



ANSI-ASQ National Accreditation Board

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

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CALIBRATION

Valid to: August 6, 2018

Certificate Number: AC-1886

I. Electromagnetic – DC/Low Frequency

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
DC Current Measure ³	(10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1.1 A	7.6 nA 35 nA 0.44 μ A 6.7 μ A 0.16 mA	HP 3458A	T.O. 33K1-4-25-1
DC Current Source ³	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.17 nA/ μ A + 23 nA 0.15 μ A/mA + 0.06 μ A 0.12 μ A/mA + 0.3 μ A 0.11 μ A/mA + 4.3 μ A 0.44 mA/A + 0.051 mA 0.43 mA/A + 0.1 mA 0.56 mA/A + 2.5 mA 0.39 mA/A + 56 mA	Fluke 5502A	T.O. 33K1-4-947-1
DC Current Source ³ Clamp Meters	(12 to 500) A	5.4 mA/A + 0.53 A	Fluke 5502A with 50 turn coil	T.O. 33K1-4-261-1



Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
AC Current Measure ³	(0 to 1) A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz (1 to 3) A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz (2 to 10) A 60 Hz and 400 Hz	12 mA 40 mA 1.8 mA 40 mA 14 mA 8.5 mA 18 mA	Agilent 34401A Fluke 87	T.O. 33K1-4-1739-1
AC Current Measure Magnetic Inspection Unit ³	(500 to 10 000) A	13 A + 1.5% of Rdg	Ammeter and Current Shunt	ASTM E1444
AC Current Source ³	(29 to 330) μA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.33 to 3.3) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (3.3 to 33) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	2.3 nA/ μ A + 0.12 μ A 1.7 nA/ μ A + 0.12 μ A 1.4 nA/ μ A + 0.12 μ A 3.5 nA/ μ A + 0.18 μ A 9.2 nA/ μ A + 0.24 μ A 18 nA/ μ A + 0.52 μ A 2.3 μ A/mA + 0.21 μ A 1.4 μ A/mA + 0.22 μ A 1.1 μ A/mA + 0.24 μ A 2.3 μ A/mA + 0.26 μ A 5.8 μ A/mA + 0.37 μ A 12 μ A/mA + 0.81 μ A 2 μ A/mA + 3.7 μ A 1 μ A/mA + 3.3 μ A 0.39 μ A/mA + 5.6 μ A 0.77 μ A/mA + 8.7 μ A 2.2 μ A/mA + 7.7 μ A 4.5 μ A/mA + 8.9 μ A 2 μ A/mA + 36 μ A 1 μ A/mA + 30 μ A 0.44 μ A/mA + 32 μ A 1.1 μ A/mA + 63 μ A 2.3 μ A/mA + 0.12 mA 4.6 μ A/mA + 0.23 mA	 Fluke 5502A	T.O. 33K1-4-127-1

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
AC Current Source ³ (cont.)	(0.33 to 1.1) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (1.1 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (12 to 500) A 60 Hz	2 mA/A + 0.25 mA 0.55 mA/A + 0.16 mA 6.9 mA/A + 1.2 mA 29 mA/A + 5.8 mA 2 mA/A + 0.4 mA 0.67 mA/A + 0.2 mA 6.9 mA/A + 1.2 mA 29 mA/A + 5.9 mA 0.63 mA/A + 3.4 mA 1.1 mA/A + 2.8 mA 34 mA/A + 4.7 mA 1.3 mA/A + 11 mA 1.5 mA/A + 16 mA 35 mA/A + 10 mA	Fluke 5502A	T.O. 33K1-4-127-1
Clamp Meters ³	60 Hz	7 mA/A + 0.52 A		T.O. 33K1-4-1871-1
Resistance Source ³	0.1 m Ω @ 100 A 1 m Ω @ 30 A 10 m Ω @ 10 A 100 m Ω @ 3 A	58 n Ω 0.58 $\mu\Omega$ 5.8 $\mu\Omega$ 58 $\mu\Omega$	Precision Resistance Standard	NA 17-20AR-17
Resistance Source ³	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω 330 M Ω to 1.1 G Ω	0.14 m Ω/Ω + 1.2 m Ω 0.14 m Ω/Ω + 1.8 m Ω 0.1 m Ω/Ω + 1.9 m Ω 0.1 m Ω/Ω + 2.4 m Ω 0.1 $\Omega/k\Omega$ + 2.3 m Ω 0.1 $\Omega/k\Omega$ + 25 m Ω 0.1 $\Omega/k\Omega$ + 24 m Ω 0.1 $\Omega/k\Omega$ + 0.24 Ω 0.13 $\Omega/k\Omega$ + 0.24 Ω 0.14 $\Omega/k\Omega$ + 2.4 Ω 0.17 k $\Omega/M\Omega$ + 2.7 Ω 0.17 k $\Omega/M\Omega$ + 53 Ω 0.69 k $\Omega/M\Omega$ + 59 Ω 1.2 k $\Omega/M\Omega$ + 2.9 k Ω 5.7 k $\Omega/M\Omega$ + 13 k Ω 5.8 k $\Omega/M\Omega$ + 0.12 M Ω 17 M $\Omega/G\Omega$ + 0.57 M Ω	Fluke 5502A	NA 17-20AR-17

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Inductance - Source ³	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	23 μH/mH 12 μH/mH 8.7 μH/mH 9 mH/H	Decade Inductance Substituter	T.O. 33K1-4-1387-1
Inductance – Measure 1 kHz	100 μH to 1 H	1.2 mH + 2.7 μH/mH	B&K Precision 885 LCR/ESR Meter	OEM-Sourced Procedures
Resistance Temperature Simulation ^{3,4}	Pt 385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C Pt 385, 200 Ω (-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C Pt 385, 500 Ω (-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C	0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C 0.23 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C 0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.23 °C 0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.15 °C 0.16 °C 0.04 °C 0.05 °C 0.06 °C 0.08 °C 0.09 °C 0.11 °C	Fluke 5502A	

