



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

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CALIBRATION

Valid until: May 31, 2012

Certificate Number: 1278.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Dial Indicators <sup>3</sup>	Up to 1 in	73 µin	Dial indicator calibrator
Dial Indicators	Up to 1 in	47 µin	Gage blocks w/MuMeter
Micrometers <sup>3</sup>	Up to 8 in (6 to 18) in	(22 + 18L)µin (68 + 20L) µin	Gage blocks Reference bar
Calipers <sup>3</sup>	Up to 8 in (8 to 18) in	(280 + 13L) µin (280 + 9.8L) µin	Gage blocks Reference bar
Height Gages <sup>3</sup>	Up to 18 in	(52 + 17L) µin	Reference bar with Mu meter
Pin Gages <sup>3</sup>	Up to 1 in	44 µin	Bench mic w/gage blocks
Plain Plug Gages	Up to 6 in	(13 + 16L) µin	Pratt & Whitney Super Mic w/ gage blocks
Steel Rules and Tapes	Up to 50'	0.037"	Gage blocks with steel rule

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Thickness Gages <sup>3</sup> – Blade Dial	Up to 1 in Up to 1 in	44 μin (280 + 13L) μin	Bench mic Gage blocks
Bore Gages <sup>3</sup>	Up to 1 in	73 μin	Dial Indicator calibrator
ID Gages <sup>3</sup>	(1 to 18) in	(280 + 9.8L) μin	Gage blocks
Thread Plugs <sup>3</sup> – Major Diameter Pitch Diameter	Non-Tapered, (4 to 80) TPI Up to 2 in	(39 + 14L) μin (82 + 8L) μin	Bench mic w/thread wires
Thread Plugs – Major Diameter Pitch Diameter	Non-Tapered, (4 to 80) TPI Up to 6 in	(13 + 11L) μin (70 + 5.7L) μin	Pratt & Whitney B w/ thread wires
NPT Plugs	Up to 6 in	(120 + 7.6L) μin	Pratt & Whitney B w/ Alameda TSB-3
Plain Ring Gages	Up to 6 in	(14 + 11L) μin	Edmunds internal comparator

## II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Voltage – Measure <sup>3</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1000) V	9.5 μV/V + 0.30 μV 4.7 μV/V + 0.30 μV 4.7 μV/V + 0.50 μV 7.0 μV/V + 30 μV 7.1 μV/V + 0.10 mV*	HP 3458A opt 002  *Add 12μV/V · (V <sub>IN</sub> /1000) <sup>2</sup> μV/V for inputs >100 V

Parameter/Equipment	Range	CMC <sup>2,5</sup> ( $\pm$ )	Comments
DC Voltage – Generate <sup>3</sup>	(0 to 220) mV 220 mV to 2.2V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	9.1 $\mu$ V/V + 0.40 $\mu$ V 4.4 $\mu$ V/V + 0.70 $\mu$ V 3.0 $\mu$ V/V + 2.5 $\mu$ V 3.0 $\mu$ V/V + 4.0 $\mu$ V 4.3 $\mu$ V/V + 5.0 $\mu$ V 5.0 $\mu$ V/V + 0.40 mV	Fluke 5700/EP (Using artifact calibrations)
DC Voltage – Generate, Fixed Points	100 mV 1 V 10 V 100 V 1000 V	3.6 $\mu$ V/V + 0.40 $\mu$ V 2.4 $\mu$ V/V + 0.70 $\mu$ V 1.8 $\mu$ V/V + 2.5 $\mu$ V 2.0 $\mu$ V/V + 40 $\mu$ V 2.4 $\mu$ V/V + 0.40 mV	Fluke 732B w/Fluke 752A
DC Current – Measure <sup>3</sup>	Up to 100 nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 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 2) A  (2 to 10) A  (10 to 20) A (20 to 100) A	43 $\mu$ A/A + 0.040 nA 28 $\mu$ A/A + 0.040 nA 24 $\mu$ A/A + 0.10 nA 24 $\mu$ A/A + 0.80 nA 24 $\mu$ A/A + 50 nA 24 $\mu$ A/A + 50 nA 42 $\mu$ A/A + 0.50 $\mu$ A 0.013 % + 10 $\mu$ A  13 $\mu$ A/A  22 $\mu$ A/A  0.024 % 0.077 %	HP 3458A opt 002  HP 3458A with L&N 4221B current shunt  HP 3458A with L&N 4222B  HP 3458A with Valhalla 2575A
DC Current – Generate <sup>3</sup>	(0 to 220) $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA  (22 to 220) mA  220 mA to 2.2 A  (2.2 to 11) A (11 to 20) A (20 to 100) A	39 $\mu$ A/A + 6.0 nA 33 $\mu$ A/A + 7.0 nA 36 $\mu$ A/A + 40 nA  44 $\mu$ A/A + 0.70 $\mu$ A*  66 $\mu$ A/A + 12 $\mu$ A*  0.048 % + 0.33 mA 0.042 % + 0.030 % rng 0.068 % + 0.03 % rng	Fluke 5700/EP (Using artifact calibrations)  *Add (200 x I <sup>2</sup> ) $\mu$ A/A for I > 100 mA  *Add (10 x I <sup>2</sup> ) $\mu$ A/A for I > 1 A  Fluke 5500A Valhalla 2555A

