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# Hearing Aid Compatibility Audio Band Magnetic (ABM) T-Coil Test Report

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**Statement of Compliance:** RIM Testing Services (RTS) declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices.

This wireless portable device has been shown to be in compliance with FCC 20.19 (10-1-05 Edition), Hearing Aid-Compatible Mobile Handsets and FCC Public Notice DA 06-1215 (June 6, 2005).

	Signatures	Date
<b>Tested and documented by:</b>  Daoud Attayi Senior Compliance Specialist		02-August-2006
<b>Approved by:</b>  Paul G. Cardinal, Ph.D. Manager, RIM Testing Services		12-June-2006

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## 1.0 Introduction

This test report demonstrates the measurement of the Audio Band Magnetic fields (ABM) generated by a wireless communication device in the region where a hearing aid would be used in the T-Coil mode.

Three quantities are measured and evaluated. The first is the field intensity of the desired signal at the center of the audio band. The second is the frequency response of the desired signal measured across the audio band. The third is the signal quality, which is defined as the ratio between the desired and undesired magnetic field levels.

The SPEAG DASY4 T-Coil extension together with the HAC RF extension allows complete characterization of the emissions of a wireless device (WD). The signals measured during these tests represent the field picked up by the T-Coil of a hearing aid. Using DASY4, three orthogonal axes are scanned with a probe incorporating a sensor coil: one axial (perpendicular), and two radial (transverse and longitudinal) directions with respect to the plane and main axis of the WD.

The WD is mounted on the Test Arch phantom (provided with the HAC RF extension). Its acoustic center is centered and represents the reference for the combination of ABM and RF field evaluation. The ABM fields of the WD (frequency range <20 kHz) are scanned with a fully RF shielded active 1D magnetic probe. The probe axis is oriented in space diagonal to the three orthogonal axes, and its single sensor can be oriented to the axes by 120° rotation. The probe signal is evaluated by an Audio Magnetic Measurement Instrument (AMMI) which is interfaced to the DASY4 computer via USB. The AMMI also provides test and calibration signals and interfaces to the Helmholtz Audio Magnetic Calibration Coil (AMCC).

Predefined or user-definable audio signals for injection into the WD during the test are available at a connector of the AMMI. The DASY4 software allows flexible control of scan, rotation, measurement duration, as well as selection of the measurement mode and signal source for all ABM measurements. Filtering as specified by the standard is applied to the sampled signal resulting in the signal level, (weighted) noise level and a third-octave resolution spectrum for the frequency response. This information is represented numerically and graphically during the scans and graphically evaluated in the postprocessor. The combination of the quantities (signal level, frequency response, signal to noise ratio) leads to an overall classification according to ANSI-C63.19. Coarse, fine and point scan together with user selectable test signals, minimize the time to find the "optimal point" with the highest class for the WD.

The background noise evaluations were made for each probe orientation without an active WD in the area of the WD scan. The background noise were measured be lower by 10 dB than the measurements.

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## 2.0 Applicable references

[1] ANSI C63.19-2006, American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

[2] FCC 47CFR § 20.19 (10-1-05 Edition), Hearing Aid-Compatible Mobile Handsets.

[3] FCC Public Notice DA 06-1215 (June 6, 2006).

[4] SPEAG DASY4 V4.7 draft user manual, May 2006.

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### 3.0 Equipment unit tested

#### 3.1 Picture of Handheld



**Figure 1: BlackBerry Wireless Handheld**

#### 3.2 Handheld description

<b>Handheld Model</b>	RAV20CW		
<b>FCC ID</b>	L6ARAV20CW		
<b>PIN Number</b>	FFFFFFF		
<b>Prototype or Production Unit</b>	Production		
<b>Mode(s) of Operation</b>	CDMA 800	CDMA 1900	* Bluetooth
<b>Transmitting Frequency Range</b>	824.70-848.31 MHz	1851.25-1908.75 MHz	2402-2483MHz
<b>Nominal Maximum conducted RF Output Power**</b>	24.50 dBm	23.50 dBm	3.5 dBm
<b>Tolerance in Power Setting on centre channel</b>	± 0.50 dB	± 0.50 dB	N/A
<b>Duty Cycle</b>	1:1	1:1	N/A

**Table 1. Test device characterization**

\*For this product, a headset is the only Bluetooth application. Therefore, HAC RF Emission or Audio Band Magnetic (ABM) T-Coil testing are not applicable to Bluetooth.

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### 3.3 Antenna description

<b>Type</b>	Internal fixed antenna
<b>Location</b>	Bottom back centre
<b>Configuration</b>	Internal fixed antenna

Table 2. Antenna description

### 4.0 List of test equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Calibration Due Date
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE3)	DAE3 V1	473	09-Mar-07
SCHMID & Partner Engineering AG	Audio Band Magnetic Probe	AM1DV2	1016	18-Apr-07
SCHMID & Partner Engineering AG	Helmholtz Coil AMCC	N/A	1021	CNR
SCHMID & Partner Engineering AG	Audio Band Magnetic Measuring Instrument (AMMI)	N/A	1013	CNR
Agilent	Dynamic Signal Analyzer	35670A	3940A04298	CNR
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	08-Feb-07
Rohde & Schwarz	Audio Analyzer	UPL16	100070	20-May-06

Table 3. List of test equipment

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## 5.0 DASY4 HAC T-Coil measurement system and setup

### 5.1 Audio signals:

The following audio signal files are used for calibration and measurements:

**1.025 kHz sinewave (duration 10 s):** used alternatively instead of 1 kHz, according to [1] 6.3.1 step 2, if the internal 1.0 kHz signal would cause interferences inside the WD. The bandwidth is suited for signal quality or signal level measurements.

**Multisine signal 50 Hz – 5 kHz (duration 10 s):** Signal with carrier centered in each third-octave band, as used during the calibration.

**48k\_voice\_300-3000 (duration 2 s):** The signal is voice like and has been processed to have a duration of 2 seconds for fast measurement. The bandwidth is suited for frequency response measurement.

Signal type	<i>1.025 kHz sinewave</i>	<i>48k_voice_300-3000</i>
Signal length (s)	10	2
Time per location for ABM1, ABM2 and input level measurement (s)	10	10
Averaging over signal repetitions	1	5

Table 4: Audio files length and averaging times

### 5.2 Input level measurement

To determine correct input level, the Encoder / Decoder of a Rohde & Schwarz CMU 200 base station simulator was calibrated for measured full-scale input voltage level. From the measured full-scale voltage level, the equivalent input voltage level of -16 dBm0 was calculated as shown in section 6.2.

Time averaging was used with an artificial speech based signal when setting the input reference level. The averaging period was adequate to cover the signal period and the averaging method was the same for setting the reference level and performing the measurement.

A Dynamic Signal Analyzer was used to measure time averaging of speech-simulated signal. The analyzer was set to measure the audio signal at 1/3 octave, 10 seconds time averaging. The speech simulated signal duration is 2 seconds and sinusoidal signal duration is 10 seconds. The DASY4 program was set to repeat the audio file while measuring time averaging. Amplifier setting of the DASY4 software was adjusted to get the correct input level. Time averaged input level measurement plots are shown below:

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Figure 2: Top plot shows RMS time averaging power for the "48k\_voice\_300-3000" signal (sum of third-octave filters from 100 Hz to 10 Hz) and bottom plot is RMS power at 1 kHz third-octave filter.



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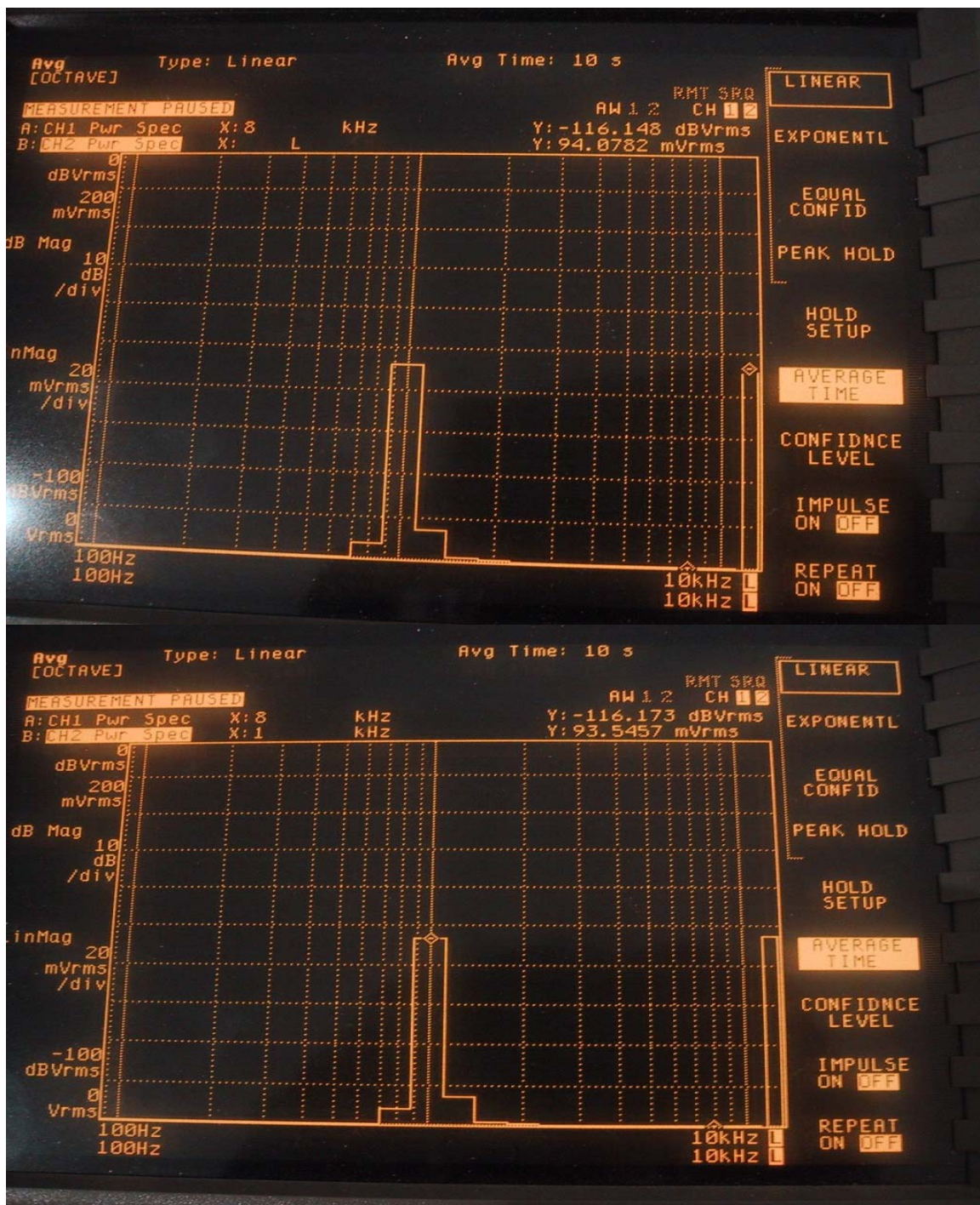


Figure 3: Top plot shows RMS time averaging power for “1.025 kHz sinewave” signal (sum of third-octave filters from 100 Hz to 10 Hz) and bottom plot is RMS power at 1 kHz third-octave filter.

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### 5.3 Bandwidth compensation

ABM1 values and deduced quantities (SNR and frequency response scaling) are based on the measured field in the 1 kHz third-octave filter. Bandwidth compensated values are available under the following conditions:

- A reference measurement with the same signal type is available (T-Coil job marked with “use as reference”) before the job to be compensated.
- The reference measurement is taken in the AMCC (z orientation), evaluating the coil signal.
- The reference measurement precedes the job within the same procedure.
- Before displaying the desired value based on the measured ABM1 value, a pop-up window appears, proposing a default value based on the reference measurement.

The proposed value is calculated as the ratio of (power sum of third-octave filters from 100 Hz to 5 kHz) / (ABM1 in 1 kHz third-octave filter). This factor leads to the “ABM1 bandwidth compensated” which is an estimation of the signal level of a narrowband ABM1 signal with the same input amplitude. The estimated value may however differ from a measurement with a narrowband signal due to nonlinearity effects or contribution of noise and interference available during the reference measurement.

If an input signal is completely within the 1 kHz third-octave band is used (narrow band signal), no compensation is required. If the test signal contains spectral components in other third-octave bands, the power in the 1 kHz subband is lower for the same overall power, and the reading from the 1 kHz band is consequently reduced. This reduction shall be compensated to give the equivalent reading as when using a narrowband signal. The reduction - when using a wideband signal with the same overall RMS power - is the ratio between the overall RMS power and the RMS power in the 1 kHz band. For signal with limited bandwidth (e.g. from 300 Hz to 3 kHz), the power is determined by summing up their contribution in all third-octave subbands. The correction is the ratio “sum power / 1 kHz power” (linear) or the equivalent value in dB ( $20 * \log(V_{rms\ total} / V_{rms\ 1k})$ ).

For 1025 Hz, the proposed factor is very close to 0 dB (linear 1), because the signal is completely within the 1 kHz subband. Small deviations may occur due to noise during the reference measurement, or due to other spectral components. Differences between the narrowband and the voice signal test: ABM1 (without BWC) for the same RMS reading is smaller for the wideband (voice) signal compared to the narrowband signal by the BWC. For the “**48k\_voice\_300-3000 (duration 2 s)**” predefined signals, the difference is provided by SPEAG to be 10.8 dB.

During the reference measurement, the spectral distribution of the input signal is determined. A spectral distribution results which is equivalent to the input distribution plus the response of the WD. To determine the response of the WD, the spectrum from the WD is deducted. The response is then compared to the limits, which are level dependent (based on the ABM1 signal level). For the display, the spectrum is displayed with the BWC applied.

The Bandwidth Compensation Factor can be calculated from the measured  $V_{rms}$  levels on Figure 2:

$$\begin{aligned}
 BWC &= 20 * \log(V_{rms\ total} / V_{rms\ 1k}). \\
 BWC &= 20 \log(26.68 / 93.52) \\
 &= 10.89\text{ dB}
 \end{aligned}$$

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## 5.4 Phantom

Figure 4 shows the phantom setup in a DASY4 system. The AMCC is mounted on the same plane as the HAC Test Arch phantom available from the HAC RF extension.

## 5.5 AMCC

The Audio Magnetic Calibration Coil is a Helmholtz Coil designed according to [1], section D.9 for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction.

