



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

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CALIBRATION

Valid To: October 31, 2019

Certificate Number: 2123.01

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

I. Electrical – RF/Microwave

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|------------------------------|-------------------|----------------------|--|
| ISN ³ – | | | CISPR 22, CISPR 32, CISPR 16-1-2 |
| Phase | 150 kHz to 80 MHz | 3.0° | HP 8751A & HP 87512A E5071C, HP 4395A |
| Insertion Loss | 150 kHz to 80 MHz | 0.36 dB | |
| Impedance | 150 kHz to 80 MHz | 2.4 Ω | |
| Longitudinal Conversion Loss | 150 kHz to 80 MHz | 0.88 dB | |
| Decoupling Attenuation | 150 kHz to 80 MHz | 0.36 dB | |

| Parameter/Equipment | Frequency | CMC ^{2, 4, 5} (\pm) | Comments | |
|---|-----------------------|----------------------------------|--|--------------|
| LISN ³ – | | | ANSI C63.4, CISPR 25 & CISPR 16-1-2, ISO 7637-2 | |
| Insertion Loss | 9 kHz to 108 MHz | 0.66 dB + <i>M</i> | HP 8751A & HP 87512A, BNC & Type “N” calibration standards | |
| | (108 to 400) MHz | 0.86 dB + <i>M</i> | | |
| | 150 kHz to 100 MHz | 0.38 dB | | |
| | (100 to 200) MHz | 0.61 dB | | |
| | (200 to 400) MHz | 1.4 dB | | |
| | (400 to 600) MHz | 1.3 dB | | |
| | (600 to 800) MHz | 1.4 dB | | |
| | 800 MHz to 1 GHz | 2.3 dB | | |
| | Impedance – Magnitude | 9 kHz to 100 MHz | | 0.2 Ω |
| | | (100 to 200) MHz | | 0.7 Ω |
| (200 to 400) MHz | | 1.2 Ω | | |
| 150 kHz to 100 MHz | | 0.35 Ω | | |
| (100 to 200) MHz | | 1.3 Ω | | |
| (200 to 400) MHz | | 2.3 Ω | | |
| (400 to 600) MHz | | 2.2 Ω | | |
| (600 to 800) MHz | | 1.9 Ω | | |
| 800 MHz to 1 GHz | | 2.2 Ω | | |
| Impedance – Phase | | 9 kHz to 100 MHz | 3.6° | |
| | (100 to 200) MHz | 3.4° | | |
| | (200 to 400) MHz | 3.2° | | |
| Isolation | 9 kHz to 100 MHz | 0.36 dB | | |
| | (100 to 200) MHz | 1.1 dB | | |
| | (200 to 400) MHz | 1.6 dB | | |
| RF Power, Absolute ³ – Measure | | | | |
| (-30 to 20) dBm | 9 kHz to 50 MHz | 1.8 % | E9304A | |
| | 50 MHz to 5.0 GHz | 2.2 % | | |
| | 50 MHz to 7 GHz | 1.6 % | HP 8487A | |
| | (7 to 18) GHz | 1.8 % | | |
| | (18 to 26) GHz | 2.0 % | | |
| | (26 to 33) GHz | 2.6 % | | |
| | (33 to 40) GHz | 3.4 % | | |
| | (40 to 47) GHz | 4.2 % | | |
| | (47 to 50) GHz | 4.4 % | | |

