HAC RF EMISSION TEST REPORT

FCC CFR47 PART 20.19
ANSI C63.19-2011

For
Cellular Phone with Bluetooth and WLAN Radio

Model: A1524, A1522
FCC ID: BCG-E2817A

Report Number: 14U17676-S3
Issue Date: 8/5/2014

Prepared for
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NVLAP LAB CODE 200065-0

REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
--	8/5/2014	Initial Issue	--

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UL Verification Services Inc.   Doc. No.: 1.0

1. Attestation of Test Results

Applicant name	Apple Inc.
FCC ID	BCG-E2817A
DUT description	Cellular Phone with Bluetooth and WLAN Radio
Exposure category	General Population/Uncontrolled Exposure
HAC Rating	M3
Applicable Standards	ANSI C63.19-2011
Test Results	Pass
Date tested	7/14/2014 – 7/15/2014

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.
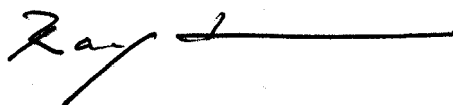
Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released By:	Prepared By:
Bobby Bayani Senior Engineer UL Verification Services Inc.	Ray Su Laboratory Engineer UL Verification Services Inc.

2. Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.19-2011 Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, FCC published KDB 285076 D01 HAC Guidance v04 and TCB workshop updates.

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

47173 Benicia Street	47266 Benicia Street
SAR Lab C	SAR Lab 2

UL VERIFICATION SERVICES INC. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due date		
				MM	DD	Year
ESG Vecto Signal Generator	Agilent	E4438C	MY47271507	6	17	2015
Power Meter	HP	438A	2822A05684	10	10	2014
Power Sensor	HP	8481A	2237A31744	10	2	2014
Power Sensor	HP	8481A	2349A36506	9	30	2014
Amplifier	MITEQ	MF-4D-00400600-50-30	1808939	N/A		
Directional coupler	Werlatone	C8060-102	2710	N/A		
DC Power Supply	AMETEK	XT15-4	1319A02778	N/A		
Robot - Six Axes	Stäubli	TX90 XL	N/A	N/A		
Robot Remote Control	Stäubli	CS8C	N/A	N/A		
DASY5 Measurement Server	SPEAG	SEUMS001BA	1041	N/A		
Probe Alignment Unit	SPEAG	LB (V2)	261	N/A		
Data Acquisition Electronics	SPEAG	DAE4	1360	3	17	2015
E-Field Probe	SPEAG	ER3DV6*	2339	2	14	2015
Calibration Dipole	SPEAG	CD835V3	1175	5	19	2015
Calibration Dipole	SPEAG	CD1880V3	1159	5	19	2015
Radio Communication Tester	R &S	CMU 200	16233	7	23	2014

Note(s):

*: According to SPEAG's Technical Report, "MIF Verification", Doc # TR-FB-12.09.04-1, issued date: 9/4/2012. E-field probes are calibrated with specified uncertainty according to ISO 17025 as described in their calibration certificate. The MIF according to the definition in ANSI C63.19 is specific for a modulation and can therefore be used as a constant value if the probe has been PMR calibrated.

4.2.   Measurement Uncertainty

HAC Uncertainty Budget According to ANSI C63.19

Error Description	Uncertainty value (±%)	Probe Dist.	Div.	(Ci) E	(Ci) H	Std. Unc.(±%) E	Std. Unc.(±%) H
Measurement System							
Probe Calibration	5.1	N	1	1	1	5.1	5.10
Axial Isotropy	4.7	R	1.732	1	1	2.7	2.71
Sensor Displacement	16.5	R	1.732	1	0.145	9.5	1.38
Boundary Effects	2.4	R	1.732	1	1	1.4	1.39
Phantom Boundary Effects	7.2	R	1.732	1	0	4.1	0.00
Linearity	4.7	R	1.732	1	1	2.7	2.71
Scaling to PMR Calibration	10.0	R	1.732	1	1	2.8	5.77
System Detection Limit	1.0	R	1.732	1	1	0.6	0.58
Readout Electronics	0.3	N	1	1	1	0.3	0.30
Response Time	0.8	R	1.732	1	1	0.5	0.46
Integration Time	2.6	R	1.732	1	1	1.5	1.50
RF Ambient Conditions	3.0	R	1.732	1	1	1.7	1.73
RF Reflections	12.0	R	1.732	1	1	6.9	6.93
Probe Positioner	1.2	R	1.732	1	0.67	0.7	0.46
Probe Positioning	4.7	R	1.732	1	0.67	2.7	1.82
Extrapolation and Interpolation	1.0	R	1.732	1	1	0.6	0.58
Test sample Related							
Test Positioning Vertical	4.7	R	1.732	1	0.67	2.7	1.82
Test Positioning Lateral	1.0	R	1.732	1	1	0.6	0.58
Device Holder and Phantom	2.4	R	1.732	1	1	1.4	1.39
Power Drift	5.0	R	1.732	1	1	2.9	2.89
Phantom and Setup Related							
Phantom Thickness	2.4	R	1.732	1	0.67	1.4	0.93
Combined Std. Uncertainty						15.4	12.2
Expanded Std. Uncertainty on Power						**30.8**	**24.4**
Expanded Std. Uncertainty on Field						**15.4**	**12.2**
Notesfor table 1. N - Nomal 2. R - Rectangular 3. Div. - Divisor used to obtain standard uncertainty 4. Ci - is te sensitivity coefficient							

