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Fox Valley Metrology, LTD.

3125 Medalist Drive Oshkosh, WI 54902
Mark Toll Phone: 920-426-5894

Including Satellite Sites located at:

303 Polk Parkway St. Croix Falls, WI 54024
Chris Kuczynski Phone: 715-483-5334

&

308 Axminister Drive Fenton, MO 63026
Caleb Pohlman Phone 636-326-1601

CALIBRATION & TESTING

Valid to: June 15, 2013

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I. Electromagnetic - DC/Low Frequency

Table with 5 columns: PARAMETER / EQUIPMENT, RANGE, CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)], REFERENCE STANDARD OR EQUIPMENT, METHOD(S). Rows include DC Voltage - Source and Measure for various ranges and equipment like Fluke 5720A, Fluke 732B, Agilent 3458A, Fluke 8508A, and Hipotronics KVM-100.



PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
DC Current - Source <sup>3,7</sup>	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mV to 2.2 A  (2.2 to 11) A (11 to 20.5) A  (20.5 to 1 000) A	118 µA/A + 6 nA 41.6 µA/A + 7 nA 40.7 µA/A + 40 nA 52.2 µA/A + 700 nA 92.8 µA/A + 12 µA  582 µA/A + 500 µA 1 211 µA/A + 750 µA  86 mA/A + 500 mA	Fluke 5720A  Fluke 5520A  Fluke 5520A with 50-turn Coil	OEM and GIDEP Sourced Procedures
DC Current - Measure <sup>3,7,8</sup>	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	47.9 µA/A + 65 pA 35.1 µA/A + 65 pA 35.1 µA/A + 150 pA 35.1 µA/A + 1.3 nA 35 µA/A + 10 nA 35.8 µA/A + 100 nA 14.4 µA/A + 1 µA 140 µA/A + 20 µA	Agilent 3458A Opt 002	
DC Current - Measure <sup>3,7</sup>	Up to 200 µA 200 µA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	12 µA/A + 400 pA 12 µA/A + 4 nA 14 µA/A + 40 nA 48 µA/A + 800 nA 185 µA/A + 16 µA 4 mA/A + 400 µA	Fluke 8508A	
DC Current - Measure <sup>3,8</sup>	(1 to 10) A	2.4 mA/A + 700 µA	Fluke DMM	
Resistance - Measure <sup>3,7</sup> Normal Mode	Up to 2 Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ	17 µΩ/Ω + 4 µΩ 9.5 µΩ/Ω + 14 µΩ 8 µΩ/Ω + 50 µΩ 8 µΩ/Ω + 500 µΩ 8 µΩ/Ω + 5 mΩ 8 µΩ/Ω + 50 mΩ 9 µΩ/Ω + 1 Ω 20 µΩ/Ω + 100 Ω 120 µΩ/Ω + 10 kΩ	Fluke 8508A	



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AC Voltage - Source <sup>3,7,8</sup>	<b>Up to 2.2 mV</b>			
	(10 to 20) Hz	2.35 mV/V + 4 μV		
	(20 to 40) Hz	2.34 mV/V + 4 μV		
	40 Hz to 20 kHz	2.17 mV/V + 4 μV		
	(20 to 50) kHz	2.18 mV/V + 4 μV		
	(50 to 100) kHz	2.25 mV/V + 5 μV		
	(100 to 300) kHz	2.49 mV/V + 10 μV		
	(300 to 500) kHz	2.71 mV/V + 20 μV		
	500 kHz to 1 MHz	3.8 mV/V + 20 μV		
	<b>(2.2 to 22) mV</b>			
	(10 to 20) Hz	612 μV/V + 4 μV		
	(20 to 40) Hz	555 μV/V + 4 μV		
	40 Hz to 20 kHz	361 μV/V + 4 μV		
	(20 to 50) kHz	418 μV/V + 4 μV		
	(50 to 100) kHz	694 μV/V + 5 μV		
	(100 to 300) kHz	1.29 mV/V + 10 μV		
	(300 to 500) kHz	1.68 mV/V + 20 μV		
	500 kHz to 1 MHz	3.35 mV/V + 20 μV		
	<b>(22 to 220) mV</b>			
	(10 to 20) Hz	289 μV/V + 12 μV		
	(20 to 40) Hz	132 μV/V + 7 μV		
	40 Hz to 20 kHz	109 μV/V + 7 μV		
	(20 to 50) kHz	238 μV/V + 7 μV		
	(50 to 100) kHz	537 μV/V + 17 μV		
(100 to 300) kHz	1.05 mV/V + 20 μV			
(300 to 500) kHz	1.62 mV/V + 25 μV			
500 kHz to 1 MHz	3.28 mV/V + 45 μV			
<b>(0.22 to 2.2) V</b>				
(10 to 20) Hz	279 μV/V + 40 μV			
(20 to 40) Hz	108 μV/V + 15 μV			
40 Hz to 20 kHz	55 μV/V + 8 μV			
(20 to 50) kHz	119 μV/V + 10 μV			
(50 to 100) kHz	130 μV/V + 30 μV			
(100 to 300) kHz	487 μV/V + 80 μV			
(300 to 500) kHz	1.16 mV/V + 200 μV			
500 kHz to 1 MHz	1.97 mV/V + 300 μV			
<b>(2.2 to 22) V</b>				
(10 to 20) Hz	279 μV/V + 400 μV			
(20 to 40) Hz	108 μV/V + 150 μV			
40 Hz to 20 kHz	56 μV/V + 50 μV			
(20 to 50) kHz	119 μV/V + 100 μV			
(50 to 100) kHz	119 μV/V + 200 μV			
(100 to 300) kHz	321 μV/V + 600 μV			
(300 to 500) kHz	1.16 mV/V + 2 mV			
500 kHz to 1 MHz	1.74 mV/V + 3.2 mV			

