



**ANSI C63.19-2007**

**Hearing Aid Compatibility (HAC)**

**T-Coil Test Report**

For

**Smart Handheld**

**Model: E310**

**Trade Name: acer**

*Issued to*

**Acer Incorporated**  
**8F., No.88, Sec. 1, Hsin Tai Wu Rd., Hsichih Town,**  
**Taipei Hsien, Taiwan, R.O.C.**

*Issued by*

**Compliance Certification Services Inc.**  
**No.11, Wugong 6th Rd., Wugu Dist.,**  
**Xinbei City 24891, Taiwan**  
**<http://www.ccsrf.com>**  
**[service@ccsrf.com](mailto:service@ccsrf.com)**



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**1. Statement of Compliance**

**Applicant** Acer Incorporated  
8F., No.88, Sec. 1, Hsin Tai Wu Rd., Hsichih Town,  
Taipei Hsien, Taiwan, R.O.C.

**Equipment Under Test:** Smart Handheld

**Trade Name:** acer

**Model Number:** E310

**Date of Test:** December 24 ~ December 25, 2010

APPLICABLE STANDARDS	
STANDARD	TEST RESULT
ANSI C63.19-2007 (8 June, 2007)	No non-compliance noted
T-Coil RATE CATEGORY	
T3	

The device was tested by Compliance Certification Services Inc. in accordance with the measurement methods and procedures specified in ANSI C63.19-2007. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

*Reviewed by:*

*Tested by*

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Rex Lai  
Section Manager  
Compliance Certification Services Inc.

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Snake  
Test Engineer  
Compliance Certification Services Inc.



## 2. General Information

### 2.1 Description of Device Under Test (DUT)

<b>Product</b>	Smart Handheld
<b>Model Number</b>	E310
<b>Trade Name</b>	acer
<b>Model Discrepancy</b>	N/A
<b>Frequency Range</b>	GSM850 : 824 MHz ~ 849 MHz GSM1900 : 1850 MHz ~ 1910 MHz WCDMA Band V : 824 MHz ~ 849 MHz WCDMA Band II : 1850 MHz ~ 1910 MHz
<b>Transmit Power(Average)</b>	GSM850 : 32.57 dBm GSM1900 : 29.45 dBm WCDMA Band V : 23.61 dBm WCDMA Band II : 23.32 dBm
<b>Signal Quality (S+N)/N in dB</b>	GSM 850 : 20.10 dB / T3 GSM 1900 : 21.10 dB / T3 WCDMA Band V : 36.10 dB / T4 WCDMA Band II : 36.00 dB / T4
<b>Modulation Technique</b>	GSM / PCS: GMSK WCDMA: QPSK
<b>Antenna Specification</b>	Antenna. Type: PIFA antenna
<b>Battery</b>	Trade Name: acer, Model: BAT-310, Rating: 3.7VDC 1300mAh 4.81Wh



## **2.2 Applied Standards**

The Standard ANSI C63.19:2007 represents 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.

## **2.3 Test Conditions**

### **2.3.1 Ambient Condition**

<b>Ambient Temperature (°C)</b>	20-24°C
<b>Humidity (%)</b>	<60%
<b>Acoustic Ambient Noise</b>	>10dB below the measurement level

### **2.3.2 Test Configuration**

The device was controlled by using a base station emulator R&S CMU200. Communication between the device and the emulator was established by coaxial connection.

The DUT was set from the emulator to radiate maximum output power during all testing.



### **3. Hearing Aid Compliance (HAC)**

#### **3.1 Introduction**

In Aug.1 2007, the T-Coil requirements of ANSI C63.19-2007 Standard went into effect. The federal communication commission (FCC) adopted ANSI C63.19 as HAC test standard.



## **4. HAC T-Coil Measurement Setup**

### **4.1 System Configuration**



**Figure 4.1: T-Coil setup with HAC Test Arch and AMCC**



The DASY5 system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical Signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY5 software
- Remove control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom
- A device holder
- Dipole for evaluating the proper functioning of the system
- Arch Phantom

Some of the components are described in details in the following sub-sections.

#### **4.2 AMID probe**

The AMID probe is an active probe with a single sensor. It is fully RF-shielded and has a rounded tip 6mm in diameter incorporating a pickup coil with its center offset 3mm from the tip and the sides. The symmetric signal preamplifier in the probe is fed via the shielded symmetric output cable from the AMMI with a 48V “phantom” voltage supply. The 7-pin connector on the back in the axis of the probe does not carry any signals. It is mounted to the DAE for the correct orientation of the sensor. If the probe axis is tilted 54.7 degree from the vertical, the sensor is approximately vertical when the signal connector is at the underside of the probe (cable hanging downwards).

Specification:

<b>Frequency range</b>	0.1 ~ 20 kHz (RF sensitivity <-100dB, fully RF shielded )
<b>Sensitivity</b>	<-50dB A/m @ 1 kHz
<b>Pre-amplifier</b>	40 dB, symmetric
<b>Dimensions</b>	Tip diameter/ length: 6/ 290 mm, sensor according to ANSI-PC63.19





#### 4.2.1 Probe Tip Description

HAC field measurements take place in the close near field with high gradients. Increasing the measuring distance from the source will generally decrease the measured field values (in case of the validation dipole approx. 10% per mm).

Magnetic field sensors are measuring the integral of the H-field across their sensor area surrounded by the loop. They are calibrated in a precise, homogeneous field. When measuring a gradient field, the result will be very close to the field in the center of the loop which is equivalent to the value of a homogeneous field equivalent to the center value. But it will be different from the field at the field at the border of the loop.

Consequently, two sensors with different loop diameters – both calibrated ideally – would give different results when measuring from the edge of the probe sensor elements. The behavior for electrically small E-field sensors is equivalent. See below for distance plots from a WD which show the conservative nature of field readings at the probe element center vs. measurements at the sensor end.