5. Device Under Test

Cellular Phone with Bluetooth and WLAN Radio

5.1. Air Interfaces and Operating Mode

Air-Interface	Bands (MHz)	Type Transport	HAC Tested	Simultaneous but not Tested	Concurrent HAC Tested or not Tested	Voice over digital Transport OTT Capability	WiFi Low Power	Additional GSM Power Reduction
GSM	850	VO	Yes	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
GSM	1900	VO	Yes	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
GPRS	850/1900	DT	No	Yes - WiFi/BT	NA	Yes	NA	NA
EGPRS	850/1900	DT	No	Yes - WiFi/BT	NA	Yes	NA	NA
WCDMA R99	Band 2 (1900)	VO	Yes	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
WCDMA R99	Band 4 (1700)	VO	Yes	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
WCDMA R99	Band 5 (850)	VO	Yes	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
HSPA	Band 2, 4 & 5	DT	No	Yes - WiFi/BT	NA	Yes	NA	NA
CDMA	BC0 (850)	VD	Yes	Yes – LTE, WiFi/BT	Not tested[1]	NA	NA	NA
CDMA	BC1 (1900)	VD	Yes	Yes – LTE, WiFi/BT	Not tested[1]	NA	NA	NA
CDMA	BC10 (800)	VD	Yes	Yes – LTE, WiFi/BT	Not tested[1]	NA	NA	NA
CDMA	BC15 (1700)	VD	Yes	Yes – LTE, WiFi/BT	Not tested[1]	NA	NA	NA
CDMA	EVDO	DT	No	Yes - WiFi/BT	Not tested[1]	NA	NA	NA
LTE	Band 2 (1900)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 4 (1700)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 5 (850)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 7 (2600)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 13 (700)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 17 (700)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 25 (1900)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 26 (800)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
LTE	Band 41 (2600)	VD	Yes[2]	Yes - WiFi/BT	Not tested[2]	Yes	NA	NA
WiFi	2400	DT	No	Yes – LTE or WCDMA	NA	Yes	No	NA
WiFi	5200	DT	No	Yes – LTE or WCDMA	NA	Yes	No	NA
WiFi	5300	DT	No	Yes – LTE or WCDMA	NA	Yes	No	NA
WiFi	5500	DT	No	Yes – LTE or WCDMA	NA	Yes	No	NA
WiFi	5800	DT	No	Yes – LTE or WCDMA	NA	Yes	No	NA
BT	2400	DT	No	Yes – LTE or WCDMA	NA	NA	NA	NA

Type Transport
VO = CMRS Voice Service
DT = Digital Transport (no voice)
VD = CMRS IP Voice Service and Digital Transport

Note:
1. No concurrent mode was found to be the Worst Case mode
2. No associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP.

Note(s):
All interfaces with "Yes" indication under the "HAC Tested" column were further evaluated for exemption from HAC testing on the basis of antenna input power under Section 10.

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6. System Specifications

E-field measurements are performed using the DASY5 automated dosimetric assessment system. The DASY5 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland.

The DASY5 HAC Extension consists of the following parts:

Test Arch Phantom

The specially designed Test Arch allows high precision positioning of both the device and any of the validation dipoles.

