HAC T-Coil Test Report

Report No.: 15070897-HAC-T-Coil

Supersede Report No.: NONE

Applicant	Verykool USA Inc
Product Name	Mobile Phone
Model No.	SL5550
Standards	FCC 47 CFR 20.19, ANSI C63.19:2011
Test Date	October 23, 2015
Issue Date	October 26, 2015
HAC T-Coil Test Result	T Rating
	T4
Test Result	PASS
Equipment complied with the specification	☑
Equipment did not comply with the specification	☐

Wiky Jam	David Huang	
Wiky Jam Test Engineer	David Huang Checked By	

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Test result presented in this test report is applicable to the tested sample only

Issued by:

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Laboratory Introduction

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In addition to testing and certification, SIEMIC provides initial design reviews and compliance management through out a project. Our extensive experience with China, Asia Pacific, North America, European, and international compliance requirements, assures the fastest, most cost effective way to attain regulatory compliance for the global markets.

Accreditations for Conformity Assessment

Country/Region	Scope
USA	EMC, RF/Wireless, SAR, Telecom
Canada	EMC, RF/Wireless, SAR, Telecom
Taiwan	EMC, RF, Telecom, SAR, Safety
Hong Kong	RF/Wireless, SAR, Telecom
Australia	EMC, RF, Telecom, SAR, Safety
Korea	EMI, EMS, RF, SAR, Telecom, Safety
Japan	EMI, RF/Wireless, SAR, Telecom
Singapore	EMC, RF, SAR, Telecom
Europe	EMC, RF, SAR, Telecom, Safety

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CONTENTS

1 TECHNICAL DETAILS 5

2 TEST CONDITION 7

3 HAC T-COIL TEST SYSTEM 8

4 HAC TEST PROCEDURE 10

5 SIGNAL VERIFICATION 12

6 PERFORMANCE CATEGORIES 13

7 LIST OF EQUIPMENTS 15

8 HAC MEASUREMENT UNCERTAINTY 16

9 SYSTEM CHECK 17

10 T-COIL TEST RESULTS 18

ANNEX A TEST SETUP PHOTO 29

ANNEX B CALIBRATION REPORT 30

1 TECHNICAL DETAILS

Purpose	Compliance testing of SL5550 with HAC RF Emission.
Applicant / Client	Verykool USA Inc 3636 Nobel Drive, Suite 325, San Diego, CA 92122 USA
Manufacturer	Zechin Communications Co.,Ltd. Unit804,8th Floor Desay Tech Building Gaoxin, Road South, Nanshan District Shenzhen,China
Laboratory performing the tests	SIEMIC(Shenzhen-China) Laboratories Zone A, Floor 1, Building 2, Wan Ye Long Technology Park, South Side of Zhoushi Road, Bao'an District, Shenzhen 518108, Guangdong, P.R.C. Tel: +(86) 0755-26014629 VIP Line: 950-4038-0435
Test report reference number	15070897-HAC- T-Coil
Date EUT received	September-28-2015
Standard applied	CFR 20.19 , ANSI C63.19:2011
Dates of test (from – to)	October 23th, 2015
No of Units:	1
Equipment Category:	PCE
Trade Name:	verykool
Model Name:	SL5550
RF Operating Frequency (ies)	GSM850 TX : 824.2 ~ 848.8 MHz; RX : 869.2 ~ 893.8 MHz PCS1900 TX : 1850.2 ~ 1909.8 MHz; RX : 1930.2 ~ 1989.8 MHz UMTS-FDD Band 5 TX : 826.4 ~ 846.6 MHz; RX : 871.4 ~ 891.6 MHz UMTS-FDD Band 2 TX :1852.4 ~ 1907.6 MHz; RX : 1932.4 ~ 1987.6 MHz UMTS-FDD Band 4 TX :1712.4 ~ 1752.6 MHz; RX : 2112.4 ~ 2152.6 MHz LTE Band 2 TX: 1852.5 ~ 1907.5 MHz; RX : 1932.5 ~ 1987.5 MHz LTE Band 4 TX: 1712.5 ~ 1752.5 MHz; RX : 2112.5 ~ 2152.5 MHz LTE Band 5 TX: 826.5 ~ 846.5 MHz; RX : 871.5 ~ 891.5 MHz LTE Band 7 TX: 2500~2570MHz; RX : 2620~2690 MHz LTE Band 12 TX:699 ~716 MHz; RX :729 ~ 746 MHz LTE Band 17 TX: 706.5 ~ 713.5 MHz; RX : 736.5 ~ 743.5 MHz BT& BLE:2402~ 2480MHz(TX/RX) WIFI:802.11b/g/n(20M): 2412-2462 MHz(TX/RX) WIFI: 802.11n(40M): 2422-2452 MHz(TX/RX)
Antenna Type:	PIFA Antenna
Modulation:	GSM / GPRS : GMSK EGPRS: GMSK WCDMA:QPSK LTE: QPSK, 16QAM Wifi: CCK, OFDM Bluetooth: GFSK, π /4-DQPSK, 8DPSK BLE:GFSK

2 Test Condition

Ambient Condition

Temperature: 20 ~ 24 C

Humidity : < 60 %

Testing Configuration

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by air link. The power control bits was set to "Always Up" from the emulator to radiate maximum output power during all testing

Measurements were performed on the low, middle and high channels of all bands

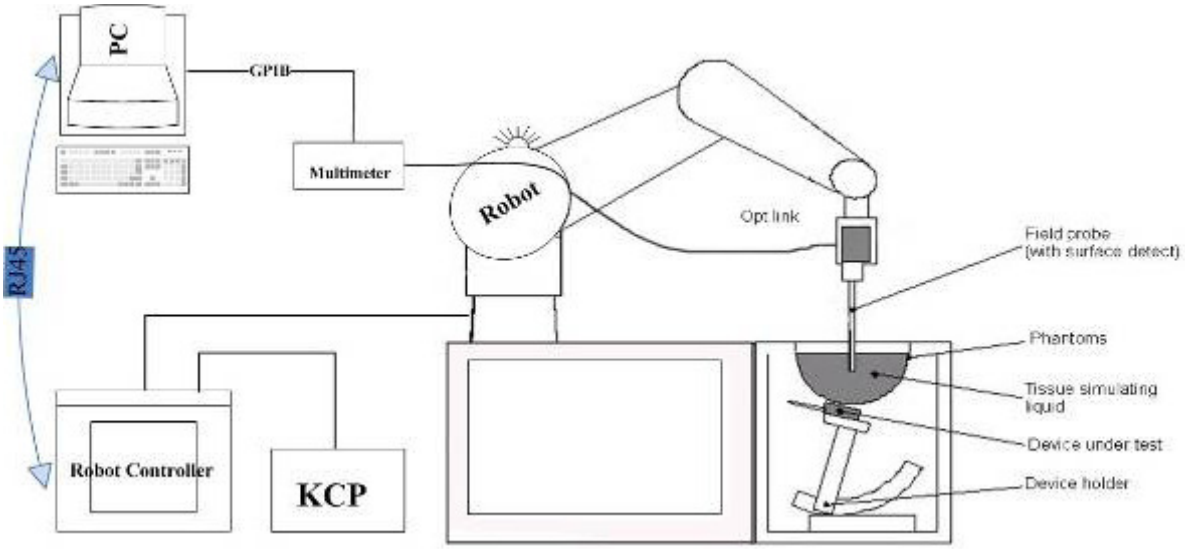
List of Air Interfaces/Bands & Operating Modes

Air-Interface	Band (MHz)	Type	C63.19/ Tested	Simultaneous Transmissions Note: Not to be test	Concurred single transmission	Reduced power 20.19(c)(1)	Voice Over Digital Transport (Data)
GSM	850	VO	YES	Yes, with Bluetooth/wifi	NA	NA	NA
	1900					NA	NA
	GPRS/EDGE	DT	No	NA	NA	NA	NA
WCDAMA	Band Ⅱ,BandⅣ, Band Ⅴ R99	VO	Yes	Yes, with Bluetooth/wifi	NA	NA	NA
	HSDPA	DT	NO	NA	NA	NA	NA
WIFI	2.4G	DT	NO	Yes, with WWAN	NA	NA	Yes
BT	2.4G	DT	NO	Yes, with WWAN	NA	NA	NA

VO Voice CMRS/PTSN Service Only
V/D Voice CMRS/PSTN and Data Service
DT Digital Transport

Note: * HAC Rating was not base on concurrent voice and data modes, Noncurrent mode was found to represent worst Case rating.

