T-Coil HAC TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

CDMA 1x Advanced Feature Phone

ISSUED TO
HOPERUN MMAX DIGITAL PTE. LTD

152 BEACH ROAD #13-06 GATEWAY EAST SINGAPORE 189721

Report No:	BL-SZ1520007-702
EUT Type:	CDMA 1x Advanced Feature Phone
Model Name:	MXC-545
Brand Name:	UMX
FCC ID:	2AB5L-MXC545
Test Standard:	FCC 47 CFR Part 20.19 ANSI C63.19: 2007 KDB 285076 D01 HAC Guidance v04
T-Rating:	T-Coil: T3
Test conclusion:	Pass
Test Date:	May. 20, 2014
Date of Issue:	Feb. 02, 2015

Prepared by: Hu Jianping
(Reporting Specialist)
Date: Feb. 02, 2015

Approved by: Wei Yanquan
(Chief Engineer)
Date: Feb. 02, 2015

Block B, 1st FL,Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100
FAX: +86-755-61824271
www.baluntek.com

Revision History

Version	Issue Date	Revisions
Rev. 01	Feb 02, 2015	Additional report base on test report BL-SZ1440002-702

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1 GENERAL INFORMATION

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6683 3402
Fax Number	+86 755 6182 4271

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory has been listed by US Federal Communications Commission to perform electromagnetic emission measurements. The recognition numbers of test site are 832625. The laboratory has met the requirements of the IAS Accreditation Criteria for Testing Laboratories (AC89), has demonstrated compliance with ISO/IEC Standard 17025:2005. The accreditation certificate number is TL-588. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Test Environment Condition

Ambient Temperature	20 to 22 ℃
Ambient Relative Humidity	30 to 60 %
Ambient Pressure	86 to 106 kPa

1.4 Announce

(1) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(2) The test report is invalid if there is any evidence and/or falsification.

(3) The results documented in this report apply only to the tested sample, under the conditions and modes of

operation as described herein.

(4) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(5) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant

Applicant	HOPERUN MMAX DIGITAL PTE. LTD
Address	152 BEACH ROAD #13-06 GATEWAY EAST SINGAPORE 189721

2.2 Manufacturer

Manufacturer	HOPERUN MMAX DIGITAL PTE. LTD
Address	152 BEACH ROAD #13-06 GATEWAY EAST SINGAPORE 189721

2.3 General Description for Equipment under Test (EUT)

EUT Type	CDMA 1x Advanced Feature Phone
Model Under the test	MXC-545
Series Model Name	N/A
Difference description	N/A
Hardware Version	N/A
Software Version	N/A
Dimensions	109×48×16 mm
Weight	120 g
Network and Wireless connectivity	CDMA BC0/BC10/BC1
Display	TFT-LCD,
Chipset	N/A

2.4 Technical Information

The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	CDMA: CDMA Voice;
Frequency Range	CDMA BC0 (US Cellular): 824.70MHz ~ 848.31 MHz; CDMA BC10 (US Secondary 800): 817.90MHz ~ 823.1` MHz; CDMA BC1 (US PCS): 1851.25MHz ~ 1908.75 MHz;
Antenna Type	WWAN: PIFA Antenna
DTM	Not Support
Hotspot Function	Not Support
Environment	Uncontrolled
EUT Stage	Portable Device

2.5 EUT Air Interface description

Air Interface	Band	Type	C63.19 Tested	OTT	Power Reduction
CDMA	BC0	Voice	Yes	NA	Not Support
	BC10	Voice	Yes	NA	Not Support
	BC1	Voice	Yes	NA	Not Support

2.6 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	N/A
	Model No	AB043446LA
	Serial No	N/A
	Capacitance	800mAh
	Rated Voltage	3.7V
	Extreme Voltage	Low: 3.4V / High:4.2V
Ancillary Equipment 2	AC Adapter (Charger for Battery)	
	Brand Name	N/A
	Model No	N/A
	Serial No	(n.a. marked #1 by test site)
	Rated Input	~ 100-240V, 50/60Hz
	Rated Output	⎓ 5V, 600mA
Ancillary Equipment 3	Stereo Headset	
Ancillary Equipment 4	USB Data Cable	

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	FCC 47 CFR Part 20.19	Hearing aid-compatible mobile handsets.
2	ANSI C 63.19:2007	American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids
3	KDB 285076 D01 HAC Guidance v04	Provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility

3.2 HAC Test Configuration and Setting

For HAC T-Coil testing, the EUT was linked and controlled by wireless communication test set. Communication between the EUT and the wireless communication test set was established by coaxial connection. The EUT was set from the wireless communication test set to radiate maximum output power during HAC testing.

3.3 Summary Of HAC T-Rating

Band	T-Rating	Frequency response
CDMA BC0 (Voice)	T3	PASS
CDMA BC10 (Voice)	T3	PASS
CDMA BC1 (Voice)	T3	PASS

3.4 ANSI C63.19 HAC T-Coil Categories

3.4.1 T-Coil Field Intensity

When measured as specified in this standard, the T-Coil signal shall be ≥－18 dB (A/m) at 1 kHz, in a 1/3 octave band filter for all orientations.

3.4.2 T-Coil Signal Quality

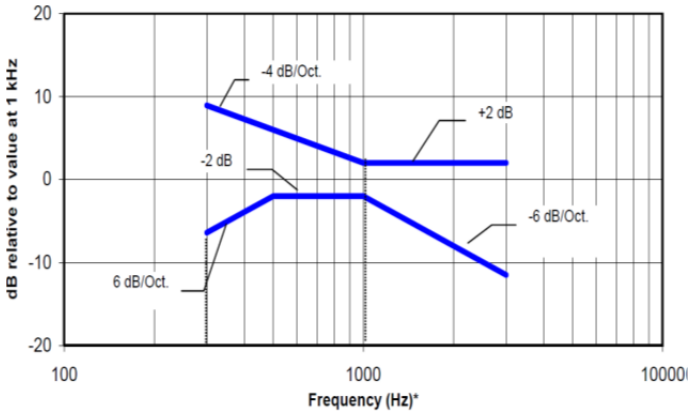
The table below provides the signal quality requirement for the intended audio magnetic signal from a wireless device. Only the RF immunity of the hearing aid is measured in T-coil mode. It is assumed that a hearing aid can have no immunity to an interference signal in the audio band, which is the intended reception band for this mode. The only criterion that can be measured is the RF immunity in T-coil mode. This is measured using the same procedure as the audio coupling mode at the same levels. The signal quality of the axial and radial components of the magnetic field was used to determine the T-coil mode category.

Category	Wireless Device Signal Quality (Signal + Noise-to-noise ratio in dB)
T1	0 to 10 dB
T2	10 to 20 dB
T3	20 to 30 dB
T4	＞30 dB
Magnetic Coupling Parameters	

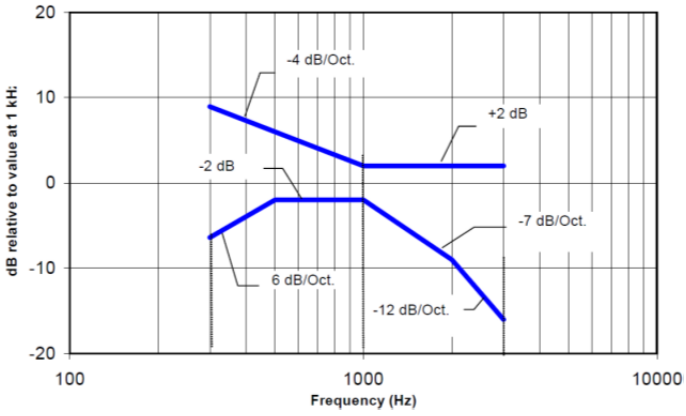
3.4.3 Frequency Response

The frequency response of the axial component of the magnetic field, measured in 1/3 octave bands, shall follow the below response curve, over the frequency range 300 Hz to 3000 Hz. Following Figures provide the boundaries for the specified frequency. These response curves are for true field strength measurements of the T-Coil signal. Thus the 6 dB/octave probe response has been corrected from the raw readings.

≤ －15 dB (A/m) at 1 kHz



> –15 dB(A/m) at 1 kHz



Note: Frequency response is between 300 Hz and 3000 Hz.

3.4.4 Articulation Weighing Factor (AWF)

Standard	Technology	AWF
T1/T1P1/3GPP	UMTS(WCDMA)	0
IS-95	CDMA	0
iden	GSM(22and 11Hz)	0
J-STD-007	GSM(217Hz)	-5
AWF has been developed from information presented to the committee regarding the interference potential of the various modulation types according to ANSI PC 63.19		

3.5 HAC Test Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in ANSI C 63.19:2007.This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Uncertainty Component	Uncertainty Value	Prob. Dist.	Div.	Ci (E)	Ci (H)	Std. Unc. (+/- %)	
						E	H
Measurement System							
Probe calibration	6.00	N	1.000	1	1	6.00	6.00
Axial Isotropy	2.02	R	1.732		1	1.17	1.17
Sensor Displacement	14.30	R	1.732	1	0.217	8.26	1.79
Boundary effect	2.50	R	1.732	1	1	0.87	0.87
Phantom Boundary Effect	6.89	R	1.732	1	0	3.52	0.00
Linearity	2.58	R	1.732	1	1	1.49	1.49
Scaling tp PMR Calibration	9.02	N	1.000	1	1	9.02	9.02
System detection limits	1.30	R	1.732	1	1	0.75	0.75
Readout Electronics	0.25	R	1.732	1	1	0.14	0.14
Reponse Time	1.23	R	1.732	1	1	0.71	0.71
Integration Time	2.15	R	1.732	1	1	1.24	1.24
RF ambient Conditions	2.03	R	1.732	1	1	1.17	1.17
RF Reflections	9.09	R	1.732	1	1	5.25	5.25
Probe positioner	0.63	N	1.000	1	0.71	0.63	0.45
Probe positioning	3.12	N	1.000	1	0.71	3.12	2.22
Extrapolation and Interpolation	1.18	R	1.732	1	1	0.68	0.68
Test sample Related							
Test sample positioning Vertical	2.73	R	1.732	1	0.71	1.58	1.12
Test sample positioning Lateral	1.19	R	1.732	1	1	0.69	0.69
Device holder and Phantom	2.20	N	1.000	1	1	2.20	2.20
Power drift	4.08	R	1.732	1	1	2.36	2.36
Phantom and Setup Related							
Phantom Thickness	2.00	N	1.000	1	0.6	2.00	1,20
Combined Std. Uncertainty(k=1)						16.18	13.25
Expanded Uncertainty on Power						**32.35**	**26.50**
Expanded Uncertainty on Field						**16.18**	**13.25**

4 SATIMO HSC MEASUREMENT SYSTEM

4.1 Definition of Hearing Aid Compatibility (HAC)

On July 10.2003.the Federal Communications Commission (FCC) adopted new rules requiring wireless manufacturers and service providers to provide digital wireless phones that are compatible with hearing aids. The FCC has modified the exemption for wireless phones under the Hearing Aid Compatibility Act of 1998 (HAC Act) in WT Docket 01-309 RM-8658 to extend the benefits of wireless telecommunications to individuals with hearing disabilities. These benefits encompass business, social and emergency communications, which increase the value of the wireless network for everyone. An estimated more than 10% of the population in the United States show signs of hearing impairment and of that fraction, almost 80% use hearing aids. Approximately 500 million people worldwide suffer from hearing loss.

