SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: December 31, 2025 Certificate Number: 2995.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory at the location above as well as the one satellite laboratory location listed below to perform the following calibrations[1, 7]:

I. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Rod Antenna[3] – Antenna factor	5 Hz to 60 MHz	0.52 dB	Equivalent capacitance substitution method CISPR 16-1-4, CISPR 16-1-6, ANSI C63.5-2006, SAE ARP958 revision D, IEEE Std 291:1991
Loop Antenna[3] – Antenna Factor	9 kHz to 30 MHz	1.4 dB	IEEE 291 1991
Large Loop Antenna[3] – Validation Factor	9 kHz to 30 MHz	0.46 dB	CISPR 16-1-4

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Current Probe[3] –			
Transfer Impedance & Insertion Loss	5 Hz to 2.1 GHz	0.56 dB	CISPR 16-1-2, IEC 61000-4-6
VSWR	5 Hz to 2.1 GHz	6.2 %	
Electric Field Probe[3] –			
Linearity & Frequency Response (2 to 300) V/m	(0.1 to 200) MHz (200 to 1000) MHz (1 to 2.5) GHz (2.5 to 6) GHz	1.3 dB 1.3 dB 1.3 dB 1.3 dB	IEC61000-4-3:2010 IEEE Std.1309
Rotational Response (Isotropic Deviation) 20 V/m	100 kHz to 6 GHz	0.89 dB	
LISN[3] –			
Impedance	9 kHz to 1 GHz	1.2 %	CISPR 16-1-2, CISPR 25, IEC 61000-4-6
Phase	9 kHz to 1 GHz	0.90 °	
Isolation	9 kHz to 1 GHz	1.8 dB	
Voltage Division Factor	9 kHz to 1 GHz	0.16 dB	
VSWR	9 kHz to 1 GHz	0.96 %	
Voltage Drop	9 kHz to 1 GHz	0.47 %	
Pre-Amplifier[3] –			
Gain	9 kHz to 8.5 GHz (1 to 20) GHz	0.56 dB 0.65 dB	Agilent E5071C, Agilent N5230C, E5061B
Linearity	9 kHz to 8.5 GHz (1 to 20) GHz	0.60 dB 0.61 dB	Agilent E5071C, Agilent N5230C, E5061B
Coupling/Decoupling Network (CDN)[3] –			
Impedance	150 kHz to 230 MHz	1.3 %	IEC61000-4-6
Insertion Loss	150 kHz to 230 MHz	0.11 dB	

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Signal Generator[3] –			
Reference Frequency	10 MHz	0.75 Hz	Keysight E53151A
Frequency Accuracy	1 Hz to 40 GHz	0.59 µHz/Hz	Keysight E5061B, Agilent E53151A & E53152A
Level Accuracy	9 kHz to 40 GHz	0.30 dB	Keysight E5061B, Agilent E4417, E9304A & N8487A
Level Linearity	9 kHz to 40 GHz	0.18 dB	Keysight E5061B, Agilent E4417, E9304A & N8487A
AM Depth	20 Hz to 100 kHz	0.62 %	Hewlett Packard 8901A
VSWR	5 Hz to 8.5 GHz	3.3 %	Agilent E5071C, Agilent N5230C, E5061B
FM Depth	(1 to 50) kHz	0.70 %	Lecroy WM8600A & WR 640Zi
Pulse Modulation Pulse: Rise/Fall Time Pulse Period Pulse Mod. Freq	10 Hz to 10 kHz (1 to 20) ns (0 to 10) kHz DC to 18 GHz	1.8 % 3.2 % 1.8 % 0.99 %	Lecroy WM8600A & WR 640Zi
Phase Modulation	(0 to 6.28) rad	0.12 %	Hewlett Packard 8901A
EM Clamp[3] –			IEC61000-4-6
Insertion Loss Decoupling Impedance	9 kHz to 1 GHz 9 kHz to 1 GHz 9 kHz to 1 GHz	0.073 dB 0.16 dB 3.0 %	
Power Meter/Sensor[3, 6] –			
Calibration Factor	9 kHz to 6 GHz 10 MHz to 18 GHz 50 MHz to 26.5 GHz (26.5 to 40) GHz	0.35 dB 0.37 dB 0.57 dB 0.29 dB	Agilent E4417A, E9304A & N8487A
Linearity	9 kHz to 6 GHz 10 MHz to 18 GHz 50 MHz to 40 GHz	0.21 dB 0.16 dB 0.14 dB	Agilent E4417A, E9304A & N8487A
VSWR	9 kHz to 8.5 GHz (1 to 20) GHz	3.5 % 2.4 %	Agilent E5071C Agilent N5230C

