\mu$ V/V	
	(20 to 50) kHz	62 $\mu$ V/V	
	(50 to 100) kHz	99 $\mu$ V/V	
(100 to 300) kHz	260 $\mu$ V/V		
(300 to 500) kHz	540 $\mu$ V/V		
(500 to 1 000) kHz	1.7 mV/V		
(22 to 70) V			
(10 to 20) Hz	230 $\mu$ V/V		
(20 to 40) Hz	81 $\mu$ V/V		
40 Hz to 20 kHz	43 $\mu$ V/V		
(20 to 50) kHz	71 $\mu$ V/V		
(50 to 100) kHz	130 $\mu$ V/V		
(100 to 300) kHz	260 $\mu$ V/V		
(300 to 500) kHz	590 $\mu$ V/V		
(500 to 1 000) kHz	1.7 mV/V		





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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	(70 to 220) V		5790B AC Measurement Standard
	(10 to 20) Hz	230 $\mu$ V/V	
	(20 to 40) Hz	85 $\mu$ V/V	
	40 Hz to 20 kHz	45 $\mu$ V/V	
	(20 to 50) kHz	90 $\mu$ V/V	
	(50 to 100) kHz	130 $\mu$ V/V	
	(100 to 300) kHz	300 $\mu$ V/V	
	(300 to 500) kHz	810 $\mu$ V/V	
	(220 to 700) V		
	(10 to 20) Hz	230 $\mu$ V/V	
	(20 to 40) Hz	130 $\mu$ V/V	
	40 Hz to 20 kHz	55 $\mu$ V/V	
	(20 to 50) kHz	170 $\mu$ V/V	
	(50 to 100) kHz	980 $\mu$ V/V	
AC Current – Source	(1 to 100) $\mu$ A		Transmille 4010 Reference Calibrator
	10 Hz to 45 Hz	1.7 mA/A + 0.15 $\mu$ A	
	45 Hz to 1 kHz	520 $\mu$ A/A + 0.09 $\mu$ A	
	1 kHz to 10 kHz	8.4 mA/A + 0.12 $\mu$ A	
	100 $\mu$ A to 1 mA		
	10 Hz to 45 Hz	1.6 mA/A + 0.15 $\mu$ A	
	45 Hz to 1 kHz	430 $\mu$ A/A + 0.12 $\mu$ A	
	1 kHz to 10 kHz	4.3 mA/A + 0.17 $\mu$ A	
	10 kHz to 30 kHz	8.4 mA/A + 0.35 $\mu$ A	
	1 mA to 10 mA		
	10 Hz to 45 Hz	1.6 mA/A + 1.8 $\mu$ A	
	45 Hz to 1 kHz	380 $\mu$ A/A + 1.2 $\mu$ A	
	1 kHz to 10 kHz	2.3 mA/A + 1.7 $\mu$ A	
	10 kHz to 30 kHz	4.3 mA/A + 2.3 $\mu$ A	
10 mA to 100 mA			
10 Hz to 45 Hz	1.6 mA/A + 18 $\mu$ A		
45 Hz to 1 kHz	380 $\mu$ A/A + 12 $\mu$ A		
1 kHz to 10 kHz	4.2 mA/A + 23 $\mu$ A		
10 kHz to 30 kHz	5.2 mA/A + 120 $\mu$ A		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source	100 mA to 1 A 10 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz 10 kHz to 30 kHz (1 to 30) A 10 Hz to 45 Hz 45 Hz to 100 Hz 100 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	1.6 mA/A + 180 $\mu$ A 420 $\mu$ A/A + 130 $\mu$ A 4.2 mA/A + 230 $\mu$ A 15 mA/A + 580 $\mu$ A 25 mA/A + 2.9 mA 1.6 mA/A + 2.3 mA 410 $\mu$ A/A + 2.1 mA 4.2 mA/A + 2.6 mA 5.2 mA/A + 2.6 mA 29 mA/A + 3 mA	Transmille 4010 Reference Calibrator
AC Current Source For Clamp Meters	(10 to 1500) A @60 Hz	0.46 % of reading + 0.42 A	Transmille 4010 Reference Calibrator, Transmille EA002 Coil
AC Current – Measure	(0 to 100) $\mu$ A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (100 to 200) $\mu$ A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz 10 kHz to 30 kHz 200 $\mu$ A to 1 mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (1 to 2) mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz 10 kHz to 30 kHz (2 to 10) mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz	490 $\mu$ A/A + 0.16 $\mu$ A 97 $\mu$ A/A + 0.13 $\mu$ A 190 $\mu$ A/A + 0.2 $\mu$ A 580 $\mu$ A/A + 0.16 $\mu$ A 140 $\mu$ A/A + 0.13 $\mu$ A 2.9 mA/A + 0.15 $\mu$ A 1.6 mA/A + 120 $\mu$ A 270 $\mu$ A/A 140 $\mu$ A/A 140 $\mu$ A/A 690 $\mu$ A/A 600 $\mu$ A/A + 0.2 $\mu$ A 170 $\mu$ A/A + 0.24 $\mu$ A 1.5 mA/A + 0.28 $\mu$ A 3 mA/A + 0.37 $\mu$ A 270 $\mu$ A/A 130 $\mu$ A/A 130 $\mu$ A/A 560 $\mu$ A/A	Transmille 8091 Multimeter, AC-DC Current Shunts