3 HAC Test System



These measurements were performed with the automated near-field scanning system OPENHAC from SATIMO. The system is based on a high precision robot (working range: 850 mm), which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit.

The OPENSAR system for performing compliance tests consist of the following items:

1. A standard high precision 6-axis robot (KUKA) with controller and software.
2. KUKA Control Panel (KCP).
3. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
4. The functions of the PC plug-in card are to perform the time critical task such as signal filtering, surveillance of the robot operation fast movement interrupts.
5. A computer operating Windows XP.
6. OPENSAR software.
7. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.
8. The SAM phantom enabling testing left-hand right-hand and body usage.
9. The Position device for handheld EUT.
10. System validation dipoles to validate the proper functioning of the system.

COMOHAC T-Coil Probe

This probe is designed to fulfill ANSI recommendations for the measurement of audio frequency magnetic fields radiated by mobile phones.

Frequency range	0.1-20 Hz
Length	350 mm
Coil dimension	6.55 mm x 2.29 mm
Maximum external diameter	10 mm
Distance between the center of the coil and the probe tip	4 mm
Sensitivity	-60.5 dB (V/A/m) ± 0.5 dB on the whole band
Measurements	Both axial and radial
Connectors	6 male wires (Hirose SR30) and BNC

This probe is designed to fulfill ANSI recommendations for the measurement of audio frequency magnetic fields radiated by mobile phones. The T-Coil probe has two connectors:

- the 6 male wires connector enables to fix the probe on the robot
- the BNC connector enables to link the probe to the audio DAQ

This probe was designed for a 6-axis robot. The coil is oriented with a 45 degree angle so that used with a 6-axis robot, both radial and axial measurements can be performed with one probe.

The following points are important for a long probe life:

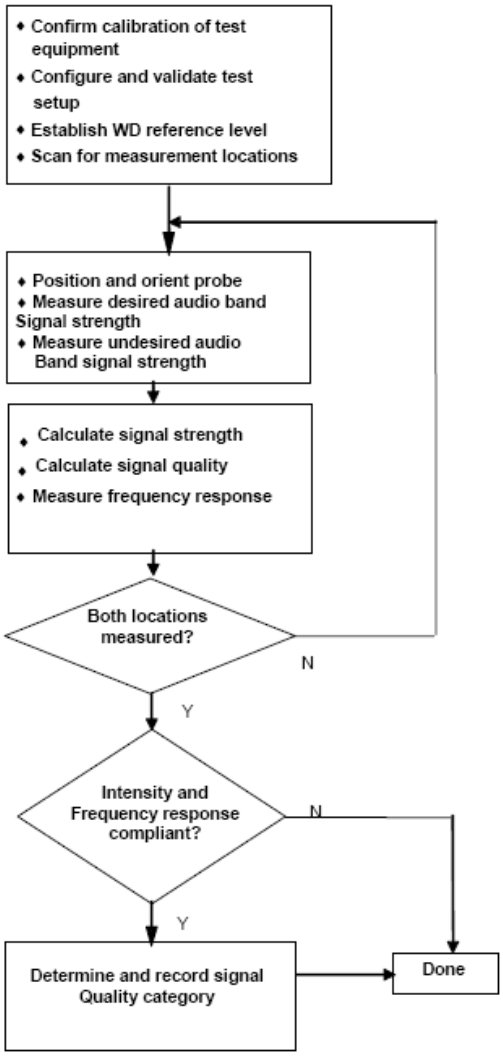
- Handle the probes carefully. Store them in their box, when they are not in use.
- Use the dummy probe for training purposes and for experimenting with new setups.
- Never try to open the probes. The calibration (of the probe) would be damaged.
- Always use the positioning system specially designed for the probe, never try to use another system without the agreement of SATIMO.

4 HAC Test Procedure

The following are step-by-step test procedures.

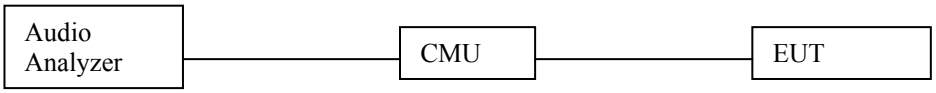
a) Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.
b) Position the WD in its intended test position.
c) Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
d) The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 1. If the field alignment method is used, align the probe for maximum field reception.
e) Record the reading at the output of the measurement system
f) Scan the entire 50 mm by 50 mm region in equally spaced increments and record the reading at each measurement point. The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.
h) Identify the maximum reading within the non-excluded sub-grids identified in step g).
i) Convert the highest field reading within identified in step h) to RF audio interference level, in V/m, by taking the square root of the reading and then dividing it by the measurement system transfer function, established in 5.5.1.1 Convert this result to dB(V/m) by taking the base-10 logarithm and multiplying by 20. Indirect measurement method Replacing step i), the RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB(V/m), from step h). Use this result to determine the category rating
j) Compare this RF audio interference level with the categories in Clause 8 (ANSI C63.19-2011) and record the resulting WD category rating
k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating. Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.

Test flowchart Per ANSI-PC63.19 2011



5 Signal Verification

Generating Audio Signal



Establish call with CMU.

1. Set voice coder to “Decode Cal”.
2. Use CMU’s internal audio analyzer to measure RMS value. This value represents 3.14 dBm0.
3. Calculate RMS value for -18 dBm0.
4. Change voice coder to “Encoder Cal”.
5. Generate P.50 artificial voice signal on audio analyzer.
6. Adjust voltage on Audio Analyzer until you reach desired RMS value on CMU’s internal audio analyzer.
7. Change voice coder to 8k (EVRC) Low.

C63.19 Table 7-1 states audio reference input levels for various technologies:

Standard	Technology	Input Level (dBm0)
TIA/EIA/IS-2000	CDMA	-18
J-STD-007	GSM (217)	-16
T1/T1P1/3GPP	UMTS (WCDMA)	-16
iDEN™	TDMA (22 and 11 Hz)	-18

The CMU200 audio levels were determined using base station simulator manufacturer calibration procedures resulting in the below corresponding voltages relative to handset test point level (in dBm0):

dBm0 Ref.	Input Voltage	Notes
3.14 dBm0	1052.0 mV	NA
-16 dBm0	115 mV	NA

6 Performance Categories

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.