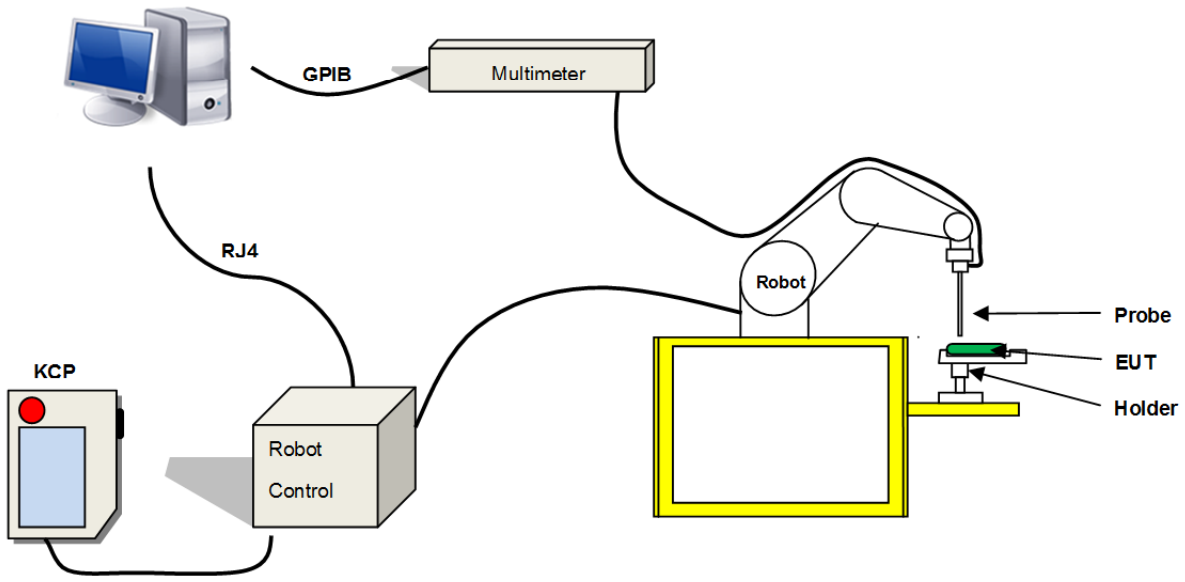
Compatibility Tests involved:

The standard calls for wireless communications devices to be measured for:
- RF Electric-field emissions.
- RF Magnetic- field emissions.
- T-coil mode, magnetic-signal strength in the audio band.
- T-coil mode, magnetic-signal frequency response through the audio band.
- T-coil mode, magnetic-signal and noise articulation index.

The hearing aid must be measured for:
- RF immunity in microphone mode
- RF immunity in T-coil mode

4.2 SATIMO HAC System

SATIMO HAC System Diagram:



4.2.1 Robot

The SATIMO HAC system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

4.2.2 HAC T-Coil Probe

Serial Number:	SN 22/12 TCP26
Frequency:	200Hz – 500Hz
Probe length:	220mm
Length of Coil:	6.55mm
Diameter of Coil:	2.29mm
Resistance:	860.6 Ω
Wire size:	51 AWG
Inductance at 1 KHz:	132.1 mH at 1 KHz

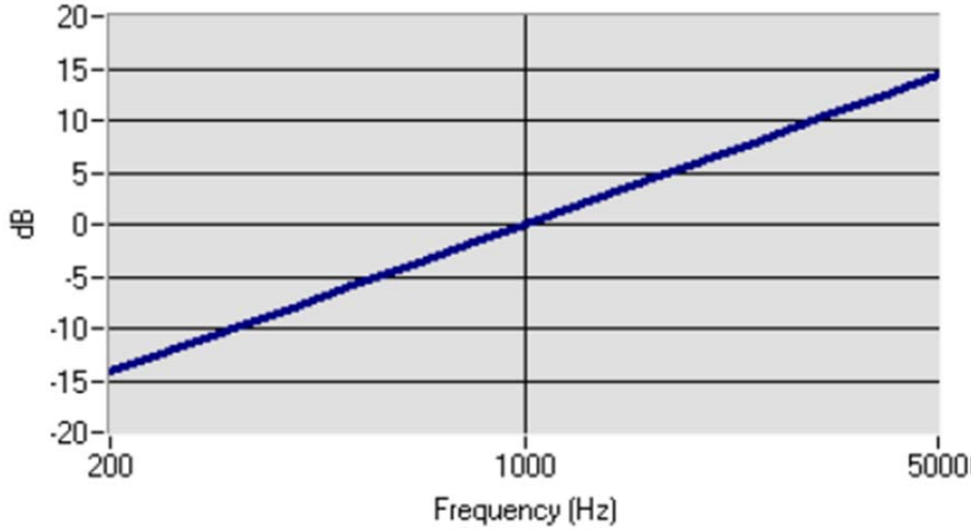
T-Coil Probe Calibration Process

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1309 standards.

SENSITIVITY

The T-coil was positioned within the Helmholtz coil in axial orientation. Using an audio generator connected to the input of the Helmholtz coil, a known field (1 A/m) was generated within the coil and the T-coil probe reading recorded over the frequency range of 100 Hz to 1000 Hz.

Probe Coil sensitivity relative to sensitivity at 1000 Hz

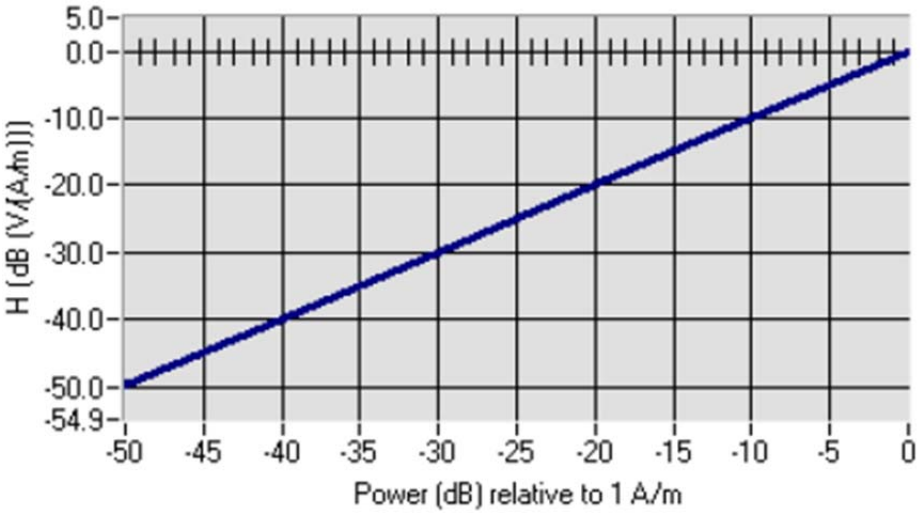


	Measured	Required
Sensitivity at 1 KHz	-60.22 dB (V/A/m)	- 60.5 +/- 0.5 dB (V/A/m)
Max. deviation from Sensitivity	0.43 dB	+/- 0.5 dB

LINEARITY

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field within the coil from 0 dB A/m to -50 dB A/m and the T-coil reading recorded at each power level (10 dB steps).

Linearity



	Measured	Required
Linearity Slope	0.09 dB	+/ 0.5 dB

SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field of -50 dB A/m. The T-coil reading was recorded. The audio generator is then turned off and the T-coil reading recorded.

	Measured	Required
Signal to Noise	-78.99 dB A/m	‘Reading with -50 dB A/m in coil’ – ‘no signal applied’ > 10 dB

5 T-Coil AUDIO VALIDATION

5.1 System Audio Validation

Put the phone on call and select the CMU decoder cal. When the decoder cal is selected, a full sacle(3.14 dBm) signal is provided to the speech port. Measure the voltage form the speech connector using the provided CMU speech cable. For this connect the GSM/WCMDA out connector (or CDMA2K OUT connector) to the front panel of the keithley and read the AC voltage. With the speech cable provided by satiom, the GSM/WCDMA OUT connector 2 and the CDMA2K OUT connector is the connector 4.

Put the phone on call and select the CMU encoder cal. And send a signal to the CMU and check to avoid influencing the calibration. An RMS voltmeter would indicate 100 mV RMS during the first phase and 10 mV RMS during the second phase. After the first two phases, the two input channels are both calibrated for absolute measurements of voltages. The resulting factors are displayed above the multi-meter window.

After phases 1 and 2, the input channels are calibrated to measure exact voltages. This is required to use the inputs for measuring voltages with their peak and RMS value.

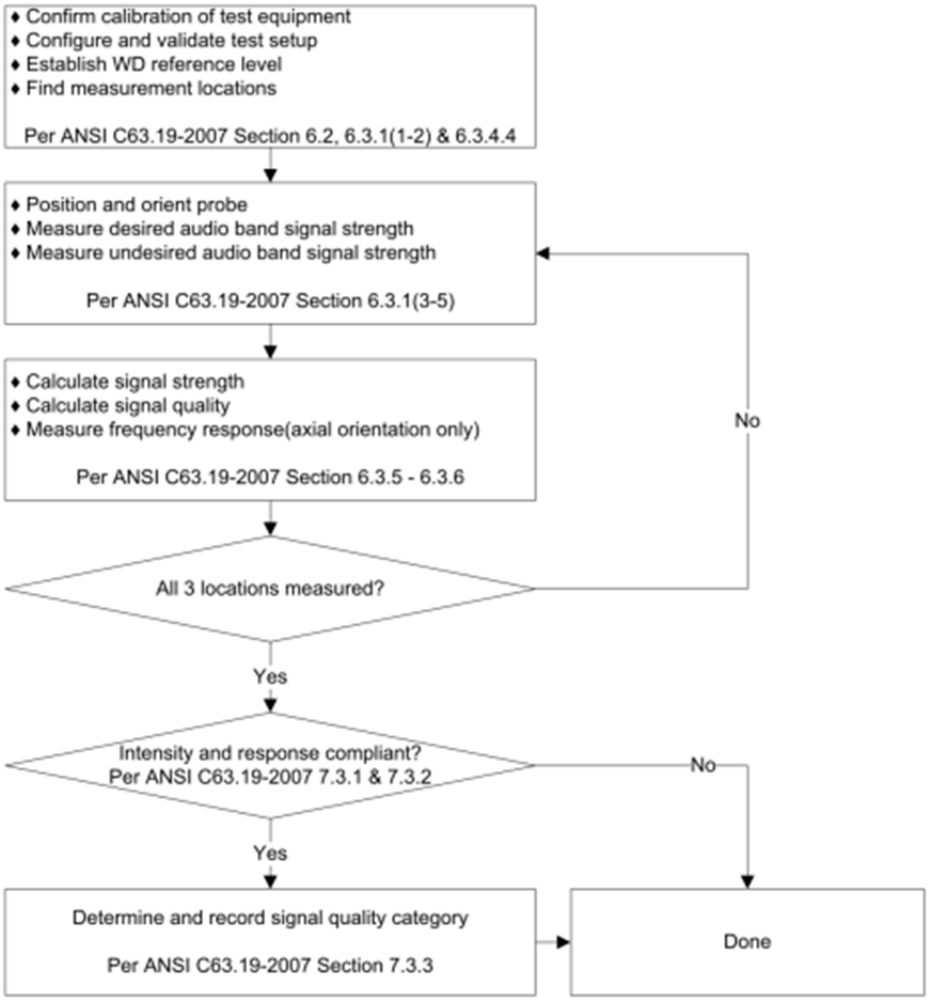
In phase 3, a multi-sine signal covering each third-octave band from 50 Hz to 10 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC and aligned in the z-direction, the field orientation of the AMCC. The “Coil In” channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the “Probe In" channel samples the amplified signal picked up by the probe coil and provides it to a numerical integrator. The ratio of the two voltages in each third-octave filter leads to the spectral representation over the frequency band of interest. The Coil signal is scaled in dBV, and the Probe signal is first integrated and normalized to show dB A/m. The ratio probe-to-coil at the frequency of 1 kHz is the sensitivity which will be used in the consecutive T-Coil jobs..

