**SAMSUNG ELECTRONICS Co., Ltd.,**
**Regulatory Compliance Group**
**IT R&D Center**

416, Maetan-3dong,
Yeongtong-gu, Suwon-si,
Gyeonggi-do, Korea 443-742

# TEST REPORT ON HAC

| | |
|---|---|
| **Model Tested:** | **SGH-T340G** |
| **FCC ID (Requested):** | **A3LSGHT340G** |
| **Job No:** | **AH-077** |
| **Report No:** | **AH-077-T1** |
| **Date issued:** | **Oct. 29, 2010** |
| **Result Summary:** | **T3 – 2007 (Signal To Noise Category)** |

- Abstract –
This document reports on HAC Tests carried out in accordance with ANSI C63.19(2007) §6.3, §7.3, FCC Rule Part(s) FCC 47 CFR §20.19

**Prepared By**

**YB KIM – Test Engineer**

**Authorized By**

**JD JANG – Technical Manager**

# Contents

# 1. GENERAL INFORMATION

| | |
|---|---|
| Test Sample : | Dual-Band GSM/GPRS Mobile Phone with Bluetooth |
| Model Number : | SGH-T340G |
| Serial Number : | Identical prototype (S/N : # FH-227-B) |
| | |
| Manufacturer : | SAMSUNG ELECTRONICS Co., Ltd. |
| Address : | 416 Maetan3-Dong, Yeongtong-gu, Suwon City |
| | Gyeonggi-Do, Korea 443-742 |
| Test Standard : | ANSI C63.19 (2007) §6.3, §7.3, FCC 47 CFR § 20.19 |
| FCC Classification : | Licensed Portable Transmitter Held to Ear (PCE) |
| Test Dates : | Oct.20,2010 |
| Tested for : | FCC/TCB Certification |

# 2. DESCRIPTION OF DEVICE

| | |
|---|---|
| Tx Freq. Range : | 824.2 ~ 848.8 MHz(GSM850)<br>1850.2 ~ 1909.8 MHz(GSM1900) |
| Rx Freq. Range : | 869.2 ~ 893.8 MHz(GSM850)<br>1930.2 ~ 1989.8 MHz(GSM1900) |
| Antenna Configuration : | PIFA |
| Antenna Manufacturer : | SAMSUNG ELECTRONICS |
| Antenna Dimensions : | 42.2 mm X 13.7 mm X 5.81 mm |

# 3. Performance

## 3.1 RF EMISSIONS

The ANSI Standard presents performance requirements for acceptable interoperability of hearing aids with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

| Category | Telephone RF Parameters | |
|---|---|---|
| **Near field Category** | **E-field emissions CW dB(V/m)** | **H-field emissions CW dB(A/m)** |
| **f < 960 MHz** | | |
| **M1** | 56 to 61 + 0.5 x AWF | 5.6 to 10.6 +0.5 x AWF |
| **M2** | 51 to 56 + 0.5 x AWF | 0.6 to 5.6 +0.5 x AWF |
| **M3** | 46 to 51 + 0.5 x AWF | –4.4 to 0.6 +0.5 x AWF |
| **M4** | < 46 + 0.5 x AWF | < –4.4 + 0.5 x AWF |
| **f > 960 MHz** | | |
| **M1** | 46 to 51 + 0.5 x AWF | –4.4 to 0.6 +0.5 x AWF |
| **M2** | 41 to 46 + 0.5 x AWF | –9.4 to –4.4 +0.5 x AWF |
| **M3** | 36 to 41 + 0.5 x AWF | –14.4 to –9.4 +0.5 x AWF |
| **M4** | < 36 + 0.5 x AWF | < –14.4 + 0.5 x AWF |

**Table 4-1**
**Hearing aid and WD near-field categories as defined in ANSI C63.19-2007 [2]**

## 3.2 ARTICULATION WEIGHTING FACTOR (AWF)

| Standard | Technology | Articulation Weighing Factor (AWF) |
|---|---|---|
| **T1/T1P1/3GPP** | **UMTS (WCDMA)** | 0 |
| **TIA/EIA/IS-2000** | **CDMA** | 0 |
| **iDEN™** | **TDMA (22 and 11 Hz)** | 0 |
| **J-STD-007** | **GSM (217 Hz)** | -5 |

**Table 4-2**
Articulation Weighting Factors

## 3.3 MAGNETIC COUPLING

### Axial and Radial Field Intensity

All orientations of the magnetic field, in the axial, horizontal and vertical position along the measurement plane shall be ≥ -18 dB(A/m) at 1 kHz in a 1/3 octave band filter per 7.3.1.

### 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 7.3.2.

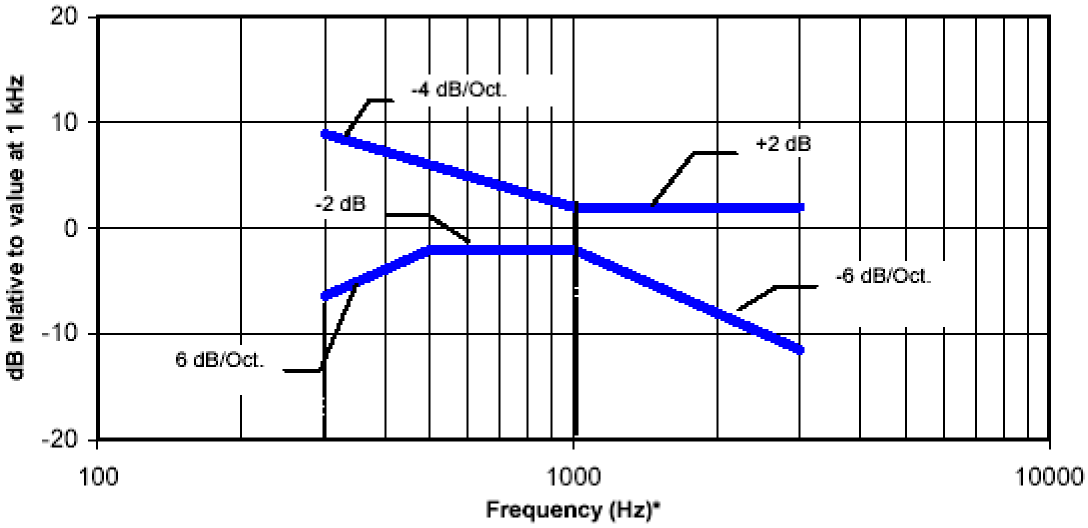



**Figure 4-1**
**Magnetic field frequency response for Wireless Devices with an axial field below ≤ -15 dB (A/m) at 1 kHz**

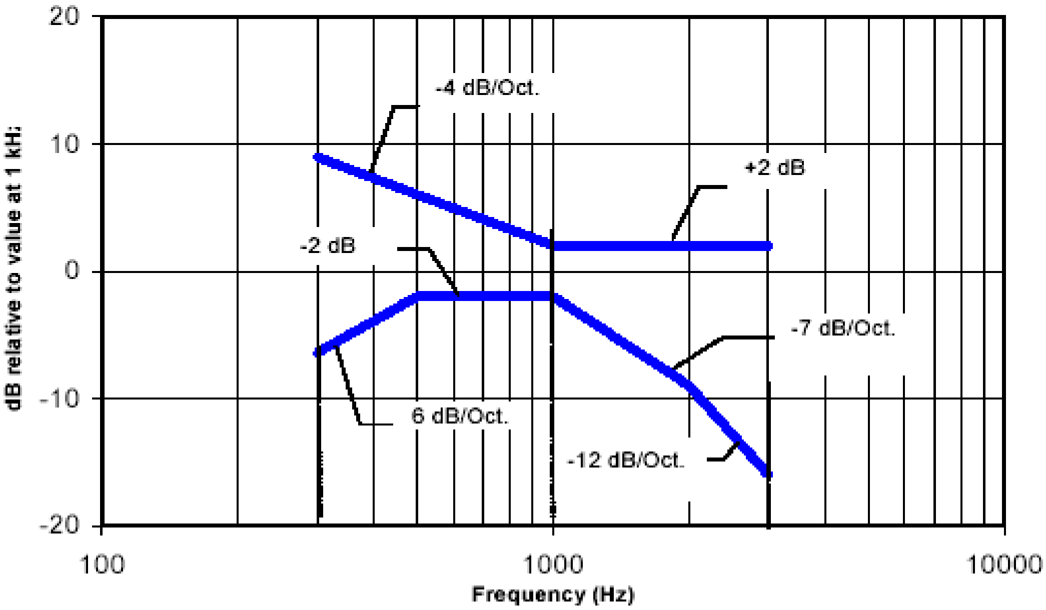



**Figure 4-2**
**Magnetic Field frequency response for wireless devices with an axial field that exceeds –15 dB(A/m) at 1 kHz**

## 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 RF Parameters |
|---|---|
| | **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 |

Table 4-3
**Magnetic Coupling Parameters**

# 4. DESCRIPTION OF TEST EQUIPMENT

## 4.1 HAC Measurement Setup

The equipment was connected as shown in an acoustic/RF hemi-anechoic chamber:

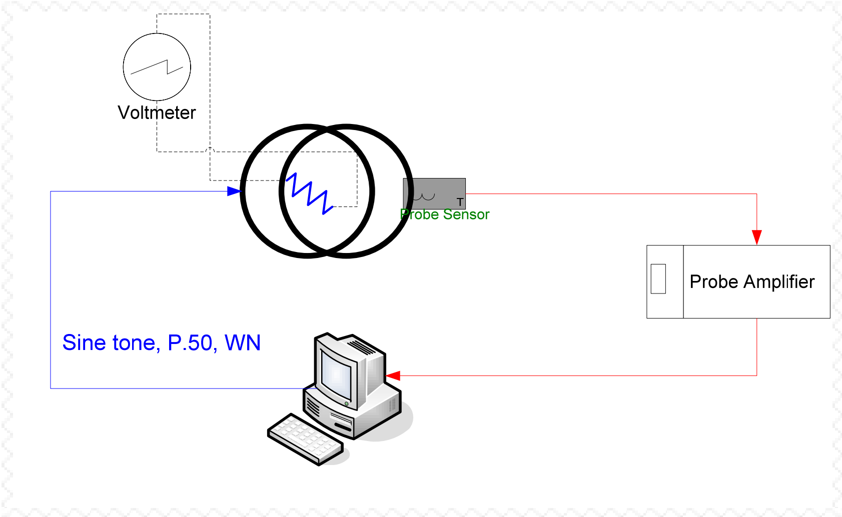



**Figure 4-1 Validation Setup with Helmholtz Coil**

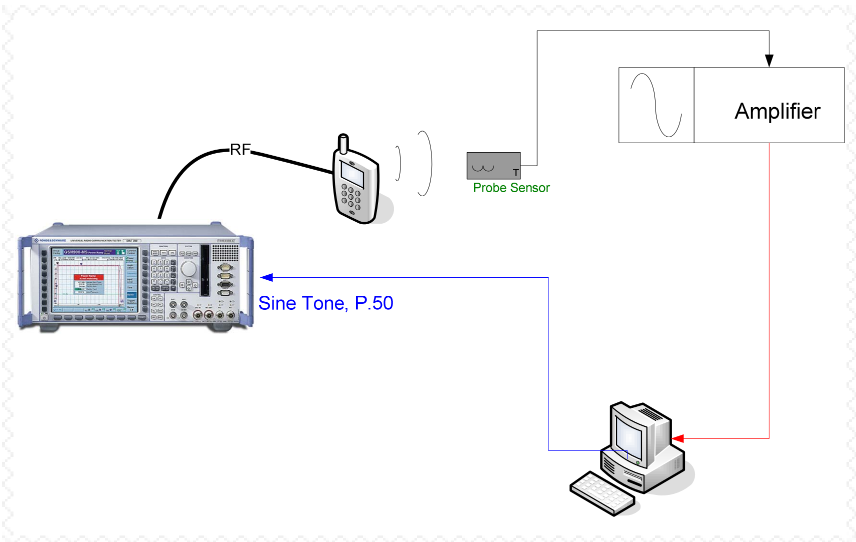



**Figure 4-2 T-Coil Test Setup**

## 4.2 Scanning Mechanism

| | |
|---|---|
| Manufacturer: | TEM |
| Accuracy: | ± 0.83 cm/meter |
| Minimum Step Size: | 0.1 mm |
| Maximum speed | 6.1 cm/sec |
| Line Voltage: | 115 VAC |
| Line Frequency: | 60 Hz |
| Material Composite: | Delrin (Acetal) |
| Data Control: | Parallel Port |
| Dynamic Range (X-Y-Z): | 45 x 31.75 x 47 cm |
| Dimensions: | 36" x 25" x 38" |
| Operating Area: | 36" x 49" x 55" |
| Reflections: | < -20 dB (in anechoic chamber) |

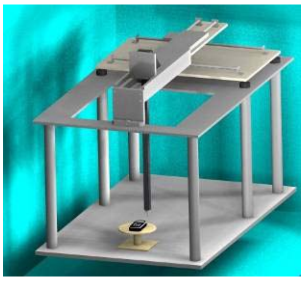


**Figure 4-3**
RF Near-Field Scanner

## 4.3 ITU-T P.50 Artificial Voice

| | |
|---|---|
| Manufacturer: | ITU-T |
| Active Frequency Range: | 100 Hz – 8 kHz |
| Stimulus Type: | Male and Female, no spaces |
| Single Sample Duration: | 20.96 seconds |
| Activity Level: | 100% |

**Figure 4-4**
Spectral Characteristic of full P.50

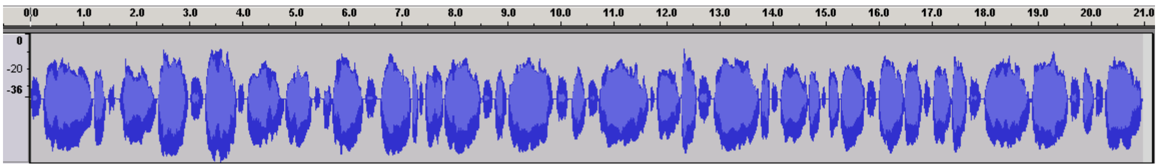
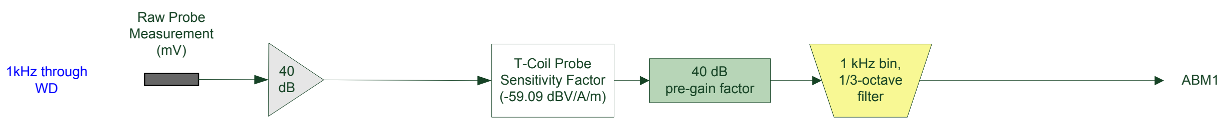



**Figure 4-5**
**Temporal Characteristic of full P.50**

ABM1 Measurement Block Diagram:




ABM2 Measurement Block Diagram:

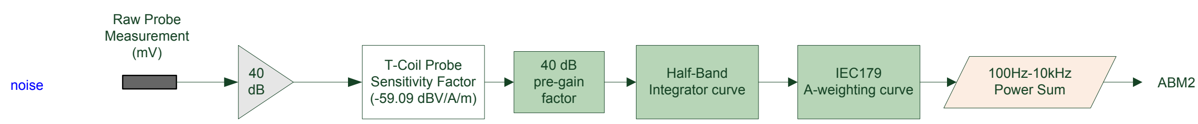



**Figure 4-6 Magnetic Measurement Processing Steps**

## 4.4 Equipment Calibration

**Table 3.2 Test Equipment Calibration**

| Model | Description | Cal. Due Date | Serial No. |
|---|---|---|---|
| CMU200 | Base Station Simulator | 10/20/2010 | 109162 |
| 4474 | Data Acquisition Card | N/A | N/A |
| Positioner | HAC Positioner | N/A | N/A |
| HAC System | HAC System controller with S/W | N/A | N/A |
| Axial T-coil Probe | Axial T-coil Probe | 6/18/2011 | TEM-1110 |
| Radial T-coil Probe | Radial T-coil Probe | 6/18/2011 | TEM-1111 |
| E4440A | PSA Spectrum analyzer | 3/8/2011 | MY45304704 |
| E4419B | EPM Power Meter | 3/2/2011 | MY45103291 |
| E9300B | Power Sensor | 3/3/2011 | MY41496209 |
| Fluke87 | RMS Multimeter | 1/13/2011 | 65030199 |
| E3640A | Power supply | 1/12/2011 | MY40009112 |
| AMCC | H/H coil(Speag) | N/A | N/A |

# 5. HAC MEASUREMENT PROCEDURE

The flow diagram below was followed (From C63.19):

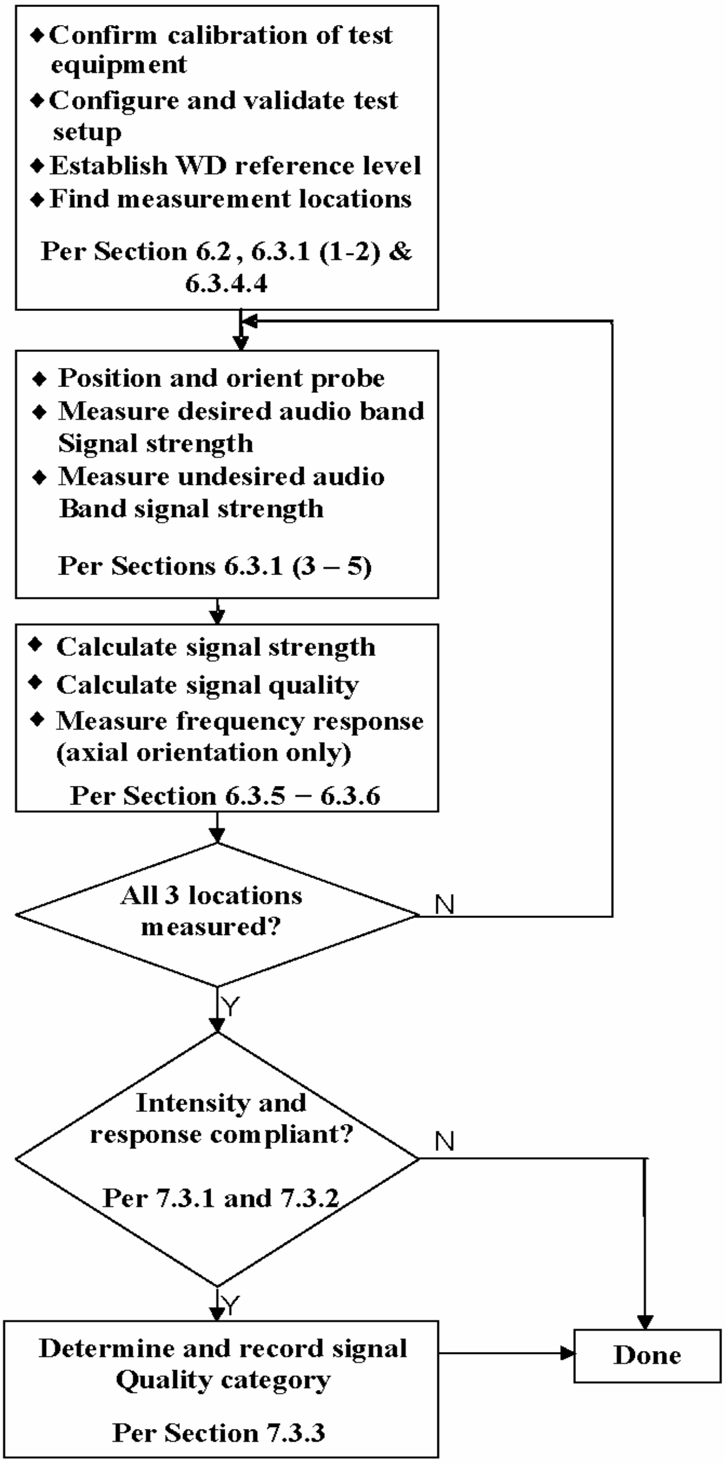



**Figure 5-1 Test Procedure for T-coil Measurement**

## 5.1 Ambient Noise Check per C63.19 §6.2.1

a. Ambient interference was monitored using a Real-Time Analyzer between 100-10,000 Hz with 1/3 octave filtering.
b. "A-weighting" and Half-Band Integration was applied to the measurements.
c. Since this measurement was measured in the same method as ABM2 measurements, this level was verified to be less than 10 dB below the lowest measurement signal (which is the highest ABM2 measurement for a T4 WD). Therefore the maximum noise level for a T4 WD with an ABM1 = -18 dBA/m is:

