

# Scope of Calibrations

NAVSEA 04-4734 / ANSI/NCSL Z540-1-1994

**MMC Metrology Lab, Inc.**  
**4989 Cleveland Street**  
**Virginia Beach, VA 23462**

## I. Electrical - DC / Low Frequency

Parameter/Equipment	Range	Best System Accuracy	Comments
DC Voltage Systems			
Generate (Laboratory)	0 to 19.9999mV 20mV to 199.999mV 200mV to 1.99999V 2V to 19.9999V 20V to 199.999V 200V to 1100V	$\pm .005\% + 5.2\mu\text{V}$ $\pm .005\% + 7\mu\text{V}$ $\pm .005\% + 25\mu\text{V}$ $\pm .005\% + 205\mu\text{V}$ $\pm .005\% + 2\text{mV}$ $\pm .005\% + 11\text{mV}$	Fluke 5102B
(On-site)	0 to 100mV 100mV to 10V 10V to 105V 100V to 1050V	$\pm .02\% + 20\mu\text{V}$ $\pm .02\% + 2\text{mV}$ $\pm .2\% + 52.5\text{mV}$ $\pm .2\% + .53\text{V}$	Fluke 715 Arbiter 1040C
Measure (Laboratory)	0 to 200mV 200mV to 2V 2V to 20V 20V to 200V 200V to 1000V 1kV to 2kV 2kV to 9kV 9kV to 100kV	$\pm .00145\% + .2\mu\text{V}$ $\pm .00115\% + 1\mu\text{V}$ $\pm .00095\% + 5\mu\text{V}$ $\pm .00135\% + .1\text{mV}$ $\pm .00145\% + 2\text{mV}$ $\pm .05\% + .05\%/\text{kV} + .5\text{V}$ $\pm .05\% + .05\%/\text{kV} + 5\text{V}$ $\pm .5\%$	Datron/Wavetek 1271 Valhalla 4600 HV voltage divider / DMM
(On-site)	0 to 200mV 200mV to 2V 2V to 20V 20V to 200V 200V to 1200V 1.2kV to 2kV 2kV to 40kV	$\pm .04\% + 20\mu\text{V}$ $\pm .02\% + .1\text{mV}$ $\pm .02\% + 1\text{mV}$ $\pm .02\% + 10\text{mV}$ $\pm .02\% + 96\text{mV}$ $\pm .05\% + .05\%/\text{kV} + .5\text{V}$ $\pm 1\%$	Fluke 8600A Valhalla 4600 HV probe / DMM

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## I. Electrical - DC / Low Frequency (Continued)

Parameter/Equipment	Range	Best System Accuracy	Comments
DC Current Systems			
Generate (Laboratory)	0 to 199.999 $\mu$ A 200 $\mu$ A to 1.99999mA 2mA to 19.9999mA 20mA to 199.999mA 200mA to 1.99999A	$\pm .025\% + .015\mu$ A $\pm .025\% + .06\mu$ A $\pm .025\% + .51\mu$ A $\pm .025\% + 5\mu$ A $\pm .025\% + 50\mu$ A	Fluke 5102B
(On-site)	2A to 20A 20A to 100A	$\pm .025\% + 1$ mA $\pm .054\% + 20$ mA	Fluke 5102B / 5220A Source / shunt / DMM
(On-site)	0 to 24mA 24mA to 105mA .1A to 1.05A 1A to 10.5A	$\pm .015\% + 2\mu$ A $\pm .2\% + 53\mu$ A $\pm .2\% + .53$ mA $\pm .2\% + 5.3$ mA	Fluke 715 Arbiter 1040C
Measure (Laboratory)	0 to .3A .3A to 100A	$\pm .0036\% + .5\mu$ A $\pm .0094\% + .1$ mA	Standard shunt / DMM
(On-site)	0 to 24mA 24mA to 200mA 200mA to 2A 2A to 4A 4A to 10A	$\pm .015\% + 2\mu$ A $\pm .1\% + 20\mu$ A $\pm .1\% + .2$ mA $\pm .2\% + 4$ mA $\pm .2\% + 20$ mA	Fluke 715 Fluke 8600A Fluke 87-3