5.2 System Validation Results

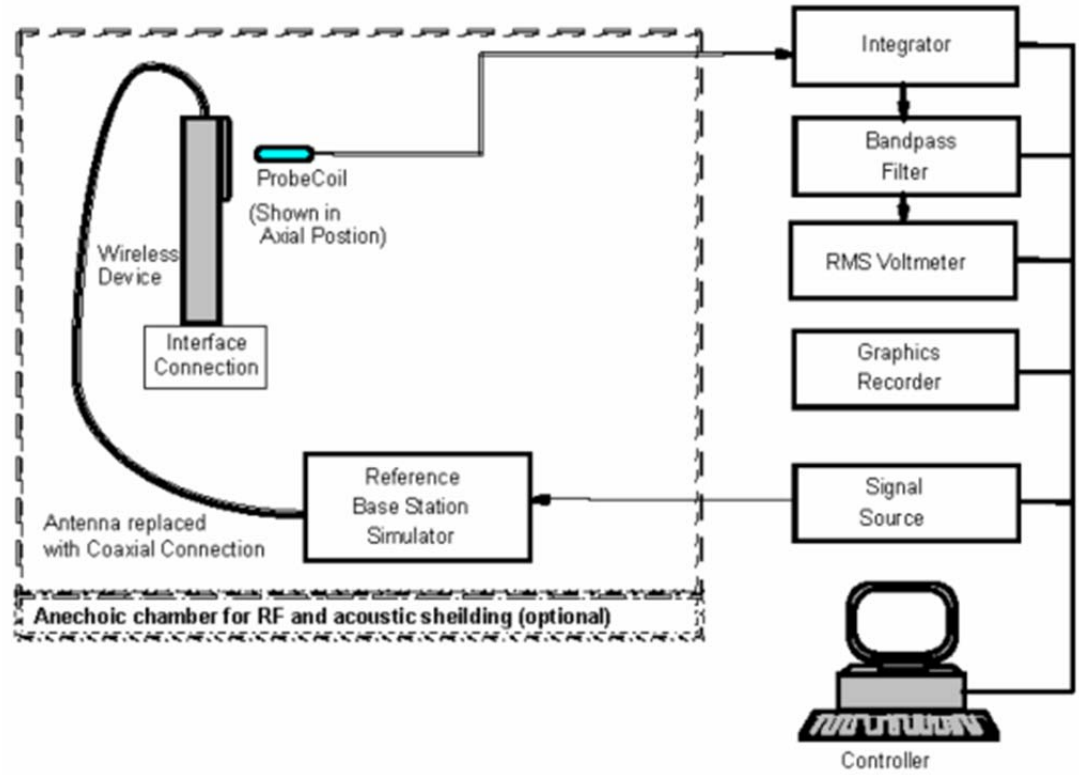
Date	Frequency	Input Level (mV)	Axial Description	Magnetic Field (dB A/m)	Target Field (dB A/m)	Tolerance (%)
2014/05/20	1025 Hz	500.0	Axial	-14.39	-13.69	-4.86
			Radial H	-19.61	-20.93	-6.31
			Radial V	-19.27	-20.47	-5.86
Note: 1. The tolerance limit of System validation ±10%.						

6 HAC MEASUREMENT PROCEDURES

6.1 HAC Measurement Process Diagram



6.2 HAC T-Coil Test Setup



T-Coil measurement test setup.

6.3 T-Coil Measurement Procedure

The following illustrate a typical T-Coil signal test scan over a wireless communications device:

a. Position the EUT in the test setup and connect the EUT RF connector to a base station simulator.

b. The drive level to the EUT is set such that the reference input level defined in 6.3.2.1, Table 6.1 is input to the base station simulator in the 1 kHz, 1/3 octave band. This drive level shall be used for the T-Coil signal test (ABM1) at f = 1 kHz. Either a sine wave at 1025 Hz or a voice-like signal, band-limited to the 1 kHz 1/3 octave, as defined in 6.3.2, shall be used for the reference audio signal. If interference is found at 1025 Hz an alternate nearby reference audio signal frequency may be used. The same drive level will be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency. The EUT volume control may be set at any level up to maximum, provided that a signal at any frequency at maximum modulation would not result in clipping or signal overload.

c. Determine the magnetic measurement locations for the EUT, if not already specified by the manufacturer, as described in 6.3.4.1.1 and 6.3.4.4.

d. At each measurement location, measure and record the desired T-Coil magnetic signals (ABM1 at f i) as described in 6.3.4.2 in each individual ISO 266-1975 R10 standard 1/3 octave band. The desired audio band input frequency (f i) shall be centered in each 1/3 octave band maintaining the same drive level as determined in Step 2) and the reading taken for that band. Equivalent methods of determining the frequency response may also be employed, such as fast Fourier transform (FFT) analysis using noise excitation or input–output comparison using simulated speech. The full-band integrated or half-band integrated probe output, as described in D.18, may be used, as long as the appropriate calibration curve is applied to the measured result, so as to yield an accurate measurement of the field magnitude. (The resulting measurement shall be an accurate measurement in dB A/m.) All measurements of the desired signal shall

be shown to be of the desired signal and not of an undesired signal. This may be shown by turning the desired signal on and off with the probe measuring the same location. If the scanning method is used the scans shall show that all measurement points selected for the ABM1 measurement meet the ambient and test system noise criterion in 6.2.1.

e. At each measurement location measure and record the undesired broadband audio magnetic signal (ABM2) as described in 6.3.4.3 with no audio signal applied (or digital zero applied, if appropriate) using A-weighting, and the half-band integrator. Calculate the ratio of the desired to undesired signal strength (i.e., signal quality).

f. Change the probe orientation to one of the two remaining orientations. At both measurement orientations, measure and record ABM1 using either a sine wave at 1025 Hz or a voice-like signal for the reference audio input signal.

g. Determine the category that properly classifies the signal quality based on Table 7.7.

7 CONDUCTED RF OUPUT POWER

The CDMA measurement conducted power as following:

BAND		CDMA BC0			CDMA BC10		
Channel		1013	384	777	476	526	684
Frequency (MHz)		824.70	836.52	848.31	817.90	819.10	823.10
RC 1	SO55 (dBm)	29.01	29.15	28.58	28.28	28.55	28.90
RC 3	SO55 (dBm)	29.08	29.15	28.63	28.30	28.57	28.90
	SO32 (dBm)	29.05	29.13	28.60	28.26	28.56	28.86
BAND		CDMA BC1			/		
Channel		25	600	1175	/	/	/
Frequency (MHz)		1851.25	1880.00	1908.75	/	/	/
RC 1	SO55 (dBm)	27.58	28.00	27.46	/	/	/
RC 3	SO55 (dBm)	27.60	28.01	27.49	/	/	/
	SO32 (dBm)	27.55	28.01	27.41	/	/	/

8 HAC T-Coil Test Results

Band	Ch.	Mode	Signal to noise (dB)	T-Rating	Frequency Response	Meas. No.
BC 0 (Voice)	1013	Axial	23.98	T3	PASS	1#
		Radial H	21.83	T3		
		Radial V	21.33	T3		
	384	Axial	21.41	T3	PASS	2#
		Radial H	21.27	T3		
		Radial V	21.44	T3		
	777	Axial	22.65	T3	PASS	3#
		Radial H	23.34	T3		
		Radial V	22.80	T3		
BC 10 (Voice)	476	Axial	21.04	T3	PASS	4#
		Radial H	22.91	T3		
		Radial V	21.43	T3		
	526	Axial	21.04	T3	PASS	5#
		Radial H	22.91	T3		
		Radial V	21.43	T3		
	684	Axial	21.98	T3	PASS	6#
		Radial H	23.83	T3		
		Radial V	23.33	T3		
BC 1 (Voice)	25	Axial	23.72	T3	PASS	7#
		Radial H	24.19	T3		
		Radial V	24.52	T3		
	600	Axial	24.48	T3	PASS	8#
		Radial H	25.75	T3		
		Radial V	25.73	T3		
	1175	Axial	23.17	T3	PASS	9#
		Radial H	24.63	T3		
		Radial V	23.85	T3		

9 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
TMFS	SATIMO	STMFS	SN 22/12 TMFS18	2014/08/17	2015/08/17
T-coil Probe	SATIMO	STCOIL	SN 22/12 TCP26	2014/08/17	2015/08/17
RF coaxial Cable	SATIMO	N/A	N/A	N/A	N/A
MultiMeter	Keithley	MultiMeter 2000	4024022	2014/02/13	2015/02/12
Signal Generator	R&S	SMF100A	1167.0000k02/104260	2014/02/17	2015/02/16
Power Meter	Agilent	5738A	11290	2014/10/26	2015/10/25
Power Sensor	R&S	NRP-Z21	103971	2014/12/18	2015/12/17
Power Amplifier	SATIMO	6552B	22374	2014/08/18	2015/08/17
Wireless Communication Test Set	Agilent	8960-E5515C	MY50260493	2014/09/13	2015/09/12
Wireless Communication Test Set	R&S	CMU 200	123666	2014/09/13	2015/09/12