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
AC Voltage - Source <sup>3,7,8</sup> (cont.)	<b>(22 to 220) V</b> (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 <b>220 V to 1.1 kV</b> (15 to 50) Hz 50 Hz to 1 kHz	279 μV/V + 4 mV 109 μV/V + 1.5 mV 65 μV/V + 600 μV 123 μV/V + 1 mV 176 μV/V + 2.5 mV 1.04 mV/V + 16 mV 5.08 mV/V + 40 mV 9.24 mV/V + 80 mV  348 μV/V + 16 mV 88 μV/V + 3.5 mV	Fluke 5720A	
AC Voltage - Measure <sup>3,7,8</sup> Bandwidth < 2 MHz	<b>Up to 10 mV</b> (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz <b>(10 to 100) mV</b> (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz <b>100 mV to 1 V</b> (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	463 μV/V + 13 μV 348 μV/V + 11.1 μV 463 μV/V + 11.1 μV 1.27 mV/V + 11.1 μV 5.89 mV/V + 11.1 μV 46 μV/V + 12 μV  140 μV/V + 4.5 μV 143 μV/V + 2.5 μV 222 μV/V + 2.5 μV 407 μV/V + 2.5 μV 984 μV/V + 2.5 μV 3.53 mV/V + 10.5 μV 11.6 mV/V + 10.5 μV 17.4 mV/V + 10.5 μV  139 μV/V + 45 μV 139 μV/V + 25 μV 220 μV/V + 25 μV 406 μV/V + 25 μV 982 μV/V + 25 μV 3.52 mV/V + 105 μV 11.6 mV/V + 105 μV 17.4 mV/V + 105 μV	Agilent 3458A OPT002	OEM and GIDEP Sourced Procedures



PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
AC Voltage - Measure <sup>3,7,8</sup> Bandwidth > 2 MHz (cont.)	<b>(1 to 10) V</b> 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz <b>(10 to 100) V</b> 45 Hz to 100 kHz <b>100 V to 1 kV</b> 45 Hz to 100 kHz	1.14 mV/V + 6.1 μV 23.7 mV/V + 5.1 μV 47.3 mV/V + 7.1 μV 47.3 mV/V + 8.1 μV 177 mV/V + 10.1 μV  1.48 mV/V + 2.5 mV  3.6 mV/V + 105 mV	Agilent 3458A Opt 002	
AC Voltage - Measure <sup>3,7</sup> Bandwidth < 1 MHz	<b>Up to 200 mV</b> (1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz <b>200 mV to 2 V</b> (1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz <b>(2 to 20) V</b> (1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	165 μV/V + 14 μV 140 μV/V + 4 μV 115 μV/V + 4 μV 110 μV/V + 2 μV 135 μV/V + 4 μV 340 μV/V + 8 μV 765 μV/V + 20 μV  150 μV/V + 120 μV 115 μV/V + 20 μV 90 μV/V + 20 μV 75 μV/V + 20 μV 110 μV/V + 20 μV 220 μV/V + 840 μV 570 μV/V + 200 μV 3 mV/V + 2 mV 10 mV/V + 2 mV  150 μV/V + 1.2 mV 115 μV/V + 200 μV 90 μV/V + 200 μV 75 μV/V + 200 μV 110 μV/V + 200 μV 220 μV/V + 8.4 mV 570 μV/V + 2 mV 3 mV/V + 20 mV 10 mV/V + 20 mV	Fluke 8508A	OEM and GIDEP Sourced Procedures



PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
AC Voltage - Measure <sup>3,7</sup> Bandwidth < 1 MHz (cont.)	<b>(20 to 200) V</b> (1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz <b>200 V to 1.05 kV</b> (1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	150 µV/V + 12 mV 115 µV/V + 2 mV 90 µV/V + 2 mV 75 µV/V + 2 mV 110 µV/V + 2 mV 220 µV/V + 84 mV 570 µV/V + 20 mV 3 mV/V + 200 mV 10 mV/V + 200 mV  150 µV/V + 70 mV 120 µV/V + 20 mV 115 µV/V + 20 mV 225 µV/V + 40 mV 580 µV/V + 200 mV	Fluke 8508A	
AC Current - Source <sup>3,7,8</sup>	<b>Up to 220 µA</b> (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz <b>220 µA to 2.2 mA</b> (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz <b>(2.2 to 22) mA</b> (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz <b>(22 to 220) mA</b> (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz <b>220 mA to 2.2 A</b> 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	299 µA/A + 16 nA 200 µA/A + 10 nA 156 µA/A + 8 nA 331 µA/A + 12 nA 1.29 mA/A + 65 nA  313 µA/A + 40 nA 220 µA/A + 35 nA 153 µA/A + 35 nA 240 µA/A + 110 nA 1.27 mA/A + 650 nA  319 µA/A + 400 nA 229 µA/A + 350 nA 151 µA/A + 350 nA 239 µA/A + 550 nA 1.27 mA/A + 5 µA  299 µA/A + 4.0 µA 200 µA/A + 3.5 µA 153 µA/A + 2.5 µA 240 µA/A + 3.5 µA 1 273 µA/A + 10 µA  309 µA/A + 35 µA 525 µA/A + 80 µA 8.09 mA/A + 160 µA	Fluke 5720A	OEM and GIDEP Sourced Procedures