Shunt sensitivity  $H_c = 1 \text{ A/m per } 100\text{mV}$  according to formula:

$$H_c = (U / R) * N / r / (1.25 ^ 1.5)$$

Number of turns  $N = 20$  per coil

Coil radius  $r = 143 \text{ mm}$

Shunt resistance  $R = 10.00 \text{ Ohm}$

Please refer to the certificate of conformity doc No 880-SD HAC P02 A-A in Annex D for more detail.

## 5.8 AM1D probe

The AM1D probe is an active probe with a single sensor according to [1] section D.8. It is fully RF shielded and has a rounded tip of 6 mm diameter incorporating a pickup coil with its center offset 3mm from the tip and the sides.

SPEAG, the manufacturer of the T-Coil system tested the probe frequency response and its dynamic range. Compliance with [1] is stated in the Certificate of conformity document 880-SPAM1001A-A. Also the probe frequency has been verified and the response deviation from the ideal differentiator was within +0.05 and - 0.46 dB in the range 100 Hz to 10 kHz on the center frequencies of the third-octave bands. Note that this verification includes the probe preamplifier and the AMMI internal preamplifiers, filters and processing.

### Frequency response:

The frequency response has been tested to be within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. The test was performed with the real integrator and deducting the ideal integrator values. The reference signal was the Helmholtz calibration coil current which is equivalent to the field. The coil is qualified according to the probe manufacturer certificate.

The test data up to 5 kHz are visible directly in the calibration job result (coil current / shut voltage and probe voltage). Separate measurements were made for a very wide frequency range, including higher frequencies. The third-octave bands up to 5 kHz do not exceed + 0.05 dB and decay by < 0.2 dB to 5 kHz and by < 0.5 dB to 10 kHz , as required.

### Dynamic range:

maximum + 21 dB A/m @ 1 kHz

Noise level typically -70 dB A/m @ 1 kHz

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ABM2 typically -60 dB A/m

#### **Linearity**

Within < 0.1 dB from 5 dB  
below limitation to 16 dB above noise level

Linearity has also been tested and is stated in the certificate. Deviation was not measurable from 5 dB below limitation to 26 dB above noise level. For lower levels, the deviation increased to 0.1 dB at 16 dB above noise level, which corresponds to the theoretical value of 0.11 dB expected at that noise suppression level.

Significant noise contribution beyond 10 kHz will be attenuated by the convolution A-filter. Such interferences also contribute to ABM2 represented as numerical value from the integration.

#### **Sensitivity**

Typically -24 dBV / A/m @ 1 kHz probe output

For detailed T-Coil probe's dynamic range, linearity and frequency response demonstration, the manufacturer has supplied a report directly to the FCC which is not intended for publication.



**Figure 4: T-Coil set up with HAC Test Arch with Helmholtz Coil (AMCC)**

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## 5.6 AMMI

The Audio Magnetic Measuring Instrument (AMMI) is a desktop 19-inch unit containing a sampling unit, a waveform generator for test and calibration signals and a USB interface.

Audio Out BNC, audio signal to the base station simulator, for > 500 Ohm load  
Coil Out BNC, test and calibration signal to the AMCC (top connector), for 50 Ohm load  
Coil In XLR, monitor signal from the AMCC BNO connector, 600 Ohm  
Probe In XLR, probe signal and phantom supply to the probe connector



Figure 5: The Audio band Magnetic field Measuring Instrument (AMMI)

## 5.7 Cabling

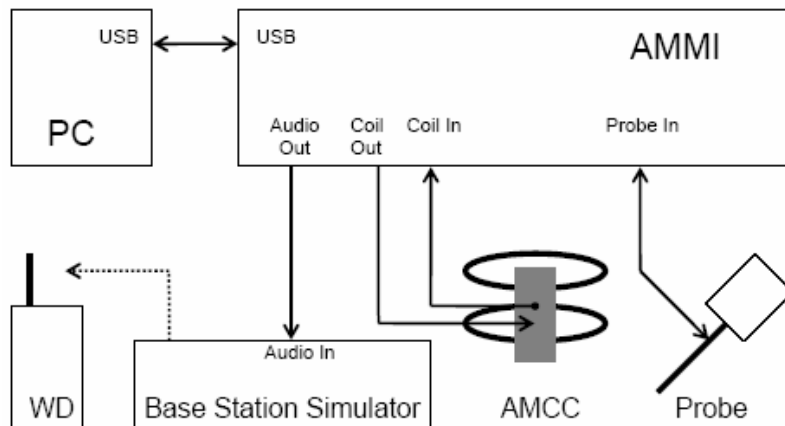


Figure 6: T-Coil set up cabling

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## 6.0 Measurement procedures

### 6.1 Surface Check Job

**Calibrate HAC phantom:** After teaching of the reference points P1, P2 and P3 of the HAC Test Arch and installation of a WD below the Test Arch, the plane defined by the 3 points may correspond to the top plane of the Test Arch. This option of the Surface Check job measures the mechanical surface with the probe in vertical position, using all 4 points and determines the optimal plane for all the following measurements. The coordinate system of the whole setup is adjusted to the resulting plane.

**Calibrate AM1D probe:** This option allows the adjustment of the sensor center of the AM1D probe accurately at the desired measurement point. In Southwest tilting mode, the probe center should be aligned to the position 3.0mm above point P1 by shifting the x, y and z coordinates. The probe surface is in this situation directly located at the center of point P1. The offset resulting from this teaching process is stored in the installation of the phantom for further use with the same configuration.

#### Calibration

If the "Calibration" signal is selected in the T-Coil measurement job, a 3-phase calibration is performed.

In phase 1, the audio output is switched off, and a 200 mV<sub>pp</sub> symmetric rectangular signal of 1 kHz is generated and internally connected directly to both channels of the sampling unit (coil in, probe in).

In phase 2, the audio output is off, and a 20 mV<sub>pp</sub> symmetric 100 Hz signal is internally connected.

The signals during these phases are available at the output on the rear panel of the AMMI. The output must however not be loaded in order not to influence the calibration. After the first two phases, the two input channels are both calibrated for absolute measurements. The resulting factors are displayed above the multimeter window.

In phase 3, a multisine signal covering each third-octave band from 50 Hz to 5 kHz is generated and applied to both audio outputs. The probe should be positioned in the center of the AMCC (user point "coil center") and aligned in the z-direction, the field orientation of the AMCC. The Coil In channel is measuring the voltage over the AMCC internal shunt, which is proportional to the magnetic field in the AMCC. At the same time, the Probe In channel samples the amplified signal picked up by the probe coil. The ratio of the two voltages – in each third-octave filter leads to the calibration factor of the probe over the frequency band of interest for the spectral representation.

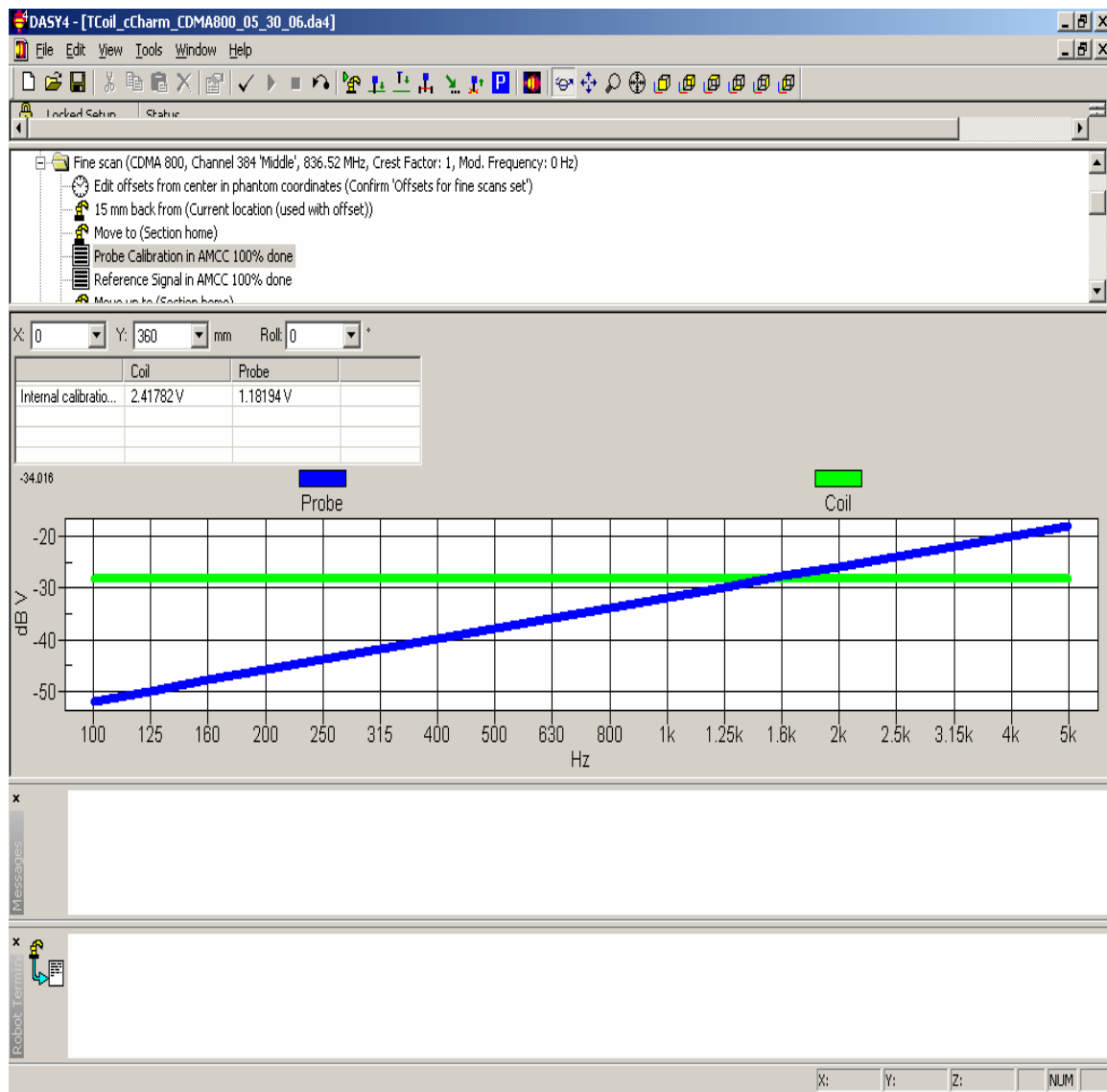
The typical representation of the calibration result in the DASY window is shown in Figure 6: The internal calibration factors of the coil and probe channel are listed.

The graphics represent the values (applying the calibration factors from the previous steps) for the probe and coil channel in dB V for each third-octave filter from 100 Hz to 5 kHz. The single values are interconnected with a blue line for the probe and a green line for the coil channel.



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The probe sensitivity in V / (A/m) at 1 kHz is calculated from the values in the chart. -20 dBV in the coil channel corresponds approx. to 1 A/m. For the AM1DV2 probe, the lines typically cross at 1.5 kHz and a level of -28 dBV.



**Figure 6. DASY4 ABM probe calibration**

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## 6.2 Input level measurement

Decoder: When an acoustic signal is provided to the microphone of the device under test it travels through the device audio path and then over the air to the CMU. At the CMU this digital signal is Decoder and an analog voltage is generated at the CMU output. This voltage is measured and related to the dBm0 level according to the Decoder calibration. The calibration of the CMU Decoder provides the relationship between the voltage generated and the dBm0 level. When the CMU Decoder CAL is selected the CMU generates a voltage equivalent to the full-scale value (3.14 dBm0). Measuring this voltage provides the Decoder calibration. The Decoder calibration was determined to be 3.39 dB.

Encoder: When a voltage signal is provided to the CMU, it is Encoded and sent over the air to the device under test. Once it reaches the device it travels through the device audio path to either the receiver (earpiece for handset mode) or the loudspeaker (for handsfree or speakerphone mode). The calibration procedure for the CMU Encoder involves determining the gain/loss in the Encoder and the signal required to produce a full-scale digital signal. The calibration of the CMU Encoder is slightly more complicated than for the Decoder because during calibration (Encoder CAL) the input signal to the CMU Encoder travels back through the Decoder so the Decoder calibration must be taken into account in the calculation procedure – a signal is input to the CMU Encoder and goes through the CMU Decoder and back out again. The calibration is determined from the level of the input signal and the output signal and knowing the previously determined Decoder calibration level. The voltage required to produce a full-scale signal for the CMU 200 SN: 109747 was determined to be 1056 mV.

Once calibration is complete, required voltage can be calculated to produce a desired dBm0 level for the device under test.

$$Z = Y - (3.14 - X)$$

Where:

Z = signal required into CMU (dBV)

Y = desired dBm0 level (-18 dBm0 for CDMA HAC T-coil testing)

X = full-scale calibration value (dBV)

Example:

Y = -18 dBm0

X = 1056 mV = 0.47 dBV

Therefore, Z = -18 - (3.14 - 0.47) = - 20.67 dBV (93 mV)

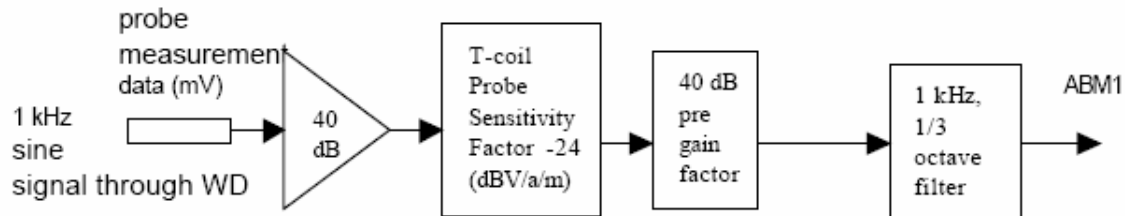
For this particular CMU200 SN: 109747 an input voltage of 93 mV will generate a -18 dBm0 signal.