10 REFERENCES

1 FCC 47 CFR Part 20.19 “Hearing aid-compatible mobile handsets.”

2 ANSI C 63.19:2007 “American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 27 May 2011

3 KDB 285076 D01 HAC Guidance v04, “provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility

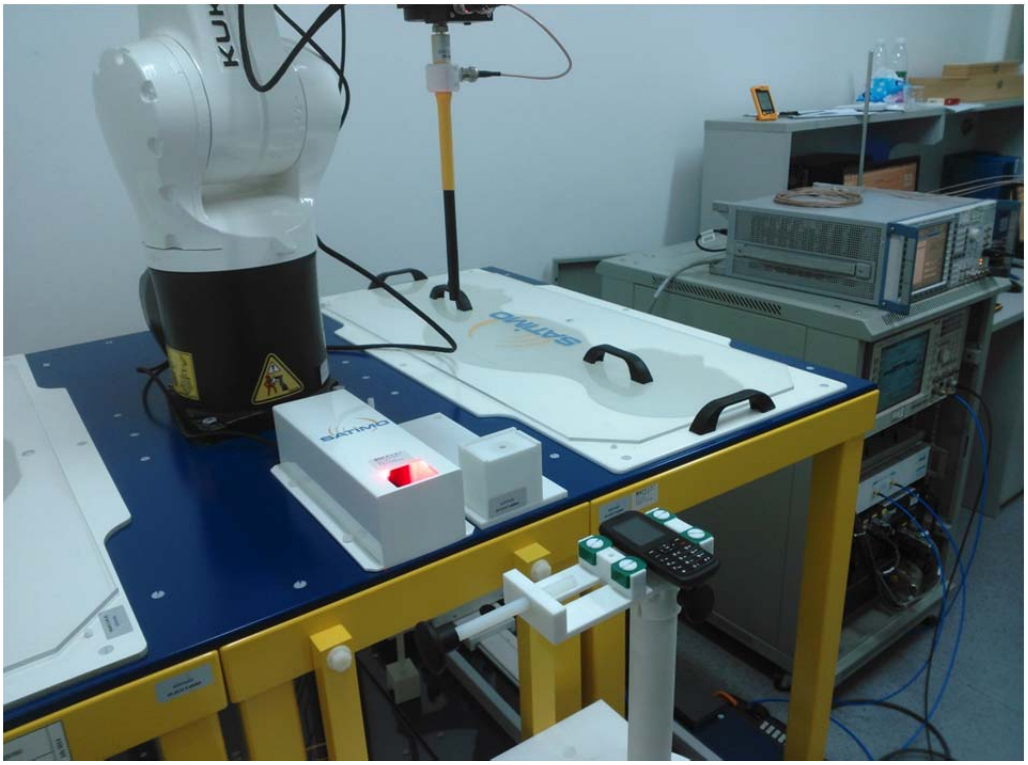
4 KDB 285076 D02, T-Coil testing for CMRS IP v01r01 provides guidance for T-Coil tests for voice-over-IP (e.g. LTE and Wi-Fi) CMRS based Telephone Services.

4 SATIMO COMOHAC_V2.1

5 SATIMO OPENHAC_V2.1

ANNEX A HAC T-Coil TEST SETUP PHOTOS

T-Coil Measurement Test Setup



ANNEX B HAC RF MEASUREMENT RESULT

TABLE OF MEASUREMENT RESULT LIST

Band	Mode	PARAMETERS
CDMA BC 0	T-Coil	Measurement 1: Low Channel
		Measurement 2: Middle Channel
		Measurement 3: High Channel
CDMA BC 10	T-Coil	Measurement 4: Low Channel
		Measurement 5: Middle Channel
		Measurement 6: High Channel
CDMA BC 1	T-Coil	Measurement 7: Low Channel
		Measurement 8: Middle Channel
		Measurement 9: High Channel

MEASUREMENT 1

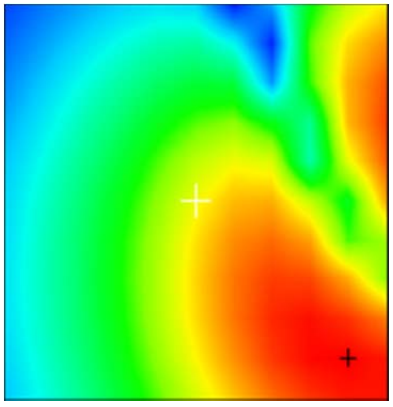
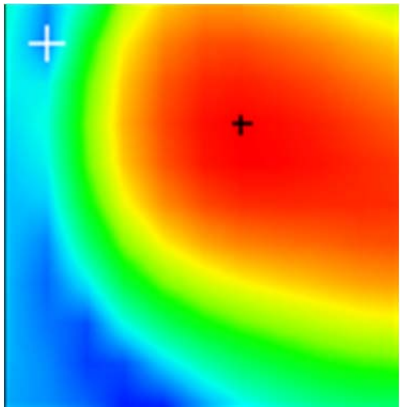
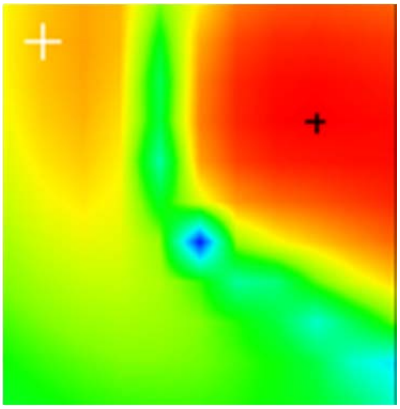
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Low
Signal	CDMA
Date of measurement	2014-05-20

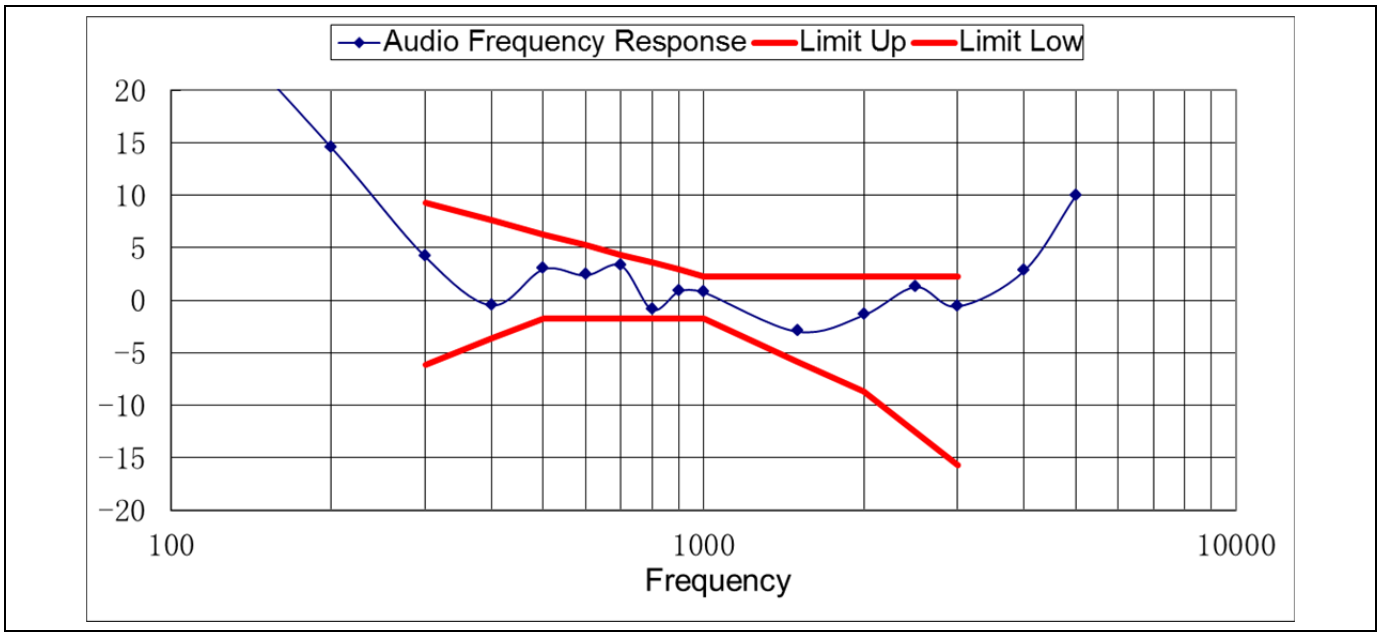
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_Cellular	Intensity, Axial	-18	Max	-12.37	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-15.23	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-16.54	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	23.98	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	21.83	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	21.33	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 2

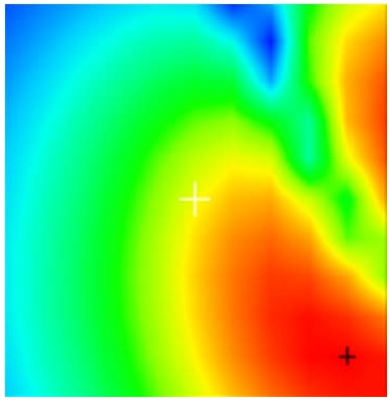
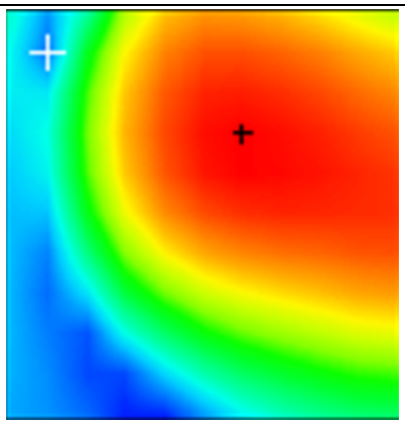
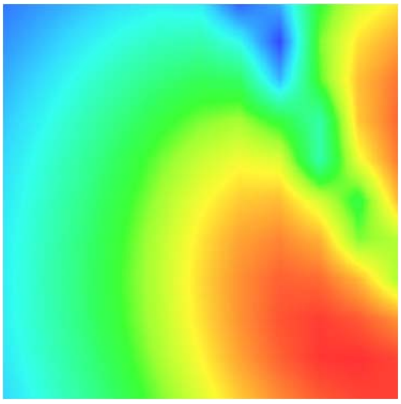
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Middle
Signal	CDMA
Date of measurement	2014-05-20

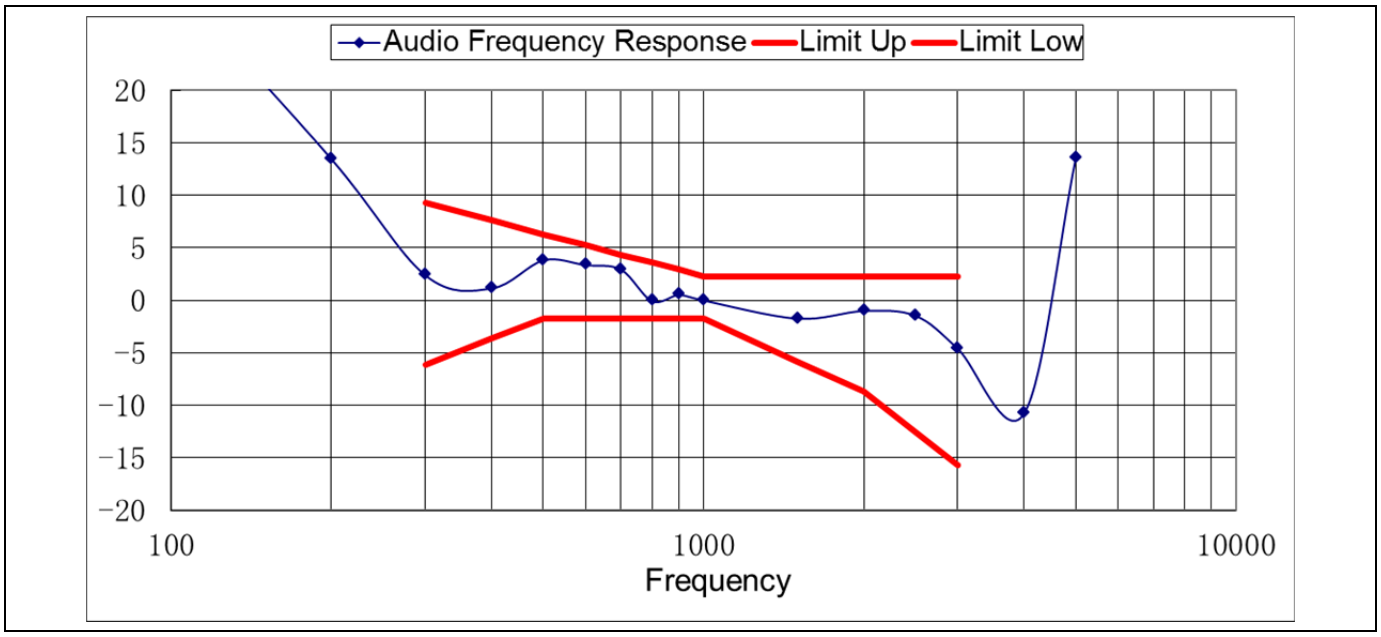
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_Cellular	Intensity, Axial	-18	Max	-17.50	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-16.23	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-16.20	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	21.41	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	21.27	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	21.44	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 3