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Parameter/Range	Frequency	Best System Accuracy	Comments
<b>AC Voltage Systems</b>			
<b>Generate (Laboratory)</b>			
0 to 20mV	50Hz to 10kHz, 10kHz to 50kHz	$\pm .05\% + 51\mu\text{V}$ $\pm .08\% + 52\mu\text{V}$	Fluke 5102B
20mV to 200mV	50Hz to 10kHz, 10kHz to 50kHz	$\pm .05\% + 60\mu\text{V}$ $\pm .08\% + 66\mu\text{V}$	
200mV to 2V	50Hz to 10kHz, 10kHz to 50kHz	$\pm .05\% + 150\mu\text{V}$ $\pm .08\% + 210\mu\text{V}$	
2V to 20V	50Hz to 10kHz, 10kHz to 50kHz	$\pm .05\% + 1.05\text{mV}$ $\pm .08\% + 1.65\text{mV}$	
20V to 110V	50Hz to 10kHz, 10kHz to 50kHz	$\pm .05\% + 10\text{mV}$ $\pm .08\% + 10\text{mV}$	
110V to 200V	50Hz to 1kHz, 1kHz to 50kHz	$\pm .05\% + 10\text{mV}$ $\pm .08\% + 10\text{mV}$	
200V to 1100V	50Hz to 1kHz, 1kHz to 50kHz	$\pm .05\% + 55\text{mV}$ $\pm .08\% + 55\text{mV}$	
<b>(On-site)</b>			
1.5V to 15.75V	50Hz to 75Hz, 333.3Hz to 500Hz	$\pm .2\% + 8\text{mV}$ $\pm .2\% + 8\text{mV}$	Arbiter 1040C
15V to 150V	50Hz to 75Hz, 333.3 Hz to 500Hz	$\pm .2\% + .079\text{V}$ $\pm .2\% + .079\text{V}$	
150V to 750V	50Hz to 75Hz, 333.3Hz to 500Hz	$\pm .2\% + .75\text{V}$ $\pm .2\% + .75\text{V}$	

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Parameter/Range	Frequency	Best System Accuracy	Comments
AC Voltage System (continued)			
Measure (Laboratory)			
2mV to 90mV	40Hz to 100Hz, 100Hz to 2kHz, 2kHz to 10kHz, 10kHz to 30kHz, 30kHz to 100kHz	$\pm .014\% + 4\mu\text{V}$ $\pm .014\% + 2\mu\text{V}$ $\pm .014\% + 4\mu\text{V}$ $\pm .047\% + 8\mu\text{V}$ $\pm .115\% + 20\mu\text{V}$	Datron/Wavetek 1271
90mV to 100V	40Hz to 20kHz, 20kHz to 50kHz, 50kHz to 100kHz	$\pm .003\%$ $\pm .007\%$ $\pm .015\%$	Datron/Wavetek 4920M
100V to 1000V	40Hz to 20kHz, 20kHz to 50kHz, 50kHz to 100kHz	$\pm .0035\%$ $\pm .0075\%$ $\pm .0150\%$	Datron/Wavetek 4920M
1kV to 2kV	20Hz to 100Hz, 100Hz to 400Hz	$\pm .1\% + .05\%/kV + 2V$ $\pm .5\% + .05\%/kV + 5V$	Valhalla 4600
2kV to 15kV	20Hz to 60Hz	$\pm .5\% + .05\%kV + 50V$	Valhalla 4600
15kV to 28kV	60Hz	$\pm 5\%$	HV probe / DMM
(On-site)			
2mV to 200mV	50Hz to 10kHz	$\pm .2\% + .16mV$	Fluke 8600A
200mV to 2V	50Hz to 10kHz	$\pm .2\% + .3mV$	
2V to 20V	50Hz to 10kHz	$\pm .2\% + 3mV$	
20V to 200V	50Hz to 10kHz	$\pm .2\% + 30mV$	
200V to 500V	50Hz to 10kHz	$\pm .2\% + .36V$	
500V to 1200V	50Hz to 10kHz	$\pm .37\% + .36V$	