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### 6.3 ABM1 / ABM2 detailed math and probe factor

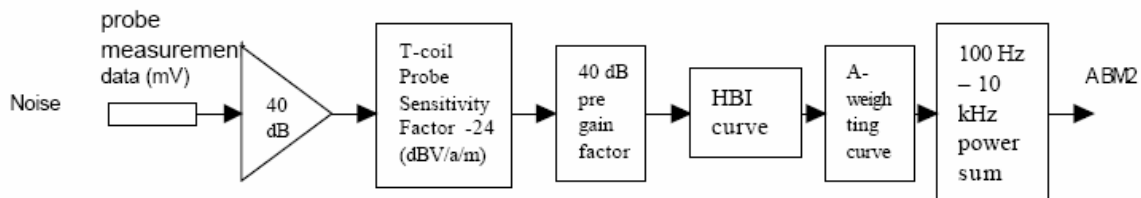
#### ABM1 measurement flow chart:



#### Sine tone:

RTA 1 kHz (data + probe sensitivity of (24.0 dB V/(a/m)) – 40 dB pre-gain) = ABM1 (in dB (A/m))

#### ABM2 measurement flow chart:



#### Broadband noise:

Power Sum 1/3 octave, 0.1 - 10 kHz [RTA 0.1 – 10 kHz (data + probe sensitivity of (24.0 dB V/(A/m)) – 40 dB pre-gain)] + HBI curve + A\_weighting curve = ABM2 (in dB (A/m))

ABM2 includes HBI as well as A-weighting curves as shown above.

The numerical values (ABM Noise) are the final result of the weighted integral. DASY4 uses filters by applying convolution in the time-domain. Therefore, significant contributions beyond 10 kHz would appear in the ABM2 result, even if they are not directly visible in the visualized spectrum.

### 6.4 FCC 3G certification policy for the Hearing Aid Compatibility

Voice modes for at the ear usage modes should be addressed.

For T-coil compliance, modes that produce higher levels of base band magnetic noise are of interest for the ABM2 measurements, such as RF modes with high peak-to-average power ratio, noisy display settings, or operational modes requiring high digital computations/processing. Additionally, ABM1 measurements might be influenced by audio processing such as vocoder or audio auto levelling options and should be investigated.

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If all operational modes are not tested justification must be made for the modes tested. The justification should be sufficient to assure to a reasonable extent that the device will comply in all untested modes.

The following Speech Services are supported, evaluated and the worst case ABM2 was determined to be RC1, SO3 and 8k Enhanced (Low).

Service Option: 3  
Radio Configuration 1 and 3  
Vocoder type: 8k Enhanced (Low) / 8k Enhanced

In addition, the RF environment for T-Coil rating was determined by evaluating 1/8 th rate RC1, SO2 option.

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## 6.5 Test measurement

1. Calibrate the AM1D probe using a Helmholtz coil with reference calibration signal as per section 6.1.
2. For each probe orientation, measure ambient noise.
3. Position the WD in the test setup as shown on Figure 4 and connect the WD RF connector to a base station simulator.
4. Set the reference drive level for the system with the maximum volume control setting. The drive level is set such that the reference input level is input to the base station in the 1 kHz, 1/3 octave band. This drive level shall be used for the audio band signal test (ABM1 at  $f_i$ ). Either a sine wave at 1025 Hz or a voice-like signal shall be used for the reference audio signal. If interference is found at 1025 Hz an alternate reference audio signal frequency may be used. The same drive level will be used for the ABM1 frequency response measurements at each 1/3 octave band center frequency.
5. Determine the peak audio magnetic measurement for the WD device by scanning a 5x5 cm coarse (10 mm step) and 1 cm x 1cm fine scan (2 mm step) and a point scan for each probe orientation.
6. At each peak field measurement location measure and record the desired audio band magnetic signals (ABM1 at  $f_i$ ). The desired audio band input frequency ( $f_i$ ) shall be centered in each 1/3 octave band maintaining the same drive level and the reading taken for that band.
7. The separation distance of 1 cm is controlled between the center of the probe sensor and the top highest surface of the WD, throughout the measurement.

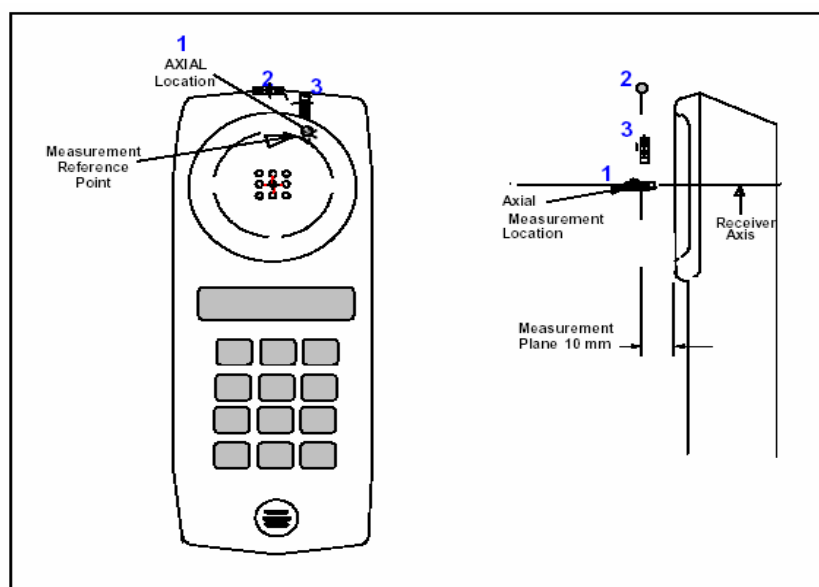
The following reference input levels that correlate to a normal speech input level shall be used for the standard transmission protocols.

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STANDARD	TECHNOLOGY	INPUT (dBm0)
TIA/EIA/IS-2000	CDMA	-18
TIA/EIA/IS-136	TDMA (50 Hz)	-18
J-STD-007	GSM (217 Hz)	-16
IDEN	TDMA (22 and 11 Hz)	-18
T1/T1P1/3GPP	UMTS (WCDMA)	-16

**Table 5: Normal speech input levels**

8. At each peak field measurement location measure and record the undesired broadband audio magnetic signal (ABM2) with no signal applied (or digital zero applied, if appropriate) using A-weighting, and calculate the ratio of the desired to undesired signal strength (i.e. – signal quality)
9. From the measured signal to noise ratio, classify signal quality as T1 to T4 using the limits from Table 6.



**Figure 7: Axis & planes for WD audio band magnetic field measurements**

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Category	Telephone parameters	
	WD signal quality ((signal + noise)-to-noise ratio in dB)	
	AWF = 0	AWF = -5
Category T1	-20 to -10 dB	-15 to -5 dB
Category T2	-10 to 0 dB	-5 to 5 dB
Category T3	0 to 10 dB	5 to 15 dB
Category T4	> 10 dB	>15 dB

**Table 6: T-Coil signal quality categories**

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## 7.0 Summary of results

Table 4 shows the results of the Audio Band Magnetic Field T-Coil tests.

Wireless Device: BlackBerry Wireless Handheld – Model: RAV20CW									
Audio Band Magnetic Field Test									
Mode	Probe location	Signal type	ABM1 dB (A/m)	ABM2 dB (A/m)	ABM1/ ABM2 dB	Freq. Resp. Verdict	T- Rating	Noise Floor ABM1 dB (A/m)	Noise Floor ABM2 dB (A/m)
CDMA 800	Axial	sine	-7.23	-31.41	24.18		4	-69.10	-59.59
	Radial L	sine	-15.07	-38.31	23.24		4	-68.59	-59.06
	Radial T	sine	-17.13	-46.27	29.14		4	-69.42	-59.68
	Axial	voice				Pass	4	-69.10	-59.59
CDMA 1900	Axial	sine	-6.72	-31.11	24.39		4	-69.10	-59.59
	Radial L	sine	-14.70	-38.55	23.85		4	-68.59	-59.06
	Radial T	sine	-17.78	-43.71	25.94		4	-69.42	-59.68
	Axial	voice				Pass	4	-69.10	-59.59
Overall T-Rating							T4		
M-rating							M3 *		
Overall M/T rating							M3T3		

**Table 4: ABM Data Summary**

\* M rating is taken from the HAC RF emission report number RTS-0181-0507-01 that was submitted in July 2005.

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## 7.1 Conclusion

The RIM BlackBerry 7130e Wireless Handheld Model Number RAV20CW is categorized to be M3T3 based on RF emission and Audio Band Magnetic (ABM) T-Coil performance in accordance with ANSI C63.19-2006: American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids.

Therefore, the handheld is found to be in compliance with the requirements of FCC 20.19 (10-1-05 Edition) Hearing Aid-Compatible Mobile Handsets as modified by FCC Public Notice DA 06-1215 (Released: June 6, 2006).

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## 8.0 Measurement uncertainty

Table 5 outlines the measurement uncertainty for the SPEAG DASY4 measurement system.

Error Description	Uncertainty value [%]	Prob. Dist.	Div.	c ABM1	c ABM2	Std. Unc. ABM1	Std. Unc. ABM2
<b>PROBE SENSITIVITY</b>							
Reference level	3.0	N	1.0	1	1	3.0	3.0
AMCC geometry	0.4	R	1.7	1	1	0.2	0.2
AMCC current	0.6	R	1.7	1	1	0.4	0.4
Probe positioning during calibration	1.0	R	1.7	1	1	0.6	0.6
Noise contribution	0.7	R	1.7	0.014	1	0.0	0.4
Frequency slope	5.9	R	1.7	0.1	1.0	0.3	3.5
<b>PROBE SYSTEM</b>							
Repeatability / Drift	1.0	R	1.7	1	1	0.6	0.6
Linearity / Dynamic range	0.6	R	1.7	1	1	0.4	0.4
Acoustic noise	1.0	R	1.7	0.1	1	0.1	0.6
Probe angle	2.3	R	1.7	1	1	1.4	1.4
Spectral processing	0.9	R	1.7	1	1	0.5	0.5
Integration time	0.6	N	1.0	1	5	0.6	3.0
Field disturbance	0.2	R	1.7	1	1	0.1	0.1
<b>TEST SIGNAL</b>							
Reference signal spectral response	0.6	R	1.7	0	1	0.0	0.4
<b>POSITIONING</b>							
Probe positioning	1.9	R	1.7	1	1	1.1	1.1
Phantom thickness	0.9	R	1.7	1	1	0.5	0.5
DUT positioning	1.9	R	1.7	1	1	1.1	1.1
<b>EXTERNAL CONTRIBUTIONS</b>							
RF interference	0.0	R	1.7	1	1	0.0	0.0
Test signal variation	2.0	R	1.7	1	1	1.2	1.2
<b>COMBINED UNCERTAINTY</b>							
Combined Std. uncertainty (ABM field)						4.1	6.2
Expanded Std. uncertainty [%]						8.2	12.3

**Table 5: Worst-Case uncertainty budget for HAC T-Coil assessment according to ANSI C63.19.**



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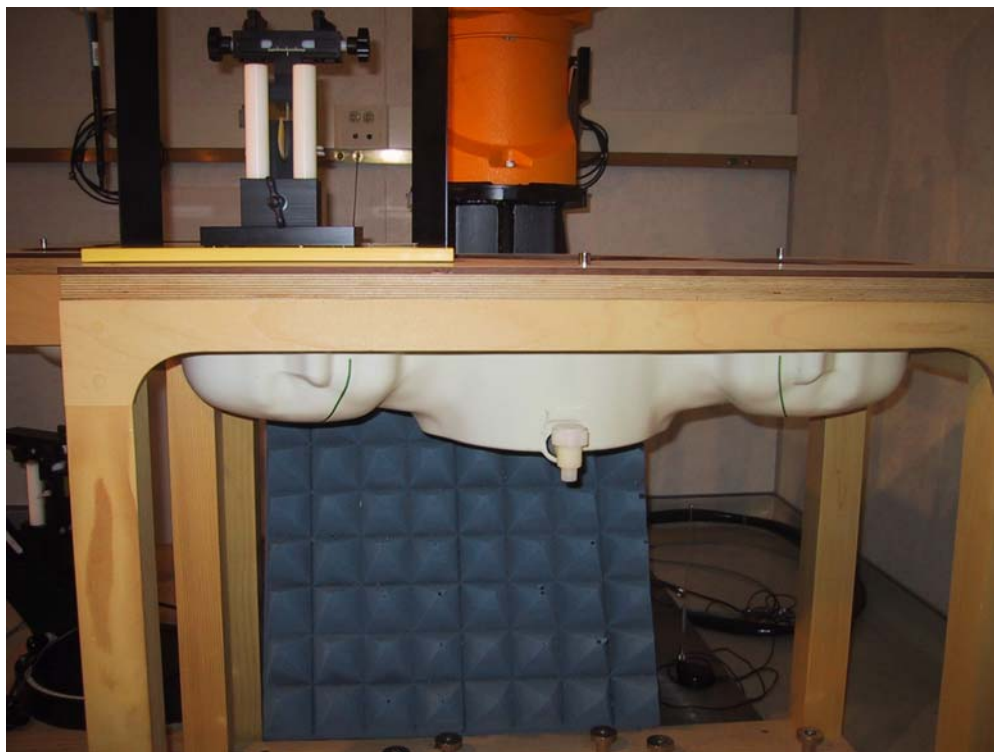
## 8.1 Site-Specific Uncertainty

### RF Reflections

ANSI C63.19 requires that any RF reflecting objects are a minimum distance of 2 wavelengths away from the WD under test. For this WD, the longest wavelength occurs when the WD is transmitting at 824.7MHz. The wavelength is:

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8 \text{ m/s}}{824.7 \text{ MHz}} = 0.364 \text{ m}$$

Therefore, 2 wavelengths result in a distance of 0.73m. Tests are performed in an RF shielded chamber. The distance to the nearest wall is >1m and the distance to the robot's safety guardrail is ~1.0m, both satisfying the requirement. In addition, RF absorbing cones are placed at the base of the robot to further reduce reflections. The HAC phantom arch is made of low dielectric constant plastic and should not be a source of reflections.