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure	(10 to 30) mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz	600 $\mu$ A/A + 3.3 $\mu$ A 160 $\mu$ A/A + 2.1 $\mu$ A 710 $\mu$ A/A + 2.1 $\mu$ A 1.5 mA/A + 2.2 $\mu$ A	Transmille 8091 Multimeter, AC-DC Current Shunts
AC Current – Measure	(20 to 100) mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (100 to 200) mA (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz 200 mA to 1 A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (1 to 2) A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (2 to 5) A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (5 to 30) A (10 to 40) Hz 40 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	510 $\mu$ A/A 130 $\mu$ A/A 140 $\mu$ A/A 140 $\mu$ A/A 600 $\mu$ A/A + 19 $\mu$ A 160 $\mu$ A /A + 23 $\mu$ A 1.5 mA/A + 22 $\mu$ A 1.6 mA/A + 120 $\mu$ A 540 $\mu$ A/A 250 $\mu$ A/A 290 $\mu$ A/A 410 $\mu$ A/A 500 $\mu$ A/A 139 $\mu$ A/A 220 $\mu$ A/A 416 $\mu$ A/A 450 $\mu$ A/A 151 $\mu$ A/A 138 $\mu$ A/A 175 $\mu$ A/A 516 $\mu$ A/A 160 $\mu$ A/A 216 $\mu$ A/A 446 $\mu$ A/A	Transmille 8091 Multimeter, AC-DC Current Shunts
Resistance – Source Fixed Values	1 $\Omega$ 5 $\Omega$ 10 $\Omega$ 15 $\Omega$ 25 $\Omega$	2.4 $\mu\Omega/\Omega$ 0.76 $\mu\Omega/\Omega$ 1.2 $\mu\Omega/\Omega$ 1.2 $\mu\Omega/\Omega$ 1.2 $\mu\Omega/\Omega$	Transmille 3000RS Transmille 3000HR & Fixed Temp Controlled Resistors



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source Fixed Values	30 Ω	1.2 μΩ/Ω	Transmille 3000RS Transmille 3000HR & Fixed Temp Controlled Resistors
	50 Ω	1.8 μΩ/Ω	
	62.5 Ω	0.65 μΩ/Ω	
	75 Ω	0.65 μΩ/Ω	
	100 Ω	0.65 μΩ/Ω	
	150 Ω	0.65 μΩ/Ω	
	200 Ω	0.65 μΩ/Ω	
	250 Ω	0.65 μΩ/Ω	
	300 Ω	0.65 μΩ/Ω	
	350 Ω	0.65 μΩ/Ω	
	400 Ω	0.65 μΩ/Ω	
	500 Ω	3.5 μΩ/Ω	
	1 kΩ	2.9 μΩ/Ω	
	10 kΩ	1.7 μΩ/Ω	
	20 kΩ	1.4 μΩ/Ω	
	100 kΩ	1.9 μΩ/Ω	
	300 kΩ	3.1 μΩ/Ω	
	400 kΩ	2 μΩ/Ω	
	1 MΩ	1.9 μΩ/Ω	
	10 MΩ	5.6 μΩ/Ω	
100 MΩ	120 μΩ/Ω		
1 GΩ	250 μΩ/Ω		
10 GΩ	580 μΩ/Ω		
100 GΩ	5.2 mΩ/Ω		
Resistance – Source Variable Ranges	(0 to 100) Ω	110 μΩ/Ω + 59 mΩ	Transmille 4010 Reference Calibrator
	(100 to 330) Ω	120 μΩ/Ω + 59 mΩ	
	0.33 Ω to 1 kΩ	87 μΩ/Ω + 120 mΩ	
	(1 to 3.3) kΩ	110 μΩ/Ω + 100 mΩ	
	(3.3 to 10) kΩ	66 μΩ/Ω + 1 Ω	
	(10 to 33) kΩ	100 μΩ/Ω + 640 mΩ	
	(33 to 100) kΩ	63 μΩ/Ω + 10 Ω	
	(100 to 330) kΩ	110 μΩ/Ω + 6.0 Ω	
	330 kΩ to 1 MΩ	64 μΩ/Ω + 100 Ω	
	(1 to 3.3) MΩ	160 μΩ/Ω + 47 Ω	
	(3.3 to 10) MΩ	82 μΩ/Ω + 1 kΩ	
(10 to 33) MΩ	690 μΩ/Ω + 1.3 kΩ		
Resistance – Source Variable Ranges	(33 to 100) MΩ	710 μΩ/Ω + 110 kΩ	Transmille 4010 Reference Calibrator
	(100 to 330) MΩ	13 mΩ/Ω + 100 kΩ	
	330 MΩ to 1 GΩ	24 mΩ/Ω + 560 kΩ	