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
AC Current - Source <sup>3,7,8</sup> (cont.)	<b>(2 to 3) A</b> (10 to 45) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz <b>(3 to 11) A</b> (45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz <b>(11 to 20.5) A</b> (45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz <b>(20.5 to 1 000) A</b> (45 to 65) Hz <b>(20.5 to 150) A</b> (65 to 440) Hz	2.1 mA/A + 100 µA 746 µA/A + 100 µA 6.9 mA/A + 1 mA 28.9 mA/A + 5 mA  738 µA/A + 2 mA 1.18 mA/A + 2 mA 34.6 mA/A + 2 mA  1.41 mA/A + 5 mA 1.75 mA/A + 5 mA 34.6 mA/A + 5 mA  90 mA/A + 500 mA 544 µA/A + 500 mA	Fluke 5720A   Fluke 5520A   Fluke 5520A w/ 50-turn Coil	OEM and GIDEP Sourced Procedures
AC Current - Measure <sup>3,7,8</sup>	<b>Up to 100 µA</b> (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz <b>100 µA to 1 mA</b> (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 <b>(1 to 10 mA)</b> (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	4.75 mA/A + 30 nA 1.89 mA/A + 30 nA 827 µA/A + 30 nA 827 µA/A + 30 nA  4.85 mA/A + 200 nA 1.89 mA/A + 200 nA 827 µA/A + 200 nA 473 µA/A + 200 nA 827 µA/A + 200 nA 4.85 mA/A + 400 nA 6.62 mA/A + 1.5 µA  4.85 mA/A + 2 µA 1.89 mA/A + 2 µA 827 µA/A + 2 µA 473 µA/A + 2 µA 827 µA/A + 2 µA 4.85 mA/A + 4 µA 6.62 mA/A + 15 µA	Agilent 3458A Opt 002	



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Capacitance - Source <sup>3,7,8</sup>	130 pF to 3.3 nF (3.3 to 11) nF (11 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	5.8 mF/F + 10 pF 2.9 mF/F + 10 pF 2.9 mF/F + 100 pF 2.9 mF/F + 300 pF 2.9 mF/F + 1 nF 2.9 mF/F + 3 nF 2.9 mF/F + 10 nF 4.7 mF/F + 30 nF 5.3 mF/F + 100 nF 1 mF/F + 300 nF 6 mF/F + 1 µF 5.3 mF/F + 3 µF 5.3 mF/F + 10 µF 8.9 mF/F + 30 µF 13 mF/F + 100 µF	Fluke 5520A	OEM and GIDEP Sourced Procedures
Capacitance - Measure <sup>3,7</sup> 42 Hz to 5 MHz	0.32 pF to 370 mF	1.1 mF/F	Hioki 3532-50	
Ionizers <sup>3,7,8</sup>  Decay Time Float Voltage	  (0.1 to 999.9) s (-1 100 to 1 100) V	  0.2 s 3.1 V	  Trek 156A	
ESD Simulators  Rise Time Peak Current 30 nS Current 60 nS Current RC Time Constant RC Time Constant	  700 ps to 1 ns (7.5 to 30) A (4 to 16) A (2 to 8) A 600 ns 300 ns	  140 ps 50 mA/A 100 mA/A 115 mA/A 20 ns 15 ns	  Tektronix TDS684B with EM Test CTR2 ESD Target	IEC 61000-4-2, SAE J1113-13
Phase - Measure <sup>3,7</sup>	(0 to 360) ° 10 Hz to 2 kHz (2 to 5) kHz (5 to 10) kHz (10 to 50) kHz (50 to 60) kHz (60 to 70) kHz (70 to 80) kHz (80 to 90) kHz (90 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	0.026 ° 0.036 ° 0.048 ° 0.059 ° 0.07 ° 0.082 ° 0.093 ° 0.1 ° 0.12 ° 0.58 ° 1.2 °	Clark Hess 6000A	OEM and GIDEP Sourced Procedures

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Oscilloscopes <sup>3,7,8</sup>				
DC Voltage (50 Ω)	1 mV to 6.6 V	2.9 mV/V + 40 μV	Fluke 5520A SC1100	OEM and GIDEP Sourced Procedures
DC Voltage (1 MΩ)	1 mV to 130 V	544 μV/V + 40 μV		
AC Voltage (50 Ω)	1 mV to 6.6 V	2.9 mV/V + 40 μV		
AC Voltage (1 MΩ)	1 mV to 130 V	1.1 mV/V + 40 μV		
Leveled Sine Wave 50 kHz to 1.1 GHz	5 mV to 5.5 V	50.7 mV/V + 100 μV		
Time Markers	1 ns to 5 s	6.4 μs/s		
Wave Generator (50 Ω)	1.8 mV to 2.5 V p-p	34.6 mV/V + 100 μV		
Wave Generator (1 MΩ)	1.8 mV to 55 V p-p	34.6 mV/V + 100 μV		
Pulse Generator - Width	(4 to 45) ns (45 to 500) ns	57.8 ms/s + 500 ps 57.8 ms/s + 4 ns		
Pulse Generator - Period	200 ns to 20 ms	57.8 ms/s + 200 ns		
Input Impedance Measure	(50 to 60) Ω 500 kΩ to 1 MΩ	1.2 mΩ/Ω 1.2 mΩ/Ω		
DC Power - Source <sup>3,7,8</sup>	10 mW to 330 W 330 W to 3 kW (3 to 20.5) kW	267 μW/W 261 μW/W 815 μW/W	Fluke 5520A	
AC Power - Source <sup>3,7,8</sup>	100 μW to 9 W (9 to 33) W (33 to 90) W (90 to 330) W (330 to 900) W 900 W to 2.2 kW	1.7 mW/W 1.2 mW/W 1.7 mW/W 1.2 mW/W 11 mW/W 4.6 mW/W		
Electrical Simulation of RTDs <sup>3</sup>			Martel M3001	
Pt 385, 100 Ω	(-328 to 1 470) °F	0.2 °F		
Pt 385 (200, 500, 1000 Ω)	(-328 to 1 150) °F	0.2 °F		
Pt 392, 100 Ω	(-328 to 1 150) °F	0.2 °F		
Pt3916 (JIS) 100 Ω	(-328 to 1 150) °F	0.2 °F		
Ni 120, 120 Ω	(-112 to 500) °F	0.2 °F		
Cu 427, 10 Ω	(-148 to 500) °F	0.2 °F		
YSI, 400 Ω	(60 to 120) °F	0.2 °F		

