



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

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CALIBRATION

Valid To: July 31, 2020

Certificate Number: 3606.01

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>2,4</sup> (±)	Comments
DC Voltage <sup>3</sup> – Measure	100 mV to 1 V	0.001 %	Agilent 3458A
	(1 to 10) V	0.001 %	
	(10 to 100) V	0.001 %	
	(100 to 1000) V	0.002 %	
	(1 to 20) kV	1.6 %	P6015A + TDS7404, DPO4101
DC Voltage <sup>3</sup> – Generate	(0 to 11.5) V	0.24 % + 2 mV	Fluke 6105A
	(11.5 to 45) V	0.092 %	
	(45 to 180) V	0.094 %	
	(180 to 504) V	0.077 %	

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Current <sup>3</sup> – Measure	(1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	0.043 % 0.012 % 0.009 % 0.009 % 0.01 % 0.021 %	Agilent 3458A
	(1 to 3) A (3 to 10) A	0.13 % 0.20 %	Fluke 8845A
DC Current <sup>3</sup> – Generate	(0.01 to 0.125) A (0.125 to 0.5) A (0.5 to 1) A (1 to 2.5) A (2.5 to 5) A (5 to 10) A	0.043 % 0.018 % 0.015 % 0.069 % 0.016 % 0.017 %	Fluke 6105A
DC Resistance <sup>3</sup> – Measure	(0.1 to 10) $\Omega$	0.018 %	Fluke 6105A and Fluke 8845A
	(1 to 10) $\Omega$ (10 to 100) $\Omega$ 100 $\Omega$ to 1 k $\Omega$ (1 to 10) k $\Omega$ (10 to 100) k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$ (1 to 10) M $\Omega$ (10 to 100) M $\Omega$ 100 M $\Omega$ to 1G $\Omega$	0.008 % 0.006 % 0.001 % 0.001 % 0.001 % 0.003 % 0.015 % 0.067 % 0.59 %	Agilent 3458A

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
DC Resistance <sup>3</sup> – Generate	1 Ω	0.019 %	Decade resistor
	10 Ω	0.006 %	
	50 Ω	0.008 %	
	100 Ω	0.001 %	
	190 Ω	0.005 %	
	500 Ω	0.005 %	
	1 kΩ	0.001 %	
	10 kΩ	0.001 %	
	100 kΩ	0.001 %	
	1 MΩ	0.003 %	
	10 MΩ	0.023 %	
	100 MΩ	0.13 %	
	(0.01 to 10) Ω	0.28 %	
(10 to 100) Ω	0.03 %		
100 Ω to 1 MΩ	0.004 %		
AC Resistance <sup>3</sup> – Generate	10 Ω	0.1 %	Decade resistor
	50 Ω	0.15 %	
	100 Ω	0.1 %	
	1 kHz	0.1 %	
	1 kΩ	0.1 %	
	10 kΩ	0.1 %	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Resistance <sup>3</sup> – Measure	(40 to 100) Hz	(0.01 to 0.1) Ω	HIOKI IM3523
		(0.1 to 100) Ω	
		100 Ω to 1 kΩ	
		(1 to 10) kΩ	
		(10 to 100) kΩ	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Resistance <sup>3</sup> – Measure (cont)			
(0.1 to 10) Ω 10 Ω to 200 kΩ	100 Hz to 1 MHz	0.1 % 0.03 %	Agilent 4194A; 4 wire method
10 Ω to 1 kΩ (1 to 100) kΩ	100 kHz to 10 MHz	1.8 % 1.7 %	Agilent 4194A and 41941A
10 Ω to 10 kΩ	(10 to 100) MHz	3.5 %	Agilent 4194A and 41941A
Capacitance <sup>3</sup> – Measure			
(10 to 100) nF 100 nF to 1 μF 1 μF to 1 mF	(40 to 100) Hz	0.95 % 0.93 % 0.93 %	HIOKI IM3523
10 pF to 100 μF	100 Hz to 1 MHz	0.23 %	Agilent 4194A
Capacitance <sup>3</sup> – Generate			
1 μF 100 nF 10 nF 1 nF 100 pF	1 kHz	0.2 % 0.2 % 0.1 % 0.1 % 0.1 %	Decade capacitor
Inductance <sup>3</sup> – Measure			
(1 to 10) mH 10 mH to 1 H (1 to 10) H	(40 to 100) Hz	0.98 % 0.93 % 1.3 %	HIOKI IM3523
(10 to 100) nH 100 nH to 10 H	100 Hz to 1 MHz	0.10 % 0.03 %	Agilent 4194A
Inductance <sup>3</sup> – Generate			
1 mH	1 kHz	1.5 %	Decade inductor