| Parameter/Range | Frequency | CMC ^{2, 4, 5} (\pm) | Comments |
|--|--|--|--|
| RF Power, Absolute ³ – Measure (cont) (-70 to -20) dBm | 50 MHz to 7 GHz (7 to 18) GHz (18 to 26) GHz (26 to 33) GHz (33 to 40) GHz (40 to 48) GHz (48 to 50) GHz | 2.0 % 2.3 % 2.4 % 2.3 % 4.1 % 4.0 % 4.1 % | HP 8487D |
| RF Power ³ – Generate | 9 kHz to 2.5 GHz (2.5 to 3.2) GHz (3.2 to 4) GHz 1 Hz to 15 MHz 10 MHz to 2 GHz @ \geq -10 dBm (2 to 20) GHz (20 to 40) GHz | 1 dB 1.5 dB 2 dB 0.1 dB 0.6 dBm 0.7 dBm 0.9 dBm | HP 8648D HP 33120 HP 83640L HP 83640L |
| Current Probes ³ & Bulk Current Injection Probes ³ – Insertion Loss Transfer Impedance | 5 Hz to 500 MHz 500 MHz to 2.4 GHz 5 Hz to 500 MHz 500 MHz to 2.4 GHz | 0.77 dB + <i>M</i> 1.1 dB + <i>M</i> 0.77 dB + <i>M</i> 1.1 dB + <i>M</i> | CISPR 16-1-2, IEC/EN 61000-4-6 HP 8751A & HP 87512A, BNC & Type “N” calibration standards |
| CDN's & Adapters ³ – (50 to 150) Ω Adapter Insertion Loss Coupling Factor Impedance Voltage Division Factor | 10 kHz to 230 MHz 10 kHz to 230 MHz 10 kHz to 230 MHz 10 kHz to 230 MHz | 1.2 dB + <i>M</i> 1.1 dB + <i>M</i> 3.5 Ω 0.25 dB | IEC/EN 61000-4-6 CISPR 16-1-2 HP 8751A & HP 87512A, BNC and Type “N” calibration standards Agilent E5061B ENA network analyzer |

| Parameter/Range | Frequency | CMC ^{2,5} (±) | Comments |
|--------------------------------------|--------------------|------------------------|--|
| Absorbing Clamps | 30 MHz to 1 GHz | 2.4 dB | CISPR 16-1-3 Annex B, Agilent E5061B |
| Injection Clamps ³ | (0.01 to 1000) MHz | 1.6 dB | IEC/EN 61000-4-6, HP 8593E, CAL801A |
| NSA Measurements ³ | (30 to 1000) MHz | 0.5 dB | ANSI C63.4: (2003, 2009, 2010, & 2014) EN 50147-2 (1997) CISPR 16-1-4, CISPR 16-1-5 Agilent E5061B & E5071C |
| | (30 to 1000) MHz | 0.1 dB | HP 8753D, Agilent E8364C, Keysight N5225A |
| Shielding Effectiveness ³ | 1 kHz to 1 GHz | 0.5 dB | EN 50147-1, IEE 299, NSA 94-106 HP 8591E, HP 8593EM |
| | (1 to 18) GHz | 0.6 dB | HP 8753D, Agilent E8364C, Keysight N5225A |
| Site VSWR Measurements ³ | (1 to 3) GHz | 0.66 dB | CISPR 16-1-4, CISPR 16-1-5 Agilent E8364C, Keysight N5225A |
| | (3 to 18) GHz | 0.84 dB | |
| Field Uniformity ³ | 26 MHz to 18 GHz | 1.2 dB | IEC/EN 61000-4-3 |
| ESD Targets ³ – | | | IEC 61000-4-2, ISO 10605 |
| Frequency Response | DC to 4.0 GHz | 0.26 dB | Agilent ENA E5071C, Fluke 123 HP 3478A, Solar 7144-1.0 |
| Low Frequency Transfer Function | (0 to 30) A | 0.32 % | |
| Insertion Loss | Up to 300 kHz | 0.072 dB | |
| | (0.30 to 10) MHz | 0.076 dB | |
| | (0.010 to 3.0) GHz | 0.080 dB | |
| | (3.0 to 4.0) GHz | 0.092 dB | |