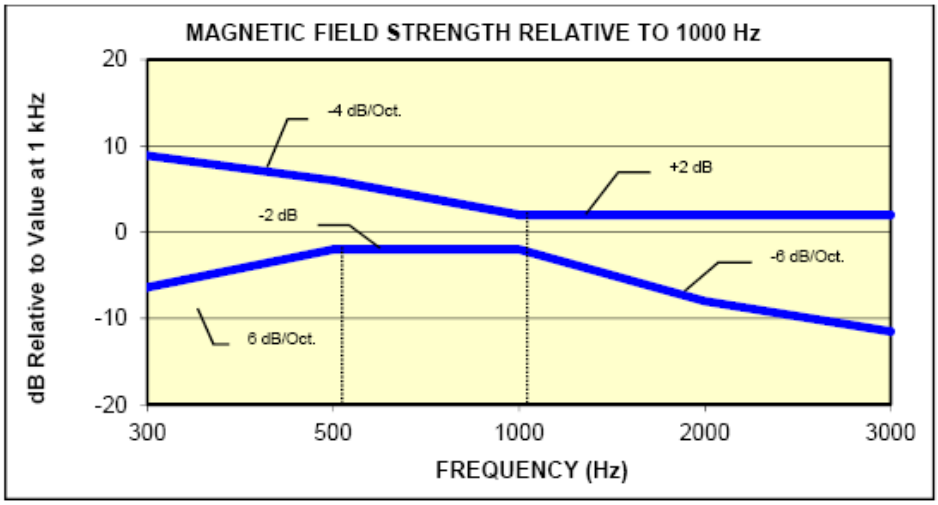


Figure 4-1
Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB (A/m) at 1 kHz

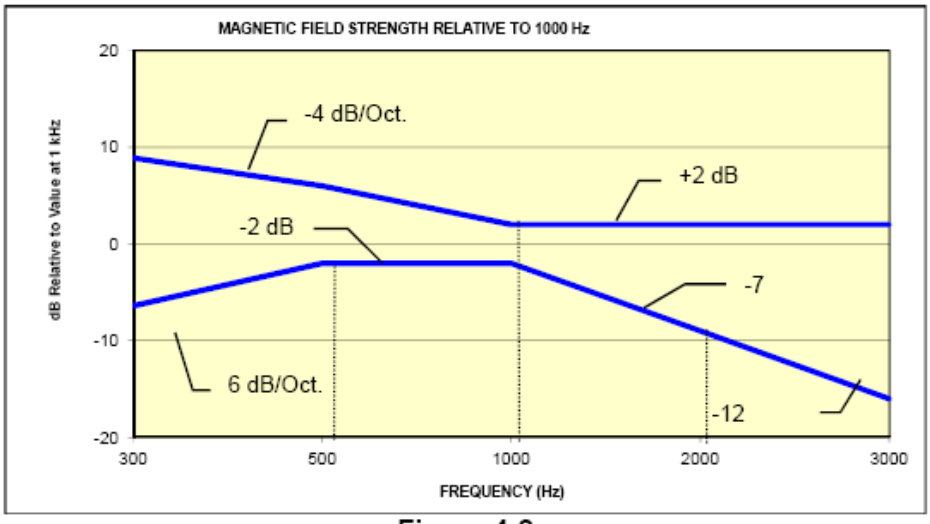


Figure 4-2
Magnetic Field frequency response for wireless devices with an axial field that exce -15 dB(A/m) at 1 kHz

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.

Category	Telephone parameters WD signal quality ((signal + noise) to noise ratio in dB)
Category T1	0 to 10 dB
Category T2	10 to 20 dB
Category T3	20 to 30 dB
Category T4	> 30 dB

7 List of Equipments

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Due
P C	Compaq	PV 3.06GHz	375052-AA1	N/A
Signal Generator	Agilent	8665B-008	3744A10293	05/15/2015
MultiMeter	Keithley	MiltiMeter 2000	1259033	06/21/2015
S-Parameter Network Analyzer	Agilent	8753ES	US39173518	08/04/2015
Wideband Radio Communication Tester	R & S	CMW500	120906	03/29/2015
Power Meter	HP	437B	3038A03648	05/17/2015
COMOHAC T-COIL PROBE	SATIMO	STCOIL	SN24/11 TCP21	10/28/2014
Mobile Phone POSITIONING DEVICE	SATIMO	MSH63	SN 31/10 MSH63	N/A
TMFS	SATIMO	STMFS	SN24/11 TMFS12	10/28/2014
PHANTOM TABLE	SATIMO	N/A	N/A	N/A
6 AXIS ROBOT	KUKA	KR5	949319	N/A
High Power Solid State Amplifier (80MHz~1000MHz)	Instruments for Industry	CMC150	M631-0408	N/A
Medium Power Solid State Amplifier (0.8~4.2GHz)	Instruments for Industry	S41-25	M629-0408	N/A
Wave Tube Amplifier 4-8 GHz at 20Watt	Hughes Aircraft Company	1277H02F000	81	N/A

8 HAC Measurement Uncertainty

Uncertainty Component	Tolerances (dB) / %	Probability Distribution	Divisor	Ci	Uncertainty (dB)	Uncertainty (%)
Measurement System Related						
RF Reflections	0.1 dB	R	√3	1	0.06	N/A
Field Probe Conv. Factor	0.2 dB	R	√3	1	0.12	N/A
Field Probe Anisotropy	0.25 dB	R	√3	1	0.14	N/A
Positioning Accuracy	0.1 dB	R	√3	1	0.06	N/A
Probe Cable Placement	0.1 dB	R	√3	1	0.06	N/A
System Repeatability	0.2 dB	R	√3	1	0.12	N/A
EUT Repeatability	0.1 dB	N	1	1	0.10	N/A
Combined Standard Uncertainty :					0.26	6.36 %
Test Sample Related						
Device Positioning Vertical	4.7 %	R	√3	0.67	N/A	1.8 %
Device Positioning Lateral	1.0 %	R	√3	1	N/A	0.6 %
Device Holder	2.4 %	R	√3	1	N/A	1.4 %
Test Sample	0.3 %	N	1	1	N/A	0.3 %
Power drift	5 %	R	√3	1	N/A	1.7 %
PMF Calculation						
Power Sensor	1.0 %	R	√3	1	N/A	0.6 %
Dual Directional Coupler	1.0 %	R	√3	1	N/A	0.6 %
Phantom and setup Related						
Phantom Thickness	2.4 %	R	√3	0.67	N/A	0.9 %
Combined Standard Uncertainty						7.1 %
Expanded Standard Uncertainty (K=2, confidence 95%)						14.2 %

9 System Check

TMFS Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1.1	Validation	-	Intensity, Axial	-	Max	-14.5	-	Pass
8.3.1.2			Intensity, RadialH	-	Right side	-21.04	-	Pass
				-	Left side	-20.55	-	Pass
8.3.1.2			Intensity, RadialV	-	Upper side	-20.77	-	Pass
				-	Lower side	-20.88	-	Pass

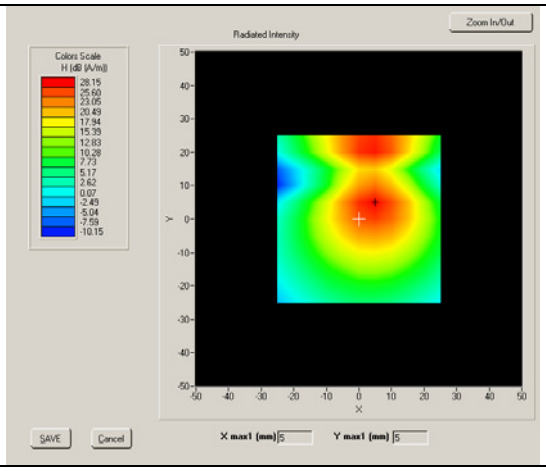
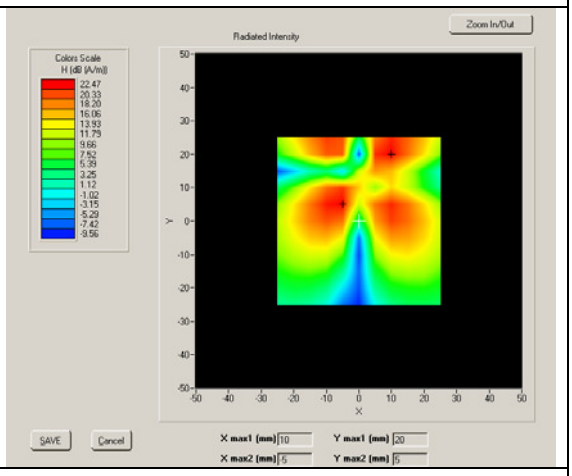
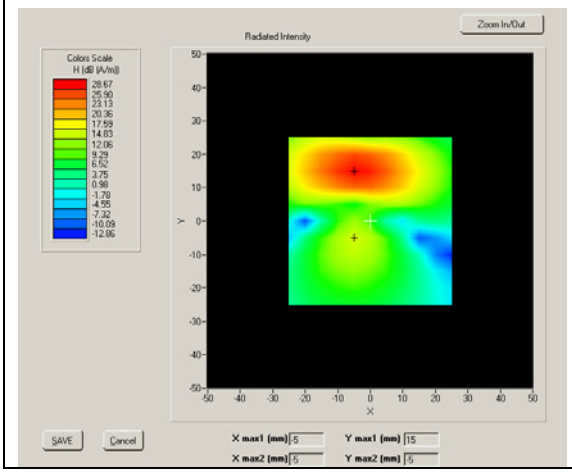
10 T-Coil Test Results

Test Summary

Band	Category
GSM850	T4
PCS1900	T4
WCDMA Band Ⅴ	T4
WCDMA Band Ⅳ	T4
WCDMA Band Ⅱ	T4

Test Results:

