# HAC T-Coil Test Report

Report No.: 15070379-HAC-T-Coil

Supersede Report No.: NONE

| | |
|---|---|
| Applicant | Verykool USA Inc |
| Product Name | Mobile Phone |
| Model No. | R28 |
| Standards | FCC 47 CFR 20.19, ANSI C63.19:2011 |
| Test Date | June 24, 2015 |
| Issue Date | June 29, 2015 |
| HAC T-Coil Test Result | T Rating |
| | T3 |
| Test Result | PASS |
| Equipment complied with the specification | ☑ |
| Equipment did not comply with the specification | ☐ |

| | | |
|---|---|---|
| Wiky Jam | Chris You | |
| **Wiky Jam**<br>**Test Engineer** | **Chris You**<br>**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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| 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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# 1 TECHNICAL DETAILS

| | |
|---|---|
| Purpose | Compliance testing of R28 with HAC RF Emission. |
| Applicant / Client | Verykool USA Inc<br>3636 Nobel Drive, Suite 325, San Diego, CA 92122 USA |
| Manufacturer | MOBIWIRE MOBILES (NINGBO) CO.,LTD<br>No.999,Dacheng East Road,Fenghua City,Zhejiang |
| Laboratory performing the tests | SIEMIC(Shenzhen-China) Laboratories<br>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.<br>Tel: +(86) 0755-26014629<br>VIP Line: 950-4038-0435 |
| Test report reference number | 15070379-HAC- T-Coil |
| Date EUT received | May 25,2015 |
| Standard applied | CFR 20.19 , ANSI C63.19:2011 |
| Dates of test (from – to) | June 24th, 2015 |
| No of Units: | 1 |
| Equipment Category: | PCE |
| Trade Name: | verykool |
| Model Name: | R28 |
| RF Operating Frequency (ies) | GSM850 TX : 824.2 ~ 848.8 MHz; RX : 869.2 ~ 893.8 MHz<br>PCS1900 TX : 1850.2 ~ 1909.8 MHz; RX : 1930.2 ~ 1989.8 MHz<br>UMTS-FDD Band 5 TX : 826.4 ~ 846.6 MHz; RX : 871.4 ~ 891.6 MHz<br>UMTS-FDD Band 2 TX :1852.4 ~ 1907.6 MHz; RX : 1932.4 ~ 1987.6 MHz<br>UMTS-FDD Band 4 TX :1712.4 ~ 1752.6 MHz; RX : 2112.4 ~ 2152.6 MHz<br>BT:2402~ 2480MHz(TX/RX) |
| Antenna Type: | PIFA Antenna |
| Modulation: | GSM / GPRS : GMSK<br>EGPRS: 8PSK<br>WCDMA:QPSK<br>Bluetooth: GFSK, π /4-DQPSK, 8DPSK |
| FCC ID: | WA6R28 |

# 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

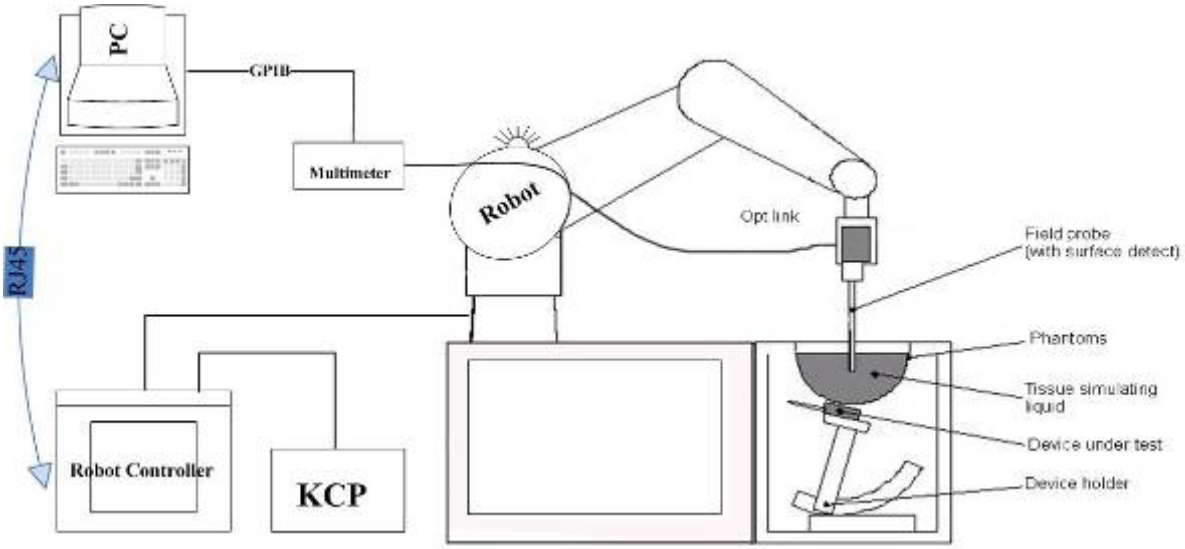
## List of Air Interfaces/Bands & Operating Modes

| 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 |
| 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.

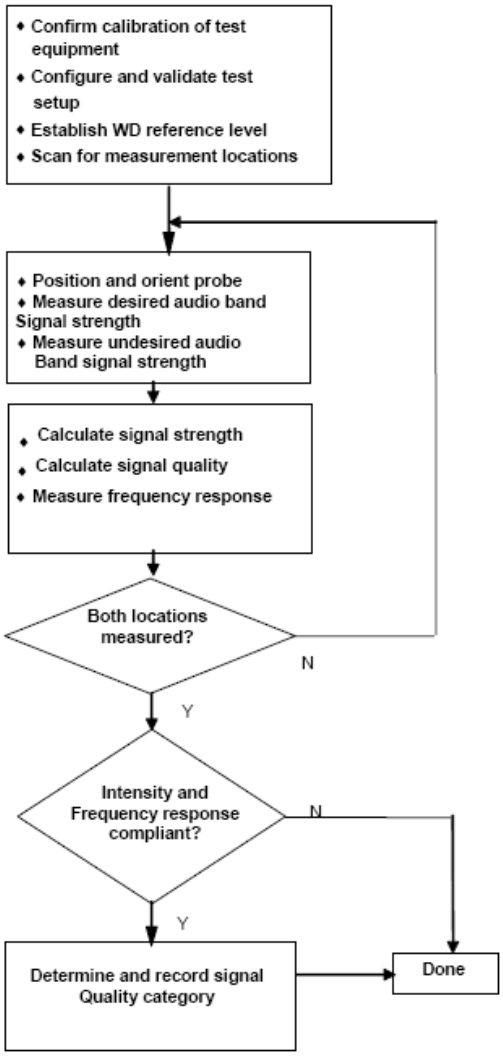
h) Identify the maximum reading within the non-excluded sub-grids identified in step g).