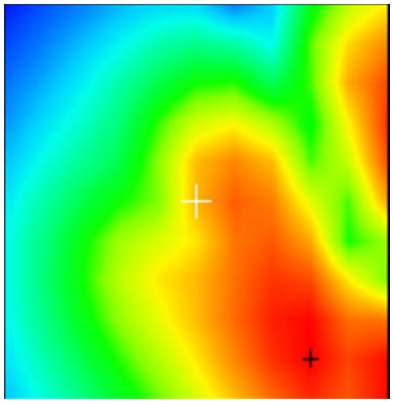
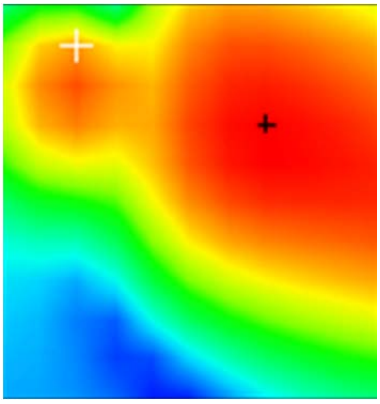
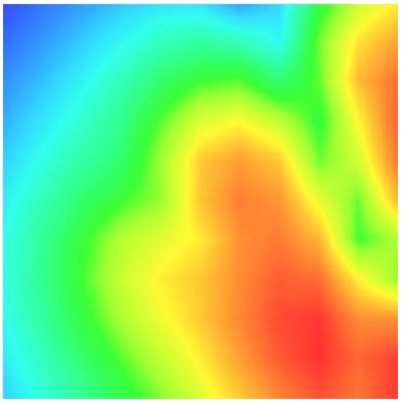
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	High
Signal	CDMA
Date of measurement	2014-05-20

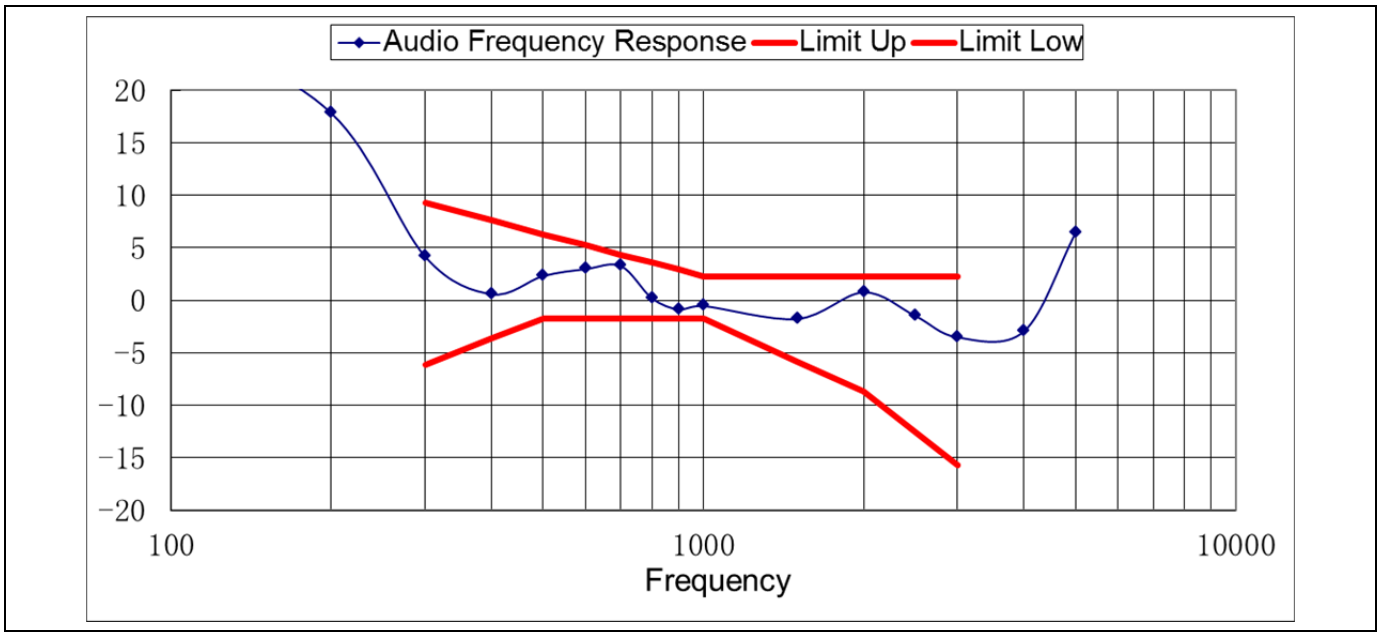
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_Cellular	Intensity, Axial	-18	Max	-15.63	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-15.21	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-16.63	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	22.65	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	23.34	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	22.80	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 4

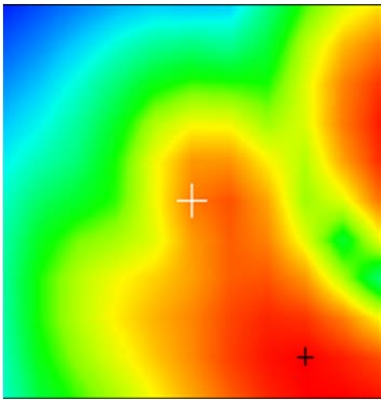
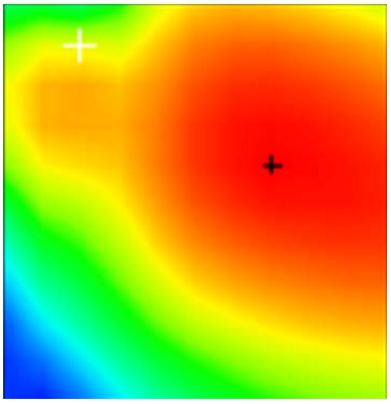
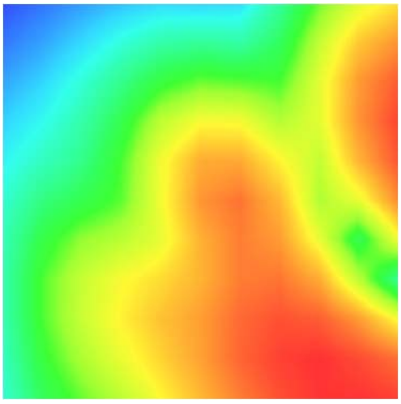
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC10_Secondary_800MHz
Channel	Low
Signal	CDMA
Date of measurement	2014-05-20

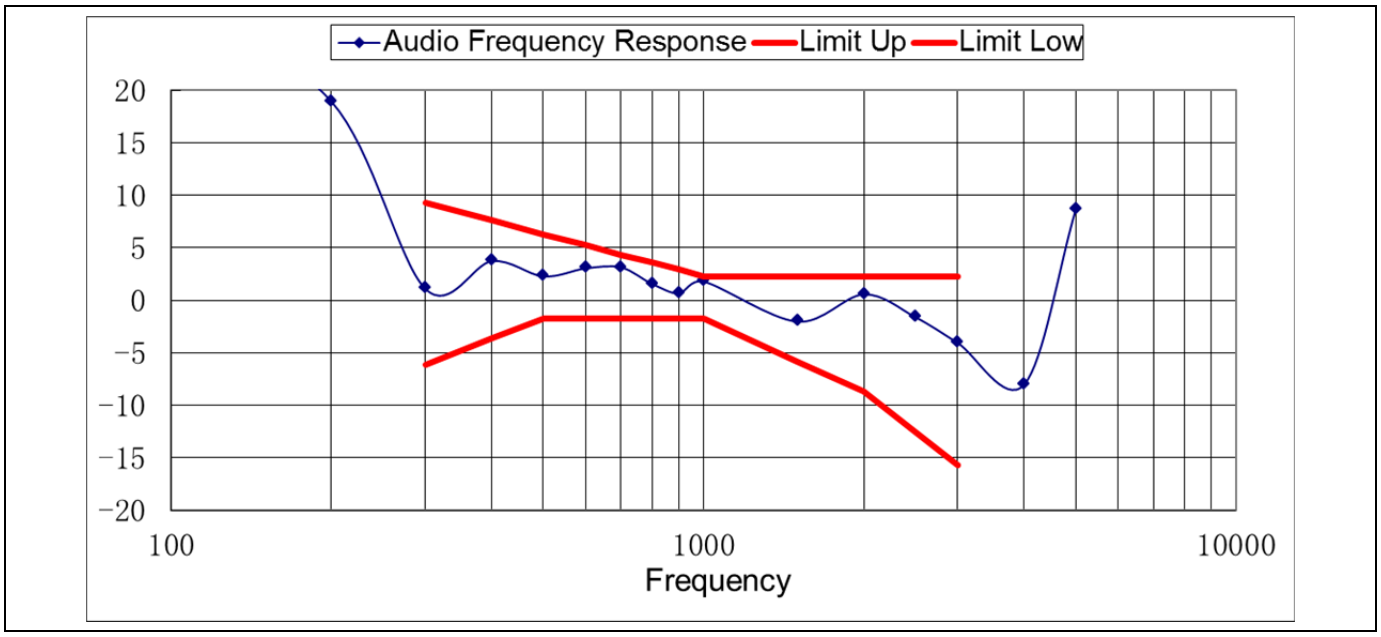
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC10_ Secondary 800	Intensity, Axial	-18	Max	-14.10	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-15.45	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-15.35	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	21.04	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	22.91	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	21.43	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 5

