



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSLI Z540-1-1994 & ANSI/NCSLI Z540.3-2006

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS
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CALIBRATION

Valid To: July 31, 2018

Certificate Number: 3005.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Resistance – Generate and Measure, Fixed Points	10 μΩ 100 μΩ 1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ	20 μΩ/Ω 10 μΩ/Ω 5.0 μΩ/Ω 2.0 μΩ/Ω 1.0 μΩ/Ω 0.30 μΩ/Ω 0.50 μΩ/Ω 0.50 μΩ/Ω 0.50 μΩ/Ω 0.50 μΩ/Ω	MI-6010C/MI-6011A
	10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ	0.50 μΩ/Ω 1.0 μΩ/Ω 2.0 μΩ/Ω 5.0 μΩ/Ω 10 μΩ/Ω 15 μΩ/Ω	MI-6000A
DC Voltage – Generate and Measure, Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	0.86 μV/V 0.56 μV/V 0.50 μV/V 0.56 μV/V 0.65 μV/V	Fluke-732A w/ Fluke 752 voltage divider

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
AC Voltage – Measure			
10 mV	10 Hz	98 µV/V	Fluke-792, AC standard
	100 Hz	89 µV/V	
	1 kHz	89 µV/V	
	10 kHz	90 µV/V	
	100 kHz	0.015 %	
	1 MHz	0.037 %	
	100 mV	10 Hz	
100 Hz		30 µV/V	
1 kHz		21 µV/V	
10 kHz		21 µV/V	
100 kHz		43 µV/V	
1 MHz		0.020 %	
1 V		10 Hz	
	100 Hz	8.7 µV/V	
	1 kHz	7.1 µV/V	
	10 kHz	7.1 µV/V	
	100 kHz	11 µV/V	
	1 MHz	43 µV/V	
	10 V	10 Hz	25 µV/V
100 Hz		7.7 µV/V	
1 kHz		6.0 µV/V	
10 kHz		6.0 µV/V	
100 kHz		8.7 µV/V	
1 MHz		41 µV/V	
100 V		10 Hz	25 µV/V
	100 Hz	8.3 µV/V	
	1 kHz	7.5 µV/V	
	10 kHz	7.6 µV/V	
	100 kHz	17 µV/V	
1000 V	40 Hz	22 µV/V	
	100 Hz	20 µV/V	
	1 kHz	18 µV/V	
	10 kHz	18 µV/V	
	20 kHz	19 µV/V	

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Attenuation (Transmission S21/S12) –			
Fixed/Variable Coaxial for Type "2.4 mm"			
(0 to 20) dB	(0.045 to 2) GHz	0.043 dB	Network analyzer HP 8510C
	(2 to 20) GHz	0.064 dB	
	(20 to 40) GHz	0.13 dB	
	(40 to 50) GHz	0.28 dB	
Fixed/Variable Coaxial for Type "3.5 mm"			
(0 to 20) dB	(0.045 to 2) GHz	0.058 dB	
	(2 to 8) GHz	0.081 dB	
	(8 to 20) GHz	0.093 dB	
	(20 to 26.5) GHz	0.14 dB	
Fixed/Variable Coaxial for Type "WR-22"			
(0 to 20) dB	(33 to 50) GHz	0.068 dB	
Fixed/Variable Coaxial for Type "WR-15"			
(0 to 20) dB	(50 to 75) GHz	0.079 dB	
Fixed/Variable Coaxial for Type "WR-10"			
(0 to 20) dB	(75 to 110) GHz	0.11 dB	
Fixed/Variable Coaxial for Type "2.4 mm"			
(20 to 40) dB	(0.045 to 2) GHz	0.24 dB	
	(2 to 20) GHz	0.095 dB	
	(20 to 40) GHz	0.56 dB	
	(40 to 50) GHz	2.0 dB	