| Parameter/Equipment | Range | CMC ^{2,5} (±) | Comments |
|--|--|---|---|
| ESD Simulators ³ – | | | |
| Contact Voltage (Positive & Negative) | (0 to 2) kV (2 to 8) kV (8 to 15) kV (15 to 30) kV (30 to 40) kV | 2.6 % 0.7 % 0.6 % 0.54 % 0.72 % | IEC/EN 61000-4-2; ISO 10605; SAE J1113-13, GR1089 |
| Rise Time – Peak Current | (0 to 2) ns | 65 ps | TEK TDS 7404 |
| 30 ns Current | (0 to 40) A | 5.0 % | IEC ESD target |
| 60 ns Current | (0 to 40) A | 5.6 % | applied kilovolt 149-3 |
| (0 to 800) ns Current | (0 to 40) A | 6.1 % | |
| Air Discharge Voltage (Positive & Negative) | (0 to 2) kV (2 to 20) kV (20 to 40) kV | 0.15 % 0.61 % 1.2 % | |
| Rise Time – RC Time Constant | (0 to 2) ns | 61 ps | |
| (at ± 15 kV) | 600 ns ± 130 ns (for 330 pF probe) | 7.2 ns | |
| | 300 ns ± 60 ns (for 150 pF probe) | 6.0 ns | |
| Magnetic Field Strength Meters – | | | |
| DC | | 0.73 dB | Standard field using |
| (15 to 19) mG | (5 to 20) Hz | 0.73 dB | Helmholtz coil |
| (150 to 190) mG | 20 Hz to 2 kHz | 1.1 dB | |
| (60 to 700) mG | (2 to 500) kHz | 1.1 dB | |
| RF Isotropic E-Field Probe – | | | |
| Anechoic Chamber Frequency Response | 45 GHz | 1.7 dB | Anechoic chamber |
| Linearity | | 0.54 dB | FEP 7050 probes using |
| Isotropic | | 0.47 dB | substitution method |
| Anechoic Chamber Frequency Response | 60 GHz | 1.8 dB | Anechoic chamber |
| Linearity | | 0.72 dB | FEP 7060 probes using |
| Isotropic | | 0.47 dB | substitution method |

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|--|------------------------|----------------------|--------------------------|
| RF Isotropic E-Field Probe – (cont) | | | |
| TEM Cell | | | |
| Frequency Response | 9 kHz to 800 MHz | 0.91 dB | TEM cell |
| Linearity | | 0.91 dB | calculated/ substitution |
| Isotropic | | 0.92 dB | |
| GTEM | | | |
| Frequency Response | 10 kHz to 1000 MHz | 0.97 dB | GTEM |
| Linearity | | 0.97 dB | calculated/ substitution |
| Isotropic | | 0.97 dB | |
| Tri-plate | | | |
| Linearity | 10 kHz to 1000 MHz | 0.89 dB | Tri-plate, |
| Isotropic | | 1.2 dB | calculated/ substitution |
| | | 1.2 dB | |
| Anechoic Chamber | | | |
| Linearity | (450 to 18 000) MHz | 1.1 dB | Anechoic chamber, |
| Isotropic | | 1.2 dB | calculated/ substitution |
| | | 1.2 dB | |
| Anechoic Chamber | | | |
| Linearity | (18 000 to 40 000) MHz | 2.0 dB | Anechoic chamber, |
| Isotropic | | 1.1 dB | calculated/ substitution |
| | | 1.1 dB | |
| RF Laser Isotropic E-Field Probe – | | | |
| TEM Cell | | | |
| Frequency Response | 5 kHz to 800 MHz | 0.73 dB | TEM cell, |
| Linearity | 9 kHz to 800 MHz | 0.91 dB | calculated/ substitution |
| Isotropic | 9 kHz to 800 MHz | 0.92 dB | |
| GTEM | | | |
| Frequency Response | 10 kHz to 1000 MHz | 0.81 dB | GTEM |
| Linearity | | 0.97 dB | |
| Isotropic | | 0.97 dB | |
| Anechoic Chamber | | | |
| Linearity | (450 to 18 000) MHz | 0.91 dB | Anechoic chamber |
| Isotropic | | 1.1 dB | |
| | | 1.1 dB | |