-18 - 30 - 10 = -58 dBA/m

## 5.2 Measurement System Validation (See Figure 4-1)

a. The measurement system including the probe, pre-amplifier and acquisition system were validated as an entire system to ensure the reliability of test measurements.

b. ABM1 Validation

The magnetic field at the center of the Helmholtz coil is given by the equation (per C63.19 Annex D.9.1):

$$H_c = \frac{NI}{r\sqrt{1.25^3}} = \frac{N(\frac{V}{R})}{r\sqrt{1.25^3}}$$

Where $H_c$ = magnetic field strength in amperes per meter

N = number of turns per coil

For a Helmholtz Coil, N=20; r=0.143m; R=10.2Ω and using V=102mV:

$$H_c = \frac{20 \cdot (\frac{0.102}{10.2})}{0.143 \cdot \sqrt{1.25^3}} = 1.0007 A/m$$

Therefore a pure tone of 1kHz was applied into the coils such that 102 mV was observed across the 10.2 Ω resistor. The voltmeter used for measurement was verified to be capable of measurements in the audio band range. This theoretically generates an expected field of 1 A/m in the center of the Helmholtz coil which was used to validate the probe measurement at 1 A/m. This was verified to be within ± 0.5 dB of the 1 A/m value.

c. Frequency Response Validation

The frequency response through the Helmholtz Coil was verified to be within 0.5 dB relative to 1 kHz, between 300 – 3000 Hz using the ITU-P.50 artificial speech signal as shown below:

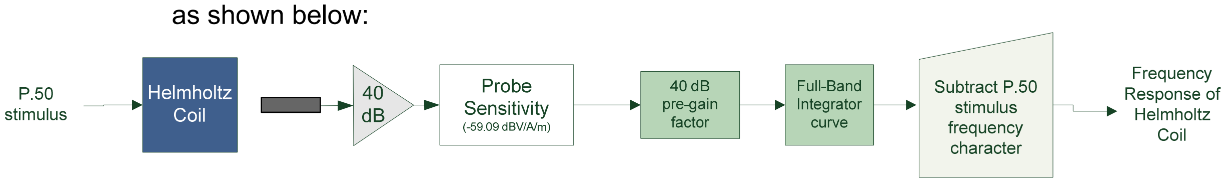



**Figure 5-2 Frequency Response Validation**

d. ABM2 Measurement Validation

WD noise measurements are filtered with A-weighting and Half-Band Integration over a frequency range of 100Hz – 10kHz to process ABM2 measurements. Below is the verification of the system processing A-weighting and Half-Band integration between system input to output within 0.5 dB of the theoretical result:

**Table 5-1**
**ABM2 Frequency Response Validation**

| f (Hz) | HBI, A - Measured (dB re 1kHz) | HBI, A - Theoretical (dB re 1kHz) | dB Var. |
|---|---|---|---|
| 100 | -16.180 | -16.170 | -0.010 |
| 125 | -13.257 | -13.250 | -0.007 |
| 160 | -10.347 | -10.340 | -0.007 |
| 200 | -8.017 | -8.010 | -0.007 |
| 250 | -5.925 | -5.920 | -0.005 |
| 315 | -4.045 | -4.040 | -0.005 |
| 400 | -2.405 | -2.400 | -0.005 |
| 500 | -1.212 | -1.210 | -0.002 |
| 630 | -0.349 | -0.350 | 0.001 |
| 800 | 0.071 | 0.070 | 0.001 |
| 1000 | 0.000 | 0.000 | 0.000 |
| 1250 | -0.503 | -0.500 | -0.003 |
| 1600 | -1.513 | -1.510 | -0.003 |
| 2000 | -2.778 | -2.780 | 0.002 |
| 2500 | -4.316 | -4.320 | 0.004 |
| 3150 | -6.166 | -6.170 | 0.004 |
| 4000 | -8.322 | -8.330 | 0.008 |
| 5000 | -10.573 | -10.590 | 0.017 |
| 6300 | -13.178 | -13.200 | 0.022 |
| 8000 | -16.241 | -16.270 | 0.029 |
| 10000 | -19.495 | -19.520 | 0.025 |

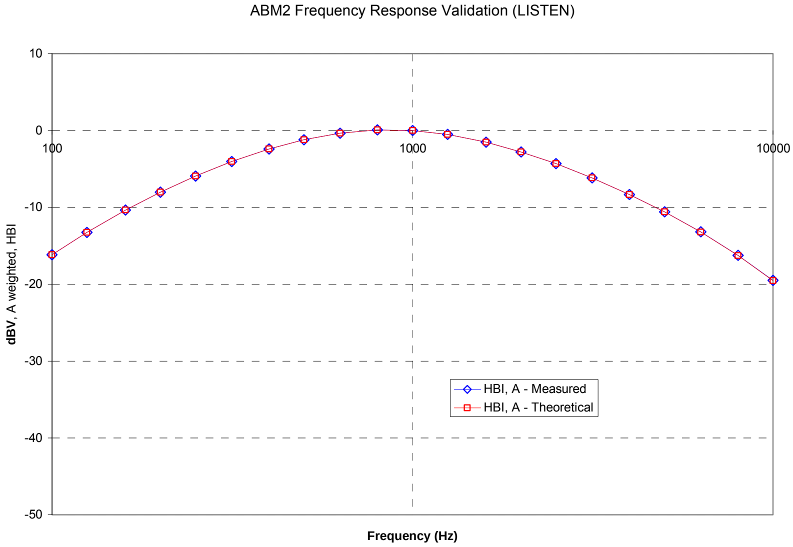



**Figure 5-3**
**ABM2 Frequency Response Validation**

The ABM2 result is a power sum from 100 Hz to 10 kHz with half-band integration and A-weighting. To verify the power sum measurement, a power sum over the full band was measured and verified to track with the source level (See Figure 5-9). Therefore the setup in this step was used to verify the power sum post-processing for ABM2 measurements. See below block diagram:

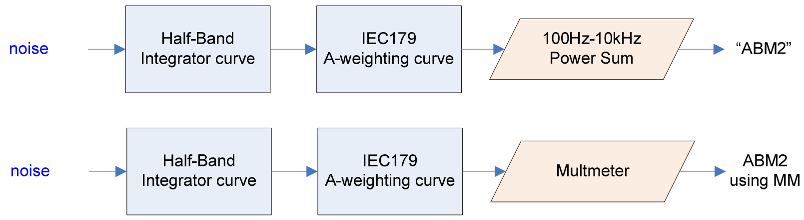



**Figure 5-4 ABM2 Validation Block Diagram**

The power summed output results for a known input were compared to the multi-meter results to verify any deviation in the post-processing implemented with the power-sum.

**Table 5-2 ABM2 Power Sum Validation**

| WN Input (dBV) | Power Sum (dBV) | Multimeter-Full (dBV) | Dev (dB) |
|---|---|---|---|
| -60 | -60.36 | -60.2 | 0.16 |
| -50 | -50.19 | -50.13 | 0.06 |
| -40 | -40.14 | -40.03 | 0.11 |
| -30 | -30.13 | -30.01 | 0.12 |
| -20 | -20.12 | -20 | 0.12 |
| -10 | -10.14 | -10 | 0.14 |

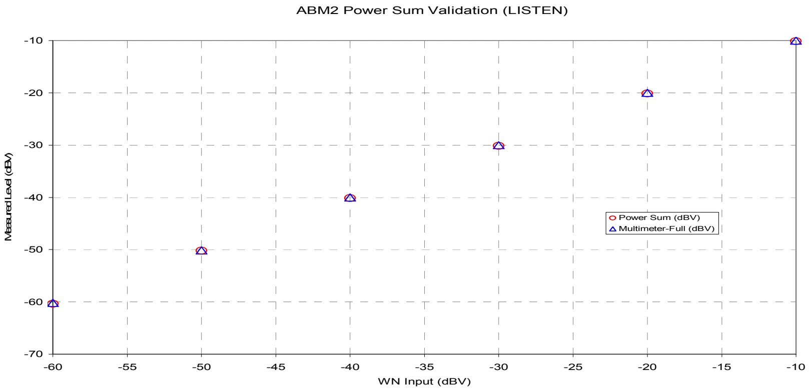



**Figure 5-5 ABM2 Power Sum Validation**

## 5.3 Measurement Test Setup

### 5.3.1 Fine scan above the WD (TEM)

a. A multi-tone signal was applied to the handset such that the phone acoustic output was stable within 1dB over the probe settling time and with the acoustic output level at the C63.19 specified levels (below). The measurement step size was in 2 mm increments at a distance of 10 mm between the surface of the wireless device as shown below:

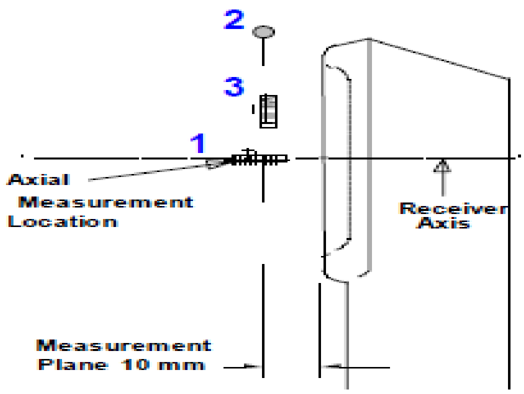



**Figure 5-6**
**Measurement Distance**

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b. After scanning, the planar field maximum point was determined. The position of the probe was moved to this location to setup the test using the sound check system.

c. These steps were repeated for the other T-coil orientations (of axial, radial transverse, or radial longitudinal) per Figure 5-16 after a T-coil orientation was fully measured with the sound check system.