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

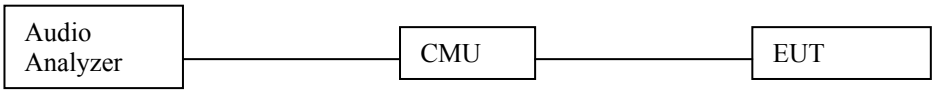
k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating. Otherwise,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

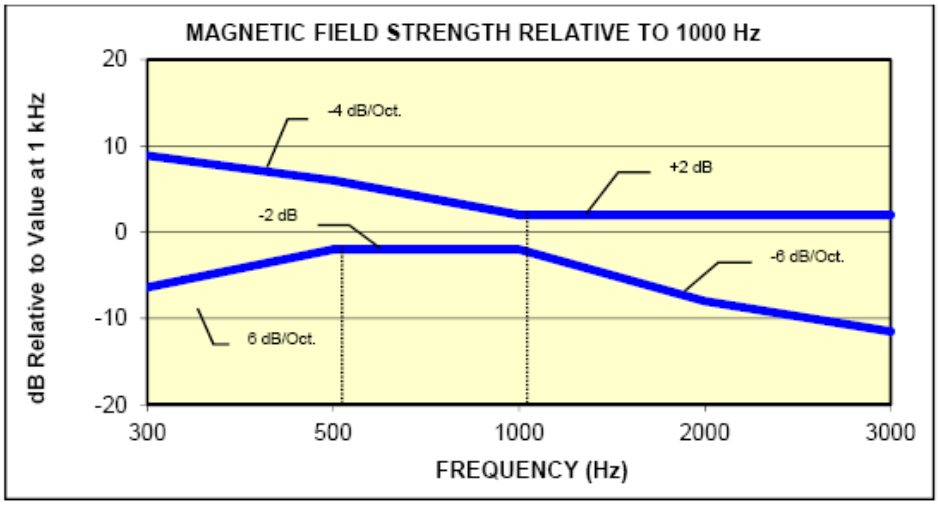



**Figure 4-1**
**Magnetic field frequency response for Wireless Devices with an axial field ≤-15 dB (A/m) at 1 kHz**

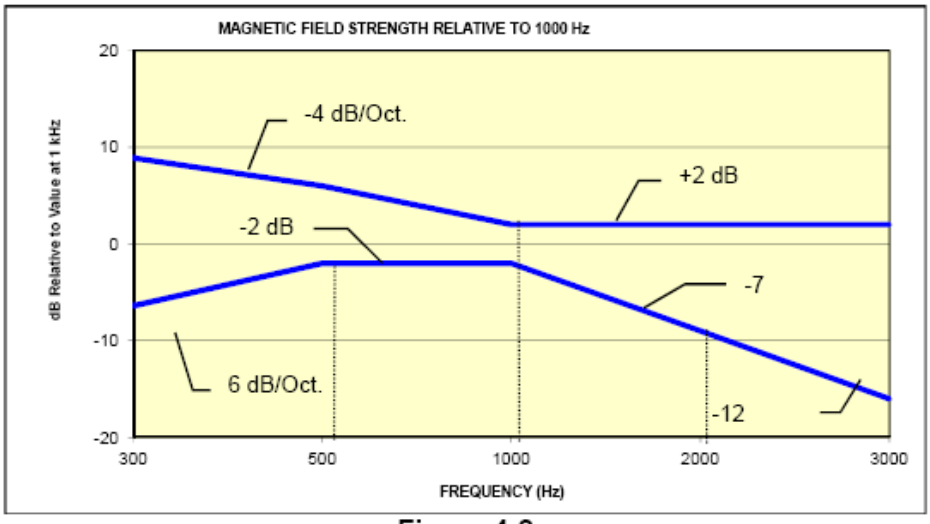



**Figure 4-2**
**Magnetic Field frequency response for wireless devices with an axial field that exce -15 dB(A/m) at 1 kHz**

## 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 | 05/15/2016 |
| MultiMeter | Keithley | MiltiMeter 2000 | 1259033 | 06/21/2016 |
| S-Parameter Network Analyzer | Agilent | 8753ES | US39173518 | 08/04/2015 |
| Wideband Radio Communication Tester | R & S | CMW500 | 120906 | 03/29/2016 |
| Power Meter | HP | 437B | 3038A03648 | 05/17/2016 |
| COMOHAC T-COIL PROBE | SATIMO | STCOIL | SN24/11 TCP21 | 10/28/2015 |
| Mobile Phone POSITIONING DEVICE | SATIMO | MSH63 | SN 31/10 MSH63 | N/A |
| TMFS | SATIMO | STMFS | SN24/11 TMFS12 | 10/28/2015 |
| 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 |

