



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

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CALIBRATION

Valid To: May 31, 2019

Certificate Number: 3128.01

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

I. Cell Phone Test System

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
W-CDMA ³ TRx/Performance Test System (ME7873F) –			
UL Measurement Accuracy	Max Output	0.27 dB	Signal analyzer, signal generator, power meter and power sensor, calibration receiver
(0.5 to 2) GHz Modulation	TX IM(UL)	0.27 dB	
	TX IM(IM)	0.28 dB	
	Min Output	0.28 dB	
Relative Level Measurement Accuracy			
(0.5 to 2) GHz Modulation	1 dB Step	0.01 dB	
	2 dB Step	0.01 dB	
	3 dB Step	0.01 dB	
	26 dB Step	0.20 dB	
RACH Measurement Accuracy (Absolute Level Measurement)			
(0.5 to 2) GHz Modulation	Pre1f (+5 dBm)	0.29 dB	
	Pre1f	0.31 dB	
	PreMAX	0.27 dB	
	Off Power	0.34 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
W-CDMA ³ TRx/Performance Test System (ME7873F) – (cont)			
RACH Measurement Accuracy (Relative Level Measurement)			
(0.5 to 2) GHz Modulation	Power Difference	0.01 dB	Signal analyzer, signal generator, power meter and power sensor, calibration receiver
DPCCH Measurement Accuracy			
(0.5 to 2) GHz Modulation	8.4.4	0.30 dB	
	8.7.9	0.30 dB	
	8.7.9 (UL)	0.30 dB	
TX Spurious Measurement Accuracy (General) CW	(0.15 to 10) MHz	0.27 dB	
	(10 to 2200) MHz	0.32 dB	
	(2.2 to 4) GHz	0.61 dB	
	(4 to 12.75) GHz	1.2 dB	
TX Spurious Measurement Accuracy (Additional) CW			
GSM	(921 to 925) MHz	0.30 dB	
	(925 to 960) MHz	0.31 dB	
	(1805 to 1880) MHz	0.31 dB	
PHS	(1884.5 to 1919.6) MHz	0.30 dB	
DL Band	Band I, II, III, IV, V, VII, VIII, IX, XI; 800 MHz	0.33 dB	
RX Spurious Measurement Accuracy (General) CW	(30 to 1000) MHz	0.30 dB	
	(1 to 2.2) GHz	0.32 dB	
	(2.2 to 4) GHz	0.61 dB	
	(4 to 13) GHz	1.2 dB	
RX Spurious Measurement Accuracy (Additional) CW			
In Band	(0.5 to 2) GHz	0.33 dB	
GSM	(921 to 925) MHz	0.30 dB	
	(925 to 960) MHz	0.30 dB	
Spectrum Emission Mask CW	(0.5 to 2) GHz CW	0.27 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
W-CDMA ³ TRx/Performance Test System (ME7873F) – (cont)			
Adjacent Channel Leakage Power Ratio (ACLR)	(0.5 to 2) GHz, Modulation/CW	0.43 dB	Signal analyzer, signal generator, power meter and power sensor, calibration receiver
Occupied Bandwidth (OBW) Modulation	(0.5 to 2) GHz	21 kHz	
Frequency Error Modulation	(0.5 to 2) GHz	0.02 Hz	
Error Vector Magnitude (EVM)	ULRMC12k	0.66 % of full scale	
(0.5 to 2) GHz Modulation	Pre1f	0.66 % of full scale	
Phase Error			
(0.5 to 2) GHz Modulation		0.23°	
Peak Code Domain Error			
(0.5 to 2) GHz Modulation		0.12 dB	
DL Output Accuracy			
(0.5 to 3) GHz Modulation			
Downlink Power	(-30 to 0) dBm (-80 to -30) dBm; Ioc (MBMS)	0.32 dB 0.37 dB	
	(-120 to -80) dBm Blocking (In-Band), Spurious	0.45 dB	
	Max Input	0.26 dB	
Ior/Ioc (TRx)			
(0.5 to 3) GHz Modulation	DPCCH_Ec/Ioc Ior/Ioc Ioc	0.09 dB 0.09 dB 0.34 dB	