### 5.3.2 Speech Signal Setup to Base Station Simulator

a. C63.19 Table 6-1 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$^{TM}$ | 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):

**Table 5-3**
**CMU200 Voltage Input Levels for Audio**

| | GSM | | | | |
|---|---|---|---|---|---|
| | Decoder Cal. | | Encoder Cal. | | Sensitivity (DUT R) |
| | Peak 1(mV) | Peak 1(dBV) | Peak 1 | RMS 1 | |
| 3.14dBm0 | 1074 | 0.62 | 1074 | 0.62 | 1.036 |
| -16dBm0 | | | 118.42 | -18.53 | |

*** Encoder cal. value adjusts to Decoder cal. value.**

b. Real-Time Analyzer (RTA)

i. The Real-Time Analyzer was configured to analyze measurements using 1/3 Octave band weighted filtering.

c. WD Radio Configuration Selection

i. The device was chosen to be tested in the worst-case ABM2 condition under Full rate 2 for GSM(see below):

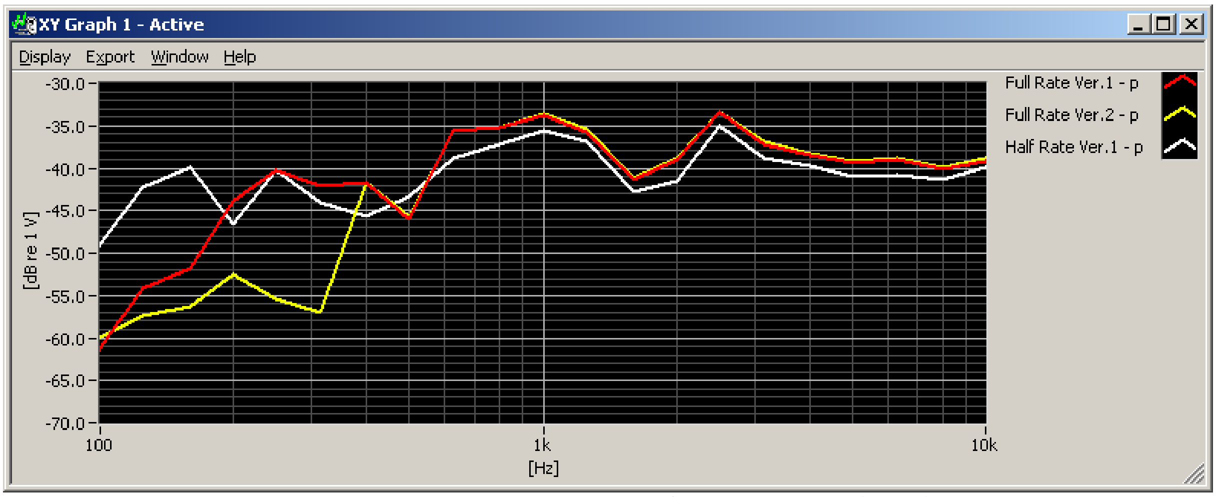



Figure 5-8 Vocoder Analysis for ABM Noise(GSM)

**Table 5-4 ABM Measurements**

| ABM2 Pre-Test (dBA/m) | | | | |
|---|---|---|---|---|
| Full Rate 1 | Full Rate 2 | Half Rate 1 | Orientation | Channel |
| -27.23 | -26.52 | -27.42 | Axial | 661 |
| **ABM1 Pre-Test (dBA/m)** | | | | |
| Full Rate 1 | Full Rate 2 | Half Rate 1 | Orientation | Channel |
| 7.08 | 7.03 | 7.12 | Axial | 661 |
| SNNR | SNNR | SNNR | Orientation | Channel |
| 34.31 | 33.55 | 34.54 | Axial | 661 |

The result shows that worst-case was defined by SNNR (ABM1-ABM2)

1. Power configuration : PCL = 5 (GSM850), PCL = 0 (GSM1900)
2. Phone condition : Mute On, Backlight On, Max Volume, Max Contrast

### 5.3.3 Signal Quality Data Analysis

a. Narrow-band Magnetic Intensity
   i. The standard specifies a 1 kHz 1/3 octave band minimum field intensity for a sine tone. The ABM1 measurements were evaluated at 1kHz with 1/3 octave band filtering over an averaged period of 10 seconds.

b. Frequency Response
   i. The appropriate frequency response curve was measured to curves in Figure 4-1 or Figure 4-2 between 300 – 3000 Hz using digital linear averaging (limit lines chosen according to measurement found in step 4a.) A linear average over 3x the length of the artificial voice signal (3x sampling) was performed. A 10 second delay was configured in the measurement process of the stimulus to ensure handset vocoder latency effects and echo cancellation devices (if any) were appropriately stabilized during measurements.
   ii. The appropriate post-processing was applied according to the system processing chain illustrated in Figure 5-13. All R10 frequencies were plotted with respect to 0dB at 1 kHz value and aligned with respect to the EIA-504 mask.

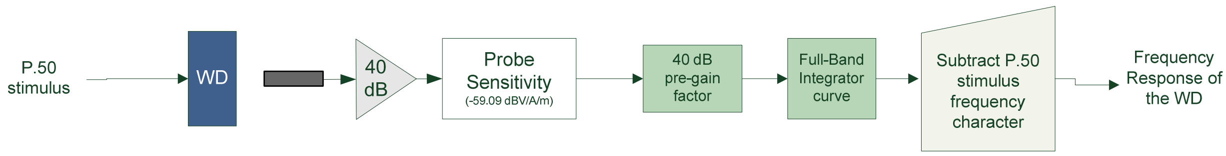



**Figure 5-8 Frequency Response Block Diagram**

   iii. The margin is represented by the closest measured data point on the curve to the EIA-504 limit lines, in dB.

c. Signal Quality Index
   i. Ensuring the WD was at maximum RF power, maximum volume, backlight on, display on, maximum contrast setting, keypad lights on (when possible) with no audio signal through the vocoder, the WD was measured over at least 100 Hz – 10,000 Hz, maximized over 5 seconds with a 50ms sample time for the ABM2 measurement (5 second time period is used in noise measurements under standards such as IEEE 269, etc.)
   ii. After applying half-band integration and A-weighting to the result, a power sum was applied over each 1/3 octave bandwidth frequency for an ABM2 value
   iii. This result was subtracted from the ABM1 result in step a, to obtain the Signal Quality.

### 5.3.4 Wireless Device Channels and Frequencies

The frequencies listed in the table below are those that lie in the center of the bands used for cellular telephony. Low, middle and high channels were tested in each band for FCC compliance evaluation to ensure the maximum emission is captured across the entire band.

To facilitate setting of a base station simulator for ABM measurements, specific band plan channel numbers are listed that may be used in lieu of the band center frequencies.

**Table 5-5**
**Center Channels and Frequencies**

| Test frequencies & associated channels | |
|---|---|
| **Channel** | **Frequency (MHz)** |
| **Cellular 850** | |
| 384 (CDMA) | 836.52 |
| UARFCN 4183(UMTS) | 836.60 |
| 190 (GSM) | 836.60 |
| **PCS 1900** | |
| 661 (GSM) | 1880 |
| 600 (CDMA) | 1880 |
| UARFCN 9400 (UMTS) | 1880 |

### 5.3.5 RF Emission Effect on T-coil Measurements

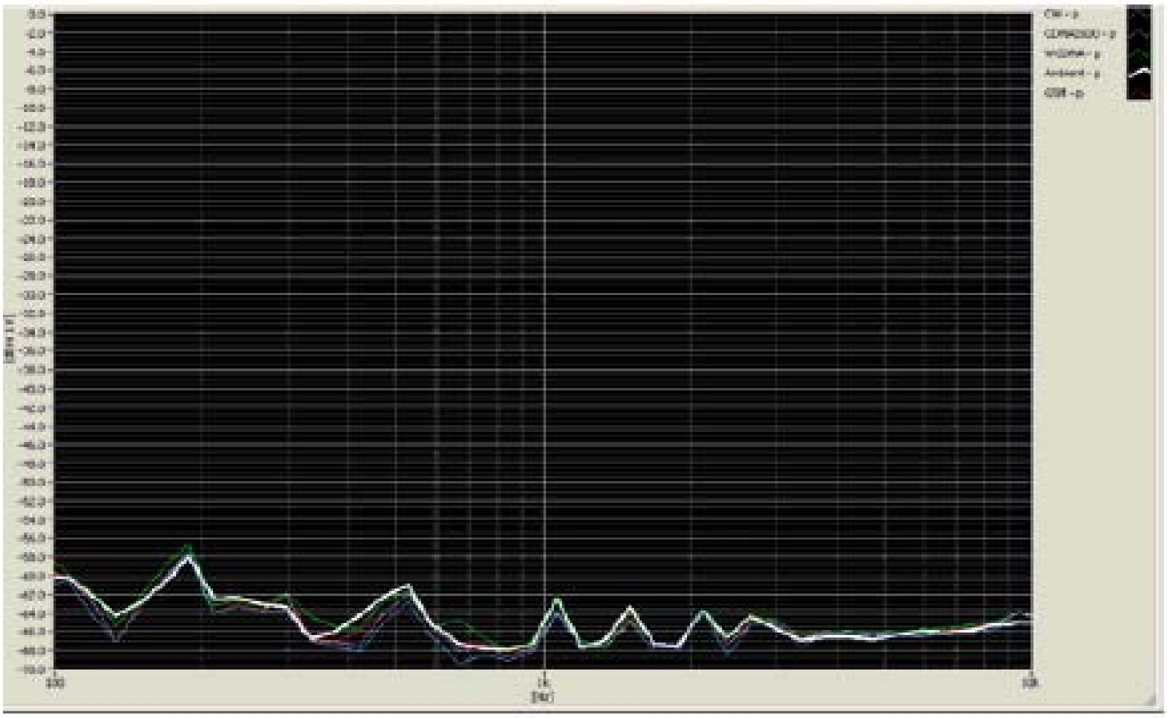


**Figure 5-9**

**High Power RF Emissions Effect with HAC Dipole on the T-coil Probe System 10mm between dipole maximum and magnetic probe**

