HAC T-COIL TEST

REPORT

Report No.:	SET2015-09700
Product:	Mobile phone
Model No.:	V351
Brand Name:	UNIMAX
Applicant:	UNIMAX Communications
Address:	18201 McDurmott Street W. Suite E Irvine, CA 92614
Issued by:	CCIC-SET
Test date	July 06th, 2015
Issued Date	July 08th, 2015
Lab Location:	Electronic Testing Building, Shahe Road，Xili, Nanshan District, Shenzhen, 518055, P. R. China
Tel:	86 755 26627338　　Fax：86 755 26627238
Mail:	manager@ccic-set.com　　Website：http://www.ccic-set.com

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Model No. ……:	V351
Brand Name……..:	UNIMAX
Applicant……...:	UNIMAX Communications
Applicant Address……..:	18201 McDurmott Street W. Suite E Irvine, CA 92614
Manufacturer……:	Shenzhen Tonhorn Communication Technology CO., LTD
Manufacturer Address……...:	Room402,Block East,2nd Phase of Innovation and Technology Square, Tian'an Digital City, Futian District, Shenzhen China.
Test Standards……:	ANSI C63.19-2011 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids KDB 285076 D01HAC Guidance v04 Provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility.
Rating……:	T-Coil : T3
Test Result……:	Pass
Tested by ……..:	Mei chun
	Mei chun , Test Egineer
Reviewed by……:	Shuangwen Zhang
	Shuangwen Zhang, Senior Egineer
Approved by……:	Wu Lian
	Wu Li'an , Manager

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1. GENERAL CONDITIONS

1.1 This report only refers to the item that has undergone the test.

1.2 This report standalone dose not constitute or imply by its own an approval of the product by the certification Bodies or competent Authorities.

1.3 This document is only valid if complete; no partial reproduction can be made without written approval of CCIC-SET

1.4 This report cannot be used partially or in full for publicity and/or promotional purposes without previous written approval of CCIC-SET and the Accreditation Bodies, if it applies.

2. Administrative Date

2.1. Identification of the Responsible Testing Laboratory

Company Name:	CCIC-SET
Department:	EMC & RF Department
Address:	Electronic Testing Building, Shahe Road, Nanshan District, ShenZhen, P. R. China
Telephone:	+86-755-26629676
Fax:	+86-755-26627238
Responsible Test Lab Managers:	Mr. Wu Li'an

2.2. Identification of the Responsible Testing Location(s)

Company Name:	CCIC-SET
Address:	Electronic Testing Building, Shahe Road, Nanshan District, Shenzhen, P. R. China

2.3. Organization Item

CCIC-SET Report No.:	SET2015-09700
CCIC-SET Project Leader:	Mr. Li Sixiong
CCIC-SET Responsible for accreditation scope:	Mr. Wu Li'an
Start of Testing:	
End of Testing:	

2.4. Identification of Applicant

Company Name:	UNIMAX Communications
Address:	18201 McDurmott Street W. Suite E Irvine, CA 92614.

2.5. Identification of Manufacture

Company Name:	Shenzhen Tonhorn Communication Technology CO., LTD
Address:	Room402,Block East,2nd Phase of Innovation and Technology Square, Tian'an Digital City, Futian District, Shenzhen China.

Notes: This data is based on the information by the applicant.

3. Equipment Under Test (EUT)

3.1. Identification of the Equipment under Test

Sample Name: Mobile Phone

Type Name: V351

Brand Name: UNIMAX

General description:	Support Band	GSM850MHz/1900MHz WCDMA 850MHz/ 1900MHz Wi-Fi 2.4GHz/ Bluetooth 2.4GHz
	Test Band	GSM 850MHz/ GSM 1900MHz WCDMA 850MHz/ 1900MHz
	Development Stage	Identical Prototype
	Accessories	Power Supply
	Antenna type	PIFA Antenna
	Operation mode	GSM GPRS /EGPRS: Multislot Class12,Class B WCDMA/HSDPA/HSUPA/HSPA+
	Modulation mode	GMSK, 8PSK, QPSK, 16QAM, DSSS, OFDM, GFSK/ π /4-DQPSK/8-DPSK
	IMEI	NA

NOTE:

a. The EUT is a model of UNIMAX operating in GSM 850 / 1900, WCDMA 850 /1900 MHz band, Bluetooth 2.4GHz, Wi-Fi in 2.4GHz.

b. Please refer to Appendix C for the photographs of the EUT. For a more detailed features description about the EUT, please refer to User's Manual.

3.2 Summary of test results

3.2.1 Test Standards

No.	Identity	Document Title
1	FCC 47 CFR Part 20.19	Hearing aid-compatible mobile handsets.
2	ANCI C63.19:2011	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

3.2.2 Summary Of HAC Rating

Summary of T-Rating

Band	T-Rating	Frequency response
GSM850	T3	PASS
GSM1900	T4	PASS
WCDMA850	T4	PASS
WCDMA1900	T4	PASS

4. Hearing Aid Compatibility (HAC)

4.1 Introduction

The purpose of the Hearing Aid Compatibility extension is to enable measurements of the near electric and magnetic fields generated by wireless communication devices in the region controlled for use by a hearing aid in accordance with ANSI-C63.19-2011 FCC has granted a request for waiver of the HAC rules in section 20.19 for dual band GSM handsets. The waiver has specific conditions, as stated in the order (FCC 05-166) and expires 1 August 2007.

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

a) Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.
b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.
c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

a) RF E-Field emissions
c) T-coil mode, magnetic signal strength in the audio band
d) T-coil mode, magnetic signal and noise articulation index
e) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

a) RF immunity in microphone mode
b) RF immunity in T-coil mode

4.2 Description of Test System

4.2.1 COMOHAC T-COIL PROBE

Serial Number:	SN 24/11 TCP23
Frequency range:	200 Hz -5000 Hz
Dimensions:	6.55mm length*2.29mm diameter
DC resistance:	860.6 Ω
Wire size:	51 AWG
Inductance:	132.1 mH at 1kHz
Sensitivity:	-60.20 dB (V/A/m) at 1kHz

4.2.4 System Hardware

The HAC positioning ruler is used to position the phone properly with the regard to the position of the probe during a measurement. The positioning system is made of a dedicated frame that can be fixed on the table. The tip of the probe is positioned on a reference point located on the top of the positioning ruler. The distance between this reference point and the cross located on the ruler being known, the speaker of the phone is positioned on this cross in order to make sure both probe and phone are positioned properly.

During the measurement, the HAC ruler has to be removed so that it does not interfere with the measurement.

Position device

5. OPERATIONAL CONDITIONS DURING TEST

5.1 Schematic Test Configuration

During SAR test, EUT was operating in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The Absolute Radio Frequency Channel Number (ARFCN) was allocated to 128, 190 and 251 respectively in the case of GSM 850MHz, or to 512, 661 and 810 respectively in the case of PCS 1900MHz, or to 4132, 4183 and 4233 respectively in the case of WCDMA 850MHz, or to 9262, 9400 and 9538 respectively in the case of WCDMA 1900MHz. The EUT was commanded to operate at maximum transmitting power.

