



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

V.J. TECHNOLOGIES, INC.  
 dba Standards and Calibrations  
 1223 Rand Road  
 Des Plaines, IL 60016  
 Vijay Jere Phone: 847 296 7121

CALIBRATION

Valid To: January 31, 2012

Certificate Number: 1988.01

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

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Calipers	Up to 40 in	$(0.5R + 20L) \mu\text{in}$	Gage blocks
Micrometers	Up to 40 in	$(0.5R + 15L) \mu\text{in}$	Gage blocks
Dial indicators	Up to 4 in	$(65 + 0.25R) \mu\text{in}$	Gage blocks
Height Gages	Up to 40 in	$(0.6R + 20L) \mu\text{in}$	Gage blocks
Pin Gages	1.18 in	$(70 + 2.0R) \mu\text{in}$	Mitutoyo LSM-3100
Scales and Tapes	Increments of 1000 mm or 3 ft	0.06 mm/increment	KIPL, tape and scale calibration unit
Gage Block	(0.05 to 4) in	$(2 + 12L) \mu\text{in}$	Electromechanical comparison

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Angle Gage	(1 to 180)°	3.5'	Mitutoyo optical comparator
Radius Gage	(0.005 to 1) in	0.0008 in	Mitutoyo optical comparator

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 6, 7, 8</sup> (±)	Comments
DC Voltage <sup>3</sup> – Measure	Up to 1 V (1 to 10) V (10 to 100) V 1000 V	0.019 mV 0.18 mV 1.9 mV 18 mV	Agilent 3458A
	100 kV	0.075 % of IV	PARK voltage divider
DC Voltage – Generate	Up to 100 μV (0.1 to 1) mV (1 to 10) mV (10 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	0.65 μV 0.65 μV 0.75 μV 1.6 μV 10 μV 90 μV 1.1 mV 1.3 mV	Wavetek 4800A and Fluke 5520A-SC600
	60 kV	0.075 % of IV	PARK voltage divider

Parameter/Equipment	Range	CMC <sup>2, 6, 7, 8</sup> ( $\pm$ )	Comments
DC Current <sup>3</sup> – Generate	Up to 100 $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1A	0.015 % of IV + 2 nA 82 $\mu$ A/A + 20 nA 88 $\mu$ A/A + 0.1 $\mu$ A 75 $\mu$ A/A + 1 $\mu$ A 0.017 % of IV + 30 $\mu$ A	Wavetek 4800A
	(1 to 2) A (2 to 11) A	0.028 % + 44 $\mu$ A 0.084 % + 0.33 mA	Fluke 5520A-SC600
DC Current <sup>3</sup> – Measure	Up to 100 $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1A	25 $\mu$ A/A + 9 $\mu$ A 24 $\mu$ A/A + 6 $\mu$ A 24 $\mu$ A/A + 6 $\mu$ A 40 $\mu$ A/A + 6 $\mu$ A 0.013 % + 24 $\mu$ A	Agilent 3458A
Resistance <sup>3</sup> – Generate	(1 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ (10 to 100) M $\Omega$	0.005 % of IV 0.0011 % of IV 0.0015 % of IV 0.0015 % of IV 0.0014 % of IV 0.0015 % of IV 0.003 % of IV	IET SR 104 242-D resistance measuring system with transfer standard using resistance transfer method.
Resistance <sup>3</sup> – Measure	(10, 100) $\Omega$ (1, 10, 100) k $\Omega$ 1 M $\Omega$ 10 M $\Omega$ 100 M $\Omega$ 1 G $\Omega$	3.9 m $\Omega$ 2.1 $\Omega$ 31 $\Omega$ 1.1 k $\Omega$ 0.13 M $\Omega$ 13 M $\Omega$	Agilent 3458A
	100 $\mu\Omega$ to 1 m $\Omega$ (1 to 10) m $\Omega$ (10 to 100) m $\Omega$ 100 m $\Omega$ to 1 $\Omega$ (1 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 10 M $\Omega$ (10 to 100) M $\Omega$	18 % of rdg 1.8 % of rdg 0.18 % of rdg 0.018 % of rdg 0.0038 % of rdg 0.003 % of rdg 0.003 % of rdg 0.0038 % of rdg	IET 242-D
Inductance <sup>3</sup> – Generate	(1, 10, 100) mH (1, 5) H	0.13 % of IV 0.2 % of IV	GenRad 1482 series