## 6. MEASUREMENT UNCERTAINTY

| Source of Uncertainty | Value % | Probability distribution | Divisor | $c_i$ | $u_i$(y) | $(u_i(y))^2$ | $v_i$ or $v_{eff}$ | $ui(y)^4/v_{eff}$ |
|---|---|---|---|---|---|---|---|---|
| **Measurement system** | | | | | | | | |
| ABM Noise | 0.16 | normal | 1.000 | 1 | 0.16 | 0.024 | 4 | 0.0001469 |
| RF Reflection | 4.70 | rectangular | 1.732 | 1 | 2.71 | 7.363 | ∞ | 0 |
| Reference Signal Level | 12.20 | rectangular | 1.732 | 1 | 7.04 | 49.613 | ∞ | 0 |
| Probe Coil Sensitivity | 12.20 | rectangular | 1.732 | 1 | 7.04 | 49.613 | ∞ | 0 |
| Probe Linearity | 2.40 | rectangular | 1.732 | 1 | 1.39 | 1.920 | ∞ | 0 |
| Cable Loss | 2.80 | rectangular | 1.732 | 1 | 1.62 | 2.613 | ∞ | 0 |
| Frequency Analyzer | 5.00 | rectangular | 1.732 | 1 | 2.89 | 8.333 | ∞ | 0 |
| System Repeatibility | 2.04 | normal | 1.000 | 1 | 2.04 | 4.176 | 4 | 4.360 |
| Positioner Accuracy | 1.00 | rectangular | 1.732 | 1 | 0.58 | 0.333 | ∞ | 0 |
| **Test sample related** | | | | | | | | |
| WD Repeatibility | 10.40 | normal | 1.000 | 1 | 10.40 | 108.137 | 4 | 2923.396 |
| **Phantom and set-up** | | | | | | | | |
| Positioning Accuracy | 9.75 | normal | 1.000 | 1 | 9.75 | 95.045 | 4 | 2258.375 |
| Combined Standard Uncertainty | | normal | | | 18.09 | 327.172 | 21 | 5186.131 |
| **Expanded Uncertainty** | | **normal k=** | **1.96** | | 35.45 | | 21 | |

Notes:

1. Test equipments are calibrated according to techniques outlined in NIS81, NIS3003 and NIST Tech Note 1297.
2. All equipments have traceability according to NIST. Measurement Uncertainties are defined in further detail in NIS 81 and NIST Tech Note 1297 and UKAS M3003.

Measurement uncertainty reflects the quality and accuracy of a measured result as compared to the true value. Such statements are generally required when stating results of measurements so that it is clear to the intended audience that the results may differ when reproduced by different facilities. Measurement results vary due to the measurement uncertainty of the instrumentation, measurement technique, and test engineer. Most uncertainties are calculated using the tolerances of the instrumentation used in the measurement, the measurement setup variability, and the technique used in performing the test. While not generally included, the variability of the equipment under test also figures into the overall measurement uncertainty. Another component of the overall uncertainty is based on the variability of repeated measurements (so-called Type A uncertainty). This may mean that the Hearing Aid compatibility tests may have to be repeated by taking down the test setup and resetting it up so that there are a statistically significant number of repeat measurements to identify the measurement uncertainty. By combining the repeat measurement results with that of the instrumentation chain using the technique contained in NIS 81 and NIS 3003, the overall measurement uncertainty was estimated.

# 7. Test Results

## 7.1 Test Summary

**Table 7-1**
**Table of Results for GSM**

| Mode | Band | Orientation | Measurement Item | Limit | Measured | Verdict | Result |
|---|---|---|---|---|---|---|---|
| **GSM** | **GSM 850** | **Axial** | Intensity | -18 | 7.71 | **PASS** | **T3** |
| | | | Frequency Response | 0 | 1.45 | **PASS** | |
| | | | SNNR | 20 | 30.84 | **PASS** | |
| | | **Radial Transverse** | Intensity | -18 | 1.01 | **PASS** | |
| | | | Frequency Response | 0 | 1.42 | **PASS** | |
| | | | SNNR | 20 | 22.54 | **PASS** | |
| | | **Radial Longitudinal** | Intensity | -18 | -5.57 | **PASS** | |
| | | | Frequency Response | 0 | 1.52 | **PASS** | |
| | | | SNNR | 20 | 27.78 | **PASS** | |
| | **GSM 1900** | **Axial** | Intensity | -18 | 7 | **PASS** | **T3** |
| | | | Frequency Response | 0 | 1.47 | **PASS** | |
| | | | SNNR | 20 | 33.45 | **PASS** | |
| | | **Radial Transverse** | Intensity | -18 | 0.96 | **PASS** | |
| | | | Frequency Response | 0 | 1.43 | **PASS** | |
| | | | SNNR | 20 | 25.31 | **PASS** | |
| | | **Radial Longitudinal** | Intensity | -18 | -5.56 | **PASS** | |
| | | | Frequency Response | 0 | 1.54 | **PASS** | |
| | | | SNNR | 20 | 30.59 | **PASS** | |

*Note
- The above results are tested in the worst case of ABM2 configuration.
  (GSM Full Rate2 configuration)
- Slide open is the configuration with maximum antenna RF efficiency.
  Therefore Slide open only tested per C63.19 §4.3.3

**The measured T-coil category is T3 for GSM mode and all raw data is in Section 7.2.**

## 7.2 Raw Data for T-coil Measurement

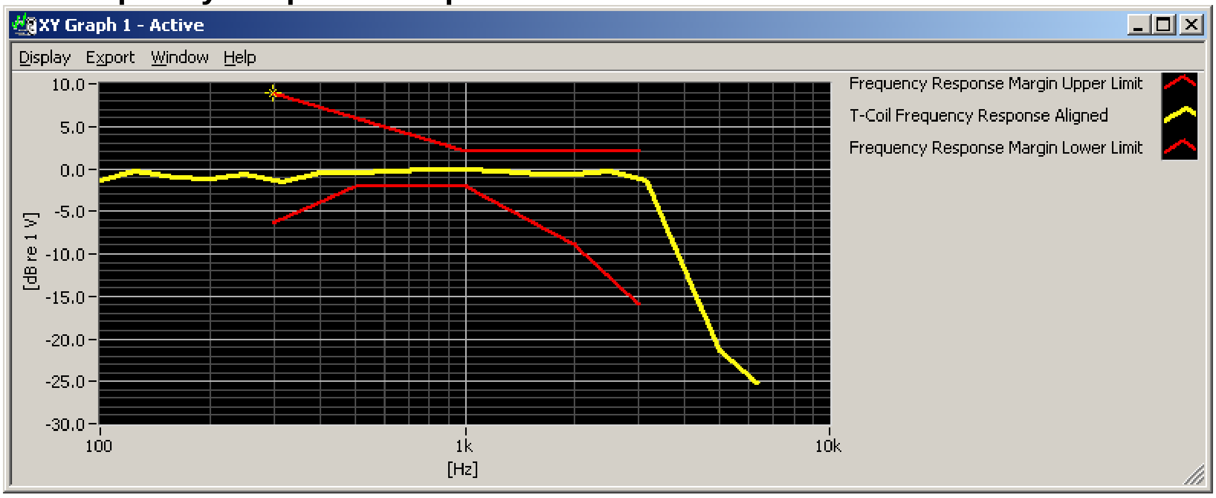
**Table 7-2**
**Rawdata for GSM**

| | GSM850 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Axial | | | Radial Transverse | | | Radial Longitudinal | | |
| | Ch.128 | Ch.190 | Ch.251 | Ch.128 | Ch.190 | Ch.251 | Ch.128 | Ch.190 | Ch.251 |
| ABM1 (dBA/m) | 7.82 | 7.71 | 7.81 | 1.04 | 1.15 | 1.01 | -5.57 | -5.42 | -5.54 |
| ABM2(dBA/m) | -23.01 | 23.34 | -25.83 | -21.5 | -21.95 | -24.36 | -33.35 | -33.86 | -36.06 |
| Frequency Response(dB) | 1.45 | 1.47 | 1.47 | 1.42 | 1.42 | 1.42 | 1.53 | 1.52 | 1.56 |
| SNNR(dB) | 30.84 | 31.05 | 33.63 | 22.54 | 23.11 | 25.36 | 27.78 | 28.44 | 30.52 |
| Ambient Noise(dBA/m) | -62.9 | | | -63.59 | | | -63.3 | | |
| Minimum of SNNR | 30.84 | | | 22.54 | | | 27.78 | | |

| | GSM1900 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Axial | | | Radial Transverse | | | Radial Longitudinal | | |
| | Ch.512 | Ch.661 | Ch.810 | Ch.512 | Ch.661 | Ch.810 | Ch.512 | Ch.661 | Ch.810 |
| ABM1 (dBA/m) | 7 | 7.14 | 7.01 | 0.98 | 0.96 | 0.98 | -5.54 | -5.56 | -5.52 |
| ABM2(dBA/m) | -26.45 | -26.72 | -27.53 | -24.34 | -24.76 | -26.52 | -36.12 | -36.91 | -36.84 |
| Frequency Response(dB) | 1.47 | 1.48 | 1.48 | 1.43 | 1.45 | 1.48 | 1.54 | 1.56 | 1.56 |
| SNNR(dB) | 33.45 | 33.86 | 34.54 | 25.31 | 25.72 | 27.5 | 30.59 | 31.35 | 31.52 |
| Ambient Noise(dBA/m) | -62.9 | | | -63.59 | | | -63.3 | | |
| Minimum of SNNR | 33.45 | | | 25.31 | | | 30.59 | | |