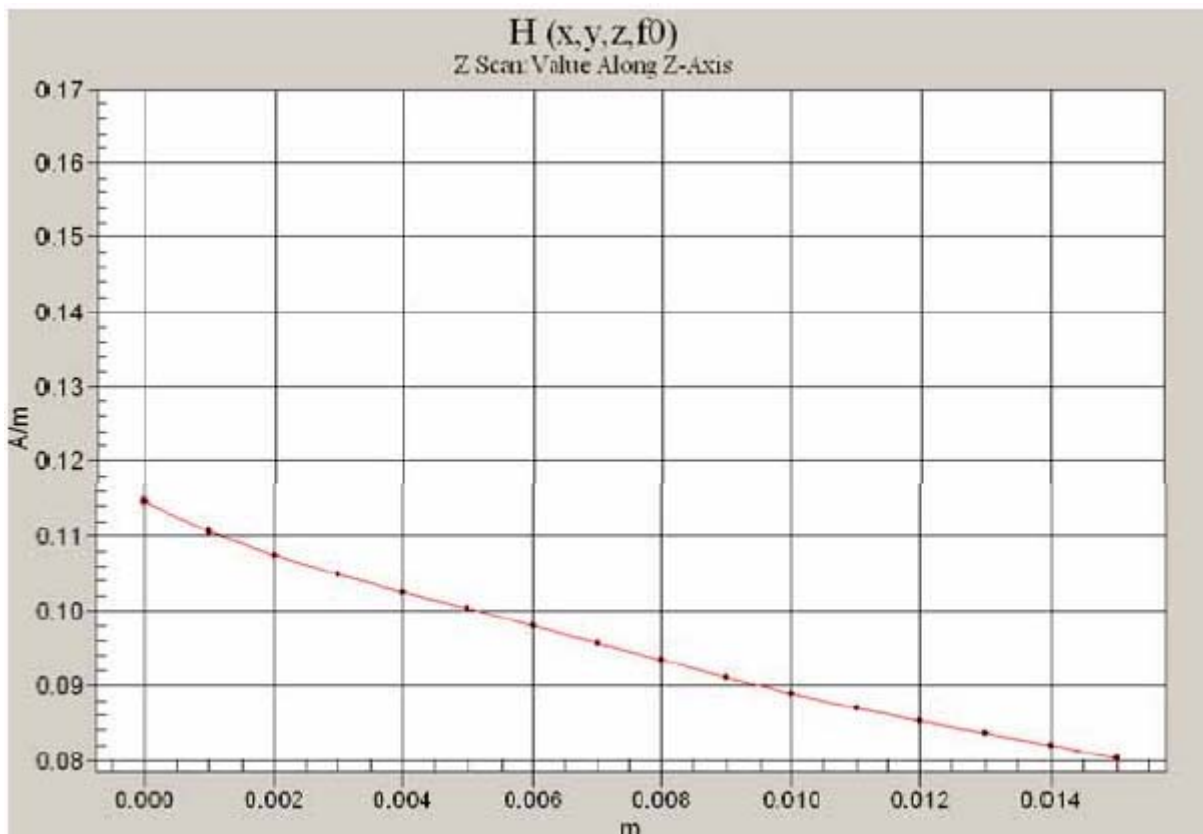


Figure 4.2: Z-Axis Scan at maximum point above a typical wireless device for H-field



### 4.2.2 Probe Calibration in AMCC

The probe sensitivity at 1 kHz is 0.0659911V/(A/m) (-24.0dBV/(A/m)) was calibrated by AMCC coil for verification of setup performance. The evaluated probe sensitivity was able to be compared to the calibration of the AM1D probe. The frequency response and sensitivity was shown in Figure 5.3. The probe signal is represented after application of an ideal integrator. The green curve represents the current though the AMCC, the blue curve the integrated probe signal. The DIFFERENCE between the two curves is equivalent to the frequency response of the probe system and shows the characteristics. The probe/system complies with the frequency response and linearity requirements in C63.19 according to the Speag’s calibrated report as shown in Annex B (AM1D probe: SPAM100AF) (1)The frequency response has been tested within +/- 0.5 dB of ideal differentiator from 100 Hz to 10 kHz. (2)The linearity has also been tested within 0.1dB from 5 dB below limitation to 16 dB above noise level. The AMCC coil is qualified according to certificate report, SDHACPO02A as shown in Annex B.

