



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017  
& ANSI/NCSLI Z540-1-1994 & ANSI/NCSLI Z540.3-2006

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS  
One Space Park, S/2746  
Redondo Beach, CA 90278  
Rafael Ojeda Phone: 310 812 7404

CALIBRATION

Valid To: July 31, 2022

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 calibrations<sup>1</sup>:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2, 5</sup> (±)	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/bridge and MI-6011A/range extender
	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/bridge
DC Voltage – Generate and Measure, Fixed Points	0.1 V 1 V 10 V 100 V 1000 V	1.1 μV/V 0.57 μV/V 0.52 μV/V 0.56 μV/V 0.65 μV/V	Fluke-732A w/ Fluke 752 voltage divider and Keysight 3458A

Parameter/Range	Frequency	CMC <sup>2,3</sup> (±)	Comments
AC Voltage – Measure			
10 mV	10 Hz	97 µV/V	Fluke-792, AC standard and Keysight 3458A
	100 Hz	89 µV/V	
	1 kHz	88 µV/V	
	10 kHz	88 µV/V	
	100 kHz	0.017 %	
	1 MHz	0.037 %	
100 mV	10 Hz	44 µV/V	
	100 Hz	30 µV/V	
	1 kHz	22 µV/V	
	10 kHz	22 µV/V	
	100 kHz	43 µV/V	
	1 MHz	0.019 %	
1 V	10 Hz	26 µV/V	
	100 Hz	9.5 µV/V	
	1 kHz	7.0 µV/V	
	10 kHz	7.5 µV/V	
	100 kHz	12 µV/V	
	1 MHz	47 µV/V	
10 V	10 Hz	26 µV/V	
	100 Hz	7.7 µV/V	
	1 kHz	6.8 µV/V	
	10 kHz	6.1 µV/V	
	100 kHz	8.7 µV/V	
	1 MHz	41 µV/V	
100 V	10 Hz	26 µV/V	
	100 Hz	8.5 µV/V	
	1 kHz	7.6 µV/V	
	10 kHz	8.1 µV/V	
	100 kHz	11 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 <sup>2</sup> (±)	Comments	
RF Attenuation (Transmission S21/S12) –				
Fixed/Variable Coaxial for Type "2.4 mm"				
(0 to 20) dB	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz (26.5 to 50) GHz	0.04 dB 0.04 dB 0.18 dB 0.31 dB	Keysight PNA-X system network analyzer	
Fixed/Variable Coaxial for Type "3.5 mm"				
(0 to 20) dB	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz	0.05 dB 0.05 dB 0.13 dB		
Fixed/Variable Coaxial for Type "WR-22"				
(0 to 20) dB	(33 to 50) GHz	0.10 dB		Network analyzer HP 8510C
Fixed/Variable Coaxial for Type "WR-15"				
(0 to 20) dB	(50 to 75) GHz	0.10 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	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz (26.5 to 50) GHz	0.03 dB 0.04 dB 0.47 dB 1.9 dB	Keysight PNA-X system network analyzer	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
RF Attenuation (Transmission S21/S12) – (cont)			
Fixed/Variable Coaxial for Type “3.5 mm”			
(20 to 40) dB	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz	0.29 dB 0.29 dB 0.14 dB	Keysight PNA-X system network analyzer
Fixed/Variable Coaxial for Type “WR-22”			
(20 to 40) dB	(33 to 50) GHz	0.07 dB	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-15”			
(20 to 40) dB	(50 to 75) GHz	0.08 dB	
Fixed/Variable Coaxial for Type “WR-10”			
(20 to 40) dB	(75 to 110) GHz	0.12 dB	
Fixed/Variable Coaxial for Type “2.4 mm”			
(40 to 50) dB	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz (26.5 to 50) GHz	0.30 dB 0.05 dB 0.47 dB 1.9 dB	Keysight PNA-X system network analyzer
Fixed/Variable Coaxial for Type “3.5mm”			
(40 to 50) dB	(0.05 to 0.5) GHz (0.5 to 2) GHz (2 to 26.5) GHz	0.10 dB 0.06 dB 0.14 dB	
Fixed/Variable Coaxial for Type “WR-22”			
(40 to 50) dB	(33 to 50) GHz	0.18 dB	Network analyzer HP 8510C