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Power Amplifier[3, 6] –			
Gain	9 kHz to 1 GHz (1 to 6) GHz	1.1 dB 2.0 dB	R&S SMA100A, Agilent E4417A, E9304A
Maximum Output Power	9 kHz to 1 GHz (1 to 6) GHz	1.1 dB 2.0 dB	
Linearity	9 kHz to 6 GHz	0.27 dB	

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Spectrum Analyzer[3] –			CISPR 16-1-1
10 MHz Reference Frequency:	10 MHz	0.75 Hz	
Input Attenuator	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.94 dB 0.92 dB 1.4 dB	
Input Impedance	9 kHz to 20 GHz	5.9 %	
Reference Level Accuracy	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.87 dB 0.91 dB 1.4 dB	
Bandwidth of Selective Filter	9 kHz to 18 GHz	1.2 Hz	
Sine Wave Accuracy	10 Hz to 30 MHz 9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.46 dB 0.88 dB 0.88 dB 1.4 dB	
Spurious Response	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.87 dB 0.85 dB 0.97 dB	
Display Linearity	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.87 dB 0.85 dB 1.4 dB	
Display Scale Fidelity	9 kHz to 12.4 GHz (12.4 to 18) GHz	1.9 dB 2.6 dB	
Noise Floor	DC to 18 GHz	2.6 dB	
Impulse Bandwidth	> 1 GHz	0.22 dB	
Frequency Span	9 kHz to 18 GHz	1.2 Hz	
Center Frequency	9 kHz to 40 GHz	1.2 Hz	
Tracking Generator Output Accuracy	9 kHz to 6 GHz	0.17 dB	

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
EMI Test Receiver[3] –			CISPR 16-1-1
10 MHz Reference Frequency	10 MHz	0.75 Hz	
Sine Wave Accuracy	10 Hz to 30 MHz 9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.47 dB 0.92 dB 0.93 dB 1.4 dB	
Input Impedance (SWR – 1.0 to 3.0)	9 kHz to 20 GHz	5.9 %	
Display Linearity	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.86 dB 0.85 dB 1.3 dB	
Bandwidth of Selective Filter	9 kHz to 18 GHz	1.3 Hz	
Impulse Bandwidth (RBW: 1 MHz)	> 1 GHz	0.22 dB	
CISPR Band A of Pulse Response (Amplitude Relationship: 60 dB)	CISPR Band A	0.67 dB	
CISPR Band B of Pulse Response (Amplitude Relationship: 60 dB)	CISPR Band B	0.67 dB	
CISPR Band C/D of Pulse Response (Amplitude Relationship: 60 dB)	CISPR Band C/D	0.69 dB	
CISPR Band A of Pulse Response (Variation with Repetition Frequency)	CISPR Band A	0.63 dB	

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
EMI Test Receiver[3] – (cont)			
CISPR Band B of Pulse Response (Variation with Repetition Frequency)	CISPR Band B	0.63 dB	CISPR 16-1-1
CISPR Band C/D of Pulse Response (Variation with Repetition Frequency)	CISPR Band C/D	0.63 dB	
CISPR Band B of Pulse Response (Variation with Repetition Frequency: Auxiliary Generator)	CISPR Band B	0.63 dB	
CISPR Band C/D of Pulse Response (Variation with Repetition Frequency: Auxiliary Generator)	CISPR Band C/D	0.90 dB	
Noise Floor	DC to 18 GHz	2.6 dB	
Intermediate Frequency Suppression Ratio	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.84 dB 0.85 dB 0.97 dB	
Image Frequency Suppression Ratio	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.84 dB 0.85 dB 0.97 dB	
Other Spurious Ratio	9 kHz to 6 GHz (6 to 18) GHz (18 to 40) GHz	0.84 dB 0.85 dB 0.97 dB	
CISPR Average Response to Unsteady Narrowband Disturbances	9 kHz to 1 GHz	0.84 dB	
Insertion Loss[3] – Directional Coupler, Coaxial Cable, Attenuator	5 Hz to 3 GHz 9 kHz to 8.5 GHz (1 to 20) GHz (20 to 40) GHz	0.16 dB 0.23 dB 0.23 dB 0.15 dB	Keysight E5061B, Agilent E5071C Agilent N5230C Keysight N5173B N8487A

