

## MID-ATLANTIC REGIONAL CALIBRATION CENTER CAPABILITY LIST

1/29/2001

Parameter	Measurement System	Range/Nominal	Expanded Uncertainty ( $\pm$ ) At K=2 coverage factor
AC Current	5700A/5725A	5 mA – 20 A, 5 Hz to 50 kHz	200 – 500 ppm
AC Current Shunts (Y5020/A40)	Automated comparison measurements using standard Y5020/A40 shunts.	10A @ 60 Hz, 400 Hz, 1 kHz, 3 kHz, and 5 kHz	0.015 TO 0.04%
AC Voltage	4920M	0.3 – 1000 V, 10 to 40 Hz 0.3 – 1000 V, .04 to 20 kHz 0.3 – 1000 V, 20 to 100 kHz 0.3 – 100 V, 100 to 500 kHz 0.3 – 100 V, 0.5 to 1 MHz 1 – 3 V, 10 Hz to 20 MHz	80 ppm 35 ppm 0.015% 0.03 % 0.1 % 0.2 %
AC Voltage	5790A (Alternate standard)	0 to 2.2mv @ 1Khz 2.2mV to 7mv @ 1Khz 7mV to 22mv @ 1Khz 22mV to 70mv @ 1Khz 70 mV to 1000V @ 1Khz	1010ppm 396ppm 169ppm 86ppm 24ppm
<b><u>Acoustics</u></b>			
Sound Level (Measure)	1551-C	60 – 140 dB, 63 – 2000 Hz 60 – 140 dB, 2000 – 11200 Hz	0.5 dB 1.0 dB
Sound Level (Source)	1986	114 dB, 500 Hz 114 dB, @ 125 Hz, 250 Hz, 1 kHz, and 2 kHz	0.5 dB 0.7 dB

Capacitance	Capacitance Bridge and Reference Group of Standards	0.01pF to 1μF @ 1kHz	4.0 ppm
	Capacitance Digibridge (Direct Reading)	0.01pF to 1F, 12 Hz to 200 kHz	231 ppm
DC Current	Comparator Bridge	0 to 15 A 15 to 100 A 100 to 300A	3.7 ppm 5.8 ppm 12.9 ppm
<u>DC Voltage</u> (Measure)	Josephson Array Intrinsic Measurement System	10 V 1.018 V	0.05 ppm 0.15 ppm
Zener standard calibrations	Automated Zener Reference Measurement System	10 V 1.018 V	0.11 ppm 0.42 ppm
MAP Transfer Program	JJ & Voltage Transfer Standards	10 V 1.018 V	0.15 ppm (typical) 0.58 ppm (typical)
DC Voltage (Source)	External Reference Standards and Reference Dividers	0 to 1kV	1.6 ppm
	Voltage Source and Precision Divider	1 to 10kV	129 ppm
Frequency and Time	Comparison to HP Model 5061A Cesium Beam Frequency Standard and Datum 9320 GPS Receiver	5 MHz, 10 MHz and 1 MHz 1 PPS	$7.0 \times 10^{-12}$

<b><u>Impedance</u></b> Coaxial Devices Type N 14 mm APC - 7 APC - 3.5 APC - 2.4	8510C VNA	<u>Reflection Coefficient   S<sub>11</sub> </u> 0 – 1, .045 to 18 GHz 0 – 1, .045 to 8.5 GHz 0 – 1, .045 to 18 GHz 0 – 1, .045 to 26.5 GHz 0 – 1, .045 to 50 GHz	<u>Reflection Coefficient   S<sub>11</sub> </u> 0.0052 0.00866 0.0038 0.0056 0.0094
Waveguide Devices H – Band X – Band P – Band K – Band R – Band	8510C VNA	<u>Reflection Coefficient   S<sub>11</sub> </u> 0 – 1, 7.1 to 10 GHz 0 – 1, 8.2 to 12.4 GHz 0 – 1, 12.4 to 18 GHz 0 – 1, 18 to 26.5 GHz 0 – 1, 26.5 to 40 GHz	<u>Reflection Coefficient   S<sub>11</sub> </u> 0.0034 0.0034 0.0045 0.0046 0.0049
<b><u>Attenuation</u></b> (Passive/Active) Coaxial: Type N APC - 7 APC - 3.5 APC - 2.4	Systems used for appropriate measurement parameters:  8902Sopt50,	  0 – 100 dB, 0.010 to 18 GHz 0 – 50 dB, 0.010 to 18 GHz 0 – 100 dB, 0.010 to 26.5 GHz 0 – 100 dB, 0.010 to 40 GHz	  0.031 – 0.859 dB 0.031 – 0.859 dB 0.031 – 0.557 dB 0.026 – 1.01 dB
Waveguide: K – Band R – Band	1295	  0 – 100 dB, 18 to 26.5 GHz 0 – 100 dB, 26.5 to 40 GHz	  0.026 – 1.01 dB 0.026 – 1.01 dB