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
W-CDMA ³ TRx/Performance Test System (ME7873F) – (cont)			
Ior/Ioc (Perf) (0.5 to 3) GHz Modulation	Ior/Ioc(Static)	0.09 dB	Signal analyzer, signal generator, power meter and power sensor, calibration receiver
	Ior/Ioc(Static)[Sqrt(0.3 ² (Static) +0.3 ² (Static)]	0.12 dB	
	Ioc	0.30 dB	
	Fading	0.09 dB	
	Ior/Ioc[Sqrt(0.3 ² (Static) +0.5 ² (Fading)]	0.12 dB	
	Ior/Ioc[Sqrt(0.3 ² (Static) +0.5 ² (Fading) +0.5 ² (Fading)]	0.15 dB	
	Ior/Ioc[3000 times average]	0.10 dB	
Ior/Ioc (RRM Fading Test Case) PropSimC2			
(0.5 to 3) GHz Modulation	Ioc	0.31 dB	
	Ior	0.31 dB	
	Ior1/Ior2	0.09 dB	
Ior/Ioc (RRM Fading Test Case) MF6900A			
(0.5 to 3) GHz Modulation	Ioc	0.28 dB	
	Ior	0.29 dB	
RRM Signal Output			
(0.5 to 3) GHz Modulation	Ior, Ioc, RXLEV	0.28 dB	
	Ior/Ioc, Ior/Ior, Ioc/Ioc	0.09 dB	
	Ioc/RXLEV, Ioc/RXLEV (8.7.3A), Ior/Ior (Inter Band), Ioc/Ioc (Inter Band), Ioc/RXLEV (Ior and Ioc are combined in digital baseband oSFS)	0.12 dB	
	RXLEV/RXLEV	0.39 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
W-CDMA ³ TRx/Performance Test System (ME7873F) – (cont)			
CW Interference	Blocking: (10 to 3000) Hz Blocking: (3 to 8) GHz Blocking: (8 to 13) GHz RX IM TX IM	0.26 dB 0.54 dB 1.1 dB 0.26 dB 0.26 dB	Signal analyzer, signal generator, power meter and power sensor, calibration receiver
Modulation Interference	SG2->CpDSG->Isolator->Antenna	0.29 dB	
(0.5 to 3) GHz Modulation	SG2->Isolator->Antenna Intermodulation Characteristics	0.29 dB 0.26 dB	
GSM Interference			
(0.5 to 3) GHz Modulation	Blocking Characteristics (Narrow Band) Intermodulation Characteristics (Narrow Band)	0.29 dB 0.26 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
LTE/A RF Conformance ³ – Test System (ME78xx ⁷)			
UL Measurement Accuracy			
(0.5 to 3) GHz Modulation, CW	Max Output Min Output Off Power TX IM (UL) TX IM (IM) Carrier Aggregation	0.37 dB 0.26 dB	Signal generator, power meter, power sensor, signal analyzer
UL Measurement Accuracy			
Freq. ≤ 3 GHz	Max Output	0.30 dB	
3 GHz < Freq. ≤ 4 GHz	Max Output	0.35 dB	
For low level WCDMA UL (5.4.1, 8.4.2*)	Max Output	0.32 dB	
(5.4.3, 5.5.1, 5.5.2)			
Frequency Error	(0.5 to 4) GHz Modulation	1.2 Hz	
Error Vector Magnitude (EVM)	(0.5 to 4) GHz Modulation	0.21 % of full scale	
Origin Offset	(0.5 to 3) GHz Modulation	0.44 dB	
In Band Emission	(0.5 to 4) GHz Modulation	0.27 dB	
In Band Emission for CA	(0.5 to 3) GHz Modulation	0.29 dB	
Occupied Bandwidth (OBW)	(0.5 to 4) GHz, CW	0.01 kHz	
Spectrum Emission Mask	(0.5 to 3) GHz Modulation, CW	0.27 dB	
	(3 to 4) GHz Modulation, CW	0.45 dB	
Adjacent Channel Leakage Power Ratio (ACLR)	(0.5 to 4) GHz Modulation	0.30 dB	
Spectrum Flatness	(0.5 to 4) GHz Modulation	0.60 dB	
Spurious, CW	(10 to 30) MHz	0.29 dB	
	(30 to 4000) MHz	0.31 dB	
	(4 to 13) GHz	0.48 dB	
	(13 to 19) GHz	0.52 dB	
	(19 to 26) GHz	0.60 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
LTE/A RF Conformance ³ – Test System (ME78*) (cont)			
DL Output Accuracy	Bandwidth: 1.4 MHz	0.35 dB	Signal generator, power meter, power sensor, signal analyzer
(0.5 to 3) GHz Modulation	Bandwidth: 20 MHz	0.33 dB	
DL Output Accuracy (RRM)	LTE Absolute AWGN Absolute	0.29 dB	
(0.5 to 3) GHz Modulation, CW	W-CDMA Absolute	0.30 dB	
	GSM Absolute	0.27 dB	
	Memory Synthesizing Function Output	0.26 dB	
	CDMA2000 Absolute	0.29 dB	
	LTE / LTE Relative (InterFreq.), LTE / W-CDMA Relative, LTE / CDMA2000 Relative, CDMA2000 / AWGN Relative	0.41 dB	
	LTE / GSM Relative	0.39 dB	
	DC-HSDPA Ior/Ioc	0.10 dB	
	TDS-CDMA Ior/Ioc	0.10 dB	
DL Output Accuracy Freq. ≤ 3 GHz	LA Absolute	0.32 dB	
3 GHz < Freq. ≤ 4GHz	LA Absolute	0.50 dB	
4 GHz < Freq. ≤ 6GHz	LA Absolute	0.59 dB	
CW Interference, CW			
Out of Band	(1 to 10) MHz	0.21 dB	
	(10 to 3000) MHz	0.27 dB	
	(3 to 4) GHz	0.43 dB	
	(4 to 13) GHz	0.50 dB	
Near Band	(4 to 13) GHz	1.1 dB	
for Intermodulation Characteristics	(400 to 3000) MHz	0.27 dB	
	(3 to 4) GHz	0.43 dB	
	(4 to 4.2) GHz	0.35 dB	
	(4.2 to 6) GHz	0.42 dB	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
LTE/A RF Conformance ³ – Test System (ME78*) (cont)			
Modulation Interference			Signal generator, power meter, power sensor, signal analyzer
(0.5 to 3) GHz Modulation	(680 to 2700) MHz (-46 to -15) dBm	0.26 dB	
UL Relative Power Measurement	LTE, MediaFLO, ATSC	0.35 dB	
	(0.5 to 3) GHz Modulation	0.23 dB	
Transmit OFF Power Measurement Accuracy	(0.5 to 3) GHz (3 to 3.8) GHz	0.31 dB 0.36 dB	
Relative carrier leakage Power	(0.5 to 4) GHz	0.40 dB	
Interference signal Output Accuracy	(400 to 3000) MHz (3 to 4) GHz (4 to 4.2) GHz (4.2 to 6) GHz	0.34 dB 0.52 dB 0.60 dB 0.70 dB	
Relative Level Measurement for LTE	(0.5 to 4) GHz	0.46 dB	
DL Relative Accuracy			
Ior/Ioc (CDMA2000) Ior/Iot(LTE)	(0.5 to 3) GHz	0.10 dB	
Ior/Ior, Ioc/Ioc (Intra-Band) Ior/Ioc (TD-SCDMA) LTE DL/AWGN	(0.5 to 3) GHz	0.13 dB	
Ior/Ior, Ioc/Ioc (Inter-Band) Ioc/RXLEV, RXLEV/RXLEV	(0.5 to 3) GHz	0.17 dB	
DPCCH Measurement Accuracy	(0.5 to 3) GHz	0.39 dB	