**Figure 7: DASY4 system with absorbing material**

### Environmental Conditions

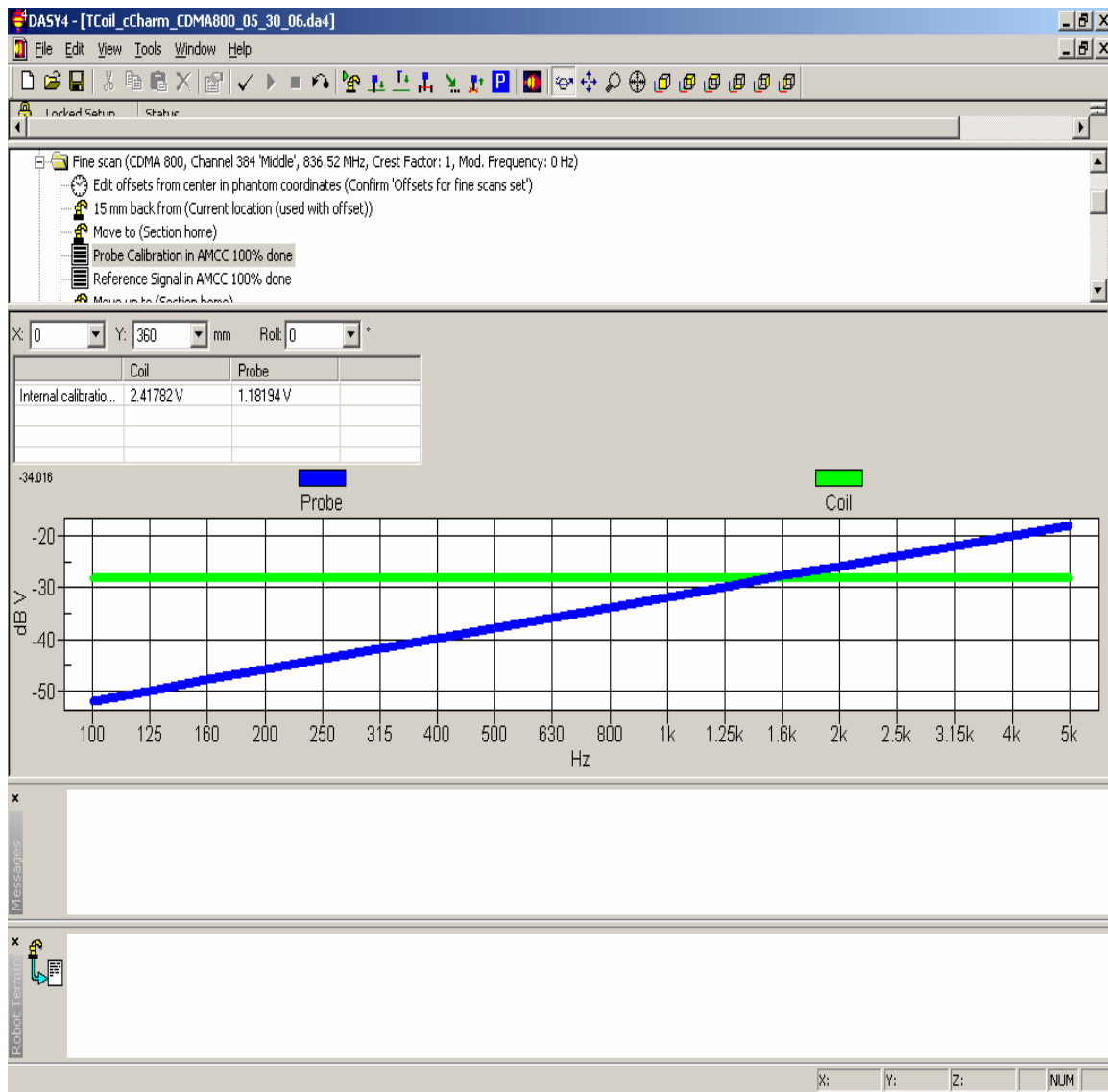
During measurements, the temperature of the test lab was kept between 21°C and 25°C and relative humidity was maintained between 20% and 55%.

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### Ambient Noise

ANSI C63.19 section 6 requires the ambient noise to be at least 10 dB below the measurement level. Measurement of the ambient magnetic field was performed for each probe orientation and the levels are shown in the Table 4 and Annex B plots to be lower by 10 dB.

## Annex A: Probe calibration and reference signal measurement plots



**Figure A1: Probe calibration data for coil and probe**

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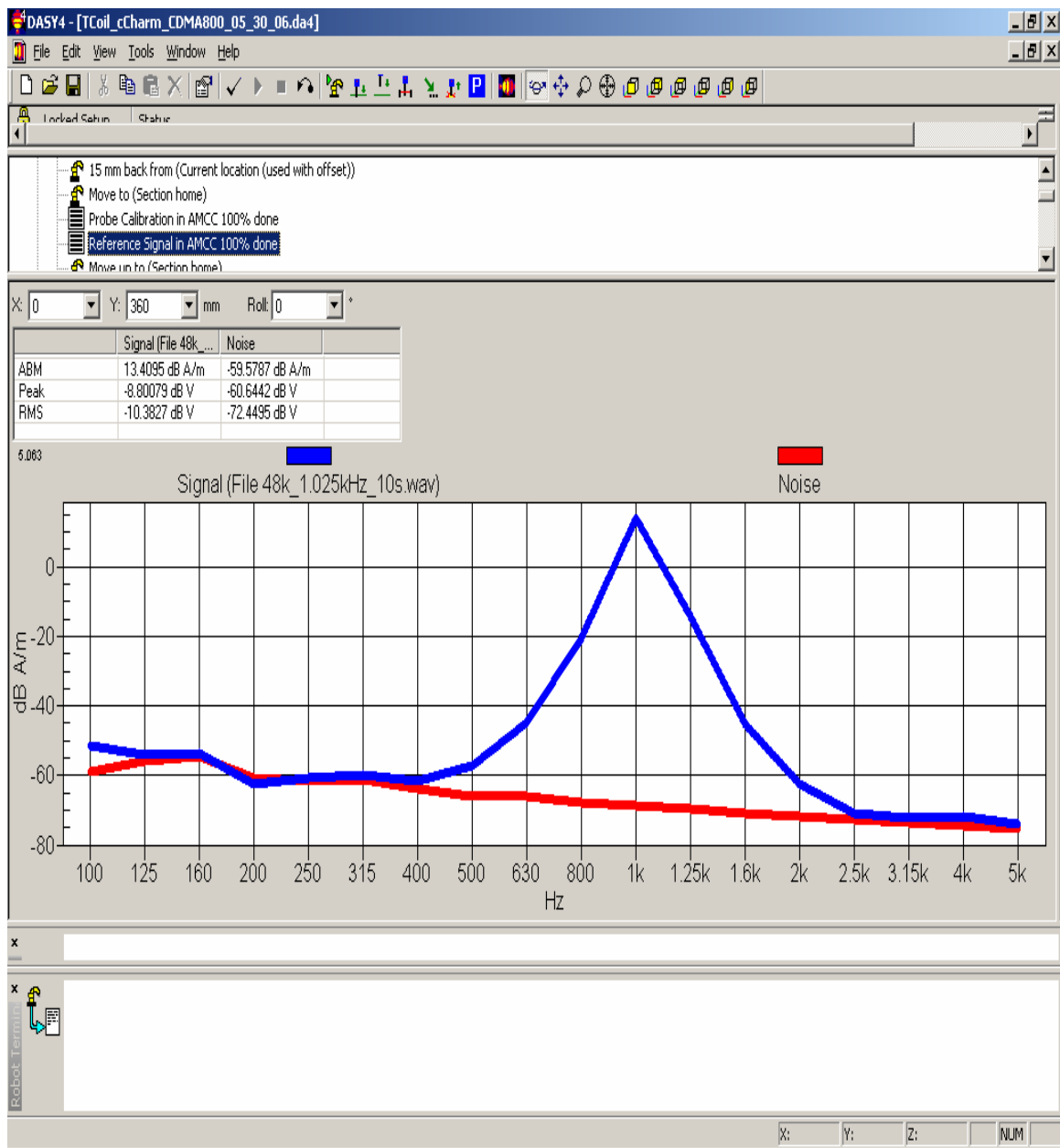
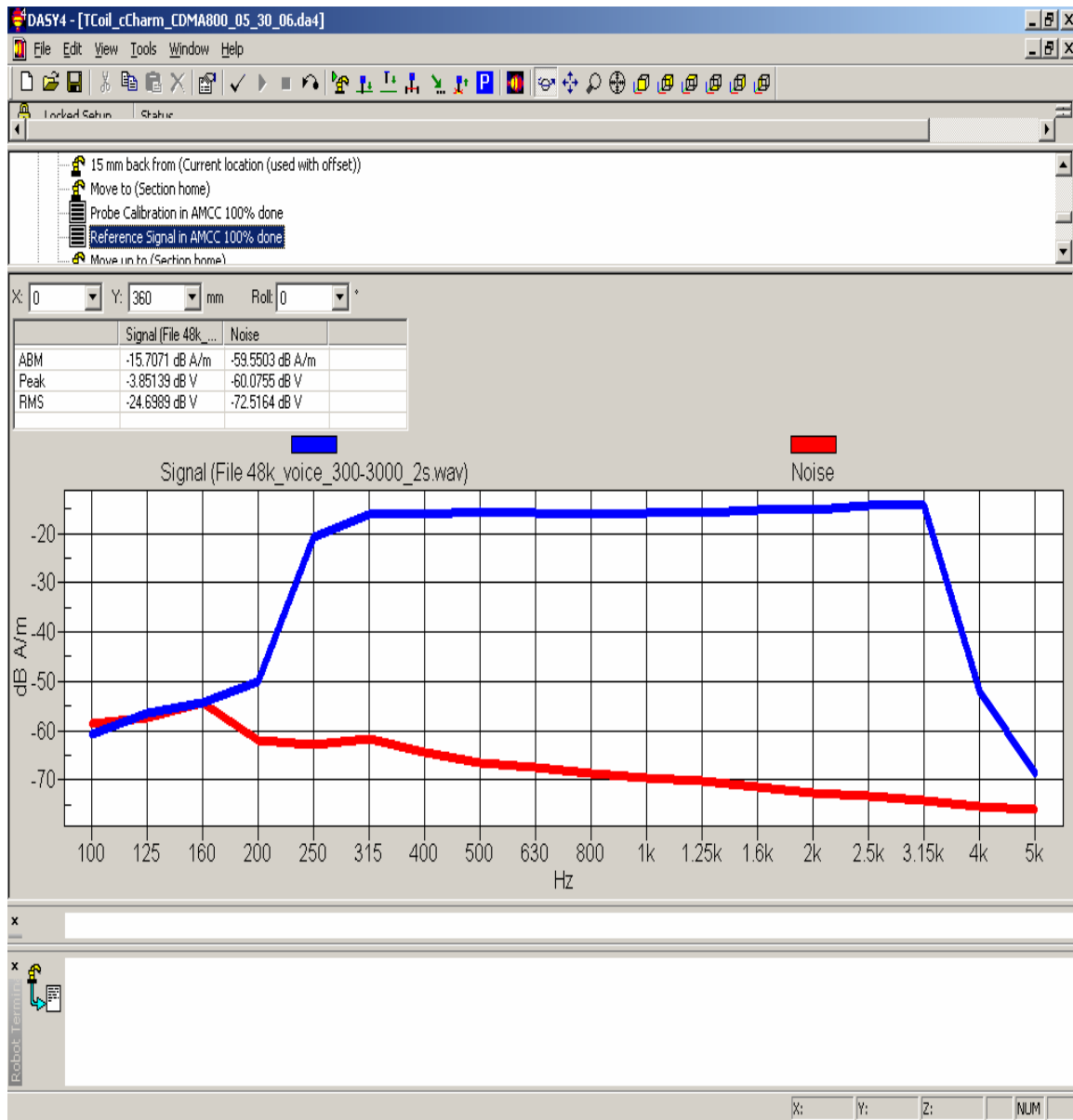


Figure A2: Reference sinusoidal 1.025 KHz signal and noise



**Figure A3: Reference voice simulated signal and noise**

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## Annex B: Ambient noise floor data and plots

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Date/Time: 30/05/2006 8:39:53 AM

Test Laboratory: RTS

File Name: [TCoil\\_cCharm\\_CDMA800\\_05\\_30\\_06.da4](#)

**DUT: BlackBerry Wireless Handheld; Type: Sample**  
**Program Name: HAC\_TCoil\_WD\_Emission**

Communication System: CDMA 800; Frequency: 836.52 MHz; Duty Cycle: 1:1

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>

Phantom section: AMB with Coil Section

DASY4 Configuration:

- Probe: AM1DV2 - 1016; ; Calibrated: 18/04/2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn473; Calibrated: 09/03/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

**Background noise 5mm above Grid Reference/z (axial) noise/ABM Noise Spectrum(x,y,z,f)**  
**(1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM = -59.5954 dB A/m

Location: 0, 0, 368.7 mm

**Background noise 5mm above Grid Reference/x (longitudinal) noise/ABM Noise Spectrum(x,y,z,f) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM = -59.0596 dB A/m