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
Resistance Temperature Simulation (cont.) ^{3,4}	Pt 385, 1 000 Ω (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C PtNi 385, 120 Ω (-80 to 100) °C (100 to 260) °C Cu 427, 10 Ω (-100 to 260) °C	0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Fluke 5502A	OEM - Sourced Procedures
Resistance - Measure ³	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω	0.49 m Ω 3.5 m Ω 20 m Ω 0.19 Ω 2 Ω 31 Ω 0.94 k Ω	HP 3458A	T.O. 33K-1-4-573-1
Capacitance – Measure ³	(1 to 5) nF (5 to 50) nF (50 to 500) nF 500 nF to 5 μ F	0.1 nF 1 nF 10 nF 0.15 nF	Fluke 87	T.O. 33K2-4-1-3-53
Capacitance – Measure ³ 1 kHz	100 pF to 1 μ F	1.2 nF + 5.65 pF/nF	B&K Precision 885 LCR/ESR Meter	T.O. 33K2-4-1-3-53
DC Power - Source ^{3,4}	(0.01 to 337) W (0.01 to 3 060) W 0.1 W to 20.91 kW	0.043 % 0.042 % 0.09 %	Fluke 5502A	OEM-Sourced Procedures
DC Voltage - Source ³	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V 330 V to 1 kV	0.069 μ V/mV + 3.5 μ V 58 μ V/V + 5.9 μ V 60 μ V/V + 0.06 mV 64 μ V/V + 0.6 mV 63 μ V/V + 2 mV	Fluke 5502A	T.O. 33K1-4-554-1
DC Voltage - Measure ³	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	3.1 μ V 19 μ V 0.18 mV 1.8 mV 19 mV	HP 3458A	T.O. 33K1-4-25-1

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
DC Voltage - Measure ³	100 V to 2 kV (2 to 40) kV	540 mV/kV + 510 mV 437 mV/kV + 11 V	High Voltage Meter	T.O. 33K1-4-1475-1
Capacitance - Source ³	(190 to 400) pF 400 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	5.7 fF/pF + 12 pF 5.6 pF/nF + 12 pF 5.3 pF/nF + 15 pF 2.7 pF/nF + 15 pF 2.4 pF/nF + 0.16 nF 2.8 pF/nF + 0.14 nF 2 nF/nF + 1 nF 2.8 nF/μF + 1.5 nF 1.9 nF/μF + 11 nF 2.8 nF/μF + 15 nF 3.7 nF/μF + 93 nF 5.2 nF/μF + 0.14 μF 4.1 μF/μF + 1 μF 4.6 μF/mF + 2.2 μF 4.2 μF/mF + 9.1 μF 5 μF/mF + 15 μF 8 μF/mF + 68 μF 13 μF/mF + 0.13 mF	Fluke 5502A	T.O. 33K8-4-9081
AC Power - Source ^{3,4} (45 to 65) Hz, PF=1	(0.1089 to 2.97) mW (0.297 to 10.89) mW (1.089 to 29.7) mW (2.97 to 108.9) mW (10.89 to 297) mW (29.7 to 726) mW 72.6 mW to 1.49 W 149 mW to 6.76 W 1.09 mW to 9.18 W 2.97 mW to 33.6 W 10.9 mW to 91.8 W 29.7 mW to 337 W 109 mW to 918 W 297 mW to 2244 W 72.6 mW to 4.59 kW 1.49 W to 20.91 kW	0.16 % 0.12 % 0.16 % 0.12 % 0.14 % 0.10 % 0.14 % 0.10 % 0.15 % 0.13 % 0.15 % 0.13 % 0.13 % 0.13 % 0.11 % 0.14 % 0.12 %	Fluke 5502A	OEM-Sourced Procedures



Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
AC Voltage Source ³	<p>(1 to 33) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz</p> <p>(33 to 330) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz</p> <p>(0.33 to 3.3) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz</p> <p>(3.3 to 33) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz</p> <p>(33 to 330) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz</p> <p>330 V to 1 kV 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz</p>	<p>1.7 μV/mV + 24 μV 1.2 μV/mV + 23 μV 1.6 μV/mV + 31 μV 2.3 μV/mV + 23 μV 4.0 μV/mV + 38 μV 11.4 μV/mV + 73 μV</p> <p>0.57 μV/mV + 25 μV 0.34 μV/mV + 25 μV 0.8 μV/mV + 25 μV 1.2 μV/mV + 48 μV 2.7 μV/mV + 200 μV 5.8 μV/mV + 380 μV</p> <p>0.57 mV/V + 0.1 mV 0.34 mV/V + 0.09 mV 0.81 mV/V + 0.08 mV 1.2 mV/V + 0.082 mV 2.7 mV/V + 0.24 mV 5.7 mV/V + 1.2 mV</p> <p>0.57 mV/V + 1.3 mV 0.24 mV/V + 5.9 mV 0.8 mV/V + 1 mV 1.1 mV/V + 1.1 mV 2.6 mV/V + 2.7 mV</p> <p>0.57 mV/V + 6.4 mV 0.92 mV/V + 11 mV 1 mV/V + 12 mV 1.4 mV/V + 15 mV 2.7 mV/V + 110 mV</p> <p>0.57 mV/V + 29 mV 0.92 mV/V + 29 mV 1 mV/V + 28 mV</p>	Fluke 5502A	T.O. 33K1-4-584-1



Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
AC Voltage - Measure ³	(1 to 10) mV		HP 3458A	T.O. 33K1-4-1739-1
	(1 to 40) Hz	15 µV		
	40 Hz to 1 kHz	14 µV		
	(1 to 20) kHz	15 µV		
	(20 to 50) kHz	20 µV		
	(50 to 100) kHz	61 µV		
	(100 to 300) kHz	0.46 mV		
	(10 to 100) mV			
	(1 to 40) Hz	27 µV		
	40 Hz to 1 kHz	26 µV		
	(1 to 20) kHz	30 µV		
	(20 to 50) kHz	45 µV		
	(50 to 100) kHz	98 µV		
	(100 to 300) kHz	0.36 mV		
	300 kHz to 1 MHz	1.2 mV		
	100 mV to 1 V			
	(1 to 40) Hz	0.20 mV		
	40 Hz to 1 kHz	0.18 mV		
	(1 to 20) kHz	0.23 mV		
	(20 to 50) kHz	0.41 mV		
	(50 to 100) kHz	0.96 mV		
	(100 to 300) kHz	3.6 mV		
	300 kHz to 1 MHz	12 mV		
	(1 to 10) V			
(1 to 40) Hz	2 mV			
40 Hz to 1 kHz	1.8 mV			
(1 to 20) kHz	2.3 mV			
(20 to 50) kHz	4.1 mV			
(50 to 100) kHz	9.6 mV			
(100 to 300) kHz	36 mV			
300 kHz to 1 MHz	0.12 V			
(10 to 100) V				
(1 to 40) Hz	31 mV			
40 Hz to 1 kHz	29 mV			
(1 to 20) kHz	30 mV			
(20 to 50) kHz	46 mV			
(50 to 100) kHz	0.14 V			
(100 to 700) V				
40 Hz to 1 kHz	0.37 V			
10 V to 2 kV				
60 Hz	0.97 mV/V + 2.3 V			
(2 to 40) kV				
60 Hz	4.8 mV/V + 69 V			



Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods	
Thermocouple Temperature Simulation ³	Type B	(600 to 800) °C	0.54 °C	Fluke 5502A	EURAMET CG-11
		(800 to 1 000) °C	0.42 °C		
		(1 000 to 1 550) °C	0.38 °C		
		(1 550 to 1 820) °C	0.40 °C		
	Type C	(0 to 150) °C	0.36 °C		
		(150 to 650) °C	0.31 °C		
		(650 to 1 000) °C	0.37 °C		
		(1 000 to 1 800) °C	0.59 °C		
		(1 800 to 2 316) °C	0.98 °C		
	Type E	(-250 to -100) °C	0.59 °C		
		(-100 to -25) °C	0.19 °C		
		(-25 to 350) °C	0.16 °C		
		(350 to 650) °C	0.19 °C		
		(650 to 1 000) °C	0.24 °C		
	Type J	(-210 to -100) °C	0.32 °C		
		(-100 to -30) °C	0.19 °C		
		(-30 to 150) °C	0.16 °C		
		(150 to 760) °C	0.20 °C		
		(760 to 1 200) °C	0.27 °C		
	Type K	(-200 to -100) °C	0.39 °C		
	(-100 to -25) °C	0.21 °C			
	(-25 to 120) °C	0.19 °C			
	(120 to 1 000) °C	0.30 °C			
	(1 000 to 1 372) °C	0.46 °C			
Type N	(-200 to -100) °C	0.47 °C			
	(-100 to -25) °C	0.26 °C			
	(-25 to 120) °C	0.22 °C			
	(120 to 410) °C	0.21 °C			
	(410 to 1 300) °C	0.31 °C			
Type R	(0 to 250) °C	0.69 °C			
	(250 to 400) °C	0.42 °C			
	(400 to 1 000) °C	0.41 °C			
	(1 000 to 1 767) °C	0.48 °C			

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Thermocouple Temperature Simulation ³ (cont.) Type S Type T	(0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 767) °C (-200 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.59 °C 0.44 °C 0.45 °C 0.55 °C 0.75 °C 0.28 °C 0.19 °C 0.16 °C	Fluke 5502A	EURAMET CG-11
Oscilloscopes Amplitude ³ 50 Ω Load 1 MΩ Load	1.8 mV to 2.2 V _{pk-pk} 1.8 mV to 105 V _{pk-pk}	810 μV + 2.3 mV/V 81 μV + 2.7 mV/V	Fluke 5500A w/SC300	OEM - Sourced Procedures
Oscilloscopes Time Marker ³ 50 Ω Load	(2 to 10) ns (20 to 1000) ns (2 to 50) μs (0.1 to 200) ms 500 ms 1 s 2 s 5 s	3.5 ps/ns 3.5 ps/ns 3.5 ns/μs 3.5 μs/ms 3.6 μs/ms 3.7 ms/s 4.2 m/s 6.8 ms/s	Fluke 5500A w/SC300	
Oscilloscopes Bandwidth ³ relative to 50 kHz 50 Ω load	50 kHz to 100 MHz 100 MHz to 300 MHz	380 mV + 5.2 % of Reading 370 mV + 5.9 % of Reading	Fluke 5500A w/SC300	
Oscilloscopes Bandwidth ³ relative to 50 kHz 50 Ω load	0.3 GHz to 1 GHz	1.3 mV + 60 μV/mV	Tektronix SG504	
Risetime ³ 50 Ω load	≤ 300 ps	100 ps	Fluke 5500A w/SC300	

II. Electromagnetic – RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
RF Absolute Power Measure ^{3,6} (-23 ≤ P < +10) dBm (0.005 ≤ P < 10) mW	100 MHz ≤ f < 6 GHz 6 GHz ≤ f ≤ 18 GHz	2.8 % of Reading 4.58 % of Reading	8481A RF Power Sensor w/E4418B RF Power Meter	OEM - Sourced Procedures
10 dBm ≤ P ≤ 20 dBm (10 ≤ P ≤ 100) mW	100 MHz ≤ f < 500 MHz 500 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f < 6 GHz 6 GHz ≤ f ≤ 18 GHz	7.5 % of Reading 4.7 % of Reading 4.5 % of Reading 5.3 % of Reading		
(-30 ≤ P < -10) dBm (1 ≤ P < 100) μW	100 kHz ≤ f < 10 MHz 10 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f ≤ 4.2 GHz	2.6 % of Reading 4.1 % of Reading 4.7 % of Reading	8482A RF Power Sensor w/E4418B RF Power Meter	
-10 dBm ≤ P < 20dBm (0.1 ≤ P < 100) mW	100 kHz ≤ f < 10 MHz 10 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f ≤ 4.2 GHz	11 % of Reading 6.5 % of Reading 6.6 % of Reading		
RF Frequency Measure ³ Into 50 Ω Into 1 M Ω	(10 to 525) MHz 10 Hz to 80 MHz	1.8 Hz + 10.7 mHz/Hz 1.2 Hz + 19.3 nHz/Hz	5350B Frequency Counter	
Into 50 Ω	(10 to 100) MHz (0.1 to 1) GHz (1 to 10) GHz (10 to 20) GHz	1 Hz + 1.2 Hz/MHz 1 Hz + 120 Hz/GHz 1 Hz + 1.2 kHz/GHz 1 Hz + 8 kHz/GHz		
Total Harmonic Distortion – Measure ³	5 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	8903B Audio Analyzer	
Absolute Power – Source ^{3,6} Into 50 Ω (0.050 to 10) V pp	Up to 100 kHz 100 kHz to 1 MHz (1 to 15) MHz	0.06 Vrms 0.075 Vrms 0.15 Vrms	33120A Arbitrary Generator	
Absolute Power – Measure ³ (-120 to 20) dBm	10 MHz to 1.3 GHz	1.0 dB	DSA1030A-TG Spectrum Analyzer	