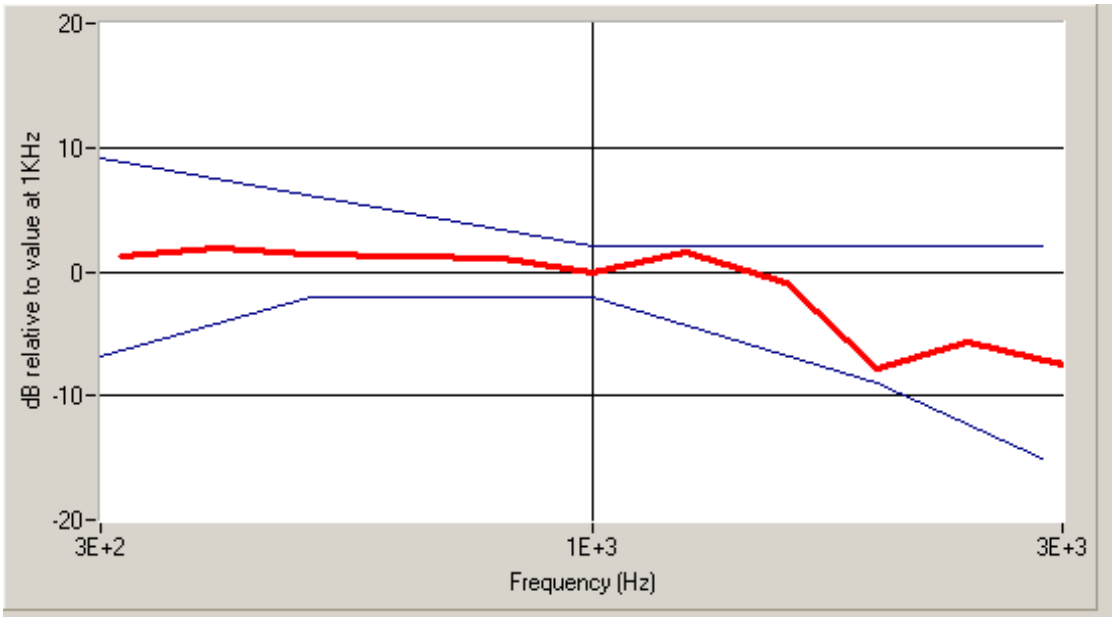
Frequency (MHz): GSM 850

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	128	189	250	128		189		250		128		189		250	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	28.15	NULL	NULL	NULL	22.47	22.45	NULL	NULL	NULL	NULL	28.67	15.29	NULL	NULL
ABM2, dBA/m	NULL	-11.33	NULL	NULL	NULL	-9.99	-7.64	NULL	NULL	NULL	NULL	-9.65	-24.99	NULL	NULL
Ambient noise, dBA/m	-44.62	-44.62	-44.62	-39.38	-39.38	-39.38	-39.38	-39.38	-39.38	-41.24	-41.24	-41.24	-41.24	-41.24	-41.24
Freq Reponse Margin (dB)	-	0.46	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	39.82	NULL	NULL	NULL	32.62	30.61	NULL	NULL	NULL	NULL	38.31	39.88	NULL	NULL
S+N/N per orientation (dB)	39.82			30.61						38.31					

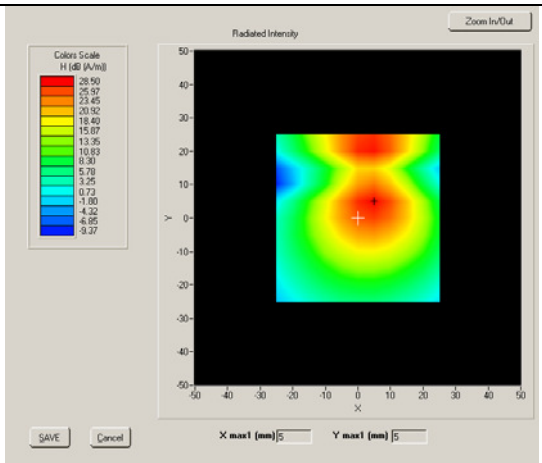
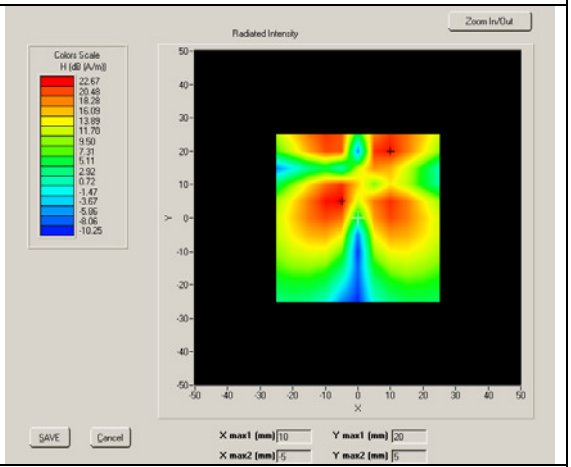
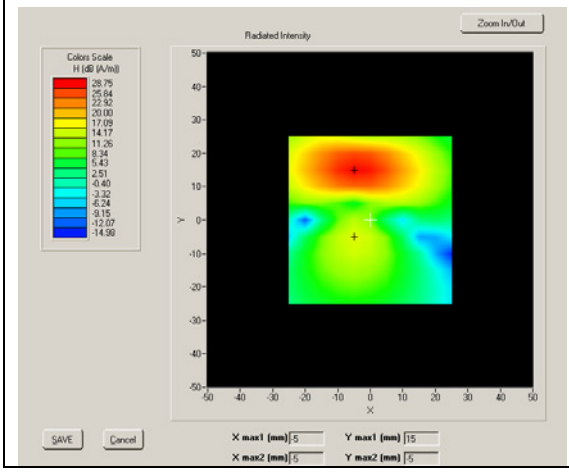
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1	GSM	GSM850	Intensity, Axial	-18	Max	28.15	-	PASS
8.3.1			Intensity, RadialH	-18	Right side	22.47	-	PASS
				-18	Left side	22.45	-	PASS
8.3.1			Intensity, RadialV	-18	Upper side	28.67	-	PASS
				-18	Lower side	15.29	-	PASS
8.3.4			Signal to noise/noise, Axial	20	Max	39.82	T4	PASS
8.3.4			Signal to noise/noise, RadialH	20	Right side	32.62	T4	PASS
				20	Left side	30.61	T4	PASS
8.3.4			Signal to noise/noise, RadialV	20	Upper side	38.31	T4	PASS
				20	Lower side	39.88	T4	PASS
8.3.2			Frequency reponse, Axial	0	-	0.46	-	PASS

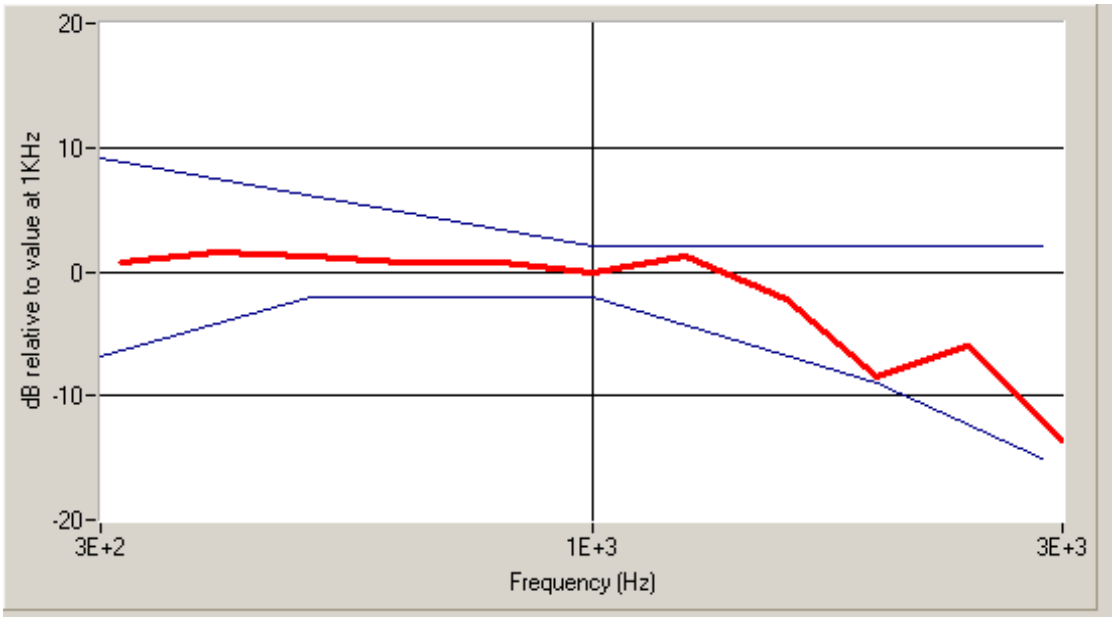
Frequency (MHz): PCS1900

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	28.50	NULL	NULL	NULL	22.26	22.67	NULL	NULL	NULL	NULL	28.75	15.43	NULL	NULL
ABM2, dBA/m	NULL	-11.46	NULL	NULL	NULL	-14.05	-11.91	NULL	NULL	NULL	NULL	-5.02	-21.35	NULL	NULL
Ambient noise, dBA/m	-44.62	-44.62	-44.62	-39.38	-39.38	-39.38	-39.38	-39.38	-39.38	-41.24	-41.24	-41.24	-41.24	-41.24	-41.24
Freq Reponse Margin (dB)	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	40.21	NULL	NULL	NULL	36.63	34.88	NULL	NULL	NULL	NULL	34.14	36.40	NULL	NULL
S+N/N per orientation (dB)	40.21			34.88						34.14					

