SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: June 30, 2027 Certificate Number: 2296.01

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory at the location above as well as the two satellite laboratory locations listed below to perform the following calibrations[1, 11]:

I. Acoustical Quantities

Parameter/Equipment[5]	Frequency	CMC[2] (±)	Comments[6]
Microphone[3]	250 Hz	0.40 dB	Microphone

II. Electrical DC & Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 12] (±)	Comments[6]
DC Voltage[3] – Generate	(0 to 32.9999) mV (33.000 to 77.999) mV (78.000 to 119.999) mV (120.000 to 329.999) mV (330.00 to 779.99) mV (0.780 00 to 1.199 99) V (1.200 00 to 3.299 99) V	61 µV 0.27 mV/V 0.14 mV/V 0.17 mV/V 87 µV/V 60 µV/V 0.12 mV/V	Fluke 5520A

Parameter/Equipment	Range	CMC[2, 4, 12,13,14] (±)	Comments[6]
DC Voltage[3] – Generate (cont)	(3.3000 to 7.7999) V (7.8000 to 11.9999) V (12.0000 to 32.9999) V (33.000 to 77.999) V (78.000 to 119.999) V (120.000 to 329.999) V	65 µV/V 49 µV/V 0.15 mV/V 84 µV/V 63 µV/V 0.2 mV/V	Fluke 5520A
DC Voltage[3] – Measure PQT[3] Output Voltage Inrush Current EFT/Burst Generator[3] (50, 1000) Ω Load Surge Generator[3] Open & Short Circuit Voltage Current Transient Immunity[3] Surge Pulse & Load Dump Pulse Peak Amplitude & Burst Pulse Peak Amplitude	 Up to 260 V (0.001 to 1) kA (0.1 to 5) kV (0.001 to 8) kV (0.001 to 4) kA (1 to 1000) V	 3.9 % + *R* 6.9 % 5.3 % 4.3 % 4.3 % 4.0 %	 IEC/EN 61000-4-11, oscilloscope IEC/EN 61000-4-4, oscilloscope IEC/EN 61000-4-5, IEC/EN 61000-4-5 (2005), oscilloscope ISO 7637-2, ISO 7637-2 (2004), ISO 16750-2, JASO D 001 oscilloscope
Resistance[3] – Measure	5 mΩ to 100 kΩ	0.018 % of reading + 0.005 % of range	DMM (2-wire measurement)

Parameter/Range	Frequency	CMC[2, 4, 12,13] (±)	Comments[6]
AC Voltage[3] – Generate			
(48.000 to 77.999) mV	1 kHz	0.19 %	Fluke 5520A
(78.000 to 119.999) mV	1 kHz	0.14 %	
(120.00 to 189.99) mV	1 kHz	0.37 %	
(190.00 to 329.00) mV	1 kHz	0.26 %	
(330.00 to 479.99) mV	1 kHz	0.18 %	
(480.00 to 779.99) mV	1 kHz	0.14 %	
(0.780 00 to 1.199 99) V	1 kHz	0.11 %	
(1.2000 to 1.8999) V	1 kHz	0.36 %	
(1.9000 to 3.2999) V	1 kHz	0.25 %	
(3.3000 to 4.7999) V	1 kHz	0.18 %	
(4.8000 to 7.7999) V	1 kHz	0.14 %	
(7.8000 to 11.9999) V	1 kHz	0.11 %	
(12.000 to 18.999) V	1 kHz	0.38 %	
(19.000 to 32.999) V	1 kHz	0.26 %	
(33.000 to 77.999) V	1 kHz	0.18 %	
(78.000 to 119.999) V	1 kHz	0.11 %	
(120.00 to 329.99) V	1 kHz	0.31 %	
AC Voltage – Measure[3, 7]			
Series Voltage Drop LISN, AN, AMN	(100, 200, 230) V 50/60 Hz	0.25 % of reading	CISPR16-1-2 using: power analyzer
PQT[3] Output Voltage	Up to 260 V (50 to 60) Hz	3.9 %	IEC/EN 61000-4-11, oscilloscope