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Tuned RF Power – Measure ³ 2.5 MHz to 1.3 GHz	(-115 to 0) dBm (-127 to -115) dBm	1.97 dB 1.3 dB	8902A Modulation Analyzer with 11722A Sensor	OEM - Sourced Procedures
Generated Power Into 50 Ω ³ (-127 to 13) dBm (-127 to 10) dBm (-127 to 7) dBm	277 kHz to 1 MHz 1 MHz to 3 GHz 3 GHz to 4 GHz	0.74 dB 1.2 dB 1.4 dB	ESG D4000 Signal Generator	
Frequency Modulation – Measure ³ Rate: 20 Hz to 10 kHz Deviation: <= 40 kHz	250 kHz to 10 MHz	410 Hz	8902A Modulation Analyzer	
Rate: 20 Hz to 100 kHz <= 400 kHz	10 MHz to 1.3 GHz	1.5 kHz		
Rate: 20 Hz to 200 kHz <= 400 kHz	10 MHz to 1.3 GHz	5.9 kHz		
Phase Modulation – Measure ³	Rate: 200 Hz to 10 kHz 150 kHz <= f _c < 10 MHz Rate: 200 Hz to 20 kHz 10 MHz <= f _c < 1.3 GHz	1.6 rad 0.58 rad	8902A Modulation Analyzer	
RF Frequency Time Based Aging ³	10 MHz	1.0 parts in 10 ⁻¹²	Fluke 910R GPS Controlled Atomic Clock	
Amplitude Modulation - Measure ³ rate: 50 Hz to 10 kHz, depth: 5% to 99%	150 kHz to 10 MHz	2.5%	8902A Modulation Analyzer	
rate: 20 Hz to 10 kHz, depth: to 99%	150 kHz to 10 MHz	3.7%		
rate: 50 Hz to 50 kHz, depth: 5% to 99%	10 MHz to 1.3 GHz	1.5%		
rate: 20 Hz to 100 kHz, depth: to 99%	10 MHz to 1.3 GHz	3.7%		

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Attenuation – Source Coaxial, Fixed ³ 3 dB	DC to 8 GHz, SWR < 1.25:1 (8 to 12.4) GHz, SWR < 1.3:1	0.35 dB 0.35 dB	8491A Coaxial Fixed Attenuator with Type- N	OEM - Sourced Procedures
6 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.47 dB 0.47 dB		
10 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.7 dB 0.7 dB		
20 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.7 dB 0.7 dB		
30 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.5) GHz, SWR < 1.3:1	1.2 dB 1.2 dB		
60 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.5) GHz, SWR < 1.3:1	2.3 dB 2.3 dB		
S12 – Reflection Magnitude Uncertainty ³ (Linear)	3 MHz to 3 GHz @ 0 dB 3 GHz to 6 GHz @ 0 dB	0.025 dB 0.043 dB		
S21 – Transmission Magnitude Uncertainty ³ (dB)	3 MHz to 6 GHz @ 0 dB	0.05 dB	E5071B Network Analyzer (Corrected using 85032E Cal Kit)	

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Thermal Noise Figure System – Measure ³ (0 to 30 dB)	10 MHz to 1.5 GHz SWR 1.7:1 ENR (14 to 16) dB	0.3 dB	8970A Noise Figure Meter w/346B Noise Source	OEM - Sourced Procedures
Thermal Noise Figure System – Generate ³ ENR (14 to 16) dB	10 MHz to 18 GHz SWR 1.25:1	0.27 dB + 0.00315 dB/GHz	346B Noise Source	

III. Time & Frequency

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Optical Tachometer ³ (Non-Contact)	(60 to 100,000) rpm	0.025 %	Function Generator and LED Light Source	T.O. 33K6-3-869-1/ NA 17-20MA-03
Stopwatches and Timers ³	Up to 48 hrs	40 msec	Function Generator and Frequency Counter	NIST SP960-12 Totalizer Method
Contact Tachometers ³	(10 to 10 000) RPM	2.5 RPM + 0.67 % of Rdg.	Tachometer Standard	T.O. 33K6-4-869-1
Frequency - Source ³	(0.01 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz	0.013 Hz 0.13 Hz 1.3 Hz 13 Hz 130 Hz 1.3 kHz	Fluke 5502A	OEM-Sourced Procedures
Frequency - Source ³	(2 to 8.4) GHz	12 Hz	Anritsu MG3691A	OEM-Sourced Procedures

IV. Thermodynamic

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Thermometers ³	(-196 to 0) °C (0 to 420) °C	0.031 °C + 80 μK/°C 0.031 °C + 11μK/°C	SPRT	ASME B40.200
Humidity Indicators at 23 ± 5 °C	11 % RH 33 % RH 75 % RH 98 % RH	1.7 % RH 1.5 % RH 1.9 % RH 2.8 % RH	Vaisala Humidity HMK15 Calibrator and Salts	OEM-Sourced Procedures
Humidity Indicators	(10 to 95) %RH	0.16% of Rdg + 0.67 %RH	Thunder Scientific 1200	
Pyrometers - Source ³	(100 to 982) °C	1.9 °C + 0.46 % of Rdg	IR Blackbody ε = 0.99	
Ovens, Incubators, Stirred Water Baths & Fridges ³	(0 to 100) °C (0 to 600) °C (-190 to 1 300) °C	2.8 °C + 0.16 % of Rdg 2.8 °C + 0.5 % of Rdg 3.9 °C + 0.6 % of Rdg	Process Calibrator and Thermocouple	
Thermocouples and Thermometers ³	(-15 to 110) °C (50 to 350) °C	0.41 °C 0.77 °C	Dry Block Calibrator	
Air Probes	(-40 to 0) °C (0 to 100) °C (100 to 130) °C	3.2 °C + 0.3 % of Reading 3.2 °C + 0.4 % of Reading 3.2 °C + 0.6 % of Reading	Thermal Chamber	