<b>Coaxial Attenuators (Passive)</b>			
Type N	8510C VNA	0 – 50 dB, .045 to 18 GHz	0.063 – 0.216 dB
APC-7		0 – 50 dB, .045 to 18 GHz	0.046 – 0.088 dB
APC-3.5		0 – 50 dB, .045 to 26.5 GHz	0.067 – 0.122 dB
APC-2.4		0 – 50 dB, .045 to 50 GHz	0.022 – 0.232 dB
<b>Waveguide Attenuators</b>			
H – Band	8510C VNA	0 – 50 dB, 7.1 to 10 GHz	0.070- 0.257dB
X – Band		0 – 50 dB, 8.2 to 12.4 GHz	0.069 – 0.217 dB
P – Band		0 – 50 dB, 12.4 to 18 GHz	0.046– 0.371 dB
K – Band		0 – 50 dB, 18 to 26.5 GHz	0.046 – 0.675 dB
R – Band		0 – 50 dB, 26.5 to 40 GHz	0.066 - 0.865 dB

<b><u>Inductance</u></b>	1693 RCL DIGIBRIDGE and Reference Standards	100 µH, 100 Hz and 1 kHz 200 µH, 100 Hz and 1 kHz 500 µH, 100 Hz and 1 kHz 1 mH, 100 Hz and 1 kHz 2 mH, 100 Hz and 1 kHz 5 mH, 100 Hz and 1 kHz 10 mH, 100 Hz and 1 kHz 20 mH, 100 Hz and 1 kHz 50 mH, 100 Hz and 1 kHz 100 mH, 100 Hz and 1 kHz 200 mH, 100 Hz and 1 kHz 500 mH, 100 Hz and 1 kHz 1 H, 100 Hz 1 H, 1 kHz 2 H, 100 Hz 2 H, 1 kHz 5 H, 100 Hz 5 H, 1 kHz 10 H, 100 Hz 10 H, 1 kHz	0.163 % 0.106 % 0.084 % 0.052 % 0.084 % 0.052 % 0.052 % 0.084 % 0.084 % 0.052 % 0.052 % 0.084 % 0.052 % 0.052 % 0.084 % 0.118 % 0.084 % 0.175 % 0.052 % 0.25 %	
Inductive Voltage Dividers	Inductive voltage dividers are calibrated at frequencies of 400 Hz, 1 kHz, and 10 kHz by comparison with traceable dividers.	0 – 1 Ratio	0.5 ppm	
Phase (Measure)	2250	0 - 360°, 50 Hz to 50 kHz	0.05°	
Phase (Source)	5500	0 - 360°, 1 Hz to 625 Hz 0 - 360°, 625 Hz to 50 kHz 0 - 360°, 50 to 100 kHz	0.005° 0.010° 0.020°	

<b><u>Resistance</u></b>	Resistance Bridge and Reference Standards  Comparator Bridges and Reference Standards	All values expressed in Ohms ( $\Omega$ )  10 M 1 M 100 k 10 k 1 k 100 10 1 0.1 0.01 0.001	5.1 ppm  3.5 ppm 2.1 ppm 1.2 ppm 0.89 ppm 0.81 ppm 0.74 ppm 0.70 ppm 0.89 ppm 1.8 ppm 4.2 ppm
<b><u>RF Power</u> (Thermistor Mounts/ Power Sensors)</b>			
Coaxial	Direct Transfer Method Expressed as Cal Factor	1 MHz to 40 GHz @ 10 $\mu$ W & 10 mW	1.4 %
Waveguide	Direct Transfer Method Expressed as Cal Factor	8.2 – 40 GHz @ 10 mW	1.4 %
RF Wattmeters	AWACS	1 – 1000 W, 1 to 30 MHz 1 – 500W, 30 to 400 MHz	2.9 % 2.6 %
Thermal Transfer Standards	540B Direct Transfer	0.5 -- 1 kV 50 Hz to 50 kHz 0.5 -- 500V 50 kHz to 100 kHz 0.5 – 10 V 100 kHz to 1 MHz	0.052 % 0.052 % 0.10 %

Thermal Voltage Converters	1395 Direct Transfer	0.5 to 6V at 1MHz 0.5 to 6V at 10MHz 0.5 to 6V at 20MHz 0.5 to 6V at 30MHz 0.5 to 6V at 50MHz 0.5 to 6V at 70MHz 0.5 to 6V at 100MHz	<u>NOTE: Currently under review</u> 0.1% 0.2% 0.2% 0.5% 1.0% 2.0% 2.0%
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### **Systems and Miscellaneous Capabilities**