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
DC Voltage – Generate	1 mV 10 mV (22 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 220) V (220 to 1000) V	2.2 μV 2.3 μV 7.6 μV/V + 24 μV 5.1 μV/V + 6.5 μV 3.6 μV/V + 48 μV 5.1 μV/V + 730 μV 6.6 μV/V + 22 mV	Calibrator
DC Voltage – Measure	1 mV (10 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	3.1 μV 5.8 μV/V + 2.2 μV 4.7 μV/V + 3.0 μV 3.9 μV/V + 6.2 μV ⁶ 5.8 μV/V + 160 μV ⁶ 18 μV/V + 3.1 mV ⁶	Multimeter
DC Current – Generate	(22 to 220) μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 1) A	41 μA/A + 6.6 nA 36 μA/A + 26 nA 36 μA/A + 0.26 μA 46 μA/A + 4.3 μA 81 μA/A + 0.14 mA	Calibrator
DC Current – Measure	(10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	24 μA/A + 1.1 nA 20 μA/A + 6.5 nA ⁶ 20 μA/A + 0.067 μA ⁶ 34 μA/A + 0.89 μA ⁶ 0.011 % + 29 μA ⁶	Multimeter
Resistance – Generate, Fixed Points	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.33 mΩ 0.43 mΩ 3.6 mΩ 14 mΩ 140 mΩ 1.5 Ω 24 Ω 730 Ω 61 kΩ	Calibrator



Parameter/Equipment	Range	CMC ^{2.5} (±)	Comments
Resistance – Measure	(1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	18 μΩ/Ω + 230 μΩ 14 μΩ/Ω + 2.3 mΩ 9.6 μΩ/Ω + 2.1 mΩ ⁶ 9.6 μΩ/Ω + 21 mΩ ⁶ 9.6 μΩ/Ω + 180 mΩ ⁶ 15 μΩ/Ω + 4.4 Ω ⁶ 48 μΩ/Ω + 150 Ω ⁶ 0.048 % + 10 kΩ ⁶ 0.49 % + 670 kΩ ⁶	Multimeter

Parameter/Range	Frequency	CMC ^{2.5} (±)	Comments
AC Voltage – Generate (22 to 220) mV	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.011 % + 14 μV 0.0082 % + 14 μV 0.014 % + 14 μV 0.032 % + 21 μV 0.066 % + 23 μV 0.15 % + 28 μV 0.28 % + 47 μV	Calibrator
(0.22 to 2.2) V	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.0091 % + 65 μV 43 μV/V + 49 μV 0.0068 % + 49 μV 0.0086 % + 57 μV 0.034 % + 150 μV 0.11 % + 240 μV 0.18 % + 510 μV	
(2.2 to 22) V	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.0091 % + 430 μV 43 μV/V + 410 μV 0.0068 % + 420 μV 0.0084 % + 450 μV 0.026 % + 0.73 mV 0.11 % + 2.1 mV 0.16 % + 3.3 mV	
(22 to 220) V	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.0091 % + 4.7 mV 53 μV/V + 4.5 mV 0.0081 % + 4.6 mV 0.016 % + 5.1 mV	
(220 to 700) V	50 Hz to 1 kHz	71 μV/V + 5.7 mV	