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Attenuation (Transmission S21/S12) – (cont)			
Fixed/Variable Coaxial for Type “3.5 mm”			
(20 to 40) dB	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.16 dB 0.088 dB 0.1 dB 0.17 dB	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-22”			
(20 to 40) dB	(33 to 50) GHz	0.094 dB	
Fixed/Variable Coaxial for Type “WR-15”			
(20 to 40) dB	(50 to 75) GHz	0.45 dB	
Fixed/Variable Coaxial for Type “WR-10”			
(20 to 40) dB	(75 to 110) GHz	0.45 dB	
Fixed/Variable Coaxial for Type “2.4 mm”			
(40 to 50) dB	(0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.5 dB 0.14 dB 1.1 dB 4.8 dB	
Fixed/Variable Coaxial for Type “3.5mm”			
(40 to 50) dB	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	0.46 dB 0.10 dB 0.14 dB 0.31 dB	
Fixed/Variable Coaxial for Type “WR-22”			
(40 to 50) dB	(33 to 50) GHz	0.17 dB	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
RF Attenuation (Transmission S21/S12) – (cont)			
Fixed/Variable Coaxial for Type “WR-15”			
(40 to 50) dB	(50 to 75) GHz	0.72 dB	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-10”			
(40 to 50) dB	(75 to 110) GHz	0.67 dB	
RF Power –			
Coaxial Power Sensor			NGAS universal auto power system
1 mW	(9 to 100) kHz	1.5 %	
1 mW	(100 to 300) kHz	1.2 %	
1 mW	300 kHz to 1 MHz	1.2 %	
1 mW	(1 to 30) MHz	1.2 %	
1 mW	(30 to 300) MHz	1.3 %	
1 mW	300 MHz to 1 GHz	0.81 %	
1 mW	(1 to 8) GHz	0.84 %	
1 mW	(8 to 15) GHz	0.86 %	
1 mW	(15 to 18) GHz	1.0 %	
1 mW	(18 to 22) GHz	1.2 %	
1 mW	(22 to 26.5) GHz	2.2 %	
1 mW	(26.5 to 40) GHz	2.4 %	
1 mW	(40 to 45) GHz	2.4 %	
1 mW	(45 to 50) GHz	3.7 %	
Waveguide Power Sensor			NGAS bench power system
Q-Band System @ 50 GHz	(33 to 50) GHz	3.3 %	
V-Band System @ 75 GHz	(50 to 75) GHz	1.8 %	
W-Band System @ 110 GHz	(92 to 98) GHz	3.9 %	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
VSWR Gamma (Reflection S11/S22) –			
Fixed/Variable Coaxial for Type “2.4 mm”			
0.0050 Reflection Coefficient	(0.045 to 2.0) GHz	0.97 %	Network analyzer HP 8510C
0.0072 Reflection Coefficient	(2.0 to 20.0) GHz	0.98 %	
0.0261 Reflection Coefficient	(20.0 to 40.0) GHz	1.5 %	
0.0440 Reflection Coefficient	(40.0 to 50.0) GHz	1.9 %	
Fixed/Variable Coaxial for Type “3.5 mm”			
0.0090 Reflection Coefficient	(0.045 to 2.0) GHz	0.52 %	
0.0095 Reflection Coefficient	(2.0 to 8.0) GHz	0.77 %	
0.0261 Reflection Coefficient	(8.0 to 20.0) GHz	0.79 %	
0.0177 Reflection Coefficient	(20.0 to 26.5) GHz	0.81 %	
Fixed/Variable Coaxial for Type “WR-22”			
0.0017 Reflection Coefficient	(33 to 50) GHz	0.43 %	
Fixed/Variable Coaxial for Type “WR-15”			
0.0065 Reflection Coefficient	(50 to 75) GHz	0.43 %	
Fixed/Variable Coaxial for Type “WR-10”			
0.0063 Reflection Coefficient	(75 to 110) GHz	0.63 %	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
VSWR Gamma (Reflection S11/S22) – (cont)			
Fixed/Variable Coaxial for Type “2.4 mm”			
(0.5 to 0.8) reflection coefficient	(0.045 to 2) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	1.2 % 1.4 % 2.3 % 2.9 %	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “3.5 mm”			
(0.5 to 0.8) Reflection Coefficient	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	1.0 % 1.9 % 2.3 % 2.3 %	
Fixed/Variable Coaxial for Type “WR-22”			
(0.5 to 0.8) Reflection Coefficient	(33 to 50) GHz	0.85 %	
Fixed/Variable Coaxial for Type “WR-15”			
(0.5 to 0.8) Reflection Coefficient	(50 to 75) GHz	1.4 %	
Fixed/Variable Coaxial for Type “WR-10”			
(0.5 to 0.8) Reflection Coefficient	(75 to 110) GHz	1.6 %	
Fixed/Variable Coaxial for Type “2.4 mm”			
(0.8 to 1.0) Reflection Coefficient	(0.045 to 2) GHz (2.0 to 20) GHz (20 to 40) GHz (40 to 50) GHz	1.4 % 1.8 % 3.1 % 3.9 %	