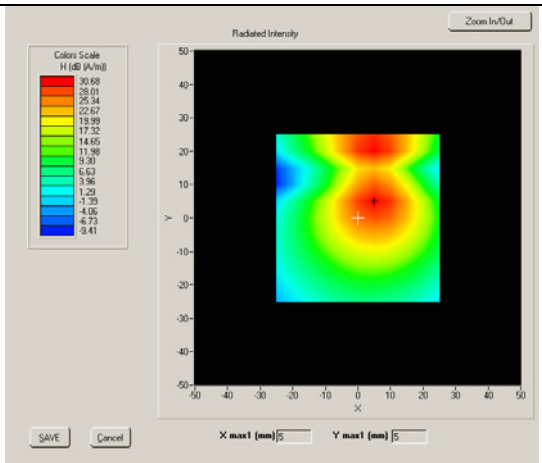
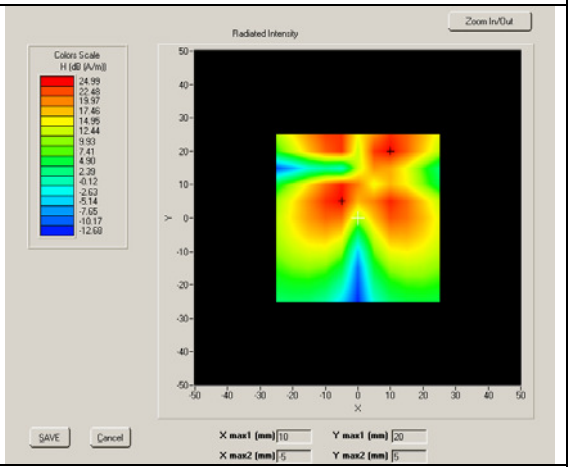
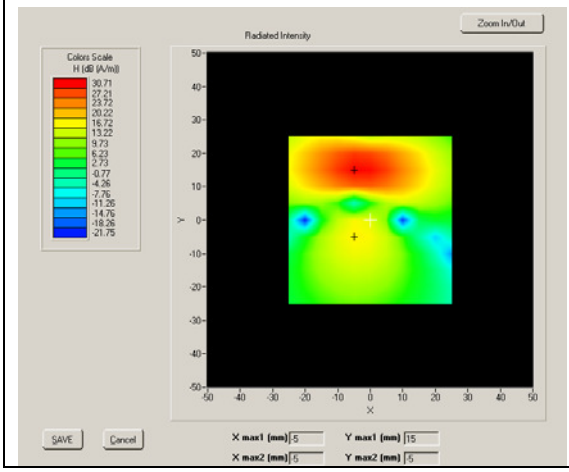
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1	GSM	GSM1900	Intensity, Axial	-18	Max	28.50	-	PASS
8.3.1			Intensity, RadialH	-18	Right side	22.26	-	PASS
				-18	Left side	22.67	-	PASS
8.3.1			Intensity, RadialV	-18	Upper side	28.75	-	PASS
				-18	Lower side	15.43	-	PASS
8.3.4			Signal to noise/noise, Axial	20	Max	40.21	T4	PASS
8.3.4			Signal to noise/noise, RadialH	20	Right side	36.63	T4	PASS
				20	Left side	34.88	T4	PASS
8.3.4			Signal to noise/noise, RadialV	20	Upper side	34.14	T4	PASS
				20	Lower side	36.40	T4	PASS
8.3.2			Frequency reponse, Axial	0	-	0.40	-	PASS

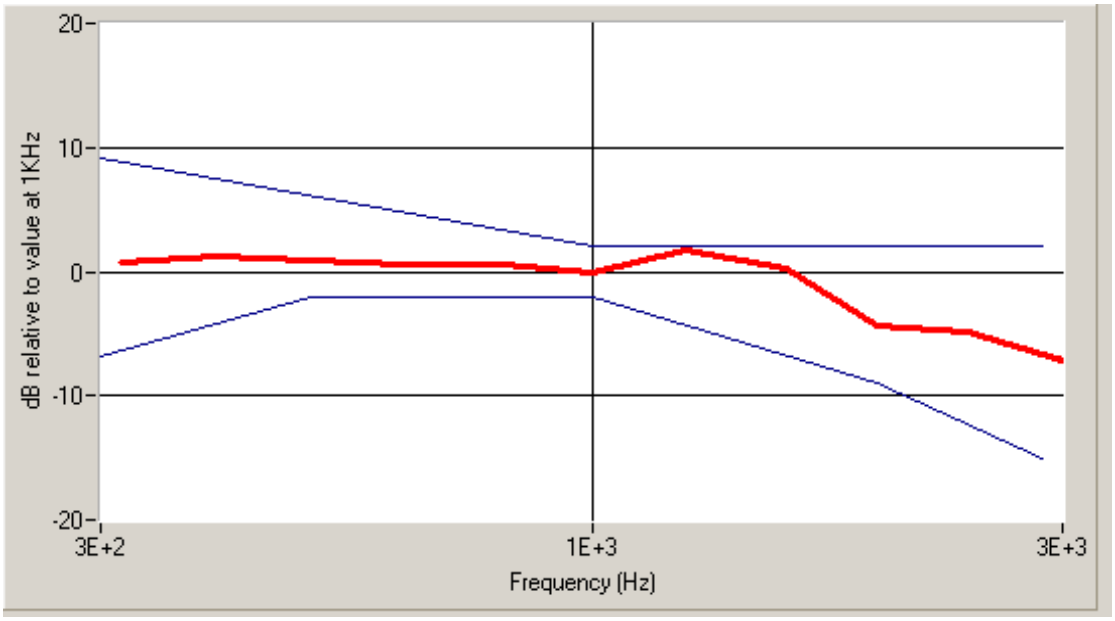
Frequency (MHz): WCDMA 850

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	RADIAL V ABM2
	NOT AVAILABLE

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	30.68	NULL	NULL	NULL	24.99	24.89	NULL	NULL	NULL	NULL	30.71	17.18	NULL	NULL
ABM2, dBA/m	NULL	-7.43	NULL	NULL	NULL	-13.85	-13.51	NULL	NULL	NULL	NULL	-7.67	-21.42	NULL	NULL
Ambient noise, dBA/m	-44.62	-44.62	-44.62	-39.38	-39.38	-39.38	-39.38	-39.38	-39.38	-41.24	-41.24	-41.24	-41.24	-41.24	-41.24
Freq Reponse Margin (dB)	-	0.27	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	38.57	NULL	NULL	NULL	39.12	38.87	NULL	NULL	NULL	NULL	38.62	38.80	NULL	NULL
S+N/N per orientation (dB)	38.57			38.87						38.62					