III. Electrical - RF/Microwave Device Specific Parameters

Parameter/Range[5]	Frequency	CMC[2] (±)	Comments[6]
Displayed Frequency Accuracy[3]	9 kHz to 30 MHz 30 MHz to 1 GHz (1 to 10) GHz (10 to 40) GHz	10 Hz 30 Hz 300 Hz 300 Hz	Signal generator, frequency standard
Span Readout Accuracy[3]	9 kHz to 40 GHz	0.7 % of reading	Signal generator, frequency standard
Intercept Point Accuracy[3] –			
3rd Order (IP3)	9 kHz to 3 GHz (3 to 8) GHz (8 to 40) GHz	1.8 dB 3.1 dB 3.9 dB	Signal generator, frequency standard
2nd Order (IP2)	9 kHz to 1 GHz (1 to 8) GHz (8 to 13) GHz	1.7 dB 2.9 dB 3.6 dB	
Absolute Amplitude Accuracy[3] –			
Calibration of Measurement Function (-70 to +20) dBm	9 kHz to 1 GHz (1 to 18) GHz (18 to 40) GHz	0.23 dB 0.40 dB 0.50 dB	Signal generator, frequency standard, power meter, power sensor, attenuator
Calibration of Signal Source (-70 to +20) dBm	9 kHz to 6 GHz 10 MHz to 18 GHz (18 to 40) GHz	0.17 dB 0.24 dB 0.21 dB	Assuming “0” reflection coefficient at input of device under test
Power Meter Ref. Out	50 MHz, 0 dBm	0.04 dB	

Parameter/Range[5]	Frequency	CMC[2] (±)	Comments[6]
Amplitude Modulation[3] –			
Carrier Frequency	(0.15 to 10) MHz	2.1 % of reading	Modulation analyzer Spectrum analyzer
Modulation Frequency 400 Hz to 3 kHz	(10 to 1300) MHz	1.3 % of reading	
Modulation Index (30 to 95) %	(1 to 18) GHz	2.5 % of reading	
Frequency Modulation[3] –			
Carrier Frequency (Modulation Frequency: (0.3 to 10) kHz; FM Deviation: (1 to 200) kHz)	(0.25 to 10) MHz (10 to 1300) MHz	2.5 % of reading 1.3 % of reading	Modulation analyzer
Pulse Modulation[3] –			
Carrier Frequency: 150 kHz to 6 GHz			
Rise & Fall Time	(0 to 90) %	6 % of reading + 70 ps	Oscilloscope
Pulse Width	(1 to 3) µs (3 to 10) µs 10 µs to 1 ms (1 to 3) ms (3 to 10) ms (10 to 30) ms	1.5 % of reading 0.5 % of reading 0.2 % of reading 0.01 % of reading 0.02 % of reading 0.01 % of reading	
Reference Level[3] (-80 to +10) dBm	9 kHz to 1 GHz (1 to 18) GHz	0.17 dB 0.48 dB	Signal generator, frequency standard, attenuator
Attenuator Check[3] – Calibration of Attenuation Measurement Function			
(0 to 110) dB	9 kHz to 1 GHz (1 to 8) GHz (8 to 18) GHz	0.25 dB 0.35 dB 0.63 dB	Signal generator, frequency standard, attenuator

Parameter/Range[5]	Frequency	CMC[2] (±)	Comments[6]
Attenuation – Measure[3]			
(0 to 110) dB	9 kHz to 1 MHz 1 MHz to 12 GHz (12 to 30) GHz (30 to 40) GHz	0.36 dB 0.25 dB 0.32 dB 0.52 dB	Spectrum analyzer
Marker Amplitude Readout Accuracy[3]	9 kHz to 1 GHz (1 to 18) GHz (18 to 40) GHz	0.23 dB 0.40 dB 0.50 dB	Signal generator, frequency standard, power meter, power sensor, attenuator Assuming "0" reflection coefficient at input of device under test.
Log Fidelity[3] –			
(1 to 49) dB (50 to 70) dB (71 to 80) dB (81 to 90) dB	9 kHz to 1 GHz	0.18 dB 0.19 dB 0.21 dB 0.22 dB	Signal generator, frequency standard, attenuator
(91 to 100) dB	1 MHz to 1 GHz	0.25 dB	
(101 to 110) dB (111 to 120) dB	5 MHz to 1 GHz	0.24 dB 0.31 dB	
(1 to 80) dB (81 to 90) dB (91 to 100) dB (101 to 110) dB (111 to 120) dB	(1 to 8) GHz	0.28 dB 0.35 dB 0.35 dB 0.50 dB 0.70 dB	
(1 to 80) dB (81 to 90) dB (91 to 100) dB (101 to 110) dB (111 to 120) dB	(8 to 18) GHz	0.53 dB 0.58 dB 0.58 dB 0.70 dB 0.87 dB	

