



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994

NATIONAL INSTRUMENTS CALIBRATION
 SERVICES PENANG (NICSP)
 NI Malaysia Sdn Bhd
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CALIBRATION

Valid To: December 31, 2019

Certificate Number: 3529.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CI ^{2,6} (±)	Comments
DC Voltage ³ – Generate	0 V (0 to 2.2) V (2.2 to 11) V (22 to 220) V (220 to 1100) V	0.2 μ V 3.5 μ V/V + 0.7 μ V 2.5 μ V/V + 2.5 μ V 3.5 μ V/V + 40 μ V 4.6 μ V/V + 400 μ V	Two wire short reference calibrator
DC Voltage ^{3,5} – Measure	0 V (0 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	1.0 μ V 7.3 μ V/V + 0.2 μ V 6.7 μ V/V + 0.2 μ V 6.7 μ V/V + 0.33 μ V 8.0 μ V/V + 20 μ V 16 μ V/V + 67 μ V	Reference digital multimeter

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
DC Current ³ – Generate	0 μA (2.2 to 22) mA (2.2 to 220) mA (0.22 to 2.2) A (2.2 to 5) A	4.9 pA 30 μA/A + 40 nA 40 μA/A + 0.7 μA 60 μA/A + 12 μA 0.05 % + 500 μA	Two wire short, reference calibrator
	(0.9 to 1) μA (1 to 10) μA (10 to 100) μA (0.10 to 1.0) mA	25 μA/A + 40 pA 25 μA/A + 0.1 nA 20 μA/A + 0.62 nA 20 μA/A + 3.9 nA	Reference calibrator, digital multimeter
DC Current ³ – Measure	(0 to 1) μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA (0.1 to 1.0) A	13 μA/A + 27 pA 13 μA/A + 67 pA 13 μA/A + 530 pA 13 μA/A + 3.3 nA 13 μA/A + 33 nA 23 μA/A + 330 nA 73 μA/A + 6.7 μA	Reference digital multimeter
	(1.0 to 2.0) A (2.0 to 5.0) A	0.039 % + 90 μA 0.069 % + 90 μA	NI 4071
	(0.9 to 10) μA 1 A 3 A	9 μA/A 65 μA/A 74 μA/A	Current shunts
Resistance ³ – Generate, Fixed Points	0 Ω 0 Ω 1 Ω 10 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	68 μΩ 150 μΩ 2.6 μΩ/Ω 47 μΩ/Ω 12 μΩ/Ω 20 μΩ/Ω 7.6 μΩ/Ω 17 μΩ/Ω 7.5 μΩ/Ω 23 μΩ/Ω 9.0 μΩ/Ω 15 μΩ/Ω 31 μΩ/Ω 98 μΩ/Ω	Two wire short Reference calibrator

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Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Resistance ³ – Measure	(0 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (100 to 1000) kΩ (1 to 10) MΩ (10 to 30) MΩ (30 to 100) MΩ	31 μΩ/Ω + 0.43 mΩ 26 μΩ/Ω + 0.5 mΩ 26 μΩ/Ω + 5.0 mΩ 28 μΩ/Ω + 0.1 Ω 30 μΩ/Ω + 1.0 Ω 70 μΩ/Ω + 100 Ω 0.024 % + 900 Ω 0.55 % + 1.0 kΩ	NI 4071
Resistance ^{3,5} – Generate	Up to 10.9999 Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.099999) kΩ (1.1 to 3.299999) kΩ (3.3 to 10.99999) kΩ (11 to 32.99999) kΩ (33 to 109.999) kΩ (110 to 329.999) kΩ	40 μΩ/Ω + 1.0 mΩ 30 μΩ/Ω + 1.5 mΩ 28 μΩ/Ω + 1.4 mΩ 28 μΩ/Ω + 2.0 mΩ 28 μΩ/Ω + 2.0 mΩ 28 μΩ/Ω + 20 mΩ 28 μΩ/Ω + 20 mΩ 28 μΩ/Ω + 0.2 Ω 28 μΩ/Ω + 0.2 Ω 32 μΩ/Ω + 2.0 Ω	Reference calibrator

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Generate			
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 μV 85 μV/V + 4.0 μV 75 μV/V + 4.0 μV 0.018 % + 4.0 μV 0.046 % + 5.0 μV 0.09 % + 10 μV 0.12 % + 20 μV 0.25 % + 20 μV	Reference calibrator
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 12 μV 85 μV/V + 7.0 μV 75 μV/V + 7.0 μV 0.018 % + 7.0 μV 0.042 % + 17 μV 0.075 % + 20 μV 0.12 % + 25 μV 0.25 % + 45 μV	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.023 % + 40 μV 81 μV/V + 15 μV 40 μV/V + 8.0 μV 70 μV/V + 10 μV 0.011 % + 30 μV 0.034 % + 80 μV 0.09 % + 200 μV 0.15 % + 300 μV	

Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Generate (cont)			
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 400 µV 80 µV/V + 150 µV 40 µV/V + 50 µV 70 µV/V + 100 µV 98 µV/V + 200 µV 0.031 % + 600 µV 0.09 % + 2.0 mV 0.13 % + 3.2 mV	Reference calibrator
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 mV 80 µV/V + 1.5 mV 47 µV/V + 0.6 mV 78 µV/V + 1.0 mV 0.013 % + 2.5 mV 0.094 % + 16 mV 0.42 % + 40 mV 0.7 % + 80 mV	
(220 to 1100) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 16 mV 80 µV/V + 5 mV 47 µV/V + 1.5 mV 78 µV/V + 1.0 mV 0.013 % + 2.5 mV 0.094 % + 16 mV 0.42 % + 40 mV 0.7 % + 80 mV	
AC Voltage ³ – Measure			
(1 to 50) mV	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.1 % + 10 µV 0.05 % + 10 µV 0.07 % + 10 µV 0.3 % + 10 µV 0.7 % + 75 µV	NI 4071
(50 to 500) mV	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.1 % + 25 µV 0.05 % + 25 µV 0.07 % + 25 µV 0.2 % + 25 µV 0.7 % + 750 µV	
500 mV to 5 V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.1 % + 250 µV 0.05 % + 250 µV 0.06 % + 250 µV 0.2 % + 250 µV 0.7 % + 7.5 mV	

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Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Voltage ³ – Measure (cont)			
(5 to 50) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.1 % + 2.5 mV 0.06 % + 5.0 mV 0.12 % + 25 mV 0.6 % + 25 mV 3.0 % + 75 mV	NI 4071
(50 to 700) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.1 % + 35 mV 0.06 % + 70 mV 0.12 % + 0.35 V 0.6 % + 0.35 V 3.0 % + 1.1 V	
AC Current ³ – Generate			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8.0 nA 0.023 % + 12 nA 0.09 % + 65 nA	Reference calibrator
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 % + 40 nA 0.014 % + 35 nA 0.011 % + 35 nA 0.018 % + 110 nA 0.09 % + 650 nA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.023 % + 400 nA 0.014 % + 350 nA 0.011 % + 350 nA 0.018 % + 550 nA 0.09 % + 5.0 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.023 % + 4.0 µA 0.014 % + 3.5 µA 0.011 % + 2.5 µA 0.018 % + 3.5 µA 0.09 % + 10 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 35 µA 0.039 % + 80 µA 0.6 % + 160 µA	
(2.2 to 5) A	40 Hz to 1 kHz	0.03 % + 170 µA	

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Parameter/Range	Frequency	CMC ^{2,4,6} (±)	Comments
AC Current ³ – Measure (9 to 100) µA (0.1 to 1.0) mA (1 to 10) mA (10 to 100) mA (0.1 to 1.0) A (1 to 3) A	1 Hz to 1 kHz 1 Hz to 5 kHz	0.03 % + 20 nA 0.03 % + 0.2 µA 0.03 % + 2.0 µA 0.03 % + 20 µA 0.1 % + 200 µA 0.1 % + 600 µA	NI 4071
Inductance ³ – Generate, Fixed Point 0 H	91 Hz to 3 kHz	10 x 10 ⁻⁹ H	Two wire short
Capacitance ³ – Generate, Fixed Points 0 F 270 pF 1 nF 100 nF 100 nF 10 µF 10 µF 1000 µF	91 Hz to 3 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 91 Hz 91 Hz	350 x 10 ⁻¹⁵ F 0.15 % 0.02 % 0.02 % 0.06 % 0.04 % 0.07 % 0.16 %	Open test standard reference capacitors
Thermocouple Simulation ³ – Type E	(18 to 28) °C	0.07 °C	Thermocouple simulator
Phase Matching ³	(1 to 20) kHz	0.001°	NI 9225