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
VSWR[3] – 50 Ω Termination, Directional Coupler, Attenuator	5 Hz to 9 kHz 9 kHz to 8.5 GHz (1 to 20) GHz	1.6 % 3.5 % 1.8 %	Keysight E5061B Agilent E5071C, Agilent 85032F calibration kit
Impedance[3] – 50 Ω Termination, Directional Coupler, Attenuator, Antenna	5 Hz to 3 GHz 9 kHz to 8.5 GHz	1.4 % 3.2 %	Keysight E5061B Agilent E5071C, Agilent 85032F calibration kit
ISN / VSWR[3], (Impedance Stabilization Network) –			CISPR 16-1-2, CISPR 22
Termination Impedance	150 kHz to 30 MHz	1.3 %	
Phase of Basic Network Asymmetric Disturbance	150 kHz to 30 MHz	0.85 deg	
Voltage Division Factor of the Asymmetry Between EUT & Measuring Receiver Port	150 kHz to 30 MHz	0.10 dB	
Insertion Loss of the Symmetric Circuit Between EUT & AE Ports	150 kHz to 30 MHz	0.097 dB	
Decoupling Attenuation for Asymmetric Signals Between AE & EUT Ports	150 kHz to 30 MHz	0.17 dB	
Longitudinal Conversion Loss (LCL) at the EUT Port of the Network	150 kHz to 30 MHz	0.25 dB	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Surge Simulator[3, 6] –			
Open-Circuit Front Time	(0 to 10) ms	0.029 µs	IEC61000-4-5
Short-Circuit Front Time	(0 to 10) ms	0.054 µs	
Peak Voltage	(-4 to 4) kV	2.9 %	
Peak Current	(-4 to 4) kV	2.1 %	
Voltage Duration	(0 to 1000) ms	0.38 µs	
Current Duration	(0 to 500) ms	0.13 µs	
Under (Over) Shoot	(-1200 to 1200) V	3.5 %	
Phase	(0 to 20) ms	0.0058 ms	
Burst Tester & High Voltage Unit[3, 6] –			
Front Time	Up to 10 µs	0.31 ns	IEC61000-4-4
Peak Voltage	(-4 to 4) kV	1.8 %	
Pulse Width	(0 to 400) ms	3.6 %	
Residual Test Pulse Voltage	(-400 to 400) V	1.8 %	
Capacitive Coupling Clamp[3, 6] –			
Front Time	(0 to 10) µs	0.31 ns	IEC61000-4-4
Peak Voltage	(-4 to 4) kV	1.8 %	
Pulse Width	(0 to 400) ms	3.6 %	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
ESD Simulator[3] –			IEC61000-4-2 ISO 10605
Peak Current	(-20 to 20) kV	2.1 %	
30 ns Current	(-20 to 20) kV	2.2 %	
60 ns Current	(-20 to 20) kV	2.2 %	
Rise Time	(0 to 1000) ps	0.12 ns	
65 ns Current	(-20 to 20) kV	2.2 %	
130 ns Current	(-20 to 20) kV	2.2 %	
180 ns Current	(-20 to 20) kV	2.1 %	
360 ns Current	(-20 to 20) kV	2.1 %	
400 ns Current	(-20 to 20) kV	2.1 %	
800 ns Current	(-20 to 20) kV	2.1 %	