*Peter Meyer*

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Resistance – Measure <sup>3</sup>	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	24 μΩ/Ω + 50 μΩ 16 μΩ/Ω + 0.50 mΩ 12 μΩ/Ω + 0.50 mΩ 13 μΩ/Ω + 5.0 mΩ 12 μΩ/Ω + 50 mΩ 18 μΩ/Ω + 2.0 Ω 30 μΩ/Ω + 0.10 kΩ 58 μΩ/Ω + 1.0 kΩ 0.058 % + 10 kΩ*	HP 3458A opt 002  *additional error from Tcal for last ACAL +/- 1 °C
Resistance – Generate, Fixed Values <sup>3</sup>	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω (1, 1.9) kΩ 10 kΩ, 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	93 μΩ/Ω 86 μΩ/Ω 26 μΩ/Ω 27 μΩ/Ω 12 μΩ/Ω 11 μΩ/Ω 8.8 μΩ/Ω 8.6 μΩ/Ω 8.7 μΩ/Ω 10 μΩ/Ω 11 μΩ/Ω 18 μΩ/Ω 19 μΩ/Ω 35 μΩ/Ω 44 μΩ/Ω 0.013 %	Fluke 5700/EP (Using artifact calibrations)

Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup>			
3 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.11 % 0.093 % 0.13 % 0.25 % 0.50 %	Datron 4920A
10 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.034 % 0.021 % 0.052 % 0.14 % 0.35 %	

*Peter Meyer*

Parameter/Range	Frequency	CMC <sup>2, 5</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
30 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.027 % 0.017 % 0.039 % 0.11 % 0.27 %	Datron 4920A
100 mV	(10 to 100) Hz 100 Hz to 30 kHz (30 to 200) kHz (200 to 500) kHz 500 kHz to 1 MHz	0.020 % 0.010 % 0.019 % 0.058 % 0.16 %	
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 kHz to 1 MHz	0.029 % 0.013 % 30 µV/V 33 µV/V 0.018 % 0.029 % 0.079 %	
1V	(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 kHz to 1 MHz	0.029 % 0.013 % 30 µV/V 32 µV/V 77 µV/V 0.029 % 0.078 %	
3V	(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 kHz to 1 MHz	0.029 % 0.013 % 30 µV/V 32 µV/V 80 µV/V 0.029 % 0.078 %	
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 kHz to 1 MHz	0.029 % 0.013 % 30 µV/V 30 µV/V 68 µV/V 0.029 % 0.078 %	

*Peter Meyer*

Parameter/Range	Frequency	CMC <sup>2, 5</sup> (±)	Comments
AC Voltage – Measure <sup>3</sup> (cont)			
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 kHz to 1 MHz	0.029 % 0.013 % 37 µV/V 30 µV/V 68 µV/V 0.029 % 0.078 %	Datron 4920A
100 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 30 kHz (30 to 200) kHz	0.029 % 0.013 % 37 µV/V 31 µV/V 83 µV/V	
300 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.031 % 0.016 % 46 µV/V 46 µV/V 0.011 %	
1000 V	(1 to 2) Hz (2 to 10) Hz (10 to 40) Hz 40 Hz to 20 kHz (20 to 100) kHz	0.032 % 0.016 % 46 µV/V 52 µV/V 0.011 %	
AC Voltage – Generate <sup>3</sup>			
Up to 2.2 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	0.033 % + 4.0 µV 0.016 % + 4.0 µV 0.015 % + 4.0 µV 0.028 % + 4.0 µV 0.067 % + 5.0 µV 0.13 % + 10 µV 0.17 % + 20 µV 0.36 % + 20 µV	Fluke 5700/EP
(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	0.026 % + 4.0 µV 0.015 % + 4.0 µV 0.015 % + 4.0 µV 0.027 % + 4.0 µV 0.055 % + 5.0 µV 0.055 % + 10 µV 0.099 % + 20 µV 0.027 % + 20 µV	