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II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Absolute Power ³ – Generate & Measure			
(4,5,6,7) dBm	(10 and 100) MHz	0.25 dB	Power meter, power sensor, power splitter, signal generator, spectrum analyzer
(-45 to -10) dBm	612.5 MHz	0.14 dBm	
-90 dBm	(85 to 2005) MHz	0.67 dBm	
-90 dBm	(2005 to 6600) MHz	0.81 dBm	
(-70 to -60) dBm	(70 to 2000) MHz	0.21 dBm	
(-70 to -60) dBm	(2000 to 6600) MHz	0.29 dBm	
(-60 to -55) dBm	10 MHz	0.53 dBm	
-60 dBm	(10 to 70) MHz	0.34 dBm	
-55 dBm	(10 to 6600) MHz	0.36 dBm	
-50 dBm	(10 to 14 000) MHz	0.16 dBm	
-50 dBm	(14 000 to 26 500) MHz	0.18 dBm	
-45 dBm	(10 to 14 000) MHz	0.22 dBm	
(-40 to -15) dBm	(10 to 8200) MHz	0.18 dBm	
(-40 to -15) dBm	(8200 to 14 000) MHz	0.22 dBm	
-10 dBm	(10 to 14 000) MHz	0.16 dBm	
-10 dBm	(14 000 to 26 500) MHz	0.25 dBm	
-5 dBm	(10 to 6600) MHz	0.40 dBm	
(0 to 10) dBm	(10 to 40) MHz	0.38 dBm	
0 dBm	(40 to 145) MHz	0.21 dBm	
0 dBm	(145 to 2000) MHz	0.13 dBm	
0 dBm	(2000 to 2650) MHz	0.21 dBm	
0 dBm	(2650 to 6000) MHz	0.17 dBm	
0 dBm	(6000 to 6600) MHz	0.23 dBm	
5 dBm	(40 to 1400) MHz	0.21 dBm	
5 dBm	(1400 to 6600) MHz	0.40 dBm	
10 dBm	(40 to 5000) MHz	0.26 dBm	
10 dBm	(5000 to 6000) MHz	0.29 dBm	
10.0 dBm	(6000 to 6600) MHz	0.40 dBm	
15.0 dBm	(10 to 6600) MHz	0.40 dBm	
(20 to 30) dBm	(76 to 2400) MHz	0.20 dBm	
(20 to 30) dBm	(2400 to 6000) MHz	0.25 dBm	

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Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Absolute Power ³ – Measure			
10 dBm	(50 to 1500) MHz	0.15 dB	Spectrum analyzer, power meter, power sensor
9.5 dBm	(800 and 4000) MHz	0.11 dB	
8 dBm	(10 to 3000) MHz	0.15 dB	
7.5 dBm	(3200 to 8300) MHz	0.28 dB	
7 dBm	3300 MHz	0.14 dB	
6 dBm	(10 to 3300) MHz	0.15 dB	
5 dBm	(0.5 to 500) MHz	0.06 dB	
(4 to -40) dBm	(0.5 to 3300) MHz	0.16 dB	
0 dBm	(3300 to 6600) MHz	0.33 dB	
(-40 to -80) dBm	(0.5 to 2000) MHz	0.6 dB	
(-40 to -60) dBm	(2000 to 3300) MHz	0.92 dB	
(-60 to -70) dBm	(2000 to 3000) MHz	0.72 dB	
(-70 to -80) dBm	(2000 to 2500) MHz	0.68 dB	
-85 dBm	(0.5 to 1500) MHz	0.68 dB	
-90 dBm	(0.5 to 500.1) MHz	0.57 dB	
-90 dBm	(500.1 to 1500) MHz	0.78 dB	
RF Relative Power ³ Measure			
-36 dBm	100 MHz	1.7 dB	Power meter, power sensor
-36 dBm	(100 to 6000) MHz	2.0 dB	
(0 to -30) dBm	80 MHz	2.7 dB	
(0 and -30) dBm	(80 to 3600) MHz	0.9 dB	
(0 and -30) dBm	(3600 to 6600) MHz	2.0 dB	
(-20 to -10) dBm	(80 to 6000) MHz	2.3 dB	
-6 dBm	100 MHz	1.8 dB	
-6 dBm	(100 to 6000) MHz	1.4 dB	
Spurious Responses – Down to -95 dBm	10 Hz to 14 GHz	0.97 dB	
	(14 to 17) GHz	1.1 dB	
	(17 to 20) GHz	1.1 dB	
	(20 to 26.5) GHz	1.4 dB	