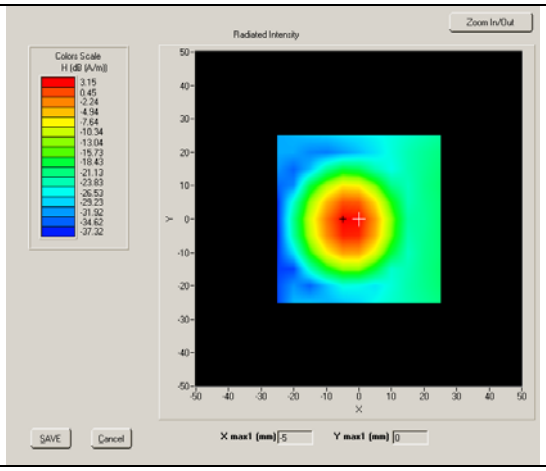
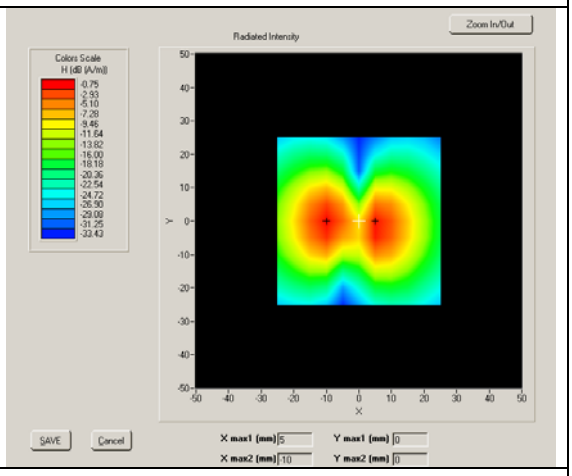
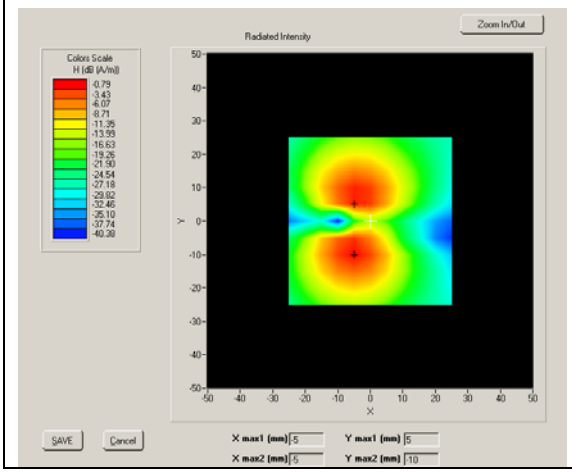
# 10 T-Coil Test Results

**Test Summary**

| Band | Category |
|---|---|
| GSM850 | T3 |
| PCS1900 | T3 |
| WCDMA Band Ⅴ | T4 |
| WCDMA Band Ⅳ | T4 |
| WCDMA Band Ⅱ | T4 |

**Test Results:**

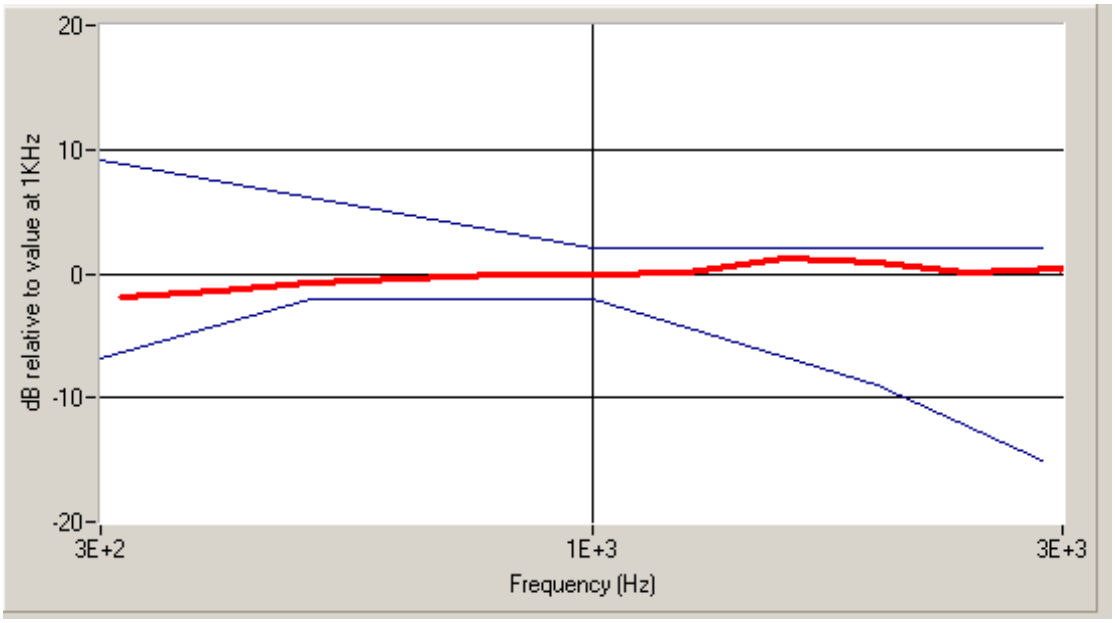
Frequency (MHz): GSM 850

| 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 | 3.15 | NULL | NULL | NULL | -1.14 | -0.75 | NULL | NULL | NULL | 3.15 | NULL | NULL | NULL | -1.14 |
| ABM2, dBA/m | NULL | -20.90 | NULL | NULL | NULL | -23.02 | -23.85 | NULL | NULL | NULL | -20.90 | NULL | NULL | NULL | -23.02 |
| Ambient noise, dBA/m | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 |
| Freq Reponse Margin (dB) | - | 0.81 | - | - | - | - | - | - | - | - | 0.81 | - | - | - | - |
| S+N/N(dB) | NULL | 24.40 | NULL | NULL | NULL | 22.05 | 22.83 | NULL | NULL | NULL | 24.40 | NULL | NULL | NULL | 22.05 |
| S+N/N per orientation (dB) | 24.40 | | | 22.05 | | | | | | 33.51 | | | | | |