Location: 0, 0, 368.7 mm

**Background noise 5mm above Grid Reference/y (transversal) noise/ABM Noise(x,y,z)**  
**(1x1x1):**

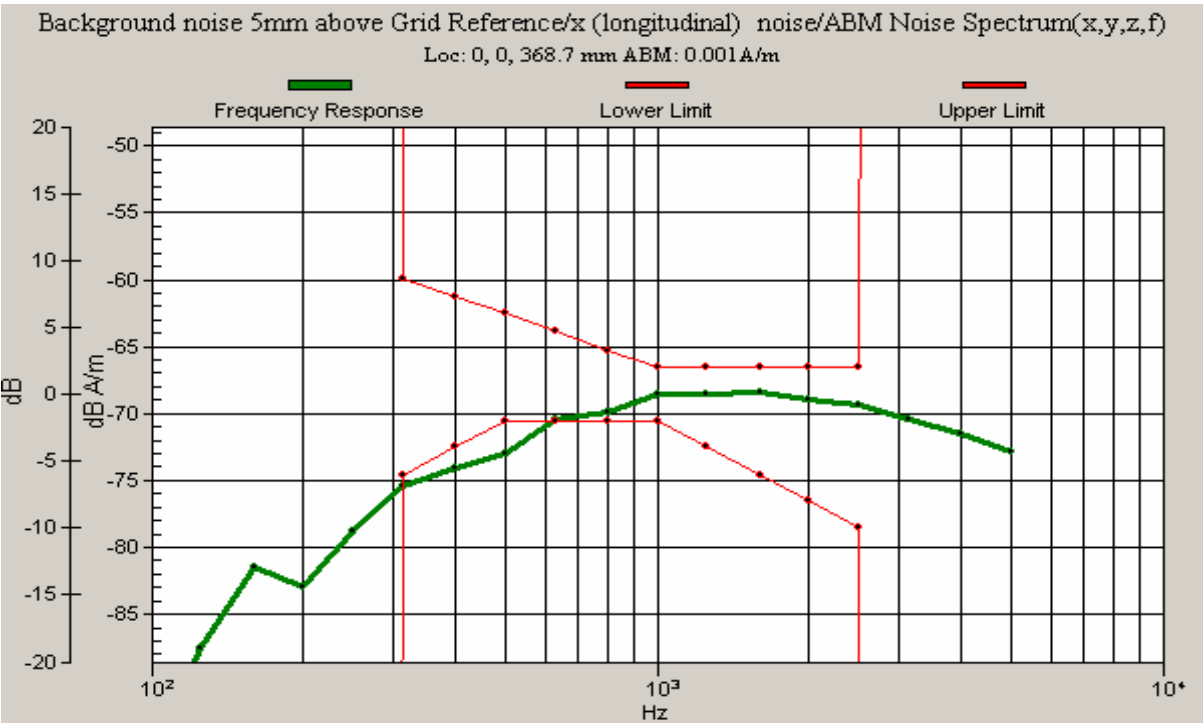
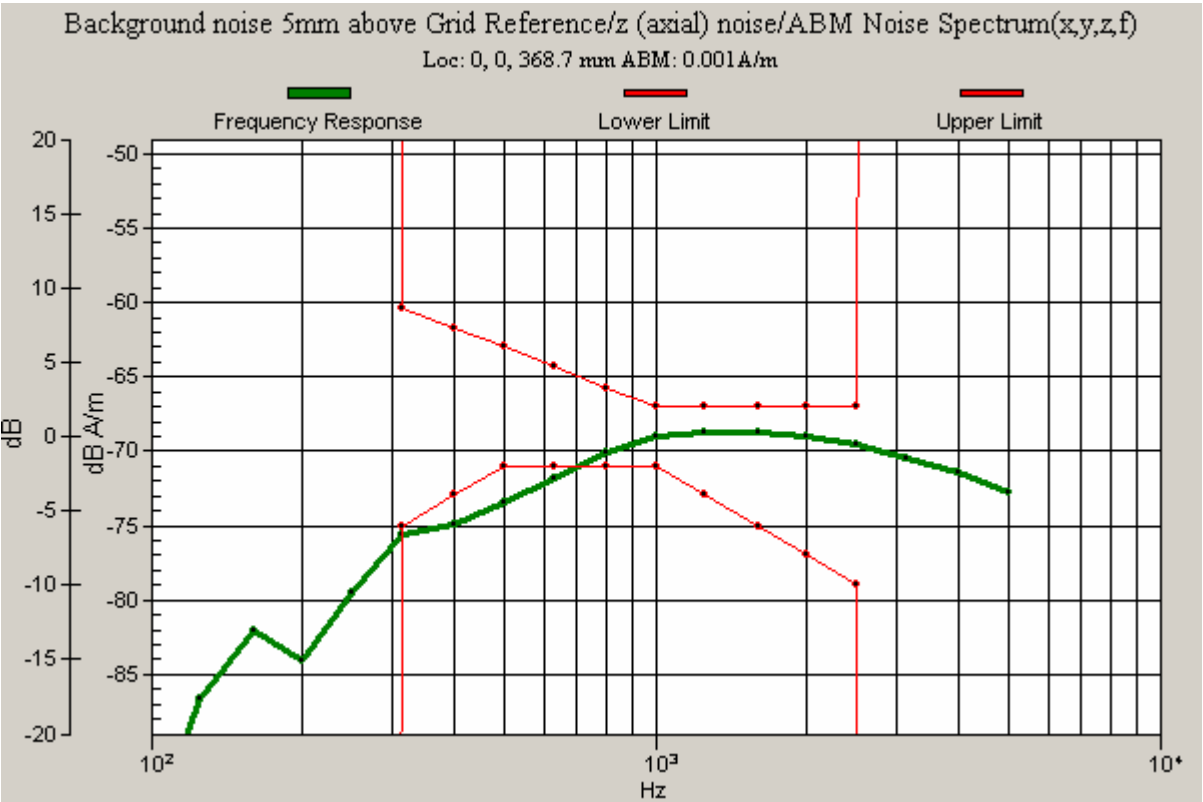
Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -59.6824 dB A/m

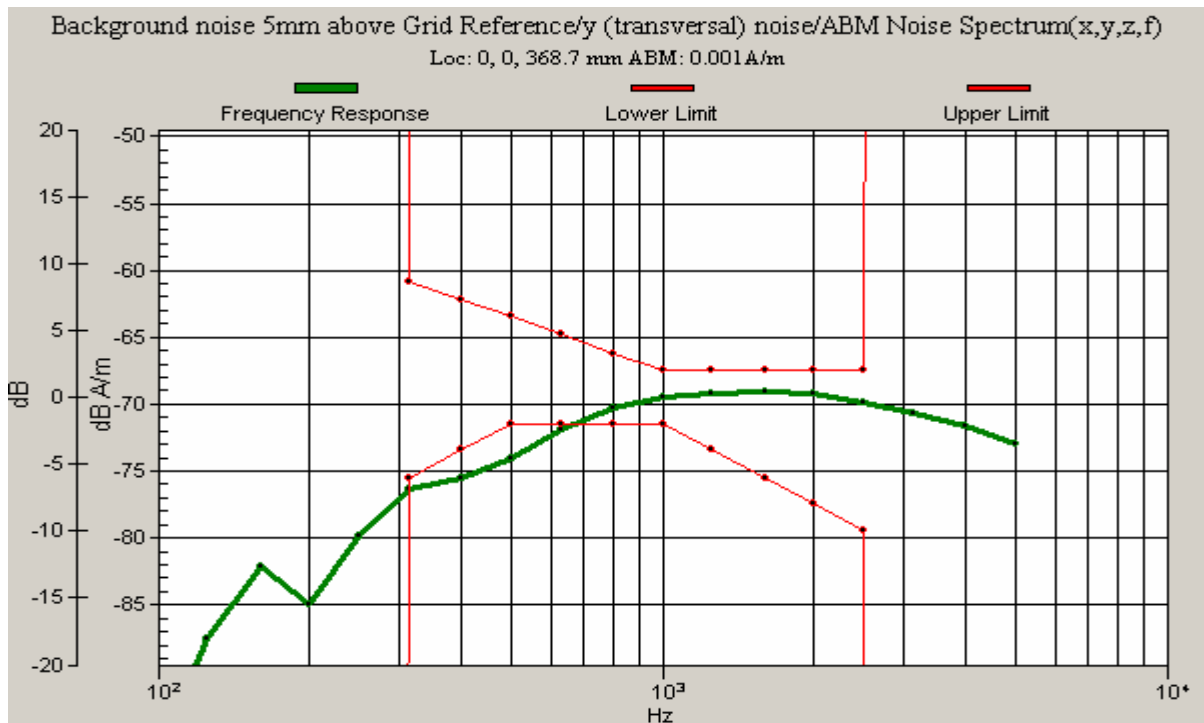
Location: 0, 0, 368.7 mm

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Date/Time: 31/05/2006 10:48:14 AM

Test Laboratory: RTS

File Name: [TCoil\\_cCharm\\_CDMA1900\\_05\\_31\\_06.da4](#)

**DUT: BlackBerry Wireless Handheld; Type: Sample ; Serial: Not Specified**  
**Program Name: HAC\_TCoil\_WD\_Emission**

Communication System: CDMA 1900; Frequency: 1880 MHz; Duty Cycle: 1:1

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>

Phantom section: AMB with Coil Section

DASY4 Configuration:

- Probe: AM1DV2 - 1016; ; Calibrated: 18/04/2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn473; Calibrated: 09/03/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

**Background noise 5mm above Grid Reference/z (axial) noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -59.56 dB A/m

Location: 0, 0, 368.7 mm

**Background noise 5mm above Grid Reference/x (longitudinal) noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -58.9978 dB A/m

Location: 0, 0, 368.7 mm

**Background noise 5mm above Grid Reference/y (transversal) noise/ABM Noise(x,y,z) (1x1x1):**

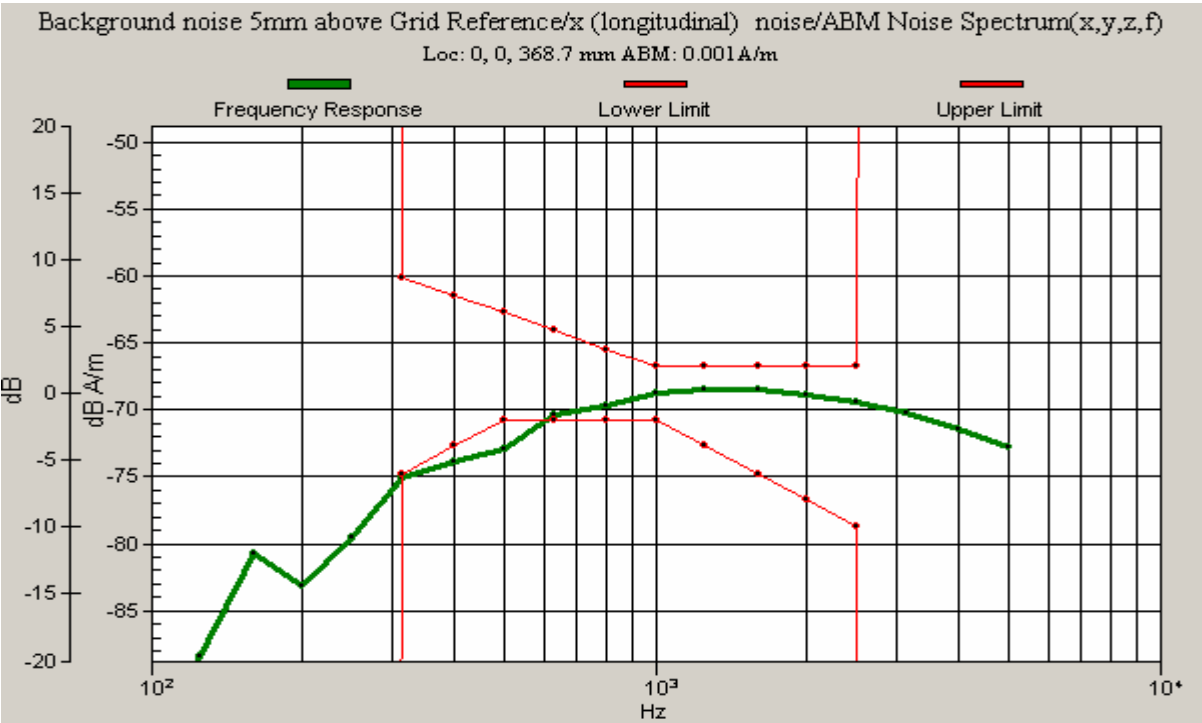
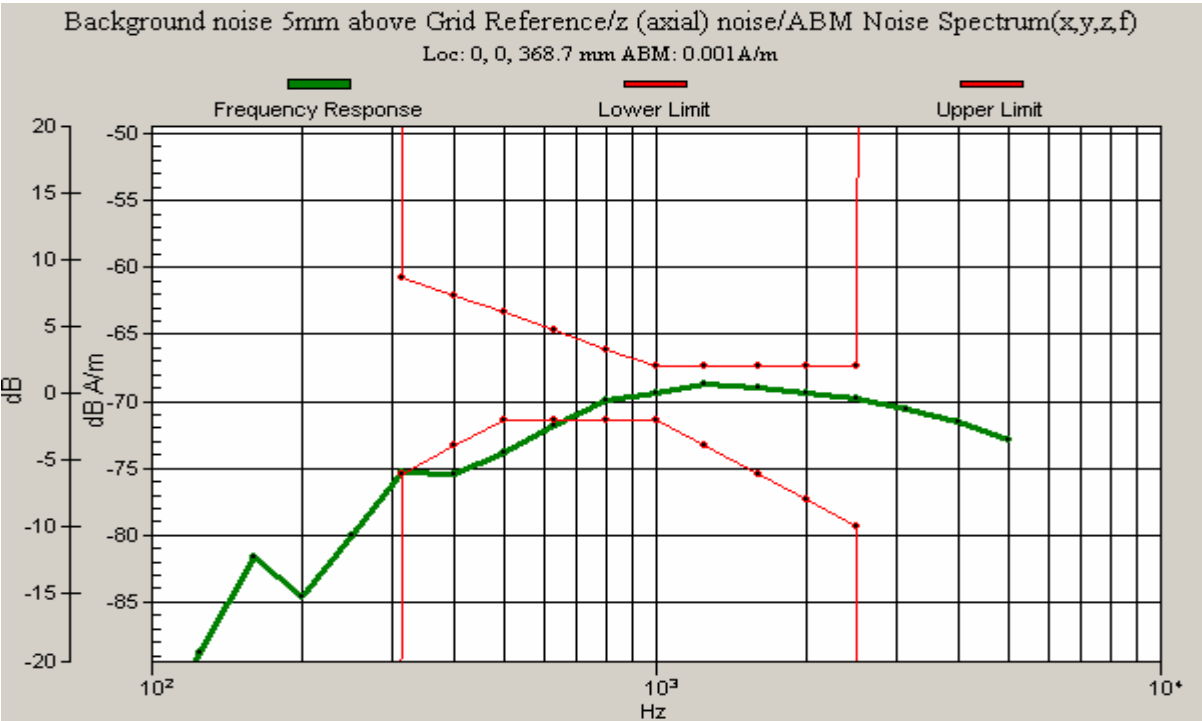
Measurement grid: dx=10mm, dy=10mm

**Cursor:**

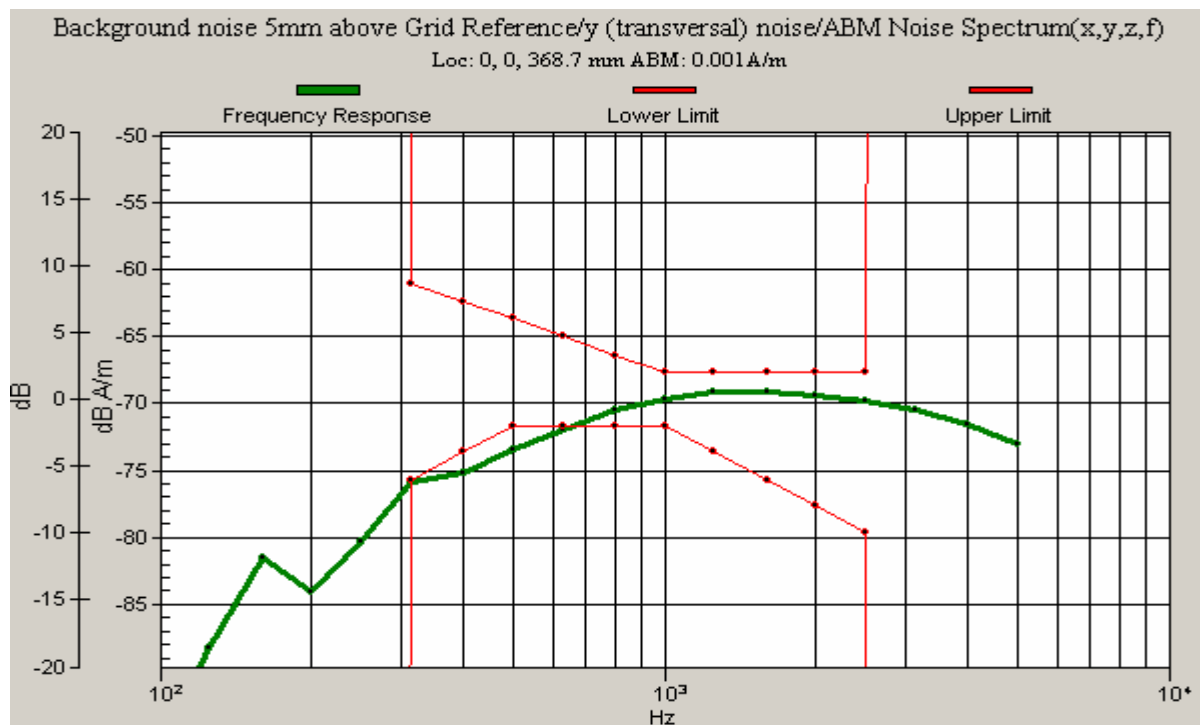
ABM2 = -59.6552 dB A/m

Location: 0, 0, 368.7 mm

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## Annex C: Audio Band Magnetic measurement data and plots

