National Voluntary Laboratory Accreditation Program

CALIBRATION LABORATORIES **NVLAP LAB CODE 200154-0**

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

Hewlett-Packard Company	**Parameter(s) of Accreditation**
11445 Compaq Center Dr. West MS 060110 Houston, TX 77070 Mr. Christopher L. Grachanen Phone: 281-518-8486 Fax: 281-518-7275 E-mail: chris.grachanen@hp.com URL: http://www.ges.corp.hp.com/Metrology/	Electromagnetics – DC/Low Frequency Time and Frequency Electromagnetics – RF/Microwave Thermodynamic

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (k=2) [Note 3]	Remarks
ELECTROMAGNETICS – DC/LOW FREQUENCY				
NVLAP Code: 20/E02 AC RESISTORS and CURRENT				
AC Current – Source	10 µA	10 Hz to 1 kHz	0.38 %	Fluke 5700A/5725A
	100 µA	10 Hz to 1 kHz	0.11 %	
	1 mA	10 Hz to 1 kHz	0.12 %	
	10 mA	10 Hz to 1 kHz	0.098 %	
	100 mA	10 Hz to 1 kHz	0.085 %	
	1 A	40 Hz to 1 kHz	0.091 %	
	10 A	40 Hz to 1 kHz	0.053 %	
	10 µA	1 kHz to 10 kHz	1.1 %	
	100 µA	1 kHz to 10 kHz	0.28 %	
	1 mA	1 kHz to 10 kHz	0.28 %	
	10 mA	1 kHz to 10 kHz	0.28 %	
	100 mA	1 kHz to 10 kHz	0.28 %	
	1 A	1 kHz to 10 kHz	1.0 %	
	10 A	1 kHz to 10 kHz	1.0 %	
	100 A	1 kHz	0.6 %	Valhalla 2555A AC-DC Calibrator
AC Current – Measure	100 µA	10 Hz to 5 kHz	0.42 %	Agilent 3458A
	1 mA	10 Hz to 100 kHz	0.7 %	
	10 mA	10 Hz to 100 kHz	0.7 %	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (*k*=2) Note 3	Remarks
	100 mA	10 Hz to 100 kHz	0.7 %	
	1 A	10 Hz to 20 kHz	0.42 %	Agilent 3458A
	1 A	20 kHz to 50 kHz	1.0 %	
	10 A	1 kHz	0.2 %	Valhalla 2575A AC-DC Shunt
	100 A	1 kHz	0.1 %	
	10 A	10 kHz	1.0 %	

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) Note 3	Remarks
NVLAP Code: 20/E05 DC RESISTANCE and CURRENT			
DC Current – Source	1 µA	1.0 %	Fluke 5700A/5725A
	10 µA	0.1 %	
	100 µA	0.016 %	
	1 mA	0.007 %	
	10 mA	0.007 %	
	100 mA	0.0081 %	
	1 A	0.012 %	
	10 A	0.04 %	
	100 A	0.076 %	Valhalla 2555A AC-DC Calibrator
DC Current – Measure	100 nA	0.1 %	Agilent 3458A
	1 µA	0.0087 %	
	10 µA	0.0034 %	
	100 µA	0.0032 %	
	1 mA	0.0028 %	
	10 mA	0.0028 %	
	100 mA	0.007 %	
	1 A	0.012 %	
	10 A	0.02 %	Valhalla 2575A AC-DC