ER3DV6 Isotropic E-Field Probe

Construction:	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration:	In air from 100 MHz to 3.0 GHz (absolute accuracy ±6.0%, k=2)
Frequency:	100 MHz to > 6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)
Directivity:	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range:	2 V/m to > 1000 V/m; Linearity: ± 0.2 dB
Dimensions:	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm The closest part of the sensor element is 1.1 mm closer to the tip
Application:	General near-field measurements up to 6 GHz Field component measurements

7. System Validation

The test setup was validated when first configured and verified periodically thereafter to ensure proper function. The procedure provided in this section is a validation procedure using dipole antennas for which the field levels were computed by numeric modeling.
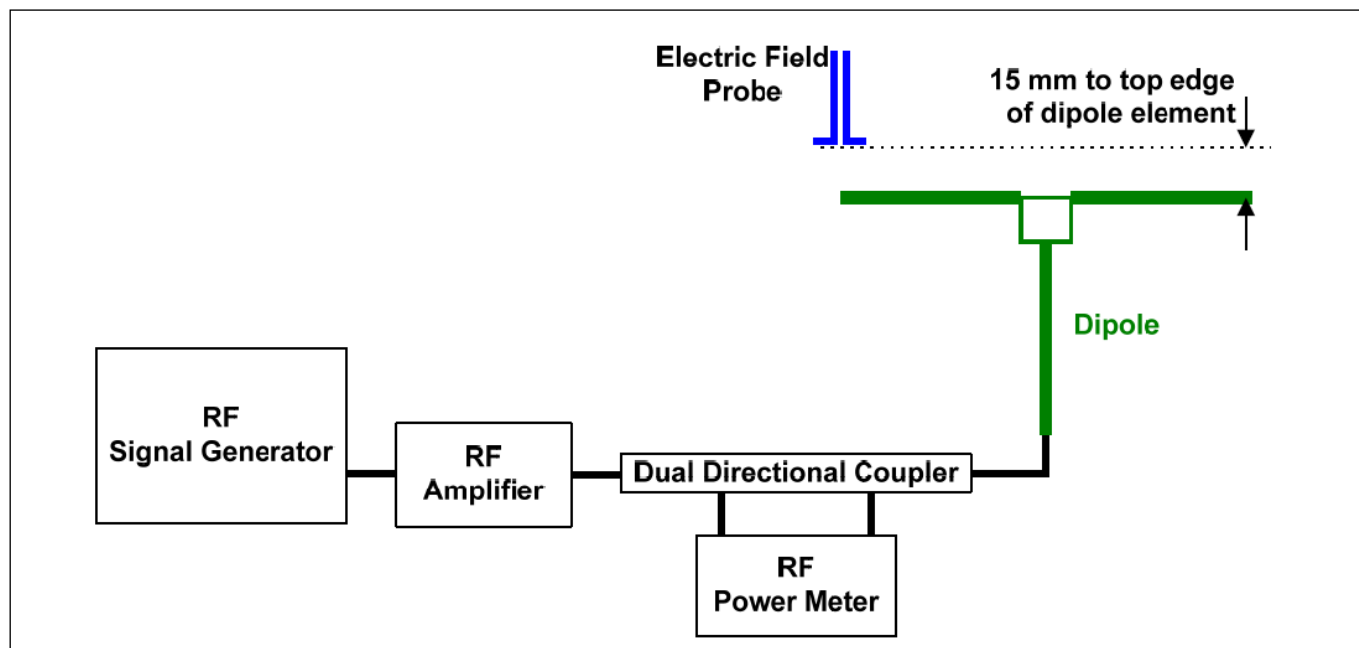
Procedure

Place a dipole antenna meeting the requirements given in ANSI C63.19-2011 in the normally occupied by the WD.

The dipole antenna serves as a known source for an electrical and magnetic output. Position the E-field probe so that the following occurs:

- The probes and their cables are parallel to the coaxial feed of the dipole antenna
- The probe cables and the coaxial feed of the dipole antenna approach the measurement area from opposite directions
- The center point of the probe element(s) is 15 mm from the closest surface of the dipole elements.

Scan the length of the dipole with the E-field probe and record the two maximum values found near the dipole ends. Average the two readings and compare the reading to the expected value in the calibration certificate or the expected value in this standard.