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure			
(1 to 10) mV	40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.16 % 0.71 % 4.9 %	Agilent 3458A
(10 to 100) mV	1 Hz to 20 kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.02 % 0.12 % 0.44 % 1.2 %	
100 mV to 1 V	1 Hz to 20 kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.02 % 0.12 % 0.44 % 1.2 %	
(1 to 10) V	1 Hz to 20 kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.02 % 0.12 % 0.44 % 1.2 %	
(10 to 100) V	1 Hz to 20 kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.06 % 0.16 % 0.55 % 1.8 %	
(100 to 750) V	1 Hz to 20 kHz (20 to 100) kHz	0.09 % 0.37 %	
(0.2 to 7) kV	10 Hz to 50 MHz	1.6 %	
AC Voltage <sup>3</sup> – Generate			
(1 to 23) V	(16 to 850) Hz	0.031 %	Fluke 6105A
(1 to 6.9) V	850 Hz to 6 kHz	0.17 %	
(23 to 90) V	(16 to 850) Hz	0.012 %	
(6.9 to 27) V	850 Hz to 6 kHz	0.089 %	
(90 to 180) V	(16 to 850) Hz	0.011 %	
(27 to 54) V	850 Hz to 6 kHz	0.071 %	
(180 to 1008) V	(16 to 850) Hz	0.014 %	
(54 to 302) V	850 Hz to 6 kHz	0.12 %	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Harmonics distortion <sup>3</sup> – Measure	10 Hz to 110 kHz	0.01 %	VA-2230 Reference frequency
AC Current <sup>3</sup> – Measure			
(1 to 10) mA	10 Hz to 5 kHz (5 to 10) kHz	0.19 % 0.5 %	Fluke 8845A
(10 to 100) mA	10 Hz to 5 kHz (5 to 10) kHz	0.16 % 0.52 %	
100 mA to 1 A	10 Hz to 5 kHz (5 to 10) kHz	0.16 % 0.5 %	
(1 to 3) A	16 Hz to 5 kHz (5 to 6) kHz	0.19 % 1.2 %	
(3 to 10) A (3 to 6.3) A	(16 to 850) Hz 850 Hz to 2 kHz	0.25 % 0.29 %	
(10 to 100) µA	45 Hz to 1 kHz	0.42 %	Agilent 3458A
100 µA to 1 mA	45 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 % 0.26 % 0.85 % 2.1 %	
(1 to 10) mA	45 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 % 0.26 % 0.85 % 2.1 %	
(10 to 100) mA	45 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.23 % 0.26 % 0.85 % 2.1 %	
100 mA to 1 A	45 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.31 % 0.42 % 1.5 %	
(10 to 1000) A	1 Hz to 10 MHz	1.6 %	Current probe and TDS 7404B

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
AC Current <sup>3</sup> – Generate			
(0.01 to 0.25) A	(16 to 850) Hz 850 Hz to 6 kHz	0.065 % 0.11%	Fluke 6105A
(0.25 to 0.5) A	(16 to 850) Hz 850 Hz to 6 kHz	0.013 % 0.063 %	
(0.5 to 1) A	(16 to 850) Hz 850 Hz to 6 kHz	0.014 % 0.062 %	
(1 to 2) A	(16 to 850) Hz 850 Hz to 6 kHz	0.02 % 0.065 %	
(2 to 5) A	(16 to 850) Hz	0.014 %	
(2 to 4.2) A	850 Hz to 6 kHz	0.067 %	
(5 to 10) A	(16 to 850) Hz	0.018 %	
(10 to 21) A	(16 to 850) Hz	0.014 %	
Magnetic Field <sup>3</sup> – Generate			Helmholtz coil Fluke 6105A Fluke 8845A and resistor
(0.1 to 220) μT	DC to 850 Hz	0.7 %	Coil size: r=0.15m
(200 to 350) μT	DC	0.7 %	14 turn
(0.1 to 20) μT	(1 to 20) kHz	0.8 %	
(1 to 1200) μT	DC to 850 Hz	1.3 %	Coil size: r=0.05m
(1000 to 12 000) μT	DC	1.3 %	50 turn
(1 to 700) μT	(1 to 20) kHz	1.3 %	
(1 to 3200) μT	DC to 850 Hz	1.4 %	Coil size: r=0.02m
(3000 to 32 000) μT	DC	1.4 %	50 turn
(1 to 1800) μT	(1 to 20) kHz	1.5 %	
(1 to 2600) μT	(10 to 50) Hz	0.8 %	Agilent 3458A and resistor
(1 to 2100) μT	(50 to 300) Hz	0.8 %	Helmholtz coil
(1 to 1100) μT	(300 to 600) Hz	0.8 %	300 turn
(1 to 750) μT	(600 to 1000) Hz	0.8 %	

Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Magnetic Field <sup>3</sup> – Generate (cont)			Helmholtz coil Fluke 6105A Fluke 8845A and resistor
(1 to 450) μT	(1 to 5) kHz	0.8 %	30 turn
(1 to 200) μT	(5 to 20) kHz	0.8 %	
(1 to 110) μT	(20 to 50) kHz	0.8 %	
(1 to 110) μT	(50 to 120) kHz	0.8 %	6 turn
(1 to 50) μT	(120 to 300) kHz	0.9 %	
(1 to 30) μT	(300 to 400) kHz	1.4 %	

## II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Absolute Power <sup>3</sup> – Measure			
(+30 to -20) dBm	10 Hz to 20 kHz	0.07 dB	Fluke 8845A
(+20 to -60) dBm	9 kHz to 6 GHz	0.23 dB	Agilent E9304A and N1913A
(+20 to -70) dBm	50 MHz to 10 GHz	0.28 dB	Agilent E4413A and N1913A
(+20 to -70) dBm	10 GHz to 26.5 GHz	0.37 dB	
Relative Power <sup>3</sup> – Measure (Attenuation)			
(0 to 30) dB	10 Hz to 100 MHz	0.13 dB	Agilent 4194A
(30 to 70) dB		0.22 dB	Anritsu MS4630B
(70 to 100) dB		0.52 dB	
(0 to 70) dB	9 kHz to 8.5 GHz	0.07 dB	Agilent E5701C
(70 to 100) dB		0.13 dB	
(0 to 50) dB	100 kHz to 18 GHz	0.07 dB	R&S ZNB 20
(50 to 90) dB		0.13 dB	



Parameter/Range	Frequency	CMC <sup>2,4</sup> (±)	Comments
Attenuation <sup>3</sup> – Generate  (0 to 30) dB (30 to 70) dB (70 to 100) dB  (0 to 30) dB (30 to 70) dB (70 to 100) dB	DC to 8 GHz  (8 to 18) GHz	0.13 dB 0.13 dB 0.26 dB  0.16 dB 0.16 dB 0.27 dB	Agilent 8496B
Impedance <sup>3</sup> – Measure  $\Gamma / \theta$  $\Gamma / \theta$	(9 to 100) kHz 100 kHz to 10 MHz (10 to 100) MHz  9 kHz to 2 GHz (2 to 8) GHz (8 to 18) GHz	$\Gamma$ : 0.03 $\theta$ : 2.2° $\Gamma$ : 0.025 $\theta$ : 1.4° $\Gamma$ : 0.03 $\theta$ : 2.2°  $\Gamma$ : 0.023 $\theta$ : 0.6° $\Gamma$ : 0.024 $\theta$ : 0.6° $\Gamma$ : 0.028 $\theta$ : 0.6°	50-ohm load  Agilent 41941A  Agilent 5071C and 85054D Agilent 5071C and 85054D R&S ZNB 20 and Agilent 85054D
LISN <sup>3</sup> –  Voltage Division Factor  Impedance: Z, $\theta$  Isolation	9 kHz to 300 MHz  9 kHz to 300 MHz  9 kHz to 300 MHz	0.2 dB  Z: 2.2 %, $\theta$ : 0.6°  0.2 dB	CISPR 16-1-2, CISPR 25 ISO7637-2, MILstd.461E Agilent 5071C
CDNs <sup>3</sup> –  Coupling Factor  Impedance: Z, $\theta$  Isolation	150 kHz to 300 MHz  150 kHz to 300 MHz  150 kHz to 300 MHz	0.2 dB  Z: 1.8 %, $\theta$ : 0.6°  0.2 dB	IEC 61000-4-6  Agilent 5071C R&S ZNB 20