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure	(0 to 1) $\Omega$ (1 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$	16 $\mu\Omega/\Omega$ + 9.0 $\mu\Omega$ 9.9 $\mu\Omega/\Omega$ + 64 $\mu\Omega$ 11 $\mu\Omega/\Omega$ + 540 $\mu\Omega$ 6.3 $\mu\Omega/\Omega$ + 5.4 m $\Omega$ 7.9 $\mu\Omega/\Omega$ + 53 m $\Omega$ 8.8 $\mu\Omega/\Omega$ + 530 m $\Omega$	Transmille 8091 Multimeter
Resistance – Measure	100 k $\Omega$ to 1 M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$ (1 to 10) G $\Omega$ 10 G $\Omega$ to 100 G $\Omega$ 100 G $\Omega$ to 1 T $\Omega$	11 $\mu\Omega/\Omega$ + 5.7 $\Omega$ 19 $\mu\Omega/\Omega$ + 110 $\Omega$ 130 $\mu\Omega/\Omega$ + 4.7 k $\Omega$ 460 $\mu\Omega/\Omega$ + 29 k $\Omega$ 5 m $\Omega/\Omega$ + 37 k $\Omega$ 27 m $\Omega/\Omega$ + 68 k $\Omega$ 27 m $\Omega/\Omega$ + 0.68 M $\Omega$	Transmille 8091 Multimeter
Capacitance – Source Fixed Values	1 nF 2 nF 5 nF 10 nF 100 nF 1 $\mu$ F 10 $\mu$ F	0.06 % of reading	Transmille 4010 Reference Calibrator w/ GW Instek LCR 819
Capacitance – Source	0.95 $\mu$ F to 100 mF	0.7 % of reading	Transmille 4010 Reference Calibrator
Capacitance-Measure	10 pF to 1 F	0.06 % of reading	GW Instek LCR 819 LCR Meter
Inductance – Source Fixed Values	1 mH 10 mH 19 mH 29 mH 50 mH 100 mH 1 H 10 H	0.06 % of reading	Transmille 4010 Reference Calibrator w/ GW Instek LCR 819 LCR Meter
Inductance Measure	1 mH to 10 H	0.06 % of reading	GW Instek LCR 819 LCR Meter
Phase – Single Phase Power (0 to 1 000) V, (0 to 30) A 40 Hz to 60 Hz	(-180 to 180) $^{\circ}$	0.12 $^{\circ}$	Transmille 8091 Multimeter

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices	Type J		Transmille 4010 Reference Calibrator W/ EA001A
	(-210 to -100) °C	0.31 °C	
	(-100 to -30) °C	0.23 °C	
	(-30 to 150) °C	0.22 °C	
	(120 to 760) °C	0.25 °C	
	(760 to 1 200) °C	0.28 °C	
	Type K		
	(-200 to -100) °C	0.34 °C	
	(-100 to -25) °C	0.25 °C	
	(-25 to 120) °C	0.23 °C	
	(120 to 1 000) °C	0.29 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type T		
	(-250 to -150) °C	0.64 °C	
	(-150 to 0) °C	0.23 °C	
	(0 to 120) °C	0.22 °C	
	(120 to 400) °C	0.23 °C	
	Type R		
	(0 to 250) °C	0.83 °C	
	(250 to 1 000) °C	0.49 °C	
	(1 000 to 1 760) °C	0.55 °C	
	Type S		
	(0 to 250) °C	0.83 °C	
	(250 to 1 000) °C	0.49 °C	
(1 000 to 1 760) °C	0.55 °C		
Type B			
(600 to 800) °C	0.76 °C		
(800 to 1 000) °C	0.69 °C		
(1 000 to 1 550) °C	0.58 °C		
(1 550 to 1 820) °C	0.59 °C		
Type N			
(-200 to -100) °C	0.47 °C		
(-100 to -25) °C	0.29 °C		
(-25 to 120) °C	0.26 °C		
(120 to 410) °C	0.26 °C		
(410 to 1 300) °C	0.32 °C		