V. Mechanical

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Liquid Flow Rate Inline ³	(0 to 65) gpm (0 to 150) gpm	0.6 gpm + 0.2 % 0.3 gpm + 0.2 %	Coriolis Meter	NIST Handbook 44
Liquid Flow Rate Non-Intrusive ³	(0 to 500) gpm (500 to 900) gpm	0.5 gpm + 0.3% 1 gpm + 0.4%	Ultrasonic Transducers	OEM-Sourced Procedures
Gas Flowmeters and Rotameters	(0 to 10) sccm (0 to 100) sccm (0 to 50) slpm	0.6 sccm + 1% of Rdg 0.9 sccm + 1% of Rdg 0.4 slpm + 0.8% of Rdg	Thermal Mass Flow Sensors	T.O. 33K6-4-26-1
Air Flow Rate	(80 to 4921) fpm	60 fpm + 4.2%	Thermo Anemometer in Wind Tunnel	T.O. 33K6-4-1769-1
Metal Detectors – Magnetic Separation ³	(0.5 to 6) lbf	0.37 lbf	Digital Magnetic Pull Tester	OEM-Sourced Procedures
Force Gauges ³	(0 to 21.5) lbs (10 to 110) lbs (110 to 1 100) lbs	0.00093 lbf + 0.035 % of Rdg 0.0073 lbf + 0.043 % of Rdg 1 lbf + 0.041 % of Rdg	NIST Class F Weights	ASTM E4
Force Machines ³ Tension	(103 to 2 500) lbf (261 to 10 000) lbf (1.658 to 60) klbf (60 to 120) klbf	2 lbf 5 lbf 12 lbf 16 lbf + 0.3 mlbf/lbf	Comparison with ASTM E74 Load Cell and Indicator	
Force Machines ³ Compression	(50 to 2 500) lbf (280 to 10) klbf (1 to 60) klbf (60 to 120) klbf (52 to 800) klbf	2 lbf 7.5 lbf 17 lbf 16 lbf + 0.3 mlbf/lbf 10 lbf + 0.0003 lbf/lbf		ASTM E643
Ductility Tester / Olsen Cup Tester ³	(0.3 to 6) klbf (6 to 30) klbf	7.5 lbf 17 lbf		

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
Tension Load Cell ³	(64 to 500) lbf (103 to 2 500) lbf (261 to 10 000) lbf (1.658 to 60) klbf (60 to 120) klbf	1.2 lbf 2 lbf 5 lbf 12 lbf 16 lbf + 0.3 mlbf/lbf	ASTM E74 Load Cell and Indicator	ASTM E74
Compression Load Cell ³	(48 to 500) lbf (50 to 2 500) lbf (280 to 10) klbf (1 to 60) klbf (60 to 120) klbf (52 to 800) klbf	1.2 lbf 2 lbf 7.5 lbf 17 lbf 16 lbf + 0.3 mlbf/lbf 10 lbf + 0.0003 lbf/lbf		
Accelerometer ³	10 Hz to 100 Hz (Up to 10 g)	4.3 % of Rdg	Accelerometer Calibrator and Reference Accelerometer – Back to Back method	OEM-Sourced Procedures
Voltage Sensitivity / Frequency Response	100 Hz to 1 kHz (Up to 7 g)	5.3 % of Rdg		
(100 mV/g)	1 kHz to 10 kHz (Up to 3 g)	5.5 % of Rdg		
Sound Level Meters ³	(94 and 114) dB 1 kHz	0.70 dB	Acoustic Calibrator	ANSI S1.40
Rockwell Hardness Testers ³	HRA Low Middle High	0.44 HRA 0.38 HRA 0.26 HRA	Hardness Standards	Indirect Verification according to ASTM E18
Rockwell Hardness Testers ³	HRBw Low Middle High	0.74 HRBw 0.69 HRBw 0.59 HRBw		
Rockwell Hardness Testers ³	HRC Low Middle High	0.41 HRC 0.36 HRC 0.36 HRC		

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Rockwell Hardness Testers ³	HRE Low High	0.62 HRE 0.55 HRE	Hardness Standards	Indirect Verification according to ASTM E18
Rockwell Hardness Testers ³	HRFw Low High	0.69 HRF 0.62 HRF		
Superficial Rockwell Hardness Testers ³	HR15N Low Middle High	0.13 HR15N 0.16 HR15N 0.10 HR15N		
Superficial Rockwell Hardness Testers ³	HR30N Low Middle High	0.67 HR30N 0.59 HR30N 0.51 HR30N		
Superficial Rockwell Hardness Testers ³	HR45N Low Middle High	0.49 HR45N 0.57 HR45N 0.50 HR45N		
Superficial Rockwell Hardness Testers ³	HR15Tw Low Middle High	0.69 HR15Tw 0.62 HR15Tw 0.40 HR15Tw		
Superficial Rockwell Hardness Testers ³	HR30Tw Low Middle High	0.52 HR30Tw 0.45 HR30Tw 0.44 HR30Tw		
Superficial Rockwell Hardness Testers ³	HR45Tw Low Middle High	0.49 HR45Tw 0.46 HR45Tw 0.62 HR45Tw		

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Leeb Hardness ³	784 LD	17 LD	Hardness Standard	Indirect Verification according to ASTM A956
Brinell Hardness Testers ³	(500 to 3 000) kgf	6.7 kgf	Proving Ring	Direct Verification according to ASTM E10
Brinell Hardness Testers ³	Repeatability Error Range	7.2 HBW 0.057 mm (500 to 3 000) kgf	Hardness Standards	Indirect Verification according to ASTM E10
Brinell Scope ³	(0 to 7) mm	6.7 µm	Stage Micrometer	Direct Verification according to ASTM E10
Vickers Hardness Tester Force	10 gf 25 gf 50 gf 100 gf 200 gf 300 gf 500 gf 1 kgf 2 kgf 5 kgf 10 kgf 20 kgf 30 kgf 50 kgf	1.1 gf 1.1 gf 1.1 gf 1.1 gf 1.1 gf 2.3 gf 3.4 gf 6.6 gf 13 gf 33 gf 66 gf 0.13 kgf 0.20 kgf 0.33 kgf	Force Gage	Direct Verification Per ASTM E92
Knoop Hardness Tester Force	10 gf 25 gf 50 gf 100 gf 200 gf 300 gf 500 gf 1 kgf 3 kgf 10 kgf 15 kgf 30 kgf 45 kgf 60 kgf 100 kgf 150 kgf	1.1 gf 1.1 gf 1.1 gf 1.1 gf 1.1 gf 2.3 gf 3.4 gf 6.1 gf 11 gf 11 gf 11 gf 11 gf 11 gf 33 gf 33 gf 33 gf	Force Gage	Direct Verification Per ASTM E92