Parameter/Equipment	Range	CMC <sup>2,4</sup> ( $\pm$ )	Comments
ISN <sup>3</sup> –			CISPR 16-1-2
Voltage Division Factor	150 kHz to 30 MHz	0.2 dB	Agilent 5071C
Impedance: Z, $\theta$	9 kHz to 30 MHz	Z: 1.8 %, $\theta$ : 0.6°	
LCL < 65dB	100 kHz to 5 MHz (5 to 30) MHz	0.35 dB 0.55 dB	
LCL < 75dB	100 kHz to 5 MHz (5 to 30) MHz	0.35 dB 0.73 dB	
Insertion Loss	150 kHz to 200 MHz	0.27 dB	
Decoupling Factor	150 kHz to 30 MHz	0.2 dB	
Spectrum Analyzer <sup>3</sup> –			
Marker Readout Accuracy	9 kHz to 6 GHz (2 to 18) GHz	20 pHz/Hz +100 $\mu$ Hz 20 pHz/Hz	Keysight N5171B R&S SMF100F
Span Accuracy	100 Hz to 10 MHz	1.0 %	
Residual FM		1.0 Hz	
Noise Side Band	(-120 to -130) dBc	0.5 dB	Keysight N5171B
Level Accuracy			
9 kHz to 6 GHz	(0 to -50) dBm (-50 to -110) dBm	0.23 dB 0.27 dB	
Input Attenuator:			
9 kHz to 18 GHz	(0 to 60) dB	0.15 dB	Agilent 8496B
Reference Level: (IF Attenuator)			
9 kHz to 18 GHz	(0 to 60) dB	0.15 dB	Agilent 8496B
Input Impedance: $\Gamma$			
9 kHz to 2 GHz		$\Gamma$ : 0.023	
(2 to 8) GHz		$\Gamma$ : 0.024	
(8 to 18) GHz		$\Gamma$ : 0.028	
Resolution Bandwidth	10 Hz to 1 MHz	2.2 %	R&S SML03 Keysight N5171B

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Spectrum Analyzer <sup>3</sup> – (cont)			R&S SML03 Keysight N5171B
Cal. Output: Frequency Accuracy	9 kHz to 18 GHz	0.01 µHz/Hz	
Level Accuracy: 9 kHz to 6 GHz	(+10 to -50) dBm	0.23 dB	
(6 to 8.5) GHz	(+10 to -50) dBm	0.28 dB	
Tracking Generator: Output Level Accuracy			
9 kHz to 6 GHz	(+10 to -50) dBm	0.23 dB	
(6 to 18) GHz	(+10 to -50) dBm	0.37 dB	
ESD Generators –			
Contact and Air Discharge:			IEC61000-4-2:2008 Tek TDS7404B
Discharge Voltage	(±0 to 30) kV	2.2 %	And Tek P6015A
Rise time (± polarity)	(0.2 to 20) ns	51 ps	And Target
Peak Current	(±0 to 15) kA	3.6 %	
EMI Receiver <sup>3</sup> –			CISPR16-1-1
Reference Frequency	(1 to 100) MHz	0.01 µHz/Hz	
Readout Accuracy	9 kHz to 6 GHz	20 pHz/Hz +100 µHz	Keysight N5171B
	(2 to 18) GHz	20 pHz/Hz	Agilent 8763E
Sine-Wave level Accuracy:			
9 kHz to 6 GHz	(+10 to -60) dBm	0.23 dB	
	(-60 to -110) dBm	0.27 dB	
(6 to 10) GHz	(+10 to -70) dBm	0.28 dB	
	(-70 to -90) dBm	0.31 dB	
(10 to 26.5) GHz	(+10 to -70) dBm	0.37 dB	
Input Attenuator: 9 kHz to 18 GHz	(0 to 60) dB	0.15 dB	Agilent 8496B