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Electrical Simulation of Thermocouples <sup>3,7,8</sup> Type K	(-200 to -100) °C (-100 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C	0.98 °C 0.93 °C 0.95 °C 1.02 °C	Fluke 5520A	OEM and GIDEP Sourced Procedures
Type J	(-210 to -100) °C (-100 to 760) °C (760 to 1 200) °C	0.5 °C 0.44 °C 0.47 °C		
Type E	(-250 to -100) °C (-100 to 650) °C (650 to 1 000) °C	0.67 °C 0.38 °C 0.41 °C		
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 400) °C	0.83 °C 0.48 °C 0.43 °C		
Type S	(0 to 250) °C (250 to 1 400) °C (1 400 to 1 767) °C	1.82 °C 1.79 °C 1.81 °C		
Electrical Simulation of Thermocouples <sup>3</sup> Type B Type C Type N Type R Type U Type D Type G	(1 112 to 3 308) °F (32 to 4 200) °F (-328 to 2 372) °F (32 to 3 182) °F (-328 to 1 112) °F (32 to 3 866) °F (374 to 4 172) °F	0.67 °F 0.43 °F 0.35 °F 0.67 °F 0.35 °F 1.15 °F 1.15 °F	Martel M3001	
Calibration of Thermocouples and Thermocouple Wire Type E Type J Type K Type N Type R Type S Type C Type B	(100 to 1 600) °F (100 to 1 400) °F (100 to 2 200) °F (100 to 2 200) °F (100 to 2 200) °F (100 to 2 200) °F (100 to 2 200) °F (1 112 to 2 200) °F	2.88 °F 2.85 °F 2.87 °F 2.85 °F 3.41 °F 3.41 °F 3 °F 3.34 °F		

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Inductance - Source <sup>3,7,8</sup>	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	22 mH/H 11 mH/H 6 mH/H 3 mH/H	General Radio 1490-D	OEM and GIDEP Sourced Procedures
Sound Level - Source <sup>3,7,8</sup> 100 Hz, 250 Hz, 500 Hz, 1 000 Hz, 2 000 Hz	114 dB	0.6 dB	Gen Rad 1562-A	

## II. Electromagnetic - RF/Microwave

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)	
RF Power - Measure <sup>3,4,7</sup> <b>Absolute Level</b>  (+20 to +30) dBm  (-20 to +20) dBm	100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz  100 kHz to 3 GHz (3 to 18) GHz (18 to 26.5) GHz	0.37 dB 0.39 dB 0.4 dB  0.15 dB 0.18 dB 0.21 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Modules	OEM and GIDEP Sourced Procedures	
<b>Relative Level</b>  (-90 to +30) dBm (-113 to -90) dBm  (-81 to +30) dBm (-104 to -81) dBm  (-70 to +30) dBm (-93 to -70) dBm  (-62 to +30) dBm (-85 to -62) dBm	(3.05 to 6.6) GHz  (6.6 to 13.2) GHz  (13.2 to 19.2) GHz  (19.2 to 26.5) GHz	0.026 dB + 0.005 dB/10 dB 0.067 dB + 0.12 dB/10 dB  0.026 dB + 0.005 dB/10 dB 0.062 dB + 0.12 dB/10 dB  0.026 dB + 0.005 dB/10 dB 0.056 dB + 0.12 dB/10 dB  0.026 dB + 0.005 dB/10 dB 0.051 dB + 0.12 dB/10 dB			
Amplitude Modulation - Source <sup>3,7</sup> Rate: DC to 100 kHz Depths: 0 % to 100 %	250 kHz to 40 GHz	7.1 % setting + 1 %			Agilent E8257D

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Amplitude Modulation - Measure <sup>3,7</sup> Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	100 kHz to 10 MHz	2.2 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules	OEM and GIDEP Sourced Procedures
Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %	10 MHz to 3 GHz	1.2 % of reading		
Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %	10 MHz to 3 GHz	4.2 % of reading		
Rate: 50 Hz to 100 kHz Depths: 20 % to 99 %	(3 to 26.5) GHz	3.5 % of reading		
Rate: 50 Hz to 100 kHz Depths: 5 % to 20 %	(3 to 26.5) GHz	6 % of reading		
Tuned RF Level - Measure <sup>3,4,7</sup> <b>Absolute Level</b>				
(+16 to +30) dBm (-106 to +16) dBm (-129 to -106) dBm	500 kHz to 3.05 GHz	0.37 dB + 0.005 dB/10 dB 0.15 dB + 0.005 dB/10 dB 0.15 dB + 0.12 dB/10 dB	Agilent N5531S Measuring Receiver with N5532A Sensor Modules	
(+20 to +30) dBm (-90 to +20) dBm (-114 to -90) dBm	(3.05 to 6.6) GHz	0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB		
(+20 to +30) dBm (-81 to +20) dBm (-104 to -81) dBm	(6.6 to 13.2) GHz	0.39 dB + 0.005 dB/10 dB 0.18 dB + 0.005 dB/10 dB 0.23 dB + 0.12 dB/10 dB		
(+20 to +30) dBm (-70 to +20) dBm (-93 to -70) dBm	(13.2 to 19.2) GHz	0.4 dB + 0.005 dB/10 dB 0.21 dB + 0.005 dB/10 dB 0.25 dB + 0.12 dB/10 dB		
(+20 to +30) dBm (-62 to +20) dBm (-85 to -62) dBm	(19.2 to 26.5) GHz	0.4 dB + 0.005 dB/10 dB 0.21 dB + 0.005 dB/10 dB 0.24 dB + 0.12 dB/10 dB		
<b>Relative Level</b>				
(-90 to +30) dBm (-106 to -90) dBm (-129 to -106) dBm	500 kHz to 3.05 GHz	0.026 dB + 0.005 dB/10 dB 0.067 dB + 0.12 dB/10 dB 0.076 dB + 0.12 dB/10 dB		