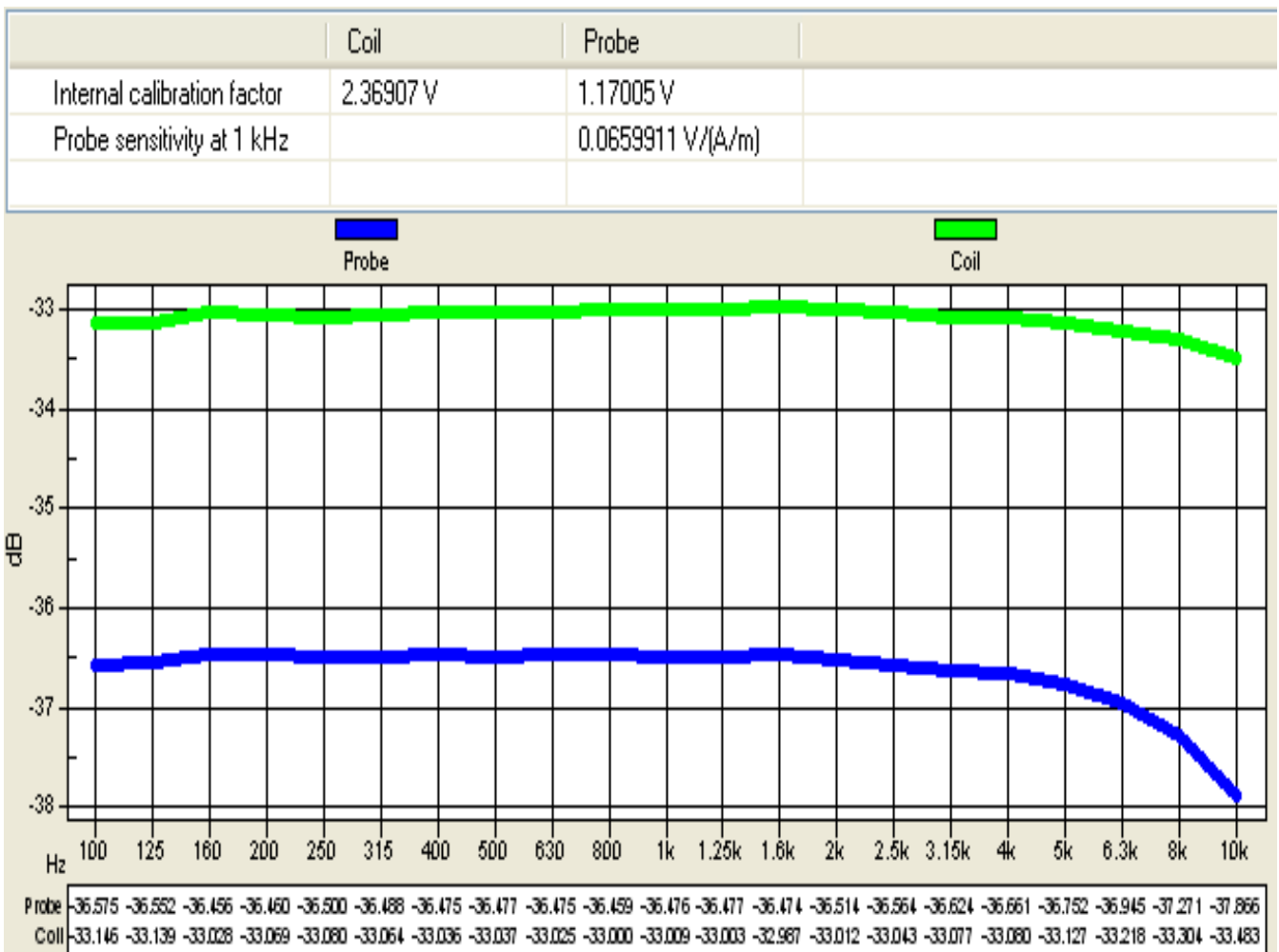


Figure 4.3: The frequency response and sensitivity of AM1D probe



### 4.3 AMCC

The Audio Magnetic Calibration coil is a Helmholtz Coil designed for calibration of the AM1D probe. The two horizontal coils generate a homogeneous magnetic field in the z direction. The DC input resistance is adjusted by a series resistor to approximately 50Ohm, and a shunt resistor of 10 Ohm permits monitoring the current with a scale of 1:10.

#### Port description:

Signal	Connector	Resistance
Coil In	BNC	typically 50 Ohm
Coil Monitor	BNO	100Ohm ±1%(100mV corresponding to 1 A/m)

#### Specification:

<b>Dimensions</b>	370 x 370 x 196 mm, according to ANSI C63.19
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### 4.4 AMMI



Figure 4.4: AMMI front panel

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.

#### Specification:

<b>Sampling rate</b>	48 kHz/24 bit
<b>Dynamic range</b>	85 dB
<b>Test signal generation</b>	User selectable and predefined (vis PC)
<b>Calibration</b>	Auto-calibration/full system calibration using AMCC with monitor output
<b>Dimensions</b>	482 x 65 x 270 mm



#### **4.5 DATA Acquisition Electronics (DAE)**

The data acquisition electronics (DAE4) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

The input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB. 4

#### **4.6 Robot**

The DASY5 system uses the high precision robots TX60L type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY5 system. The robot series have many features that are important for our application:

- ¾ High precision (repeatability 0.02 mm)
- ¾ High reliability (industrial design)
- ¾ Jerk-free straight movements
- ¾ Low ELF interference (the closed metallic construction shields against motor control fields)
- ¾ 6-axis controller

#### **4.7 Measurement Server**

The DASY5 measurement server is based on a PC/104 CPU board with

166 MHz CPU  
32 MB chipset and  
64 MB RAM.

Communication with  
the DAE4 electronic box  
the 16-bit AD-converter system for optical detection and digital I/O interface.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.



#### **4.8 Phone Positioner**

The phone positioner shown in Figure 4.5 is used to adjust DUT to the suitable position.



**Figure 4.5: Phone Positioner**



#### 4.8.1 Test Arch Phantom

<b>Construction</b>	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
<b>Dimensions</b>	370 x 370 x 370 mm



**Figure 4.6: Test Arch Phantom**



#### 4.9 Cabling of System

The principal cabling of the T-Coil setup is shown in Figure 4.6. All cables provided with the basic setup have a length of approximately 5 m.

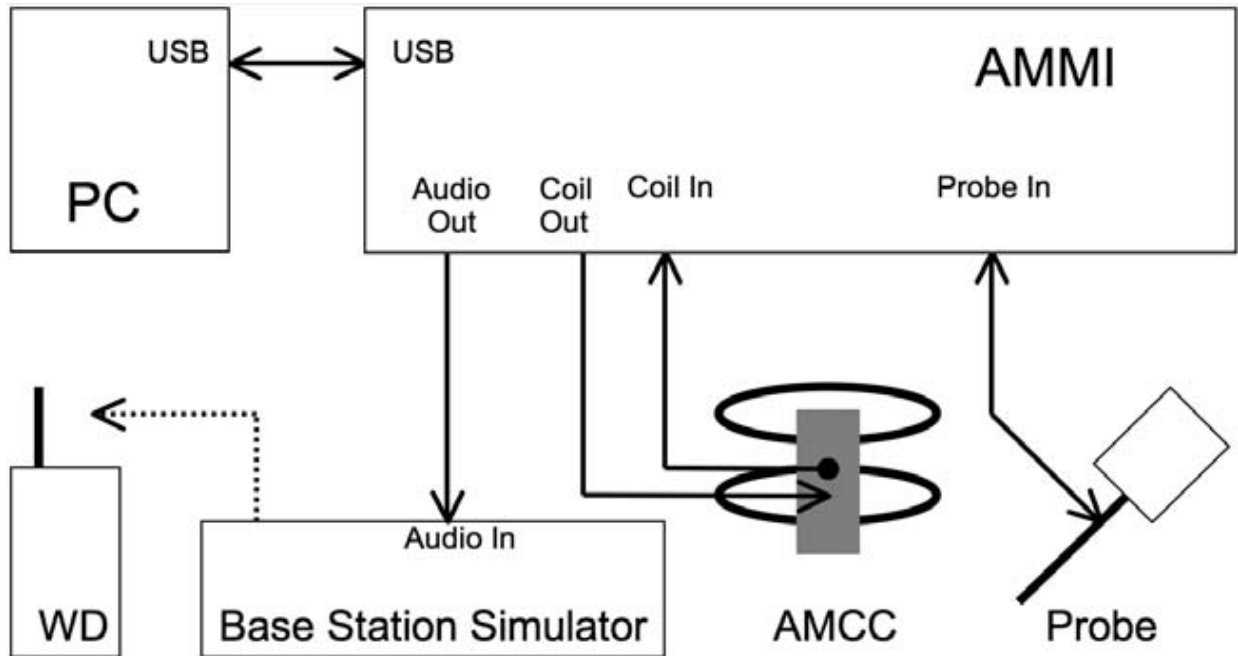


Figure 4.7: T-Coil setup cabling

#### 4.10 HAC Extension Software for DASY5

**Specification:**

<b>Precise teaching</b>	Easy teaching with adaptive distance verification
<b>Measurement area</b>	Flexible selection of measurement area, predefined according to ANSI C63.19
<b>Evaluation</b>	ABM: spectral processing, filtering, weighting and evaluation according to ANSI C63.19
<b>Report</b>	Documentation ready for compliance report



**4.11 Test Equipment List**

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1080	2010/02/23	2011/02/22
SPEAG	Audio Magnetic Calibration Coil	AMCC	1077	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1077	NCR	NCR
SPEAG	835MHz Calibration Dipole	CD835V3	1031	2009/04/22	2011/04/21
SPEAG	1880MHz Calibration Dipole	CD1880V3	1024	2009/04/22	2011/04/21
SPEAG	Data Acquisition Electronics	DAE4	877	2010/02/18	2011/02/17
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positoiner	N/A	N/A	NCR	NCR
R&S	Radio Communication Test	CMU200	116604	2010/11/22	2010/11/22

**Table 4.1 Test Equipment List**





#### 4.12 Reference Input of Audio Signal Spectrum

With the reference job "use as reference" in the beginning of a procedure, measure the spectrum of the current when applied to the AMCC, i.e. the input magnetic field spectrum, as shown below Fig. 4.8 and Fig. 4.9. For this, the delay of the window shall be set to a multiple of the signal period and at least 2s. From the measurement on the device, using the same signal, the postprocessor deducts the input spectrum, so the result represents the net DUT response.