Setup diagram

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7.1. System Validation Results

7-14-2014

E-field Probe ER3DV6 SN2339							
Calibration Dipole	f (MHz)	Input Power (mW)	Max. measured from above high end (V/m)	Max. measured from above low end (V/m)	Average max. above arm (V/m)	E-field Target Values (V/m) (From SPEAG)	Deviation[1] (%)
CD835V3 SN 1175	835	100	100.40	102.80	101.60	107.00	-5.05
CD1880V3 SN 1159	1880	100	83.12	84.16	83.64	89.40	-6.44
CD1880V3 SN 1159	1730	100	91.75	92.58	92.17	97.57	-5.53

Notes:

1) Delta (Deviation) % = 100 * (Measured value minus Target value) divided by the Target value. Deltas within ±25% are acceptable, of which 12% is deviation and 13% is measurement uncertainty.

2) The maximum E-field or were evaluated and compared to the target values provided by SPEAG in the calibration certificate of specific dipoles.

3) Please refer to the appendix for detailed measurement data and plots.

8. Modulation Interference Factor (MIF)

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF) which replaces the need for the Articulation Weighting Factor (AWF) during the evaluation and is applicable to any modulation scheme.

The Modulation Interference factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF Audio Interference level (in dBV/m). This level considers the audible amplitude modulation components in the RF E-field. CW fields without amplitude modulation are assumed to not interfere with the hearing aid electronics. Modulations without time slots and low fluctuations at low frequencies have low MIF values, TDMA modulations with narrow transmission and repetition rates of few 100 Hz have high MIF values and give similar classifications as ANSI C63-2007.

Definitions

ER3D, E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the "indirect" measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by probe modulation response (PMR) calibration in order to not overestimate the field reading.

The evaluation method or the MIF is defined in ANSI C63.19-2011 section D.7. An RMS demodulated RF signal is fed to a spectral filter (similar to an A weighting filter) and forwarded to a temporal filter acting as a quasi-peak detector. The averaged output of these filtering is called to a 1 kHz 80% AM signal as reference. MIF measurement requires additional instrumentation and is not well suited for evaluation by the end user with reasonable uncertainty. It may alternatively be determined through analysis and simulation, because it is constraint and characteristic for a communication signal. DASY52 uses well defined signals for PMR calibration. The MIF of these signals has been determined by simulation and is automatically applied.

MIF values were not tested by a probe or as specified in the standards but are based on analysis provided by SPEAG for the following User Identifiers and air interfaces.

UID	Communication System Name	MIF (dB)
10021-DAA	GSM-FDD (TDMA, GMSK)	3.63
10011-CAA	UMTS-FDD (WCDMA)	-27.23
10295-AAA	CDMA2000 (1xRTT, RC1, SO3, 1/8th Rate 25 fr.)	3.26
10170-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-9.76
10182-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	-9.76
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	-9.76
10173-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44

A PMR calibrated probe is linearized for the selected waveform over the full dynamic range within the uncertainty specified in its calibration certificate. ER3D, EF3D and EU2D E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the \indirect" measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by PMR calibration in order to not overestimate the field reading.

The MIF measurement uncertainty is estimated as follows, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz:

- *0.2 dB for MIF -7 to +5 dB,*
- *0.5 dB for MIF -13 to +11 dB*
- *1 dB for MIF > -20 dB*

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9. Average Antenna Input Power

9.1. Upper Antenna (UAT)

Air-Interface	Average Power (dBm) Max. Tune-up Limit
GSM850	33.2
GSM1900	28.8
WCDMA Band 2	19.0
WCDMA Band 4	19.0
WCDMA Band 5	24.7
CDMA BC0	24.7
CDMA BC1	19.0
CDMA BC10	24.7
CDMA BC15	19.0
LTE Band 2	19.0
LTE Band 4	19.0
LTE Band 5	23.7
LTE Band 13	23.7
LTE Band 17	23.7
LTE Band 25	19.0
LTE Band 26	23.5
LTE Band 41	22.3

9.2. Lower Antenna (LAT)

Air-Interface	Average Power (dBm) Max. Tune-up Limit
GSM850	33.5
GSM1900	30.0
WCDMA Band 2	25.0
WCDMA Band 4	25.0
WCDMA Band 5	25.0
CDMA BC0	25.0
CDMA BC1	25.0
CDMA BC10	25.0
CDMA BC15	25.0
LTE Band 2	24.0
LTE Band 4	24.0
LTE Band 5	24.0
LTE Band 13	24.0
LTE Band 17	24.0
LTE Band 25	24.0
LTE Band 26	23.5
LTE Band 41	22.5

10.   Evaluation for Low-power Exemption

An RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17 dBm for any of its operating modes. If a device supports multiple RF air interfaces, each RF air interface shall be evaluated individually.