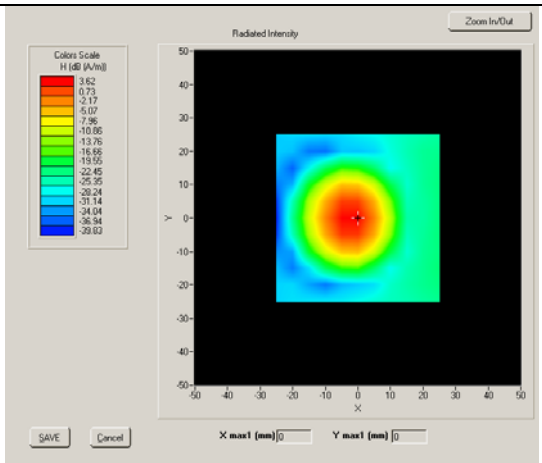
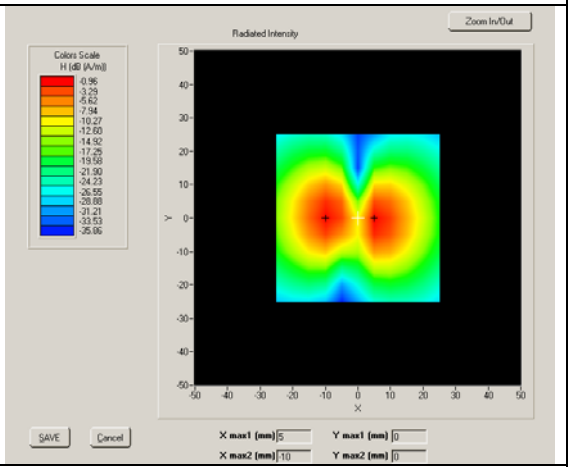
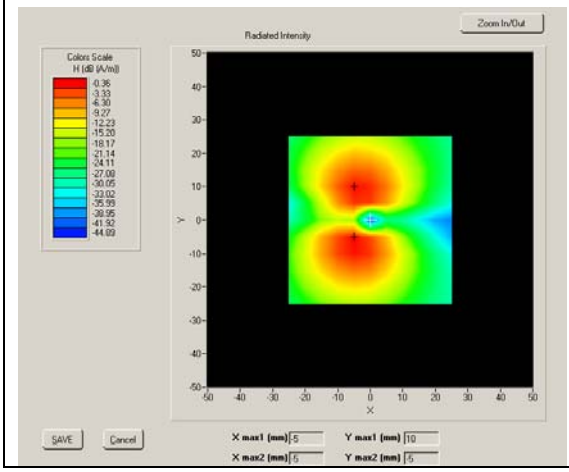
# Magnetic field frequency response (field that exeeds -15 dB)




# 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 | 33.55 | - | PASS |
| 8.3.1 | | | Intensity, RadialH | -18 | Right side | 25.12 | - | PASS |
| | | | | -18 | Left side | 25.59 | - | PASS |
| 8.3.1 | | | Intensity, RadialV | -18 | Upper side | 34.50 | - | PASS |
| | | | | -18 | Lower side | 31.51 | - | PASS |
| 8.3.4 | | | Signal to noise/noise, Axial | 20 | Max | 48.18 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialH | 20 | Right side | 23.28 | T3 | PASS |
| | | | | 20 | Left side | 24.98 | T3 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialV | 20 | Upper side | 47.25 | T4 | PASS |
| | | | | 20 | Lower side | 43.06 | T4 | PASS |
| 8.3.2 | | | Frequency reponse, Axial | 0 | - | 0.68 | - | PASS |

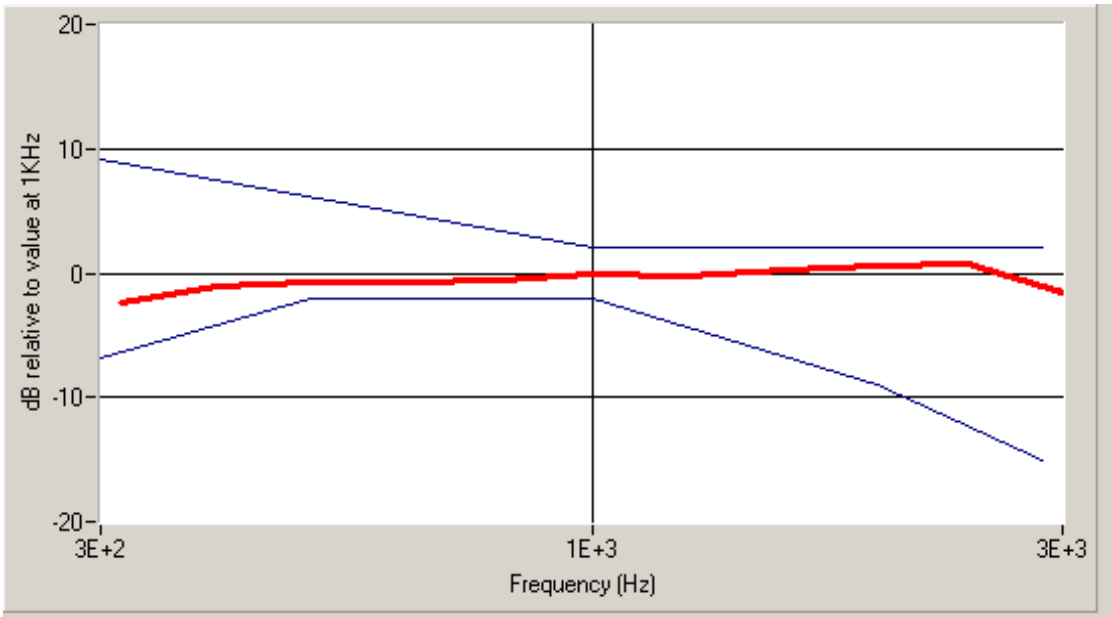
Frequency (MHz): PCS1900

| 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 | 3.62 | NULL | NULL | NULL | -0.96 | -1.06 | NULL | NULL | NULL | 3.62 | NULL | NULL | NULL | -0.96 |
| ABM2, dBA/m | NULL | -22.10 | NULL | NULL | NULL | -25.40 | -26.45 | NULL | NULL | NULL | -22.10 | NULL | NULL | NULL | -25.40 |
| Ambient noise, dBA/m | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 |
| Freq Reponse Margin (dB) | - | 1.21 | - | - | - | - | - | - | - | - | 1.21 | - | - | - | - |
| S+N/N(dB) | NULL | 25.61 | NULL | NULL | NULL | 24.45 | 26.00 | NULL | NULL | NULL | 25.61 | NULL | NULL | NULL | 24.45 |
| S+N/N per orientation (dB) | 25.61 | | | 24.45 | | | | | | 36.81 | | | | | |