WD Configuration :
1. Power configuration : PCL = 5 (GSM850), PCL = 0 (GSM1900)
2. Phone condition : Mute On, Backlight On, Max Volume, Max Contrast
3. Radio Configuration : Full Rate 2

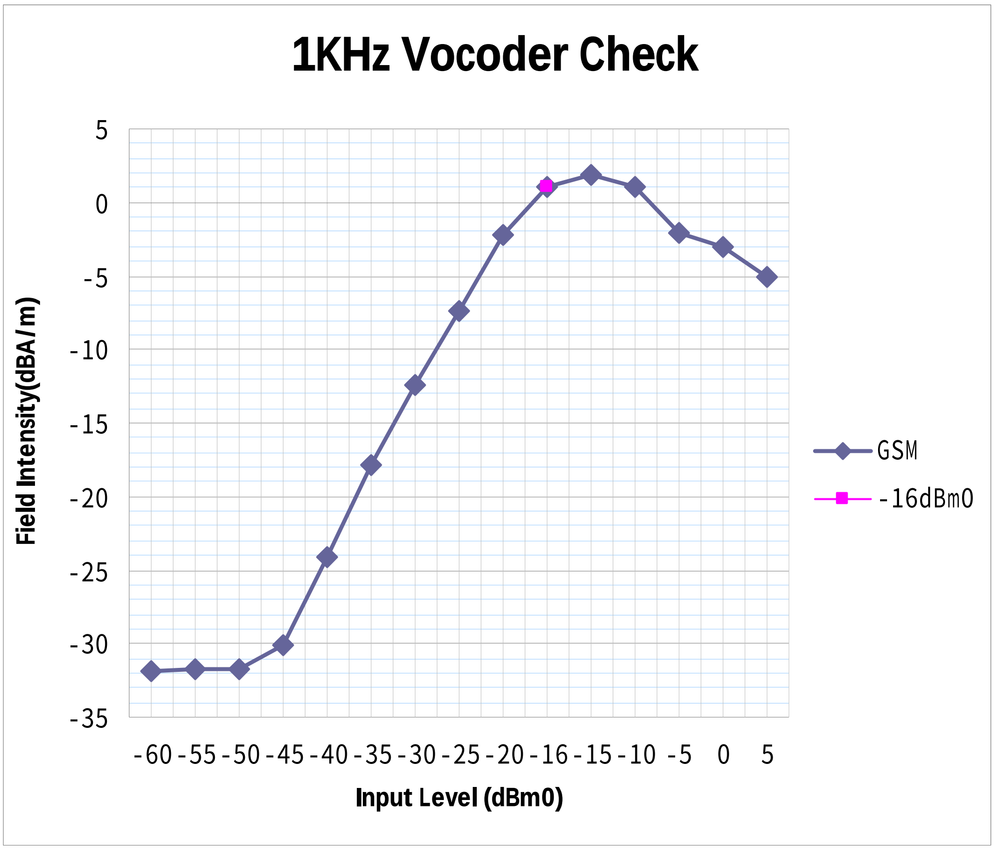
## 7.3 Frequency Response Graph



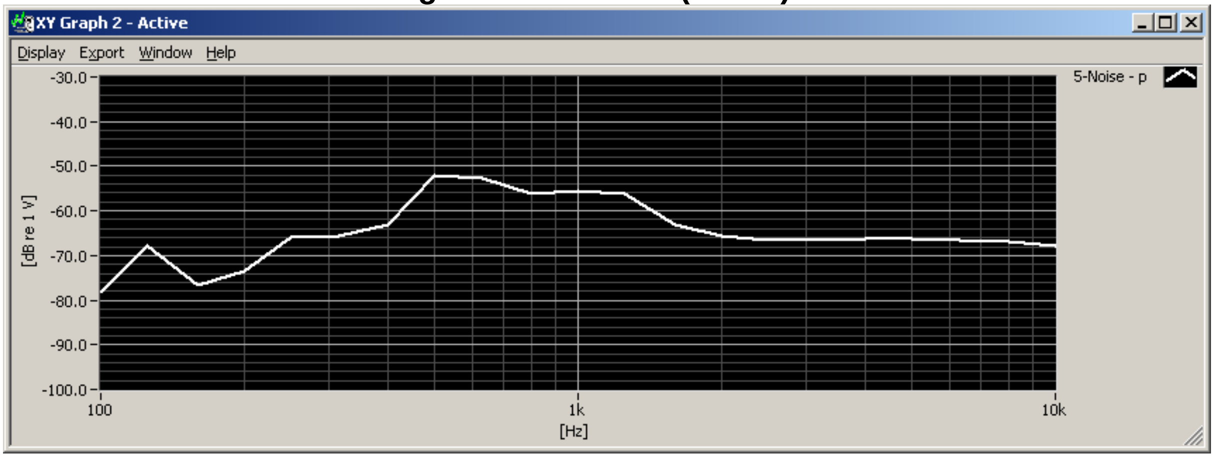

Note : This frequency response represents the worst-case ABM2 test configuration according to Table 7-2 for GSM

## 7.4 1KHz Vocoder Application Check

This model was verified to be within the linear region for ABM1 measurements. Two type of modes were tested in the axial configuration above the ABM1 maximum location/configuration derived from Table 7-3 & Table 7-4.



## 7.5 Undesirable Audio Magnetic Band Plot (ABM2)




Note : This plot represents the data from the location/configuration resulting in the highest ABM2 result regarding Table 7-2 for GSM

## 7.6 T-coil Validation Test Results

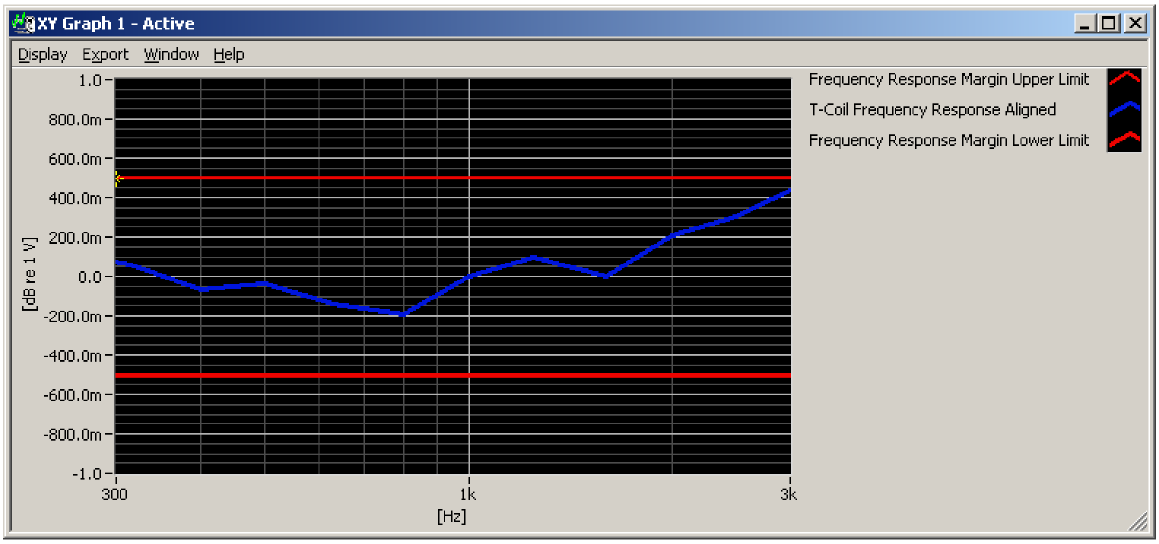



**Figure 7-1**
**Helmholtz coil Validation for Frequency Response**

**Table 7-5**
**Table of Results for Helmholtz coil and Noise Validation**

| Orientation | Item | Target | Measured dB | Verdict |
|---|---|---|---|---|
| **Helmholtz coil validation** | | | | |
| Axial | Frequency Response | 0 ±0.5dB | **0.09** | **PASS** |
| | Magnetic Intensity, 0 dBA/m | 0 ±0.5dB | **0.409** | **PASS** |
| Radial | Frequency Response | 0 ±0.5dB | **0.06** | **PASS** |
| | Magnetic Intensity, 0 dBA/m | 0 ±0.5dB | **0.249** | **PASS** |
| **Noise Validation** | | | | |
| Axial | | <-58dBA/m | **-61.65** | **PASS** |
| Radial Transverse | | <-58dBA/m | **-61.51** | **PASS** |
| Radial Longitudinal | | <-58dBA/m | **-61.55** | **PASS** |

## 8. Conclusion

The measurements indicate that the wireless communications device complies with the HAC limits specified in accordance with the ANSI C63.19 standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item tested.