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Parameter/Range	Frequency	Best System Accuracy	Comments
AC Current System			
Generate			
(Laboratory)			
0 to 200 $\mu$ A	50Hz to 1000Hz	$\pm .05\% + .03\mu$ A	Fluke 5102B
200 $\mu$ A to 2 mA	50Hz to 1000Hz	$\pm .05\% + .12\mu$ A	
2mA to 20mA	50Hz to 1000Hz	$\pm .05\% + 1.02\mu$ A	
20mA to 200mA	50Hz to 1000Hz	$\pm .05\% + 10\mu$ A	
200mA to 2A	50Hz to 1000Hz	$\pm .05\% + .1$ mA	
2A to 20A	50Hz to 400Hz	$\pm .07\% + 1$ mA	Fluke 5102B / 5220A
(On-site)			
.1A to 1.05A	50Hz to 75Hz, 333.3Hz to 500Hz	$\pm .2\% + .53$ mA	Arbiter 1040C
1A to 7.5A	50Hz to 75Hz, 333.3Hz to 500Hz	$\pm .2\% + 7.5$ mA	
Measure			
(Laboratory)			
2 $\mu$ A to 20 $\mu$ A	40Hz to 2kHz	$\pm .0147\%$	1k $\Omega$ shunt / 1271
20 $\mu$ A to 1mA	40Hz to 100Hz, 100Hz to 2kHz	$\pm .0117\%$ $\pm .0097\%$	1k $\Omega$ shunt / 1271
1mA to 10mA	40Hz to 100Hz, 100Hz to 2kHz	$\pm .012\%$ $\pm .01\%$	100 $\Omega$ shunt / 1271
10mA to 100mA	40Hz to 100Hz, 100Hz to 2kHz	$\pm .0136\%$ $\pm .0116\%$	10 $\Omega$ shunt / 1271
100mA to 1A	40Hz to 2kHz	$\pm .019\%$	.1 $\Omega$ shunt / 1271
1A to 20A	60Hz and 400Hz	$\pm .022\%$	.01 $\Omega$ shunt / 1271
20A to 70A	60Hz, 400Hz	$\pm .0192\%$ $\pm .0172\%$	
(On-site)			
0 to 200 $\mu$ A	50Hz to 10kHz	$\pm .3\% + .16\mu$ A	Fluke 8600A
200 $\mu$ A to 2mA	50Hz to 10kHz	$\pm .3\% + 1.6\mu$ A	
2mA to 20mA	50Hz to 10kHz	$\pm .3\% + 16\mu$ A	
20mA to 200mA	50Hz to 10kHz	$\pm .3\% + .16$ mA	
200mA to 2000mA	50Hz to 5kHz	$\pm .3\% + 1.6$ mA	
2000mA to 10A	45Hz to 2kHz	$\pm 1\% + 20$ mA	Fluke 87

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Parameter/Range	Frequency	Best System Accuracy	Comments
Phase			
Generate      0 to 360°	60Hz and 400Hz	± .33°	Arbiter 1040C
Measure      0 to 360°	50Hz to 500Hz	± .1°	Dranetz 305D/PA3008

Parameter/Range	Frequency	Best System Accuracy	Comments
AC Power / VARS			
Generate (Laboratory)			
0 to 10000VA	60Hz and 400Hz	± .5%	Fluke 760A system
(On-site)			
1.5VA to 165VA	60Hz and 400Hz	± .4% + .165VA	Arbiter 1040C
165VA to 1180VA	60Hz and 400Hz	± .4% + 2.36VA	
1180VA to 5625VA	60Hz and 400Hz	± .4% + 11.25VA	

Parameter/Equipment	Range	Best System Accuracy	Comments
Capacitance			
Generate (Fixed point)	.02μF	± .011%	Standard Capacitor
Measure (1kHz)	.1pF to .0012μF	± .2% + .1pF +(1% x D)	ESI 250DE
	.0012μF to .012μF	± .2% + 1pF +(0.5% x D)	
	.012μF to .12μF	± .2% + 10pF +(0.5% x D)	
	.12μF to 1.2μF	± .2% + 100pF +(0.5% x D)	
	1.2μF to 12μF	± .2% + .001μF +(0.5% x D)	
	12μF to 120μF	± .2% + .01μF +(0.5% x D)	
	120μF to 1200μF	± .2% + .1μF + (1% x D)	

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Parameter/Equipment	Range	Best System Accuracy	Comments
Inductance			
Generate (Fixed point)	200mH	± .05%	Standard Inductor
Measure (1kHz)	.1μH to 1.2mH 1.2mH to 12mH 12mH to 120mH 120mH to 1.2H 1.2H to 12H 12H to 120H 120H to 1200H	± .2% + .1μH + 1.2%/Q ± .2% + 1μH + .7%/Q ± .2% + 10μH + .7%/Q ± .2% + 100μH + .7%/Q ± .2% + 1mH + .7%/Q ± .2% + 10mH + .7%/Q ± .2% + 100mH + 1.2%/Q	ESI 250DE