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## 1.025 KHz sinusoidal signal

Date/Time: 30/05/2006 8:39:53 AM

Test Laboratory: RTS

File Name: [TCoil\\_cCharm CDMA800 05 30 06.da4](#)

**DUT: BlackBerry Wireless Handheld; Type: Sample ; Serial: Not Specified**

**Program Name: HAC\_TCoil\_WD\_Emission**

Communication System: CDMA 800; Frequency: 836.52 MHz; Duty Cycle: 1:1

Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>

Phantom section: AMB with Coil Section

DASY4 Configuration:

- Probe: AM1DV2 - 1016; ; Calibrated: 18/04/2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn473; Calibrated: 09/03/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

### **Coarse scan/z (axial) scan 50 x 50 (grid 10) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -9.71232 dB A/m

BWC Factor = -0.206004 dB

Location: -4, 0, 363.7 mm

### **Fine scan/z (axial) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -6.88129 dB A/m

BWC Factor = -0.206004 dB

Location: -2, 0, 363.7 mm

### **Point scan/z (axial) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -7.2262 dB A/m

BWC Factor = -0.206004 dB

Location: -2, 0, 363.7 mm

### **Point scan/z (axial) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -31.4055 dB A/m

Location: -2, 0, 363.7 mm

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**Point scan/z (axial) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1/ABM2 = 24.1793 dB

BWC Factor = -0.206004 dB

Location: -2, 0, 363.7 mm

**Coarse scan/x (longitudinal) scan 50 x 50 (grid 10) with noise/ABM Interpolated**

**Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -15.9339 dB A/m

BWC Factor = -0.206004 dB

Location: 5, -2, 363.7 mm

**Fine scan/x (longitudinal) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -14.4148 dB A/m

BWC Factor = -0.206004 dB

Location: -13.8, -2.2, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -15.0654 dB A/m

BWC Factor = -0.206004 dB

Location: -14, -2, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -38.3061 dB A/m

Location: -14, -2, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1/ABM2 = 23.2407 dB

BWC Factor = -0.206004 dB

Location: -14, -2, 363.7 mm

**Coarse scan/y (transversal) scan 50 x 50 (grid 10) with noise/ABM Interpolated**

**Signal(x,y,z) (41x41x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -17.1051 dB A/m

BWC Factor = -0.206004 dB

Location: -2, 11, 363.7 mm

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**Fine scan/y (transversal) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -17.5352 dB A/m

BWC Factor = -0.206004 dB

Location: -6.8, -10.8, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -17.1267 dB A/m

BWC Factor = -0.206004 dB

Location: -9, -7, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -46.2656 dB A/m

Location: -9, -7, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

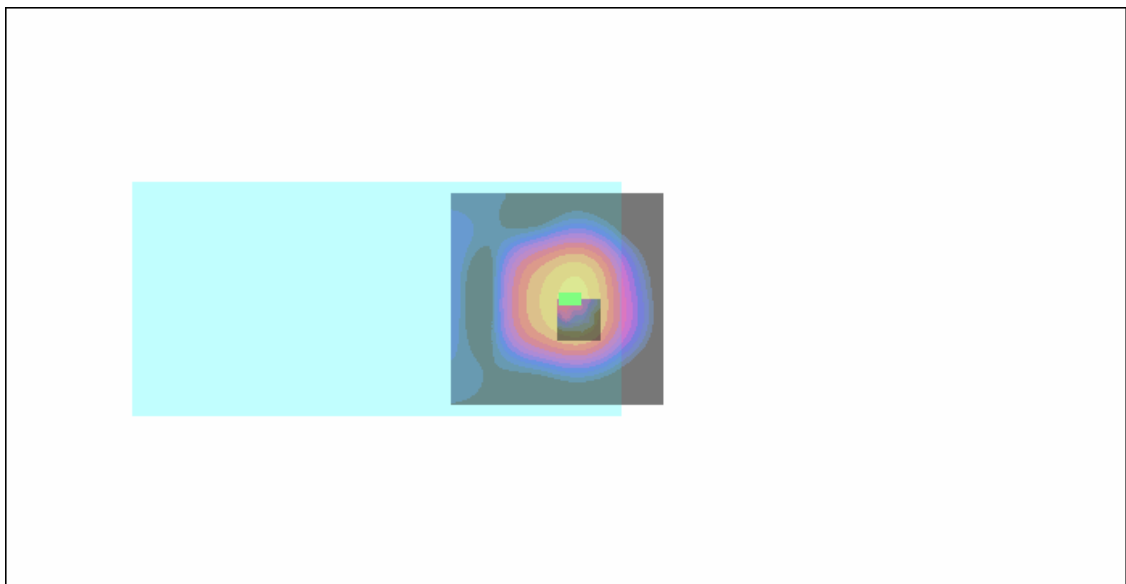
Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1/ABM2 = 29.139 dB

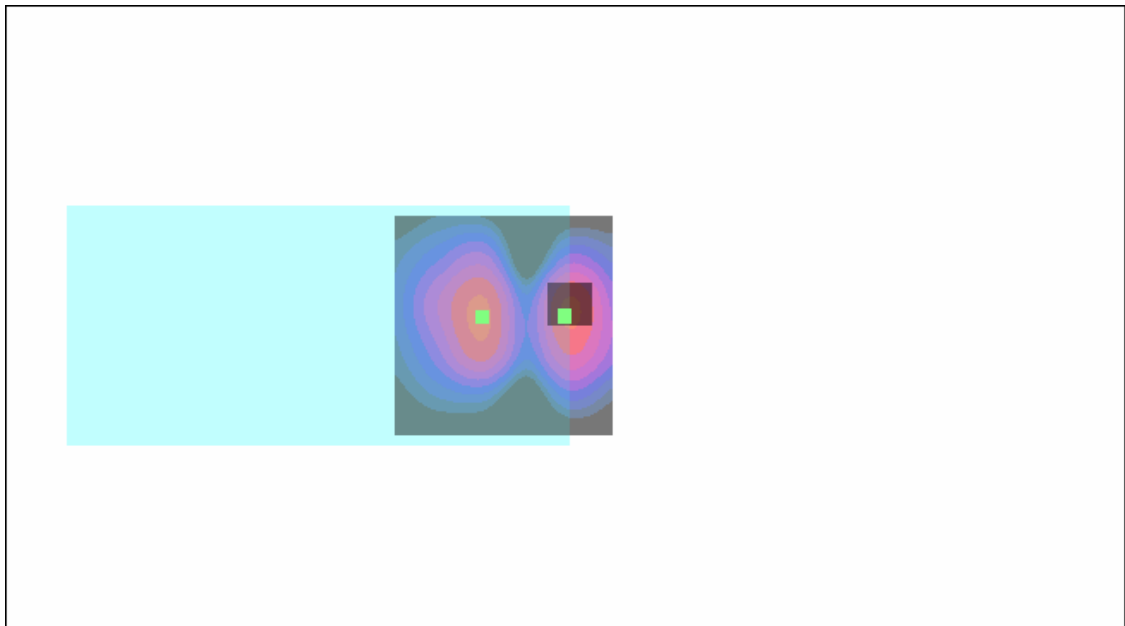
BWC Factor = -0.206004 dB

Location: -9, -7, 363.7 mm

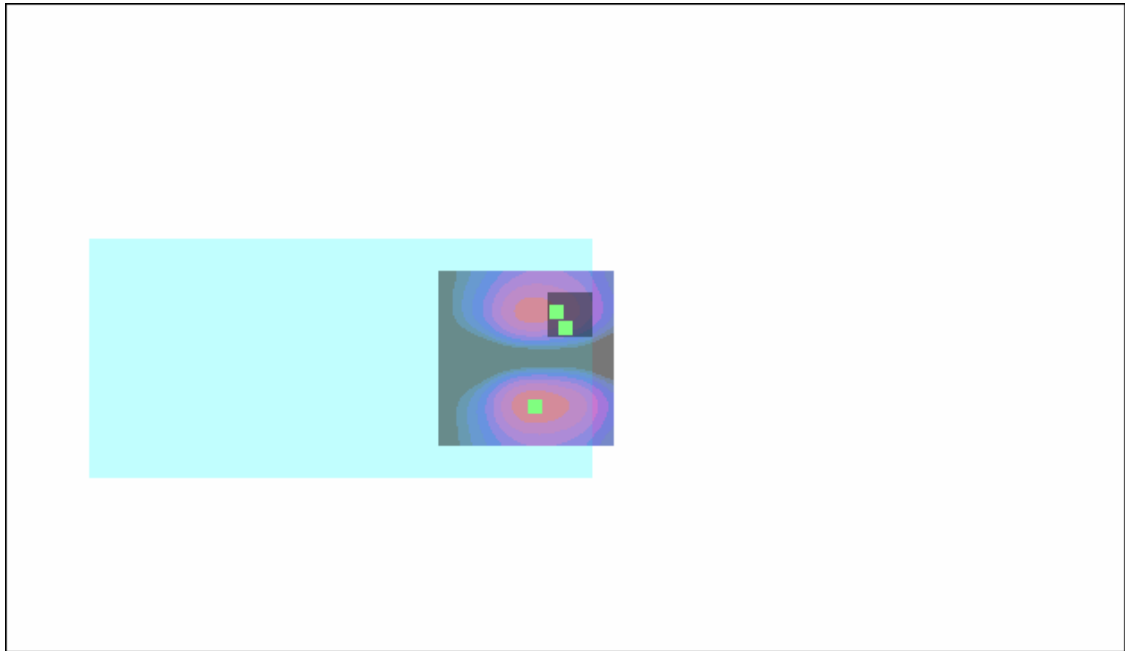




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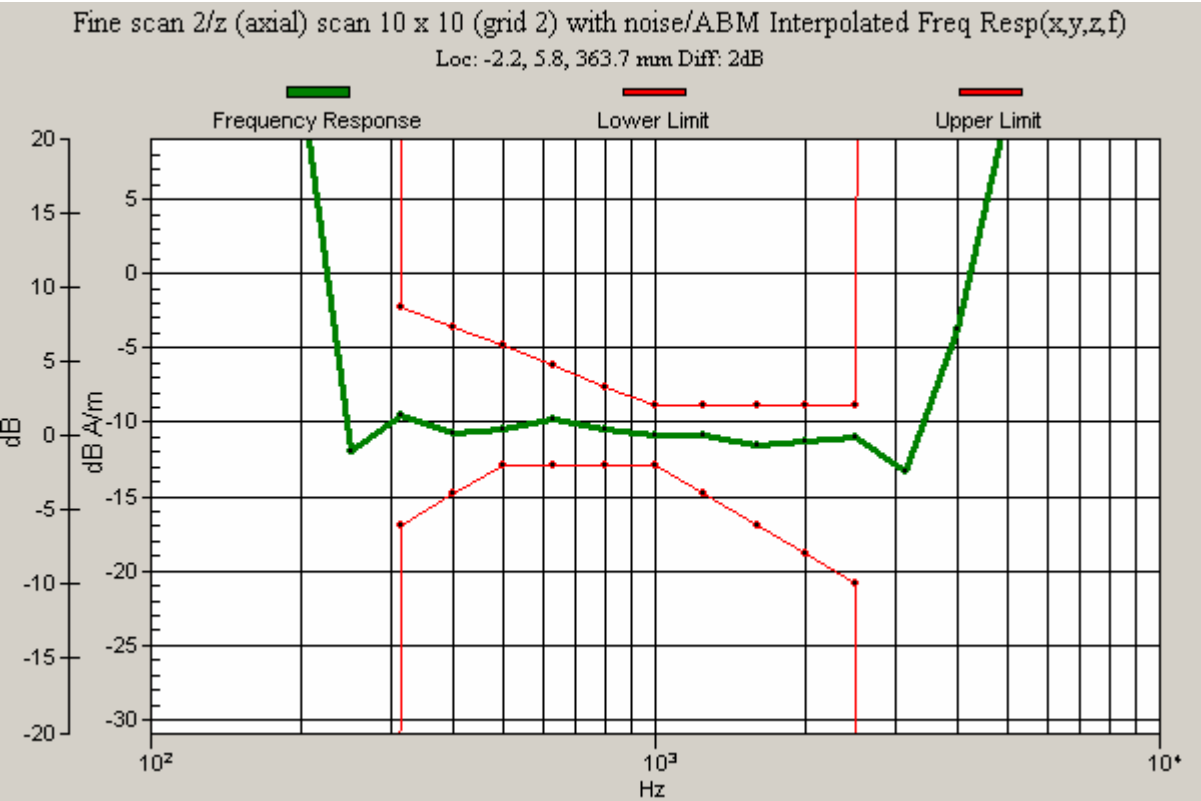


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Voice simulated signal



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Daoud Attayi	May 14-31, 2006	RTS-0445--0606-06 rev 02	L6ARAV20CW	

## 1.025 KHz sinusoidal

Date/Time: 31/05/2006 10:48:14 AM

Test Laboratory: RTS

File Name: [TCoil\\_cCharm\\_CDMA1900\\_05\\_31\\_06.da4](#)

**DUT: BlackBerry Wireless Handheld; Type: Sample ; Serial: Not Specified**  
**Program Name: HAC\_TCoil\_WD\_Emission**

Communication System: CDMA 1900; Frequency: 1880 MHz; Duty Cycle: 1:1  
Medium parameters used:  $\sigma = 0$  mho/m,  $\epsilon_r = 1$ ;  $\rho = 1$  kg/m<sup>3</sup>  
Phantom section: AMB with Coil Section