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) [Note 3]	Remarks
			Shunt
	100 A	0.054 %	
Resistance – Source	1 Ω	0.011 %	Fluke 5700A/5725A
	10 Ω	0.0035 %	
	100 Ω	0.0024 %	
	1 kΩ	0.0015 %	
	10 kΩ	0.0014 %	
	100 kΩ	0.0016 %	
	1 MΩ	0.0024 %	
	10 MΩ	0.0047 %	
	100 MΩ	0.015 %	
Resistance – Measure	1 Ω	0.0077 %	Agilent 3458A
	10 Ω	0.0023 %	
	100 Ω	0.0018 %	
	1 kΩ	0.0011 %	
	10 kΩ	0.0011 %	
	100 kΩ	0.0011 %	
	1 MΩ	0.0017 %	
	10 MΩ	0.0061 %	
	100 MΩ	0.051 %	
	1 GΩ	0.5 %	
NVLAP Code: 20/E06			
DC VOLTAGE			
DC Voltage – Source	1 mV	0.0025 %	Fluke 5700A
	10 mV	0.0025 %	
	100 mV	0.0028 %	
	1 V	0.0007 %	
	10 V	0.0007 %	
	100 V	0.0008 %	
	1000 V	0.0013 %	
DC Voltage – Measure	1 mV	0.11 %	Agilent 3458A
	10 mV	0.012 %	
	100 mV	0.0022 %	

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Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) Note 3	Remarks
	1 V	0.001 %	
	10 V	0.001 %	
	100 V	0.0012 %	
	1000 V	0.0026 %	
High Voltage – Measure	1 kV to 60kV	0.13 %	HVD-60 HV Divider
	1 kV to 40kV	2.0 %	80K-40 HV Probe

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (*k*=2) Note 3	Remarks
NVLAP Code: 20/E09 LF AC VOLTAGE				
AC Voltage – Source	1 mV	10 Hz to 100 kHz	0.89 %	Fluke 5700A / 5725A
	10 mV	10 Hz to 100 kHz	0.17 %	
	100 mV	10 Hz to 100 kHz	0.12 %	
	1 V	10 Hz to 100 kHz	0.07 %	
	10 V	10 Hz to 100 kHz	0.07 %	
	100 V	10 Hz to 100 kHz	0.07 %	
	1000 V	50 Hz to 1 kHz	0.07 %	
	1 mV	100 kHz to 1 MHZ	3.4 %	
	10 mV	100 kHz to 1 MHZ	0.66 %	
	100 mV	100 kHz to 1 MHZ	0.46 %	
	1 V	100 kHz to 1 MHZ	0.34 %	
	10 V	100 kHz to 1 MHZ	0.39 %	
	100 V	100 kHz to 1 MHz	1.5 %	
AC Voltage – Measure	1 mV	1 Hz to 100 kHz	0.8 %	Agilent 3458A
	10 mV	1 Hz to 100 kHz	0.51 %	
	100 mV	1 Hz to 100 kHz	0.082 %	
	1 V	1 Hz to 100 kHz	0.082 %	
	10 V	1 Hz to 100 kHz	0.082 %	
	100 V	1 Hz to 100 kHz	0.14 %	
	1000 V	1 Hz to 100 kHz	0.3 %	

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Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (*k*=2) Note 3	Remarks
	1 mV	100 kHz to 300 kHz	4.2 %	
	10 mV	100 kHz to 300 kHz	4.0 %	
	100 mV	100 kHz to 300 kHz	0.31 %	
	1 V	100 kHz to 300 kHz	0.31 %	
	10 V	100 kHz to 300 kHz	0.31 %	
	100 V	100 kHz to 300 kHz	0.41 %	
	100 mV	300 kHz to 2 MHz	1.5 %	
	1 V	300 kHz to 2 MHz	1.5 %	
	10 V	300 kHz to 2 MHz	1.5 %	
	100 V	300 kHz to 1 MHz	1.5 %	
NVLAP Code: 20/E12 **LF POWER/ENERGY** True Power (W), Apparent Power (VA) – Generate	23 W to 13 kW (46 V to 650 V) (0.5 A to 20 A)	16 Hz to 850 Hz	0.024%	Fluke 6105A Power Standard

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) Note 3	Remarks
NVLAP Code: 20/E17 **PULSE WAVEFORM**			
Rise Time – Generate	< 20 ps	12 %	
Rise Time – Measure	≤ 100 ps	4.7 x 10-^{12} s	Single Shot
Impulse Spectral Amplitude Impulse Noise (Source)	10 kHz to 150 kHz	12%	Band A
	150 kHz to 30 MHz	12%	Band B
	30 MHz to 1 GHz	20%	Band C & D
NVLAP Code: 20/E20 **OSCILLOSCOPES** Source	1 mVDC	2.6	Fluke 9500B with 9530
	10 mVDC	0.26	
	100 mVDC	0.052	