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Phase Modulation - Source <sup>3,7</sup> Rate: DC to 100 kHz	250 kHz to 40 GHz	5.9 % setting + 0.1 rad	Agilent E8257D	OEM and GIDEP Sourced Procedures
RF Power - Source <sup>3,7</sup> > -10 dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	0.72 dB 0.96 dB 1.08 dB	Agilent E8257D	
(-10 to -70) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	0.89 dB 1.07 dB 1.19 dB		
(-70 to -90) dBm	250 kHz to 2 GHz (2 to 20) GHz (20 to 40) GHz	0.95 dB 1.2 dB 1.21 dB		
RF Power Sensors- Calibration Factor <sup>3,4,7</sup>  (-20 to +14) dBm	100 kHz to 10 MHz 10 MHz to 10 GHz (10 to 18) GHz	1.5 % 1.5 % 1.7 %	Tegam 1827, Agilent 3458A, Agilent E8257D, Agilent E4419B, Agilent 3325B	
Frequency Modulation - Measure <sup>3,7</sup> Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	250 kHz to 10 MHz	3.1 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules	
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	10 MHz to 3 GHz	3.1 % of reading		
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	(3 to 26.5) GHz	7.7 % of reading		
Frequency Modulation - Source <sup>3,7</sup> 1 dB Rate: DC to 100 kHz 3 dB Rate: DC to 10 MHz Dev.: ≤ (N X 800 kHz)	250 kHz to 40 GHz	4.2 % setting + 20 Hz	Agilent E8257D	
Pulse Generation - Measure <sup>3,7</sup> DC to 225 MHz Pulse Width Rise/Fall Time	5 ns to 10 <sup>5</sup> s 5 ns to 10 <sup>5</sup> s	1.1 ns 1.1 ns	Agilent 53132A	
Pulse Generation - Source <sup>3,7</sup> Repetition Frequency: 0.024 Hz to 14.28 MHz Period: 70 ns to 42 s	10 ns to 42 s	17.3 ns	Agilent E8257D	

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Phase Modulation - Measure <sup>3,7</sup> Rate: 200 Hz 20 kHz Dev.: > 0.7 rad Rate: 200 Hz 20 kHz Dev.: > 0.3 rad Rate: 200 Hz 20 kHz Dev.: > 2.0 rad Rate: 200 Hz 20 kHz Dev.: > 0.6 rad Rate: 200 Hz 20 kHz Dev.: > 2.0 rad Rate: 200 Hz 20 kHz Dev.: > 0.6 rad	100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	1.2 % of reading 3.6 % of reading 1.2 % of reading 3.6 % of reading 1.2 % of reading 3.6 % of reading	Agilent N5531S Measuring Receiver with N5532A Sensor Modules	OEM and GIDEP Sourced Procedures
Pulse Modulation - Source <sup>3,7</sup> Level Rise/Fall Time	(0 to 9) dBm 10 MHz to 40 GHz	0.59 dBm 11.5 ns	Agilent E8257D	

### III. Optical Radiation

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Optical Power - Measure <sup>3,7</sup> (800 to 1650) nm	(+20 to -70) dBm	0.03 dB/dBm	Agilent 8153A, 81533B, and 81525A	OEM and GIDEP Sourced Procedures
Optical Power - Source <sup>3,7</sup> 1310 nm, 1550 nm	(0 to -60) dB	0.05 dB/dB	Agilent 81554SM, 8153A, 81533B, 81525A, and 8158B	
Optical Attenuation - Source <sup>3,7</sup> (1 200 to 1 650) nm	(0 to 60) dB	0.04 dB/dB	Agilent 8158B	

#### IV. Time and Frequency

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Time Interval <sup>3,7,8</sup>	(1 to 86 400) s	0.00045 s	Agilent 53132A & Spectracom 8197B	OEM and GIDEP Sourced Procedures
Frequency - Measure <sup>3</sup>	DC to 225 MHz	2.4 parts in 10 <sup>-11</sup>	Agilent 53132A, Spectracom 8797B	
	DC to 26.5 GHz	2.4 parts in 10 <sup>-11</sup>	Agilent N5531S, Spectracom 8197B	
Frequency Measure <sup>3,7,8</sup>	DC to 225 MHz	6.7 parts in 10 <sup>-11</sup>	Agilent 53132A, SRS FS725	
	DC to 26.5 GHz	6.7 parts in 10 <sup>-11</sup>	Agilent N5531S, SRS FS725	
Frequency - Source <sup>3</sup>	10 MHz	2.4 parts in 10 <sup>-11</sup>	Spectracom 8197B	
	DC to 40 GHz	2.4 parts in 10 <sup>-11</sup>	Agilent 3325B, Agilent E8257D, Spectracom 8197B	
Frequency Source <sup>3,7,8</sup>	10 MHz	6.7 parts in 10 <sup>-11</sup>	SRS FS725	
	DC to 40 GHz	6.7 parts in 10 <sup>-11</sup>	Agilent 3325B, Agilent E8257D, SRS FS725	
Tachometers				
Contact <sup>3,7,8</sup>	(1 to 6 500) rpm	0.08 % of reading	King Nutronics 3711-B	
Non-Contact <sup>3,7,8</sup>	(500 to 40 000) rpm			
Non-Contact <sup>3,7,8</sup>	Up to 100 000 rpm	0.005 % of reading	Fluke 5520A	