DASY4 Configuration:

- Probe: AM1DV2 - 1016; ; Calibrated: 18/04/2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn473; Calibrated: 09/03/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

### **Coarse scan/z (axial) scan 50 x 50 (grid 10) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -7.68436 dB A/m  
BWC Factor = -0.206004 dB  
Location: -4, 2, 363.7 mm

### **Fine scan/z (axial) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -6.08274 dB A/m  
BWC Factor = -0.206004 dB  
Location: -2.6, 0, 363.7 mm

### **Point scan/z (axial) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -6.72376 dB A/m  
BWC Factor = -0.204999 dB  
Location: -6, 0, 363.7 mm

### **Point scan/z (axial) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -31.1108 dB A/m  
Location: -6, 0, 363.7 mm

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**Point scan/z (axial) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1/ABM2 = 24.3871 dB

BWC Factor = -0.204999 dB

Location: -6, 0, 363.7 mm

**Coarse scan/x (longitudinal) scan 50 x 50 (grid 10) with noise/ABM Interpolated**

**Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -15.3741 dB A/m

BWC Factor = -0.206004 dB

Location: 5, 0, 363.7 mm

**Fine scan/x (longitudinal) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -14.4622 dB A/m

BWC Factor = -0.206004 dB

Location: -11.8, 1.8, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -14.6998 dB A/m

BWC Factor = -0.204999 dB

Location: -12, 2, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -38.553 dB A/m

Location: -12, 2, 363.7 mm

**Point scan/x (longitudinal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1/ABM2 = 23.8531 dB

BWC Factor = -0.204999 dB

Location: -12, 2, 363.7 mm

**Coarse scan/y (transversal) scan 50 x 50 (grid 10) with noise/ABM Interpolated**

**Signal(x,y,z) (101x101x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -14.121 dB A/m

BWC Factor = -0.206004 dB

Location: -4, 10, 363.7 mm

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**Fine scan/y (transversal) scan 10 x 10 (grid 2) with noise/ABM Interpolated Signal(x,y,z) (51x51x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 = -14.8756 dB A/m

BWC Factor = -0.206004 dB

Location: 0, -7.2, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM Signal(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM1 comp = -17.7759 dB A/m

BWC Factor = -0.204999 dB

Location: -6, -4, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM Noise(x,y,z) (1x1x1):**

Measurement grid: dx=10mm, dy=10mm

**Cursor:**

ABM2 = -43.7111 dB A/m

Location: -6, -4, 363.7 mm

**Point scan/y (transversal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**

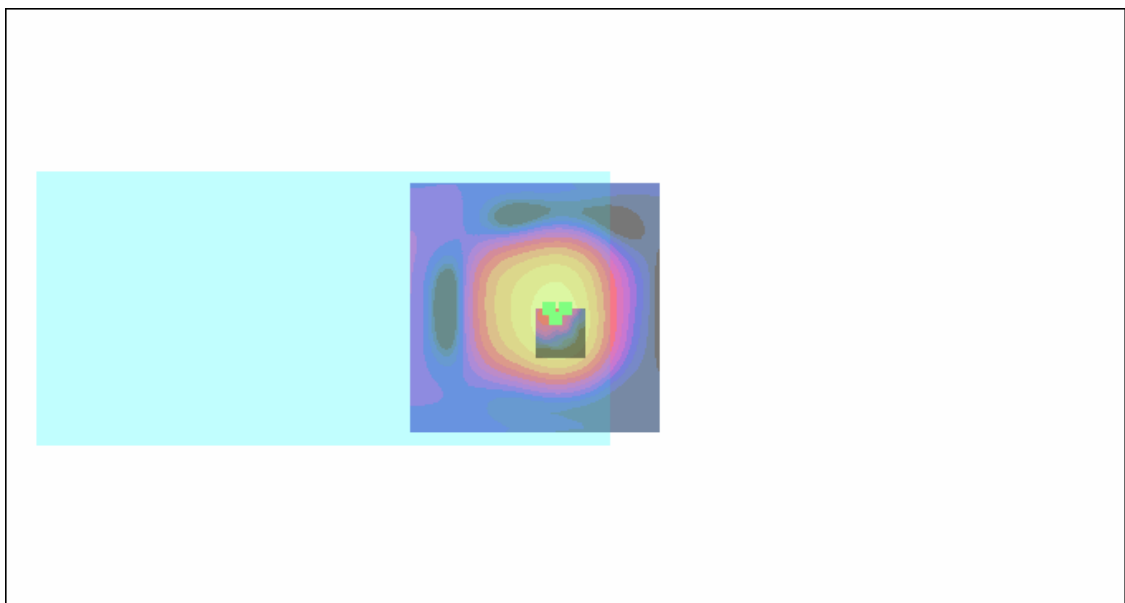
Measurement grid: dx=10mm, dy=10mm

**Cursor:**

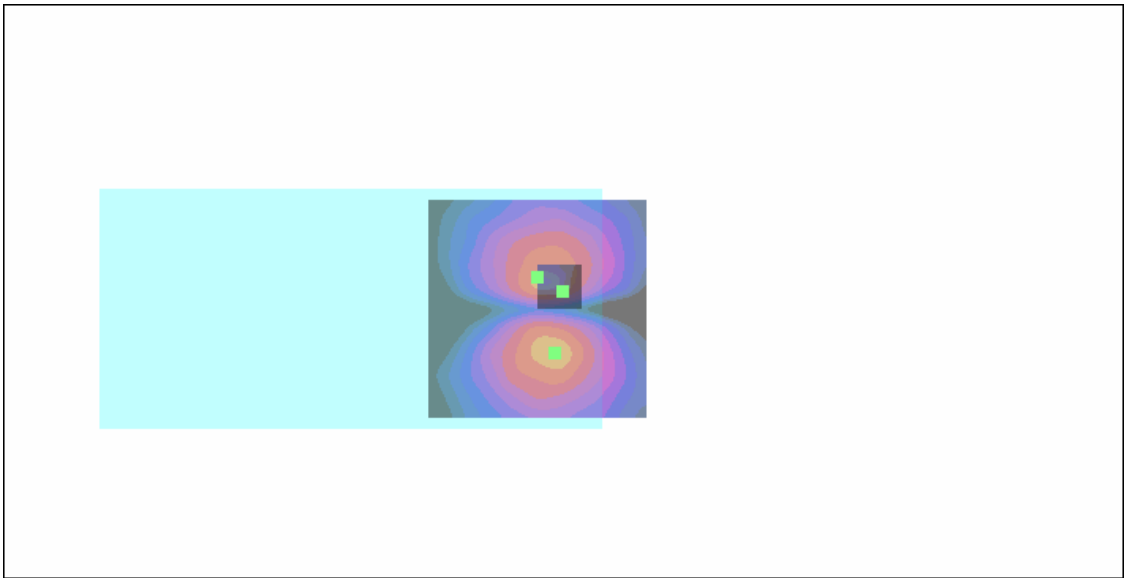
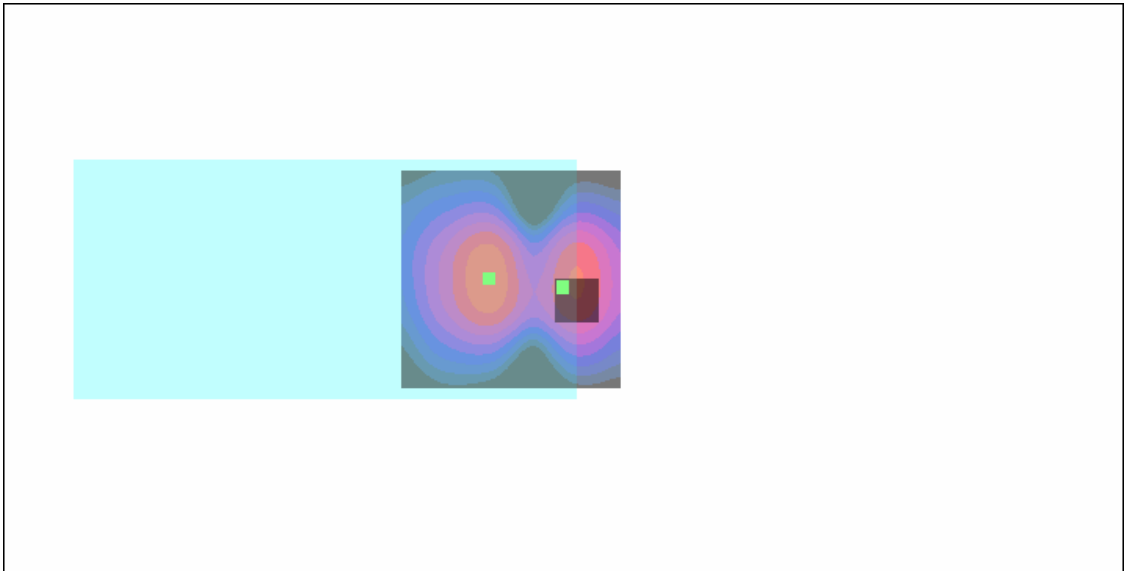
ABM1/ABM2 = 25.9352 dB

BWC Factor = -0.204999 dB

Location: -6, -4, 363.7 mm

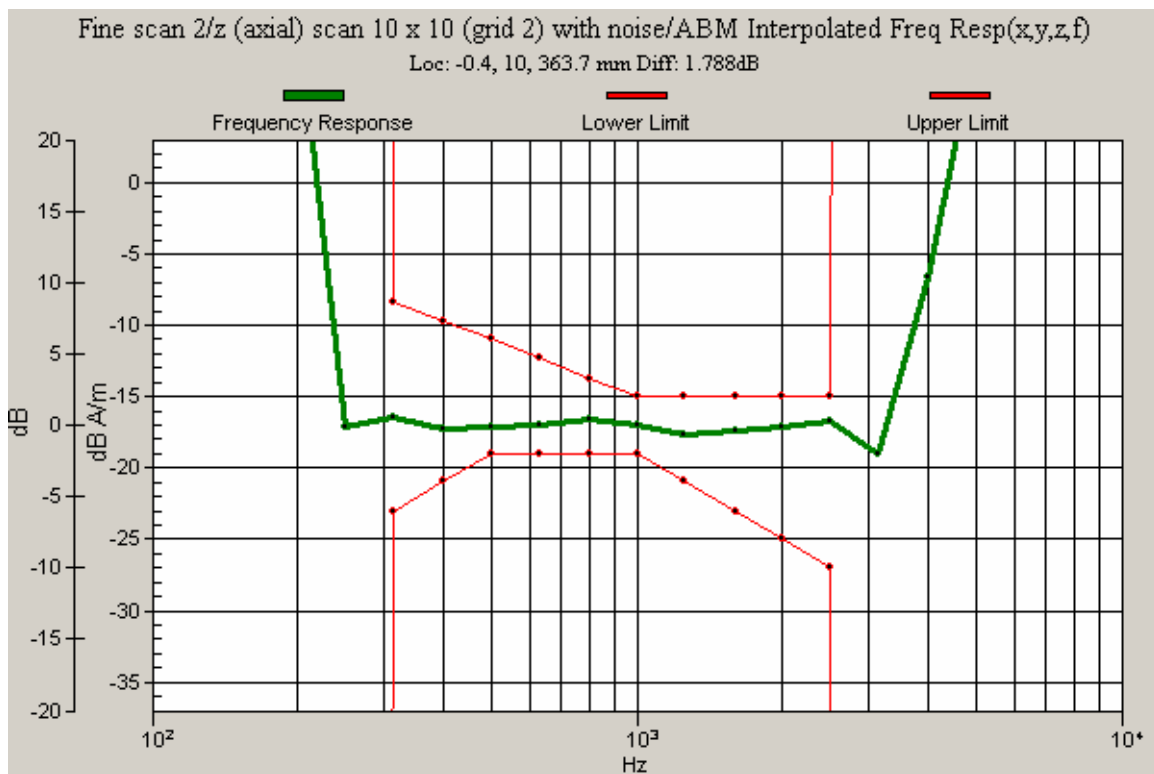


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## Voice simulated signal






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## Annex D: Probe certificate and equipment spec

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Schmid & Partner Engineering AG		<b>s p e a g</b>	
Zeughausstrasse 43, 8004 Zurich, Switzerland Phone +41 1 245 9700, Fax +41 1 245 9779 info@speag.com, http://www.speag.com			
<b>Certificate of test and configuration</b>			
Item	Audio Magnetic 1D Field Probe <b>AM1DV2</b>		
Type No	SP AM1 001 A		
Series No	<b>1016</b>		
Manufacturer / Origin	Schmid & Partner Engineering AG Zurich, Switzerland		
<b>Description of the item</b> The Audio Magnetic Field Probe is a fully shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The pickup coil is compliant with the dimensional requirements of [1]. The probe includes a symmetric 40dB low noise amplifier for the signal available at the shielded 3 pin connector at the side. Power is supplied via the same connector (phantom power supply) and monitored via the LED near the connector. The 7 pin connector at the end of the probe does not carry any signals, but determines the angle of the sensor when mounted on the DAE. The probe supports mechanical detection of the surface. The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components when rotating the probe by 120° around its axis. It is aligned with the perpendicular component of the field, if the probe axis is tilted 35.3° above the measurement plane, using the connector rotation below. The probe is fully RF shielded when operated with the matching signal cable (shielded) and allows measurement of audio magnetic fields in the close vicinity of RF emitting wireless devices according to [1] without additional shielding.			
<b>Handling of the item</b> The probe is manufactured from stainless steel. In order to maintain the performance and calibration of the probe, it must not be opened. The probe is designed for operation in air and shall not be exposed to humidity or liquids. For proper operation of the surface detection and emergency stop functions in the DASY4 system, the probe must be operated with the special probe cup provided (larger diameter).			
<b>Functional test</b> The probe configuration data were evaluated after a functional test including amplification, dynamic range and RF immunity.			
<b>DASY4 configuration data for the probe</b>			
Configuration item	Condition	Configuration Data	Dimension
Overall length	mounted on DAE in DASY4 system	<b>296</b>	mm
Tip diameter	at the cylindrical part	6	mm
Sensor offset	center of sensor, from tip	3	mm
Connector rotation	Evaluated in homogeneous 1 kHz magnetic field generated with AMCC Helmholtz Calibration Coil	<b>253</b>	°
<b>Standards</b> [1] ANSI PC63.19-2006 Draft 3.12			
Date		18.4.2006	
Signature			
Doc No. 884 - SP AM1 001 A - 1016 - A		Date 1/11	

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		FCC ID <b>L6ARAV20CW</b>

Schmid & Partner Engineering AG

**s p e a g**

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

#### Certificate of conformity

Item	Audio Magnetic Calibration Coil AMCC
Type No	SD HAC P02 A
Series No	1001 ff.
Manufacturer / Origin	Schmid & Partner Engineering AG Zurich, Switzerland

#### Description of the item

The Audio Magnetic Calibration coil (AMCC) is a Helmholtz Coil designed according to standard [1], section D.9 for calibration of the AM1D probe. Two horizontal coils are positioned above a non-metallic base plate and generate a homogeneous magnetic field in the z direction (normal to it).