Parameter/Equipment	Range	CMC <sup>2,4,8</sup> (±)	Comments
Inductance <sup>3</sup> – Measure @ 1 kHz	(0 to 10) H	0.027 % of rdg	Quadtech 1689M
Capacitance <sup>3</sup> – Generate	100 pF to 1.1 μF  (1, 10) pF  (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	0.13 % of IV  0.13 % of IV  0.5 % + 3 nF 0.5 % + 10 nF 0.55 % + 30 nF 0.7 % + 100 nF 0.95 % + 300 nF 1.3 % + 300 nF	GenRad 1423A, 1403G  HP 16380A  Fluke 5520A-SC600
Capacitance – Measure @ 1 kHz	10 aF to 1.1111 μF (1.1 to 11) μF	0.013 % of rdg + 0.00003 pF 0.066 % of rdg	Quadtech 1620-AP
Thermocouple Indicating Devices <sup>3</sup> –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Fluke 5520A-SC600
Type C	(0 to 150) °C (150 to 650) °C (350 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Thermocouple Indicating Devices <sup>3</sup> – (cont)			
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	Fluke 5520A-SC600
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.37 °C 0.26 °C 0.17 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C	0.63 °C 0.24 °C 0.16 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate			
Up to 1 mV	(10 to 31) Hz	7.2 μV	Wavetek 4800A and Fluke 5520A-SC600
	(32 to 330) Hz	7.2 μV	
	(0.3 to 10) kHz	7.1 μV	
	(10 to 33) kHz	7.2 μV	
	(30 to 100) kHz	7.5 μV	
	(100 to 330) kHz	33 μV	
	(0.3 to 1) MHz	40 μV	
(1 to 10) mV	(10 to 31) Hz	8.9 μV	
	(32 to 330) Hz	8.5 μV	
	(0.3 to 10) kHz	8.0 μV	
	(10 to 33) kHz	8.7 μV	
	(30 to 100) kHz	11 μV	
	(100 to 330) kHz	47 μV	
	(0.3 to 1) MHz	69 μV	
(10 to 100) mV	(1 to 2) MHz	48 μV	Wavetek 4800A w/ 50 Ω and 0.75 m cable
	(2 to 10) MHz	67 μV	
	(10 to 20) MHz	84 μV	
	(20 to 30) MHz	100 μV	
(10 to 100) mV	(10 to 31) Hz	30 μV	
	(32 to 330) Hz	26 μV	
	(0.3 to 10) kHz	21 μV	
	(10 to 33) kHz	29 μV	
	(30 to 100) kHz	52 μV	
	(100 to 330) kHz	210 μV	
	(0.3 to 1) MHz	510 μV	
(0.1 to 1) V	(1 to 2) MHz	460 μV	Wavetek 4800A w/ 50 Ω and 0.75 m cable
	(2 to 10) MHz	640 μV	
	(10 to 20) MHz	640 μV	
	(20 to 30) MHz	1 mV	
(0.1 to 1) V	(10 to 31) Hz	210 μV	
	(32 to 330) Hz	130 μV	
	(0.3 to 33) kHz	117 μV	
	(30 to 100) kHz	220 μV	
	(100 to 330) kHz	690 μV	
	(0.3 to 1) MHz	3.7 mV	
(0.1 to 1) V	(1 to 2) MHz	4.6 mV	
	(2 to 10) MHz	6.4 mV	
	(10 to 20) MHz	8.1 mV	
	(20 to 30) MHz	10 mV	

Parameter/Range	Frequency	CMC <sup>2,7</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(1 to 10) V	(10 to 31) Hz (32 to 330) Hz (0.3 to 33) kHz (30 to 100) kHz (100 to 330) kHz (0.3 to 1) MHz	2.2 mV 1.3 mV 1.2 mV 2.2 mV 6.5 mV 3.4 mV	Wavetek 4800A w/ 50 Ω and 0.75 m cable
(3 to 10) V	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	34 mV 46 mV 63 mV 79 mV	
(10 to 100) V	(10 to 31) Hz (32 to 330) Hz (0.3 to 10) kHz (10 to 33) kHz (30 to 100) kHz (100 to 330) kHz (0.3 to 1) MHz	29 mV 18 mV 12 mV 14 mV 43 mV 18 mV 1.4 V	Wavetek 4800A w/ 50 Ω and 0.75 m cable
(100 to 1000) V	(10 to 31) Hz (32 to 330) Hz (0.3 to 3.3) kHz (3 to 10) kHz (10 to 33) kHz (30 to 100) kHz	320 mV 320 mV 260 mV 260 mV 330 mV 1.8 V	Wavetek 4800A
AC Voltage <sup>3</sup> – Measure			
100 mV to 10 V	(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 (0.3 to 1) MHz (1 to 2) MHz	1.4 mV 12 mV 4.4 mV 4.2 mV 11 mV 40 mV 0.13 V 0.2 V	Agilent 3458A