Parameter/Equipment	Frequency	CMC <sup>2,4</sup> (±)	Comments
EMI Receiver <sup>3</sup> – (cont)			
Input Impedance: $\Gamma$	9 kHz to 2 GHz (2 to 8) GHz (8 to 18) GHz	$\Gamma$ : 0.023 $\Gamma$ : 0.024 $\Gamma$ : 0.028	Agilent 8496B
QP Pulse Response:			IGUU2918
Band A	(9 to 150) kHz	0.34 dB	
Band B	150 kHz to 30 MHz	0.34 dB	
Band C/D	(30 to 200) MHz (200 to 1000) MHz	0.43 dB 0.52 dB	
QP Pulse Rate Response:			
Band A: (9 to 150) kHz	Repeat: < 10 Hz Repeat: > 10 Hz	0.40 dB 0.34 dB	
Band B: 150 kHz to 30 MHz	Repeat: < 10 Hz Repeat: > 10 Hz	0.40 dB 0.34 dB	
Band C/D: (30 to 200) MHz	Repeat: < 10 Hz Repeat: > 10 Hz	0.48 dB 0.43 dB	
(200 to 1000) MHz	Repeat: < 10 Hz Repeat: > 10 Hz	0.56 dB 0.52 dB	
Relative Pulse Response QP vs. AV, PK:			
Band A	(9 to 150) kHz	0.34 dB	
Band B	150 kHz to 30 MHz	0.34 dB	
Band C/D	(30 to 200) MHz (200 to 1000) MHz	0.43 dB 0.52 dB	
RMS – Average Pulse Rate:			
Band A	(9 to 150) kHz	0.34 dB	
Band B	150 kHz to 30 MHz	0.34 dB	
Band C/D	(30 to 200) MHz (200 to 1000) MHz	0.43 dB 0.52 dB	
Band E	(1 to 18) GHz	0.52 dB	

Parameter/Equipment	Range	CMC <sup>2,4</sup> ( $\pm$ )	Comments
EMI Receiver <sup>3</sup> – (cont)			
Selectivity: 6 dB BW	200 Hz 9 kHz 120 kHz 1 MHz	1.4 % 1.4 % 1.4 % 1.4 %	R&S SML03 Keysight N5171B
Impulse Bandwidth	1 MHz	0.8 dB	Keysight N5171B
Pulse-Modulated Sine Wave Input:			
Band A/B	9 kHz to 30 MHz	0.8 dB	Meter simulating
Band C/D	(30 to 300) MHz	0.8 dB	Keysight N5171B
Signal Generator <sup>3</sup> –			
Output Level Accuracy and Flatness:			
9 kHz to 6 GHz	(+20 to -60) dBm (-60 to -110) dBm	0.23 dB 0.27 dB	
(6 to 10) GHz	(+20 to -70) dBm (-70 to -90) dBm	0.28 dB 0.31 dB	
(10 to 26.5) GHz	(+20 to -70) dBm	0.37 dB	
Output Impedance	9 kHz to 2 GHz (2 to 8) GHz (8 to 18) GHz	$\Gamma$ : 0.023 $\Gamma$ : 0.024 $\Gamma$ : 0.028	
Residual FM:		1.5 %	
Amplitude Modulation	100 Hz to 20 kHz (30 to 100) %	2.1 %	AF modulation frequency CW: 1 MHz to 1 GHz
Frequency Modulation	$\Delta$ FM: (10 to 50) kHz	0.13 %	CW: 1 MHz to 1 GHz
Phase Modulation	2.405/5.520/8.654 rad	0.01 rad	CW: 200 MHz to 3 GHz
Pulse Modulation	Tr / Tf	2.4 %	TDS7404B, DPO4104

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Power Analyzer <sup>3</sup> –			IEC61000-3-2, 3, 11, 12 IEC 61000-4-15, 4-7
AC Power: (45 to 65) Hz, PF = 1	20 W to 4.6 kW	0.02 %	AC Voltage 45 Hz to 6 kHz
Power Factor <sup>5</sup> : (45 to 65) Hz	(0.3 to 1)	0.23 %	AC Current 45 Hz to 6 kHz
Harmonic Current: 100 Hz to 6 kHz	(0.01 to 2) A	0.065 %	Fluke 6105A 1φ, (3φ)
Frequency	(45 to 65) Hz	0.02 %	Fluke 6105A
Voltage THD	(16 to 850) Hz 850 Hz to 6 kHz	0.022 % 0.31 %	
Current THD	(16 to 850) Hz 850 Hz to 6 kHz	0.016 % 0.13 %	
Pst <sup>6</sup> : (45 to 65) Hz	(0.1 to 3)	0.34 %	
dc	(0.1 to 5) %	0.30 %	
d <sub>max</sub>	(0.1 to 5) %	0.31 %	
d <sub>t</sub>	(400 to 1200) ms	0.11 %	
Antenna Factor <sup>3</sup> –			
Horn Antenna: Radiation Pattern	(0.5 to 18) GHz	0.36 dB	ANSI C63.5 SSM with floor absorber, SAE ARP 958
POD Antenna: Radiation Pattern	(1 to 18) GHz	1.1 dB	
Mono Pole	30 Hz to 1 kHz 1 kHz to 50 MHz	0.32 dB 0.25 dB	Capacitive substitute standard magnetic field method
Loop Antenna	10 Hz to 10 MHz (10 to 30) MHz	0.4 dB 0.5 dB	IEEE Std. 291-1991
Loop Sensor	10 Hz to 500 kHz	0.35 dB	IEEE.EMC-7.1965