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Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
<p>Average Noise Level³ – Measure</p> <p>-60 dBm (100 to 6000) MHz -50 dBm (10 to 200) MHz -50 dBm (200 to 8400) MHz -50 dBm (8400 to 14 000) MHz -50 dBm (14 000 to 26 500) MHz -30 dBm (85 to 3600) MHz -30 dBm (3600 to 6600) MHz -10 dBm (10 to 20) MHz -10 dBm (85 to 4000) MHz -10 dBm (4000 to 6000) MHz -10 dBm (6000 to 6600) MHz (0 to 10) dBm (85 to 3600) MHz (0 to 10) dBm (3600 to 6000) MHz (0 to 10) dBm (6000 to 6600) MHz</p>			Vector signal analyzer NI 5663E spectrum analyzer
<p>SSB Phase Noise³ – Measure</p> <p>Carrier Frequency and Power Offset</p> <p>800 MHz, 0 dBm 10 Hz 1.2 dB 800 MHz, 0 dBm 1 kHz to 1MHz 1.6 dB 800 MHz, 0 dBm 5 MHz 2.5 dB 4000 MHz, 0 dBm 100 Hz to 5 MHz 1.7 dB 5412.5 MHz, 0 dBm 100 Hz to 5 MHz 1.6 dB 7812.5 MHz, 0 dBm 100 Hz to 5 MHz 2.0 dB</p> <p>(0.5 to 3.3) GHz, 0 dBm 10 kHz 0.7 dB (3.3 to 6.6) GHz, 0 dBm 10 kHz 2.2 dB</p> <p>Harmonics (10 to 200) MHz 1.4 dB (200 to 3600) MHz 0.62 dB (3600 to 6000) MHz 1.5 dB</p> <p>Non-Harmonics (35 to 3300) MHz 0.6 dB (3300 to 6000) MHz 1.4 dB</p>			Spectrum analyzer
<p>RMS EVM³ –</p> <p>-10 dBm (400 to 6000) MHz</p>			Spectrum analyzer

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Parameter/Range	Frequency	CMC ^{2, 5, 6} (\pm)	Comments
Modulation Impairments ³ – 0 dBm 0 dBm	(85 to 3600) MHz (3600 to 6600) MHz	0.5 dBm 2.1 dBm	Spectrum analyzer

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 5, 6} (\pm)	Comments
Frequency ³ – Measuring Equipment	0.1 Hz to 80 MHz	3.9 μ Hz/Hz	Frequency generator
	10 MHz 2.2 GHz	0.5 nHz/Hz 39 nHz/Hz	Rubidium frequency standard
Frequency ³ – Measuring Equipment	10 kHz 1 MHz 5 MHz	9.5 μ Hz/Hz 2.8 μ Hz/Hz 8.6 μ Hz/Hz	frequency counter
	100 MHz 110 MHz 400 MHz	3.4 nHz/Hz 1.9 nHz/Hz 0.42 μ Hz/Hz	Spectrum analyzer

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Parameter/Equipment	Range	CMC ^{2, 4, 5, 6} (\pm)	Comments
Oscilloscope Functions ³			
Amplitude – DC Voltage:			
1 M Ω	1 mV to 200 V	0.019 % + 19 μ V	Oscilloscope calibrator
50 Ω	1 mV to 5 V	0.019 % + 19 μ V	
Bandwidth	(1.1 to 400.1) MHz	0.13 dB	Generator with sensor/splitter
Reference to 50 kHz	475.1 MHz	0.53 dB	
	1500.1 MHz	0.25 dB	
Leveled Sine Wave	(0.125 to 0.5) Vp-p	0.013 dB	Generator/DMM as transfer standard
Amplitude Reference to 50 kHz	(0.70 to 1.4) Vp-p	0.012 dB	
	(2.5 to 5) Vp-p	0.015 dB	
	(7.0 to 20) Vp-p	0.023 dB	
Input Impedance	50 Ω 1 M Ω	41 m Ω 0.8 k Ω	Oscilloscope calibrator
Capacitance	15 pF 20 pF	0.43 pF 0.52 pF	
Time Base Accuracy	11 to 100 MHz	3.2 Hz	
RMS Noise	(0 to 0.11) % (2 to 2.5) %	0.001 % of full scale 0.018 % of full scale	50 Ω termination
Time Interval	1 ns 120 ns	11 ps 13 ps	Reference time standard

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¹ This laboratory offers commercial calibration service.

² Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ Field calibration service is available for this calibration and this laboratory meets A2LA R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the Calibration and Measurement Capability Uncertainty (CMC) found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

⁴ In the statement of CMC, the value is defined as the percentage of reading, unless otherwise noted.

⁵ The contributions from the “best existing device” are not included in the CMC claim.

⁶ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

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Accredited Laboratory

A2LA has accredited

NATIONAL INSTRUMENTS CALIBRATION SERVICE PENANG (NICSP)

Bayan Lepas, Penang, MALAYSIA

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This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and R205 – *Specific Requirements: Calibration Laboratory Accreditation Program*. 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 8 January 2009*).



Presented this 8th day of January 2018.

President and CEO
For the Accreditation Council
Certificate Number 3529.01
Valid to December 31, 2019
Revised on September 4, 2018

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.