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

NORTHROP GRUMMAN SYSTEMS CORPORATION, STRATEGIC SPACE SYSTEMS DIVISION
One Space Park, S/2049
Redondo Beach, CA 90278
Rafael Ojeda Phone: 310 813 7404

CALIBRATION

Valid To: July 31, 2024 Certificate Number: 3005.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory at the location listed above as well as the two satellite laboratory locations listed below to perform the following calibrations[1, 4]:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Resistance – Generate & Measure, Fixed Points	10 µΩ 100 µΩ 1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ	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 0.50 µΩ/Ω 1.0 µΩ/Ω 2.0 µΩ/Ω 5.0 µΩ/Ω 10 µΩ/Ω 15 µΩ/Ω	MI-6010B/bridge and MI-6011B/range extender MI-6000B/bridge, resistors
DC Voltage – Generate & 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 752A voltage divider, Keithley 155, Keysight 3458A

Parameter/Range	Frequency	CMC[2, 3, 6] (±)	Comments
AC Voltage – Measure			
10 mV	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	97 µV/V 89 µV/V 88 µV/V 88 µV/V 0.017 % 0.037 %	Fluke-792A, AC standard, Fluke 8588A, Keysight 3458A
100 mV	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	44 µV/V 30 µV/V 22 µV/V 22 µV/V 43 µV/V 0.019 %	
1 V	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	26 µV/V 9.5 µV/V 7.0 µV/V 7.5 µV/V 12 µV/V 47 µV/V	
10 V	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz	26 µV/V 7.7 µV/V 6.8 µV/V 6.1 µV/V 8.7 µV/V 41 µV/V	
100 V	10 Hz 100 Hz 1 kHz 10 kHz 100 kHz	26 µV/V 8.5 µV/V 7.6 µV/V 8.1 µV/V 11 µV/V	
1000 V	40 Hz 100 Hz 1 kHz 10 kHz 20 kHz	22 µV/V 20 µV/V 18 µV/V 18 µV/V 19 µV/V	

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Attenuation (Transmission S_{21}/S_{12}) –			
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[2] (±)	Comments
RF Attenuation (Transmission S_{21}/S_{12}) – (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[2, 3] (±)	Comments
RF Attenuation (Transmission S_{21}/S_{12}) – (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			
1 mW	(40 to 100) kHz	2.0 %	NGC universal auto power system w/ power sensors and thermistor mounts
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			
Q-Band System	(33 to 50) GHz	2.6 %	NGC bench power system w/ waveguide power sensors
V-Band System	(50 to 75) GHz	2.2 %	
W-Band System	(92 to 98) GHz	4.2 %	

Parameter/Range	Frequency	CMC[2] (±)	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	0.0097	Keysight PNA-X-System
(0 to 0.5) Reflection Coefficient	(0.5 to 2.0) GHz	0.0097	
(0 to 0.5) Reflection Coefficient	(2.0 to 26.5) GHz	0.016	
(0 to 0.5) Reflection Coefficient	(26.5 to 50.0) GHz	0.02	
Fixed/Variable Coaxial for Type “3.5 mm”			
(0 to 0.5) Reflection Coefficient	(0.05 to 0.5) GHz	0.0049	
(0 to 0.5) Reflection Coefficient	(0.5 to 2.0) GHz	0.0049	
(0 to 0.5) Reflection Coefficient	(2.0 to 26.5) GHz	0.0075	
Fixed/Variable Coaxial for Type "WR-22"			
(0 to 0.5) Reflection Coefficient	(33 to 50) GHz	0.0060	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type "WR-15"			
(0 to 0.5) Reflection Coefficient	(50 to 75) GHz	0.0080	
Fixed/Variable Coaxial for Type "WR-10"			
(0 to 0.5) Reflection Coefficient	(75 to 110) GHz	0.01	

Parameter/Range	Frequency	CMC[2] (±)	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	0.01 0.01 0.017 0.021	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	0.06 0.06 0.012	
Fixed/Variable Coaxial for Type "WR-22"			
(0.5 to 0.8) Reflection Coefficient	(33 to 50) GHz	0.009	Network analyzer HP 8510C
Fixed/Variable Coaxial for Type "WR-15"			
(0.5 to 0.8) Reflection Coefficient	(50 to 75) GHz	0.015	
Fixed/Variable Coaxial for Type "WR-10"			
(0.5 to 0.8) Reflection Coefficient	(75 to 110) GHz	0.017	
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	0.0012 0.0012 0.023 0.029	Keysight PNA-X-system