Parameter/Range	Frequency	CMC <sup>2,3</sup> (±)	Comments
RF Attenuation (Transmission S21/S12) – (cont)			
Fixed/Variable Coaxial for Type “WR-15”  (40 to 50) dB	(50 to 75) GHz	0.73 dB	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-10”  (40 to 50) dB	(75 to 110) GHz	0.68 dB	
RF Power –			
Coaxial Power Sensor			NGAS universal auto power system w/ power sensors and thermistor mounts
1 mW	(9 to 100) kHz	2.0 %	
1 mW	(100 to 300) kHz	1.3 %	
1 mW	300 kHz to 1 MHz	1.3 %	
1 mW	(1 to 30) MHz	1.3 %	
1 mW	(30 to 300) MHz	1.3 %	
1 mW	300 MHz to 1 GHz	1.2 %	
1 mW	(1 to 8) GHz	1.0 %	
1 mW	(8 to 15) GHz	1.0 %	
1 mW	(15 to 18) GHz	1.2 %	
1 mW	(18 to 22) GHz	1.9 %	
1 mW	(22 to 26.5) GHz	2.5 %	
1 mW	(26.5 to 40) GHz	5.1 %	
1 mW	(40 to 45) GHz	4.8 %	
1 mW	(45 to 50) GHz	5.0 %	
Waveguide Power Sensor			NGAS bench power System with waveguide power sensors
Q-Band System @ 50 GHz	(33 to 50) GHz	2.6 %	
V-Band System @ 75 GHz	(50 to 75) GHz	2.2 %	
W-Band System @ 110 GHz	(92 to 98) GHz	3.9 %	

Parameter/Range	Frequency	CMC <sup>2,3</sup> (±)	Comments
VSWR Gamma (Reflection S11/S22) –			
Fixed/Variable Coaxial for Type “2.4 mm”			
(0 to 0.5) Reflection Coefficient	(0.05 to 0.5) GHz	0.97 %	Keysight PNA-X-System
(0 to 0.5) Reflection Coefficient	(0.5 to 2.0) GHz	0.97 %	
(0 to 0.5) Reflection Coefficient	(2.0 to 26.5) GHz	1.6 %	
(0 to 0.5) Reflection Coefficient	(26.5 to 50.0) GHz	2.0 %	
Fixed/Variable Coaxial for Type “3.5 mm”			
(0 to 0.5) Reflection Coefficient	(0.05 to 0.5) GHz	0.49 %	
(0 to 0.5) Reflection Coefficient	(0.5 to 2.0) GHz	0.49 %	
(0 to 0.5) Reflection Coefficient	(2.0 to 26.5) GHz	0.75 %	
Fixed/Variable Coaxial for Type “WR-22”			
(0 to 0.5) Reflection Coefficient	(33 to 50) GHz	0.60 %	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-15”			
(0 to 0.5) Reflection Coefficient	(50 to 75) GHz	0.80 %	
Fixed/Variable Coaxial for Type “WR-10”			
(0 to 0.5) Reflection Coefficient	(75 to 110) GHz	1.0 %	

Parameter/Range	Frequency	CMC <sup>2,3</sup> (±)	Comments
VSWR Gamma (Reflection S11/S22) – (cont)			
Fixed/Variable Coaxial for Type “2.4 mm”			
(0.5 to 0.8) Reflection Coefficient	(0.05 to 0.5) GHz (0.5 to 2.0) GHz (2.0 to 26.5) GHz (26.5 to 50.0) GHz	1.0 % 1.0 % 1.7 % 2.1 %	Keysight PNA-X-System
Fixed/Variable Coaxial for Type “3.5 mm”			
(0.5 to 0.8) Reflection Coefficient	(0.05 to 0.5) GHz (0.5 to 2.0) GHz (2.0 to 26.5) GHz	0.6 % 0.6 % 1.2 %	
Fixed/Variable Coaxial for Type “WR-22”			
(0.5 to 0.8) Reflection Coefficient	(33 to 50) GHz	0.9 %	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type “WR-15”			
(0.5 to 0.8) Reflection Coefficient	(50 to 75) GHz	1.5 %	
Fixed/Variable Coaxial for Type “WR-10”			
(0.5 to 0.8) Reflection Coefficient	(75 to 110) GHz	1.7 %	
Fixed/Variable Coaxial for Type “2.4 mm”			
(0.8 to 1.0) Reflection Coefficient	(0.05 to 0.5) GHz (0.5 to 2.0) GHz (2.0 to 26.5) GHz (26.5 to 50.0) GHz	1.2 % 1.2 % 2.3 % 2.9 %	Keysight PNA-X-System