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Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Voltage – Generate <sup>3</sup> (cont)			
(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	0.025 % + 12 μV 0.013 % + 7.0 μV 0.012 % + 7.0 μV 0.021 % + 7.0 μV 0.045 % + 17 μV 0.078 % + 20 μV 0.12 % + 25 μV 0.26 % + 450 μV	Fluke 5700/EP
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 95 μV/V + 15 μV 62 μV/V + 8.0 μV 89 μV/V + 10 μV 0.012 % + 30 μV 0.036 % + 80 μV 0.093 % + 0.20 mV 0.13 % + 0.30 mV	
(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	0.023 % + 0.40 mV 84 μV/V + 0.15 mV 46 μV/V + 50 μV 78 μV/V + 0.10 mV 0.011 % + 0.20 mV 0.028 % + 0.60 mV 0.093 % + 2.0 mV 0.14 % + 3.2 mV	
(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	0.023 % + 4.0 mV 0.010 % + 1.5 mV 76 μV/V + 0.60 mV 0.010 % + 1.0 mV 0.015 % + 2.5 mV 0.082 % + 16 mV 0.43 % + 40 mV 0.71 % + 80 mV	
(220 to 1100) V	50 Hz to 1 kHz	75 μV/V + 3.5 mV	

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Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Current – Measure <sup>3</sup>			
(20 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.46 % + 0.03 μA 0.17 % + 0.03 μA 0.070 % + 0.03 μA 0.070 % + 0.03 μA	HP 3458A opt 002
100 μA to 1 mA	(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 (50 to 100) kHz	0.46 % + 0.2 μA 0.17 % + 0.2 μA 0.070 % + 0.2 μA 0.036 % + 0.2 μA 0.070 % + 0.2 μA 0.46 % + 0.4 μA 0.64 % + 1.5 μA	
(1 to 10) mA	(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 (50 to 100) kHz	0.46 % + 2 μA 0.17 % + 2 μA 0.070 % + 2 μA 0.036 % + 2 μA 0.070 % + 2 μA 0.46 % + 4 μA 0.64 % + 15 μA	
(10 to 100) mA	(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 (50 to 100) kHz	0.46 % + 20 μA 0.17 % + 20 μA 0.070 % + 20 μA 0.036 % + 20 μA 0.070 % + 20 μA 0.46 % + 40 μA 0.64 % + 150 μA	HP 3458A opt 002
100 mA to 1 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	0.46 % + 0.2 mA 0.19 % + 0.2 mA 0.093 % + 0.2 mA 0.12 % + 0.2 mA 0.35 % + 0.2 mA 1.2 % + 0.4 mA	
(1 to 2) A	10 Hz to 10 kHz	0.12 %	Datron 4920M with Valhalla 2575A
(2 to 20) A	10 Hz to 1 kHz (1 to 10) kHz	0.12 % 0.58 %	Datron 4920M Valhalla 2575A
(20 to 100) A	10 Hz to 1 kHz	0.12 %	Datron 4920M with Valhalla 2575A

*Peter Mlynar*

Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Current – Generate <sup>3</sup>			
(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	0.025 % + 16 nA 0.015 % + 10 nA 0.012 % + 8.0 nA 0.030 % + 12 nA 0.095 % + 65 nA	Fluke 5700/EP
220 µA 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	0.025 % + 40 nA 0.017 % + 35 nA 0.015 % + 35 nA 0.021 % + 0.11 µA 0.093 % + 0.65 µA	
(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	0.025 % + 0.40 µA 0.016 % + 0.35 µA 0.013 % + 0.35 µA 0.020 % + 0.55 µA 0.092 % + 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	0.025 % + 4.0 µA 0.016 % + 3.5 µA 0.013 % + 2.5 µA 0.020 % + 3.5 µA 0.095 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 35 µA 0.041 % + 80 µA 0.61 % + 0.16 mA	
(2.2 to 11) A	(45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz	0.048 % + 2 mA 0.079 % + 2 mA 0.26 % + 2 mA	Fluke 5500A
(11 to 20) A	10 Hz to 1 kHz (1 to 10) kHz	0.12 % of rng 0.58 % of rng	Vallhalla 2555A
(11 to 100) A	20 Hz to 1 kHz	0.12 % of rng	w/ Vallhalla 2575A