Parameter/Equipment[5]	Frequency	CMC[2] (±)	Comments[6]
Bandwidth Accuracy[3, 7]	9 kHz to 1 GHz (1 to 18) GHz	2 % of reading 3.5 % of reading	Signal generator, frequency standard, attenuator
Bandwidth Switching Accuracy[3]	9 kHz to 1 GHz (1 to 18) GHz	0.1 dB 0.1 dB	Signal generator, frequency standard, attenuator
Harmonic Measurements[3]	9 kHz to 18 GHz	1.8 dB	Signal generator, frequency standard, power meter, power sensor, spectrum analyzer Assuming "0" reflection coefficient at input of device under test
Displayed Average Noise Level[3]	9 kHz to 3.6 GHz (3.6 to 8) GHz (8 to 40) GHz	1.2 dB 2.0 dB 2.7 dB	50 Ω termination
Frequency Response[3] – Measuring Equipment	9 kHz to 1 GHz (1 to 18) GHz (18 to 40) GHz	0.23 dB 0.40 dB 0.50 dB	Signal generator, frequency standard, power meter, power sensor, attenuator Assuming "0" reflection coefficient at input of device under test
Frequency Response[3] – Generator	9 kHz to 6 GHz 10 MHz to 18 GHz (18 to 40) GHz	0.17 dB 0.24 dB 0.21 dB	Power meter, power sensor Assuming "0" reflection coefficient at input of device under test

Parameter/Equipment[5]	Range	CMC[2] (±)	Comments[6]
CISPR Amplitude Calibration[3, 7 –]			
Pulse Repetitions	Bands A/B/C/D/E	0.65 dB	CISPR pulse generator, signal generator, power meter, power sensor, function generator
Relative Amplitude		0.77 dB	
Amplitude Relationship		0.66 dB	
Response To Intermittent, Unsteady & Drifting Narrowband Disturbances		0.65 dB	
Impedance[3, 7] – Measure			VNA with calibration kit
LISN, AN, AMN	9 kHz to 200 MHz	0.6 Ω	CISPR16-1-2, ANSI C63.4
CDNs	(0.1 to 230) MHz	4.7 Ω	IEC/EN 61000-4-6
Terminator	9 kHz to 500 MHz 45 MHz to 18 GHz	0.6 Ω 1.4 Ω	
Impedance Phase Angle[3, 7]			VNA with calibration kit
LISN, AN, AMN	9 kHz to 110 MHz	6.3 deg (Reflection Coefficient > 0.01(lin))	CISPR16-1-2(2006), CISPR16-1-2 ANSI C63.4(2003/2009) ANSI C63.4
	(110 to 200) MHz	6.4 deg (Reflection Coefficient > 0.01(lin))	

Parameter/Equipment[5]	Frequency	CMC[2,13] (±)	Comments[6]
Insertion Loss[3, 7, 9] –			VNA with calibration kit
LISN, AN, AMN (Voltage Division Factor, Isolation)	9 kHz to 30 MHz (30 to 200) MHz	0.34 dB 0.45 dB	CISPR16-1-2, ANSI C63.4
CDNs, (50 to 150) Ω Adapters	9 kHz to 230 MHz	0.18 dB	IEC/EN 61000-4-6
Current Injection /Monitor Probes (Transfer Impedance) Calibration Fixture	(10 to 300) kHz 300 kHz to 200 MHz (200 to 400) MHz (400 to 1000) MHz	0.23 dB 0.31 dB 0.44 dB 0.86 dB	CISPR16-1-2, IEC/EN 61000-4-6 ISO11452-4
Amplifiers (Gain), Attenuators, Directional Couplers (Coupling Factor, Isolation), RF Cables & Filters	9 kHz to 10 MHz 10 MHz to 2 GHz (2 to 8) GHz (8 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz	0.06 dB 0.07 dB 0.08 dB 0.14 dB 0.17 dB 0.18 dB	
Calibration Factor[3] –			
Power Sensor	9 kHz to 6 GHz 10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 40 GHz	2.0 % of reading 3.2 % of reading 3.9 % of reading 4.6 % of reading	Signal generator, power meter, power sensor, power splitter
Pulse Area[3, 7] –			
CISPR Pulse Generator	9 kHz to 1 GHz	5.3 % of reading	CISPR16-1-1 using oscilloscope
Spectrum Flatness[3, 7] –			
CISPR Pulse Generator	9 kHz to 1 GHz	0.35 dB	Power meter, power sensor, signal generator, EMI test receiver