The EUT should use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link was used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point should be lower than the output power level of the handset by at least 35 dB

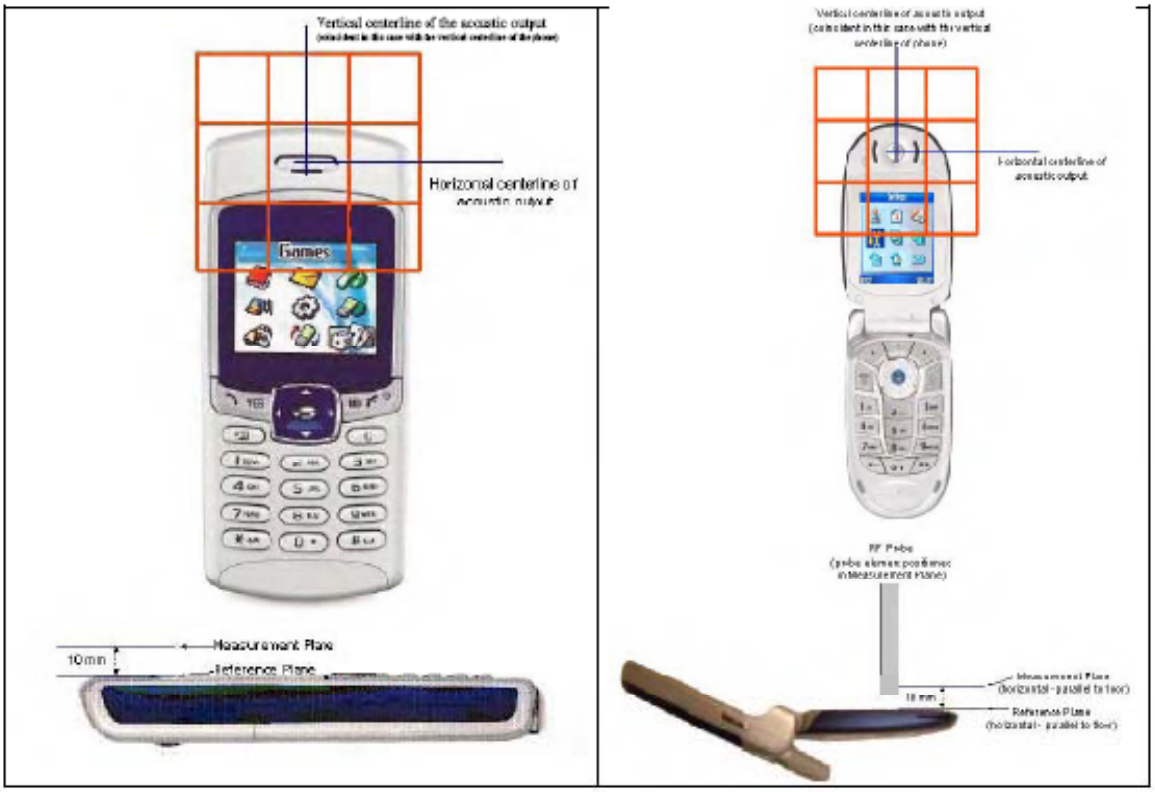
Air-interface	Band (MHz)	Type	C63.19-2007 Tested	Simultaneous Transmissions Scenarios invoice (Not to be tested)	Reduced power	VOIP
GSM	850	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	1900	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	GPRS	Data	N/A	N/A	N/A	N/A
WCDMA	850	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	1900	Voice	Yes	Yes: WIFI or BT	N/A	N/A
	HSDPA	Data	N/A	N/A	N/A	N/A
	HSUPA	Data	N/A	N/A	N/A	N/A
WIFI	2450	Data	N/A	Yes GSM or WCDMA	N/A	N/A
BT	2450	Data	N/A	Yes GSM or WCDMA	N/A	N/A

The volume is at the maximum value, and the backlight of the phone is turned off. The Manufacturer doesn't design HAC mode software on the EUT

5.2 HAC Measurement System

The HAC measurement system being used is the COMO HAC system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an 2D scan at a fixed depth within a 50mm*50mm area. When the maximum HAC point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged HAC level.



WD reference and plane for RF emission measurements

5.3 Magnetic measurement locations for the WD

T-Coil measurement points and reference planeThe following figure illustrates the three standard probeorientations. Position 1 is the axial orientation of the probe coil;orientation 2 and orientation 3 are radial orientations. The space between themeasurement positions is not fixed. It is recommended that a scan of the EUT bedone for each probe coil orientation and that the maximum level recorded beused as the reading for that orientation of the pro be coil.

1) The reference plane is the planar area that contains thehighest point in the area of th e phone that normally rests against the user'sear. It is parallel to the centerline of the recei ver area of the phone and isdefined by the points of the receiver-end of the EUT handset,

which, in normal handsetuse, rest against the ear.

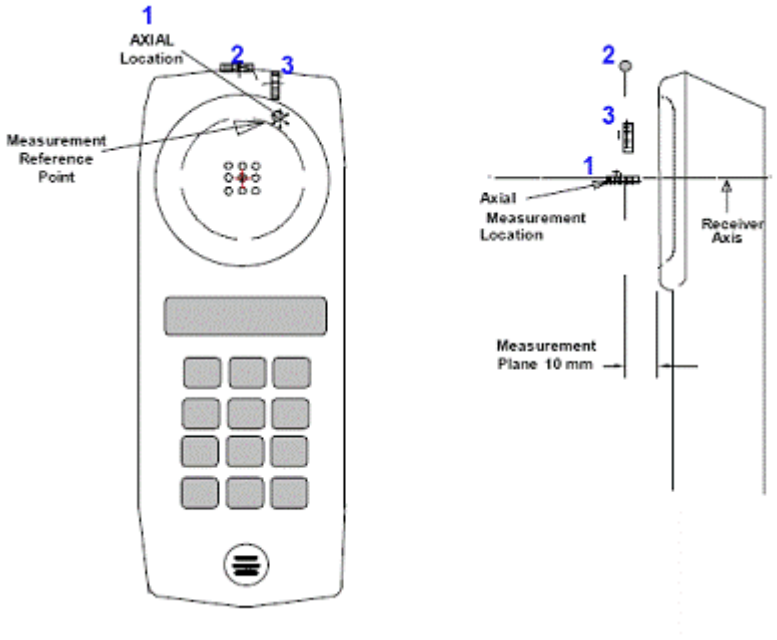
2) The measurement plane is parallel to, and10 mmin front of, the reference plane.

3) The reference axis is normal to the reference plane andpasses through the center of t he receiver speaker section (or the center of thehole array); or may be centered on a seco ndary inductive source. The actuallocation of the measurement point shall be noted in the t est report as the measurement reference point.

4) The measurement points may be located where the axialand radial field intensity mea surements are optimum with regard to therequirements. However, the measurement points should be near the acousticoutput of the EUT and shall be located in the same half of the phone as the EUTreceiver. In a EUT handset with a centered receiver and a circularly sym metricalmagnetic field, the measurement axis and the reference axis would coincide.

5) The relative spacing of each measurement orientation isnot fixed. The axial and two r adial orientations should be chosen to select the optimal position.

6) The measurement point for the axial position is located10 mmfrom the reference plan e on themeasurement axis. The actual location of the measurementpoint shall be noted in test reports and designated as the measurement reference point.



Axis and planes for EUT audio frequency magnetic field measurements

5.4 Equipments and results of validation testing

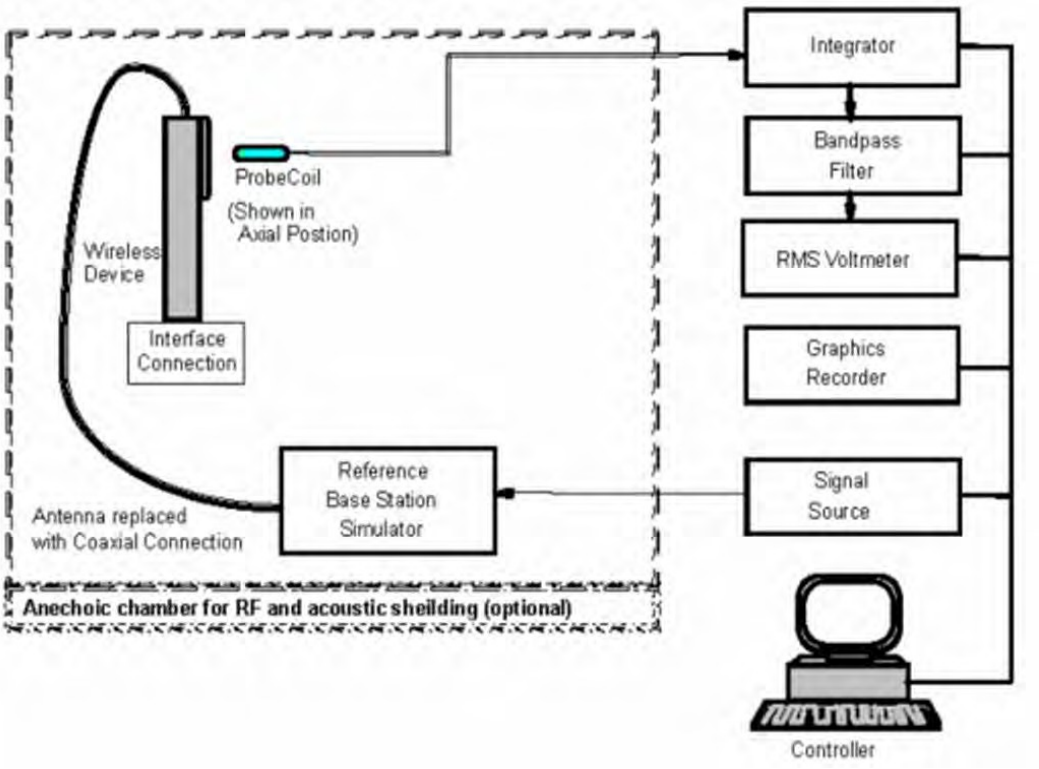
System Audio Validation

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..