*Peter Meyer*

Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
Capacitance – Generate <sup>3</sup>  (0.33 to 0.4999) nF (0.5 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.2999) nF (11 to 32.999) nF (33 to 109.99) nF (110 to 329.99) nF (0.33 to 1.0999) μF (1.1 to 3.2999) μF (3.3 to 10.999) μF (11 to 32.999) μF (33 to 109.99) μF (110 to 329.99) μF (0.33 to 1.1) mF	50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz (50 to 400) Hz (50 to 400) Hz (50 to 200) Hz (50 to 100) Hz (50 to 100) Hz	0.57 % + 0.01 nF 0.44 % + 0.01 nF 0.39 % + 0.01 nF 0.39 % + 0.01 nF 0.21 % + 0.10 nF 0.21 % + 0.10 nF 0.21 % + 0.30 nF 0.21 % + 1.0 nF 0.31 % + 3.0 nF 0.28 % + 10 nF 0.32 % + 30 nF 0.41 % + 0.10 μF 0.57 % + 0.30 μF 0.81 % + 0.30 μF	Fluke 5500A
Capacitance – Generate, Fixed Points <sup>3</sup>  1 pF           10 pF           100 pF	100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz           100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz           100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.038 % 0.039 % 0.058 % 0.12 % 0.20 % 0.31 % 1.2 % 2.2 %           0.037 % 0.037 % 0.037 % 0.037 % 0.038 % 0.041 % 0.079 % 0.15 %           0.038 % 0.046 % 0.046 % 0.050 % 0.059 % 0.078 % 0.18 % 0.24 %	HP 16381A           HP 16382A, 16383A           HP 16382A, 16383A

*Peter Meyer*

Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
Capacitance – Generate, Fixed Points <sup>3</sup> (cont)			
1000 pF	100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.037 % 0.068 % 0.079 % 0.15 % 0.19 % 0.25 % 0.61 % 0.86 %	HP 16384A
Inductance – Generate, Fixed Points <sup>3</sup>	100 μH 1 mH 10 mH 100 mH 1 H	2.3 % 2.4 % 2.4 % 1.2 % 0.87 %	Gen Rad 1490D/F
Oscilloscope – Generate <sup>3</sup>			
DC Signal 50 Ω Load 1 MΩ Load	1.0 mV to 6.6 V (0 to 130) V	0.19 % + 40 μV 0.039 % + 40 μV	Fluke 5500A SC600
Squarewave Signal 50 Ω Load 1 MΩ Load	1.0 mV to 6.6 V <sub>pk-pk</sub> 1.0 mV to 130 V <sub>pk-pk</sub>	0.19 % + 40 μV 0.078 % + 40 μV*	* >1 kHz, uncertainty is 0.25 % + 40 μV
Edge Characteristics (50 Ω Load)	5 mV to 2.5 V	1.6 % + 0.20 mV	
Risetime (50 Ω Load)	≤ 300 ps	(+ 0 / - 78) ps	
Level Sine Wave, into 50 Ω Load 5 mV <sub>pk-pk</sub> to 5.5 V <sub>pk-pk</sub>	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.9 % + 0.30 mV 2.9 % + 0.30 mV 3.3 % + 0.30 mV 4.8 % + 0.30 mV	
Time Marker, 50 Ω	5 s to 50 ms 20 ms to 2 ns	(25 + 1000*t) μs/s 2.5 μs/s	t = time in seconds

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Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
Oscilloscope – Generate <sup>3</sup> (cont)			
DC Signal 50 Ω Load 1 MΩ Load	1.0 mV to 6.6 V (0 to 33) V	0.25 % + 0.10 mV 0.25 % + 0.10 mV	Fluke 5500A SC300
Squarewave Signal 50 Ω Load 1 MΩ Load	1.8 mV to 2.2 V <sub>pk-pk</sub> 1.8 mV to 105 V <sub>pk-pk</sub>	0.25 % + 0.10 mV 0.25 % + 0.10 mV	
Edge Characteristics (50 Ω Load)	4.5 mV to 2.75 V	2.0 % + 0.20 mV	
Level Sine Wave, into 50 Ω Load 5 mV <sub>pk-pk</sub> to 5.5 V <sub>pk-pk</sub>	50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz	2.0 % + 0.20 mV 3.5 % + 0.30 mV 4.0 % + 0.30 mV	
Time Marker, 50 Ω	5 s to 100 μs 50 μs to 2 μs 1 μs to 2 ns	(25 + 1000*t) μs/s (25 + 15 000*t) μs/s 25 μs/s	t = time in seconds
Oscilloscope – Measure <sup>3</sup>			
Risetime	Up to 12.4 GHz	73 ps	HP 54120B sampling oscilloscope
DC High Voltage – Measure <sup>3</sup>	Up to 2 kV (2 to 40) kV  (41 to 120) kV	0.048 % + 0.02 % rng 0.065 % + 0.02 % rng  0.14 %	Vitrek 4640A  Ross VD120
DC High Voltage – Generate <sup>3</sup>	Up to 10 kV	0.33 % rng	Fluke 410B