Parameter/Range	Frequency	CMC[2, 10] (±)	Comments
Reflection S_{11}/S_{22}, Magnitude & Phase (VSWR) – Measure[3]			
(0 to 0.4) lin	9 kHz to 10 MHz	(0.004 to 0.008) lin	Network analyzer with calibration kit
(0.4 to 0.6) lin		(0.008 to 0.01) lin	
(0.6 to 0.8) lin		(0.01 to 0.014) lin	
(0.8 to 1) lin		(0.014 to 0.017) lin	
(0 to 0.2) lin		(1.6 to 180) deg	
(0.2 to 0.4) lin		(1.1 to 1.6) deg	
(0.4 to 1) lin		(1.0 to 1.1) deg	
(0 to 0.4) lin	10 MHz to 2 GHz	(0.005 to 0.011) lin	
(0.4 to 0.6) lin		(0.011 to 0.015) lin	
(0.6 to 0.8) lin		(0.015 to 0.02) lin	
(0.8 to 1) lin		(0.02 to 0.027) lin	
(0 to 0.2) lin		(2.1 to 180) deg	
(0.2 to 1) lin		(1.4 to 2.1) deg	
(0 to 0.2) lin	(2 to 8) GHz	(0.009 to 0.011) lin	
(0.2 to 0.4) lin		(0.011 to 0.015) lin	
(0.4 to 0.6) lin		(0.015 to 0.021) lin	
(0.6 to 0.8) lin		(0.021 to 0.029) lin	
(0.8 to 1) lin		(0.029 to 0.028) lin	
(0 to 0.2) lin		(3.2 to 180) deg	
(0.2 to 1) lin		(2.2 to 3.2) deg	
(0 to 0.2) lin	(8 to 18) GHz	(0.009 to 0.011) lin	
(0.2 to 0.4) lin		(0.011 to 0.015) lin	
(0.4 to 0.6) lin		(0.015 to 0.021) lin	
(0.6 to 0.8) lin		(0.021 to 0.029) lin	
(0.8 to 1) lin		(0.029 to 0.038) lin	
(0 to 0.2) lin		(3.2 to 180) deg	
(0.2 to 1) lin		(2.2 to 3.2) deg	

Parameter/Range	Frequency	CMC[2, 10] (±)	Comments
Reflection S_{11}/S_{22}, Magnitude & Phase (VSWR)– Measure[3] (cont)			
(0 to 0.2) lin (0.2 to 0.4) lin (0.4 to 0.6) lin (0.6 to 0.8) lin (0.8 to 1) lin	(18 to 26.5) GHz	(0.0074 to 0.0094) lin (0.094 to 0.014) lin (0.014 to 0.02) lin (0.02 to 0.03) lin (0.03 to 0.04) lin	Network analyzer with calibration kit
(0 to 0.2) lin (0.2 to 1) lin		(2.7 to 180) deg (2.3 to 2.7) deg	
(0 to 0.2) lin (0.2 to 0.4) lin (0.4 to 0.6) lin (0.6 to 0.8) lin (0.8 to 1) lin	(26.5 to 40) GHz	(0.0017 to 0.02) lin (0.02 to 0.025) lin (0.025 to 0.031) lin (0.031 to 0.041) lin (0.041 to 0.052) lin	
(0 to 0.2) lin (0.2 to 1) lin		(5.6 to 180) deg (3.0 to 5.6) deg	
Transmission S_{12}/S_{21}, Magnitude & Phase – Measure[3]			
(0 to -10) dB	9 kHz to 10 MHz	(0.045 to 0.056) dB (0.3 to 0.37) deg	Network analyzer with calibration kit non-reflecting device
(-10 to -20) dB		(0.056 to 0.068) dB (0.37 to 0.45) deg	
(-20 to -30) dB		(0.068 to 0.098) dB (0.45 to 0.65) deg	
(-30 to -40) dB		(0.098 to 0.18) dB (0.65 to 1.1) deg	
(-40 to -50) dB		(0.18 to 0.42) dB (1.1 to 2.8) deg	
(-50 to -60) dB		(0.42 to 1.2) dB (2.8 to 8.4) deg	