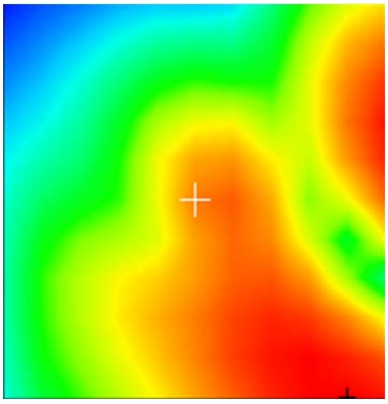
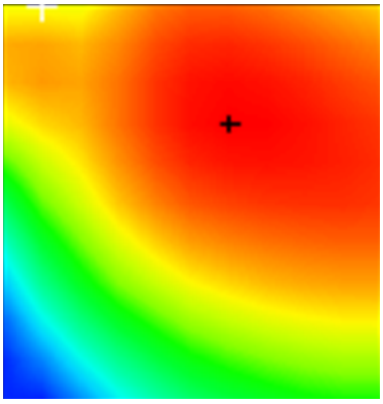
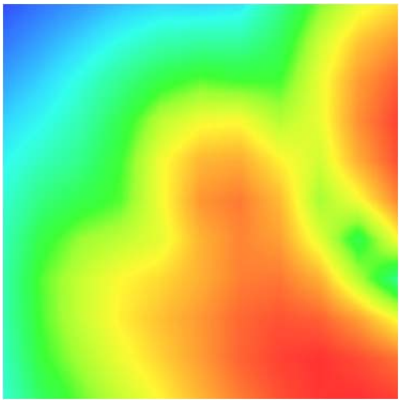
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC10_Secondary_800MHz
Channel	Middle
Signal	CDMA
Date of measurement	2014-05-20

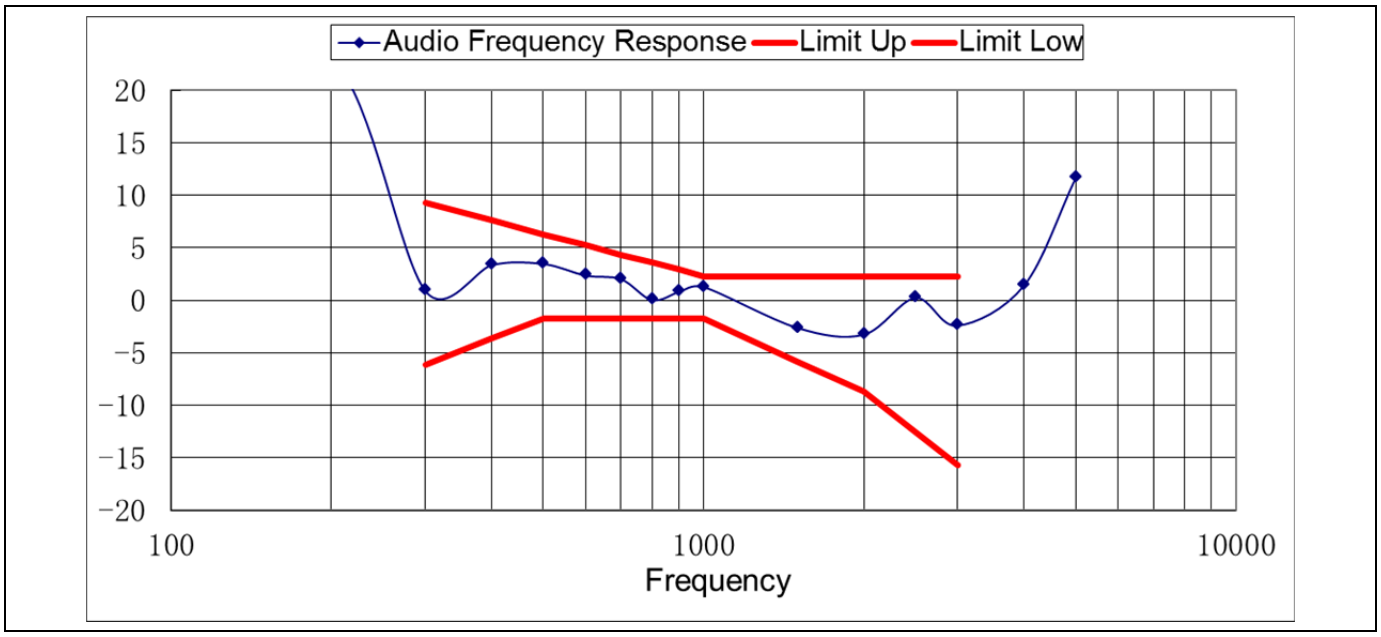
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC10_ Secondary 800	Intensity, Axial	-18	Max	-14.10	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-15.45	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-15.35	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	21.04	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	22.91	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	21.43	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 6

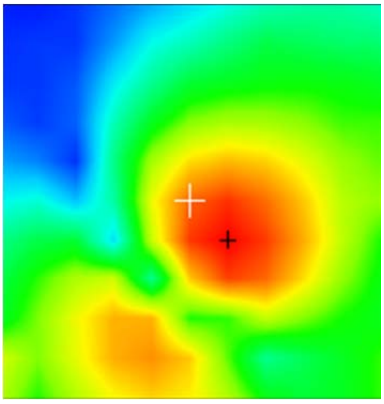
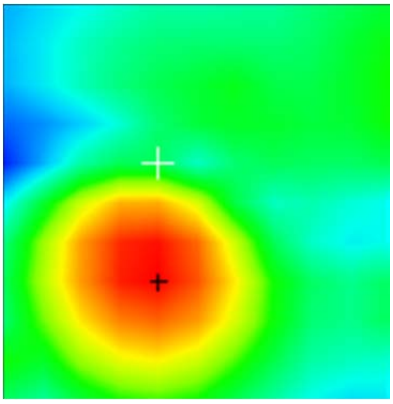
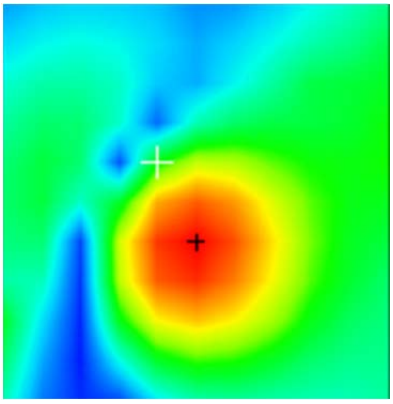
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC10_Secondary_800MHz
Channel	High
Signal	CDMA
Date of measurement	2014-05-20

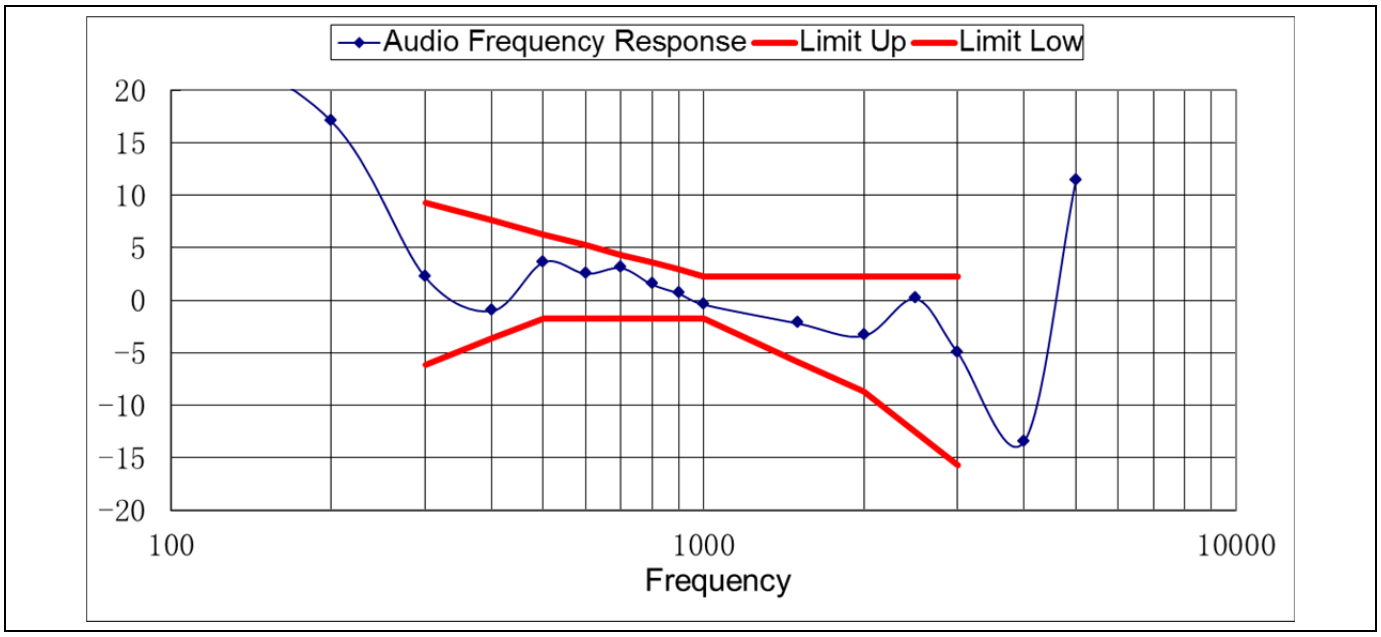
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC10_ Secondary 800	Intensity, Axial	-18	Max	-13.80	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-14.34	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-14.37	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	21.98	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	23.83	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	23.33	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 7

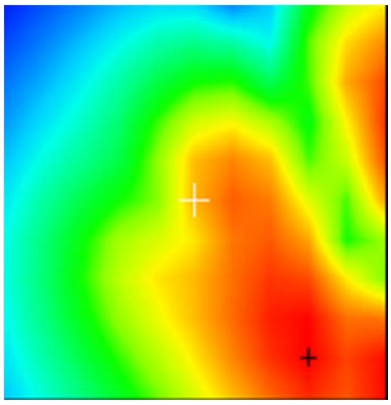
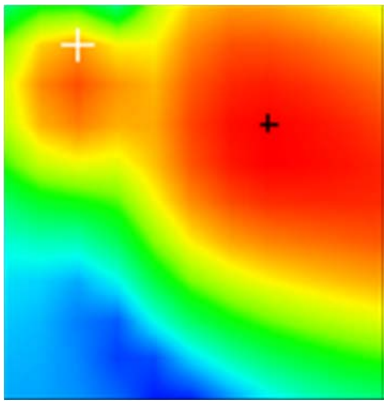
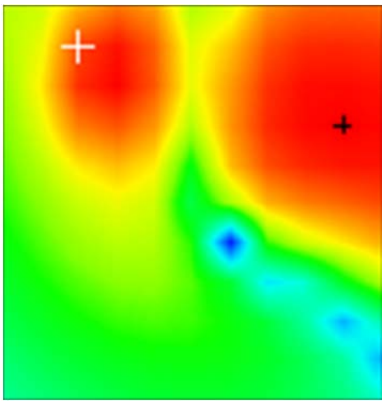
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC1_North_American_PCS
Channel	Low
Signal	CDMA
Date of measurement	2014-05-20