## V. Thermodynamic

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Temperature - Source Immersion Probes <sup>3,7,8</sup>	(-30 to 600) °C	0.03 °C	Hart Scientific 9011 with PRT	OEM and GIDEP Sourced Procedures
Infrared <sup>3,7</sup>	(122 to 932) °F	0.9 °F	Hart Scientific 9132	
Surface Probes <sup>3</sup>	(35 to 400) °C	1.24 °C	Hart Scientific 2200	
Temperature - Measure <sup>3,7</sup>	(-30 to 600) °C	0.03 °C	Hart Scientific 1502 with PRT	
IR Temperature - Measure <sup>3</sup>	(1 200 to 3 200) °F	7.8 °F	DT260 or Equivalent with ML Thermocouple	
Thermo-Hygrometers <sup>7</sup> Temperature Humidity	(0 to 70) °C (10 to 98) %RH	0.2 °C 0.9 %RH	Thunder Scientific 2500	
System Accuracy Test <sup>3</sup> (SAT)	(0 to 2 200) °F	2.63 °F	Certified Thermocouple	
Temperature Uniformity Survey <sup>3</sup> (TUS)	(0 to 2 200) °F	4.9 °F	MV 1000 Data Logger or Equivalent	

## VI. Mechanical

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Bench and Floor Scales	Up to 120 lb <sup>3,8</sup> Up to 5 000 lb <sup>3,7</sup>	0.08 lb 1 lb	NIST 105 Class F Weights	NIST Handbook 44
Analytical Balances <sup>3,7,8</sup>	Up to 13 kg	28 mg	ASTM E617 Class 1 Weights	

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Mass	0.5 lb	24 mg	Class 1 Weights and Analytical Balance	Modified Substitution
	1 lb	73 mg		
	5 lb	84 mg		
	10 lb	135 mg		
	20 lb	370 mg		
	25 lb	460 mg		
	50 lb	650 mg		
	5 000 g	46 mg		
	3 000 g	30.3 mg		
	2 000 g	23.2 mg		
	1 000 g	17.7 mg		
	500 g	16.1 mg		
	300 g	15.7 mg		
	200 g	1.74 mg		
	100 g	0.89 mg		
	50 g	0.47 mg		
	30 g	0.32 mg		
	20 g	0.25 mg		
10 g	0.2 mg			
5 g	0.18 mg			
3 g	0.18 mg			
2 g	0.18 mg			
1 g	0.17 mg			
Pressure	(-13 to 300) psi <sup>3,7,8</sup>	0.1 psi	Pressure Calibrator	OEM and GIDEP Sourced Procedures
	(300 to 1 000) psi <sup>3,7,8</sup>	1.3 psi		
	(1 000 to 10 000) psi <sup>3,7,8</sup>	3.9 psi	Pressure Transducers	
(10 000 to 30 000) psi <sup>3</sup>	35.2 psi			
Pressure	(0.2 to 500) psia	1.3E-05 psi/psi	Ruska 2465 Ruska 2470 Budenburg 380	
	(500 to 3 000) psi	3E -05 psi/psi		
	(3 000 to 16 000) psi	2E-04 psi/psi		
Environmental Pressure Gage <sup>3</sup>	(0 to 100) in H <sup>2</sup> O	0.017 in H <sup>2</sup> O	Pressure Module	

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Indirect Verification of Rockwell Hardness Testers and Rockwell Superficial Testers <sup>3,7,8</sup>	HRA Low HRA Med HRA High	1.22 HRA 1.24 HRA 0.75 HRA	Rockwell Test Blocks	Indirect comparison per ASTM E18
	HRB Low HRB Med HRB High	1.39 HRB 1.39 HRB 1.33 HRB		
	HRC Low HRC Med HRC High	1.22 HRC 1.22 HRC 0.7 HRC		
	HRE Low HRE Med HRE High	1.28 HRE 1.42 HRE 1.34 HRE		
	HRF Low HRF Med HRF High	1.43 HRF 1.43 HRF 1.42 HRF		
	HRH Low HRH Med HRH High	1.35 HRH 1.35 HRH 1.35 HRH		
	HRKW Low HRKW Med HRKW High	1.42 HRKW 1.29 HRKW 1.25 HRKW		
	HRMW Low HRMW Med HRMW High	1.4 HRMW 1.34 HRMW 1.33 HRMW		
	HR15N Low HR15N Med HR15N High	1.51 HR15N 1.24 HR15N 0.9 HR15N		
	HR30N Low HR30N Med HR30N High	1.31 HR30N 1.25 HR30N 0.93 HR30N		
	HR45N Low HR45N Med HR45N High	1.34 HR45N 1.26 HR45N 0.95 HR45N		



PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Hardness Testers <sup>3,7,8</sup> Rockwell (cont.)	HR15T Low HR15T Med HR15T High  HR30T Low HR30T Med HR30T High  HR45T Low HR45T Med HR45T High	1.95 HR15T 1.4 HR15T 1.47 HR15T  1.99 HR30T 1.51 HR30T 1.33 HR30T  1.95 HR45T 1.33 HR45T 1.42 HR45T	Rockwell Test Blocks	Indirect comparison per ASTM E18
Brinell	(1 to 7) mm	0.026 mm	Brinell Test Blocks & Brinell Scope	Indirect comparison per ASTM E10
Knoop	(1 to 200) µm	0.25 µm	Knoop & Vickers Test Blocks	Indirect comparison per ASTM E384
Vickers	(1 to 200) µm	0.17 µm		
Direct Verification of Brinell Hardness Testers <sup>3</sup> Verification of Test Force	(500, 750, 1 500, 2 000, 3 000) Kgf	7.21 Kgf	Morehouse Proving Ring	ASTM E10
Verification of Indenter Mean Diameter	10 mm 5 mm	0.0023 mm 0.0019 mm		
Indirect Verification of Leeb Hardness Tester <sup>3</sup>	550 LD, 836 LD	19.9 LD	Leeb Test Block	ASTM A956
Durometers <sup>3,7,8</sup>  Spring Force Indenter Angle	(0.1 to 45.0) N (20 to 40) °	0.05 N 0.07 °	Triple Beam Balance Video Measuring Machine  Gage Blocks Gage Blocks	Per ASTM D2240
Indenter Length Indenter Radius	(0.049 to 0.198) in (0.05 to 0.1) in	333 µin 337 µin		
Force <sup>3</sup>	Up to 200 lb  (200 to 10 000) lb (10 000 to 50 000) lb	0.05 % of reading  0.073 % of reading 0.1 % of reading	Dead Weight  Load Cell Load Cell	OEM and GIDEP Sourced Procedures