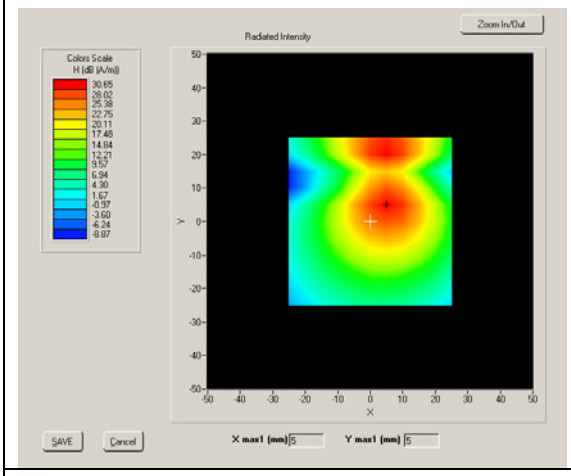
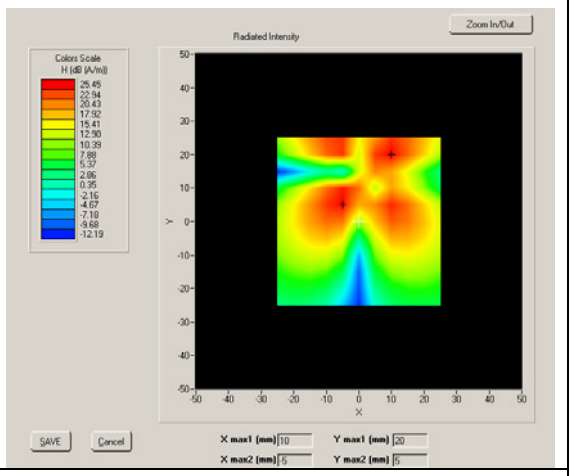
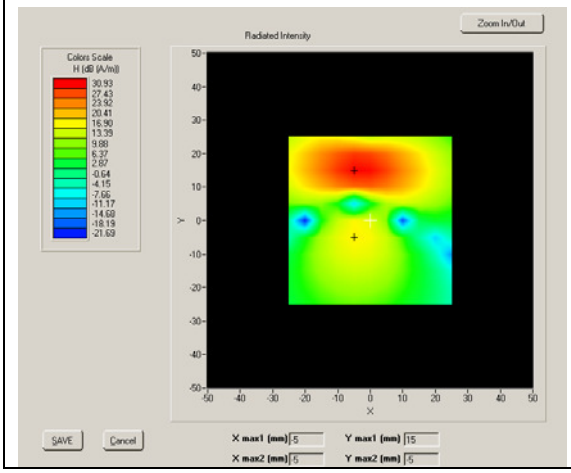
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1	WCDMA	Band5_WCDMA850	Intensity, Axial	-18	Max	30.68	-	PASS
8.3.1			Intensity, RadialH	-18	Right side	24.99	-	PASS
				-18	Left side	24.89	-	PASS
8.3.1			Intensity, RadialV	-18	Upper side	30.71	-	PASS
				-18	Lower side	17.18	-	PASS
8.3.4			Signal to noise/noise, Axial	20	Max	38.57	T4	PASS
8.3.4			Signal to noise/noise, RadialH	20	Right side	39.12	T4	PASS
				20	Left side	38.87	T4	PASS
8.3.4			Signal to noise/noise, RadialV	20	Upper side	38.62	T4	PASS
				20	Lower side	38.80	T4	PASS
8.3.2			Frequency reponse, Axial	0	-	0.27	-	PASS

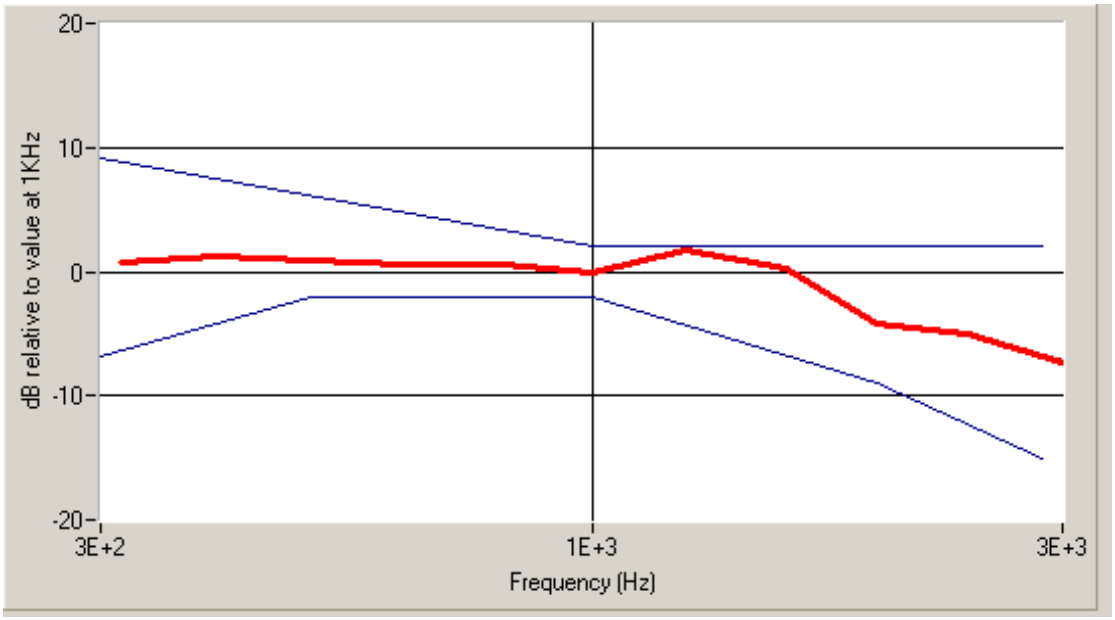
Frequency (MHz):WCDM Band Ⅳ

AXIAL ABM1	RADIAL H ABM1
	
RADIAL V ABM1	
	

Raw Data Results

	Axial			Radial H						Radial V					
	1312	1412	1513	1312		1412		1513		1312		1412		1513	
	Max	Max	Max	Left	Right	Left	Right	Left	Right	Max	Max	Max	Left	Right	Left
ABM1, dBA/m	NULL	30.65	NULL	NULL	NULL	25.45	25.33	NULL	NULL	NULL	NULL	30.93	17.37	NULL	NULL
ABM2, dBA/m	NULL	-7.98	NULL	NULL	NULL	-13.41	-13.28	NULL	NULL	NULL	NULL	-7.90	-22.26	NULL	NULL
Ambient noise, dBA/m	-44.62	-44.62	-44.62	-39.38	-39.38	-39.38	-39.38	-39.38	-39.38	-41.24	-41.24	-41.24	-41.24	-41.24	-41.24
Freq Reponse Margin (dB)	-	0.29	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	39.06	NULL	NULL	NULL	39.02	38.89	NULL	NULL	NULL	NULL	39.02	39.78	NULL	NULL
S+N/N per orientation (dB)	39.06			38.89						39.02					

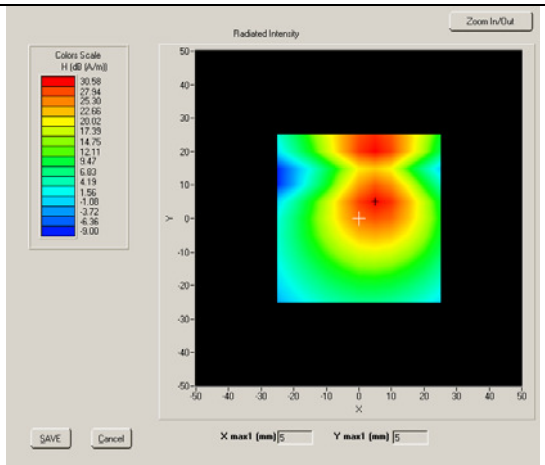
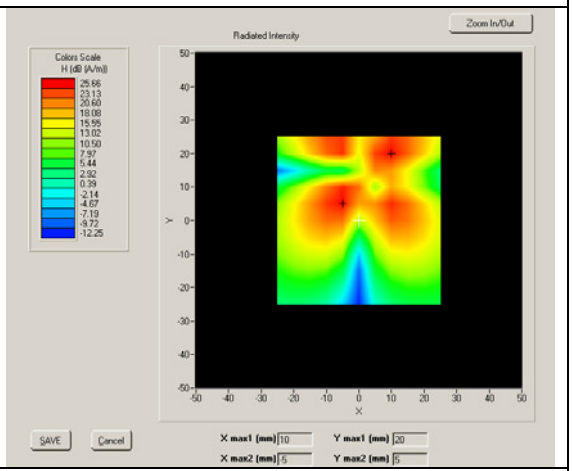
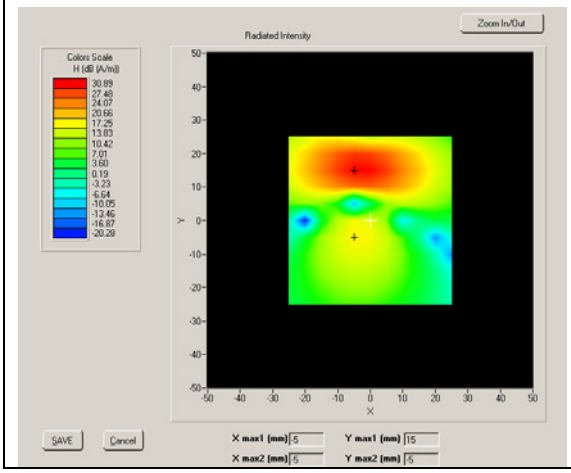
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1	WCDMA	Band4_WCDMA1700	Intensity, Axial	-18	Max	30.65	-	PASS
8.3.1			Intensity, RadialH	-18	Right side	25.45	-	PASS
				-18	Left side	25.33	-	PASS
8.3.1			Intensity, RadialV	-18	Upper side	30.93	-	PASS
				-18	Lower side	17.37	-	PASS
8.3.4			Signal to noise/noise, Axial	20	Max	39.06	T4	PASS
8.3.4			Signal to noise/noise, RadialH	20	Right side	39.02	T4	PASS
				20	Left side	38.89	T4	PASS
8.3.4			Signal to noise/noise, RadialV	20	Upper side	39.02	T4	PASS
				20	Lower side	39.78	T4	PASS
8.3.2			Frequency reponse, Axial	0	-	0.29	-	PASS