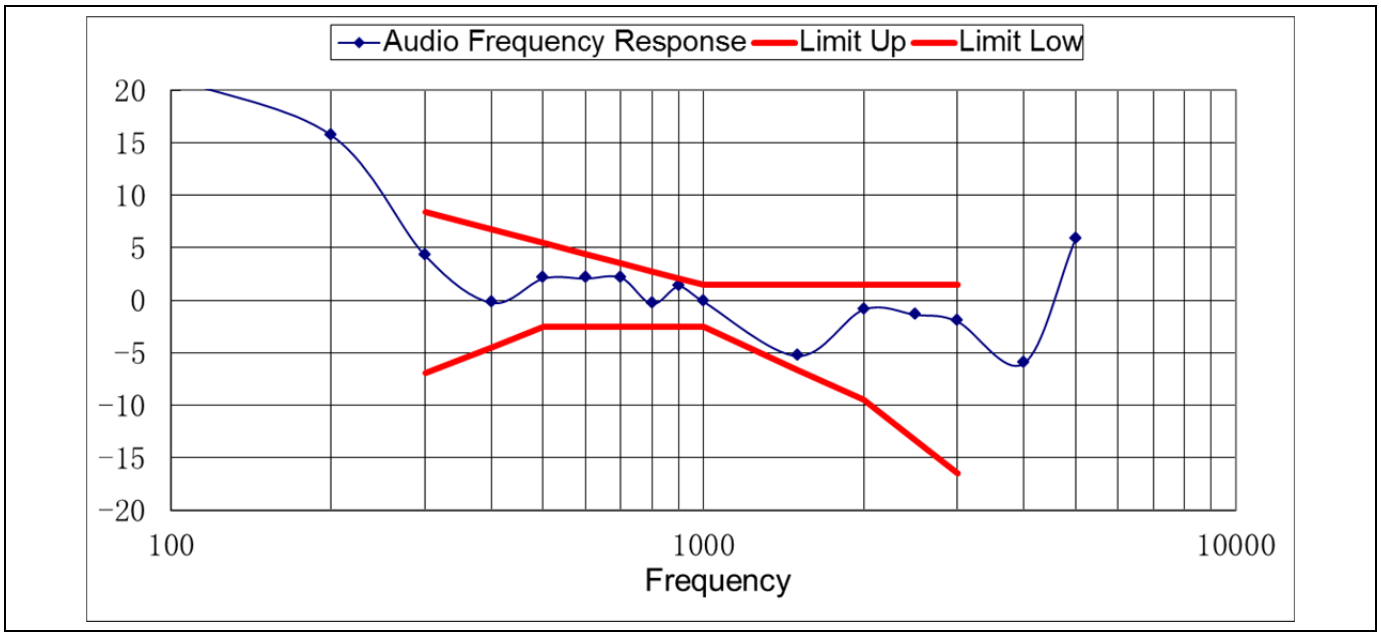
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_PCS	Intensity, Axial	-18	Max	-14.91	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-12.59	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-12.50	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	23.72	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	24.19	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	24.52	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 8

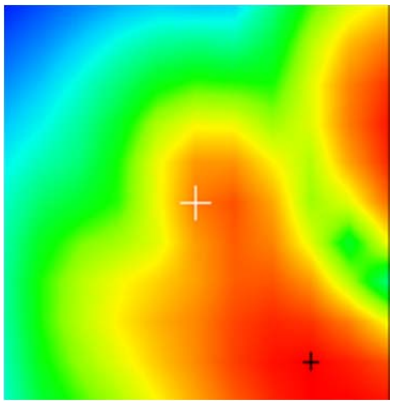
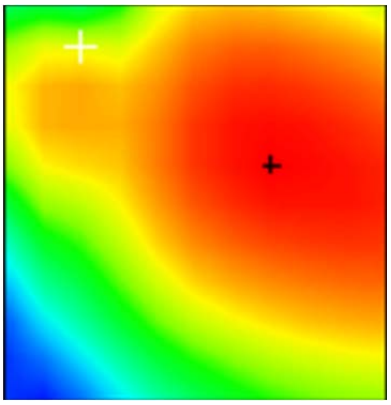
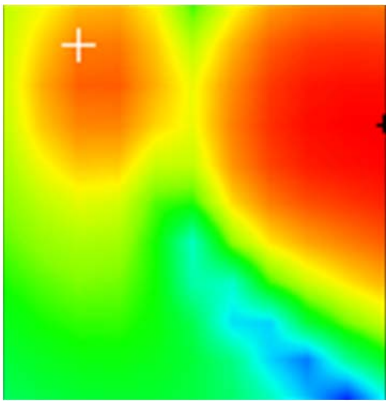
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC1_North_American_PCS
Channel	Low
Signal	CDMA
Date of measurement	2014-05-20

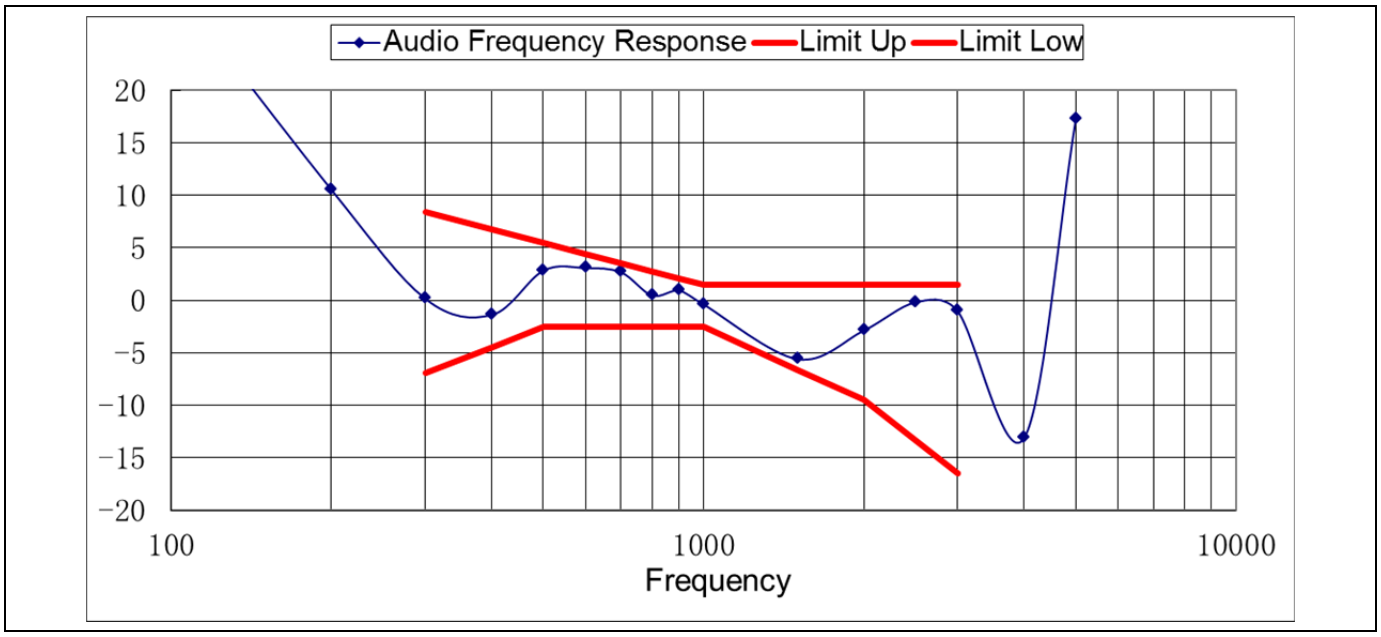
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_PCS	Intensity, Axial	-18	Max	-14.91	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-12.59	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-12.50	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	24.48	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	25.75	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	25.73	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



MEASUREMENT 9

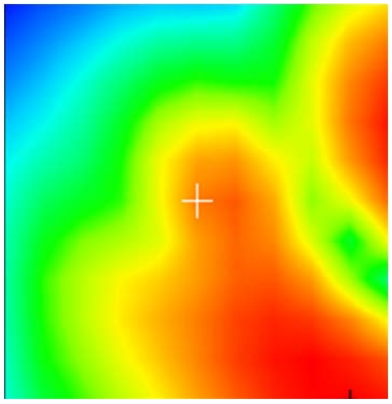
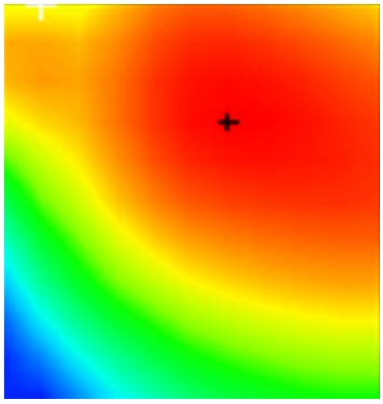
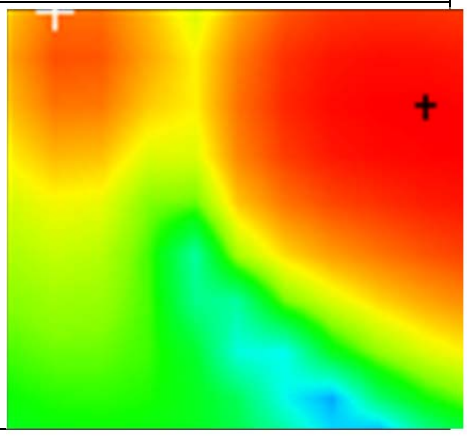
Experimental conditions

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC1_North_American_PCS
Channel	Low
Signal	CDMA
Date of measurement	2014-05-20