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
VSWR Gamma (Reflection S11/S22) – (cont)			
Fixed/Variable Coaxial for Type “3.5 mm”			
(0.8 to 1.0) reflection coefficient	(0.045 to 2) GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	1.4 % 2.8 % 3.4 % 3.4 %	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-22”			
(0.8 to 1.0) reflection coefficient	(33 to 50) GHz	1.1 %	
Fixed/Variable Coaxial for Type “WR-15”			
(0.8 to 1.0) reflection coefficient	(50 to 75) GHz	2.0 %	
Fixed/Variable Coaxial for Type “WR-10”			
(0.8 to 1.0) reflection coefficient	(75 to 110) GHz	2.3 %	

Parameter/Range	Frequency	CMC ² (±)	Comments
Noise Figure and Excess Noise Ratio –			
Coaxial			
APC-7	10 MHz to 1 GHz	0.21 dB	Agilent N8975A noise figure analyzer (NFA)
	(1 to 3) GHz	0.09 dB	
	(3 to 5) GHz	0.09 dB	
	(5 to 9) GHz	0.09 dB	
	(9 to 11) GHz	0.10 dB	
	(11 to 13) GHz	0.10 dB	
	(13 to 18) GHz	0.10 dB	
	18 GHz	0.10 dB	
3.5 mm	10 MHz to 6 GHz	0.15 dB	
	(6 to 10) GHz	0.15 dB	
	(10 to 20) GHz	0.17 dB	
	(20 to 26.5) GHz	0.16 dB	
	26.5 GHz	0.16 dB	
2.4 mm	(1 to 6) GHz	0.14 dB	
	(6 to 10) GHz	0.17 dB	
	(10 to 20) GHz	0.22 dB	
	(20 to 26) GHz	0.27 dB	
	(26 to 33) GHz	0.23 dB	
	(33 to 40) GHz	0.22 dB	
	(40 to 44) GHz	0.27 dB	
	(44 to 50) GHz	0.40 dB	
	50 GHz	0.33 dB	
Waveguide			
WR-42	(18 to 20) GHz	0.22 dB	
	(20 to 22) GHz	0.22 dB	
	(22 to 24) GHz	0.23 dB	
	(24 to 26) GHz	0.22 dB	
	26 GHz	0.24 dB	
WR-28	(26.5 to 28) GHz	0.21 dB	
	(28 to 30) GHz	0.24 dB	
	(30 to 35) GHz	0.26 dB	
	(35 to 40) GHz	0.22 dB	
	40 GHz	0.22 dB	
WR-22	(35 to 40) GHz	0.23 dB	
	(40 to 44) GHz	0.21 dB	
	(44 to 48) GHz	0.31 dB	
	48 GHz	0.24 dB	

Parameter/Range	Frequency	CMC ² (±)	Comments
Noise Figure and Excess Noise Ratio – (cont)			
Waveguide			
WR-15	(55 to 60) GHz	0.22 dB	Agilent N8975A noise figure analyzer (NFA)
	(60 to 64) GHz	0.25 dB	
	(64 to 65) GHz	0.21 dB	
	65 GHz	0.20 dB	
WR-10	(75 to 80) GHz	0.49 dB	
	(80 to 85) GHz	0.47 dB	
	(85 to 90) GHz	0.81 dB	
	(90 to 94) GHz	0.60 dB	
	(94 to 100) GHz	0.51 dB	
	100 GHz	0.67 dB	

III. Time & Frequency

Parameter/Equipment	Frequency	CMC ² (±)	Comments
Cesium Frequency Reference –	5 MHz, 10 MHz	1.0 pHz/Hz	Agilent-5071A with high performance option 001
Frequency Offset (GPS Transfer Standard)	10 MHz	2.0 pHz/Hz	Symmetricom-Xli GPS receiver

¹ This laboratory offers commercial calibration service.

² Calibration and Measurement Capability Uncertainty (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. CMC's 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.

³ In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.



Accredited Laboratory

A2LA has accredited

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS

Redondo Beach, CA

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/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 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 7th day of July 2016.

A handwritten signature in blue ink, appearing to read "J. C. Burt".

Senior Director of Quality and Communications
For the Accreditation Council
Certificate Number 3005.01
Valid to July 31, 2018

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