#### Configuration

The AMCC consists of two parallel coils of 20 turns with radius 143 mm connected in parallel in a distance of 143 mm. With this design, a current of 10 mA produces a field of 1 A/m.  
The DC input resistance at the input BNC socket is adjusted by a series resistor to a DC resistance of approximately 50 Ohm. The voltage required to produce a field of 1 A/m is consequently approx. 500 mV.  
To current through the coil is monitored via a shunt resistor of 10 Ohm +/- 1%. The voltage is available on a BNO socket with 100 mV corresponding to 1 A/m.

#### Handling of the item

The coil shall be positioned in a non-metallic environment to avoid distortion of the magnetic field.

#### Tests

Test	Requirement	Details	Units tested
Number of turns	N = 20 per coil	Resistance measurement	all
Orientation of coils	parallel coils with same direction of windings	Magnetic field variation in the AMCC axis	all
Coil radius	r = 143 mm	mechanical dimension	First article
Coil distance	d = 143 mm distance between coil centers	mechanical dimension	First article
Input resistance	51.7 +/- 2 Ohm	DC resistance at BNC input connector	all
Shunt resistance	R = 10.0 Ohm +/- 1 %	DC resistance at BNO output connector	all
Shunt sensitivity	Hc = 1 A/m per 100 mV according to formula $H_c = (U/R) * N / r / (1.25^{1.5})$	Field measurement compared with Narda ELT400 + BN2300/90.10	First article

#### Standards

[1] ANSI PC63.19-2006 Draft 3.12

#### Conformity

Based on the tests above, we certify that this item is in compliance with the requirements of [1].

Date 22.5.2006

Stamp / Signature

**s p e a g**

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Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

Doc No 880 - SD HAC P02 A - A

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		FCC ID <b>L6ARAV20CW</b>	

Schmid & Partner Engineering AG

**s p e a g**

Zeughausstrasse 43, 8004 Zurich, Switzerland  
Phone +41 1 245 9700, Fax +41 1 245 9779  
info@speag.com, http://www.speag.com

#### Certificate of conformity

Item	Audio Magnetic 1D Field Probe AM1DV2
Type No	<b>SP AM1 001 A</b>
Series No	1001 ff.
Manufacturer / Origin	Schmid & Partner Engineering AG Zurich, Switzerland

#### Description of the item

The Audio Magnetic Field Probe AM1DV2 is a fully RF shielded magnetic field probe for the frequency range from 100 Hz to 20 kHz. The signal from the pickup coil is amplified in a symmetric 40dB low noise amplifier and fed to a 3 pin connector at the side. Power is supplied via the same and monitored via the LED near the connector. The single sensor in the probe is arranged in a tilt angle allowing measurement of 3 orthogonal field components by rotating the probe around its axis.

#### Handling of the item

The probe is manufactured and designed for operation in air and shall not be exposed to humidity or liquids. In order to keep the performance and alignment, the probe must not be disassembled. The full performance can only be achieved using the SPEAG provided accessories and following the corresponding manual.

#### Tests

Test	Requirement	Details	Units tested
Sensor angle	Probe configuration data for alignment with field	see corresponding probe certificate	all
Dimensions	according to corresponding probe certificate	verified at delivery / light beam alignment prior to measurement usage	all / in setup by user
Frequency response	within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz	Coil current of AMCC measured with R&S UPL, probe including amplifier and AMMI ADC input	First article
Dynamic range	max. + 21 dB A/m @ 1 kHz Noise level typ. -70 dB A/m @ 1 kHz ABM2 typ. -60 dB A/m	with AMMI	Samples / all
Linearity	within < 0.1 dB from 5 dB below limitation to 16 dB above noise level	tested between +15 dB A/m @ 1 kHz, to -70 dB A/m @ 10 kHz	Samples
Sensitivity	typ. -24 dBV / A/m @ 1 kHz at probe output	verified at delivery / calibrated in setup prior to measurement usage	all / in setup by user
RF shielding	immunity to AM modulated RF signal	1 kHz 80 % AM	all

#### Standards

[1] ANSI PC63.19-2006 Draft 3.12

#### Conformity

Based on the tests above, we certify that this item is in compliance with the requirements of [1].

Date 22.5.2006

Stamp / Signature

**s p e a g**  
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Author Data <b>Daoud Attayi</b>	Dates of Test <b>May 14-31, 2006</b>	Report No <b>RTS-0445--0606-06 rev 02</b>	FCC ID <b>L6ARAV20CW</b>

## Specifications

### Audio Magnetic Field Probe AM1D

The AM1D probe is an active probe with a single sensor according to [1] section D.8. It is fully RF shielded and has a rounded tip of 6 mm diameter incorporating a pickup coil with its center offset 3mm from the tip and the sides.

SPEAG, the manufacturer of the T-Coil system tested the probe frequency response and its dynamic range. The compliance is stated in the Certificate of conformity document 880-SPAM1001A-A. Also the probe frequency has been verified and the response deviation from the ideal differentiator was within +0.05 and - 0.46 dB in the range 100 Hz to 10 kHz on the center frequencies of the third-octave bands. Note that it includes the probe preamplifier and also with the AMMI internal preamplifiers, filters and processing.

#### Dynamic range:

maximum + 21 dB A/m @ 1 kHz

Noise level typically -70 dB A/m @ 1 kHz

ABM2 typically -60 dB A/m

#### Linearity

Within < 0.1 dB from 5 dB

below limitation to 16 dB above noise level

#### Sensitivity

Typically -24 dBV / A/m @ 1 kHz probe output

### Audio Magnetic Measurement Instrument (AMMI)

sampling rate 48 kHz / 24 bit

dynamic range 85 dB

test signal generation user selectable and predefined (via PC)

calibration auto-calibration / full system calibration using AMCC

with monitor output

dimensions 482 x 65 x 270 mm

### Helmholtz Calibration Coil (AMCC)

dimensions 370 x 370 x 196 mm, according to ANSI-PC63.19

The Audio Magnetic Calibration coil is a Helmholtz Coil designed according to [1], section D.9 for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction.

Shunt sensitivity  $H_c = 1$  A/m per 100mV according to formula:

$$H_c = (U / R) * N / r / (1.25^{1.5})$$

Number of turns  $N = 20$  per coil

Coil radius  $r = 143$  mm

Shunt resistance  $R = 10.00$  Ohm

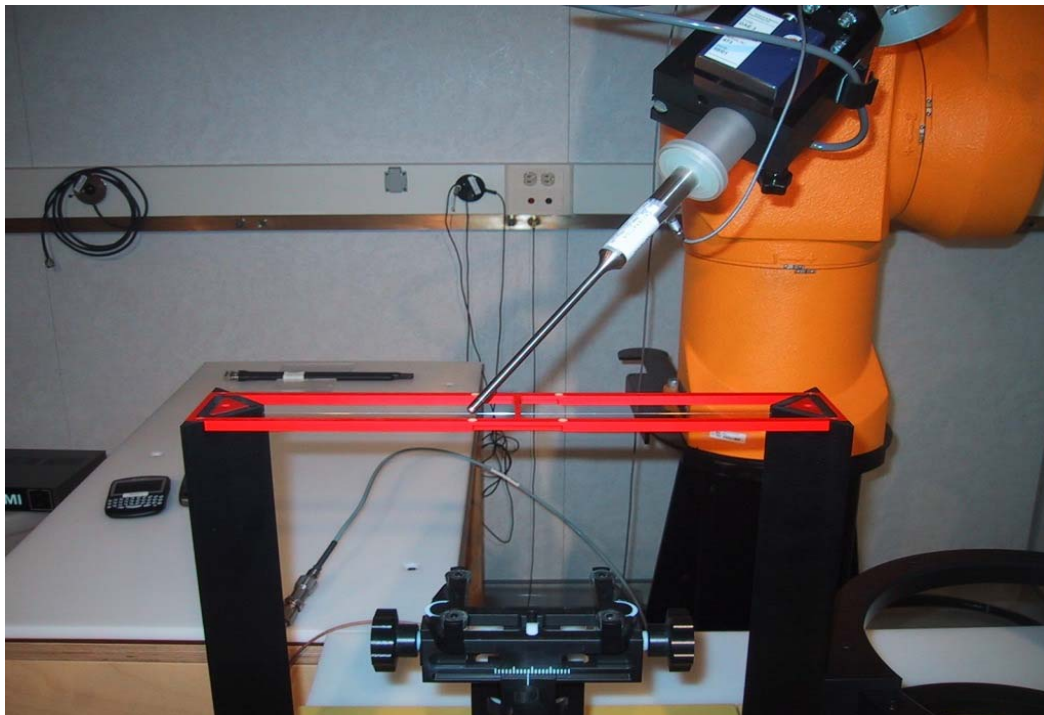
## Annex E: Test Setup Photos

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Figure E1: Probe calibration and reference signal measurement setup

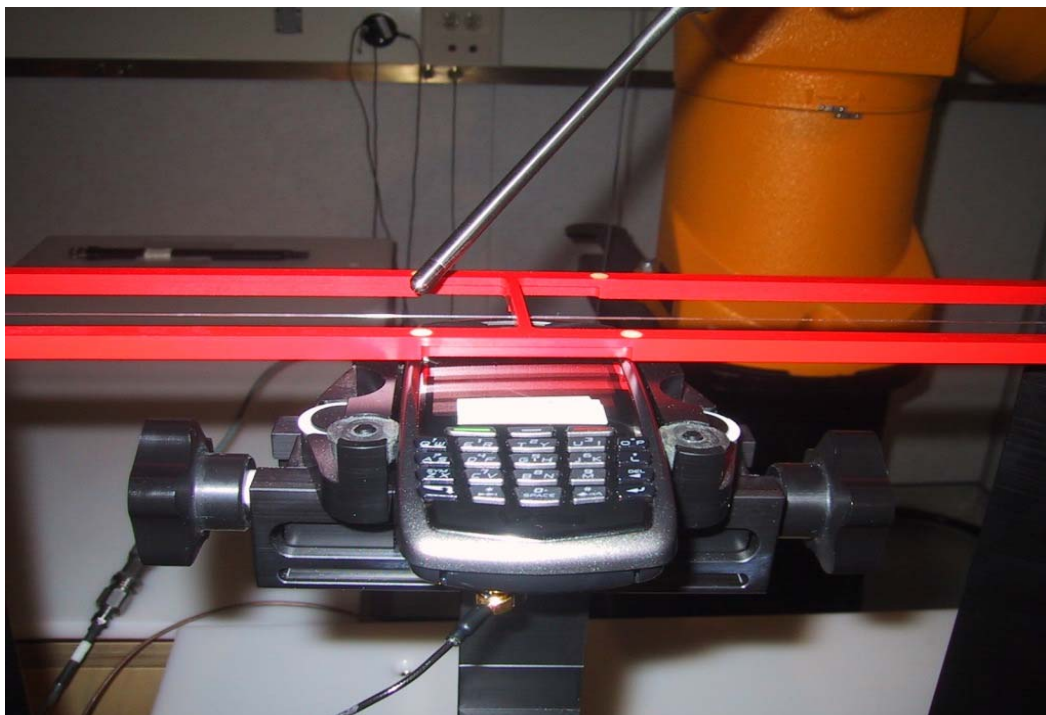
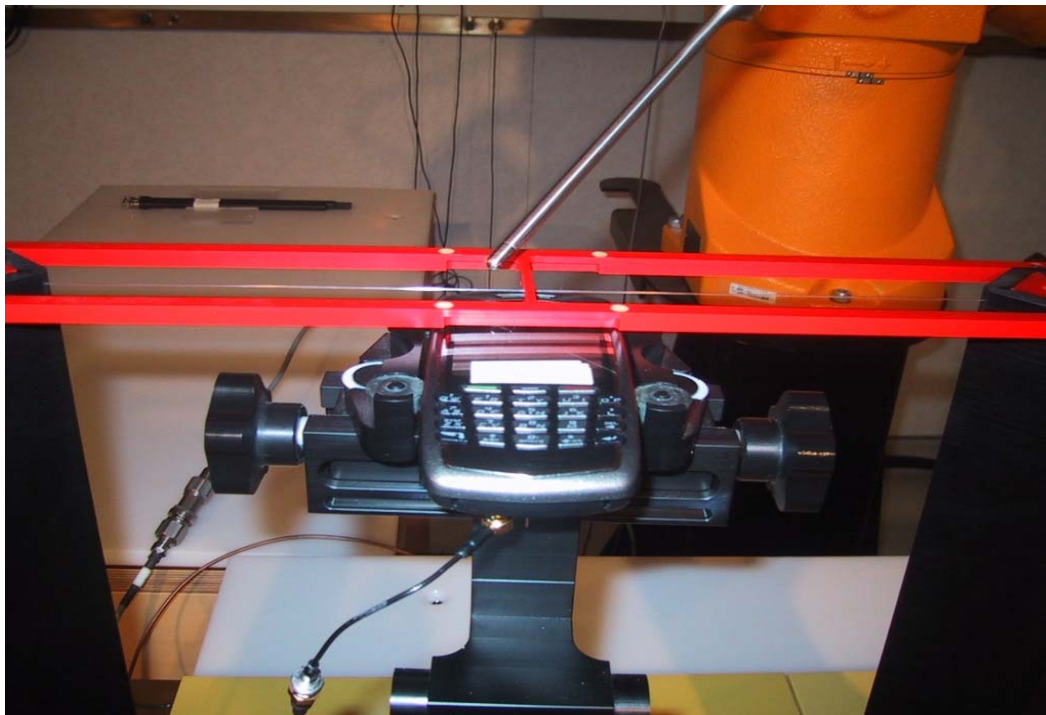
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**Figure E2: Ambient noise measurement setup**



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**Figure E3: Audio Band Magnetic (ABM) T-Coil measurement setup**