Parameter/Equipment	Range	Best System Accuracy	Comments
Resistance			
Generate (Fixed Points)	.0001Ω .001Ω .01Ω .1Ω 1Ω 10Ω 100Ω 1kΩ 10kΩ 100GΩ	± .0277% ± .0141% ± .0082% ± .0050% ± .0010% ± .0026% ± .0010% ± .00072% ± .0007% ± .1%	Standard shunts and resistors
Measure	0Ω to 10Ω 10Ω to 100Ω 100Ω to 1kΩ 1kΩ to 10kΩ 10kΩ to 100kΩ 100kΩ to 1MΩ 1MΩ to 10MΩ 10MΩ to 100MΩ 100MΩ to 1GΩ	± .00225% + .04mΩ ± .00145% + .1mΩ ± .00145% + 1mΩ ± .00145% + 10mΩ ± .0018% + .1Ω ± .0027% + 2Ω ± .0045% + 100Ω ± .05% + 10kΩ ± .3% + .5MΩ	Datron / Wavetek 1271

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## II. Time and Frequency

Parameter/Equipment	Range	Best System Accuracy	Comments
Frequency			
Generate (Laboratory)	.1MHz, 1MHz, and 5MHz 10Hz to 10.99999MHz 1MHz to 520MHz	$\pm 5$ parts in $10^{12}$ $\pm 1$ part in $10^6$ $\pm 10$ parts in $10^6$	Cesium beam standard Fluke 6011A-01 Wavetek 3000
(On-site)	50Hz to 75Hz 333.3Hz to 500Hz	$\pm .01\%$ $\pm .01\%$	Arbiter 1040C
Measure	10Hz to 520MHz	$\pm 3$ parts in $10^8$	Fluke 7220A

## III. Acoustics

Parameter/Equipment	Range	Best System Accuracy	Comments
Acoustics			
Generate	114dB @ 125Hz 114dB @ 250Hz 114dB @ 500Hz 114dB @ 1000Hz 114dB @ 2000Hz 94dB @ 1000Hz	$\pm .7$ dB $\pm .7$ dB $\pm .5$ dB $\pm .7$ dB $\pm .7$ dB $\pm .8$ dB	GENRAD 1562A  Exttech 407766

## IV. Chemical

Parameter/Equipment	Range	Best System Accuracy	Comments
pH (Fixed points)	4.000pH @ 25°C 7.000pH @ 25°C 10.000pH @ 25°C	$\pm .002$ pH $\pm .002$ pH $\pm .002$ pH	Standard buffer solution

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## IV. Chemical (Continued)

Parameter/Equipment	Range	Best System Accuracy	Comments
Conductivity (Fixed points)	10 $\mu$ S @ 25°C 100 $\mu$ S @ 25°C 1000 $\mu$ S @ 25°C 1413 $\mu$ S @ 25°C 10000 $\mu$ S @ 25°C	$\pm$ .25 $\mu$ S $\pm$ .25% $\pm$ .25% $\pm$ .25% $\pm$ .25%	Standard solution

## V. Thermodynamics

Parameter/Equipment	Range	Best System Accuracy	Comments
Relative Humidity			
Generate (Fixed points)	11.30%RH @ 25°C 43.16%RH @ 25°C 75.29%RH @ 25°C 84.34%RH @ 25°C 97.30%RH @ 25°C	$\pm$ 1%RH $\pm$ 1%RH $\pm$ 1%RH $\pm$ 1%RH $\pm$ 1%RH	Saturated ACS salt solution
Measure	0 to 90%RH 90 to 100%RH	$\pm$ 1%RH $\pm$ 2%RH	Vaisala HMP233

Parameter/Equipment	Range	Best System Accuracy	Comments
Temperature			
Generate	- 13°F to 30°F 30°F to 220°F 220°F to 284°F 284°F to 600°F 600°F to 1200°F	$\pm$ .45°F $\pm$ .15°F $\pm$ .45°F $\pm$ 1°F $\pm$ .2%	Hart 9103 Thermo Unit Temperature bath / Azonix Hart 9103 Thermo Unit King Nutronics 3604
Measure	- 40°F to 1220°F	$\pm$ .036°F	Rosemount 162CE

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## VI. Mechanical

Parameter/Equipment	Range	Best System Accuracy	Comments
Pressure  (Laboratory)	0psig to 6psig	± .0036psig	Meriam 350
	6psig to 12000psig	± .01%	Ruska 2400 system
	12000psig to 60000psig	± 78psig	Viatran HP transmitter
	0psia to 38psia 38psia to 150psia	± .0038psia ± .03psia	Ruska 6222
(On-site)	0psig to 7psig	± .0036psig	Hand pump / test gage
	7psig to 36psig	± .05% + .0018psig	
	36psig to 3000psig	± .05% + .15psig	
	3000psig to 5000psig	± 5psig	
	5000psig to 10000psig	± 10psig	
Vacuum  (Laboratory)	0 in Hg to 29.5 in Hg	± .03 in Hg	Vacuum pump / test gage
(On-site)	0 in Hg to 27 in Hg	± .075 in Hg	Hand pump / Test gage