T-Coil measurement test setup

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.

5.4.3 Test System Validation

T-coil system validation Results

Input Level （mV)	Axial Description	Location	Magnetic Field (dB A/m)
500	Axial	Max	-12.28
	Radial H	Right	-19.38
		Left	19.88
	Radial V	Upper	-19.71
		Lower	-19.56
Note: The tolerance limit of System validation ±25%			

Note: Target value was referring to the Measurement value in the calibration certificate of reference dipole.

6. CHARACTERISTICS OF THE TEST

6.1 Applicable Limit Regulations

Axial and Radial Field Intensity

All orientations of the magnetic field, in the axial and radial position along the measurement plane shall be ⩾ -18 dB(A/m) at 1 kHz in a 1/3 octave band filter per § 8.3.1.

Frequency Response

The frequency response of the axial component of the magnetic field shall follow the response curve specified in EIA RS-504-1983, over the frequency range 300 Hz – 3000 Hz per § 8.3.2.

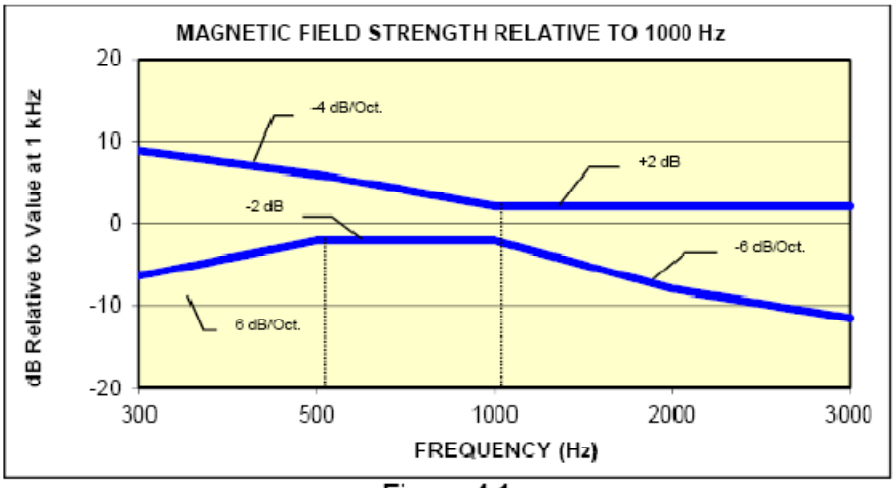


Figure 4-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB (A/m) at 1 kHz

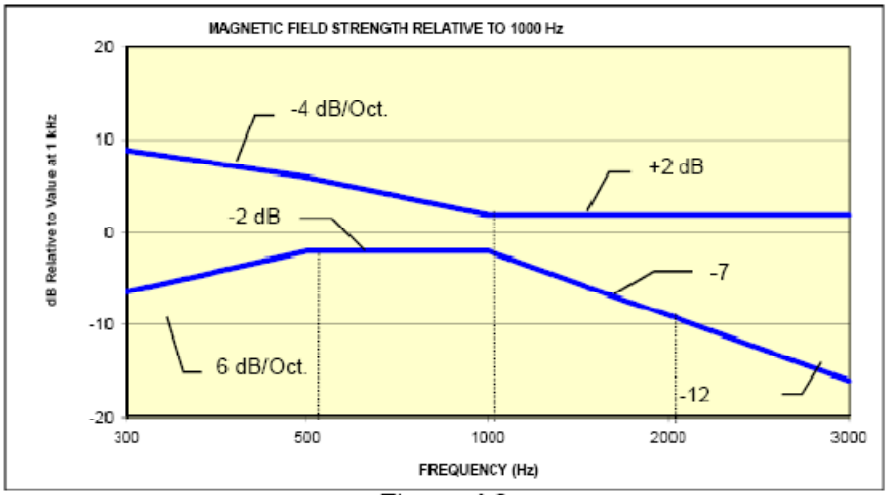


Figure 4-2
Magnetic Field frequency response for wireless devices with an axial field that exce -15 dB(A/m) at 1 kHz

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.

Table 3 T-Coil Mode Categories

Category	Telephone RF Parameter
	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

6.2 Applicable Measurement Standards

ANSI C63.19-2011: American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids

It specifies the measurement method for demonstration of compliance with the HAC limits for such equipments.

7. LABORATORY ENVIRONMENT

Table 4: The Ambient Conditions during HAC Test

Temperature	Min. = 20 ° C, Max. = 25 ° C
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

8. TEST RESULTS

8.1 Summary of Power Measurement Results

The power level results were listed in the following two tables:

Table 5: Conducted RF Power of GSM850

Band	GSM 850			GSM 1900		
Channel	128	190	251	512	661	810
Frequency	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM	32.76	32.82	32.78	29.79	29.84	29.86

Table 6: Conducted RF Power of WCDMA

Band	WCDMA 850			WCDMA1900		
TX Channel	4132	4182	4233	9262	9400	9538
Frequency	826.4	835	846.6	1852.4	1880.0	1907.6
RMC 12.2K	22.81	22.83	22.79	22.73	22.77	22.72

8.2 Summary of Measurement Results

Table 8: T-Coil Values of the EUT

Temperature: 23.0~23.5°C, humidity: 62~64%.			
Band	Channel	Frequency (MHz)	Test Results Category
GSM850	190	836.4	T3
GSM1900	661	1880.0	T3
WCDMA850	4182	835	T4
WCDMA1900	9538	1907.6	T4

9. Measurement Uncertainty

Table 9: Measurement Uncertainty of RF Emission Test

Uncertainty Component	Uncertainty value	Probe 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	1.17	1.17
Sensor Displacemant	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 to PMR Calibration	9.02	N	1.000	1	1	9.02	9.02
System Detection Limit	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
Uncertainties of the EUT							
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
Conbined Std. Uncertainty(k=1)						16.18	13.25
Expanded Uncertainty on Power						32.35	26.50
Expanded Uncertainty on Field						16.18	13.25

Note:

N-Nomal

R-Rectangular

Div.- Divisor used to obataion standard uncertanty

Table 10: Measurement Uncertainty of T-Coil Test

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	－Probe Calibration	B	6	N	3	1	3.5	∞
2	－Axial isotropy	B	4.7	R	1.732	0.5	4.3	∞
3	－Hemispherical Isotropy	B	9.4	R	1.732	0.5	4.3	∞
4	－Boundary Effect	B	11.0	R	1.732	1	6.4	∞
5	－Linearity	B	4.7	R	1.732	1	2.7	∞
6	－System Detection Limits	B	1.0	R	1.732	1	0.6	∞
7	－Probe Coil Sensitivity	B	0.49	R	1.732	1	0.28	∞
8	－Response Time	B	0.00	R	1.732	1	0.00	∞
9	－Integration Time	B	0.00	R	1.732	1	0.00	∞
10	－RF Ambient Conditions	B	3.0	R	1.732	1	1.73	∞
11	－Probe Position Mechanical tolerance	B	0.4	R	1.732	1	0.2	∞
12	－Probe Position with respect to Phantom Shell	B	2.9	R	1.732	1	1.7	∞
	Uncertainties of the DUT							
13	－Position of the DUT	A	4.8	N	3	1	4.8	5
14	－Holder of the DUT	A	7.1	N	3	1	7.1	5
15	－Repeatability of the WD	B	5.0	R	1.732	1	2.9	∞
	Acoustic noise							
16	－Acoustic noise	B	1.0	R	1.732	1	0.6	∞
21	－Cable loss	B	0.46	N	1.732	1	0.46	∞
Combined Standard Uncertainty				RSS			17.26	42.33
Expanded uncertainty (Confidence interval of 95 %)				K=2			34.52	