JET ENGINE TEST CELLS OXYGEN TEST SYSTEMS AWM-23 – Coolant section AN/APM-417 (RTBS) AN/USM-641 Countermeasures T/S AWM-53 TACAN SIMULATORS IFF SYSTEM TESTERS (155) SONAR/RADAR SYSTEM TESTERS ECM SYSTEM TESTERS	HYBRID TEST SYSTEM [AN/USM 484] AVIONICS TEST SET [AN/USM 470 (V)2] WEAPONS SYSTEM TEST STATION (VI) SERVO SYSTEMS TEST SETS WEAPONS SYSTEM TESTERS MICROWAVE SYSTEM TEST SETS HYDRAULIC ATE F14 CONSOLES ACTUATOR TEST SETS Torque Night Vision Radiometers Rotation Mercury Vapor Detector Conductivity
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**Note:** Red font indicates information taken from the MARCC's A2LA Scope of Accreditation  
 Blue font indicates current laboratory capability NOT under A2LA Scope of Accreditation

<b>Parameter</b>	<b>Measurement System</b>	<b>Range/Nominal</b>	<b>Expanded Uncertainty (<math>\pm</math>) At K=2 coverage factor</b>
Dimensional (Angular) Angle Gage Blocks	Angle Gage Blocks	1 sec to 45°	1 sec
Dimensional (Length) Gage Blocks	Gage Blocks and Transfer Standard	< 0.8 in 0.8 to 2 in 3 to 10 in 12 to 20 in	3.4 $\mu$ in 4 $\mu$ in 4 to 9 $\mu$ in 10 to 15 $\mu$ in
End Standards	Laser Interferometer	< 20 in 20 to 72 in	2 or 3 $\mu$ in / in 3 or 4 $\mu$ in / in
Optical Flats	Plano-interferometer Model D-309-L	1 to 5 in	1.5 $\mu$ in
Toolmaker Flats		3 to 6 in	2 $\mu$ in
Dimensional (Diameter) Plug Gages	Gage Blocks and External Comparator	0.01 to 6 in 6 to 12.26 in	11 $\mu$ in 18 $\mu$ in
Ring Gages	Gage Blocks and Internal Comparator	0.125 to 6 in 6 to 13.25 in	11 $\mu$ in 18 $\mu$ in
60° English Thread Wires	Comparison to Calibrated Master Wires	4 to 100 TPI	6 $\mu$ in
29° ACME Best Wires		1 to 20 TPI	6 $\mu$ in

Dimensional (Threads) Major, minor, and pitch diameters	Sip-305M	< 4 in 4 to 10 in > 10 in	0.00005 in 0.0001 in 0.0003 in
Contour		20 pitch & coarser 20 to 40 pitch 40 pitch & finer	5 minutes 10 minutes 20 minutes
Lead and Helix Angle		2 to 56 pitch	0.00005 in
Fiber Optics Optical Power 850, 1300, and 1500 nm	ML9001A/MA9712A	-60 to 0 dBm	3 to 4%
Peak wavelength and Bandwidth	MS9030A/MS9701A	350 to 1750 nm	0.5 to 10nm
<b><u>Flow</u></b> Gas Flow Rate	Brooks Vol-U-Meters Bell Provers Sonic Nozzles	5 to 10000 ccm 0.25 to 60 cfm 60 to 400 cfm	0.5 % 0.5 % 0.8 %
Air Velocity	Transducer Pitot tube/Digital Indicator	0 to 1000FPM 1000 to 1500FPM 1500 to 2000FPM 2000 to 6000FPM	3 % 2.3 % 1.5% UP to 1%
Liquid Flow Rate	Flow Provers	0.01 to 2100 gpm	0.25 %
Force	Standard Load Cells	0 to 1k lb 1K to 25k lb 25k to 100k lb 100k to 300k lb	0.05% 0.04% 0.04% 0.06%

Humidity (Dew Point)	General Eastern Hygro-M3 Humidity Analyzer w/1311DR Chilled Mirror Sensor	-65 to -36°C -35 to 35°C	0.4°C 0.3°C

<u>Mass</u>	Comparison to Standard Weights		
	20 g to 20 kg	0.8 ppm	
	2g to 10 g	1.5 ppm	
	1g	3 ppm	
	500 mg	4 ppm	
	300 mg	7 ppm	
	200 mg	9 ppm	
	100 mg	20 ppm	
	50 mg	24 ppm	
	30 mg	44 ppm	
	20 mg	54 ppm	
	10 mg	140 ppm	
	5 mg	240 ppm	
	3 mg	440 ppm	
	2 mg	540 ppm	
	1 mg	.14 %	
	50 lb	140 micro lb	
	30 lb	91 micro lb	
	20 lb	63 micro lb	
	10 lb	29 micro lb	
	5 lb	10 micro lb	
	2 lb	5 micro lb	
	1 lb	1 micro lb	
	8 oz	.3 micro lb	
	4 oz	.2 micro lb	
	2 oz	.1 micro lb	
	1 oz	.1 micro lb	
	½ oz	.05 micro lb	
	¼ oz	.03 micro lb	
	1/8 oz	.03 micro lb	
	1/16 oz	.01 micro lb	
	1/32 oz	.01 micro lb	