Parameter/Range	Frequency	CMC <sup>2, 6, 7</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – Measure (cont)			
Fixed Points –			
10 mV	(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	7.8 $\mu$ V 3.9 $\mu$ V 4 $\mu$ V 15 $\mu$ V 66 $\mu$ V 0.52 mV	Agilent 3458A
100 V	(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 (0.3 to 1) MHz	31 mV 120 mV 29 mV 48 mV 160 mV 540 mV 2 V	
1000 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	570 mV 550 mV 810 mV 1.6 V 4 V	
AC Current <sup>3</sup> – Generate			
Fixed Points –			
100 $\mu$ A	10 Hz to 1 kHz (1 to 5) kHz	33 nA 64 nA	Wavetek 4800A
1 mA	10 Hz to 1 kHz (1 to 5) kHz	0.26 $\mu$ A 0.45 $\mu$ A	
10 mA	10 Hz to 1 kHz (1 to 5) kHz	2.6 $\mu$ A 4.6 $\mu$ A	
100 mA	10 Hz to 1 kHz (1 to 5) kHz	26 $\mu$ A 46 $\mu$ A	
1 A	10 Hz to 1 kHz (1 to 5) kHz	0.52 mA 0.77 mA	

Parameter/Range	Frequency	CMC <sup>2,6,7</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)			
(1 to 2.2) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	6.1 mA 3.3 mA 22 mA	Fluke 5520A-SC600
(2.2 to 11) A	(45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz	11 mA 17 mA 50 mA	
AC Current <sup>3</sup> – Measure			
Fixed Points –			
100 µA	10 Hz to 1 kHz (1 to 5) kHz	0.18 % + 0.03 µA 0.07 % + 0.03 µA	Agilent 3458A
1 mA	10 Hz to 1 kHz (1 to 5) kHz	0.17 % + 0.02 mA 0.03 % + 0.02 mA	
10 mA	10 Hz to 1 kHz (1 to 5) kHz	0.17 % + 0.02 mA 0.03 % + 0.02 mA	
100 mA	10 Hz to 1 kHz (1 to 5) kHz	0.17 % + 0.02 mA 0.03 % + 0.02 mA	
1 A	10 Hz to 1 kHz (1 to 5) kHz	0.09 % + 0.02 mA 0.03 % + 0.02 mA	

Parameter/Equipment	Range	CMC <sup>2,6,8</sup> (±)	Comments
Oscilloscope <sup>3</sup> –			
Amplitude	DC and Square Wave 10 Hz to 10 kHz	0.25 % of Output + 100 µV	Fluke 5520A-SC600
Leveled Sine Wave Flatness, Relative to 50 kHz	50 kHz to 100 MHz (100 to 300) MHz 300 MHz to 1 GHz	2.3 % + 100 µV 3 % + 100 µV 6.5 % of rdg	Fluke 5520A-SC600 Tektronix SG 504

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
Oscilloscope <sup>3</sup> – (cont)			
Time Marker, 50 Ω	5 s to 100 μs (50 to 2.0) μs 1 μs to 20 ns (10 to 2) ns	30 μHz/Hz + 1 mHz 50 μHz/Hz + 15 mHz 50 parts in 10 <sup>6</sup> 50 parts in 10 <sup>6</sup>	Fluke 5520A-SC600
Rise Time	≤ 1 ns	0.005 %	Fluke 5520A-SC600

### III. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC <sup>2,8</sup> (±)	Comments
Attenuation <sup>3</sup> –			
Up to 26.5 GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB	0.12 dB 1 dB 0.13 dB 0.17 dB 0.15 dB 0.17 dB 0.22 dB 0.24 dB 0.25 dB 0.32 dB	HP 8902MS
Amplitude Modulation <sup>3</sup> –			
Carrier Frequency:  150 kHz to 26.5 GHz Rate: 50 Hz to 10 kHz Rate: 20 Hz to 10 kHz	Depths: Up to 99 % Depths: 5 % to 99 %	5 % of rdg + 1 digit 5 % of rdg + 1 digit	HP 8902MS
Phase Modulation <sup>3</sup> –			
150 kHz to 26.5 GHz Rate: 20 Hz to 20 kHz	Up to 400 radians	5 % of rdg + 1 digit	HP 8902MS