10. MAIN TEST INSTRUMENTS

No	EQUIPMENT	TYPE	Series No.	Due Date
1	T-Coil Probe	SATIMO/STCOIL	SN 24/11 TCP23	2016/05/05
2	TMFS	SATIMO/STMFS	SN 07/14 TMFS24	2015/09/01
3	Vector Network Analyzer	ZVB8	1145.1010.08	2016/06/13
4	Amplifier	Nucletudes	143060	2016/04/04
5	Power Meter	NRVS	1020.1809.02	2016/06/13
6	Multimeter	Keithley - 2000	4014020	2016/04/04
7	Power Sensor	NRV-Z4	100069	2016/06/10
8	Wireless Communication Test Set	CMU200	A0304212	2016/06/10

11. ANNEX A SYSTEM SETUP

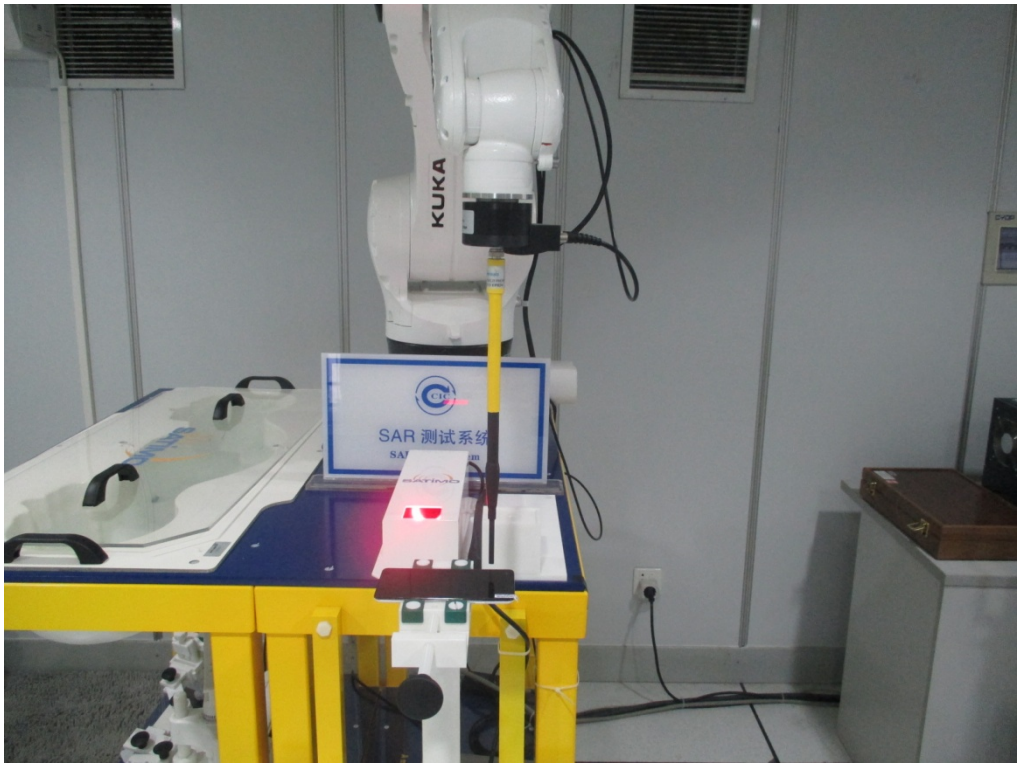


Fig.1 Testing Photo

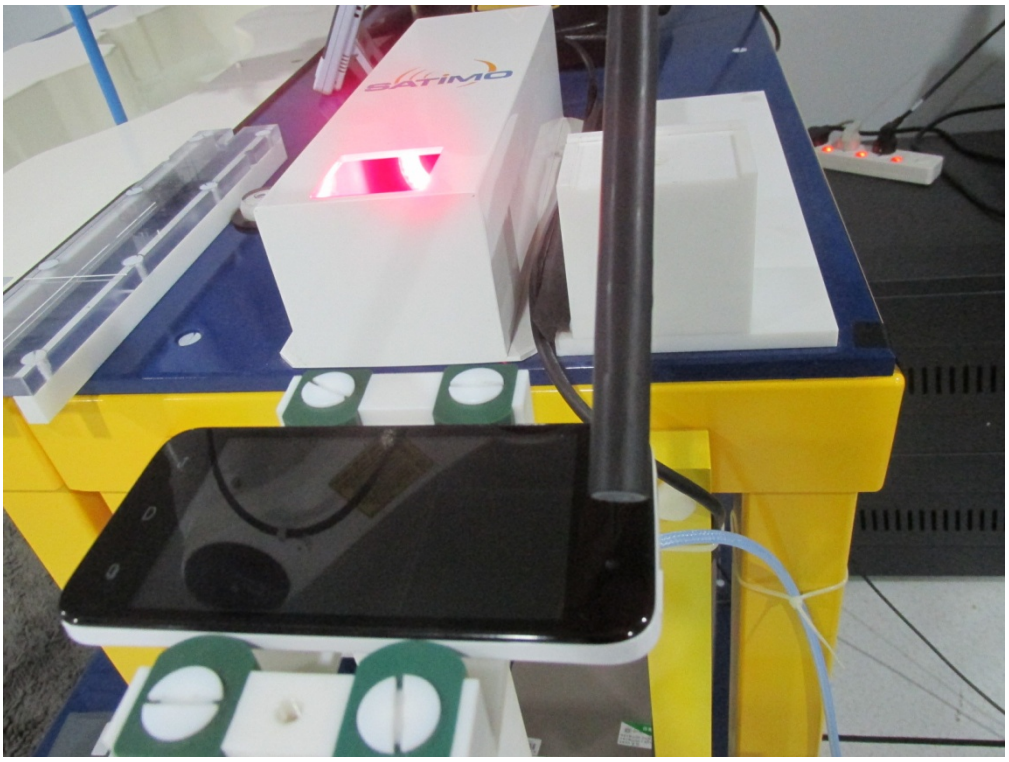


Fig.2 Testing Photo

12. ANNEX B EUT PHOTO

Appearance and size (obverse)

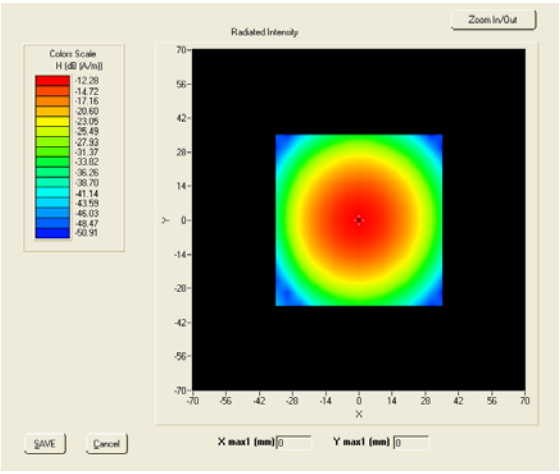
Appearance and size (reverse)

13. ANNEX C SYSTEM VERIFICATION (TMFS)

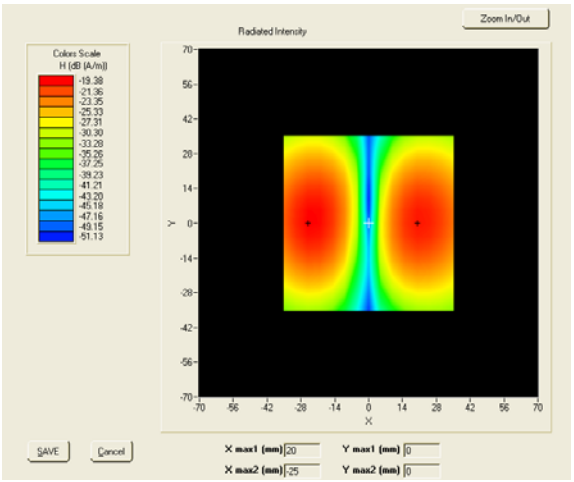
Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	Val		Intensity, Axial	-	Max	-12.28	-	-
7.3.1.2			Intensity, RadialH	-	Right side	-19.38	-	-
				-	Left side	19.88	-	-
7.3.1.2			Intensity, RadialV	-	Upper side	-19.71	-	-
				-	Lower side	-19.56	-	-