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Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC High Voltage – Measure <sup>3</sup>			
(Up to 2) kV	(20 to 100) Hz	0.11 % + 0.1 % rng	Vitretek 4640A
(2 to 40) kV (25 kV RMS)	(100 to 400) Hz	0.25 % + 0.2 % rng	
	(50 to 60) Hz	0.47 % + 0.15 % rng	
(20 to 85) kV	60 Hz	0.64 %	Ross VD120

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicating Devices <sup>3</sup> –			
Type J	-210 °C to -100 °C	0.27 °C	Fluke 5500A
	-100 °C to 760 °C	0.17 °C	
	760 °C to 1200 °C	0.23 °C	
Type K	-200 °C to -100 °C	0.33 °C	
	-100 °C to 120 °C	0.18 °C	
	120 °C to 1000 °C	0.26 °C	
	1000 °C to 1372 °C	0.40 °C	
Type T	-250 °C to -150 °C	0.63 °C	
	-150 °C to 0 °C	0.24 °C	
	0 °C to 400 °C	0.16 °C	
Type E	-250 °C to -100 °C	0.50 °C	
	-100 °C to 650 °C	0.16 °C	
	650 °C to 1000 °C	0.21 °C	

*Peter Meyer*

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Attenuation <sup>3</sup> –			
DC to 12.4 GHz	(1 to 2) dB (3 to 4) dB (5 to 6) dB (7 to 10) dB 11 dB	0.44 dB 0.58 dB 0.72 dB 0.86 dB 1.0 dB	HP 8902A 1 dB step attenuator
(12.4 to 18) GHz	(1 to 6) dB (6 to 9) dB (10 to 11) dB	1.1 dB 1.2 dB 1.3 dB	
DC to 12.4 GHz	10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	0.73 dB 1.0 dB 1.3 dB 1.7 dB 2.1 dB 2.6 dB 3.0 dB 3.4 dB 3.9 dB 4.3 dB 4.7 dB	HP 8902A 10 dB step attenuator
(12.4 to 18) GHz	10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	0.89 dB 1.2 dB 1.8 dB 2.3 dB 2.9 dB 3.4 dB 4.0 dB 4.6 dB 5.1 dB 5.7 dB 6.3 dB	
RF Power (tuned)– Measure <sup>3</sup>			
(20 to -127) dBm	(0.1 to 1.3) GHz  (1.3 to 26.5) GHz	0.20 dB  0.43 dB	HP 8902A w/opt 050 and HP 11722A power sensor  HP 8902A w/11793A down converter and HP 11792A power sensor

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Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
RF Power – Generate <sup>3</sup>			
(+10 to 0) dBm (0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm < -30 dbm	(0.05 to 6.6) GHz	1.6 dB 1.3 dB 1.9 dB 2.1 dB 2.4 dB	HP 8673D generator
(+10 to 0) dBm (0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm < -30 dbm	(6.6 to 12.3) GHz	1.8 dB 1.5 dB 2.1 dB 2.3 dB 2.7 dB	
(+10 to 0) dBm (0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm < -30 dbm	(12.3 to 18.6) GHz	2.1 dB 1.8 dB 2.5 dB 2.7 dB 3.2 dB	
(+10 to 0) dBm (0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm < -30 dbm	(18.6 to 26) GHz	2.7 dB 2.4 dB 3.0 dB 3.3 dB 3.9 dB	
Amplitude Modulation – Measure <sup>3</sup>			
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	2.8 % + 1 digit	HP 8902A w/ HP 11722A power sensor
Rate: 20 Hz to 10 kHz Depths: to 99 %	150 kHz to 10 MHz	3.8 % + 1 digit	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	10 MHz to 1.3 GHz	1.7 % + 1 digit	HP 8902A w/ HP 11792A power sensor
Rate: 20 Hz to 100 kHz Depths: to 99 %	10 MHz to 1.3 GHz	3.7 % + 1 digit	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	(1.3 to 18) GHz	3.2 % + 1 digit	
Rate: 20 Hz to 100 kHz Depths: to 99 %	10 MHz to 26.5 GHz	4.7 % + 1 digit	