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Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) [Note 3]	Remarks
	1 VDC 10 VDC 100 VDC	0.0064 0.027 0.026	
Fast Edge Pulse 10 kHz to 2 MHz	5 mV to 3 V	3.8 %	Fluke 9500B with 9530
High Edge Pulse 10 kHz to 100 kHz	1 mV to 200 V	3.8 %	Fluke 9500B with 9530
Level Sine Wave 10 kHz to 3.2 GHz	5 mV to 2 V	6.0 %	Fluke 9500B with 9530
Timing Markers	10 ns to 55 s	0.25 µs/s	Fluke 9500B with 9530
Capacitance Measure	10 pF to 95 pF	3.0 %	Fluke 9500B with 9530
Impedance	10 Ω to 12 MΩ	0.51 %	Fluke 9500B with 9530
TIME and FREQUENCY			
NVLAP Code: 20/F01 **FREQUENCY DISSEMINATION** Frequency/Period			
Frequency (Source)	10 MHz	8.4×10^{-11} Hz	GPS Reference Output
Frequency (Measure)	10 MHz, 1 Vrms	6.2×10^{-10} Hz	Rubidium Counter
Frequency (Comparison)	10 MHz, 1 Vrms	8.2×10^{-10} Hz	
Frequency (Measure)	26.5 GHz to 46 GHz	8.6×10^{-10} Hz	High Frequency Counter
NVLAP Code: 20/F03 **OSCILLATOR CHARACTERIZATION** Duty Cycle/Duration at 10 s Time Interval	10 MHz, 1 Vrms	8.5×10^{-10} Hz	Rubidium Counter
Drift at 10 s Time Interval	10 MHz	8.2×10^{-10} Hz	Rubidium Counter

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) [Note 3]	Remarks
Spectral Purity Phase Noise			
0 dBc/Hz to -138 dBc/Hz	10 MHz to 18 GHz	34 %	Noise Test Set
at 0 dBm to -22 dBm	1 GHz	14 %	Spectrum Analyzer
Harmonic Distortion			
0 dBc to 80 dBc	1 GHz	14 %	71210C Spectrum Analyzer
0 dBc to 80 dBc	10 Hz to 100 kHz	8.4 %	Agilent U8903A Analyzer
AM Modulation			
AM (Source)	50 Hz to 50 kHz Rates	0.47 %	AM/FM Test
AM (Measure)	50 Hz to 50 kHz Rates	1.2 %	Measurement Receiver
AM (Source)	33.33 % of depth	0.11 %	Measurement Receiver Calibrator
FM Modulation			
FM (Source)	DC to 100 kHz Rates	0.16 %	AM/FM Test Set
FM (Measure)	50 Hz to 100 kHz Rates	1.6 %	Measurement Receiver
FM (Source)	34 kHz Peak Deviation	0.14 %	Measurement Receiver Calibrator
PM Modulation			
PM (Measure)	150 kHz to 1300 MHz	4.2 %	Measurement Receiver

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) [Notes 1,2]

Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (*k*=2) [Note 3]	Remarks
ELECTROMAGNETICS – RF/MICROWAVE				
NVLAP Code: 20/R09				
NOISE TEMPERATURE				
Noise Figure	0 dB to +30 dB	10 MHz to 2.9 GHz	0.73 dB	70875A Plug-In
	0 dB to +30 dB	2.9 GHz to 26.5 GHz	0.88 dB	