<b>Optical Instruments</b> <i>(See table at the end of this section)</i>			
Photometry Illuminance (Source)	Standard Lamp/Light Rail	0 to 500 foot candles	4.6 %
Luminance (Source)	Luminance Standard (LS-65-8D)	0 to 1000 foot lamberts	2 %
Chromaticity Coordinates	Luminance Standard (LS-65-8D)	(x) and (y)	0.001 to 0.003
Pressure and Vacuum	Schwien Precision Mercury Manometer	0.5 to 10 in Hg (abs or diff) 10 to 50 in Hg (abs or diff) 50 to 110 in Hg (abs or diff) 0 to 54 psi (abs or diff)	0.001 in Hg 0.002 in Hg 0.004 in Hg 0.002 psi
	Dead Weight Tester	54 psig to 4 kpsig 4 to 20 kpsig 20 to 40 kpsig	0.008 % 0.011 % 0.013 %
Vacuum	MKS Baratron Pressure Measurement System	0.001 to 0.5 Torr 0.5 to 1 Torr	1.0% 0.5%
Radiometry Infrared Temperature	Area Blackbody Source	23 to 100°C 100 to 200°C 200 to 300°C	3.2°C 3.5°C 4°C
Ultra Violet Irradiance	DM-365X/Transilluminator	0 to 2000uW/ cm <sup>2</sup>	5.9 %

<b><u>Temperature</u></b> Thermometers	Ice Point Check and Comparison to Standard Platinum Resistance Thermometer	-38 to 0°C 0 to 100°C 100 to 200°C 200 to 260°C 260 to 500°C	0.05°C 0.03°C 0.06°C 0.12°C 1.0°C
Temperature Resistance Thermometry	ITS 90 Calibration at AL, ZN, SN, H <sub>2</sub> O, HG Fixed Points and Comparison Method at BP of Liquid N <sub>2</sub>	-196 to -38.8344°C -38.8344 to 0.1°C 0.01°C 0 to 231.928°C 0 to 419.527°C 0 to 660.323°C	0.03°C 0.005°C 0.001°C 0.005°C 0.006°C 0.006°C
Thermocouples and Pyrometer Indicators Type S Type K Type J Type T	Comparison Calibration to Type S Thermocouples	0 to 1100°C 0 to 1100°C 0 to 750°C 0 to 350°C	1.5°C 3.0°C 3.0°C 2.0°C
Specific Gravity	Measurements made using Specific Gravity Balance,	0.6700 to 2.000	0.0004 of the indicated specific gravity
Vibration	Direct Comparison of Accelerometers via an Electrodynamic Calibrator	2 to 10 G, 10 to 100 Hz 2 to 10 G, 100 Hz to 2 kHz 2 to 10 G, 2 to 10 kHz	2.7 % 1.8 % 2.7 %
Viscosity	Efflux Time is measured with an Electronic Counter	0.5 to 3 Centistokes 3 to 30 Centistokes 30 to 100 Centistokes 100 to 7000 Centistokes	0.3 % 0.35 % 0.5 % 0.74 %

Optical Instruments	
<b>ANGLE BLOCKS</b> <b>POLYGONS AND PRISMS</b> <b>ROTARY TABLES</b> <b>THEODOLITES</b> <b>TRANSITS</b> <b>TELESCOPES</b> <b>MIRRORS</b> <b>COLLIMATORS</b> <b>LEVELS</b> <b>SQUARES</b>	<b>UNIQUE OPTICAL AND OPTI-MECHANICAL GAGING AND FIXTURES</b> <b>OPTICAL FLAT AND PARALLELS</b> <b>ROUGHNESS STANDARDS</b> <b>GRANITE AND STEEL SURFACE PLATES</b> <b>STRAIGHT EDGES</b> <b>SINE BARS</b> <b>PROTRACTORS</b> <b>SPHERICAL AND PARABOLIC MIRRORS</b> <b>A-6 AND F-14 BORESIGHT SYSTEMS</b> Surface Plates, Parallels and Straight Edge
<p><b>Note:</b> Red font indicates information taken from the MARCC's A2LA Scope of Accreditation          Blue font indicates current laboratory capability <u>NOT</u> under A2LA Scope of Accreditation</p>	