Parameter/Equipment	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Measure			
(10 to 100) mV	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.01 % + 5.9 μV 0.01 % + 4.3 μV 0.018 % + 4.3 μV 0.029 % + 3.6 μV ⁶ 0.077 % + 3.6 μV ⁶ 0.29 % + 10 μV ⁶ 0.96 % + 10 μV ⁶	Multimeter
(0.1 to 1) V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	81 μV/V + 59 μV 67 μV/V + 36 μV ⁶ 0.014 % + 36 μV ⁶ 0.029 % + 36 μV ⁶ 0.077 % + 36 μV ⁶ 0.29 % + 100 μV ⁶ 0.96 % + 100 μV ⁶	
(1 to 10) V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	81 μV/V + 670 μV 67 μV/V + 330 μV ⁶ 0.014 % + 440 μV ⁶ 0.029 % + 440 μV ⁶ 0.077 % + 500 μV ⁶ 0.29 % + 1.1 mV ⁶ 0.96 % + 2.7 mV ⁶	
(10 to 100) V	(20 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % + 5.1 mV ⁶ 0.02 % + 3.9 mV ⁶ 0.02 % + 3.9 mV ⁶ 0.034 % + 3.9 mV ⁶ 0.12 % + 3.9 mV ⁶	
(100 to 700) V	50 Hz to 1 kHz	0.039 % + 42 mV ⁶	
Linearity at 10 V _p			
(-40 to 0) dB	20 Hz to 100 kHz (100 to 300) kHz 300 kHz to 1 MHz 100 kHz to 15 MHz	0.009 dB 0.037 dB 0.12 dB 0.097 dB	Multimeter Attenuator

Parameter/Equipment	Frequency	CMC ^{2, 5} (\pm)	Comments
AC Current – Generate (2.2 to 22) mA (22 to 220) mA (0.22 to 1) A	50 Hz to 1 kHz 50 Hz to 1 kHz 50 Hz to 1 kHz	0.011 % + 0.79 μ A 0.011 % + 8.4 μ A 0.025 % + 97 μ A	Calibrator
AC Current – Measure (1 to 10) mA (10 to 100) mA (0.1 to 1) A	(50 to 100) Hz 100 Hz to 1 kHz (50 to 100) Hz 100 Hz to 1 kHz (50 to 100) Hz 100 Hz to 1 kHz	0.07 % + 3.7 μ A 0.035 % + 2.6 μ A 0.07 % + 38 μ A 0.035 % + 26 μ A 0.077 % + 610 μ A ⁶ 0.096 % + 220 μ A ⁶	Multimeter
AC Phase – Measure (-180 to +180) deg.	10 Hz to 100 kHz 100 kHz to 1 MHz (1 to 5) MHz	0.04° 0.06° 0.22°	Digital oscilloscope
AC Distortion – Measure	400 Hz, 1 kHz	0.12 %	Measuring receiver

III. Electrical – RF/Microwave

Parameter/Frequency	Range	CMC ^{2, 4, 5} (±)	Comments
RF Power – Generate ³			
50 MHz	1 mW	0.53 %	Reference oscillator
100 kHz to 5 GHz	0 dBm	0.08 dB	Power meter and power sensor
(5 to 12) GHz	0 dBm	0.09 dB	
(12 to 14) GHz	0 dBm	0.09 dB	
(14 to 18) GHz	0 dBm	0.12 dB	
(18 to 25) GHz	0 dBm	0.14 dB	
(25 to 40) GHz	0 dBm	0.16 dB	
100 kHz to 10 MHz	(-10 to 0) dBm (-100 to -10) dBm	0.08 dB 0.10 dB	Power meter and power sensor, measuring receiver, signal analyzer
(0.01 to 3) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.10 dB 0.07 dB 0.09 dB	
(3 to 5) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.12 dB 0.07 dB 0.08 dB	
(5 to 12) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.16 dB 0.09 dB 0.10 dB	
(12 to 18) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.17 dB 0.12 dB 0.13 dB	

Parameter/Frequency	Range	CMC ^{2, 4, 5} (±)	Comments
RF Power – Measuring Equipment ³			
Power Sensor Correction Factor			
100 kHz	0 dBm	1.6 %	Power meter and power sensor
300 kHz	0 dBm	1.3 %	
500 kHz	0 dBm	1.3 %	
1 MHz	0 dBm	1.3 %	
3 MHz	0 dBm	1.5 %	
5 MHz	0 dBm	1.6 %	
10 MHz	0 dBm	1.4 %	
30 MHz	0 dBm	1.3 %	
50 MHz	0 dBm	1.1 %	
100 MHz	0 dBm	1.3 %	
300 MHz	0 dBm	1.3 %	
500 MHz	0 dBm	1.3 %	
1 GHz	0 dBm	1.3 %	
1.5 GHz	0 dBm	1.2 %	
2 GHz	0 dBm	1.3 %	
2.5 GHz	0 dBm	1.4 %	
3 GHz	0 dBm	1.4 %	
4 GHz	0 dBm	1.4 %	
4.2 GHz	0 dBm	1.5 %	
5 GHz	0 dBm	1.3 %	
6 GHz	0 dBm	1.3 %	
7 GHz	0 dBm	1.4 %	
8 GHz	0 dBm	1.6 %	
9 GHz	0 dBm	1.6 %	
10 GHz	0 dBm	1.7 %	
11 GHz	0 dBm	1.7 %	
12 GHz	0 dBm	1.7 %	
12.4 GHz	0 dBm	1.6 %	
13 GHz	0 dBm	1.7 %	
14 GHz	0 dBm	1.9 %	
15 GHz	0 dBm	1.9 %	
16 GHz	0 dBm	1.9 %	
17 GHz	0 dBm	2.1 %	
18 GHz	0 dBm	2.2 %	
19 GHz	0 dBm	1.9 %	
20 GHz	0 dBm	2.0 %	
21 GHz	0 dBm	2.1 %	
22 GHz	0 dBm	2.2 %	
23 GHz	0 dBm	2.2 %	
24 GHz	0 dBm	2.3 %	
25 GHz	0 dBm	2.5 %	