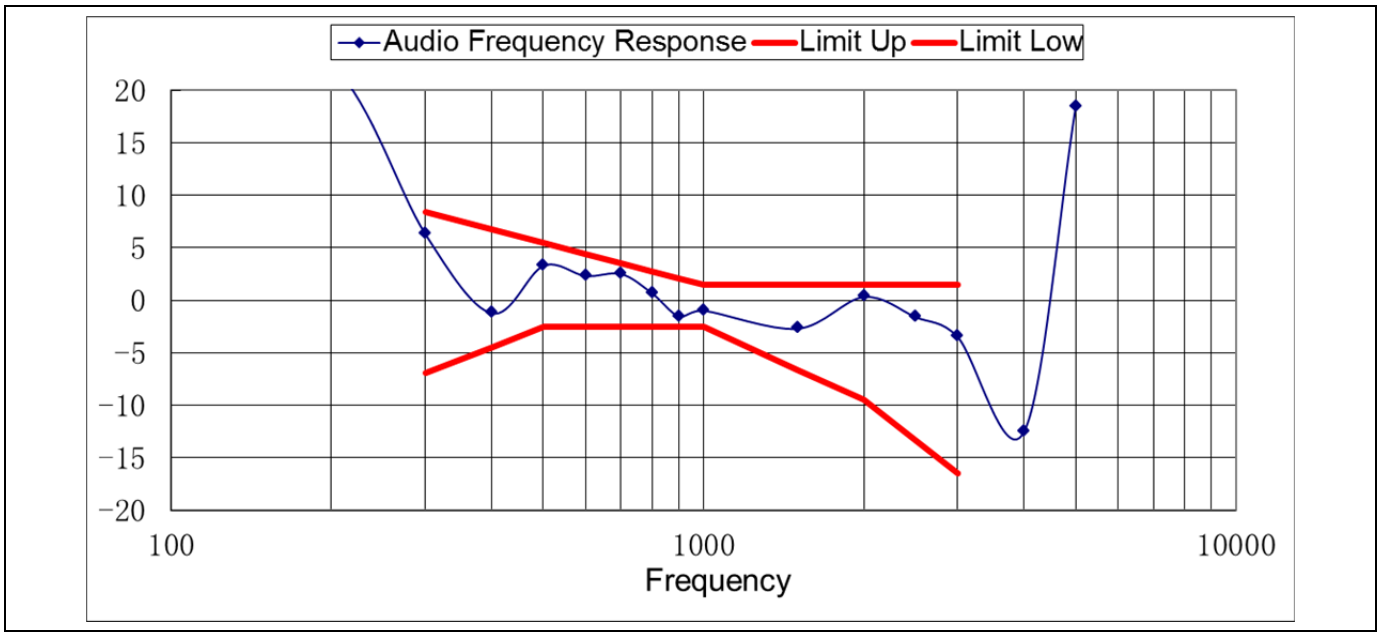
HAC Measurement Results

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	CDMA	BC0_US_PCS	Intensity, Axial	-18	Max	-14.91	-	PASS
7.3.1.2			Intensity, RadialH	-18	Max	-12.59	-	PASS
7.3.1.2			Intensity, RadialV	-18	Max	-12.50	-	PASS
				dB		dB		
7.3.3			Signal to noise/noise, Axial	20	Max	23.17	T3	PASS
7.3.3			Signal to noise/noise, RadialH	20	Max	24.63	T3	PASS
7.3.3			Signal to noise/noise, RadialV	20	Max	23.85	T3	PASS
7.3.2			Frequency reponse, Axial	PASS				

T.Coil Scan Overlay Magnetic Field Distributions

AXIAL	RADIAL H	RADIAL V
		

Frequency reponse



ANNEX C CALIBRATION FOR PROBE AND DIPOLE

COMOHAC T-coil Probe Calibration Report

Ref : ACR.219.15.13.SATU.A

SHENZHEN BALUN TECHNOLOGY CO., LTD.
ROOM 601, EAST TOWER, NANSHAN SOFTWARE PARK,
10128 SHENNAN ROAD, SHENZHEN, 518084, CHINA
SATIMO COMOHAC T-COIL PROBE
SERIAL NO.: SN 22/12 TCP26

Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

17/08/2014

Summary:

This document presents the method and results from an accredited COMOHAC T-coil Probe calibration performed in SATIMO USA using the COMOHAC test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/17/2014	
Checked by :	Jérôme LUC	Product Manager	8/17/2014	
Approved by :	Kim RUTKOWSKI	Quality Manager	8/17/2014	

	Customer Name
Distribution :	Shenzhen BALUN Technology Co., Ltd.

Issue	Date	Modifications
A	8/17/2014	Initial release

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC T-COIL PROBE
Manufacturer	Satimo
Model	STCOIL
Serial Number	SN 22/12 TCP26
Product Condition (new / used)	New
Frequency Range of Probe	200-5000 Hz

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

Satimo's COMOHAC T-coil Probes are built in accordance to the ANSI C63.19 and IEEE 1027 standards.

Figure 1 – *Satimo COMOHAC T-coil Probe*

Coil Dimension	6.55 mm length * 2.29 mm diameter
DC resistance	860.6 Ω
Wire size	51AWG
Inductance at 1 kHz	132.1 mH at 1 kHz

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1027 standards. All measurements were performed using a Helmholtz coil built according to the specifications outlined in ANSI C63.19 and IEEE 1027.

3.1 SENSITIVITY

The T-coil was positioned within the Helmholtz coil in axial orientation. Using an audio generator connected to the input of the Helmholtz coil, a known field (1 A/m) was generated within the coil and the T-coil probe reading recorded over the frequency range of 100 Hz to 1000 Hz.

3.2 LINEARITY

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field within the coil from 0 dB A/m to -50 dB A/m and the T-coil reading recorded at each power level (10 dB steps).

3.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

The T-coil probe was positioned within the Helmholtz coil in axial orientation. The audio generator connected to the input of the Helmholtz coil was adjusted to obtain a field of -50 dB A/m. The T-coil reading was recorded. The audio generator is then turned off and the T-coil reading recorded.

4 MEASUREMENT UNCERTAINTY

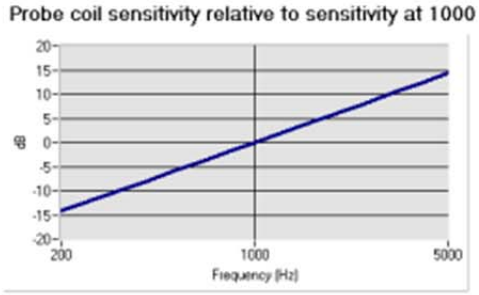
The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the T-coil probe calibration					
Uncertainty Component	Tol. (± dB)	Prob. Dist.	Div.	Uncertainty (dB)	Uncertainty (%)
Current/Volage Accuracy	0.224	R	√3	0.13	
Acoustic/ Signal Source drift	0.008	R	√3	0.00	
Probe coil sensitivity	0.2	R	√3	0.12	
Positioning accuracy	0.4	R	√3	0.23	
Acoustic Signal Receive Accuracy	0.03	R	√3	0.02	
Acoustic Signal Receive Linearity	0.006	R	√3	0.00	
System repeatability	0.4	N	1	0.40	
Combined Standard Uncertainty		N	1	0.49	
Expanded uncertainty (confidence level of 95%, k = 2)		N	k=2	1.00	12.0

5 CALIBRATION MEASUREMENT RESULTS

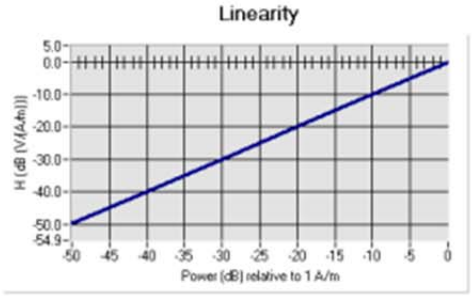
Calibration Parameters	
Lab Temperature	21°C
Lab Humidity	45%

5.1 SENSITIVITY



	Measured	Required
Sensitivity at 1 kHz	-60.22 dB (V/A/m)	–60.5 +/- 0.5 dB (V/A/m)
Max. deviation from Sensitivity	0.43 dB	+/- 0.5 dB

5.2 LINEARITY



	Measured	Required
Linearity Slope	0.09 dB	+/ 0.5 dB

5.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

	Measured	Required
Signal to Noise	-78.99 dB A/m	'Reading with -50 dB A/m in coil' – 'no signal applied' > 10 dB

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Audio Generator	National Instruments	15222AE	01/2012	01/2015
Reference Probe	Satimo	TCP 18 SN 47/10	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2012	11/2015
Helmholtz Coil	Satimo	HC07 SN47/10	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	3/2013	3/2015

COMOHAC TMFS Calibration Report

Ref : ACR.219.19.13.SATU.A

SHENZHEN BALUN TECHNOLOGY CO., LTD.
ROOM 601, EAST TOWER, NANSHAN SOFTWARE PARK,
10128 SHENNAN ROAD, SHENZHEN, 518084, CHINA
SATIMO COMOHAC MAGNETIC FIELD SIMULATOR
SERIAL NO.: SN 22/12 TMFS18

Calibrated at SATIMO US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

17/08/2014

Summary:

This document presents the method and results from an accredited COMOHAC TMFS calibration performed in SATIMO USA using the COMOHAC test bench, for use with a SATIMO COMOHAC system only. All calibration results are traceable to national metrology institutions.

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/17/2014	
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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	STMFS
Serial Number	SN 22/12 TMFS18
Product Condition (new / used)	New
Frequency Range	200-5000 Hz

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

Satimo's COMOHAC T-coil Probes are built in accordance to the ANSI C63.19 and ANSI S3.22-2003 standards.

Figure 1 – *Satimo COMOHAC Magnetic Field Simulator*

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19. All measurements were performed with the TMFS in the standard device test configuration, with the TMFS in free space, 10 mm below the coil center.

3.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

An audio signal was fed into the TMFS and the magnetic field measured and recorded over an area scan with the T-coil probe in three orientations; axial and two radial. The maximum magnetic field is recorded for all three T-coil orientations.

4 MEASUREMENT UNCERTAINTY

The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

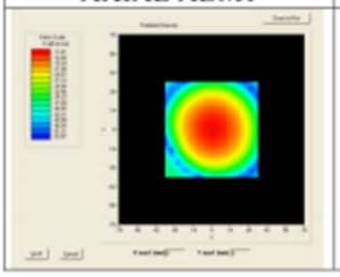
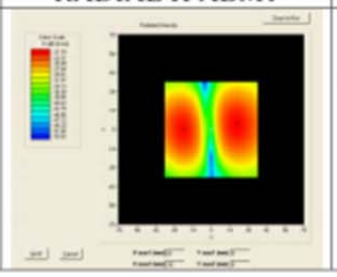
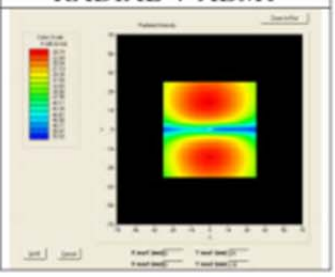
Uncertainty analysis of the probe calibration in Helmholtz Coil					
Uncertainty Component	Tol. (± dB)	Prob. Dist.	Div.	Uncertainty (dB)	Uncertainty (%)
Reflections	0.1	R	$\sqrt{3}$	0.06	
Acoustic noise	0.1	R	$\sqrt{3}$	0.06	
Probe coil sensitivity	0.49	R	$\sqrt{3}$	0.28	
Reference signal level	0.25	R	$\sqrt{3}$	0.14	
Positioning accuracy	0.2	R	$\sqrt{3}$	0.12	
Cable loss	0.1	N	1	0.05	
Frequency analyzer	0.15	R	$\sqrt{3}$	0.09	
System repeatability	0.2	N	1	0.20	
Repeatability of the WD	0.1	N	1	0.10	
Combined standard uncertainty		N	1	0.43	
Expanded uncertainty 95 % confidence level k = 2		N	2	0.85	10.3%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Software	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
T-Coil probe	SN 47/10 TCP18
Distance between TMFS and coil center	10 mm
Frequency	1025 Hz
Scan Size	X=70mm/Y=70mm
Scan Resolution	dx=5mm/dy=5mm
Output level	0.5 VAC
Lab Temperature	21°C
Lab Humidity	45%

5.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

Test Description	Measured Magnetic Field	
	Location	Intensity (dB A/m)
Axial	Max	-13.69
Radial H	Right side	-20.93
	Left side	-21.15
Radial V	Upper side	-20.47
	Lower side	-20.81

AXIAL ABM1	RADIAL H ABM1	RADIAL V ABM1
		

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--END OF REPORT--