Parameter/Range	Frequency	CMC[2] (±)	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	0.009 0.009 0.023	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	0.011	
Fixed/Variable Coaxial for Type "WR-15"			
(0.8 to 1.0) Reflection Coefficient	(50 to 75) GHz	0.02	
Fixed/Variable Coaxial for Type "WR-10"			
(0.8 to 1.0) Reflection Coefficient	(75 to 110) GHz	0.023	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Noise Figure & Excess Noise Ratio –			
Coaxial			
APC-7	10 MHz to 1 GHz (1 to 3) GHz (3 to 5) GHz (5 to 9) GHz (9 to 11) GHz (11 to 13) GHz (13 to 18) GHz	0.16 dB 0.16 dB 0.17 dB 0.22 dB 0.21 dB 0.21 dB 0.20 dB	Agilent N8975A noise figure analyzer (NFA)
3.5 mm	10 MHz to 6 GHz (6 to 10) GHz (10 to 20) GHz (20 to 26.5) GHz	0.16 dB 0.20 dB 0.20 dB 0.21 dB	
2.4 mm	(1 to 6) GHz (6 to 10) GHz (10 to 20) GHz (20 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 44) GHz (44 to 50) GHz	0.19 dB 0.26 dB 0.25 dB 0.34 dB 0.26 dB 0.28 dB 0.44 dB 0.39 dB	
Waveguide			
WR-42	(18 to 20) GHz (20 to 22) GHz (22 to 24) GHz (24 to 26) GHz	0.23 dB 0.22 dB 0.24 dB 0.21 dB	
WR-28	(26.5 to 28) GHz (28 to 30) GHz (30 to 35) GHz (35 to 40) GHz	0.22 dB 0.28 dB 0.27 dB 0.25 dB	
WR-22	(35 to 40) GHz (40 to 44) GHz (44 to 48) GHz	0.24 dB 0.20 dB 0.25 dB	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Noise Figure & 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[2, 3, 5] (±)	Comments
Torque Wrenches	(20 to 200) ozf·in	1.5 %	CDI torque system w/ transducers
Pressure – Generate	(0 to 15) psig (15 to 1000) psig	0.016 % of FS 0.01 %	Fluke 6270A, PM500 modules

IV. Thermodynamic

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Temperature – Measure	(-90 to 110) °C	0.010 °C	Fluke SPRT, temperature baths, Fluke Superthermometer

V. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Cesium Frequency Reference –	5 MHz, 10 MHz	1.0×10^{-12} Hz/Hz (Aging rate: 24 h)	HP 5071A cesium clock primary frequency standard w/ high performance option 001
Frequency Offset (GPS Transfer Standard)	10 MHz	2.0×10^{-12} Hz/Hz	Symmetricom-Xli GPS receiver

SATELLITE LOCATION

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS
3520 East Avenue M
Palmdale, CA 93550
Rafael Ojeda Phone: 310 813 7404

I. Mechanical

Parameter/Equipment	Range	CMC[2, 3] (±)	Comments
Torque Wrench	(20 to 200) ozf·in	1.5 %	CDI torque system

II. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Rubidium Frequency Standard – Frequency Reference	10 MHz	7.2×10^{-10} Hz/Hz	Rubidium ball EFRAT MRT-L

SATELLITE LOCATION

NORTHROP GRUMMAN SYSTEMS CORPORATION, AEROSPACE SYSTEMS
15333 Avenue of Science
San Diego, CA 92128
Rafael Ojeda Phone: 310 813 7404

I. Mechanical

Parameter/Equipment	Range	CMC[2, 3] (±)	Comments
Torque Wrench	(20 to 200) ozf·in	1.5 %	CDI torque system

II. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Rubidium Frequency Standard – Frequency Reference	10 MHz	7.2×10^{-10} Hz/Hz	Rubidium Stanford research FS725

[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. 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.

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

[4] This scope meets A2LA's *P112 Flexible Scope Policy*.

[5] 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.

[6] The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

Accredited Laboratory

A2LA has accredited

NORTHROP GRUMMAN SYSTEMS CORPORATION, STRATEGIC SPACE SYSTEMS DIVISION

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 22nd day of June 2022.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3005.01
Valid to July 31, 2024

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