Parameter/Frequency	Range	CMC ^{2, 4, 5} (±)	Comments
RF Power Measuring Equipment ³ (cont)-			
Power Sensor Correction Factor			
26 GHz	0 dBm	2.6 %	Power meter and power sensor
26.5 GHz	0 dBm	2.9 %	
27 GHz	0 dBm	3.3 %	
28 GHz	0 dBm	3.0 %	
29 GHz	0 dBm	2.8 %	
30 GHz	0 dBm	2.6 %	
31 GHz	0 dBm	2.7 %	
32 GHz	0 dBm	2.6 %	
33 GHz	0 dBm	2.6 %	
34 GHz	0 dBm	2.7 %	
35 GHz	0 dBm	2.6 %	
36 GHz	0 dBm	2.5 %	
37 GHz	0 dBm	2.7 %	
38 GHz	0 dBm	2.6 %	
39 GHz	0 dBm	2.8 %	
40 GHz	0 dBm	2.7 %	
(0.1 to 1) MHz	0 dBm	1.7 %	
1 MHz to 2 GHz	0 dBm	1.6 %	
(2 to 6) GHz	0 dBm	1.5 %	
(6 to 8) GHz	0 dBm	1.5 %	
(8 to 12) GHz	0 dBm	1.7 %	
(12 to 18) GHz	0 dBm	2.3 %	
Power Meter Linearity			
10 MHz to 6 GHz	(0 to 10) dBm	3.9 %	Power meter and power sensor, step attenuator
(6 to 12) GHz	(0 to 10) dBm	6.4 %	
(12 to 18) GHz	(0 to 10) dBm	7.1 %	
10 MHz to 6 GHz	(-50 to 0) dBm	4.6 %	
(6 to 12) GHz	(-50 to 0) dBm	6.6 %	
(12 to 18) GHz	(-50 to 0) dBm	7.0 %	

Parameter/Frequency	Range	CMC ^{2,5} (±)	Comments
<p>Frequency Modulation – Measure</p> <p>(0.25 to 10) MHz Rate: 20 Hz to 10 kHz</p> <p>(10 to 1300) MHz Rate: 20 Hz to 200 kHz</p> <p>(10 to 1300) MHz Rate: 50 Hz to 100 kHz</p>	<p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz</p> <p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz</p> <p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz</p>	<p>3.4 % + 1 Hz 2.6 % + 10 Hz</p> <p>6.3 % + 1 Hz 5.9 % + 10 Hz 5.9 % + 100 Hz</p> <p>2.5 % + 1 Hz 2.1 % + 10 Hz 1.4 % + 100 Hz</p>	Measuring receiver
<p>Frequency Modulation – Measuring Equipment</p> <p>(0.25 to 10) MHz Rate: 20 Hz to 10 kHz</p> <p>(10 to 1300) MHz Rate: 20 Hz to 200 kHz</p> <p>(10 to 1300) MHz Rate: 50 Hz to 100 kHz</p>	<p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz</p> <p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz</p> <p>Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz</p>	<p>3.3 % + 1 Hz 2.5 % + 10 Hz</p> <p>6.3 % + 1 Hz 6.0 % + 10 Hz 5.9 % + 100 Hz</p> <p>2.5 % + 1 Hz 2.1 % + 10 Hz 1.4 % + 100 Hz</p>	Measuring receiver
<p>Attenuation – Measure</p> <p>10 MHz to 18 GHz</p>	<p>(0 to 90) dB</p> <p>(90 to 100) dB</p>	<p>0.08 dB</p> <p>0.1 dB</p>	Measuring receiver
<p>Attenuation – Measuring Equipment</p> <p>10 MHz to 12 GHz</p> <p>(12 to 18) GHz</p>	<p>(0 to 100) dB</p> <p>(0 to 100) dB</p>	<p>0.24 dB</p> <p>0.34 dB</p>	Step attenuator