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CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (k=2) Note 3	Remarks
NVLAP Code: 20/R13 RF/MICROWAVE ATTENUATORS			M = Mismatch uncertainty	
Relative RF Power – Attenuation-Measure	0 dB to -58 dB -58 dB to -78 dB -78 dB to -114 dB	30 MHz to 26.5 GHz 30 MHz to 26.5 GHz 30 MHz to 26.5 GHz	0.05 dB + M 0.10 dB + M 0.15 dB + M	Agilent N5530S Measuring Receiver System
	0 dB to 50 dB	30 MHz	M + 0.07 dB	Agilent Verification Kit
Impedance – Measure	10 Ω to 1000 Ω 10 Ω to 1000 Ω	10 Hz to 500 MHz 100 kHz to 500 MHz	7.7 % 1.9 %	Impedance Probe and VNA HP 4395A VNA
Scattering Parameters – Reflection, S11, S22 Note 8	0 LinMag to 0.333 LinMag	0.05 GHz to 2 GHz 2 GHz to 26.5 GHz	0.017 LinMag 0.013 LinMag	N5230A VNA & 3.5mm Cal Kit
		30 kHz to 300 kHz 300 kHz to 1.3 GHz 1.3 GHz to 3 GHz 3 GHz to 6 GHz 0	0.018 LinMag 0.017 LinMag 0.015 LinMag 0.036 LinMag	8753D VNA & 7mm Cal Kit
		18.0 GHz to 26.5 GHz 26.5 GHz to 40 GHz 40 GHz to 50 GHz	0.049 LinMag 0.073 LinMag 0.11 LinMag	8757D VNA & 2.4mm Cal Kit
Scattering Parameters – Transmission, S21, S12	0.0031 LinMag to 0.8912 LinMag	0.05 GHz to 2 GHz 2 GHz to 26.5 GHz	0.0095 LinMag 0.0095 LinMag	N5230A VNA & 3.5mm Cal Kit

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Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (k=2) [Note 3]	Remarks
		30 kHz to 300 kHz 300 kHz to 1.3 GHz 1.3 GHz to 3 GHz 3 GHz to 6 GHz	0.017 LinMag 0.016 LinMag 0.014 LinMag 0.035 LinMag	8753D VNA & 7mm Cal Kit
		18 GHz to 26.5 GHz 26.5 GHz to 40 GHz 40 GHz to 50 GHz	0.052 LinMag 0.16 LinMag 0.33 LinMag	8757D VNA & 2.4mm Cal Kit
NVLAP Code: 20/R17 RF/MICROWAVE POWER METERS			M = Mismatch uncertainty	
RF Power Sensor Transfer		10 MHz to 18 GHz	M + 1.3 %	1807A RF Standard
		50 MHz to 26.5 GHz	M + 2.5 %	F1117AC RF Standard
RF Power – Absolute	+30 dBm to +10 dBm +10 dBm to -30 dBm	30 MHz to 26.5 GHz 30 MHz to 26.5 GHz	M + 0.24 dB M + 0.14 dB	Agilent N5530S
	+20 dBm to -70 dBm +20 dBm to -70 dBm	26.5 GHz to 40 GHz 40 GHz to 50.0 GHz	M + 4.4 % M + 5.6 %	8487A Power Sensor
	+20 dBm to -20 dBm	50 MHz to 26.5 GHz	M + 2.8 %	M1118 RF Standard
	0.5 mV 1.0 mV 10 mV to 1000 mV	10 kHz to 1.2 GHz 10 kHz to 1.2 GHz 10 kHz to 1.2 GHz	M + 0.43 % M + 0.41 % M + 0.40 %	952001B RF Probe
Tuned RF Power – Absolute	0 dBm to -58 dBm	30 MHz to 26.5 GHz	0.15 dB + M	Agilent N5530S Measuring Receiver System

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Measured Parameter or Device Calibrated	Range	Frequency Range	Uncertainty (*k*=2) Note 3	Remarks
	-58 dBm to -78 dBm	30 MHz to 26.5 GHz	0.17 dB + M	
	-78 dBm to -114 dBm	30 MHz to 26.5 GHz	0.20 dB + M	
RF Current – Frequency Response measured in dB				
Transfer Impedance		10 kHz to 400 MHz	2.1 dB	HP 4395A VNA
Transmission (Loss)		10 kHz to 400 MHz	2.6 dB	
Longitudinal Conversion Loss		100 kHz to 1.5 MHz	1.5 %	Schaffner LCL Probes
		1.5 MHz to 30 MHz	1.3 %	
		30 MHz to 100 MHz	1.3 %	
Transmission (Loss – Crosstalk)		10 kHz to 100 MHz	5.6 %	HP 4395A VNA