Parameter/Range	Frequency	CMC <sup>2,3</sup> (±)	Comments
VSWR Gamma (Reflection S11/S22) – (cont)			
Fixed/Variable Coaxial for Type “3.5 mm”			
(0.8 to 1.0) Reflection Coefficient	(0.05 to 0.5) GHz (0.5 to 2.0) GHz (2.0 to 26.5) GHz	0.9 % 0.9 % 2.3 %	Keysight PNA-X-System
Fixed/Variable Coaxial for Type “WR-22”			Network analyzer HP 8510C
(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 <sup>2</sup> (±)	Comments
Noise Figure and Excess Noise Ratio –			
Coaxial			
APC-7	10 MHz to 1 GHz	0.16 dB	Agilent N8975A noise figure analyzer (NFA)
	(1 to 3) GHz	0.16 dB	
	(3 to 5) GHz	0.17 dB	
	(5 to 9) GHz	0.22 dB	
	(9 to 11) GHz	0.21 dB	
	(11 to 13) GHz	0.21 dB	
	(13 to 18) GHz	0.20 dB	
3.5 mm	10 MHz to 6 GHz	0.16 dB	
	(6 to 10) GHz	0.20 dB	
	(10 to 20) GHz	0.20 dB	
	(20 to 26.5) GHz	0.21 dB	
2.4 mm	(1 to 6) GHz	0.19 dB	
	(6 to 10) GHz	0.26 dB	
	(10 to 20) GHz	0.25 dB	
	(20 to 26) GHz	0.34 dB	
	(26 to 33) GHz	0.26 dB	
	(33 to 40) GHz	0.28 dB	
	(40 to 44) GHz	0.44 dB	
	(44 to 50) GHz	0.39 dB	
Waveguide			
WR-42	(18 to 20) GHz	0.23 dB	
	(20 to 22) GHz	0.22 dB	
	(22 to 24) GHz	0.24 dB	
	(24 to 26) GHz	0.21 dB	
WR-28	(26.5 to 28) GHz	0.22 dB	
	(28 to 30) GHz	0.28 dB	
	(30 to 35) GHz	0.27 dB	
	(35 to 40) GHz	0.25 dB	
WR-22	(35 to 40) GHz	0.24 dB	
	(40 to 44) GHz	0.20 dB	
	(44 to 48) GHz	0.25 dB	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Noise Figure and Excess Noise Ratio – (cont)			
Waveguide			
WR-15	(55 to 60) GHz (60 to 64) GHz (64 to 65) GHz	0.44 dB 0.45 dB 0.59 dB	Agilent N8975A noise figure analyzer (NFA)
WR-10	(75 to 80) GHz (80 to 85) GHz (85 to 90) GHz (90 to 94) GHz (94 to 100) GHz	0.53 dB 0.82 dB 0.82 dB 0.67 dB 0.69 dB	

### III. Mechanical

Parameter/Equipment	Range	CMC <sup>2,3</sup> (±)	Comments
Torque Wrenches	(20 to 200) in-ozf	1.5 %	CDI torque system w/ transducers

### IV. Thermodynamic

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature – Measure	(-100 to 110) °C	0.010 °C	Fluke SPRT, Fluke 7100 temperature bath, and Fluke Superthermometer

V. Time & Frequency

Parameter/Equipment	Frequency	CMC <sup>2</sup> (±)	Comments
Cesium Frequency Reference –	5 MHz, 10 MHz	1.0 x 10 <sup>-12</sup> Hz/Hz	Agilent-5071A with high performance option 001 as intrinsic standard
Frequency Offset (GPS Transfer Standard)	10 MHz	2.0 x 10 <sup>-12</sup> Hz/Hz	Symmetricon-Xli GPS receiver

SATELLITE LOCATION

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS  
 3520 East Avenue M  
 Palmdale, CA 93550  
 Rafael Ojeda Phone: 310 812 7404

I. Mechanical

Parameter/Equipment	Range	CMC <sup>2,3</sup> (±)	Comments
Torque Wrench	(20 to 200) in-ozf	1.5 %	CDI torque system

II. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Rubidium Frequency Standard-Frequency Reference	10 MHz	5 x 10 <sup>-11</sup>	Rubidium ball EFRAT MRT-L

## SATELLITE LOCATION

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS

15333 Avenue of Science

San Diego, CA 92128

Rafael Ojeda      Phone: 310 812 7404

### I. Mechanical

Parameter/Equipment	Range	CMC <sup>2,3</sup> (±)	Comments
Torque Wrench	(20 to 200) in-ozf	1.5 %	CDI torque system

### II. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Rubidium Frequency Standard-Frequency Reference	10 MHz	$6 \times 10^{-11}$	Rubidium Stanford Research FS725

---

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

<sup>2</sup> 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. CMCs 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> In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.

<sup>4</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.

<sup>5</sup> The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.



## 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 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and the requirements of ANSI/NCSL Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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 April 2017*).



Presented this 5<sup>th</sup> day of November 2020.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 3005.01  
Valid to July 31, 2022

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