Parameter/Range	Frequency	CMC[2, 10] (±)	Comments
Transmission S_{12}/S_{21}, Magnitude & Phase – Measure[3] (cont)			
(0 to -10) dB	10 MHz to 2 GHz	(0.055 to 0.065) dB (0.37 to 0.43) deg	Network analyzer with calibration kit non-reflecting device
(-10 to -20) dB		(0.065 to 0.076) dB (0.43 to 0.5) deg	
(-20 to -30) dB		(0.076 to 0.097) dB (0.5 to 0.65) deg	
(-30 to -40) dB		(0.097 to 0.13) dB (0.65 to 0.81) deg	
(-40 to -50) dB		(0.13 to 0.16) dB (0.81 to 1.1) deg	
(-50 to -60) dB		(0.16 to 0.24) dB (1.1 to 1.6) deg	
(0 to -10) dB	(2 to 8) GHz	(0.076 to 0.081) dB (0.5 to 0.54) deg	
(-10 to -20) dB		(0.081 to 0.086) dB (0.54 to 0.57) deg	
(-20 to -30) dB		(0.086 to 0.09) dB (0.57 to 0.6) deg	
(-30 to -40) dB		(0.09 to 0.096) dB (0.6 to 0.64) deg	
(-40 to -50) dB		(0.096 to 0.11) dB (0.64 to 0.7) deg	
(-50 to -60) dB		(0.11 to 0.15) dB (0.7 to 0.99) deg	

Parameter/Range	Frequency	CMC[2, 10] (±)	Comments
Transmission S_{12}/S_{21}, Magnitude & Phase – Measure[3] (cont)			
(0 to -10) dB	(8 to 18) GHz	(0.1 to 0.11) dB (0.66 to 0.7) deg	Network analyzer with calibration kit non-reflecting device
(-10 to -20) dB		(0.11 to 0.11) dB (0.7 to 0.73) deg	
(-20 to -30) dB		(0.11 to 0.12) dB (0.73 to 0.76) deg	
(-30 to -40) dB		(0.12 to 0.12) dB (0.76 to 0.8) deg	
(-40 to -50) dB		(0.12 to 0.13) dB (0.8 to 0.86) deg	
(-50 to -60) dB		(0.13 to 0.17) dB (0.86 to 1.13) deg	
(0 to -10) dB	(18 to 26.5) GHz	(0.11 to 0.12) dB (0.73 to 0.76) deg	
(-10 to -20) dB		(0.12 to 0.12) dB (0.76 to 0.79) deg	
(-20 to -30) dB		(0.12 to 0.13) dB (0.79 to 0.82) deg	
(-30 to -40) dB		(0.13 to 0.13) dB (0.82 to 0.86) deg	
(-40 to -50) dB		(0.13 to 0.14) dB (0.86 to 0.92) deg	
(-50 to -60) dB		(0.14 to 0.18) dB (0.92 to 1.18) deg	

Parameter/Range	Frequency	CMC[2, 10] (±)	Comments
Transmission S_{12}/S_{21}, Magnitude & Phase – Measure[3] (cont)			
(0 to -10) dB	(26.5 to 40) GHz	(0.18 to 0.18) dB (1.2 to 1.2) deg	Network analyzer with calibration kit non-reflecting device
(-10 to -20) dB		(0.18 to 0.19) dB (1.2 to 1.2) deg	
(-20 to -30) dB		(0.19 to 0.19) dB (1.2 to 1.3) deg	
(-30 to -40) dB		(0.19 to 0.2) dB (1.3 to 1.3) deg	
(-40 to -50) dB		(0.2 to 0.22) dB (1.3 to 1.4) deg	
(-50 to -60) dB		(0.22 to 0.33) dB (1.4 to 2.2) deg	

IV. Mechanical

Parameter/Range[5]	Frequency	CMC[2] (±)	Comments[6]
Accelerometers[3] –			
(0.98 to 100) m/s^2	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz (0.921 to 5) kHz (5 to 10) kHz (10 to 15) kHz (15 to 20) kHz	1.8 % of reading 1.3 % of reading 1.2 % of reading 1.3 % of reading 1.4 % of reading 2.2 % of reading 2.6 % of reading 4.2 % of reading	Reference PCB Accelerometer, data acquisition card & shaker
Shock Accelerometer[3]	(20 to 2000) g (2000 to 10 000) g	2.4 % of reading 2.4 % of reading	Data acquisition card, reference shock accelerometer, shock exciter