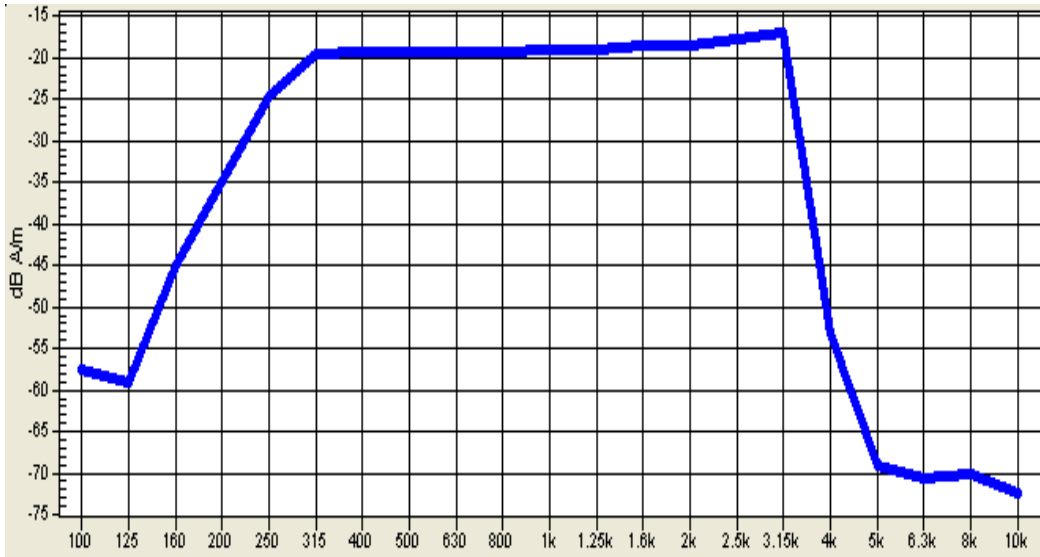


Figure 4.8: Audio signal spectrum of the broadband signal (48kHz\_voice\_300Hz~3 kHz)

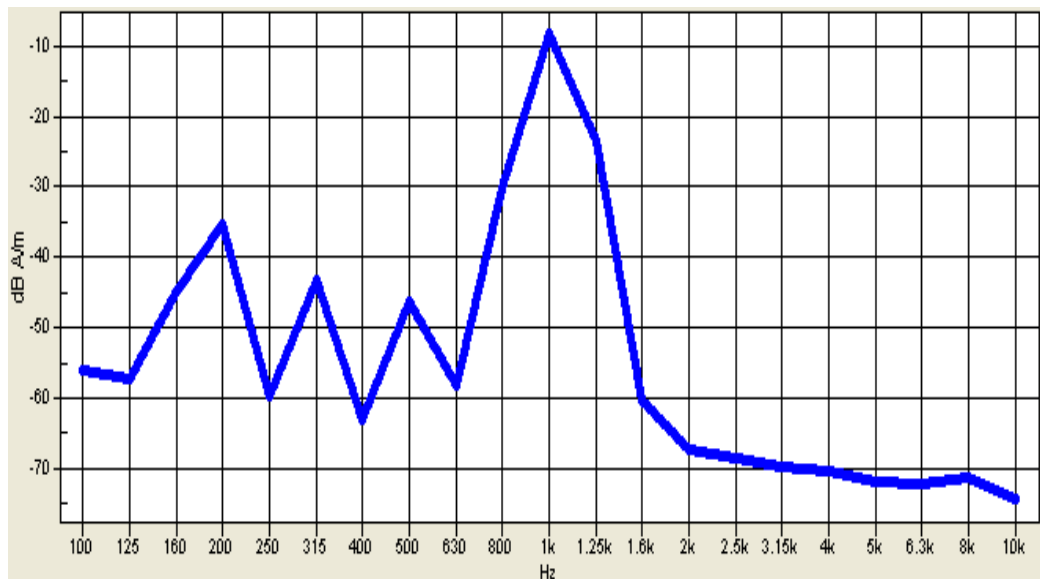


Figure 4.9: Audio signal spectrum of the narrowband signal (48kHz\_voice\_1kHz)



4.13 Signal Verification

According to ANSI C63.19:2007 section 6.3.2.1, the normal speech input level for HAC T-coil tests shall be set to -16 dBm0 for GSM and UMTS (WCDMA), and to -18 dBm0 for CDMA. This technical note shows a possibility to evaluate and set the correct level with the HAC T-Coil setup with a Rohde&Schwarz communication tester CMU200 with audio option B52 and B85.

Establish a call from the CMU200 to a wireless device. Select CMU200 Network Bitstream "Decoder Cal" to have a 1kHz signal with a level of 3.14 dBm0 at the speech output. Run the measurement job and read the voltage level at the multi-meter display "Coil signal". Read the RMS voltage corresponding to 3.14 dBm0 and note it. Calculate the desired signal levels of -16dBm0:

3.14 dBm0 = -2.697 dBV  
-16 dBm0 = -21.837 dBV

Determine the 1 kHz input level to generate the desired signal level of -18 dBm0. Select CMU200 Network Bitstream "Codec Cal" to loop the input via the codec to the output. Run the measurement job (AMMI 1kHz signal with gain 10 inserted) and read the voltage level at the multimeter display "Coil signal". Calculate the required gain setting for the above levels:

Gain 10 = -20.52 dBV  
Difference for -16 dBm0 = -21.837 - (-20.52) = -1.317 dB  
Gain factor = 10 ^ ((-1.317) / 20) = 0.86  
Resulting Gain = 10 x 0.86 = 8.6

The predefined signal types have the following differences / factors compared to the 1 kHz sine signal:

Signal Type	Duration (s)	Peak to RMS (dB)	RMS (dB)	Gain Factor	Gain Setting
1kHz	1	15.78	-31.76	4.33	37.238
300Hz ~ 3kHz	2	22.31	-27.35	8.48	72.928



## 5. Description for DUT Testing Position

Figure 5.1 illustrate the references and reference plane that shall be used in a typical DUT emissions measurement. The principle of this section is applied to DUT with similar geometry.