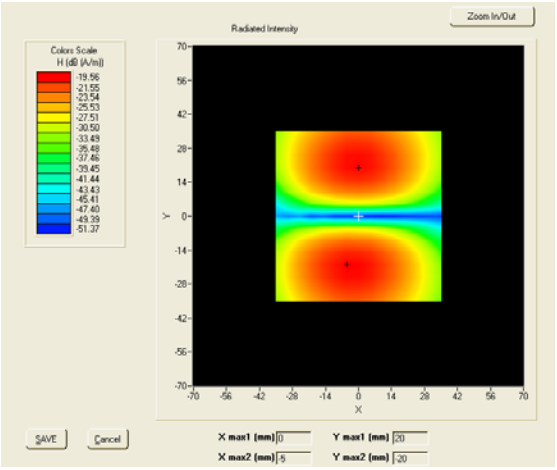
AXIAL ABM1



RADIAL H ABM1

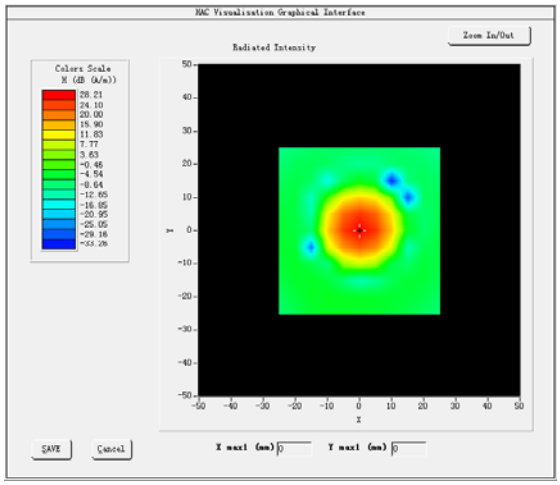
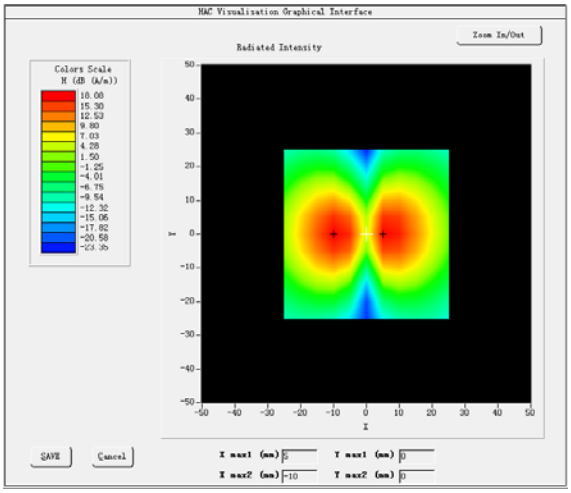
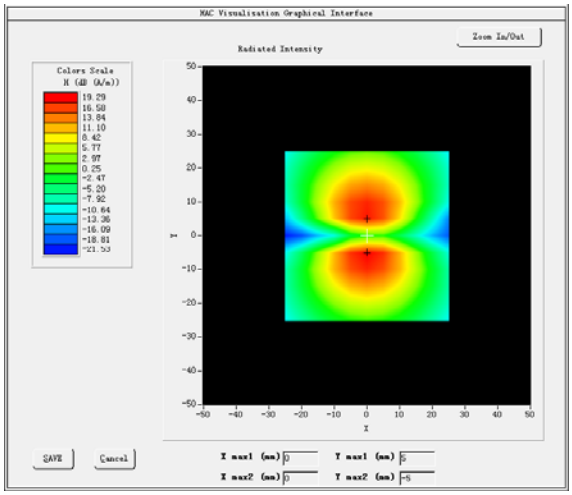


RADIAL V ABM1



14. ANNEX D TEST PLOTS

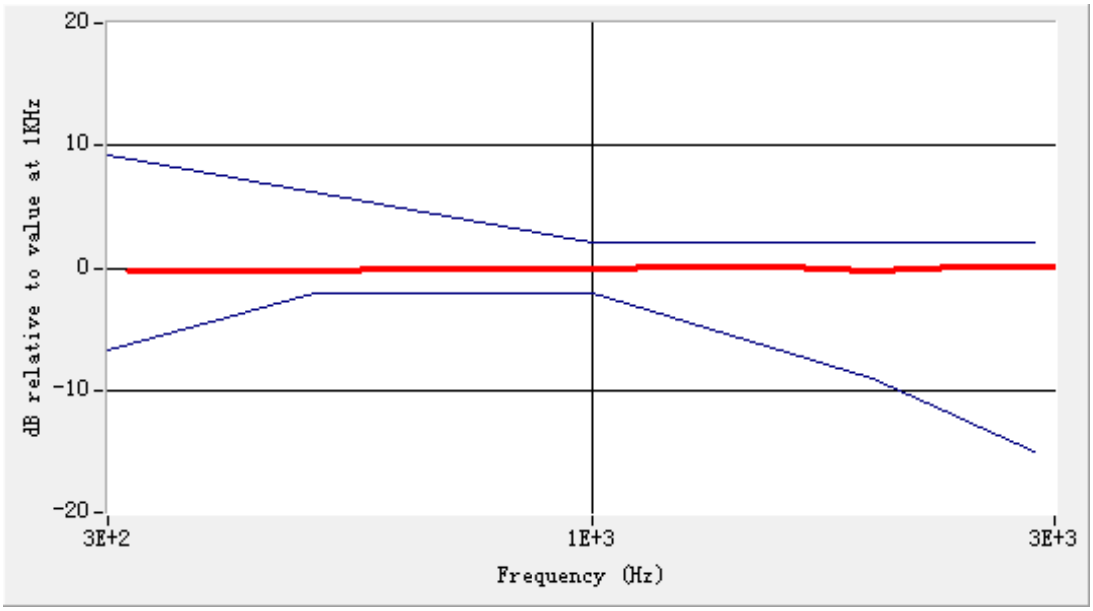
Measurement Results GSM850 Frequency (MHz): 836.400000

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	124	190	251	124		190		251		124		190		251	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	28.21	NULL	NULL	NULL	17.90	18.08	NULL	NULL	NULL	18.28	NULL	NULL	NULL	19.31
ABM2, dBA/m	NULL	-22.51	NULL	NULL	NULL	-20.89	-23.26	NULL	NULL	NULL	-22.51	NULL	NULL	NULL	-20.88
Ambient noise, dBA/m	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00
Freq Reponse Margin (dB)	-	1.75	-	-	-	-	-	-	-	-	1.75	-	-	-	-
S+N/N(dB)	NULL	51.01	NULL	NULL	NULL	39.08	41.68	NULL	NULL	NULL	51.01	NULL	NULL	NULL	39.08
S+N/N per orientation (dB)	51.00			39.08						26.73					