V. Time & Frequency

Parameter/Equipment[5]	Frequency	CMC[2, 12, 13] (±)	Comments[6]
Time Interval & Frequency[3] –			
EFT/Burst Generator[3] (50, 1000) Ω Load			
Rise Time	(2 to 7) ns	5.5 %	IEC/EN 61000-4-4, oscilloscope
Impulse Duration	(30 to 170) ns	4.0 %	
Burst Duration	(0.5 to 20) ms	3.3 %	
Burst Period	(200 to 400) ms	3.3 %	
Repetition Frequency	1 kHz to 1 MHz	3.3 %	
Surge Generator[3] Open & Short Circuit			
Front Time, Rise Time	(0.3 to 13) µs	3.8 %	IEC/EN 61000-4-5, IEC/EN 61000-4-5 (2005), oscilloscope
Time to Half Value, Duration	(10 to 900) µs	3.6 %	
Open Circuit Phase Shifting	Up to 20 ms	3.6 %	

Parameter/Equipment[5]	Range	CMC[2, 12, 13,14] (±)	Comments[6]
Time Interval & Frequency[3] (cont) –			
Voltage Transient Emission[3]			
Switching Time	(200 to 400) ns	3.3 %	ISO 7637-2, ISO 7637-2 (2004), oscilloscope
Transient Immunity[3] Surge Pulse & Load Dump Pulse			
Rise Time	0.4 µs to 15 ms	4.4 %	ISO 7637-2, ISO 7637-2 (2004), ISO 16750-2, JASO D 001 oscilloscope
Duration	0.1 µs to 700 ms	4.1 %	
Transient Immunity[3] Burst Pulse			
Rise Time	(3 to 7) ns	5.3 %	ISO 7637-2, ISO 7637-2 (2004), oscilloscope
Duration	(30 to 200) ns	5.3 %	
PQT[3]			
Phase Angle	Up to 359 °	3.3 % + *R*	IEC/EN 61000-4-11, oscilloscope
Pulse Rise/Fall Time	(1 to 5) µs	5.3 %	
Voltage Dropout Time	20 µs to 200 ms	3.3 %	Oscilloscope
Repetition Time	1 ms to 5 s	3.3 %	
Frequency – Measure[3] (Generating Devices)	0.1 Hz to 9 kHz 9 kHz to 10 MHz (10 to 100) MHz	0.1 mHz 10 mHz 100 mHz	Frequency counter, frequency standard
	100 MHz to 15 GHz (15 to 40) GHz	1×10^{-9} Hz/Hz 1×10^{-9} Hz/Hz	After 72 h warm-up period for frequency standard

SATELLITE FACILITY

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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 %	
E-field Probe[3] —			
Frequency Response, Linearity	100 kHz to 80 MHz 80 MHz to 1 GHz (1 to 3.2) GHz (3.2 to 6) GHz (1.2 to 3.2) GHz	0.98 dB 0.96 dB 0.97 dB 0.95 dB 1.1 dB	IEEE Std 1309 Transfer standard method using GTEM cell using Anechonic chamber
Isotropic Response	10 kHz to 6 GHz	0.31dB	
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		0.47 %	
Pre-Amplifier[3] –			
Gain	9 kHz to 8.5 GHz (1 to 20) GHz	0.56 dB 0.65 dB	Network analyzer with calibration kit
Linearity	9 kHz to 8.5 GHz (1 to 20) GHz	0.60 dB 0.61 dB	
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	Frequency counter
Frequency Accuracy	1 Hz to 40 GHz	0.59 µHz/Hz	
Level Accuracy	9 kHz to 40 GHz	0.30 dB	Network analyzer with calibration kit, power meter, power sensor
Level Linearity	9 kHz to 40 GHz	0.18 dB	
AM Depth	20 Hz to 100 kHz	0.62 %	Modulation analyzer
VSWR	5 Hz to 8.5 GHz	3.3 %	Network analyzer with calibration kit
FM Depth	(1 to 50) kHz	0.70 %	Oscilloscope
Pulse Modulation	10 Hz to 10 kHz	1.8 %	
Pulse:			
Rise/Fall Time	(1 to 20) ns	3.2 %	
Pulse Period	(0 to 10) kHz	1.8 %	
Pulse Mod. Freq	DC to 18 GHz	0.99 %	
Phase Modulation	(0 to 6.28) rad	0.12 %	Modulation analyzer
EM Clamp[3] –			IEC61000-4-6
Insertion Loss	9 kHz to 1 GHz	0.073 dB	
Decoupling	9 kHz to 1 GHz	0.16 dB	
Impedance	9 kHz to 1 GHz	3.0 %	
Power Meter/Sensor[3, 8] –			
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	Signal generator, power meter, power sensor
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	
VSWR	9 kHz to 8.5 GHz (1 to 20) GHz	3.5 % 2.4 %	Network analyzer with calibration kit