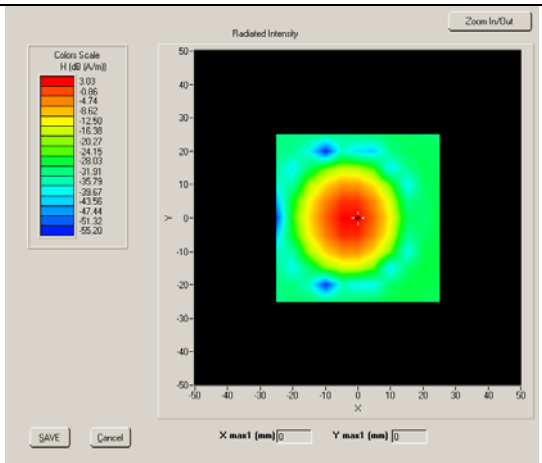
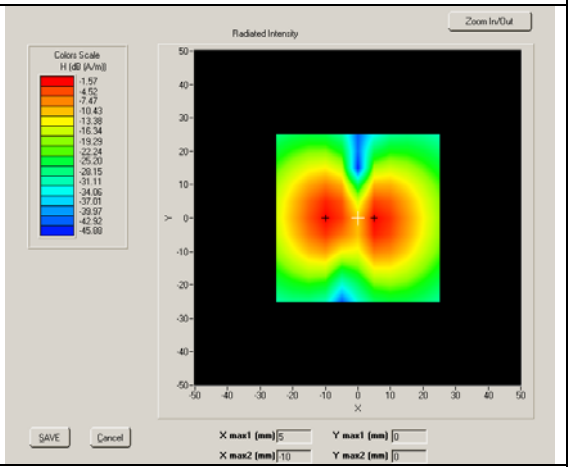
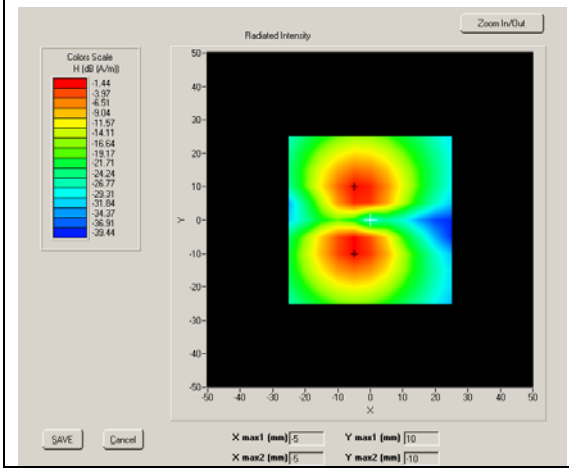
# Magnetic field frequency response (field that exeeds -15 dB)




# 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 | 3.62 | - | PASS |
| 8.3.1 | | | Intensity, RadialH | -18 | Right side | -0.96 | - | PASS |
| | | | | -18 | Left side | -1.06 | - | PASS |
| 8.3.1 | | | Intensity, RadialV | -18 | Upper side | -0.71 | - | PASS |
| | | | | -18 | Lower side | -0.36 | - | PASS |
| 8.3.4 | | | Signal to noise/noise, Axial | 20 | Max | 25.61 | T3 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialH | 20 | Right side | 24.45 | T3 | PASS |
| | | | | 20 | Left side | 26.00 | T3 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialV | 20 | Upper side | 36.81 | T4 | PASS |
| | | | | 20 | Lower side | 37.21 | T4 | PASS |
| 8.3.2 | | | Frequency reponse, Axial | 0 | - | 1.21 | - | PASS |

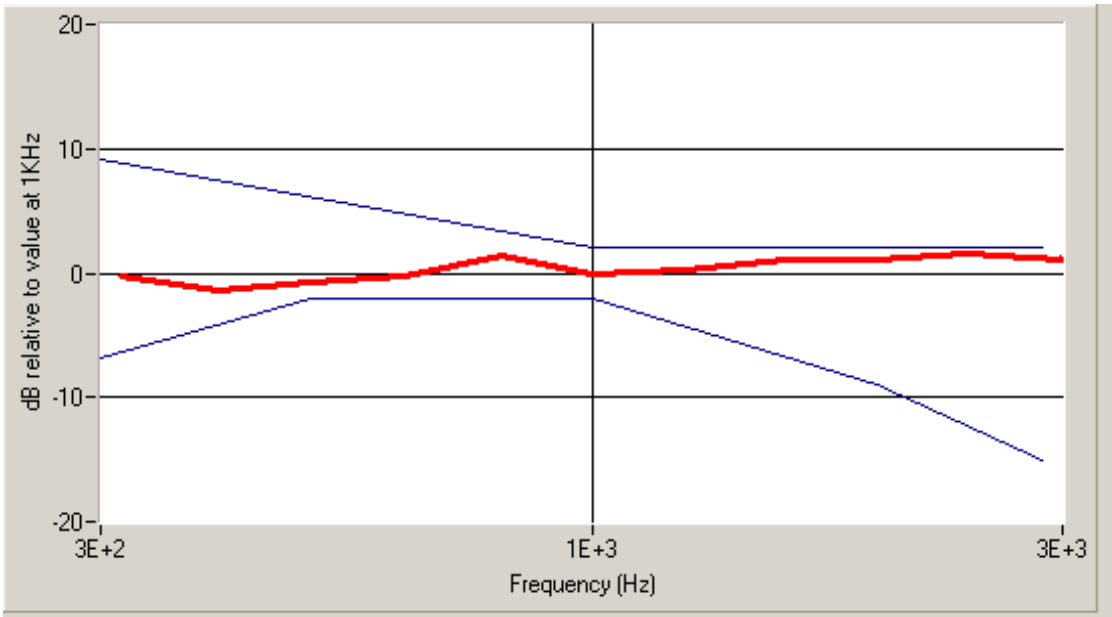
Frequency (MHz): WCDMA 850

| 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 | 3.03 | NULL | NULL | NULL | -1.61 | -1.57 | NULL | NULL | NULL | 3.03 | NULL | NULL | NULL | -1.61 |
| ABM2, dBA/m | NULL | -34.20 | NULL | NULL | NULL | -34.11 | -40.17 | NULL | NULL | NULL | -34.20 | NULL | NULL | NULL | -34.11 |
| Ambient noise, dBA/m | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 |
| Freq Reponse Margin (dB) | - | 0.38 | - | - | - | - | - | - | - | - | 0.38 | - | - | - | - |
| S+N/N(dB) | NULL | 37.72 | NULL | NULL | NULL | 32.71 | 39.10 | NULL | NULL | NULL | 37.72 | NULL | NULL | NULL | 32.71 |
| S+N/N per orientation (dB) | 37.72 | | | 32.71 | | | | | | 38.30 | | | | | |