| Parameter/Equipment | Range | CMC ^{2,5} (\pm) | Comments |
|---|--|------------------------------|---|
| RF Laser Isotropic E-Field Probe – (cont) | | | |
| Anechoic Chamber | (18 000 to 40 000) MHz | 1.7 dB | Anechoic chamber |
| Linearity | | 1.7 dB | |
| Isotropic | | 1.7 dB | |
| Electronic E-Field Probes | | | IEEE 1309, IEC/EN 61000-4-3, substitution method |
| | 10 kHz to 5000 MHz Correction Factor | 1.3 dB | FP 5000 type probe |
| | 10 kHz to 5000 MHz Linearity Factor | 0.83 dB | FP 5000 type probe |
| | 10 kHz to 5000 MHz Channel Match Factor | 1 dB | FP 5000 type probe |
| | (200 to 1000) MHz Isotropic Response | 0.83 dB | FP 5000 type probe |
| | 80 MHz to 18 GHz Correction Factor | 1.9 dB | FP 2080 type probe, calculated/substitution |
| | 80 MHz to 18 GHz Linearity Factor | 0.84 dB | FP 2080 type probe, calculated/substitution |
| | 80 MHz to 18 GHz Channel Match Factor | 1 dB | FP 2080 type probe, calculated/substitution |
| | (18 to 40) GHz Correction Factor | 2.3 dB | FP2080 type probe |
| | Linearity | 1.3 dB | |
| | Channel Match | 1.3 dB | |
| | Isotropic: (400 & 1000) MHz | 1.2 dB | |
| RF Pre-Amplifiers, Amplifiers ³ – | | | IEEE 291 |
| Gain | 5 Hz to 18 GHz (18 to 50) GHz | 0.97 dB 1 dB | Agilent E5061B, E5071C Agilent E8364C, Keysight N5225A |

| Parameter/Equipment | Range | CMC ^{2, 4, 5} (\pm) | Comments |
|--|----------------------------------|-------------------------------------|---|
| RF Pre-Amplifiers, Amplifiers ³ – (cont) | | | IEEE 291 |
| Output of Power Source DC Voltage | (0 to 200) V | 0.023 % + 2.4 mV | Agilent 3478 |
| DC Current | (0 to 3) A | 1.2 % + 0.46 A | |
| Reflection S_{11}/S_{22} – Magnitude ³ | | | |
| 5 Hz to 300 kHz | (0 to 0.5) lin (0.5 to 1) lin | $M + 0.05$ (lin) $M + 0.1$ (lin) | Agilent E5061B, E5071C, Agilent E8364C, Keysight N5225A w/ electronic calibration kit |
| 300 kHz to 6 GHz | (0 to 1) lin | $M + 0.1$ (lin) | |
| 10 MHz to 50 GHz | (0 to 1) lin | $M + 0.1$ (lin) | |
| Reflection S_{11}/S_{22} – Phase ³ | | | |
| 5 Hz to 300 kHz | (0 to 180) $^{\circ}$ | 3.5 $^{\circ}$ | Agilent E5061B, E5071C, E8364C Keysight N5225A |
| 300 kHz to 6 GHz | (0 to 180) $^{\circ}$ | 3.3 $^{\circ}$ | |
| 10 MHz to 18 GHz | (0 to 180) $^{\circ}$ | 3.5 $^{\circ}$ | |
| (18 to 50) GHz | (0 to 180) $^{\circ}$ | 4.1 $^{\circ}$ | |