- The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.
- The grid is centered on the audio frequency output transducer of the DUT.
- The grid is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the DUT handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 1.0 cm in front of, the reference plane.



Figure 5.1: A typical DUT reference and plane for HAC measurements



## **6. T-Coil Test Procedure**

The following illustrate a typical test scan over a wireless communications device:

1. Geometry and signal check: system probe alignment, proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
2. Set the reference drive level of signal voice defined in C63.19 per 6.3.2.1, as shown in this report of section 5.12.
3. The ambient and test system background noise (dB A/m) was measured as well as ABM2 over the full measurement. The maximum noise level must be at least 10dB below the limit of C63.19 per 7.3.2.
4. The DUT was positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
5. The DUT operation for maximum rated RF output power was configured and connected by using of coaxial cable connection to the base station simulator at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The DUT audio output was positioned tangent (as physically possible) to the measurement plane.
6. The DUT's RF emission field was eliminated from T-coil results by using a well RF-shielding of the probe, AM1D, and by using of coaxial cable connection to a Base Station Simulator. One test channel was pre-measurement to avoid this possibility.
7. Determined the optimal measurement locations for the DUT by following the three steps, coarse resolution scan, fine resolution scans, and point measurement, as described in C63.19 per 6.3.4.4. At each measurement locations, samples in the measurement window duration were evaluated to get ABM1 and the signal spectrum. The noise measurement was performed after the scan with the signal, the same happened, just with the voice signal switched off. The ABM2 was calculated from this second scan.
  - (1) Coarse resolution scans (1 kHz signal at 50 x 50 mm grid area with 4.2 mm spacing). Only ABM1 was measured in order to find the location of T-Coil source.
  - (2) Fine resolution scans (1 kHz signal at 8 x 8 mm grid area with 2 mm spacing for Axial, 42 x 6 mm grid area with 3 mm spacing for Longitudinal, 6 x 42 mm grid area with 3 mm spacing for Transversal).  
The positioned appropriately based on optimal AMB1 of coarse resolution scan. Both ABM1 and ABM2 were measured in order to find the location of the SNR point.
  - (3) Point measurement (1 kHz signal) for ABM1 and ABM2 in axial, radial transverse and radial longitudinal. The positioned appropriately based on optimal SNR of fine resolution scan. The SNR was calculated for axial, radial transverse and radial longitudinal orientation.
  - (4) Point measurement (300Hz to 3 kHz signal) for frequency response in axial. The positioned appropriately based on optimal SNR of fine resolution axial scan.



8. All results resulting from a measurement point in a T-Coil job were calculated from the signal samples during this window interval. ABM values were averaged over the sequence of these samples.
9. At an optimal point measurement, the SNR (ABM1/ABM2) was calculated for axial, radial transverse and radial longitudinal orientation, and the frequency response was measured in axial axis.
10. Corrected for the frequency response after the DUT measurement since the DASY5 system had known the spectrum of the input signal by using a reference job, as shown in this report of section 5.12.
11. In SEMCAD post-processing, the spectral points are in addition scaled with the high-pass (half-band) and the A-weighting, bandwidth compensated factor (BWC) and those results are final as shown in this report.
12. Classified the signal quality based on the table 8.1: T-Coil Signal Quality Categories.



## 7. T-Coil Articulation Weighting Factor and Signal Quality Categories

### 7.1 Signal Quality Categories

This section provides the signal quality requirement for the intended T-Coil signal from a WD. 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. A device is assessed beginning by determining the category of the RF environment in the area of the T-Coil source.

The RF measurements made for the T-Coil evaluation are used to assign the category T1 through T4. The limitation is given in Table 7.1. This establishes the RF environment presented by the WD to a hearing aid.

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

Table 7.1: T-Coil signal quality categories



## 8. Summary of Measurement Result

### 8.1 Test Result

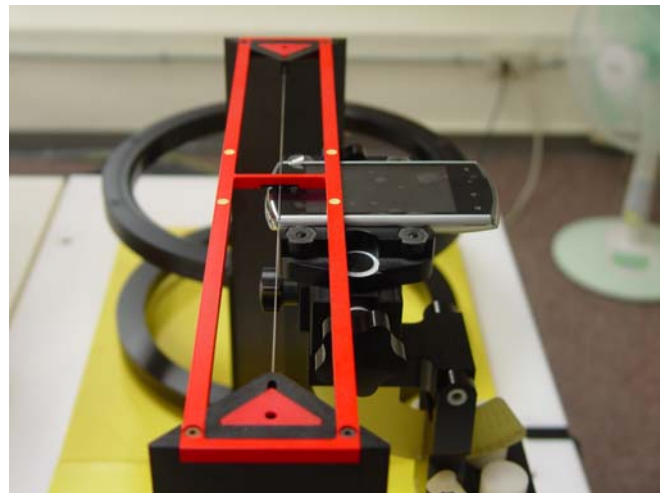
#### 8.1.1 Conducted Power

Band	GSM 850			GSM 1900		
Channel	128	189	251	512	661	810
GSM	32.32	32.34	32.57	29.33	29.45	29.26

Band	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
AMR	23.35	23.61	23.15	23.32	22.78	22.72

※Unit: dBm

#### 8.1.2 EUT Setup photo





### 8.1.3 Magnitude Result

The Table 8.1 & 8.2 shows testing result in position coordinates which are defined as deviation from earpiece center in millimeters. Axial measurement location was defined by the manufacture of the device.

Probe Position	Band	Chan.	Measurement Position (x mm, y mm)	ABM2 (dB A/m)	ABM1 (dB A/m)	SNR (dB)
Radial 1 (Longitudinal)	GSM850	128	(10.2,-3)	-30.06	-7.296	22.80
		190	(11.3,-3)	-30.19	-6.962	23.20
		251	(10.2,3)	-28.53	-6.128	22.40
	GSM1900	512	(9.3,-1.2)	-31.18	-6.372	24.80
		661	(12.7,0)	-31.86	-7.924	23.90
		810	(9.7,-3)	-31.39	-5.663	25.70
	WCDMA Band V	4132	(-8.3,-1.2)	-41.15	-5.028	36.10
		4182	(-8.3,3)	-41.72	-5.577	36.10
		4233	(6.7,0)	-41.72	-4.826	36.90
	WCDMA Band II	9262	(6.7,1.2)	-41.57	-4.991	36.60
		9400	(-8.3,0)	-41.17	-4.807	36.40
		9538	(6.7,0)	-41.68	-5.017	36.70
Radial 2 (Transversal)	GSM850	128	(-3,3.7)	-37.62	-11.28	26.30
		190	(-4.2,-3.7)	-35.53	-8.416	27.10
		251	(0,6.7)	-33.45	-5.286	28.20
	GSM1900	512	(-4.2,6.7)	-35.50	-7.703	28.00
		661	(0,3.7)	-40.69	-9.069	31.60
		810	(-1.2,6.7)	-37.55	-6.017	31.50
	WCDMA Band V	4132	(0,8.3)	-42.29	-6.131	36.20
		4182	(-3,-9.7)	-42.85	-6.262	36.60
		4233	(0,-8.3)	-42.75	-5.656	37.10
	WCDMA Band II	9262	(-1.2,-8.3)	-42.50	-5.625	36.90
		9400	(-3,-8.3)	-42.60	-6.236	36.40
		9538	(0,-5.3)	-42.98	-6.931	36.00
Axial	GSM850	128	(-2,0)	-17.95	2.157	20.10
		190	(0,-0.2)	-16.14	4.355	20.50
		251	(-2,2)	-17.64	3.494	21.10
	GSM1900	512	(-2,-2)	-19.62	1.889	21.50
		661	(-2,-2.2)	-19.53	1.533	21.10
		810	(0,0.3)	-19.82	3.605	23.40
	WCDMA Band V	4132	(-4,4)	-43.03	-1.092	41.90
		4182	(-4,4.2)	-40.31	-0.844	39.50
		4233	(-4,0)	-41.76	1.104	42.90
	WCDMA Band II	9262	(-0.2,2)	-39.64	2.792	42.40
		9400	(-2,-2)	-40.28	2.121	42.40
		9538	(2,2)	-40.82	1.783	42.60