CALIBRATION AND MEASUREMENT CAPABILITIES (CMC) Notes 1,2

Measured Parameter or Device Calibrated	Range	Uncertainty (*k*=2) Note 3	Remarks
THERMODYNAMIC			
NVLAP Code: 20/T02 HUMIDITY			
Relative Humidity – Measure	5 % RH to 85 % RH	0.85 % RH	Optsonde Hygrometer
NVLAP Code: 20/T03 LABORATORY THERMOMETERS, DIGITAL and ANALOG			
Temperature – Measure	-25 °C to 300 °C	0.039 °C	Hart Scientific 5609 PRT
Temperature – Source	-25 °C to 140 °C	0.12 °C	Hart Scientific 9105
	140°C to 300 °C	0.52 °C	Hart Scientific 9123
END			

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Notes

Note 1: A Calibration and Measurement Capability (CMC) is a description of the best result of a calibration or measurement (result with the smallest uncertainty of measurement) that is available to the laboratory's customers under normal conditions, when performing more or less routine calibrations of nearly ideal measurement standards or instruments. The CMC is described in the laboratory's scope of accreditation by: the measurement parameter/device being calibrated, the measurement range, the uncertainty associated with that range (see note 3), and remarks on additional parameters, if applicable.

Note 2: Calibration and Measurement Capabilities are traceable to the national measurement standards of the U.S. or to the national measurement standards of other countries and are thus traceable to the internationally accepted representation of the appropriate SI (Système International) unit.

Note 3: The uncertainty associated with a measurement in a CMC is an expanded uncertainty using a coverage factor, $k = 2$, with a level of confidence of approximately 95 %. Units for the measurand and its uncertainty are to match. Exceptions to this occur when marketplace practice employs mixed units, such as when the artifact to be measured is labeled in non-SI units and the uncertainty is given in SI units (Example: 5 lb weight with uncertainty given in mg).

Note 3a: The uncertainty of a specific calibration by the laboratory may be greater than the uncertainty in the CMC due to the condition and behavior of the customer's device and specific circumstances of the calibration. The uncertainties quoted do not include possible effects on the calibrated device of transportation, long term stability, or intended use.

Note 3b: As the CMC represents the best measurement results achievable under normal conditions, the accredited calibration laboratory shall not report smaller uncertainty of measurement than that given in a CMC for calibrations or measurements covered by that CMC.

Note 3c: As described in Note 1, CMCs cover calibrations and measurements that are available to the laboratory's customers under *normal conditions.* However, the laboratory may have the capability to offer special tests, employing special conditions, which yield calibration or measurement results with lower uncertainties. Such special tests are not covered by the CMCs and are outside the laboratory's scope of accreditation. In this case, NVLAP requirements for the labeling, on calibration reports, of results outside the laboratory's scope of accreditation apply. These requirements are set out in Annex A.1.h. of NIST Handbook 150, Procedures and General Requirements.

Note 4: Uncertainties associated with field service calibration may be greater as they incorporate on-site environmental contributions, transportation effects, or other factors that affect the measurements. (This note applies only if marked in the body of the scope.)

Note 5: Values listed with percent (%) are percent of reading or generated value unless otherwise noted.

Note 6: NVLAP accreditation is the formal recognition of specific calibration capabilities. Neither NVLAP nor NIST guarantee the accuracy of individual calibrations made by accredited laboratories.

Note 7: See NIST Handbook 150 for further explanation of these notes.

Note 8: Assumes S21 and S12 ≥ 0.8912 LinMag

Note 9: Assumes S11 and S22 ≤ 0.3349 LinMag

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