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Antenna Factor <sup>3</sup> – (cont)			
Broad Band Antenna: Bi-conical Log Periodic Bi-Log	(24 to 300) MHz (200 to 1000) MHz (30 to 1000) MHz	1.0 dB 0.74 dB 1.0 dB	CISPR 16-1-6 SAM method SAE ARP958
Dipole Antenna	(30 to 1000) MHz	1.2 dB	ANSI C63.5 RAM method
Network Analyzer <sup>3</sup> –			
Reference Frequency	9 kHz to 18 GHz	0.01 µHz/Hz	Frequency – measure
Port Impedance	DC to 2 GHz (2 to 18) GHz	0.004 dB 0.01 dB	Agilent 85054D Type-N
Output Level Accuracy	9kHz to 6GHz 50 MHz to 10 GHz (10 to 26.5) GHz	0.23 dB 0.28 dB 0.37 dB	Absolute power – measure
Attenuation (S <sub>12</sub> , S <sub>21</sub> )	9 kHz to 8 GHz (0 to 70) dB (70 to 100) dB  (8 to 18) GHz (0 to 70) dB (70 to 100) dB	0.13 dB 0.26 dB  0.16 dB 0.27 dB	Attenuation – generate
Phase	(-180 to 180)°	0.64 %	Agilent 85054D
Return Loss (S <sub>11</sub> , S <sub>22</sub> )	ρ = 12 dB ρ = 24 dB	0.27 dB 0.34 dB	
Current/Injection Probe <sup>3</sup> –			
LF Sensitivity Factor	(10 to 850) Hz 10 mA to 20A	1.0 %	FLUKE 6105A and 8845A
Transfer Impedance: dBΩ	10 Hz to 100 MHz 100 MHz to 1 GHz (1 to 2.1) GHz	0.2 dB 1.1 dB 3.1 dB	Agilent 4194A Agilent E5071C 50 Ω current calibration fixture

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Surge Generator <sup>3</sup> –			
V <sub>peak</sub>	(± 0.2 to 7) kV	1.7 %	IEC61000-4-5 IEC61000-4-12 IEC61000-4-18 TDS7404B, DPO4104 and SI-9010
I <sub>peak</sub>	1 A to 10 kA	1.7 %	TDS7404B, DPO4104 and 110A
Effective Output Impedance	2 Ω, 12 Ω	2.4 %	
Front Time	5 ns to 10 μs	2.4 %	Time Tr, Tf
Time to Half Value	(0.1 to 700) μs	2.4 %	
Phase Shift	(1 to 360)°	2.4 %	
EFT/Burst Generator –			IEC61000-4-4
V <sub>peak</sub>	(0.1 to 10) kV	2.9 %	Tek TDS7404B, DPO4104 and attenuators
Pulse Duration	1 μs to 500 ms	2.4 %	
Rise Time / Fall Time	(1 to 10) ns	2.4 %	
Pulse Width	(10 to 100) ns	2.4 %	
Voltage Dip Generator –			IEC 61000-4-11
Nominal Voltage	(90 to 264) V	1.8 %	Tek TDS7404B, DPO4104, SI-9010, 110A
Dip Voltage	(0.01 to 264) V	1.8 %	
Rise Time / Fall time	(0.01 to 20) μs	2.4 %	No load / 100 Ω load
Duration	(0.1 to 1000) ms	2.4 %	
Phase Angle	(0 to 360)°	2.4 %	
EM Clamp –			IEC 61000-4-6
Coupling Factor:			Jig method E5071C
EM Clamp	(0.15 to 230) MHz	0.7 dB	
Injection Clamp	10 kHz to 500 MHz 500 MHz to 2.1 GHz	0.8 dB 1.3 dB	
Decoupling Factor	150 kHz to 230 MHz	0.7 dB	



Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Voltage Probe Calibration <sup>3</sup> –  Passive Probe: Attenuation: DC/1 kHz - 3 dB Bandwidth Rise Time  Differential Probe: Attenuation -3 dB Bandwidth Rise Time	(0.1 to 2000) V DC to 4 GHz Tr > 0.7 ns Tr > 0.35 ns  (0.001 to 2.8) kV DC to 100 MHz Tr > 3 ns	0.33 % 4.0 % 4.0 % 5.3 %  0.33 % 4.0 % 4.0 %	TDS7404B, DSO7104A WF1965, 6105A Keysight N5171B IGUU2918  Fluke 6105A Keysight N5171B IGUU2918
Oscilloscope <sup>3</sup> –  Vertical: V/Div  Horizontal: Time/Div  -3 dB Bandwidth  Rise Time (>144 ps)  Input Impedance: DC  Delay Time	2 mV to 10 mV/div 0.02 V to 10 V/div  10 s to 100 ns/div 10 ns to 200 ps/div  DC to 4 GHz  fc: < 500 MHz fc: < 2.5 GHz  50 Ω, 1 MΩ  (0.1 to 100) ms	0.22 % 0.12 %  0.1 % 0.2 %  3.6 %  2.2 % 3.6 %  0.015 %  0.000 02 %	NF WF1965, WF1967  NF WF1965, WF1967 R&S SML03  R&S SML03, Agilent 8673E, Keysight N5171B  IGUU2918  NF WF1965, WF1967
7637 Pulse Generator <sup>3</sup> –  Pulse 1, Pulse 2a, 2b, Pulse 3a, 3b, Pulse 5a, 5b:  Voltage Rise Time Duration	(0.1 to 660) V 1 ns to 5 μs 100 ns to 3 s	2.6 % 2.4 % 2.4 %	ISO7637-2 (2004, 2011(E)) ISO7637-3 Load / No load  Tek TDS7404B, DPO4104 and TT-HV150

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Pulse Generator, Function Generator <sup>3</sup> –			
Sine Wave Form: 10 kHz to 100 MHz	(+20 to -60) dBm	0.23 dB	square voltage DC voltage – measure  Agilent E9304A and N1913A  Tek TDS7404B, DPO4104
Rise Time / Fall Time	Tr > 1 ns	2.4 %	
Pulse Width	10 μs to 1 s	2.4 %	Delay time measure
Phase	(0 to 360) °	0.4 °	

Parameter/Equipment	Frequency	CMC <sup>2</sup> (±)	Comments
RF Amp, Pre Amp <sup>3</sup> –			
Gain	9 kHz to 1 GHz (1 to 18) GHz	0.24 dB 0.28 dB	Agilent E5071C R&S ZNB 20
Input /Output Impedance	9 kHz to 2 GHz (2 to 8) GHz (8 to 18) GHz	Γ: 0.023 Γ: 0.024 Γ: 0.028	
Power Amp:			
1 dB Compression Gain	9 kHz to 1 GHz  (1 to 18) GHz	0.31 dB  0.34 dB	Agilent E5071C and attenuation  R&S ZNB 20 and attenuation
Maximum OUT (0 to 1 kW)	(1 to 18) GHz	0.34 dB	R&S ZNB 20 and attenuation
Harmonic Distortion	9 kHz to 2.2 GHz	64 dBc	R&S ESIB40, SML03
Bipolar Power / Amp:			
Gain	10 Hz to 300 MHz	0.26 dB	Anritsu MS4630B