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Amplitude Modulation – Measure			
(0.15 to 10) MHz Rate: 20 Hz to 10 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale	Measuring receiver
(0.15 to 10) MHz Rate: 50 Hz to 10 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	2.6 % + 0.01 % of full scale 2.5 % + 0.1 % of full scale	
(10 to 1300) MHz Rate: 20 Hz to 100 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale	
(10 to 1300) MHz Rate: 50 Hz to 50 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	1.6 % + 0.01 % of full scale 1.4 % + 0.1 % of full scale	
Amplitude Modulation – Measuring Equipment			
(0.15 to 10) MHz Rate: 20 Hz to 10 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale	Measuring receiver
(0.15 to 10) MHz Rate: 50 Hz to 10 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	2.6 % + 0.01 % of full scale 2.5 % + 0.1 % of full scale	
(10 to 1300) MHz Rate: 20 Hz to 100 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale	
(10 to 1300) MHz Rate: 50 Hz to 50 kHz	Depth: (5 to 40) % Depth: (40 to 99) %	1.6 % + 0.01 % of full scale 1.3 % + 0.1 % of full scale	

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Spectrum Analyzer ⁸ –			
Standard Frequency Accuracy	10 MHz	2.4 μHz	Cesium standard and precision phase comparator
Displayed Frequency Accuracy	10 Hz to 1 GHz (1 to 40) GHz	1.3 Hz 1.4 Hz	Cesium standard and signal generator
Span Accuracy	10 kHz to 40 GHz	0.013 % of setting	Cesium standard and signal generator

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Spectrum Analyzer ⁸ –			
Frequency Response,	100 kHz	0.10 dB	Power meter and power sensor
Reference Level	300 kHz	0.09 dB	
Accuracy,	500 kHz	0.10 dB	
Absolute Amplitude	1 MHz	0.10 dB	
Accuracy	3 MHz	0.10 dB	
	5 MHz	0.10 dB	
	10 MHz	0.10 dB	
	30 MHz	0.09 dB	
	50 MHz	0.09 dB	
	100 MHz	0.09 dB	
	300 MHz	0.10 dB	
	500 MHz	0.10 dB	
	1 GHz	0.10 dB	
	1.5 GHz	0.10 dB	
	2 GHz	0.10 dB	
	2.5 GHz	0.11 dB	
	3 GHz	0.11 dB	
	4 GHz	0.11 dB	
	4.2 GHz	0.11 dB	
	5 GHz	0.11 dB	
	6 GHz	0.11 dB	
	7 GHz	0.11 dB	
	8 GHz	0.12 dB	
	9 GHz	0.12 dB	
	10 GHz	0.11 dB	
	11 GHz	0.11 dB	
	12 GHz	0.11 dB	
	12.4 GHz	0.14 dB	
	13 GHz	0.12 dB	
	14 GHz	0.12 dB	
	15 GHz	0.12 dB	
	16 GHz	0.12 dB	
	17 GHz	0.13 dB	
	18 GHz	0.13 dB	
	19 GHz	0.12 dB	
	20 GHz	0.13 dB	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Spectrum Analyzer (cont) ⁸ –			
Frequency Response, Reference Level Accuracy, Absolute Amplitude Accuracy	21 GHz 22 GHz 23 GHz 24 GHz 25 GHz 26 GHz 26.5 GHz 27 GHz 28 GHz 29 GHz 30 GHz 31 GHz 32 GHz 33 GHz 34 GHz 35 GHz 36 GHz 37 GHz 38 GHz 39 GHz 40 GHz	0.14 dB 0.14 dB 0.14 dB 0.15 dB 0.16 dB 0.17 dB 0.17 dB 0.17 dB 0.17 dB 0.18 dB 0.18 dB 0.20 dB 0.18 dB 0.16 dB 0.15 dB 0.15 dB 0.14 dB 0.16 dB 0.15 dB 0.16 dB 0.17 dB	Power meter and power sensor
	(0.1 to 1) MHz 1 MHz to 2 GHz (2 to 6) GHz (6 to 8) GHz (8 to 12) GHz (12 to 18) GHz	0.12 dB 0.12 dB 0.12 dB 0.13 dB 0.15 dB 0.17 dB	
Reference Level Accuracy, Absolute Amplitude Accuracy	(0.01 to 2) GHz (2 to 10) GHz (10 to 12) GHz (12 to 18) GHz	(-100 to -10) dBm (-100 to -10) dBm (-100 to -10) dBm (-100 to -10) dBm	0.26 dB 0.26 dB 0.34 dB 0.39 dB
Scale Fidelity –	(0 to 100) dB (0 to 100) dB (0 to 100) dB (0 to 100) dB	0.22 dB 0.21 dB 0.24 dB 0.34 dB	Step Attenuator

Parameter/Equipment	Range	CMC ^{2.5} (±)	Comments
Spectrum Analyzer (cont) ⁸ –			
Attenuator Switching Accuracy	10 kHz to 40 GHz	0.09 dB	Signal generator
Bandwidth Switching Accuracy	10 kHz to 40 GHz	0.09 dB	
Bandwidth Accuracy	10 Hz to 50 MHz	3.5 %	
Signal Generator –			
Standard Frequency Accuracy	10 MHz	2.4 µHz	Cesium standard and precision phase comparator
Frequency Accuracy	10 Hz to 1 MHz	0.012 Hz	Cesium standard and frequency counter
	(1 to 10) MHz	0.85 mHz	
	10 MHz	0.85 mHz	
	10 MHz to 1 GHz	0.075 Hz	
	(1 to 10) GHz	0.14 Hz	
	(10 to 20) GHz	0.26 Hz	
	(20 to 30) GHz	0.37 Hz	
	(30 to 40) GHz	0.49 Hz	