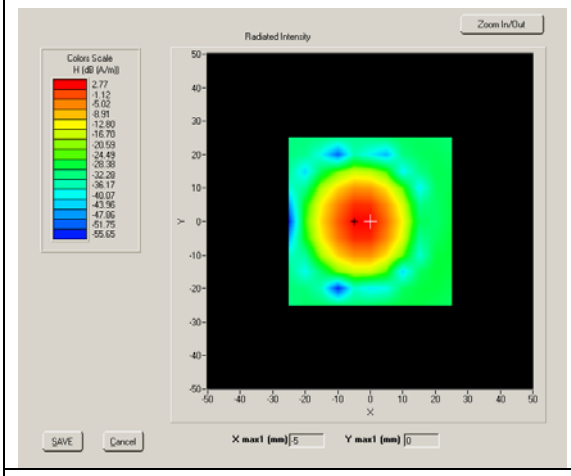
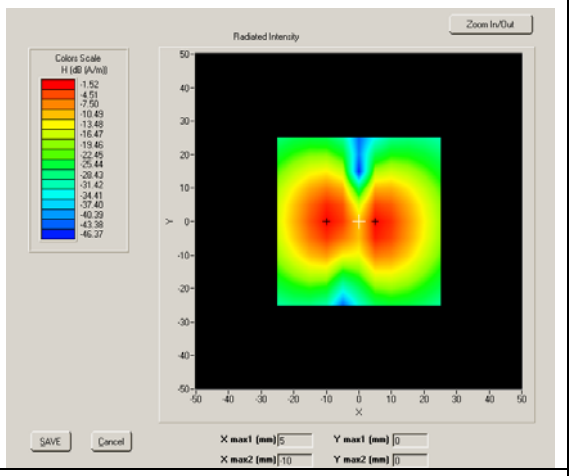
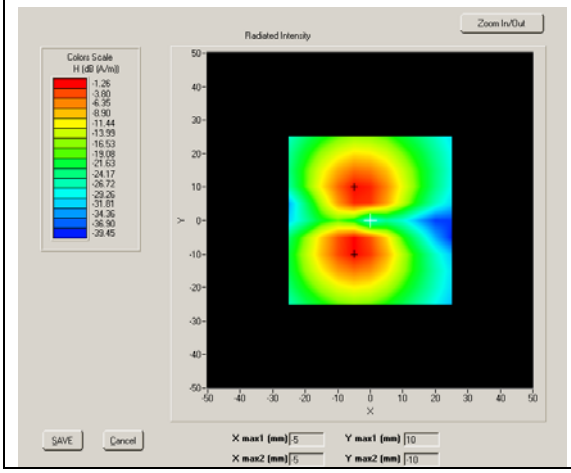
# Magnetic field frequency response (field that exeeds -15 dB)




# Test Summary

| C63.19 | Mode | Band | Test Description | Minimum Limit | Location | Measured | Category | Verdict |
|---|---|---|---|---|---|---|---|---|
| | | | | dBA/m | - | dBA/m | - | Pass/Fail |
| 8.3.1 | WCDMA | Band5_WCDMA850 | Intensity, Axial | -18 | Max | 3.03 | - | PASS |
| 8.3.1 | | | Intensity, RadialH | -18 | Right side | -1.61 | - | PASS |
| | | | | -18 | Left side | -1.57 | - | PASS |
| 8.3.1 | | | Intensity, RadialV | -18 | Upper side | -1.56 | - | PASS |
| | | | | -18 | Lower side | -1.44 | - | PASS |
| 8.3.4 | | | Signal to noise/noise, Axial | 20 | Max | 37.72 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialH | 20 | Right side | 32.71 | T4 | PASS |
| | | | | 20 | Left side | 39.10 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialV | 20 | Upper side | 38.34 | T4 | PASS |
| | | | | 20 | Lower side | 38.30 | T4 | PASS |
| 8.3.2 | | | Frequency reponse, Axial | 0 | - | 0.38 | - | PASS |