Parameter/Equipment	Frequency	CMC <sup>2</sup> (±)	Comments	
NSA Validation Test <sup>3</sup> –				
Distance 10 m, Horizontal:				
Bi-Conical Antenna	(30 to 70) MHz	1.0 dB	ANSI C63.5, CISPR 16-1-4 Horizontal: Tx = 1.0 m, 2.0 m Vertical: Tx = 1.0 m, 1.5 m Standard antenna: VHBB9124: (30 to 200) MHz VULP9118A: 200 MHz to 1 GHz Network analyzer	
	(70 to 200) MHz	0.69 dB		
Log Periodic Antenna	(200 to 1000) MHz	0.71 dB		
Distance 10 m, Vertical:				
Bi-Conical Antenna	(30 to 70) MHz	1.1 dB		
	(70 to 200) MHz	0.72 dB		
Log Periodic Antenna	(200 to 1000) MHz	0.74 dB		
Distance 3 m, Horizontal:				
Bi-Conical Antenna	(30 to 70) MHz	1.0 dB		
	(30 to 200) MHz	0.72 dB		
Log Periodic Antenna	(200 to 1000) MHz	0.72 dB		
Distance 3 m, Vertical:				
Bi-Conical Antenna	(30 to 70) MHz	1.1 dB		
	(30 to 200) MHz	0.75 dB		
Log Periodic Antenna	(200 to 1000) MHz	0.76 dB		
3 m method:				
Biconical Antenna	(30 to 200) MHz	0.86 dB	ETSI TR 102 273-2, 273-3	
LPDA Antenna	(200 to 1000) MHz	0.69 dB		
Small LPDA Antenna	(1 to 18) GHz	0.59 dB		

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Broadband Antenna, NSA Factor <sup>3</sup> –  Distance 10 m, Horizontal H = 1.0, 2.0 m  Distance 10 m, Vertical H = 1.0, 1.5 m  Distance 3 m, Horizontal H = 1.0, 2.0 m  Distance 3 m, Vertical H = 1.0, 1.5 m	(30 to 200) MHz (200 to 1000) MHz  (30 to 200) MHz (200 to 1000) MHz  (30 to 200) MHz (200 to 1000) MHz  (30 to 200) MHz (200 to 1000) MHz	1.1 dB 0.7 dB  1.1 dB 0.74 dB  1.1 dB 0.7 dB  1.1 dB 0.76 dB	Standard antenna Method Standard antenna VHBB9124: (30 to 300) MHz VULP9118A: 200 MHz to 1 GHz Network analyzer
SVSWR Validation Test <sup>3</sup> –  POD16: (1 to 6) GHz POD618: (6 to 18) GHz	(0 to 20) dB (0 to 20) dB	0.43 dB 0.43 dB	CISPR16-1-4, VCCI  Agilent E5071C Agilent N9917A R&S ZNB 20
SAC/Shield Validation Test <sup>3</sup> –  Dynamic Range (69 to 145) dB	14 kHz to 18 GHz	2.9 dB	IEEE 299-2006  Agilent N9917A, Signal generators, reference antennas

### III. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Frequency <sup>3</sup> – Measure	10 Hz to 18 GHz	0.01 $\mu\text{Hz}/\text{Hz}$ + 100 $\mu\text{Hz}$	Rubidium standard and phase locked counter
Frequency <sup>3</sup> – Generate	10 MHz	20 pHz/Hz	Rubidium standard
	10 Hz to 18 GHz	20 pHz/Hz + 100 $\mu\text{Hz}$	Rubidium standard with signal generators phase locked
Period, Time Interval <sup>3</sup> –  Tr, Tf Td	10 ns to 10 s (10 to 1000) s (1000 to 100 000) s  50 ps to 1 ms 50 ps to 1 ms	0.003 % 0.003 % 0.003 %  2.4 % 2.4 %	Tek TDS7404B Tek DPO4104 Oscilloscope

SATELLITE FACILITY  
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I. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC <sup>2,4</sup> (±)	Comments
Antenna Factor –			
Biconical Antenna	(30 to 300) MHz	0.51 dB	Free-space calibration of biconical antenna
LPDA Antenna	(200 to 1000) MHz	0.59 dB	A LPDA free-space factor calibration
Hybrid Antenna	(30 to 1000) MHz	0.58 dB	Free-space factor calibration of hybrid antenna

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

<sup>4</sup> In the statement of CMC, the value is defined as the percentage of reading unless otherwise noted.

<sup>5</sup> Power factor is ratio of  $PF=Pa/VI$  and has no units, where Pa: active power, VI: apparent power.

<sup>6</sup> Pst is the flicker severity and has no units. It is regulated by IEC61000 -3-3.



## Accredited Laboratory

A2LA has accredited

**OHTAMA CALIBRATION SERVICE CO., LTD.**

*Kanagawa, JAPAN*

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 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 1<sup>st</sup> day of October 2018.

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

President and CEO  
For the Accreditation Council  
Certificate Number 3606.01  
Valid to July 31, 2020

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