| Parameter/Range | Frequency | CMC ^{2, 4} (\pm) | Comments |
|--|------------------|-------------------------------|--|
| Transmission S_{12}/S_{21} – Magnitude ³ | | | |
| (0 to 70) dB | 5 Hz to 500 MHz | 0.15 dB | Agilent E8364C, Agilent E5061B, Agilent E5071C, Keysight N5225A |
| (0 to 70) dB | 10 MHz to 50 GHz | 0.15 dB | |
| (0 to 70) dB | 10 Hz to 500 MHz | 0.97 dB | |
| (0 to 70) dB | (0.5 to 18) GHz | 0.97 dB | |
| (0 to 30) dB | 300 kHz to 6 GHz | $M + 0.07$ dB | |
| (30 to 40) dB | | $M + 0.08$ dB | |
| (40 to 50) dB | | $M + 0.09$ dB | |
| (50 to 60) dB | | $M + 0.1$ dB | |
| (60 to 70) dB | | $M + 0.15$ dB | |

| Parameter/Equipment | Frequency | CMC ^{2,4} (±) | Comments |
|--|---|--|---|
| Transmission S_{12}/S_{21} – Magnitude ³ (cont) (0 to 12) dB (12 to 40) dB (40 to 60) dB (60 to 70) dB | 10 MHz to 18 GHz | $M + 0.05$ dB $M + 0.07$ dB $M + 0.08$ dB $M + 0.15$ dB | Agilent E8364C, Agilent E5061B, Agilent E5071C, Keysight N5225A |
| Transmission S_{12}/S_{21} – Phase ³ (0 to 180)° Antenna Symmetry 300 kHz to 1 GHz 10 MHz to 18 GHz | 5 Hz to 500 MHz 10 MHz to 50 GHz 300 kHz to 6 GHz 10 MHz to 18 GHz -- -- | 3.5° 3.2° 3.7° 3.9° 0.07 dB 0.05 dB | Agilent E8364C Keysight N5225A Agilent E5061B & E5071C Agilent E8364C Keysight N5225A ANSI C63.5 4.4, CISPR 16- 1-6 |
| Antenna Pattern Measurements | (1 to 1000) MHz (1 to 40) GHz | 0.87 dB 1 dB | Agilent E8364C Keysight N5225A |
| Antenna Cross – Polar Response | 20 MHz to 40 GHz | 0.5 dB | CISPR 16-1-4 CISPR 16-1-6 Agilent E5061B & E5071C Keysight N5225A |
| Antenna Balance | 20 MHz to 40 GHz | 0.5 dB | CISPR 16-1-4 CISPR 16-1-6 Agilent E5061B & E5071C Keysight N5225A |
| Antenna VSWR | (20 to 2000) MHz (1 to 40) GHz | 0.6 dB 0.9 dB | IEEE 149-1979 Agilent E5061B & E5071C Keysight N5225A |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|---|--|--|---|
| Rod Antennas ³ (ECSM) – Antenna Factor | 10 Hz to 60 MHz | 0.23 dB | CISPR 25, ANSI C63.5 SAE ARP 958, CISPR 16-1-4, CISPR 16-1-6 Agilent E5061B and E5071C, E8364C & Keysight N5225A |
| Loop Antennas | 1 kHz to 30 MHz 10 Hz to 2 MHz 10 Hz to 30 MHz | 0.32 dB 0.34 dB 0.44 dB | Standard field using Vacuo junction Standard field using loop current measurement Substitution method using reference antenna |
| Conical Log Spiral Antennas – 1 Meter Distance | (200 to 400) MHz (400 to 1000) MHz (1000 to 10 000) MHz | 2.2 dB 0.88 dB 1.7 dB | SAE ARP 958 Agilent E5061B, E5071C, E8364C, Keysight N5225A, OATS ⁶ |
| Dipole Antennas – 3 Meter Distance 3 Meter Distance 3 Meter Distance 3 Meter Distance | (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz (30 to 1000) MHz | 0.5 dB 0.48 dB 0.55 dB 0.60 dB 0.52 dB 0.55 dB 0.60 dB 0.62 dB 0.45 dB 0.52 dB 0.45 dB 0.58 dB 0.59 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM Reference antenna method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM Identical antenna method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM Standard antenna method, horizontal/vertical |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|--------------------------|--|--|--|
| Dipole Antennas – (cont) | | | ANSI C63.5, CISPR 16-1-6 |
| 3 Meter Distance | (30 to 1000) MHz | 0.40 dB | Three antenna method, horizontal/vertical |
| 10 Meter Distance | (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz | 0.41 dB 0.45 dB 0.51 dB 0.55 dB | Standard site method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM |
| 10 Meter Distance | (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz | 0.35 dB 0.40 dB 0.45 dB 0.51 dB | Reference antenna method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM |
| 10 Meter Distance | (30 to 60) MHz (50 to 150) MHz (140 to 400) MHz (400 to 1000) MHz | 0.41 dB 0.38 dB 0.45 dB 0.50 dB | Identical antenna method, horizontal/vertical polarization, OATS ⁶ , HP 8591E, HP 8593EM |
| 10 Meter Distance | (30 to 1000) MHz | 0.63 dB | Standard antenna method, horizontal/vertical |
| 10 Meter Distance | (30 to 1000) MHz | 0.41 dB | Three antenna method, horizontal/vertical |
| Biconical Antenna – | | | |
| 1 Meter Distance | (20 to 70) MHz (70 to 200) MHz (200 to 300) MHz | 0.33 dB 0.34 dB 0.37 dB | SAE ARP 958, OATS, Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (20 to 70) MHz (70 to 200) MHz (200 to 300) MHz | 0.37 dB 0.48 dB 0.37 dB | SAE ARP 958, Appendix C, OATS, Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (20 to 70) MHz (70 to 200) MHz (200 to 300) MHz | 0.93 dB 0.54 dB 0.25 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|--------------------------------|---|---|---|
| Biconical Antennas – (cont) | | | |
| 3 Meter Distance | (20 to 72.5) MHz (72.5 to 115) MHz (115 to 157.5) MHz (157.5 to 200) MHz (200 to 300) MHz | 0.95 dB 0.55 dB 0.41 dB 0.50 dB 0.60 dB | ANSI C63.5, CISPR 16-1-6 Reference antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (20 to 72.5) MHz (72.5 to 115) MHz (115 to 157.5) MHz (157.5 to 200) MHz (200 to 300) MHz | 0.96 dB 0.6 dB 0.39 dB 0.47 dB 0.52 dB | ANSI C63.5, CISPR 16-1-6 Identical antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (20 to 300) MHz | 0.50 dB | Standard antenna method, horizontal/vertical |
| 3 Meter Distance | (20 to 300) MHz | 0.40 dB | Three antenna method, horizontal/vertical |
| 10 Meter Distance | (20 to 72.5) MHz (72.5 to 115) MHz (115 to 157.5) MHz (157.5 to 200) MHz (200 to 300) MHz | 0.93 dB 0.52 dB 0.24 dB 0.20 dB 0.25 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (20 to 72.5) MHz (72.5 to 115) MHz (115 to 157.5) MHz (157.5 to 200) MHz (200 to 300) MHz | 0.97 dB 0.62 dB 0.41 dB 0.30 dB 0.31 dB | ANSI C63.5, CISPR 16-1-6 Reference antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (20 to 72.5) MHz (72.5 to 115) MHz (115 to 157.5) MHz (157.5 to 200) MHz (200 to 300) MHz | 0.96 dB 0.60 dB 0.38 dB 0.46 dB 0.52 dB | ANSI C63.5, CISPR 16-1-6 Identical antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|--------------------------------|---|--|---|
| Biconical Antennas – (cont) | | | |
| 10 Meter Distance | (20 to 300) MHz | 0.52 dB | Standard antenna method, horizontal/vertical |
| 10 Meter Distance | (20 to 300) MHz | 0.43 dB | Three antenna method, horizontal/vertical |
| Log-Periodic Antennas – | | | |
| 1 Meter Distance | (140 to 400) MHz (400 to 1000) MHz (1000 to 5000) MHz | 0.32 dB 0.38 dB 0.52 dB | SAE ARP 958 OATS, Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (140 to 400) MHz (400 to 1000) MHz (1000 to 5000) MHz | 0.38 dB 0.45 dB 0.58 dB | SAE ARP 958, Appendix C, OATS, Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (140 to 300) MHz (300 to 400) MHz (400 to 500) MHz (500 to 600) MHz (600 to 700) MHz (700 to 800) MHz (800 to 900) MHz (900 to 1000) MHz (1000 to 5000) MHz | 0.3 dB 0.3 dB 0.4 dB 0.4 dB 0.4 dB 0.5 dB 0.5 dB 0.6 dB 0.7 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (140 to 300) MHz (300 to 400) MHz (400 to 500) MHz (500 to 600) MHz (600 to 700) MHz (700 to 800) MHz (800 to 900) MHz (900 to 1000) MHz (1000 to 5000) MHz | 0.2 dB 0.2 dB 0.2 dB 0.25 dB 0.35 dB 0.45 dB 0.45 dB 0.5 dB 0.6 dB | ANSI C63.5, CISPR 16-1-6 Identical antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (140 to 5000) MHz | 0.65 dB | Standard antenna method, horizontal/vertical |