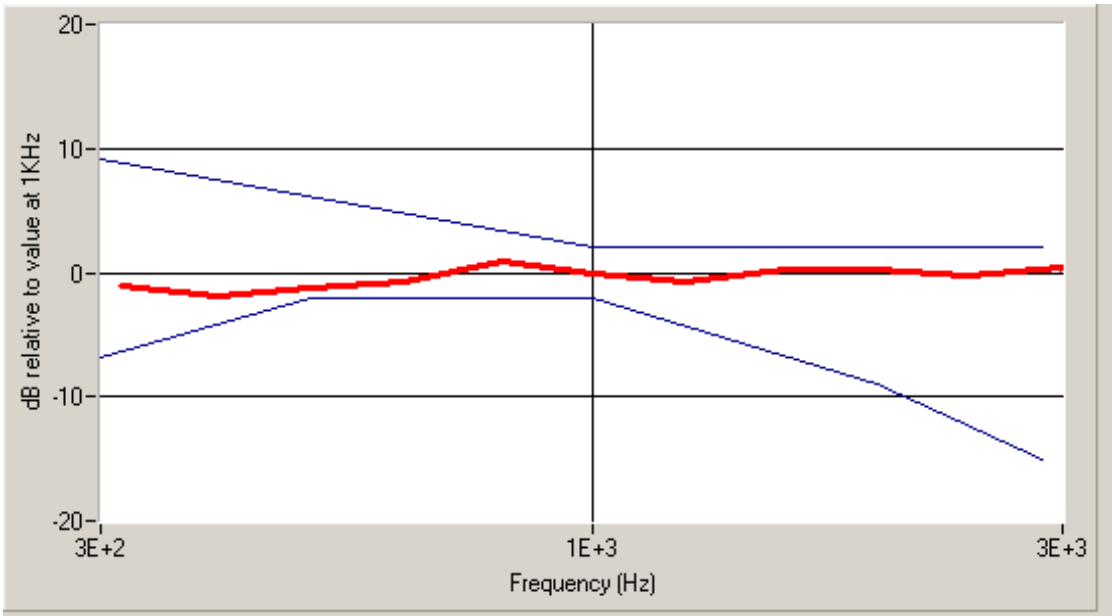
Frequency (MHz):WCDM Band Ⅳ

| 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 | 2.77 | NULL | NULL | NULL | -1.59 | -1.52 | NULL | NULL | NULL | 2.77 | NULL | NULL | NULL | -1.59 |
| ABM2, dBA/m | NULL | -40.55 | NULL | NULL | NULL | -35.59 | -40.98 | NULL | NULL | NULL | -40.55 | NULL | NULL | NULL | -35.59 |
| Ambient noise, dBA/m | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 |
| Freq Reponse Margin (dB) | - | 0.76 | - | - | - | - | - | - | - | - | 0.76 | - | - | - | - |
| S+N/N(dB) | NULL | 43.66 | NULL | NULL | NULL | 34.34 | 39.82 | NULL | NULL | NULL | 43.66 | NULL | NULL | NULL | 34.34 |
| S+N/N per orientation (dB) | 43.66 | | | 34.34 | | | | | | 38.17 | | | | | |

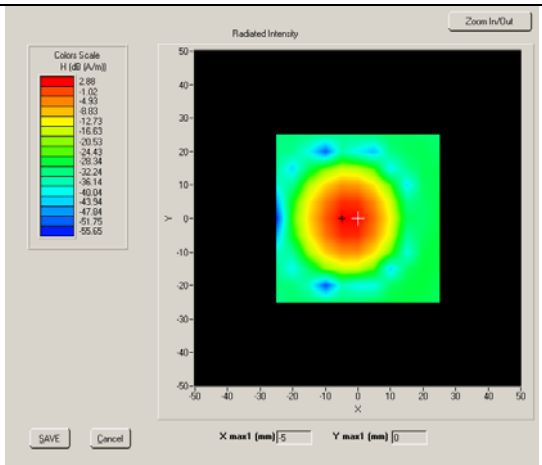
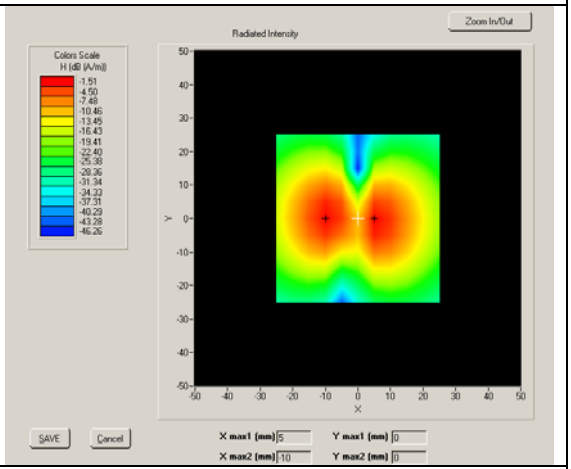
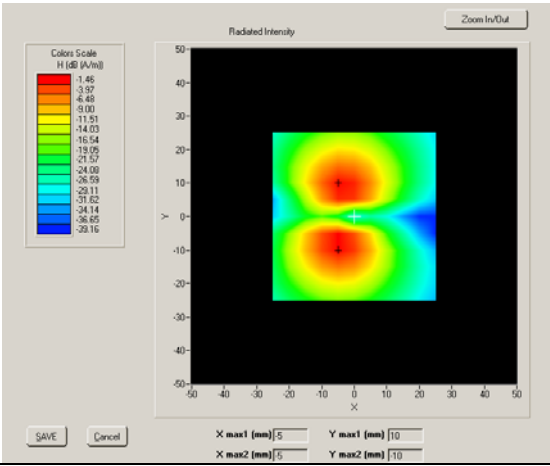
# Magnetic field frequency response (field that exeeds -15 dB)




# 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 | 2.77 | - | PASS |
| 8.3.1 | | | Intensity, RadialH | -18 | Right side | -1.59 | - | PASS |
| | | | | -18 | Left side | -1.52 | - | PASS |
| 8.3.1 | | | Intensity, RadialV | -18 | Upper side | -1.43 | - | PASS |
| | | | | -18 | Lower side | -1.26 | - | PASS |
| 8.3.4 | | | Signal to noise/noise, Axial | 20 | Max | 43.66 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialH | 20 | Right side | 34.34 | T4 | PASS |
| | | | | 20 | Left side | 39.82 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialV | 20 | Upper side | 38.28 | T4 | PASS |
| | | | | 20 | Lower side | 38.17 | T4 | PASS |
| 8.3.2 | | | Frequency reponse, Axial | 0 | - | 0.76 | - | PASS |