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Absorbing Clamp[3] –			
Clamp Factor	(30 to 300) MHz 300 MHz to 1 GHz	1.1 dB 2.0 dB	CISPR16-1-3, CISPR16-4-1
Decoupling Factor DF	(30 to 300) MHz 300 MHz to 1 GHz	1.6 dB 2.3 dB	
Decoupling Factor DR	(30 to 300) MHz 300 MHz to 1 GHz	0.50 dB 1.1 dB	
Click Analyzer[3] –			
Count Level	0.1 ms to 1.2 s 150 kHz to 30 MHz (20 to 110) dB/µV	1.2 dB	CISPR 16-1-1

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
High Impedance Probe[3] –			
Voltage Division Factor	9 kHz to 30 MHz	0.23 dB	CISPR 16-1-2
Impedance	9 kHz to 30 MHz	8.2 %	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Power Supply[3] –			
Voltage	Up to 1 kV Up to 4 kV	0.013 % 2.5 %	Agilent 34410A Lecroy WM8600A, Lecroy WR 640Zi
Current	Up to 3 A Up to 40 A	2.2 % 3.4 %	Agilent 34410A Sanwa current clamp
Constant Voltage Load Regulation	Up to 1 kV	0.17 %	Agilent 34410A, load resistor
	Up to 4 kV	2.5 %	Lecroy WM8600A Lecroy WR 640Zi, load resistor
AC Power Supply/CVCF[3] –			IEC61000-3-2
Voltage:			
Up to 750 V Up to 4 kV	(50, 60, 400) Hz (50, 60, 400) Hz	0.20 % 2.6 %	
Current:			
Up to 3 A Up to 40 A	(50, 60, 400) Hz (50, 60, 400) Hz	1.5 % 3.6 %	
Voltage Regulation:			
Up to 750 V Up to 4 kV	(50, 60, 400) Hz (50, 60, 400) Hz	0.23 % 2.5 %	
Frequency	(50, 60, 400) Hz	0.028 %	
Phase	Up to 360°	0.58 %	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Reference Impedance Network[3]–			
Resistance – (0.1 to 10) Ω	(0.05 to 1) kHz	1.4 %	IEC 61000-3-3, IEC 61000-3-2, IEC 61000-3-11, JIS C 61000-3-2
Reactance – (0.1 to 10) Ω	(0.05 to 1) kHz	1.1 %	
Inductance – (0.1 to 1000) mH	(0.05 to 1) kHz	1.9 %	
Capacitive Voltage Probe[3]–			
Voltage Division Factor	9 kHz to 100 MHz	0.12 dB	
RF Output Port VSWR	9 kHz to 100 MHz	1.6 %	CISPR16-1-2
Pulse Response	9 kHz to 30 MHz (30 to 100) MHz	0.67 dB 1.0 dB	
Pulse Repetition Frequency	9 kHz to 30 MHz (30 to 100) MHz	0.63 dB 0.90 dB	
Effect of Electric Field	9 kHz to 100 MHz	0.38 dB	
CMAD (Common Mode Absorption Device) [3]–			
S11 Magnitude	9 kHz to 1 GHz	3.4 %	CISPR16-1-4
S21 Magnitude	9 kHz to 1 GHz	1.2 %	

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Normalized Site Attenuation[3]	30 MHz to 1 GHz	1.2 dB	CISPR 16-1-4, ANSI C63.4
Site Voltage Standing Wave Ratio (SVSWR)[3]	(1 to 6) GHz (6 to 18) GHz	0.7 dB 0.73 dB	CISPR 16-1-4

SATELLITE FACILITY

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I. Electrical – RF/Microwave

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Antenna Factor[3] –			
Reference Antenna Method:			ANSI C63.5-2017 ANSI C63.5-2006
Dipole Antenna – Horizontal Polarization	(30 to 1000) MHz	0.74 dB	
Broadband Antenna – Horizontal Polarization	(30 to 1000) MHz	1.1 dB	
Double Ridged Guide Horn[4] – Horizontal Polarization	(1 to 18) GHz	1.1 dB	
Standard Site Method: Broadband Antenna Types			
Tunable Dipole – Horizontal Polarization	(30 to 1000) MHz	1.1 dB	ANSI C63.5 2006 ANSI C63.5-2017 CISPR 16-1-6