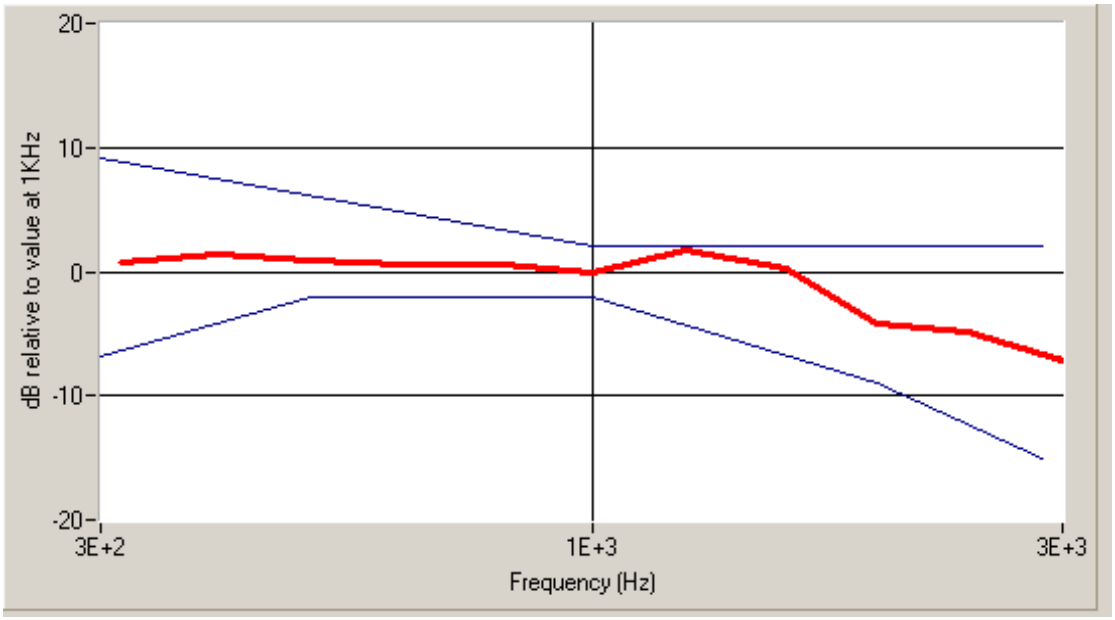
Frequency (MHz): WCDMA Band Ⅱ

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	30.58	NULL	NULL	NULL	25.66	25.52	NULL	NULL	NULL	NULL	30.89	17.32	NULL	NULL
ABM2, dBA/m	NULL	-7.75	NULL	NULL	NULL	-13.26	-12.14	NULL	NULL	NULL	NULL	-8.15	-21.28	NULL	NULL
Ambient noise, dBA/m	-44.62	-44.62	-44.62	-39.38	-39.38	-39.38	-39.38	-39.38	-39.38	-41.24	-41.24	-41.24	-41.24	-41.24	-41.24
Freq Reponse Margin (dB)	-	0.26	-	-	-	-	-	-	-	-	-	-	-	-	-
S+N/N(dB)	NULL	38.80	NULL	NULL	NULL	39.03	37.94	NULL	NULL	NULL	NULL	39.31	38.84	NULL	NULL
S+N/N per orientation (dB)	38.80			37.94						38.84					

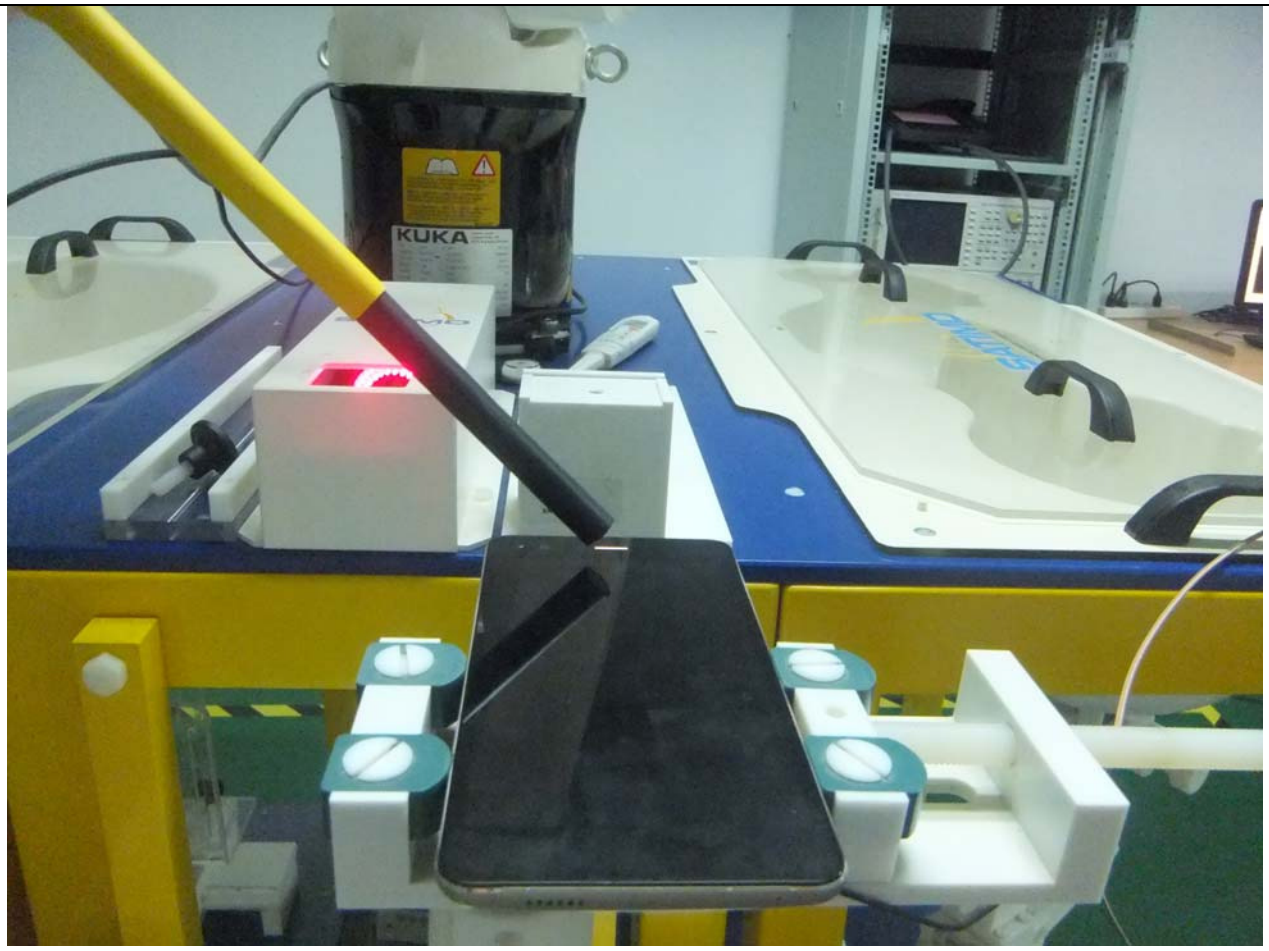
Magnetic field frequency response (field that exeeds -15 dB)