The measurement system and techniques presented in this evaluation are proposed in the ANSI standard as a means of best approximating wireless device compatibility with a hearing-aid. The literature is under continual re-construction.

## 9. Reference

[1] ANSI C63.19-2007, American National Standard for Methods of Measurement of Compatibility between Wireless communication devices and Hearing Aids.", New York,NY, IEEE, June. 2008.

[2] FCC Public Notice DA 06-1215, Wireless Telecommunications Bureau and Office of Engineering and Technology Clarify Use of Revised Wireless Phone Hearing Aid Compatibility Standard, June 6,2006

[3] FCC 3G Review Guidance, Laboratory Division OET FCC, Oct 2007

[4] Berger, H. S., "Compatibility Between Hearing Aids and Wireless Devices," Electronic Industries Forum, Boston, MA, May, 1997

[5] Berger, H. S., "Hearing Aid and Cellular Phone Compatibility: Working Toward Solutions," Wireless Telephones and Hearing Aids: New Challenges for Audiology, Gallaudet University, Washington, D.C., May, 1997 (To be reprinted in the American Journal of Audiology).

[6] Berger, H. S., "Hearing Aid Compatibility with Wireless Communications Devices," IEEE International Symposium on Electromagnetic Compatibility, Austin, TX, August, 1997.

[7] Bronaugh, E. L, "Simplifying EMI Immunity (Susceptibility) Tests in TEM Cells," in the 1990 IEEE International Symposium on Electromagnetic Compatibility Symposium Record, Washington, D.C., August 1990, pp. 488-491

[8] Byrne, D. and Dillon, H., The National Acoustics Laboratory (NAL) New Procedure for Selecting the Gain and Frequency Response of a Hearing Aid, Ear and Hearing 7:257-265, 1986.

[9] Crawford, M. L, "Measurement of Electromagnetic Radiation from Electronic Equipment using TEM Transmission Cells," U.S. Department of Commerce, National Bureau of Standards, NBSIR 73-306, Feb. 1973.

[10] Crawford, M. L, and Workman, J. L, "Using a TEM Cell for EMC Measurements of Electronic Equipment," U.S. Department of Commerce, National Bureau of Standards. Technical Note 1013, July 1981.

[11] EHIMA GSM Project, Development phase, Project Report (1st part) Revision A. Technical-Audiological Laboratory and Telecom Denmark, October 1993.

[12] EHIMA GSM Project, Development phase, Part II Project Report. Technical-Audiological Laboratory and Telecom Denmark, June 1994.

[13] EHIMA GSM Project Final Report, Hearing Aids and GSM Mobile Telephones: Interference Problems, Methods of Measurement and Levels of Immunity. Technical-Audiological Laboratory and Telecom Denmark, 1995.

[14] HAMPIS Report, Comparison of Mobile phone electromagnetic near field with an upscaled electromagnetic far field, using hearing aid as reference, 21 October 1999.

[15] Hearing Aids/GSM, Report from OTWIDAM, Technical-Audiological Laboratory and Telecom Denmark, April 1993.

[16] EEE 100, The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition.

[17] Joyner, K. H, et. al., Interference to Hearing Aids by the New Digital Mobile Telephone System, Global System for Mobile (GSM) Communication Standard, National Acoustic Laboratory, Australian Hearing Series, Sydney 1993.

[18] Joyner, K. H., et. al., Interference to Hearing Aids by the Digital Mobile Telephone System, Global System for Mobile Communications (GSM), NAL Report #131, National Acoustic Laboratory Australian Hearing Series, Sydney, 1995.

[19] Keeker, W. T., Crawford, M. L., and Wilson, W. A., "Contruction of a Transverse Electromagnetic Cell", U.S. Department of Commerce, National Bureau of Standards, Technical Note 1011, Nov. 1978.

[20] Konigstein, D., and Hansen, D., "A New Family of TEM Cells with enlarged bandwidth and Optimized working Volume," in the Proceedings of the 7th International Symposium on EMC, Zurich, Switzerland, March 1987; 50:9, pp. 127-132.

[21] Kuk, F., and Hjorstgaard, N. K., "Factors affecting interference from digital cellular telephones, " Hearing Journal, 1997; 50:9, pp 32-34.

[22] Ma, M. A., and Kanda, M., "Electromagnetic Compatibility and Interference Metrology," U.S. Department of Commerce, National Bureau of Standards, Technical Note 1099, July 1986, pp.17-43.

[23] Ma, M. A., Sreenivashiah, I. , and Chang, D. C, "A Method of Determining the Emission and Susceptibility Levels of Electrically Small Objects Using a TEM Cell," U.S. Department of Commerce, National Bureau of Standards, Technial Note 1040, July 1981.

[24] McCandless, G. A., and Lyregaard, P. E., Prescription of Gain/Output (POGO) for Hearing Aids, Hearing Instruments 1:16-21, 1983

[25] Skopec, M., "Hearing Aid Electromagnetic Interference from Digital Wireless Telephones, "IEEE Transactions on Rehabilitation Engineering, vol. 6, no. 2, pp. 235-239, June 1998.

[26] Technical Report, GSM 05.90, GSM EMC Considerations, European Telecommunications Standards Institute, January 1993.

[27] Victorian, T. A., "Digital Cellular Telephone Interference and Hearing Aid Compatibility—an Update," Hearing Journal 1998; 51:10, pp. 53-60

[28] Wong, G. S. K., and Embleton, T. F. W., eds., AIP Handbook of Condenser Microphones: Theory, Calibration and Measurements, AIP Press.

## West Caldwell Calibration Laboratories Inc.

# Certificate of Calibration

for

RADIAL T COIL PROBE

| | |
|---|---|
| Manufactured by: | TEM CONSULTING |
| Model No: | RADIAL T COIL |
| Serial No: | TEM-1110 |
| Calibration Recall No: | 19873 |

**Submitted By:**

| | |
|---|---|
| Customer: | STEVE LIU |
| Company: | PCTEST ENGINEERING LAB |
| Address: | 6660-B DOBBIN ROAD |
| | COLUMBIA MD 21045 |

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. RADIAL T TEM

Upon receipt for Calibration, the instrument was found to be:

Within ( X ) see attached Report of Calibration.

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2000 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: 18-Jun-10

Certificate No: 19873 -2

Felix Christopher
Quality Manager

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.
Calibration Traceable To N. I. S. T.
Phone: (585) 586-3900 Fax.: (585) 586-4327

ACCREDITATION ISO/IEC 17025 ACCREDITED 1533.01

O.k to use 2010.11.28

**West Caldwell Calibration Laboratories, Inc.**
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO 9001:2000 Registered Company
Calibration Traceable to N.I.S.T.

ACCREDITATION ISO/IEC 17025
ACCREDITED
1533.01

# REPORT OF CALIBRATION

for

**TEM Consulting LP Radial T Coil Probe** **Model No.: Radial T Coil Probe** **Serial No.: TEM-1110**

**Company : Pctest Engineering Lab.** **I. D. No: XXXX**

Calibration results: **Before data:** ......... **After data:** .........

**Probe Sensitivity measured with Helmholtz Coil**

**Before & after data same:** ...**X**......

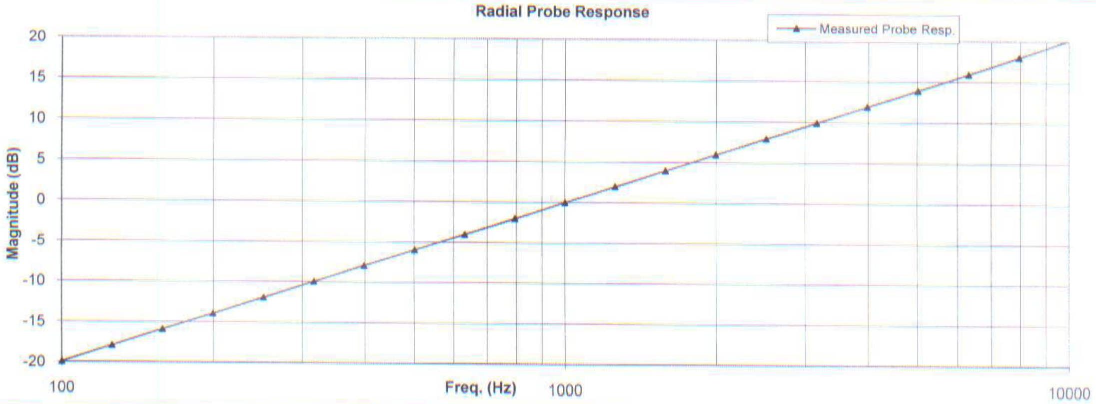
| | | | | | |
|---|---|---|---|---|---|
| ***Helmholtz Coil;*** | | | | | |
| the number of turns on each coil; | 20 | No. | | | |
| the radius of each coil, in meters; | 0.204 | m | Laboratory Environment: | | |
| the current in the coils, in amperes.; | 0.10 | A | Ambient Temperature: | 21.4 | °C |
| *Helmholtz Coil Constant;* | 6.99 | A/m/V | Ambient Humidity: | 51.5 | % RH |
| *Helmholtz Coil magnetic field;* | 7.04 | A/m | Ambient Pressure: | 99.8 | kPa |
| | | | Calibration Date: | 18-Jun-10 | 3:42 PM |
| Probe Sensitivity at | 1000 | Hz. | Re-calibration Due: | 18-Jun-11 | |
| was | -60.39 | dBV/A/m | Report Number: | 19873 | -2 |
| | 0.956 | mV/A/m | Control Number: | 19873 | |
| Probe resistance | 883 | Ohms | | | |

**The above listed instrument meets or exceeds the tested manufacturer's specifications.**

This Calibration is traceable through NIST test numbers: ,100016001

The expanded uncertainty of calibration: 0.28dB at 95% confidence level with a coverage factor of k=2.