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Force - In Lab <sup>7</sup>	1 g to 500 lb (500 to 1 000) lb (1 000 to 10 000) lb (10 000 to 100 000) lb	0.05 % reading 0.03 % reading 0.03 % reading 0.04 % reading	Dead Weight, Proving Ring	OEM and GIDEP Sourced Procedures
Force - On Site <sup>3,7,8</sup>	Up to 500 lb (500 to 1 000) lb (1 000 to 10 000) lb	0.05 % reading 0.6 % reading 0.5 % reading	Dead Weight, Load Cell	
Wedge Tester <sup>3</sup>	(0 to 40 000) N	32.03 N	Load Cell	
Torque Transducers <sup>3,7</sup>	Up to 250 lbf-ft (250 to 2 000) lbf-ft	0.05 % of range 0.06 % of range	Torque Arms, Dead Weight	
Torque Tools <sup>3,8</sup>	4 lbf-in to 2 500 lbf-ft	0.3 % of reading	CDI Torque System	
Torque Tools <sup>3,7</sup>	4 lbf-in to 2 500 lbf-ft	0.3 % of reading	AKO Torque System	
Accelerometers 1 g reference 1 g reference	20 Hz to 2 kHz (2 to 15) kHz	1.7 % of reading 2.6 % of reading	PCB 9150C	

## VII. Dimensional

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Gage Blocks <sup>7,8</sup>	Up to 8 in (8 to 20) in	(4.6 + 1.6L) μin (8.5 + 1L) μin	P&W Labmaster ULM 600	ASME B89.1.9
Length Standards <sup>7,8</sup>	Up to 9 in (9 to 24) in	(39 + 0.4L) μin (12 + 1L) μin	P&W Supermicrometer ULM 600	OEM and GIDEP Sourced Procedures

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Cylindrical Rings <sup>7,8</sup>	(0.025 to 12) in	(12.5 + 1.8 <i>D</i> ) μin	ULM 600	ASME B89.1.6
Cylindrical Plugs <sup>3,5,7,8,10</sup>	(0.010 to 8) in	(11.7 + 0.8 <i>D</i> ) μin		OEM and GIDEP Sourced Procedures
Thread Rings <sup>7,8</sup> Pitch Diameter Pitch Diameter Minor Diameter	Up to 8 in Up to 8 in Up to 8 in	(236 + 0.3 <i>D</i> ) μin 38 μin 422 μin	Setting Plug Gages ULM 600 ID Bore Gages	ASME B1.2
NPT Rings <sup>7,8</sup> Standoff and Basic Length	(0.0625 to 6) in	244 μin	NPT Plugs, P&W Labmaster	ASME B1.20.5
NPT Plugs <sup>7,8</sup> Standoff and Basic Length	(0.0625 to 6) in	488 μin	NPT Rings, P&W Labmaster	
Threaded Plugs <sup>3,5,7,8,9</sup> Pitch Diameter Major Diameter	(0.01 to 10) in (0.01 to 10) in	(73 + 0.9 <i>D</i> ) μin (40 + 1.2 <i>D</i> ) μin	P&W Supermicrometer, Thread Measuring Wires	ASME B1.2
Thread Wires <sup>7</sup>	(0.005 to 0.5) in	(10.5 + 1.5 <i>D</i> ) μin	ULM 600	ASME B89.1.17
Calipers <sup>3,7,8</sup>	Up to 80 in	(382 + 15 <i>L</i> ) μin	Gage Blocks	OEM and GIDEP Sourced Procedures
Dial Indicators <sup>3,7,8</sup>	Up to 4 in	(36 + 10 <i>L</i> ) μin	Indicator Checker	
Test Indicators <sup>3,7,8</sup>	Up to 0.06 in	232 μin		
OD Micrometers <sup>3,7,8</sup>	Up to 60 in	(69 + 40 <i>L</i> ) μin	Gage Blocks	