Parameter/Equipment	Frequency	CMC[2, 5] (±)	Comments
Power Amplifier[3, 8] –			
Gain	9 kHz to 1 GHz (1 to 6) GHz	1.1 dB 2.0 dB	Signal generator, power meter, power sensor
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	

Parameter/Equipment	Frequency	CMC[2,13] (±)	Comments
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	Network analyzer with calibration kit Signal generator, power meter, power sensor
Impedance[3] – 50 Ω Termination, Directional Coupler, Attenuator, Antenna	5 Hz to 3 GHz 9 kHz to 8.5 GHz	1.4 % 3.2 %	Network analyzer with calibration kit
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
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, 13] (±)	Comments
Surge Simulator[3, 8] –			
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) kA	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, 8] –			
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, 8] –			
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, 13] (±)	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, 13] (±)	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, 13] (±)	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, 13] (±)	Comments
DC Power Supply[3] –			
Voltage	Up to 1 kV Up to 4 kV	0.013 % 2.5 %	DMM Oscilloscope
Current	Up to 3 A Up to 40 A	2.2 % 3.4 %	DMM Current clamp
Constant Voltage Load Regulation	Up to 1 kV	0.17 %	DMM, load resistor
	Up to 4 kV	2.5 %	Oscilloscope, 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, 13] (±)	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]–			
S_{11} Magnitude	9 kHz to 1 GHz	3.4 %	CISPR16-1-4
S_{21} 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[8] – 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 CISPR 16-1-6
Log Periodic Array – Horizontal & Vertical Polarization	(200 to 1000) MHz	0.71 dB	
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, 13] (±)	Comments
VSWR[3] – Antennas	30 MHz to 20 GHz	1.8 %	Network analyzer with calibration kit

[1] This laboratory offers commercial calibration service and field 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] The measurands stated are generated with the Fluke 5520A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

[5] Some of the types of instruments calibrated under these parameters are EMI Receivers, EFT/Burst Generators, Surge Generators, Generators for Voltage Dips, Short Interrupts and Variations, Ring Wave Generators, Network Analyzers, Pulse Generators, Power Meters, Power Sensors, Signal Generators, Spectrum Analyzers, Attenuators, Terminations, Power Analyzer, CVCF power supply and Audio Analyzer.

[6] For standards or methods listed below without a revision date, laboratories are expected to be competent in the use of the current version within one year of the date of publication of the standard test method or upon the date specified by the standard test method originator when the originator has implementation authority. When a superseded standard or method is required for an accredited test, the scope will include the superseded date/version.

[7] Instruments are calibrated against standard's specifications. These calibrations may also, at customer request, be based on conformance to the calibration requirements of various standards such as ANSI C63.2, CISPR 16-1-1, CISPR 16-1-2, CISPR 25. Other standards may apply and the customer should contact the lab for further information.

[8] 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.

[9] CMCs do not include mismatch error due to connections of the device to other devices in actual use. Mismatch CMCs, 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 CMCs at approximately the 95% level of confidence, (using a coverage factor of k=2) is to be applied for this calculation as well.

[10] CMC for intermediate values of the measurand can be found by interpolation.

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

[12] The contributions from the best existing device are not included in the CMC claim.

[13] In the statement of CMC, the percentages are percentages of reading, unless otherwise noted.

[15] In the statement of CMC, R is the numerical value of the resolution of the unit under test.

Accredited Laboratory

A2LA has accredited

TOYO CORPORATION CALIBRATION LABORATORY

Tokyo, 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 the requirements of 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 30th day of July 2025.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2296.01
Valid to June 30, 2027

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