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Vickers Hardness Tester	< 240 HV 0.01 > 600 HV 0.01 < 240 HV 0.025 > 600 HV 0.025 < 240 HV 0.05 > 600 HV 0.05 < 240 HV 0.1 > 600 HV 0.1 < 240 HV 0.2 > 600 HV 0.2 < 240 HV 0.3 > 600 HV 0.3 < 240 HV 0.5 > 600 HV 0.5 < 240 HV 1 > 600 HV 1 < 240 HV 5 240 to 600 HV 5 > 600 HV 5 < 240 HV 10 240 to 600 HV 10 > 600 HV 10	12 HV 0.01 44 HV 0.01 11 HV 0.025 33 HV 0.025 11 HV 0.05 30 HV 0.05 11 HV 0.1 28 HV 0.1 9 HV 0.2 22 HV 0.2 9 HV 0.3 21 HV 0.3 8 HV 0.5 20 HV 0.5 7 HV 1 17 HV 1 6 HV 5 13 HV 5 22 HV 5 5 HV 10 10 HV 10 17 HV 10	Hardness Standards	Indirect Verification Per ASTM E92
Knoop Hardness Tester	< 250 HK 0.01 > 650 HK 0.01 < 250 HK 0.025 > 650 HK 0.025 < 250 HK 0.05 > 650 HK 0.05 < 250 HK 0.1 > 650 HK 0.1 < 250 HK 0.2 > 650 HK 0.2	9 HK 0.01 35 HK 0.01 9 HK 0.025 24 HK 0.025 9 HK 0.05 22 HK 0.05 9 HK 0.1 21 HK 0.1 7 HK 0.2 17 HK 0.2	Hardness Standards	Indirect Verification Per ASTM E92



Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Knoop Hardness Tester (cont.)	< 250 HK 0.3 > 650 HK 0.3	7 HK 0.3 21 HK 0.3	Hardness Standards	Indirect Verification Per ASTM E92
	< 250 HK 0.5 > 650 HK 0.5	7 HK 0.5 18 HK 0.5		
	< 250 HK 1 > 650 HK 1	8 HK 1 18 HK 1		
Pressure ³	(20 to 200) in H ₂ O	0.72 in H ₂ O	Manometer Calibrator	ASME B40.100
Pressure ³	(10 to 2000) psig (100 to 10 000) psig	0.27 psig + 0.18% of rdg 0.52 psig + 0.075% of rdg	Deadweight Testers	
Pressure ³	(0 to 1 000) psig	0.54 psig + 0.03% of Rdg	Pressure Calibrator/ Comparison to High Accuracy Gage	
Vacuum ³	(-660 to 0) mmHg	0.83 mmHg + 0.68 % of Rdg	Pressure Calibrator	ASME B40.100
Conventional Mass NIST Class F	(1 to 40) g (40 to 100) g (100 to 220) g (0.22 to 3.1) kg	20 µg + 6 µg/g 110 µg + 4 µg/g 170 µg + 5 µg/g 36 mg + 0.00124 mg/g	Comparison to ASTM Class 1 Weights	NIST SOP 7
Conventional Mass NIST Class F	5 lb 10 lb 20 lb 25 lb 50 lb	14 mg (0.45 moz) 21 mg (0.68 moz) 31 mg (1 moz) 37 mg (1.19 moz) 1.6 g (45 moz)	Comparison to ASTM Class 1 Weights	
Weighing Systems ³ 0.00001 g Resolution	(0 to 40) g	15 µg + 5 µg / g	Comparison to ASTM Class 1 Weights	NIST Handbook 44
Weighing Systems ³ 0.00001 g Resolution	(40 to 100) g	89 µg + 3 µg / g		
Weighing Systems ³ 0.0001 g Resolution	(100 to 220) g	140 µg + 4 µg/g		
Weighing Systems ³ 0.0001g Resolution	(0 to 310) g	120 µg + 8 µg/g		
Weighing Systems ³ 0.01g Resolution	(0 to 14 200) g	4.6 mg + 2µg/g		

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Weighing Systems ³ 0.005 Resolution	(0 to 10) lb	0.0045 lb	Comparison to ASTM Class 3 & NIST Class F Weights	NIST Handbook 44
Weighing Systems ³ 0.005 Resolution	(0 to 50) lb	0.07 oz + 0.013 % of Rdg		
Weighing Systems ³ 0.02 Resolution	(25 to 250) lb	0.023 lb + 4 % of Rdg		
Weighing Systems ³ 0.05 Resolution	(50 to 500) lb	0.082 lb + 0.29 % of Rdg		
Weighing Systems ³ 0.2 Resolution	(100 to 1 000) lb	0.4 lb		
Moisture Analyzers ³ Weighing System Temperature	(0 to 220) g 160 °C	140 µg + 4 µg / g 2.5 °C	Comparison to ASTM Class 1 Weights Reference Thermometer	OEM - Sourced Procedures
Torque Watch ³	(0.5 to 2.5) ozf-in (2 to 10) ozf-in (6 to 43) ozf-in (30 to 215) ozf-in	0.08 ozf-in + 0.3 % of Rdg 0.07 ozf-in + 0.2 % of Rdg 0.3 ozf-in + 0.2 % of Rdg 3 ozf-in + 0.2 % of Rdg	Torque Watch Calibrator	T.O. 33K6-4-450-1
Torque Wrenches ³	(2.5 to 25) lbf-in (25 to 250) lbf-in (100 to 1 000) lbf-in (25 to 250) lbf-ft (80 to 800) lbf-ft	0.05 lbf-in + 0.54 % of Rdg 0.02 lbf-in + 0.64 % of Rdg 0.24 lbf-in + 0.76 % of Rdg 0.05 lbf-in + 1.2 % of Rdg 2 lbf-ft	Torque Wrench Calibration System	ASME B107.300
Torque Analyzers, Transducers ³	(2.5 to 25) lbf-in (25 to 250) lbf-in (100 to 1 000) lbf-in (300 to 3 000) lbf-in (100 to 1 200) lbf-ft	0.4 % of Rdg 0.0041% of Rdg + 0.13 lbf-in 0.06% of Rdg + 0.066 lbf-in 0.04% of Rdg + 0.11 lbf-in 0.024% of Rdg + 0.07 lbf-ft	Torque Arms with NIST Class F Weights	
Torque Watch Calibrators ³ Masses Dial	0.5 oz 2 oz 8.5 oz 42.5 oz 13.25 ° 76.75 °	4 µoz 12 µoz 1.3 moz 1.4 moz 0.58 ° 0.58 °	Comparison to ASTM Class 1 Weights Masses	T.O. 33K6-4-411-1