Parameter/Equipment	Frequency	CMC[2] (±)	Comments
Antenna Factor[3] – (cont)			
Broadband Hybrid – Horizontal & Vertical Polarization	(20 to 30) MHz (30 to 300) MHz (300 to 1000) MHz (1000 to 3000) MHz	1.7 dB 0.72 dB 0.71 dB 0.96 dB	ANSI C63.5-2017 CISPR 16-1-6 ANSI C63.5-2006 ANSI C63.5-1998 ARP 958 rev. D
Biconical Dipole – Horizontal & Vertical Polarization	(20 to 30) MHz (30 to 300) MHz	1.7 dB 0.72 dB	ANSI C63.5-2017 CISPR 16-1-6 ANSI C63.5-2006 ANSI C63.5-1998 ARP958 rev. D
Log Periodic Array – Horizontal & Vertical Polarization	(200 to 1000) MHz (1000 to 3000) MHz	0.71 dB 0.96 dB	
Double Ridged Guide Horn – Horizontal & Vertical Polarization	(1 to 18) GHz	0.84 dB	ANSI C63.5-2017 CISPR 16-1-6 ANSI C63.5-2006 SAE ARP958 rev. D
Standard Gain Horn – Horizontal & Vertical Polarization	(1 to 18) GHz	0.84 dB	ANSI C63.5-2017 CISPR 16-1-6 ANSI C63.5-2006
For NSA –			
Biconical Dipole – Horizontal & Vertical Polarization	(30 to 300) MHz	0.72 dB	ANSI C63.5-2017 ANSI C63.5-2006 ANSI C63.5-1998
Log Periodic Array – Horizontal & Vertical Polarization	(200 to 1000) MHz	0.71 dB	CISPR 16-1-6
Biconical, Log Periodic, Hybrid Antenna – Horizontal & Vertical Polarization			
Antenna Symmetry – Vertical Polarization	30 MHz to 1 GHz (1 to 18) GHz	0.53 dB 0.76 dB	ANSI C63.5 – 2017 CISPR 16-1-4
Cross-Polar Response – Horizontal/ Vertical Polarization	30 MHz to 1 GHz (1 to 18) GHz	0.56 dB 0.76 dB	ANSI C63.5 - 2017 CISPR 16-1-4

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
VSWR[3] – Antennas	30 MHz to 20 GHz	1.8 %	Keysight N5230C, calibration kit

[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] Field calibration service is available for this calibration. 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.

[4] Distance between horn or double ridge guide antennas being calibrated are at a distance equal to or greater than R = 2D2 /wavelength; with calibrated distance is not less than R = 0.5D2 /wavelength. D is the largest linear dimension (e.g., width or height) of the aperture of the antenna and the wavelength is for the frequency being considered, both in meters. (Derived from ANSI C63.5-2006, clause 5.2). No calibration shall be performed at R < 0.62(D3/λ)-0.5. Antenna Factor measured at distances of 0.62(D3/λ)-0.5 <= R >= 2 D2/λ) shall be deemed acceptable at the calibrated distance. Antenna Factor measured at distances of R >= 2 D2/λ) shall be deemed acceptable at the calibrated distance and greater. (Derived from ANSI C63.5-2017, clause 5.1.3.1). Separation distance of 3 meters is normally used between the front face of the antennas.

[5] In the statement of CMC, percentages are to be read as percentage of reading, unless otherwise noted.

[6] In the statement of CMC, uncertainty does not include mismatch error due to connections of the device to other devices in actual use. Mismatch uncertainties, due to the reflection coefficient of the device to be calibrated, are to be included in the overall measurement uncertainty. The approach of determining expanded uncertainties at approximately the 95% level of confidence, (using a coverage factor of k = 2) is to be applied for this calculation as well. All other uncertainties include the mismatch error.

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

Accredited Laboratory

A2LA has accredited

TOYO EMC ENGINEERING

Tsukuba-City, Ibaraki, JAPAN

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 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 29th day of February 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2995.01
Valid to December 31, 2025
Revised July 17, 2024

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