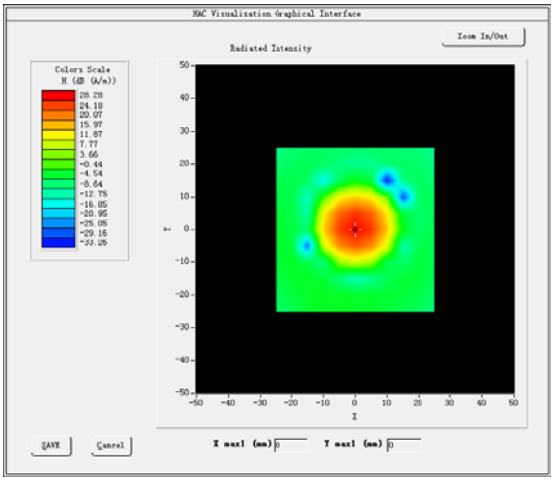
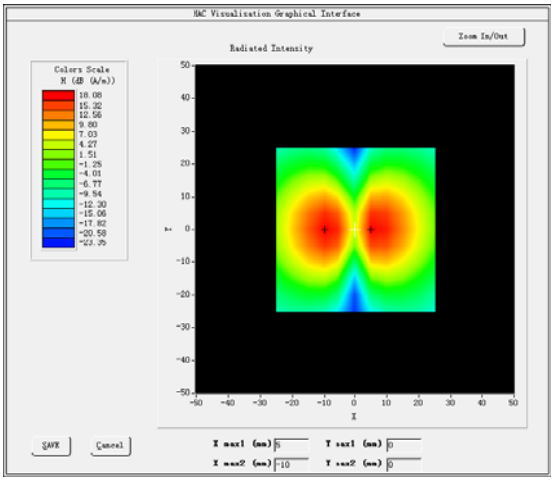
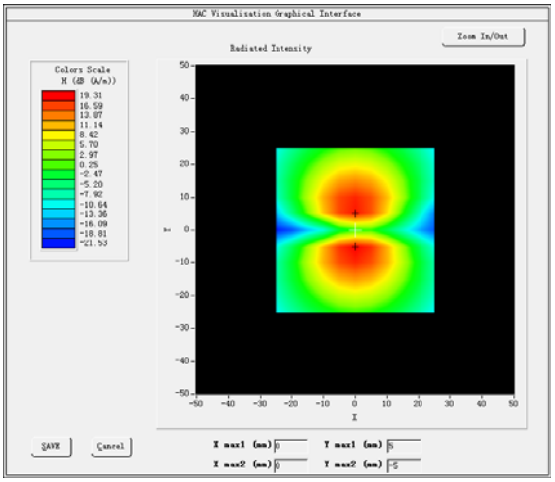
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	GSM	GSM850	Intensity, Axial	-18	Max	28.21	-	PASS
7.3.1.2			Intensity, RadialH	-18	Right side	17.90	-	PASS
				-18	Left side	18.08	-	PASS
7.3.1.2			Intensity, RadialV	-18	Upper side	18.28	-	PASS
				-18	Lower side	19.3	-	PASS
7.3.3			Signal to noise/noise, Axial	20	Max	51.00	T4	PASS
7.3.3			Signal to noise/noise, RadialH	20	Right side	39.01	T4	PASS
				20	Left side	41.40	T4	PASS
7.3.3			Signal to noise/noise, RadialV	20	Upper side	30.11	T4	PASS
				20	Lower side	26.66	T3	PASS
7.3.2			Frequency reponse, Axial	0	-	1.75	-	PASS

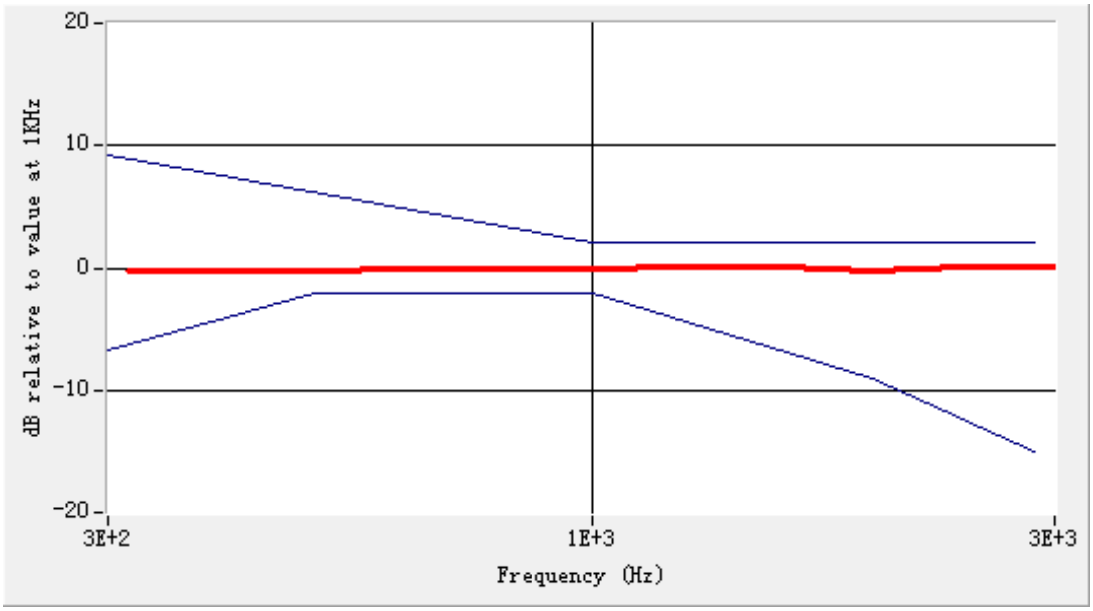
Measurement Results GSM1900 Frequency (MHz): 1880.00000

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	513	661	809	513		661		809		513		661		809	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	28.28	NULL	NULL	NULL	17.93	18.08	NULL	NULL	NULL	28.28	NULL	NULL	NULL	17.93
ABM2, dBA/m	NULL	-22.51	NULL	NULL	NULL	-20.88	-23.28	NULL	NULL	NULL	-22.51	NULL	NULL	NULL	-20.88
Ambient noise, dBA/m	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00
Freq Reponse Margin (dB)	-	1.75	-	-	-	-	-	-	-	-	1.75	-	-	-	-
S+N/N(dB)	NULL	51.01	NULL	NULL	NULL	39.08	41.68	NULL	NULL	NULL	51.01	NULL	NULL	NULL	39.08
S+N/N per orientation (dB)	51.01			39.08						26.73					

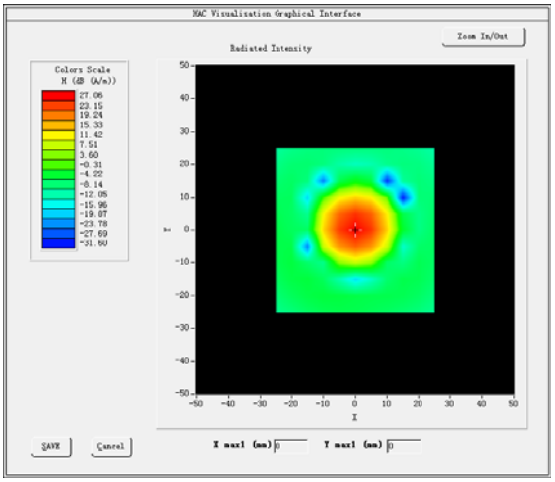
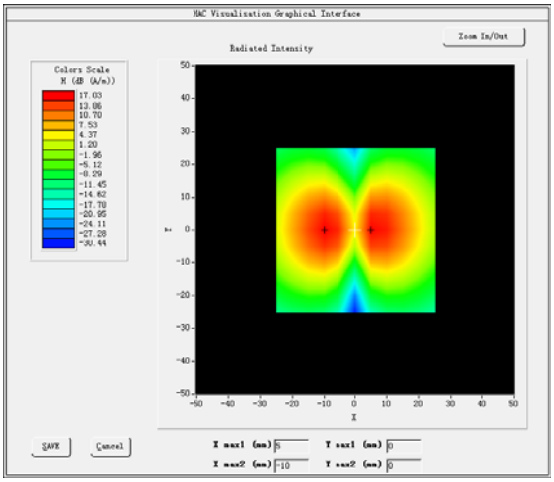
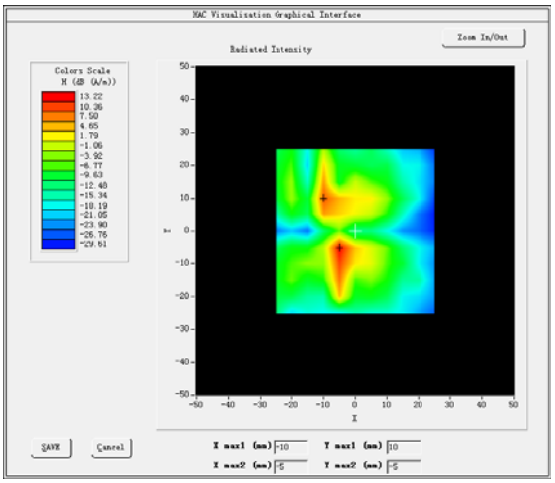
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	GSM	GSM1900	Intensity, Axial	-18	Max	28.28	-	PASS
7.3.1.2			Intensity, RadialH	-18	Right side	17.93	-	PASS
				-18	Left side	18.08	-	PASS
7.3.1.2			Intensity, RadialV	-18	Upper side	18.39	-	PASS
				-18	Lower side	19.31	-	PASS
7.3.3			Signal to noise/noise, Axial	20	Max	51.01	T4	PASS
7.3.3			Signal to noise/noise, RadialH	20	Right side	39.08	T4	PASS
				20	Left side	41.68	T4	PASS
7.3.3			Signal to noise/noise, RadialV	20	Upper side	30.15	T4	PASS
				20	Lower side	26.73	T3	PASS
7.3.2			Frequency reponse, Axial	0	-	1.75	-	PASS