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Gloss Meters ³	92.1 GU, 20 ° 94.9 GU, 60 ° 99.5 GU, 85 °	0.088 GU 0.8 GU 0.82 GU	Gloss Standard ASTM D523-08	ASTM D523
Gauss Meters / Hall Effect Meters	(-5 to 5) Gauss (-10 to 10) Gauss (-20 to 20) Gauss (-50 to 50) Gauss (-100 to 100) Gauss	0.1 Gauss 0.2 Gauss 0.4 Gauss 1 Gauss 2 Gauss	Helmholtz Coil and Power Supply	T.O. 33K1-4-1336-1
Rotational Viscometers	(0 to 2 000) RPM	2.5 RPM + 0.67 % of Rdg	Optical Tachometer	ASTM D2106

VI. Dimensional

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Inside Micrometers ³ (0.001 in Resolution)	(0 to 4) in (4 to 20) in (20 to 36) in (36 to 60) in	580 μin (560 + 2.1L) μin (500 + 4.6L) μin (400 + 6.7L) μin	Gage Blocks	ASME B89.1.13
Feeler Gages	(0 to 0.25) in (0 to 6) mm	20 μin 0.51 μm	Gages Blocks and ULM	NA 17-20MD-15
Surveillance Micrometer Masters	(1 to 12) in (25 to 300) mm	(5.5 + 11L) μin (0.14 + 0.011L) μm	Gages Blocks and ULM	T.O. 33K6-4-529-1
Taper Thread Plugs Pitch Diameter	Up to 3 in	130 μin	Thread Measuring Wires, Taper Block, ULM	ASME B1.20.5
Major Diameter		100 μin	Taper Block and ULM	
Length at Notch		250 μin	Gage Blocks, Height Gage	

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Radius Gage	(0 to 0.5) in	260 μin	Vision System	NA 17-20MD-43
Rulers	Up to 24 in	0.0058 in	Vision System	NIST SOP 10
Steel Tape ³	Up to 10 m	250 μm	Master Tape	ASME B89.1.7
Vision System ³ XY Linearity Z Linearity	Up to 18 in Up to 4 in	100 μin 52 μin	Master Grid, Gage Blocks	OEM-Sourced Procedures
Refractometer ³	(0 to 30) °Brix	0.94 °Brix	Reference Solutions	OIML R142
Levels ³ Base Flatness Parallelism	(0 to 12) in	100 μin	Height Transfer Standard, Gage Blocks, Surface Plate	33K6-4-54-1
Metal / X-Ray Detector Standards ⁷	(0.8 to 7.0) mm	(5.5 + 11L) μin	ULM	OEM - Sourced Procedures
Gage Blocks	(0.01 to 8) in	(5 + 2.2L) μin	Reference Blocks, Comparator	OEM-Sourced Procedures
Laser Micrometer ² (1 μin Resolution)	(0.01 to 2) in	23 μin	XXX Pin Gage	
Angle Blocks	(1 to 45) °	3 arc seconds	Sine Block, Height Transfer Standard, Surface Plate	

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Bench / Super Micrometers / ULMs				
Linearity	(0 to 4) in	3 μin + 22 μin/in	Gage Blocks	T.O. 33K6-4-81-1
Anvil Parallelism	25 μin TIR	4 μin	Optical Flats w/Monochromatic Light	
Force	2 ozf	0.019 ozf	Digital Force Gage	
	4 ozf	0.021 ozf		
	8 ozf	0.027 ozf		
	16 ozf	0.74 ozf		
40 ozf	0.78 ozf			
Snap Gages ³	(0.05 to 4) in	22 μin	Gage Blocks	T.O. 33K6-4-1678-1
Pin Gages / Plug Gages ²	(0.01 to 2) in	46 μin	Laser Micrometer	ASME B89.1.5
Pin Gages / Plug Gages	Up to 2 in (1.9 to 18) in	(6.9 + 10D) μin (4.7 + 11D) μin	ULM	
Plain Rings	(0.275 to 13.25) in	(41 + 11D) μin	Master Rings, ULM	OEM-Sourced Procedures
Thread Wires	Up to 0.14434 in	(11 + 13D) μin	ULM	ASME B89.1.17
Measuring Rods	(1 to 12) in (12 to 18) in	(5.5 + 11L) μin (1.7 + 12L) μin	Gage Blocks, ULM	T.O. 33K6-4-369-1
Height Masters Micrometer Linearity Step Height, Top Step Height, Bottom Step Parallelism	(0 to 1) in (1 to 24) in (0 to 100) μin	66 μin (43 + 2L) μin 84 μin	Height Transfer Standard, Gage Blocks, Surface Plate	T.O. 33K6-4-673-1
Thread Plugs Pitch Diameter (5 to 100) TPI	Up to 8 in	(76 + 7.7D) μin	Thread Wires, ULM	ASME B1.2