10.1. Upper Antenna (UAT)

Air-Interface	Average Antenna Input Power (dBm)[1]	MIF (dB)	Input Power plus its MIF (dBm)	HAC Tested
GSM850	33.2	3.63	36.83	Yes
GSM1900	28.8	3.63	32.43	Yes
WCDMA Band 2	19.0	-27.23	-8.23	No
WCDMA Band 4	19.0	-27.23	-8.23	No
WCDMA Band 5	24.7	-27.23	-2.53	No
CDMA BC0	24.7	3.26	27.96	Yes
CDMA BC1	19.0	3.26	22.26	Yes
CDMA BC10	24.7	3.26	27.96	Yes
CDMA BC15	19.0	3.26	22.26	Yes
LTE Band 2[2]	19.0	-9.76	9.24	No
LTE Band 4[2]	19.0	-9.76	9.24	No
LTE Band 5[2]	23.7	-9.76	13.94	No
LTE Band 13[2]	23.7	-9.76	13.94	No
LTE Band 17[2]	23.7	-9.76	13.94	No
LTE Band 25[2]	19.0	-9.76	9.24	No
LTE Band 26[2]	23.5	-9.76	13.74	No
LTE Band 41[2]	22.3	-1.44	20.81	No

Note(s):

1. Max tune-up limit

2. No associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP.

Conclusions

RF Emission testing for this device is required only for GSM and CDMA voice modes. All other applicable air-interfaces are exempt.

10.2. Lower Antenna (LAT)

Air-Interface	Average Antenna Input Power (dBm)[1]	MIF (dB)	Input Power plus its MIF (dBm)	HAC Tested
GSM850	33.5	3.63	37.13	Yes
GSM1900	30.0	3.63	33.63	Yes
WCDMA Band 2	25.0	-27.23	-2.23	No
WCDMA Band 4	25.0	-27.23	-2.23	No
WCDMA Band 5	25.0	-27.23	-2.23	No
CDMA BC0	25.0	3.26	28.26	Yes
CDMA BC1	25.0	3.26	28.26	Yes
CDMA BC10	25.0	3.26	28.26	Yes
CDMA BC15	25.0	3.26	28.26	Yes
LTE Band 2[2]	24.00	-9.76	14.24	No
LTE Band 4[2]	24.0	-9.76	14.24	No
LTE Band 5[2]	24.0	-9.76	14.24	No
LTE Band 13[2]	24.0	-9.76	14.24	No
LTE Band 17[2]	24.0	-9.76	14.24	No
LTE Band 25[2]	24.0	-9.76	14.24	No
LTE Band 26[2]	23.5	-9.76	13.74	No
LTE Band 41[2]	22.5	-1.44	21.06	No

Note(s):

1.   Max tune-up limit

2.   No associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP.

Conclusions

RF Emission testing for this device is required only for GSM and CDMA voice modes. All other applicable air-interfaces are exempt.

11.   HAC RF Emissions Test Procedure

The following are step-by-step test procedures.

a)   Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.

b)   Position the WD in its intended test position.

c)   Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.

d)   The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 1. If the field alignment method is used, align the probe for maximum field reception.

e)   Record the reading at the output of the measurement system

f)   Scan the entire 50 mm by 50 mm region in equally spaced increments and record the reading at each measurement point. The distance between measurement points shall be sufficient to assure the identification of the maximum reading.

g)   Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.

h)   Identify the maximum reading within the non-excluded sub-grids identified in step g).

i)   Convert the highest field reading within identified in step h) to RF audio interference level, in V/m, by taking the square root of the reading and then dividing it by the measurement system transfer function, established in 5.5.1.1 Convert this result to dB(V/m) by taking the base-10 logarithm and multiplying by 20.

Indirect measurement method

Replacing step i), the RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB(V/m), from step h). Use this result to determine the category rating

j)   Compare this RF audio interference level with the categories in Clause 8 (ANSI C63.19-2011) and record the resulting WD category rating

k)   For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating.

Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.
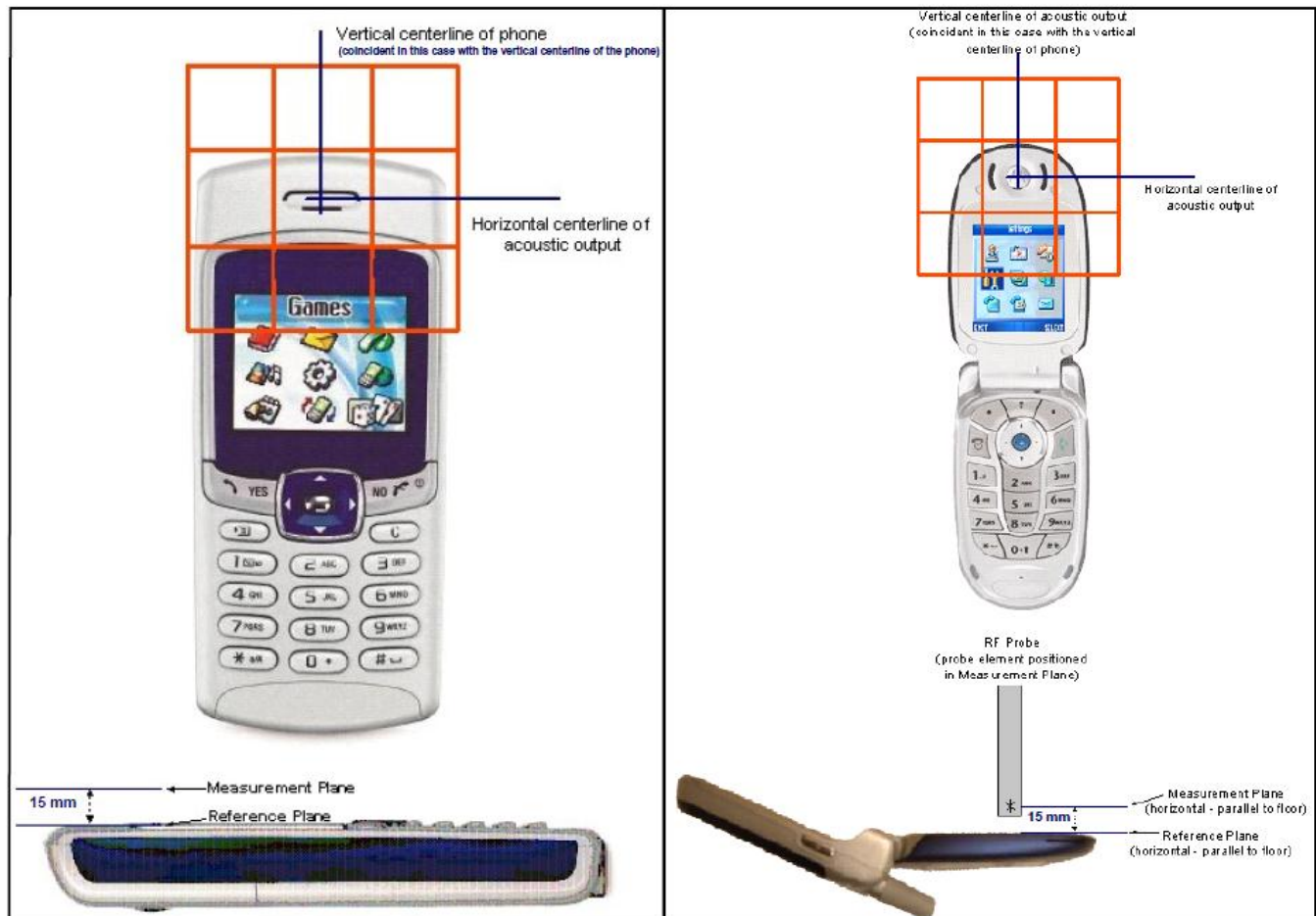
Figure 1 - WD reference and plane for RF emission measurements

Test flowchart Per ANSI-PC63.19 2011

Test Instructions

- Confirm proper operation of probes and instrumentation
- Position WD
- Configure WD Tx Operation

(Step a-c)

↓

- Initialize field probe and take first reading
- Scan Area

(Step d-f)

↓

- Identify exclusion area
- Rescan or reanalyze open area todetermine maximum
- Indirect method: Add the MIF to the maximum steady state rms field strength and record RF Audio Interference Level, in dB (V/m)

(Step g-i)

↓

Identify & Record Category

(Step j)

12.   RF Emissions Measurement Criteria

WD RF audio interference level caterories in logarithmic units

Emission Categories	E-field emissions	
	< 960 MHz	> 960 MHz
Category M1	50 to 55 dB (V/m)	40 to 45 dB (V/m)
Category M2	45 to 50 dB (V/m)	35 to 40 dB (V/m)
Category M3	40 to 45 dB (V/m)	30 to 35 dB (V/m)
Category M4	<40 dB (V/m)	<30 dB (V/m)

13.   HAC (RF Emissions) Test Results

MIF values were not tested by a probe or as specified in the standards but are based on analysis provided by SPEAG for the following User Identifiers and air interfaces.