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments	
Signal Generator – (cont)				
Linearity				
(0.01 to 18) GHz	(-50 to 20) dBm (-100 to -50) dBm	0.31 dB 0.39 dB	Spectrum analyzer and step attenuator	
Absolute Level Accuracy				
100 kHz to 5 GHz	0 dBm	0.08 dB	Power meter and power sensor	
(5 to 12) GHz	0 dBm	0.09 dB		
(12 to 14) GHz	0 dBm	0.09 dB		
(14 to 18) GHz	0 dBm	0.12 dB		
(18 to 25) GHz	0 dBm	0.14 dB		
(25 to 40) GHz	0 dBm	0.16 dB		
100 kHz to 10 MHz	(-10 to 0) dBm (-100 to -10) dBm	0.08 dB 0.10 dB	Power meter and power sensor, measuring receiver	
(0.01 to 3) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.10 dB 0.07 dB 0.09 dB		
(3 to 5) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.12 dB 0.07 dB 0.08 dB		
(5 to 12) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.16 dB 0.09 dB 0.10 dB		
(12 to 18) GHz	(0 to 20) dBm (-10 to 0) dBm (-100 to -10) dBm	0.17 dB 0.12 dB 0.13 dB		
2nd and 3rd Harmonic				
(0.02 to 3) GHz	(0 to -70) dBc	0.9 dB		Signal analyzer
(3 to 13.5) GHz	(0 to -90) dBc	1.7 dB		
(13.5 to 18) GHz	(0 to -90) dBc	2.9 dB		

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Signal Generator – (cont) FM Modulation Accuracy (0.25 to 10) MHz Mod. Frequency: 20 Hz to 10 kHz (10 to 1300) MHz Mod. Frequency: 20 Hz to 200 kHz (10 to 1300) MHz Mod. Frequency: 50 Hz to 100 kHz	Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz Deviation: (0.3 to 4) kHz Deviation: (4 to 40) kHz Deviation: (40 to 400) kHz	3.4 % + 1 Hz 2.6 % + 10 Hz 6.3 % + 1 Hz 5.9 % + 10 Hz 5.9 % + 100 Hz 2.5 % + 1 Hz 2.1 % + 10 Hz 1.4 % + 100 Hz	Measuring receiver
Signal Generator – (cont) AM Modulation Accuracy (0.15 to 10) MHz Rate: 20 Hz to 10 kHz (0.15 to 10) MHz Rate: 50 Hz to 10 kHz (10 to 1300) MHz Rate: 20 Hz to 100 kHz (10 to 1300) MHz Rate: 50 Hz to 50 kHz	Depth: (5 to 40) % Depth: (40 to 99) % Depth: (5 to 40) % Depth: (40 to 99) % Depth: (5 to 40) % Depth: (40 to 99) % Depth: (5 to 40) % Depth: (40 to 99) %	3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale 2.6 % + 0.01 % of full scale 2.5 % + 0.1 % of full scale 3.7 % + 0.01 % of full scale 3.6 % + 0.1 % of full scale 1.6 % + 0.01 % of full scale 1.4 % + 0.1 % of full scale	Measuring receiver



Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Attenuator – Attenuation Accuracy 10 MHz to 18 GHz	(0 to 90) dB (90 to 100) dB	0.08 dB 0.1 dB	Measuring receiver

Parameter/Frequency	Range	CMC ² (±)	Comments
S Parameters for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Reflection S ₁₁ /S ₂₂ Magnitude and Phase – Measure ⁹ (70 to 300) kHz	(0.0001 to 0.03) lin (0.03 to 0.1) lin (0.1 to 0.2) lin (0.2 to 0.5) lin (0.5 to 1) lin	(0.005 to 0.011) lin (90 to 13) deg (0.005 to 0.011) lin (13 to 4.2) deg (0.005 to 0.011) lin (4.2 to 2.3) deg (0.005 to 0.011) lin (2.3 to 0.82) deg (0.008 to 0.021) lin (2.3 to 0.82) deg	VNA: MS4644A calibration kit : 3652A, 3652A-1, 3653, 3653A Verification kit: 3668-1



Parameter/Frequency	Range	CMC ² (±)	Comments
S Parameters for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ (cont)			
Reflection S ₁₁ /S ₂₂ Magnitude and Phase – Measure ⁹ (cont)			
300 kHz to 18 GHz	(0.0001 to 0.03) lin	(0.005 to 0.02) lin (90 to 21) deg	VNA: MS4644A calibration kit : 3652A, 3652A-1, 3653, 3653A Verification kit: 3668-1
	(0.03 to 0.1) lin	(0.005 to 0.02) lin (21 to 7.4) deg	
	(0.1 to 0.2) lin	(0.005 to 0.02) lin (7.4 to 4.5) deg	
	(0.2 to 0.5) lin	(0.005 to 0.02) lin (4.5 to 0.80) deg	
	(0.5 to 1) lin	(0.008 to 0.041) lin (4.5 to 0.80) deg	
(18 to 40) GHz	(0.0001 to 0.03) lin	(0.011 to 0.033) lin (90 to 21) deg	
	(0.03 to 0.1) lin	(0.011 to 0.033) lin (21 to 7.4) deg	
	(0.1 to 0.2) lin	(0.011 to 0.033) lin (7.4 to 4.5) deg	