| 3 Meter Distance | (140 to 5000) MHz | 0.46 dB | Three antenna method, horizontal/vertical |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|-----------------------------------|---|---|--|
| Log-Periodic Antennas – (cont) | | | |
| 10 Meter Distance | (140 to 300) MHz (300 to 400) MHz (400 to 500) MHz (500 to 600) MHz (600 to 700) MHz (700 to 800) MHz (800 to 900) MHz (900 to 1000) MHz (1000 to 5000) MHz | 0.3 dB 0.3 dB 0.4 dB 0.4 dB 0.4 dB 0.5 dB 0.5 dB 0.6 dB 0.7 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (140 to 300) MHz (300 to 400) MHz (400 to 500) MHz (500 to 600) MHz (600 to 700) MHz (700 to 800) MHz (800 to 900) MHz (900 to 1000) MHz (1000 to 5000) MHz | 0.3 dB 0.3 dB 0.3 dB 0.3 dB 0.45 dB 0.45 dB 0.55 dB 0.6 dB 0.7 dB | ANSI C63.5, CISPR 16-1-6 Identical antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (140 to 5000) MHz | 0.69 dB | Standard antenna method, horizontal/vertical |
| 10 Meter Distance | (140 to 5000) MHz | 0.50 dB | Three antenna method, horizontal/vertical |
| Hybrid Antennas – | | | |
| 1 Meter Distance | (20 to 70) MHz (70 to 200) MHz (200 to 400) MHz (400 to 1000) MHz (1000 to 6000) MHz | 0.5 dB 0.76 dB 0.91 dB 0.74 dB 0.75 dB | SAE ARP 958 OATS, HP 8593EM w/ electronic calibration kit |
| 3 Meter Distance | (20 to 70) MHz (70 to 200) MHz (200 to 400) MHz (400 to 1000) MHz (1000 to 6000) MHz | 0.11 dB 0.11 dB 0.19 dB 0.26 dB 0.41 dB | SAE ARP958, Appendix C OATS, Agilent E5061B and E5071C, E8364C and Keysight N5225A |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|------------------------------------|---|-------------------------------|--|
| Hybrid Antennas – (cont) | | | |
| 3 Meter Distance | (20 to 1000) MHz (1000 to 6000) MHz | 0.58 dB 0.75 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 3 Meter Distance | (20 to 6000) MHz | 0.74 dB | Standard antenna method |
| 3 Meter Distance | (20 to 6000) MHz | 0.46 dB | Three antenna method |
| 10 Meter Distance | (20 to 1000) MHz (1000 to 6000) MHz | 0.58 dB 0.75 dB | ANSI C63.5, CISPR 16-1-6 Standard site method, horizontal/vertical polarization, OATS, Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (20 to 1000) MHz (1000 to 6000) MHz | 0.68 dB 0.89 dB | ANSI C63.5, CISPR 16-1-6 Identical antenna method, horizontal/vertical polarization, OATS ⁶ , Agilent E5061B, E5071C, E8364C & Keysight N5225A |
| 10 Meter Distance | (20 to 6000) MHz | 0.77 dB | Standard antenna method |
| 10 Meter Distance | (20 to 6000) MHz | 0.50 dB | Three antenna method |
| Horn Antennas ⁷ – LPA's | | | |
| 1 Meter Distance | 700 MHz to 50 GHz | 0.45 dB | SAE ARP 958 Identical Agilent E8364C, Keysight N5225A |
| 3 Meter Distance | 700 MHz to 50 GHz | 0.48 dB | SAE ARP958, Appendix C, Agilent E8364C, Keysight N5225A |
| 1 & 3 Meter Distance | 700 MHz to 18 GHz (18 to 26.5) GHz (26.5 to 50) GHz | 0.37 dB 0.42 dB 0.47 dB | ANSI C63.5, CISPR 16-1-6 standard site method, three antenna method, horizontal/vertical polarization, Agilent E8364C, Keysight N5225A |