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Thread Rings ²	Up to 2 in	340 μin	Reference Thread Plugs	ASME B1.2
External Spline Gages Measurement over Pins Circular Tooth Thickness Major Diameter	Up to 8 in	(180 + 30D) μin (120 + 20L) μin (30 + 16D) μin	Wires and ULM Vision System ULM	OEM-Sourced Procedures
Chamfer Gages / Countersink Gages ²	Up to 3 in	540 μin	Master Plain Rings	OEM-Sourced Procedures
Bore Gages ³ (0.000 1 in Resolution)	(1 to 8) in	0.0018 in + 0.002 % of Rdg	Bore Gage Calibrator	T.O. 33K6-4-992-1
Calipers ³ (0.000 5 in Resolution) (0.001 in Resolution)	(0.05 to 24) in (0.05 to 12) in (12 to 60) in	470 μin 800 μin 1 800 μin	Gage Blocks, End Measuring Rods, Surface Plate	T.O. 33K6-4-552-1
Outside Micrometers ³ 50 μin Resolution 100 μin Resolution 0.001 in Resolution	Up to 1 in (1 to 12) in (12 to 20) in	(56 + 26L) μin (770 + 26L) μin (1 600 + 106L) μin	Gage Blocks, End Measuring Rods	ASME B89.1.13
Depth Micrometers ³ (0.0001 in Resolution) (0.001 in Resolution)	(0 to 12) in	(88 + 4L) μin (890 + 23L) μin	Gage Blocks, Surface Plate	
V-Anvil Outside Micrometers ³ 100 μin Resolution	(0.4 to 1) in	60 μin	Plug Gages	NA 17-20MD-41
Ultrasonic Thickness Gage ³	(0 to 12) in	760 μin + 13 μin/in	Gage Blocks	OEM-Sourced Procedures
Dial & Digital Indicators ³ 10 μin Resolution 20 μin Resolution 50 μin Resolution 100 μin Resolution 0.001 in Resolution Test Indicators ²	(-0.015 to 0.015) in (-0.001 to 0.001) in (0 to 2) in 50 μin to 0.01 in	7.3 μin 13 μin 61 μin 110 μin 1 200 μin 61 μin	Gage Blocks Indicator Calibrator, Surface Plate Indicator Calibrator, Surface Plate	ASME B89.1.10M

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
Height Gages ³ 50 μin Resolution	(0 to 12) in (12 to 36) in	(59 + 5L) μin (93 + 39L) μin	Gage Blocks, Surface Plate Measuring Rods	T.O. 33K6-4-17-1
Extensometers ³ 50 μin Resolution	Up to 2 in	140 μin	Micrometer Head	ASTM E83
Linear Scales ³ 0.005 in Resolution	(1 to 142) in	0.0095 in + 7 μin/in	Measuring Rods	T.O. 33K6-4-552-1
Optical Comparators ³ Magnification Linearity (10 μin Resolution) Angularity	10x & 100x (0 to 6) in 0° to 30°	210 μin 120 μin 0° 2' 10"	Glass Scale, Angle Blocks	T.O. 33K6-4-2908-1
Coating Thickness ³ Measuring Systems	Up to 0.018 inch	7.65 % of reading	Ferrous Coated Thickness Standards	OEM-Sourced Procedures
Protractors	0° to 180°	3 arc seconds	Height Transfer Standard, Sine Block, Surface Plate	T.O. 33K6-4-148-1
Microscopes ³	(0 to 2) in	160 μin	Glass Scale	T.O. 33K6-4-1268-1
Profilometers ³	(118 and 123) μin	3.1 μin	Roughness Standard	ASME B46.1
Roundness Measuring System ³ Radial Error	Up to 360°	5.5 μin	Precision Ball	T.O. 33K6-4-2060-1

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
CMM Linear Accuracy ³	(0.5 to 24.5) in	(90 + 9.24L) μ in	Step Gage	ASME B89.4.1
CMM Volumetric Accuracy ³	(9 to 25) in	(0.88 + 23.56L) μ in	Ball Bars	
CMM Squareness ³	(0.25 to 11.75) in	210 μ in	Square and Indicator	ASME B89.4.1
Surface Plates – Flatness ^{2,8}	Up to 68 Inches Diagonal	(5 + 0.5D) μ in	Optodyne LDDM Laser Measurement System	ASME B89.3.7
Repeatability ²	0.03 inch	16 μ in	Repeat Reading Gage	
Optical Flats	N/A	5 μ in	Optical Flat and Monochromatic Light	T.O. 33K6-4-168-1

VII. Optical Quantities

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(\pm)]	Reference Standard or Equipment	Methods
Spectrophotometers Total Hemispherical Diffuse Reflectance ³ (8°:t)	(360 to 830) nm	0.08 % Reflectance Value	Ceramic Reflectance Standards	ASTM E1164

VIII. Fluid Quantities

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment	Methods
pH Meters ³	4 pH 7 pH 10 pH	0.017 pH 0.023 pH 0.052 pH	Aqueous pH Solutions With or Without Fluoride	T.O. 33K1-4-2273-1
Conductivity Meters ³	10 µS/cm 100 µS/cm 1 000 µS/cm 1 400 µS/cm 10 000 µS/cm 100 mS/cm	0.65 µS/cm 2.9 µS/cm 20 µS/cm 28 µS/cm 190 µS/cm 1.8 mS/cm	Aqueous Conductivity Solutions	T.O. 33K1-4-186-1
Ammonia Sensors ³	100 ppm 250 ppm	12 ppm 29 ppm	Compressed Gas Mixture	OEM-Sourced Procedures

IX. Dimensional Inspection

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty(±)]	Reference Standard or Equipment
Length	(1 to 12) in (12 to 18) in	(5.5 + 11L) µin (2.7 + 12L) µin	ULM
Diameter/Radius	(0 to 24) in	(260 + 4D) µin	Vision System
Dimensional Measurement 3D	X = (0 to 18) in Y = (0 to 20) in Z = (0 to 16) in	(370 + 11L) µin	Coordinate Measuring Machine utilized as Reference Standard for Dimensional Measurement

X. Mechanical Testing

Parameter/ Equipment	Range	Method	*Key Equipment or Technology
Rockwell Hardness	HRA, HRB, HRC	ASTM E18	Rockwell Hardness Tester
Rockwell Superficial Hardness	HR15N, HR30N, HR45N, HR15TW, HR30TW, HR45TW	ASTM E18	Rockwell Hardness Tester
Brinell Hardness	BHN	ASTM E10	Brinell Hardness Tester
MicroHardness	Knoop, Vickers	ASTM E384	MicroHardness Tester

Notes:

1. Calibration and Measurement Capabilities (Expanded Uncertainties) are based on approximately a 95% confidence interval, using a coverage of k=2.
2. This laboratory calibration services in its laboratory and on-site at customer-designated locations. Since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
3. On-site calibration service is offered for these parameters.
4. The uncertainty does not include gage R&R study, and the unit under test resolution. Larger measurement uncertainties are expected.
5. Sine wave relative to 1 kHz
6. P = Power in dBm
7. This calibration is only applicable to the dimensional properties. The metallurgical properties / composition of the test spheres are not tested.
8. Flatness measurement uncertainty is not less than the accepted closure error of the Moody method.



 Vice President