Parameter/Equipment	Range	Best System Accuracy	Comments
Torque	0 to 600 in-oz	± 1%	Torque calibrator
	0 to 250 in-lb	± 1%	
	0 to 500 ft-lb	± 1 ft-lb	Torque transducer system
	500 ft-lb to 1000 ft-lb	± .2%	

Parameter/Equipment	Range	Best System Accuracy	Comments
Rotation	62.5 RPM to 40000 RPM	± .02%	Tachometer calibrator

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## VI. Mechanical (Continued)

Parameter/Equipment	Range	Best System Accuracy	Comments
Flow			
(Gas)	0 scfm to .22 scfm .22 scfm to 3 scfm	$\pm .5\%$ $\pm .5\%$	Laminar flow elements and indicator
(Liquid)	.9 gpm to 275 gpm	$\pm .25\%$	Standard turbine flow meter and indicator

Parameter/Equipment	Range	Best System Accuracy	Comments
Force (Compression)			
Measure	0 lbs to 20000 lbs	$\pm 10$ lbs	Load cell / Indicator

Parameter/Equipment	Range	Best System Accuracy	Comments
Gas Analysis (Fixed points)	Carbon monoxide-20ppm Carbon monoxide-50ppm Carbon monoxide-100ppm Hexane-100ppm Hexane-500ppm Hydrogen-1.0% Hydrogen sulfide-25ppm Methane-1.0% Methane-1.62% Methane-2.5% Nitrogen-99.99% Oxygen-2.0% Oxygen-17.0% Pentane-.75% with Oxygen-15%	$\pm 1$ ppm of component $\pm 1$ ppm of component $\pm 2$ ppm of component $\pm 2$ ppm of component $\pm 10$ ppm of component $\pm .02\%$ of component $\pm .5$ ppm of component $\pm .02\%$ of component $\pm .016\%$ of component $\pm .05\%$ of component 99.9995% pure $\pm .04\%$ of component $\pm .34\%$ of component $\pm .015\%$ pentane and $\pm .3\%$ oxygen component	Certified calibration gas

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## VI. Mechanical (Continued)

Parameter/Equipment	Range	Best System Accuracy	Comments
Mass (Fixed points)	10mg	± .21mg	Certified weights
	20mg	± .26mg	
	50mg	± .35mg	
	100mg	± .43mg	
	200mg	± .54mg	
	500mg	± .72mg	
	1g	± 2mg	
	2g	± 2mg	
	5g	± 2mg	
	10g	± 2mg	
	20g	± 3mg	
	50g	± 7mg	
	100g	± 10mg	
	200g	± 20mg	
	500g	± 50mg	
	1kg	± 2.5mg	
	5kg	± 12mg	
	.5lb	± .045g	
	1lb	± .065g	
	2lb	± .097g	
3lb	± .14g		
5lb	± .19g		
10lb	± .26g		
20lb ( quantity 15 in set)	± .39g		
Scales and Balances	Up to 320 lbs	Cumulative per weight	Certified weights

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## VII. Dimensional

Parameter/Equipment	Range	Best System Accuracy	Comments
Plain Rings	.125 in to 16 in	± .0001 in	Bore gage / Gage blocks
Plain Plugs	.011 in to 1 in 1 in to 10 in	± 10µin ± (12 + 1µin/in) µin	STD measuring machine and gage blocks
Length standards	.05 in to 1 in 1 in to 10 in 10 in to 36 in	± 10µin ± (12 + 1µin/in) µin ± (19 + 2µin/in) µin	STD measuring machine and gage blocks
Micrometers			
Inside	Up to 1 in 1 in to 36 in	± 2µin ± (4 + 2µin/in) µin	Gage blocks (Inch and Metric)
Outside (INCH)	Up to 1 in 1 in to 54 in	± 2µin ± (4 + 2µin/in) µin	
(METRIC)	Up to 10mm 10mm to 1450mm	± .1µm ± (.1 + .05µm/25mm) µm	
Depth	Up to 1 in 1 in to 12 in	± 2µin ± (4 + 2µin/in) µin	
Height gages	Up to 1 in 1 in to 10 in 10 in to 24 in	± 7µin ± (7 + 1µin/in) µin ± (9 + 2µin/in) µin	Gage blocks / Comparator
Dial Indicators	Up to 4 in	± 50µin	Indicator calibrator
Calipers			
(Dial, digital and vernier)	Up to 1 in 1 in to 72 in	± 2µin ± (4 + 2µin/in) µin	Gage blocks