UID	Communication System Name	MIF (dB)
10021-DAA	GSM-FDD (TDMA, GMSK)	3.63
10011-CAA	UMTS-FDD (WCDMA)	-27.23
10295-AAA	CDMA2000 (1xRTT, RC1, SO3, 1/8th Rate 25 fr.)	3.26
10170-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-9.76
10182-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	-9.76
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	-9.76
10173-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44

The data included in this report are for the worst case operating modes. **Refer to a separate attestation letter signed by the grantee that the MIF vales represent worst case operation modes.**

13.1.   Upper Antenna (UAT)

Air-Interface	Ch. No.	Freq. (MHz)	Results* (dB V/m)	M-Rating	Plots Page #
GSM850	128	824.2	36.38	M4	1
	190	836.6	37.44	M4	2
	251	848.8	**38.52**	**M4****	3
GSM1900	512	1850.2	32.71	M3	4
	661	1880.0	31.48	M3	5
	810	1909.8	30.88	M3	6
CDMA BC0	1013	824.7	29.25	M4	7
	384	836.5	30.30	M3	8
	777	848.31	30.86	M3	9
CDMA BC1	25	1851.25	22.37	M4	10
	600	1880.0	21.94	M4	11
	1175	1908.75	22.02	M4	12
CDMA BC10	476	817.9	28.56	M4	13
	580	820.5	28.75	M4	14
	684	823.1	28.98	M4	15
CDMA BC15	25	1711.25	23.88	M4	16
	450	1732.5	23.95	M4	17
	875	1753.75	23.83	M4	18
W-CDMA	Refer to Section 10 Evaluation for Low-power Exemption. RF Emission testing for this device is required only for GSM and CDMA voice modes. All other applicable air-interfaces are exempt from testing in accordance with C63.19-2011 Clause 4.4 and are rated M4.			M4	N/A
LTE	RF Emission testing for this device is required only for GSM and CDMA voice modes. No Associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP			M4	N/A

Note(s):

*: Measured Audio Interference level in dB (V/m): indirect method (max rms field strength Plus MIF)

**: According to the last paragraph of Section 8, the MIF measurement uncertainty is estimated to be 0.2 dB for MIF -7 to + 5 dB. The maximum E-field result of 40.84 dB V/m plus measurement uncertainty of 0.2 dB is 34.42 dB V/m, which is still within M3 rating.

13.2. Lower Antenna (LAT)

Air-Interface	Ch. No.	Freq. (MHz)	Results* (dB V/m)	M-Rating	Plots Page #
GSM850	128	824.2	34.68	M4	1
	190	836.6	34.91	M4	2
	251	848.8	35.10	M4	3
GSM1900	512	1850.2	32.02	M3	4
	661	1880.0	31.54	M3	5
	810	1909.8	32.82	M3	6
CDMA BC0	1013	824.7	27.34	M4	7
	384	836.5	28.10	M4	8
	777	848.31	28.29	M4	9
CDMA BC1	25	1851.25	27.98	M4	10
	600	1880.0	28.18	M4	11
	1175	1908.75	28.29	M4	12
CDMA BC10	476	817.9	28.14	M4	13
	580	820.5	27.40	M4	14
	684	823.1	27.52	M4	15
CDMA BC15	25	1711.25	26.12	M4	16
	450	1732.5	27.36	M4	17
	875	1753.75	27.14	M4	18
W-CDMA	Refer to Section 10 Evaluation for Low-power Exemption. RF Emission testing for this device is required only for GSM and CDMA voice modes. All other applicable air-interfaces are exempt from testing in accordance with C63.19-2011 Clause 4.4 and are rated M4.			M4	N/A
LTE	RF Emission testing for this device is required only for GSM and CDMA voice modes. No Associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP			M4	N/A

Note(s):