Parameter/Range	Frequency	CMC <sup>2,5,8</sup> ( $\pm$ )	Comments
Frequency Modulation –  Carrier Frequency:  150 kHz to 26.5 GHz 20 Hz to 200 kHz  50 Hz to 100 kHz	Deviation up to 400 kHz  Deviation up to 400 kHz	5 % of rdg + 1 digit  1 % of rdg + 1 digit	HP 8902MS
Phase Angle Measuring Equipment <sup>3</sup>	1 Hz to 6.25 kHz 6.25 kHz to 100 kHz	0.02° 0.1°	Phase Standard Clark Hess 5000
Phase Angle – Measure	10 Hz to 10 kHz 10 kHz to 50 kHz 50 kHz to 100 kHz	0.04° 0.7° 1.2°	Phase meter Krohn Hite 6620
Power Meter Power Reference <sup>3</sup> (1 mW)	50 MHz	2 % of IV	HP 478A
RF Power <sup>3</sup> – Measure			<i>M</i> is source mismatch uncertainty.
(-70 to -20) dBm	10 MHz to 18 GHz	5 % of rdg + <i>M</i>	HP 8481D
(-30 to +20) dBm	100 kHz to 4.2 GHz	5.1 % of rdg + <i>M</i>	HP 8482A
(-30 to +20) dBm	10 MHz to 18 GHz	5.2 % of rdg + <i>M</i>	HP 8481A
	50 MHz to 26.5 GHz	4.6 % of rdg + <i>M</i>	HP 8485A
	33 GHz to 50 GHz	7 % of rdg + <i>M</i>	HP 8487A

IV. Mechanical

Parameter/Equipment	Range	CMC <sup>2, 5, 8</sup> (±)	Comments
Scales and Balances	1 mg to 100 g	2.1 mg	Class ASTM-1 weights
	100 g to 2 kg	230 mg	Class F weights
	1 oz to 50 lbs	0.11 lb	Class F weights
Torque Wrench	(0 to 550) Nm	0.7 % of FS	Mikrotek TWT-1
Pressure Gages	600 psig	0.079 % of FS	Dead weight tester
Force, Tension Only	1 ozf to 150 lbf	0.2 % of rdg + 1.5R	Class F weights

V. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2, 8</sup> (±)	Comments
Temperature <sup>3</sup> – Measure	0 °C to 400 °C	0.025 °C	SPRT Rosemount 162CE
Temperature Measuring Equipment <sup>3</sup>	Ambient to 400 °C	0.6 % of rdg + 1 digit	Jofra 600
Relative Humidity	11 %, 33 %, 75 % RH	1.5 % RH	Certified saturated salt solutions

VI. Time & Frequency

Parameter/Equipment	Frequency	CMC <sup>2</sup> (±)	Comments
Frequency	10 MHz reference	5 parts in 10 <sup>10</sup>	FS 700, Loran C system
Frequency <sup>3</sup>	10 MHz reference	5 parts in 10 <sup>10</sup>	Rubium frequency standard
Frequency – Measure	0.01 Hz to 40 GHz	5 parts in 10 <sup>10</sup>	Frequency converters and counters, Loran C system

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

<sup>2</sup> Calibration and Measurement Capability (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. Calibration and Measurement Capabilities represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of  $k = 2$ . The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

<sup>3</sup> Field calibration service is available for this calibration and this laboratory meets A2LA R104 – *General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

<sup>4</sup> Based on using the standard at the temperature the Fluke 5520A was calibrated ( $t_{cal} \pm 5 \text{ }^\circ\text{C}$ ) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than 5  $^\circ\text{C}$ . CMCs are based upon 1-year specifications and are read as ppm or percent output plus floor specification.

<sup>5</sup> In the statement of CMC,  $R$  is the numerical value of the resolution of the device in micro inches/lbf;  $L$  is the nominal length of the device in inches;  $D$  is the numerical value of the nominal diameter of the device measured in inches; pitch diameter is measured by the three-wire method.

- <sup>6</sup> The measurands stated are generated with the Fluke 5520A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. The CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.
- <sup>7</sup> The measurands stated are measured with the Agilent 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.
- <sup>8</sup> In the statement of CMC, “rdg” represents “reading”, “IV” represents “indicated value”, and “FS” represents “full scale”.



World Class Accreditation

The American Association for Laboratory Accreditation

# Accredited Laboratory

A2LA has accredited

**V.J. TECHNOLOGIES, INC. DBA STANDARDS AND CALIBRATIONS**

*Des Plaines, IL*

for technical competence in the field of

## Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 24<sup>th</sup> day of May 2010.



A handwritten signature in black ink, appearing to read "Peter M. Meyer", written over a horizontal line.

President & CEO  
For the Accreditation Council  
Certificate Number 1988.01  
Valid to January 31, 2012  
Revised December 31, 2011

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