**Table 8.1: Test Result for Various Positions**

**Remark:** The HAC mode of DUT is turn on and LCD backlight, Bluetooth and WLAN functions are turn off, and volume is adjusted to maximum level during T-Coil testing.





### 8.1.4 Frequency Response

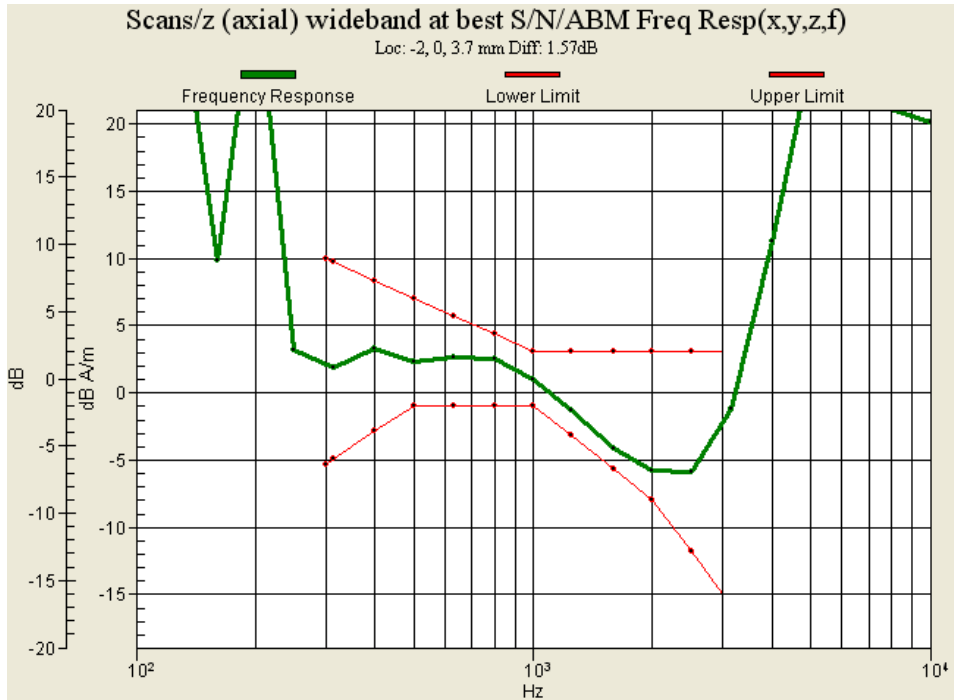


Figure 8.1: Frequency Response of GSM850 for Ch128