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)	
ID Micrometer <sup>3,7,8</sup>	(1.5 to 40) in	(64 + 6L) μin	Gage Blocks	OEM and GIDEP Sourced Procedures	
Height Gages <sup>3,7,8</sup>	Up to 40 in	(375 + 11L) μin			
Bore Gages <sup>3,7,8</sup>	(0.25 to 12) in	351 μin	Cylindrical Rings		
Crimpers <sup>3,7,8</sup> Die Check Crimp Height	(0.011 to 0.5) in (0.01 to 0.5) in	233 μin 0.0012 in	Pin Gages Micrometer		
Profilometers <sup>3,7,8</sup> Ra	(2 to 300) μin	2.2 μin	Roughness Specimen		
Profilometer Reference Specimens Ra	(0.01 to 300) μin	2.1 μin	Profilometer		
Surface Plates <sup>3,7,8</sup> Repeatability Flatness	(4 to 34) in Diagonal (34 to 175) in Diagonal	(30 + 0.2D) μin (66 + 0.2D) μin	Repeat – O – Meter Electronic Levels		
CMM Calibration <sup>3,7</sup> Volumetric Linearity Linearity	(5 to 40) in (1 to 60) in Above 60 in	(12 + 14L) μin (7 + 14L) μin (20 + 0.4L) μin	Ball Bars Step Gage Renishaw Laser System		B89.4.1
Optical Comparators <sup>3,7,8</sup> Linearity Magnification	Up to 12 in 10x, 20x, 31.25x, 50x, 62.5x, 100x, 200x	(97 + 12L) μin 0.00046 in	Glass Scale Precision Balls Calibration Sphere		OEM and GIDEP Sourced Procedures
Roundness Testers <sup>3,7</sup> Axial Error Radial Error	All	0.15 μm 0.15 μm	Test Sphere		
ULMs <sup>3,7</sup> Length	(1 to 100) mm	0.19 μm	Gage Blocks		
Film Thickness Gages <sup>3,7,8</sup>	(0.01 to 0.06) in	382 μin	Film Thickness Standards		
Brinell Scopes <sup>3,7,8</sup>	(1 to 6) mm	11 μm	Stage Micrometer		

### VIII. Fluid Properties

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Refractometers <sup>3,7,8</sup>	(0.0, 18.0, 29.7) BRIX	0.24 BRIX	Refractive Index Solutions	OEM and GIDEP Sourced Procedures
Viscosity <sup>8</sup> Rotational Viscometers	500 cP 5 000 cP	0.02 cP/cP	Viscosity Solutions, Temperature Bath	
Viscosity Cups <sup>8</sup>	17.82 cP 65.28 cP 231.0 cP	0.03 cP/cP	Viscosity Solutions, Temperature Bath, Stopwatch	OEM Sourced Procedures and ASTM D4212
pH Meters <sup>3,7,8</sup>	(4.01, 7.00, 10.00) pH	0.02 pH	pH Buffer Solutions	OEM and GIDEP Sourced Procedures
Conductivity Meters <sup>3,7,8</sup>	12.85 mS/cm 1408 µS/cm	0.18 mS/cm 13.5 µS/cm	Conductivity Solutions	

### IX. Foundry Sand Test Equipment / Measurement

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
AFS Clay Tester <sup>3</sup>	(0 to 10) min	1.18 sec	Stopwatch	AFS Core and Mold Handbook Third Edition
Friability Tester <sup>3</sup>	60 sec	1.18 sec	Stopwatch	
Sand Rammer <sup>3</sup>		0.012 in	Impact Rings	
Moisture Teller <sup>3</sup>	(0 to 300 °F)	1.93 °F	Temperature Calibrator	
Permmeter <sup>3</sup>	(0 to 500) perm	0.43 perm	Perm Standards	
Sand Strength Tester <sup>3</sup>	(0 to 500) psi (0 to 1 000) lb	1.02 psi 4.2 lb	Proving Ring	
Core Scratch Tester <sup>3</sup>	(0 to 0.1) in	0.0059 in	Flatness Block	
Green Sand Hardness Tester <sup>3</sup> (B&C)	(0 to 0.1) in	0.0059 in	Flatness Block	


PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Ultrasonic Cleaner/Scrubber <sup>3</sup>	18 °F 30 min	1.66 °F 1.18 sec	Temperature Calibrator Stopwatch	AFS Core and Mold Handbook Third Edition
Wet Tensile Tester <sup>3</sup>	0.449 N/cm <sup>2</sup> (300 to 320) °F	0.0031 N/cm <sup>2</sup> 1.93 °F	Dead Weight Temperature Calibrator	
Sand Squeezer <sup>3</sup>	(0 to 200) psi	3.81 psi	Proving Ring	
Tensile Testers <sup>3</sup>	(0 to 10 000) lb	7.23 lb	Load Cell	

### X. Dimensional Inspection / Measurement

PARAMETER / EQUIPMENT	RANGE	CALIBRATION AND MEASUREMENT CAPABILITY [EXPRESSED AS UNCERTAINTY(±)]	REFERENCE STANDARD OR EQUIPMENT	METHOD(S)
Dimensional Inspection <sup>7,8</sup> Volumetric Linear	Up to (28 x 40 x 24) in Up to 6 in	323 µin (332 + 38L) µin	CMM Video Measuring Machine	Customer Drawings
Surface Finish <sup>8</sup> (Ra)	(0.01 to 300) µin	2.1 µin	Profilometer	

Notes:

1. Calibration and Measurement Capabilities (CMC) (Expanded Uncertainties) are based on approximately a 95% confidence interval, using a coverage of k=2.
2. This laboratory offers 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 capability is offered for this parameter.
4. CMC for Electromagnetic-RF/Microwave do not include inaccuracies due to sensor mismatch.
5. On-site capability is available for this parameter using a plug gage comparator only. Gages up to 4 inches.
6. This laboratory offers calibration service at satellite sites at the following location:  
303 Polk Parkway, St. Croix Falls, WI 54024  
Point of contact: Chris Kuczynski, Phone: 715-483-5334  
308 Axminister Dr., Fenton, MO 63026  
Point of contact: Caleb Pohlman, Phone: 636-326-1601
7. These parameters are available at the St. Croix Falls satellite site.
8. These parameters are available at the Fenton, MO satellite site.
9. On-site calibration available for this parameter using plug gage comparator only (gages up to 4 inches).
10. For CMC expressed as b + mL, L = Length in inches.
11. For CMC expressed as b + mD, D = Diameter or Diagonal in inches.
12. Where ranges overlap, the CMC for the overlapping specifications will be the lower of the two.
13. This scope is part of and must be included with the Certificate of Accreditation No. ACT-1272.



Vice-President