Parameter/Frequency	Range	CMC ² (±)	Comments
S Parameters for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂			
Reflection S ₁₁ /S ₂₂ Magnitude and Phase – Measure ⁹			
(18 to 40) GHz	(0.2 to 0.5) lin	(0.011 to 0.033) lin (4.5 to 1.2) deg	VNA: MS4644A calibration kit : 3652A, 3652A-1, 3653, 3653A Verification kit: 3668-1
	(0.5 to 1) lin	(0.020 to 0.059) lin (4.5 to 1.2) deg	
Transmission S ₁₂ /S ₂₁ , Magnitude and Phase – Measure ⁹			
(70 to 300) kHz	(0 to -5) dB	(0.062 to 0.019) dB (0.41 to 0.13) deg	
	(-5 to -30) dB	(0.019 to 0.039) dB (0.13 to 0.26) deg	
	(-30 to -35) dB	(0.019 to 0.044) dB (0.13 to 0.30) deg	
	(-35 to -60) dB	(0.024 to 0.045) dB (0.16 to 0.30) deg	
	(-60 to -70) dB	(0.025 to 0.048) dB (0.17 to 0.32) deg	
	(-70 to -80) dB	(0.034 to 0.11) dB (0.23 to 0.67) deg	
300 kHz to 18 GHz	(0 to -5) dB	(0.19 to 0.017) dB (1.8 to 0.11) deg	
	(-5 to -30) dB	(0.017 to 0.20) dB (0.11 to 1.7) deg	
	(-30 to -35) dB	(0.017 to 0.20) dB (0.11 to 1.7) deg	

Parameter/Frequency	Range	CMC ² (±)	Comments
S Parameters for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ (cont)			
Transmission S ₁₂ /S ₂₁ , Magnitude and Phase – Measure ⁹ (cont)			
300 kHz to 18 GHz	(-35 to -60) dB	(0.022 to 0.20) dB (0.15 to 1.7) deg	
	(-60 to -70) dB	(0.023 to 0.20) dB (0.16 to 1.7) deg	
(18 to 40) GHz	(-70 to -80) dB	(0.033 to 0.20) dB (0.22 to 1.9) deg	
	(0 to -5) dB	(0.19 to 0.16) dB (1.8 to 1.7) deg	
	(-5 to -30) dB	(0.039 to 0.31) dB (0.26 to 3.3) deg	
	(-30 to -35) dB	(0.039 to 0.31) dB (0.26 to 3.4) deg	
	(-35 to -60) dB	(0.044 to 0.31) dB (0.30 to 3.4) deg	
	(-60 to -70) dB	(0.044 to 0.31) dB (0.30 to 3.4) deg	
	(-70 to -80) dB	(0.044 to 0.31) dB (0.30 to 3.4) deg	
	(-70 to -80) dB	(0.044 to 0.31) dB (0.30 to 3.4) deg	



IV. Time & Frequency

Parameter/Equipment	Frequency	CMC ² (±)	Comments
Frequency – Measure			
High Stability Frequency Standard	10 MHz	2.4 µHz	Cesium standard and precision phase comparator
Frequency Generators	10 Hz to 1 MHz (1 to 10) MHz 10 MHz 10 MHz to 1 GHz (1 to 10) GHz (10 to 20) GHz (20 to 30) GHz (30 to 40) GHz	0.012 Hz 0.85 mHz 0.85 mHz 0.075 Hz 0.14 Hz 0.26 Hz 0.37 Hz 0.49 Hz	Cesium standard and frequency counter
Frequency – Measuring Equipment	10 Hz to 1 MHz (1 to 10) MHz 10 MHz to 1 GHz	0.058 Hz 0.058 Hz 0.17 Hz	Cesium standard and signal generator
Counters and Timers	(1 to 10) GHz (10 to 20) GHz (20 to 30) GHz (30 to 40) GHz 10 MHz	0.22 Hz 0.37 Hz 0.49 Hz 0.63 Hz 0.067 mHz	Cesium standard

¹ This laboratory offers commercial calibration 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 A2LAR104 – *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 Calibration and Measurement Capabilities Uncertainty (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.

⁴ 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.

⁵ Unless otherwise defined, in the statement of CMC, the value of % is defined as the percentage of reading.

⁶ The coverage factor of $k = 1.65$ is used such that the level of confidence corresponds to approximately 95 %.

⁷ xx are suffix letters A to Z or number 0 to 9 for LTE RF conformance test system options.

⁸ Includes other frequency selective level measuring equipment like Signal Analyzers.

⁹ The CMC for intermediate values of measurand can be found by interpolation.



Accredited Laboratory

A2LA has accredited

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Atsugi-shi, Kanagawa-Prf, 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 the requirements of ANSI/NCCL Z540-1-1994 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 21st day of September 2017.

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

President and CEO
For the Accreditation Council
Certificate Number 3128.01
Valid to May 31, 2019

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