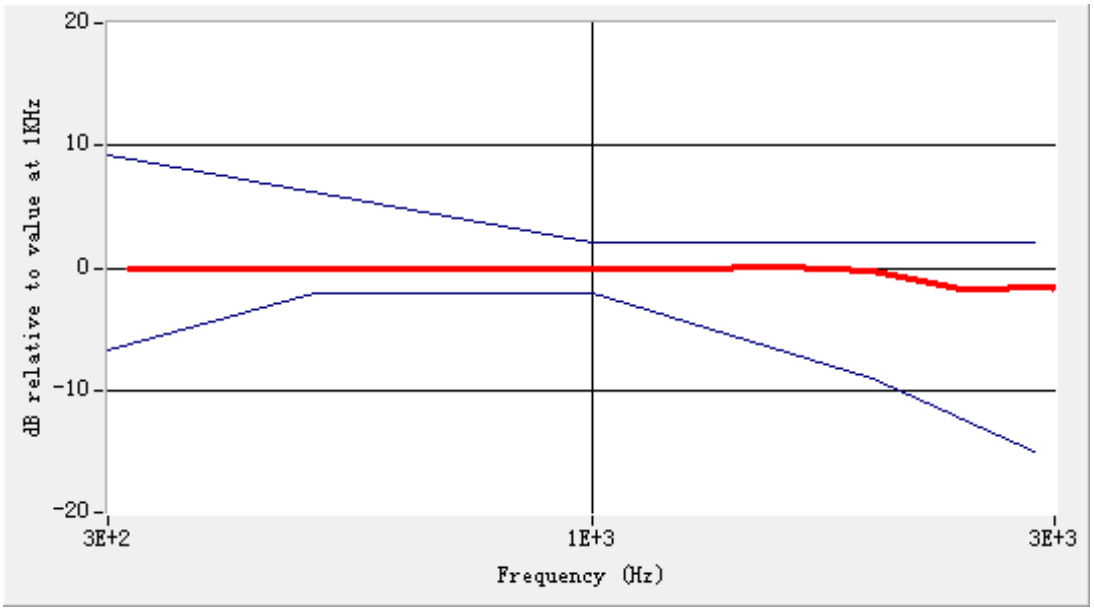
Measurement Results WCDMA 850 Frequency (MHz): 835.00000

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	4132	4182	4233	4132		4182		4233		4132		4182		4233	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	27.06	NULL	NULL	NULL	16.79	17.03	NULL	NULL	NULL	27.06	NULL	NULL	NULL	16.79
ABM2, dBA/m	NULL	-28.88	NULL	NULL	NULL	-25.59	-30.54	NULL	NULL	NULL	-28.88	NULL	NULL	NULL	-25.59
Ambient noise, dBA/m	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00
Freq Reponse Margin (dB)	-	1.85	-	-	-	-	-	-	-	-	1.85	-	-	-	-
S+N/N(dB)	NULL	56.16	NULL	NULL	NULL	42.66	47.81	NULL	NULL	NULL	56.16	NULL	NULL	NULL	42.66
S+N/N per orientation (dB)	56.16			42.66						45.31					

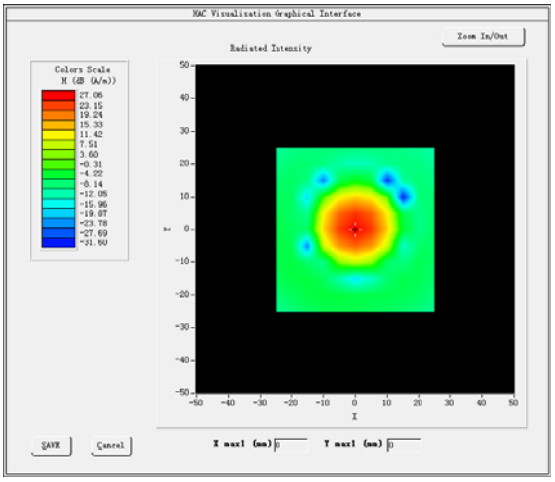
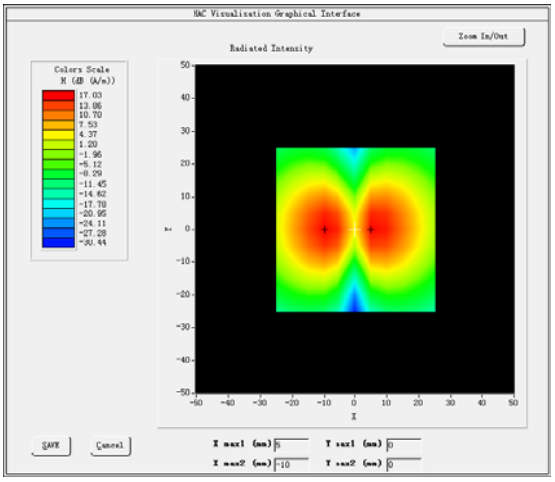
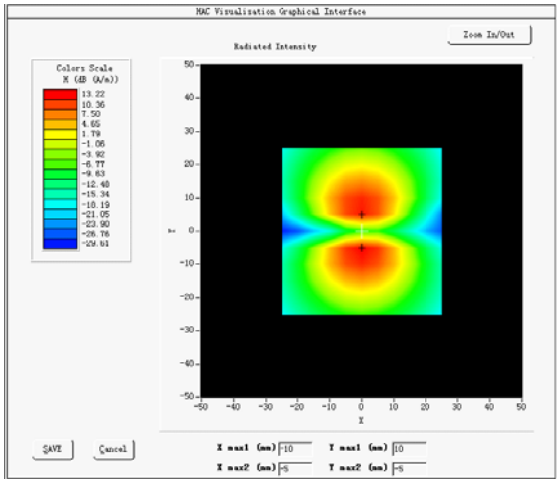
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	WCDMA	Band5_WCDMA850	Intensity, Axial	-18	Max	27.06	-	PASS
7.3.1.2			Intensity, RadialH	-18	Right side	16.79	-	PASS
				-18	Left side	17.03	-	PASS
7.3.1.2			Intensity, RadialV	-18	Upper side	9.31	-	PASS
				-18	Lower side	13.22	-	PASS
7.3.3			Signal to noise/noise, Axial	20	Max	56.16	T4	PASS
7.3.3			Signal to noise/noise, RadialH	20	Right side	42.66	T4	PASS
				20	Left side	47.81	T4	PASS
7.3.3			Signal to noise/noise, RadialV	20	Upper side	46.88	T4	PASS
				20	Lower side	45.31	T4	PASS
7.3.2			Frequency reponse, Axial	0	-	1.85	-	PASS