*: Measured Audio Interference level in dB (V/m): indirect method (max rms field strength Plus MIF)

13.3. Worst Case RF EmissionTest Plot

Test Laboratory: UL Verification Services Inc. SAR Lab C   Date: 7/15/2014

HAC-RF Emission

Communication System: UID 10021 - CAA, GSM-FDD (TDMA, GMSK); Frequency: 848.6 MHz; Duty Cycle: 1:8.6896
Phantom section: RF Section
DASY5 Configuration:
- Probe: ER3DV6 - SN2339; ConvF(1, 1, 1); Calibrated: 2/14/2014;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1360; Calibrated: 3/17/2014
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BB
- Measurement SW: DASY52, Version 52.8 (7);SEMCAD X Version 14.6.10 (7164)

UAT_GSM850 E-Field measurement/Voice_ch 251/Hearing Aid Compatibility Test

(101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
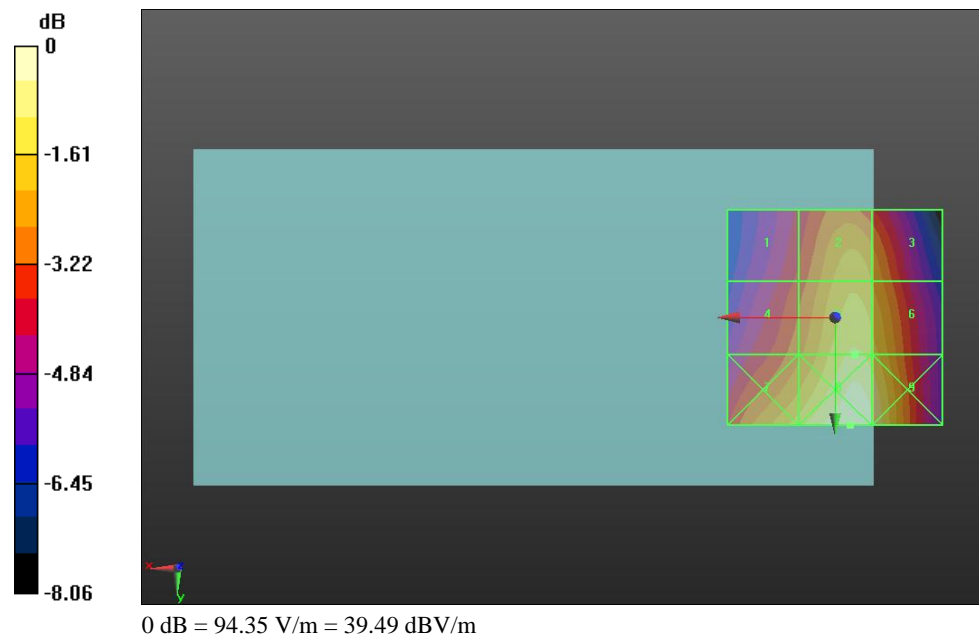Reference Value = 72.58 V/m; Power Drift = -0.04 dB
Applied MIF = 3.63 dB
RF audio interference level = 38.52 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** 35.93 dBV/m	Grid 2 **M4** 37.76 dBV/m	Grid 3 **M4** 37.37 dBV/m
Grid 4 **M4** 36.7 dBV/m	Grid 5 **M4** 38.52 dBV/m	Grid 6 **M4** 38.19 dBV/m
Grid 7 **M4** 38.23 dBV/m	Grid 8 **M4** 39.49 dBV/m	Grid 9 **M4** 39.02 dBV/m

0 dB = 94.35 V/m = 39.49 dBV/m

14.   Appendixes

Refer to separated files for the following appendixes

14.1.   System Validation Plots

14.2.   RF Emissions Test Plots

14.3.   Calibration Certificate - E-Field Probe ER3DV6 - SN 2339

14.4.   Calibration Certificate for Dipole CD835V3 - SN 1175

14.5.   Calibration Certificate for Dipole CD1880V3 - SN 1159

14.6.   UID 10021-DAA GSM Specification

14.7.   UID 10011-CAA WCDMA Specification

14.8.   UID 10295-AAA CDMA Specification

14.9.   UID 10170-CAB LTE-FDD 20 MHz 16QAM Specification

14.10.   UID 10176-CAB LTE-FDD 10 MHz 16QAM Specification

14.11.   UID 10173-CAB LTE-TDD 20 MHz 16QAM Specification

14.12.   Setup Photo