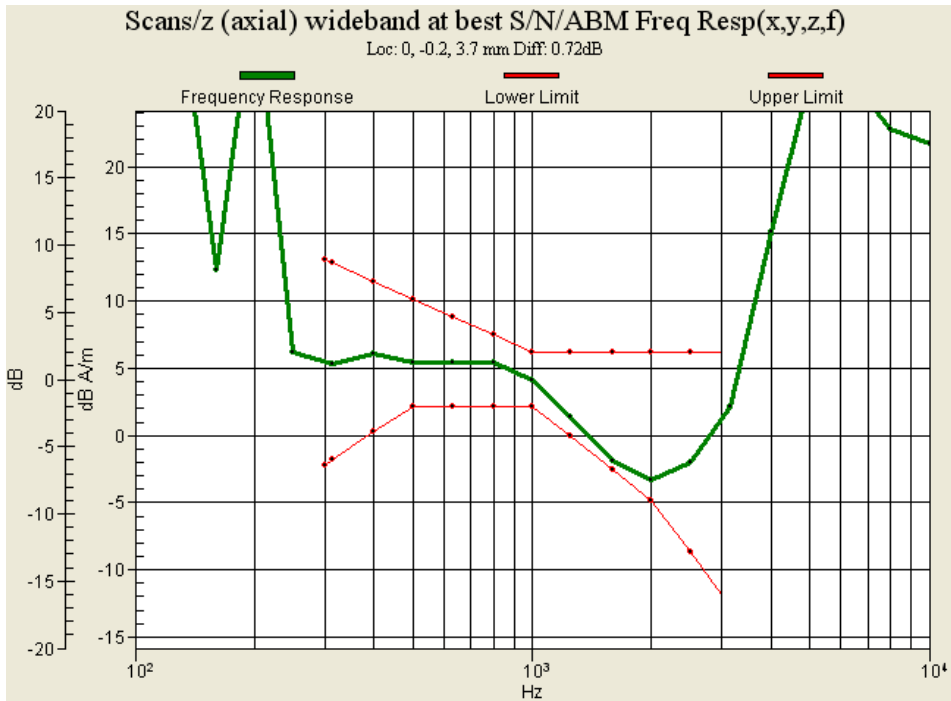


Figure 8.2: Frequency Response of GSM850 for Ch189

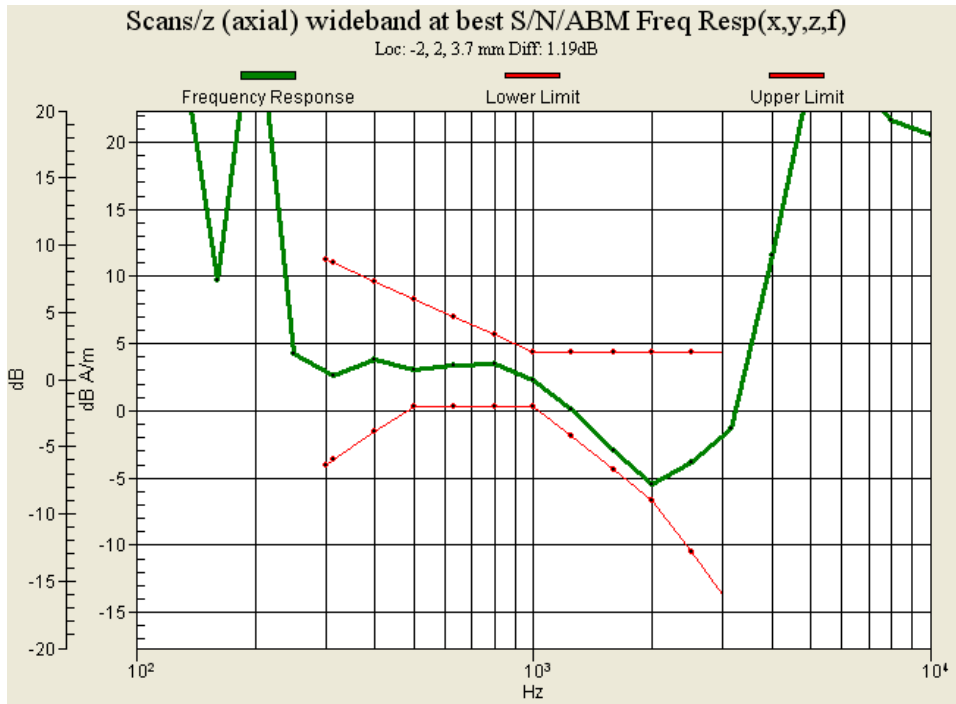


Figure 8.3: Frequency Response of GSM850 for Ch251

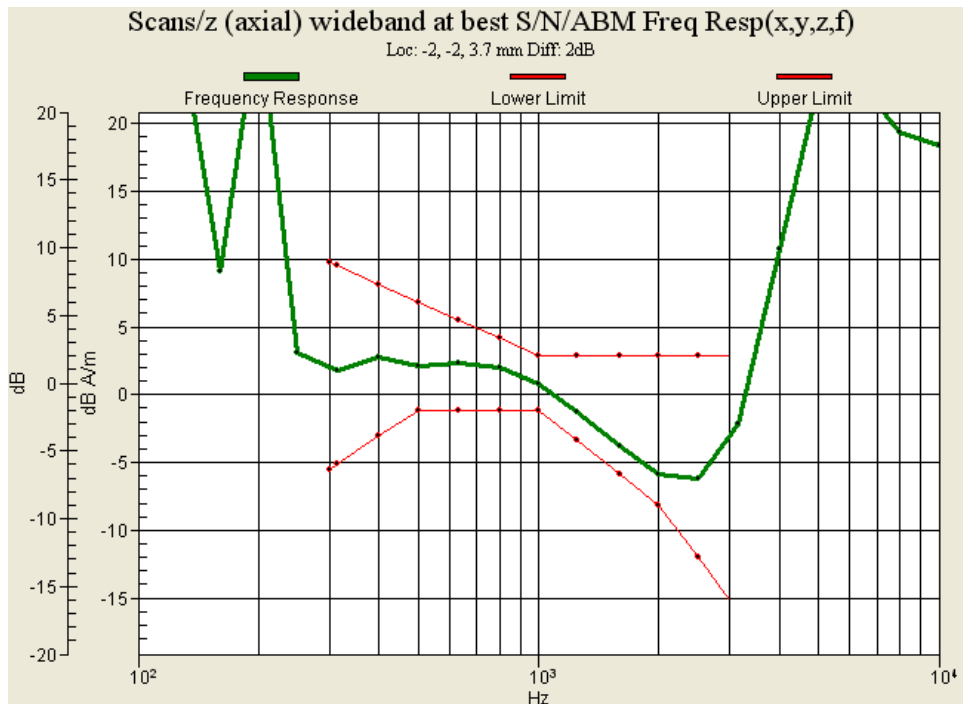


Figure 8.4: Frequency Response of GSM1900 for Ch512

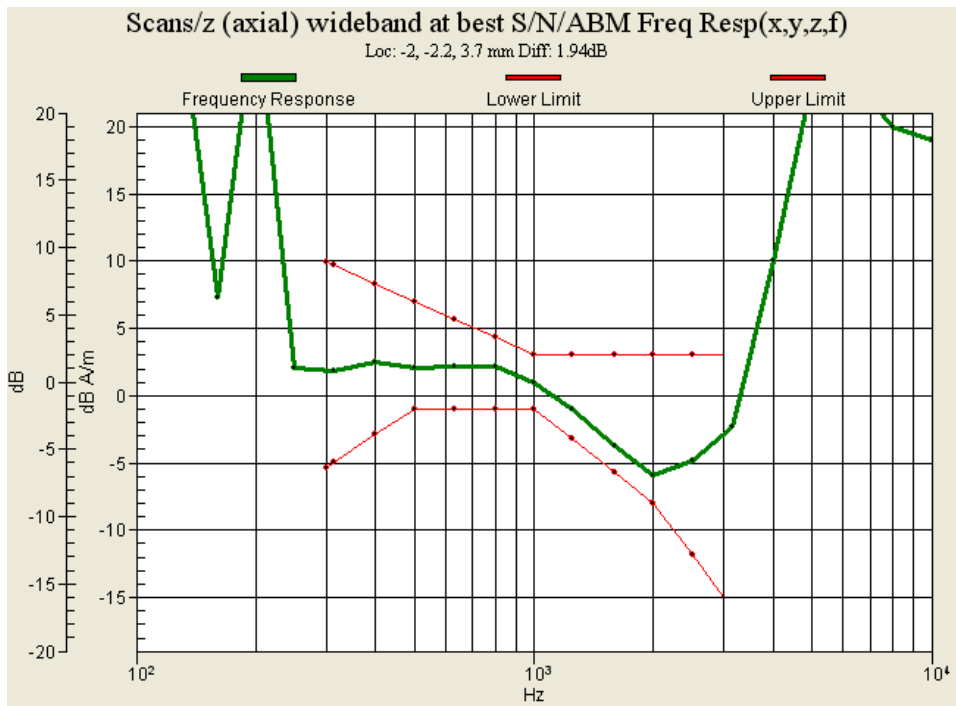