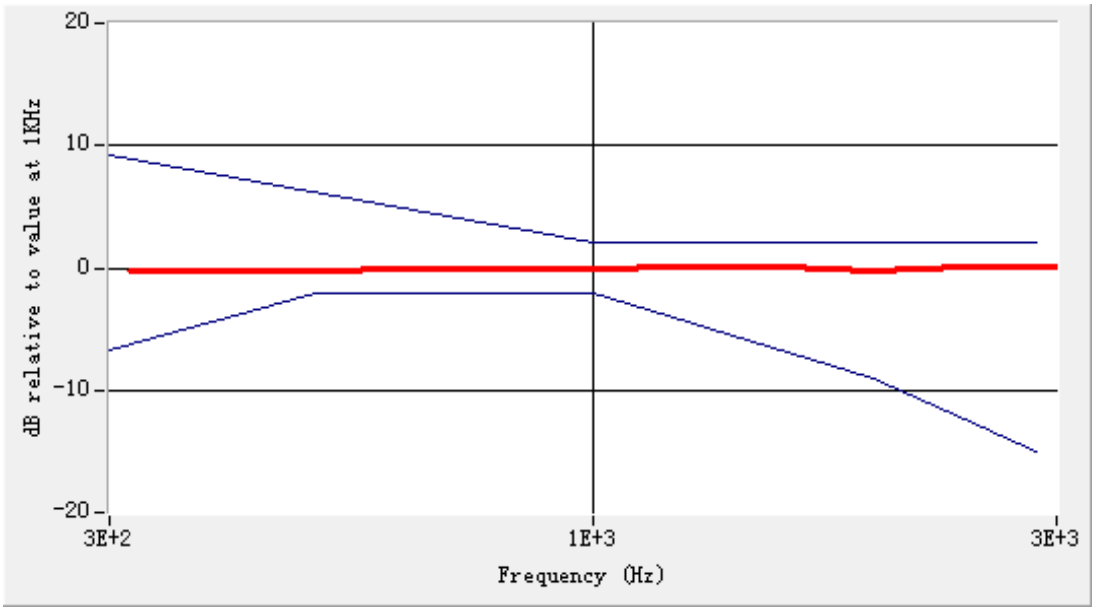
Measurement Results WCDMA1900 Frequency (MHz): 1880.00000

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	9262	9400	9538	9262		9400		9538		9262		9400		9538	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	27.06	NULL	NULL	NULL	16.79	17.03	NULL	NULL	NULL	27.06	NULL	NULL	NULL	16.79
ABM2, dBA/m	NULL	-28.88	NULL	NULL	NULL	-25.59	-30.54	NULL	NULL	NULL	-28.88	NULL	NULL	NULL	-25.59
Ambient noise, dBA/m	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00	-50.00
Freq Reponse Margin (dB)	-	1.85	-	-	-	-	-	-	-	-	1.85	-	-	-	-
S+N/N(dB)	NULL	56.16	NULL	NULL	NULL	42.66	47.81	NULL	NULL	NULL	56.16	NULL	NULL	NULL	42.66
S+N/N per orientation (dB)	56.15			42.64						45.30					

Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
7.3.1.1	WCDMA	Band2_WCDMA1900	Intensity, Axial	-18	Max	32.43	-	PASS
7.3.1.2			Intensity, RadialH	-18	Right side	29.20	-	PASS
				-18	Left side	19.72	-	PASS
7.3.1.2			Intensity, RadialV	-18	Upper side	20.29	-	PASS
				-18	Lower side	26.78	-	PASS
7.3.3			Signal to noise/noise, Axial	20	Max	57.35	T4	PASS
7.3.3			Signal to noise/noise, RadialH	20	Right side	59.35	T4	PASS
				20	Left side	53.96	T4	PASS
7.3.3			Signal to noise/noise, RadialV	20	Upper side	57.77	T4	PASS
				20	Lower side	56.46	T4	PASS
7.3.2			Frequency reponse, Axial	0	-	1.75	-	PASS

15. ANNEX E CALIBRATION REPORT

COMOHAC T-coil Probe Calibration Report

Ref : ACR.125.4.15.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN

SHENZHEN, P.R. CHINA (POST CODE:518055)

MVG COMOHAC T-COIL PROBE

SERIAL NO.: SN 24/11 TCP23

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

05/05/15

Summary:

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

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	5/5/2015	
Checked by :	Jérôme LUC	Product Manager	5/5/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	5/5/2015	

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	*Date*	*Modifications*
A	5/5/2015	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 24/11 TCP23
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).

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC T-COIL PROBE
Manufacturer	MVG
Model	STCOIL
Serial Number	SN 24/11 TCP23
Product Condition (new / used)	Used
Frequency Range of Probe	200-5000 Hz

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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

Figure 1 – *MVG 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

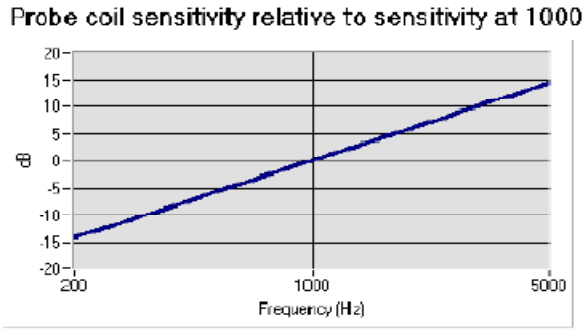
The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the 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	0.39 dB	+/- 0.5 dB

5.2 LINEARITY

	Measured	Required
Linearity Slope	0.35 dB	+/ 0.5 dB

5.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

	Measured	Required
Signal to Noise	-61.69 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	01/2014	01/2017
Reference Probe	MVG	TCP 18 SN 47/10	10/2014	10/2015
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Helmholtz Coil	MVG	HC07 SN47/10	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	8/2012	8/2015

COMOHAC TMFS Calibration Report

Ref : ACR.262.19.14.SATU.A

SHENZHEN STS TEST SERVICES CO., LTD.

1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING ROAD

FUYONG, BAO' AN DISTRICT, SHENZHEN,CHINA

SATIMO COMOHAC MAGNETIC FIELD SIMULATOR

SERIAL NO.: SN 07/14 TMFS24

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED

Calibration CERT #2246-02

09/01/2014

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	9/19/2014	
Checked by :	Jérôme LUC	Product Manager	9/19/2014	
Approved by :	Kim RUTKOWSKI	Quality Manager	9/19/2014	

	Customer Name
Distribution :	Shenzhen STS Test Services Co., Ltd.

Issue	*Date*	*Modifications*
A	9/19/2014	Initial release

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5.1 Maximum Axial and Radial Magnetic Field Values 5

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	STMFS
Serial Number	SN 07/14 TMFS24
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.

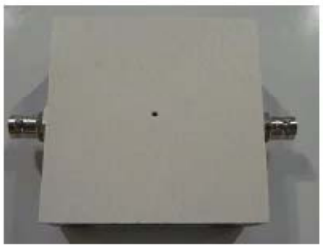


Figure 1 – *Satimo COMOHAC Magnetic Field Simulator*

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%

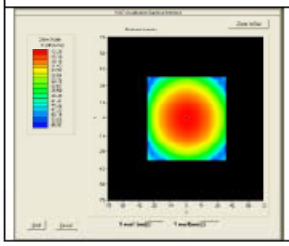
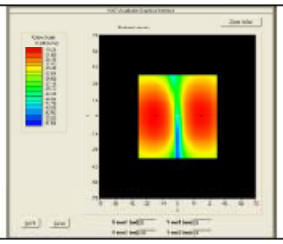
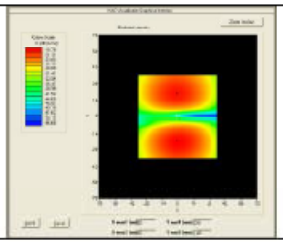
5 CALIBRATION MEASUREMENT RESULTS

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 IIz
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	-12.06
Radial H	Right side	-19.27
	Left side	-19.03

Radial V	Upper side	-19.12
	Lower side	-18.56

AXIAL ABM1	RADIAL H ABM1	RADIAL V ABM1
		

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
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HAC positioning ruler	Satimo	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
Audio Generator	National Instruments	15222AE	01/2014	01/2017
Reference Probe	Satimo	TCP 18 SN 47/10	10/2013	10/2014
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Temperature / Humidity Sensor	Control Company	11-661-9	8/2012	8/2015

End of the Report