Test Summary

C63.19	Mode	Band	Test Description	Minimum Limit	Location	Measured	Category	Verdict
				dBA/m	-	dBA/m	-	Pass/Fail
8.3.1	WCDMA	Band2_WCDMA1900	Intensity, Axial	-18	Max	30.58	-	PASS
8.3.1			Intensity, RadialH	-18	Right side	25.66	-	PASS
				-18	Left side	25.52	-	PASS
8.3.1			Intensity, RadialV	-18	Upper side	30.89	-	PASS
				-18	Lower side	17.32	-	PASS
8.3.4			Signal to noise/noise, Axial	20	Max	38.80	T4	PASS
8.3.4			Signal to noise/noise, RadialH	20	Right side	39.03	T4	PASS
				20	Left side	37.94	T4	PASS
8.3.4			Signal to noise/noise, RadialV	20	Upper side	39.31	T4	PASS
				20	Lower side	38.84	T4	PASS
8.3.2			Frequency reponse, Axial	0	-	0.26	-	PASS

Annex A Test Setup Photo



Annex B Calibration Report

SATIMO
The microwave vision company

COMOHAC T-coil Probe Calibration Report

Ref : ACR.301.2.13.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

SUITE 311, BUILDING 1, SECTION 30 ,NO.2 KEFA ROAD, SCIENCE AND TECHNOLOGY PARK

NAN SHAN DISTRICT, SHENZHEN 518057 , GUANGDONG ,P.R.C.

SATIMO COMOHAC T-COIL PROBE

SERIAL NO.: SN 24/11 TCP21

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

10/28/2014

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	10/28/2014	
Checked by :	Jérôme LUC	Product Manager	10/28/2014	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/28/2014	Kim Rutkowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	*Date*	*Modifications*
A	10/28/2014	Initial release

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TABLE OF CONTENTS

1 Device Under Test 4
2 Product Description 4
2.1 General Information 4
3 Measurement Method 4
3.1 Sensitivity 4
3.2 Linearity 4
3.3 Signal to Noise Measurement of the Calibration System 5
4 Measurement Uncertainty 5
5 Calibration Measurement Results 5
5.1 Sensitivity 6
5.2 Linearity 6
5.3 Signal to Noise measurement of the Calibration System 6
6 List of Equipment 7

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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 TCP21
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

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).

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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%

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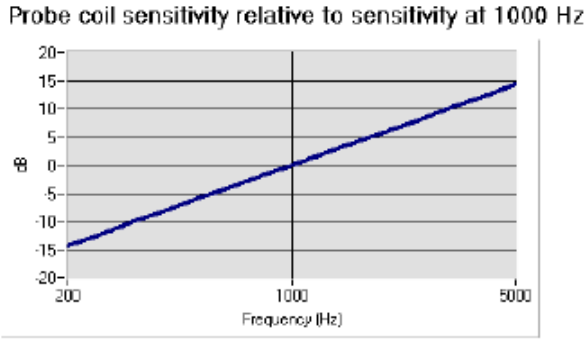
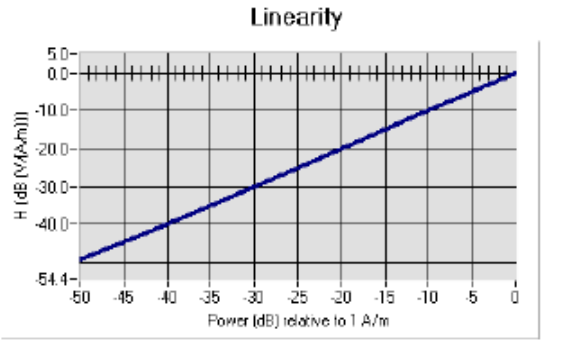
5.1 SENSITIVITY



	Measured	Required
Sensitivity at 1 kHz	-60.17 dB (V/A/m)	–60.5 +/- 0.5 dB (V/A/m)
Max. deviation from Sensitivity	0.38 dB	+/- 0.5 dB

5.2 LINEARITY



	Measured	Required
Linearity Slope	0.26 dB	+/ 0.5 dB

5.3 SIGNAL TO NOISE MEASUREMENT OF THE CALIBRATION SYSTEM

	Measured	Required
Signal to Noise	-61.48 dB A/m	'Reading with -50 dB A/m in coil' – 'no signal applied' > 10 dB

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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	01/2016
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	11/2013	11/2016
Helmholtz Coil	Satimo	HC07 SN47/10	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	3/2014	3/2016

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SATIMO
The microwave vision company

COMOHAC TMFS Calibration Report

Ref : ACR.301.5.13.SATU.A

SIEMIC TESTING AND CERTIFICATION SERVICES

SUITE 311, BUILDING 1, SECTION 30 ,NO.2 KEFA ROAD, SCIENCE AND TECHNOLOGY PARK

NAN SHAN DISTRICT, SHENZHEN 518057 , GUANGDONG ,P.R.C.

SATIMO COMOHAC MAGNETIC FIELD SIMULATOR

SERIAL NO.: SN 24/11 TMFS12

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

10/28/2014

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.

SATIMO

COMOHAC TMFS' PROBE CALIBRATION REPORT

Ref: ACR.301.5.13.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	10/28/2014	JS
Checked by :	Jérôme LUC	Product Manager	10/28/2014	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	10/28/2014	Kim Rutkowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	*Date*	*Modifications*
A	10/28/2014	Initial release

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TABLE OF CONTENTS

1 Device Under Test 4
2 Product Description 4
2.1 General Information 4
3 Measurement Method 4
3.1 Maximum Axial and Radial Magnetic Field Values 4
4 Measurement Uncertainty 4
5 Calibration Measurement Results 5
5.1 Maximum Axial and Radial Magnetic Field Values 6
6 List of Equipment 7

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1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC Magnetic Field Simulator
Manufacturer	Satimo
Model	STMFS
Serial Number	SN 24/11 TMFS12
Product Condition (new / used)	Used
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.

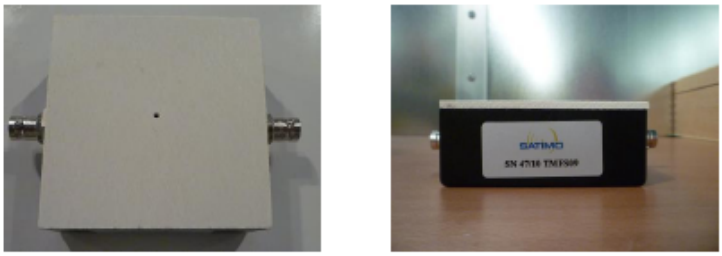

Figure 1 – *Satimo COMOHAC Magnetic Field Simulator*

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.

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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%

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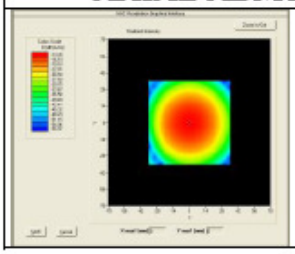
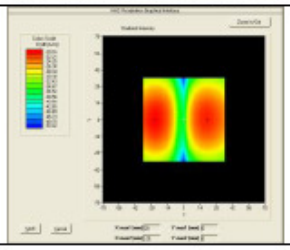
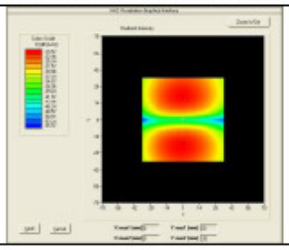
5.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

Test Description	Measured Magnetic Field	
	Location	Intensity (dB A/m)
Axial	Max	-13.06
Radial H	Right side	-20.82
	Left side	-19.93
Radial V	Upper side	-20.32
	Lower side	-20.40

AXIAL ABM1	RADIAL H ABM1	RADIAL V ABM1
		

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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.
HAC positioning ruler	Satimo	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
Audio Generator	National Instruments	15222AE	01/2014	01/2016
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	11/2013	11/2016
Temperature / Humidity Sensor	Control Company	11-661-9	3/2014	3/2016

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