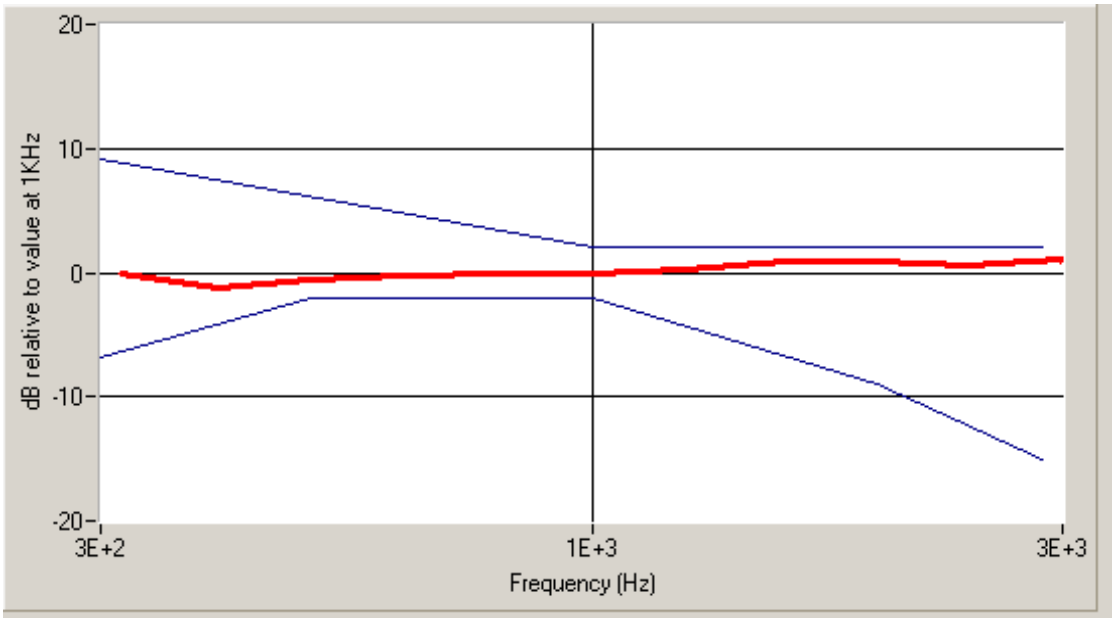
Frequency (MHz): WCDMA Band Ⅱ

| 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 | 2.88 | NULL | NULL | NULL | -1.59 | -1.51 | NULL | NULL | NULL | 2.88 | NULL | NULL | NULL | -1.59 |
| ABM2, dBA/m | NULL | -41.24 | NULL | NULL | NULL | -35.47 | -40.30 | NULL | NULL | NULL | -41.24 | NULL | NULL | NULL | -35.47 |
| Ambient noise, dBA/m | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -39.38 | -44.62 | -44.62 | -44.62 | -39.38 | -39.38 | -39.38 |
| Freq Reponse Margin (dB) | - | 0.90 | - | - | - | - | - | - | - | - | 0.90 | - | - | - | - |
| S+N/N(dB) | NULL | 44.71 | NULL | NULL | NULL | 34.17 | 39.15 | NULL | NULL | NULL | 44.71 | NULL | NULL | NULL | 34.17 |
| S+N/N per orientation (dB) | 44.71 | | | 34.17 | | | | | | 38.18 | | | | | |

# 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 | 2.88 | - | PASS |
| 8.3.1 | | | Intensity, RadialH | -18 | Right side | -1.59 | - | PASS |
| | | | | -18 | Left side | -1.51 | - | PASS |
| 8.3.1 | | | Intensity, RadialV | -18 | Upper side | -1.58 | - | PASS |
| | | | | -18 | Lower side | -1.46 | - | PASS |
| 8.3.4 | | | Signal to noise/noise, Axial | 20 | Max | 44.71 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialH | 20 | Right side | 34.17 | T4 | PASS |
| | | | | 20 | Left side | 39.15 | T4 | PASS |
| 8.3.4 | | | Signal to noise/noise, RadialV | 20 | Upper side | 38.21 | T4 | PASS |
| | | | | 20 | Lower side | 38.18 | T4 | PASS |
| 8.3.2 | | | Frequency reponse, Axial | 0 | - | 0.90 | - | 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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# 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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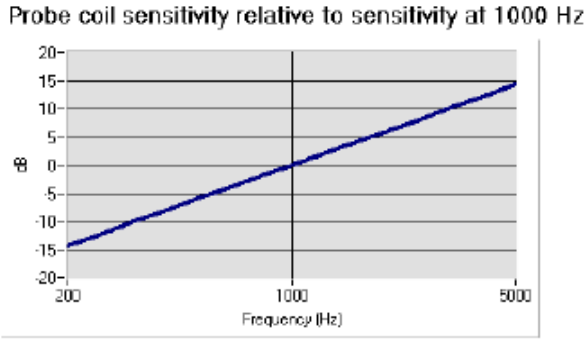
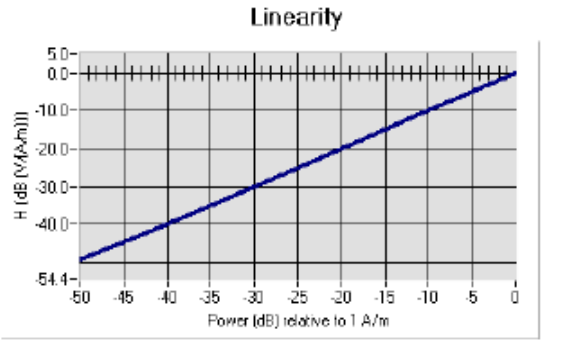
## 5.1 SENSITIVITY




| | 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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# 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.

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 10/28/2014 | JS |
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| *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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# 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.

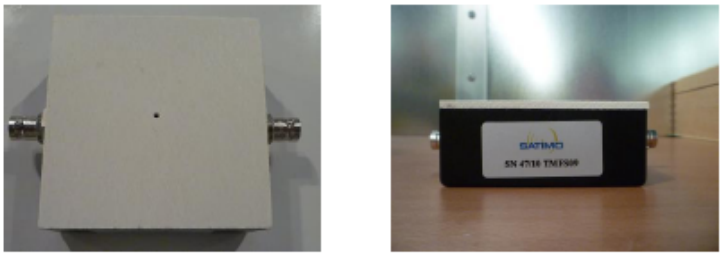

**Figure 1** – *Satimo COMOHAC Magnetic Field Simulator*

# 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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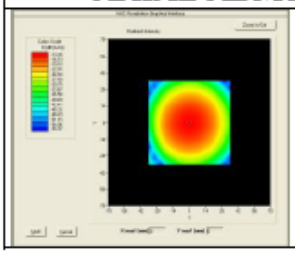
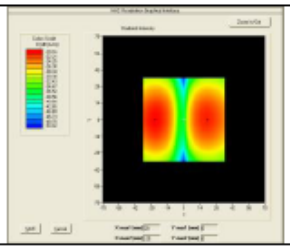
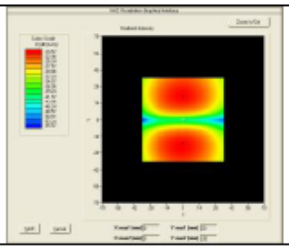
## 5.1 MAXIMUM AXIAL AND RADIAL MAGNETIC FIELD VALUES

| 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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