Graph represents Probes Frequency Response.




The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCRTEMC**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2000, ISO 17025

Cal. Date: 18-Jun-2010 3:42 PM

**Calibrated on WCCL system type 9700**

Measurements performed by: ................................
**Felix Christopher**



Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCRTEMC

**West Caldwell Calibration Laboratories Inc.**
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

# *Calibration Data Record*

for

**TEM Consulting LP Radial T Coil Probe** **Model No.: Radial T Coil Probe** **Serial No.: TEM-1110**

**Company : Pctest Engineering Lab.**

| Test | Function | | Tolerance | Measured values Before | Out | Remarks |
|---|---|---|---|---|---|---|
| 1.0 | Probe Sensitivity at | 1000 Hz. | dBV/A/m | -60.39 | | |
| 2.0 | Probe Level Linearity | | dB | | | |
| | | | 6 | 6.03 | | |
| | | Ref. (0 dB) | 0 | 0.00 | | |
| | | | -6 | -6.02 | | |
| | | | -12 | -12.02 | | |
| 3.0 | Probe Frequency Response | | Hz | | | |
| | | | 100 | -19.9 | | |
| | | | 126 | -17.9 | | |
| | | | 158 | -15.9 | | |
| | | | 200 | -13.9 | | |
| | | | 251 | -11.9 | | |
| | | | 316 | -9.9 | | |
| | | | 398 | -8.0 | | |
| | | | 501 | -6.0 | | |
| | | | 631 | -4.0 | | |
| | | | 794 | -2.0 | | |
| | | Ref. (0 dB) | 1000 | 0.0 | | |
| | | | 1259 | 2.0 | | |
| | | | 1585 | 4.0 | | |
| | | | 1995 | 6.0 | | |
| | | | 2512 | 7.9 | | |
| | | | 3162 | 9.9 | | |
| | | | 3981 | 11.9 | | |
| | | | 5012 | 13.9 | | |
| | | | 6310 | 15.9 | | |
| | | | 7943 | 18.0 | | |
| | | | 10000 | 20.2 | | |

| Instruments used for calibration: | | | Date of Cal. | Traceability No. | Due Date |
|---|---|---|---|---|---|
| HP | 34401A | S/N US360641 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| HP | 34401A | S/N US361024 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| HP | 33120A | S/N S3604371 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| B&K | 2133 | S/N 1492410 | 27-Feb-2010 | 822/275722-08 | 27-Feb-2011 |

Cal. Date: 18-Jun-2010 3:42 PM

Tested by: Felix Christopher

Calibrated on WCCL system type 9700



Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCRTEMC

West Caldwell Calibration Laboratories Inc.

# Certificate of Calibration

for

AXIAL T COIL PROBE

| | |
|---|---|
| Manufactured by: | TEM CONSULTING |
| Model No: | AXIAL T COIL |
| Serial No: | TEM-1111 |
| Calibration Recall No: | 19873 |

Submitted By:

| | |
|---|---|
| Customer: | STEVE LIU |
| Company: | PCTEST ENGINEERING LAB |
| Address: | 6660-B DOBBIN ROAD |
| | COLUMBIA MD 21045 |

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. AXIAL T C TEM

Upon receipt for Calibration, the instrument was found to be:

Within ( X ) see attached Report of Calibration.

the tolerance of the indicated specification.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2000 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: 18-Jun-10

Certificate No: 19873 - 3

FC

Felix Christopher
Quality Manager

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1

West Caldwell Calibration Laboratories, Inc.
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1575 State Route 96, Victor, NY 14564, U.S.A.
Calibration Traceable To N. I. S. T.
Phone: (585) 586-3900 Fax.: (585) 586-4327

O.k to use 2010.7.29

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO 9001:2000 Registered Company

Calibration Traceable to N.I.S.T.

ACCREDITATION ISO/IEC 17025

ACCREDITED 1533.01

# REPORT OF CALIBRATION

for

**TEM Consulting LP Axial T Coil Probe** **Model No.: Axial T Coil Probe** **Serial No.: TEM-1111**

**Company : Pctest Engineering Lab.** **I. D. No: XXXX**

Calibration results: **Before data:** ......... **After data:** .........

**Probe Sensitivity measured with Helmholtz Coil**

**Before & after data same:** ...**X**......

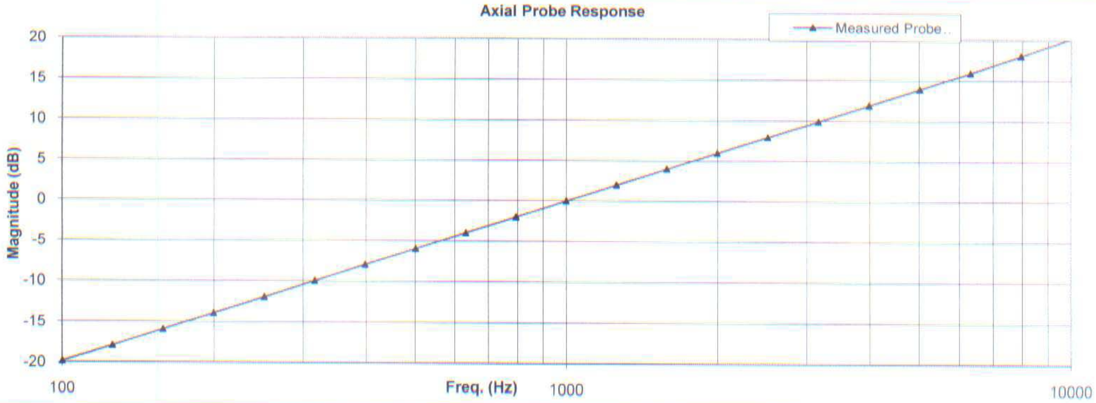
| | | | | | |
|---|---|---|---|---|---|
| *Helmholtz Coil;* | | | | | |
| the number of turns on each coil; | 20 | No. | | | |
| the radius of each coil, in meters; | 0.204 | m | Laboratory Environment: | | |
| the current in the coils, in amperes.; | 0.10 | A | Ambient Temperature: | 21.4 | °C |
| *Helmholtz Coil Constant;* | 6.98 | A/m/V | Ambient Humidity: | 51.5 | % RH |
| *Helmholtz Coil magnetic field;* | 7.02 | A/m | Ambient Pressure: | 99.8 | kPa |
| | | | Calibration Date: | 18-Jun-10 | 4:19 PM |
| Probe Sensitivity at | 1000 | Hz. | Re-calibration Due: | 18-Jun-11 | |
| was | -60.30 | dBV/A/m | Report Number: | 19873 | -3 |
| | 0.966 | mV/A/m | Control Number: | 19873 | |
| Probe resistance | 898 | Ohms | | | |

**The above listed instrument meets or exceeds the tested manufacturer's specifications.**

This Calibration is traceable through NIST test numbers: ,100016001

The expanded uncertainty of calibration: 0.28dB at 95% confidence level with a coverage factor of k=2.

Graph represents Probes Frequency Response.




The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCATEMC**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2000, ISO 17025

Cal. Date: 18-Jun-2010 4:19 PM

Measurements performed by: ..............................

**Calibrated on WCCL system type 9700**

**Felix Christopher**



Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCATEMC

**West Caldwell Calibration Laboratories Inc.**
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

# Calibration Data Record

for

**TEM Consulting LP Axial T Coil Probe** **Model No.: Axial T Coil Probe** **Serial No.: TEM-1111**

**Company : Pctest Engineering Lab.**

| Test | Function | | Tolerance | | Measured values Before | Out | Remarks |
|---|---|---|---|---|---|---|---|
| 1.0 | Probe Sensitivity at | 1000 Hz. | | dBV/A/m | -60.30 | | |
| | | | | dB | | | |
| 2.0 | Probe Level Linearity | | | 6 | 6.03 | | |
| | | | Ref. (0 dB) | 0 | 0.00 | | |
| | | | | -6 | -6.02 | | |
| | | | | -12 | -12.03 | | |
| | | | | Hz | | | |
| 3.0 | Probe Frequency Response | | | 100 | -19.8 | | |
| | | | | 126 | -17.9 | | |
| | | | | 158 | -15.9 | | |
| | | | | 200 | -13.9 | | |
| | | | | 251 | -11.9 | | |
| | | | | 316 | -9.9 | | |
| | | | | 398 | -8.0 | | |
| | | | | 501 | -6.0 | | |
| | | | | 631 | -4.0 | | |
| | | | | 794 | -2.0 | | |
| | | | Ref. (0 dB) | 1000 | 0.0 | | |
| | | | | 1259 | 2.0 | | |
| | | | | 1585 | 4.0 | | |
| | | | | 1995 | 6.0 | | |
| | | | | 2512 | 7.9 | | |
| | | | | 3162 | 9.9 | | |
| | | | | 3981 | 11.9 | | |
| | | | | 5012 | 13.9 | | |
| | | | | 6310 | 15.9 | | |
| | | | | 7943 | 18.0 | | |
| | | | | 10000 | 20.2 | | |

| Instruments used for calibration: | | | Date of Cal. | Traceablity No. | Due Date |
|---|---|---|---|---|---|
| HP | 34401A | S/N US360641 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| HP | 34401A | S/N US361024 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| HP | 33120A | S/N S3604371 | 10-Nov-2009 | ,100016001 | 10-Nov-2010 |
| B&K | 2133 | S/N 1492410 | 27-Feb-2010 | 822/275722-08 | 27-Feb-2011 |

Cal. Date: 18-Jun-2010 **4:19 PM** Tested by: Felix Christopher

Calibrated on WCCL system type 9700



Rev. 4.0 Mar. 09, 2010 Doc. # 1038 HCATEMC