*Peter Meyer*

Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
Frequency Modulation – Measure <sup>3</sup>			
Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz pk	250 kHz to 10 MHz	2.9 % + 1 digit	HP 8902A w/ HP 11722A power sensor
Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	1.9 % + 1 digit	
Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	6.0 % + 1 digit	
Rate: 50 Hz to 100 kHz Dev: ≤ 400 kHz pk	10 MHz to 26.5 GHz	3.5 % + 1 digit	HP 8902A w/ HP 11792A power sensor
Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz pk	10 MHz to 1.3 GHz	6.6 % + 1 digit	
Phase Modulation – Measure <sup>3</sup>			
Rate: 200 Hz to 10 kHz	$150 \text{ kHz} \leq f_c < 10 \text{ MHz}$	5.3 % + 1 digit	HP 8902A w/ HP 11722A power sensor
Rate: 200 Hz to 20 kHz	$10 \text{ MHz} \leq f_c \leq 1.3 \text{ GHz}$	4.3 % + 1 digit	
Rate: 200 Hz to 20 kHz	$10 \text{ MHz} \leq f_c \leq 26.5 \text{ GHz}$	5.2 % + 1 digit	HP 8902A w/ HP 11792A power sensor
			$f_c$ represents the frequency carrier
ESD Guns	Contact & Air Discharge Voltage: (1 to 16) kV		LC574AL LeCroy oscilloscope and ESD target
	Amplitude Rise Time	6.2 % 1.2 ns	

IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 4, 5</sup> (±)	Comments
Torque Wrench <sup>3</sup>	1 in·oz to 650 ft·lb	0.11 % + 0.6R	AKO TSD 1200 torque calibrator
Pressure (Liquid) <sup>3</sup>	(5 to 10 000) psi	0.011 % + 0.6R	Dead weight
Force <sup>3</sup>	(1 to 300) lbf	0.015 %	ASTM 6, weights
Scales <sup>3</sup>	(1 to 500) g (0.5 to 5) kg (50 to 300) lb	0.082 g 5.8 g 0.017 lb	Class 6 weights
Balances	(50 to 500) mg (5 to 100) g	0.029 mg 0.31 mg	Class S weights
Torque Cells / Standards	(1 to 100) in/lb (1 to 650) ft/lb	0.014 % + 0.6R 0.018 % + 0.6R	Torque arm and class 6 weights

V. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature – Measure <sup>3</sup>	-170 °C to 660 °C	0.016 °C	Hart 5626 PRT probe with Azonix 1011 display
Temperature – Measuring Equipment <sup>3</sup>	35 °C to 200 °C	0.023 °C	Hart 5626 PRT with Azonix 1011 display, Hart 6102 bath
Infrared Measuring Equipment	(0 to 650) °C	2.1 °C	EDL DBB-650
Relative Humidity – Measuring Equipment <sup>3</sup>	~13 and ~74 %	2.5 % RH	ASTM E104-02 RH salts

*Peter Meyer*

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Relative Humidity – Measure <sup>3</sup>	(10 to 90) % RH	1.5 % RH	Vaisala HMT-337

## VI. Time and Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Timers & Stopwatches <sup>3</sup>	Per day/month	0.072 s/day	Timometer TM-4500 from Helmut Klein
Frequency <sup>3</sup>	10 MHz reference	1 parts in 10 <sup>12</sup>	GPS w. Symmetricon XLi

<sup>1</sup> This laboratory offers commercial calibration service and field calibration service.

<sup>2</sup> Calibration and Measurement Capability (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. Calibration and Measurement Capabilities 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.

<sup>3</sup> 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 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 actual 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.

<sup>4</sup> In the statement of CMC,  $L$  is the numerical value of the nominal length of the device measured in inches and  $R$  is the resolution of the device.

<sup>5</sup> All numbers stated as % should be taken as % of reading unless stated otherwise.





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# Accredited Laboratory

A2LA has accredited

## TRU CAL INTERNATIONAL INC.

*Bensenville, IL*

for technical competence in the field of

### Calibration

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 any additional program requirements in the field of calibration. 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 26<sup>th</sup> day of August 2010.



  
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Peter Meyer

President & CEO  
For the Accreditation Council  
Certificate Number 1278.01  
Valid to May 31, 2012  
Revised April 30, 2012

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