| Parameter/Equipment | Frequency | CMC ² (±) | Comments |
|--|-------------------|----------------------|--|
| Horn Antennas ⁷ – LPA's (cont) | | | |
| 3 Meter Distance | 700 MHz to 50 GHz | 0.50 dB | ANSI C63.5, CISPR 16-1-6 identical antenna method, horizontal/vertical polarization, three antenna method, Agilent E8364C, Keysight N5225A |
| Far Field | 700 MHz to 50 GHz | 0.44 dB | |
| Time Domain | 700 MHz to 50 GHz | 0.46 dB | ANSI C63.5, CISPR 16-1-6 identical antenna method, horizontal/vertical polarization, three antenna method, Agilent E8364C, Keysight N5225A |

II. Mechanical

| Parameter/Equipment | Range | CMC ² (±) | Comments |
|---------------------|-------------------|----------------------|-----------------------|
| Pin Depth | (0.18 to 0.23) in | 0.000 40 in | Maury Microwave A020D |

¹ This laboratory offers commercial 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 and this laboratory meets *A2LA R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. 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 In the statement of CMC, M is the uncertainty contribution of the mismatch error caused by the impedance mismatch between the calibration system of the laboratory and the device under calibration.

⁵ In the statement of CMC, all percentages are to be read as percent of reading unless noted otherwise.

⁶ The ground plane of size of calibration site 2 is 50 × 80 square meters and does meet the stated requirements for antenna calibration test sites called out in CISPR 16-1-5. Keysight Technologies maintains multiple OATS, including a 50 meter x 80 meter ground plane meeting the requirements for CALTS called out in CISPR 16-1-4, CISPR 16-1-5, CISPR 16-1-6. In addition all Keysight Technologies OATS meet the +/-2dB NSA as described in ANSI C63.4 and C63.5 for calibration and qualification of antennas.

⁷ Horns in the range of 700 MHz to 50 GHz are calibrated in a free space environment void of any conductive surfaces unless instructed otherwise.

⁸ When listing equipment, Keysight, Agilent, and HP may be used interchangeably.



Accredited Laboratory

A2LA has accredited

KEYSIGHT TECHNOLOGIES, INC. SERVICE CENTERS

Kimballton, IA

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, the requirements of ANSI/NCSLI 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 8 January 2009*).



Presented this 13th day of December 2017.

A handwritten signature in blue ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 2123.01
Valid to October 31, 2019

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