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Electrical Simulation of Thermocouple Indicating Devices	Type E		Transmille 4010 Reference Calibrator W/ EA001A	
		(-250 to -100) °C		0.54 °C
		(-100 to -25) °C		0.23 °C
		(-25 to 350) °C		0.22 °C
		(350 to 650) °C		0.24 °C
		(650 to 1 000) °C		0.26 °C
	Type L			
		(-200 to -100) °C		0.4 °C
		(-100 to 800) °C		0.39 °C
		(800 to 900) °C		0.4 °C
	Type U			
		(-200 to 0) °C		0.47 °C
		(0 to 600) °C		0.37 °C
Type C				
	(0 to 150) °C	0.37 °C		
	(150 to 650) °C	0.34 °C		
	(650 to 1 000) °C	0.38 °C		
	(1 000 to 18 00) °C	0.51 °C		
	(1 800 to 2 316) °C	0.71 °C		
Electrical Simulation of RTD/PRT Indicating Devices (Fixed Values)	Pt 100 Sensors		Transmille 4010 Reference Calibrator	
		-100 °C		0.023 °C
		0 °C		0.02 °C
		30 °C		0.021 °C
		60 °C		0.021 °C
		100 °C		0.023 °C
		200 °C		0.029 °C
		400 °C		0.045 °C
	800 °C	0.083 °C		
Electrical Simulation of RTD/PRT Indicating Devices (Variable Ranges)	Pt 100 Sensors		Transmille 4010 Reference Calibrator	
		(-200 to 100) °C		0.03 °C
		(400 to 630) °C		0.19 °C
	(630 to 800) °C	0.26 °C		



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**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure	(-200 °C to 156) °C (156 to 660) °C (660 to 1 100) °C (1 100 to 1 300) °C	5 mK 8 mK 0.4 °C 0.6 °C	Precision Thermometers with SPRT and Primary TC
Temperature - Thermometers and Probes by comparison	(-80 to 30) °C 0 °C (30 to 300) °C (300 to 650) °C (650 to 1 100) °C (1 100 to 1 200) °C	7.6 mK 5 mK 14 mK 61 mK 0.53 °C 0.6 °C	Comparison in liquid baths & dry wells with Reference measurement systems
Temperature – SPRT/PRT Calibration by Fixed Points	-195.798 °C -38.8344 °C 0.01 °C 29.7646 °C 156.598 °C 231.928 °C 419.527 °C 660.323 °C	3.7 mK 1.8 mK 0.7 mK 1.3 mK 2.7 mK 2.7 mK 2.9 mK 6.5 mK	Liquid N <sub>2</sub> comparison Mercury cell Water triple point cell Gallium cell Indium cell Tin cell Zinc cell Aluminum cell
Infrared (IR) Thermometers / Pyrometers	50 °C 150 °C 300 °C 450 °C 550 °C 600 °C 700 °C 800 °C 900 °C 1 000 °C 1 100 °C 1 200 °C	0.30° C 0.64 °C 1.1 °C 2 °C 2.2 °C 2.7 °C 3.2 °C 3.3 °C 3.3 °C 3.9 °C 4.5 °C 4.9 °C	Blackbody Sources (Cavity) $\epsilon = (0.95 \text{ to } 1.0)$ , $\lambda = (8 \text{ to } 14) \text{ um}$

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure	(1 to 100) Hz 100 Hz to 1 GHz	0.015 $\mu$ Hz/Hz+ 1.2 $\mu$ Hz 0.026 $\mu$ Hz/Hz	Transmille 8600 GPS Frequency Standard



**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source	(1 to 100) Hz 100 Hz to 1 GHz	0.015 $\mu$ Hz/Hz+ 1.2 $\mu$ Hz 0.026 $\mu$ Hz/Hz	Transmille 8600 GPS Frequency Standard

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. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2691.



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