Figure 8.5: Frequency Response of GSM1900 for Ch661

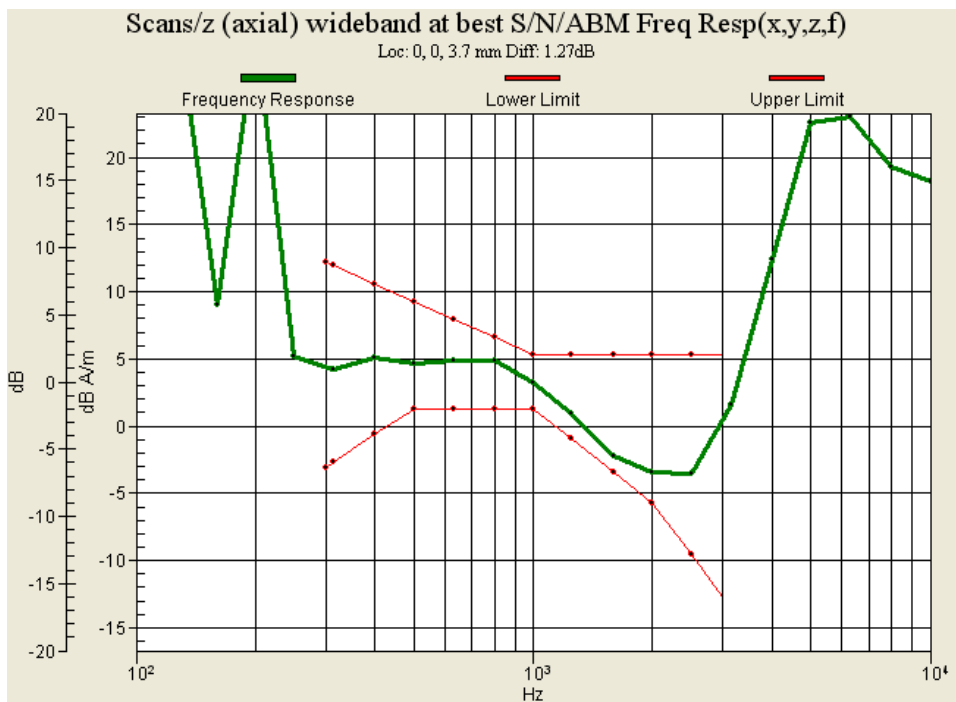


Figure 8.6: Frequency Response of GSM1900 for Ch810

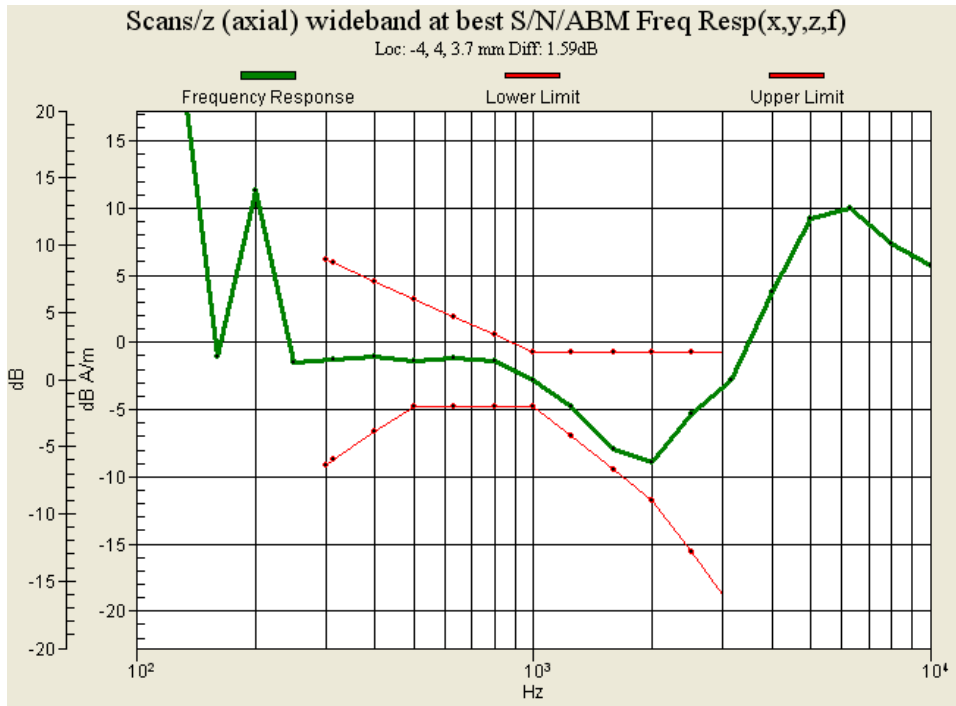


Figure 8.7: Frequency Response of WCDMA Band V for Ch4132

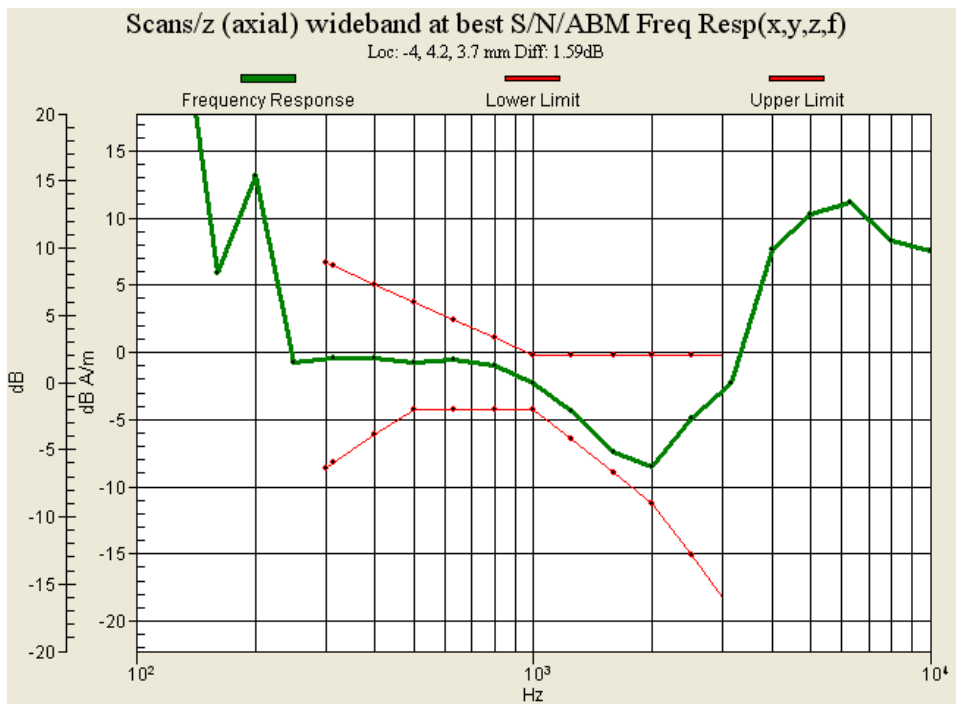


Figure 8.8: Frequency Response of WCDMA Band V for Ch4182

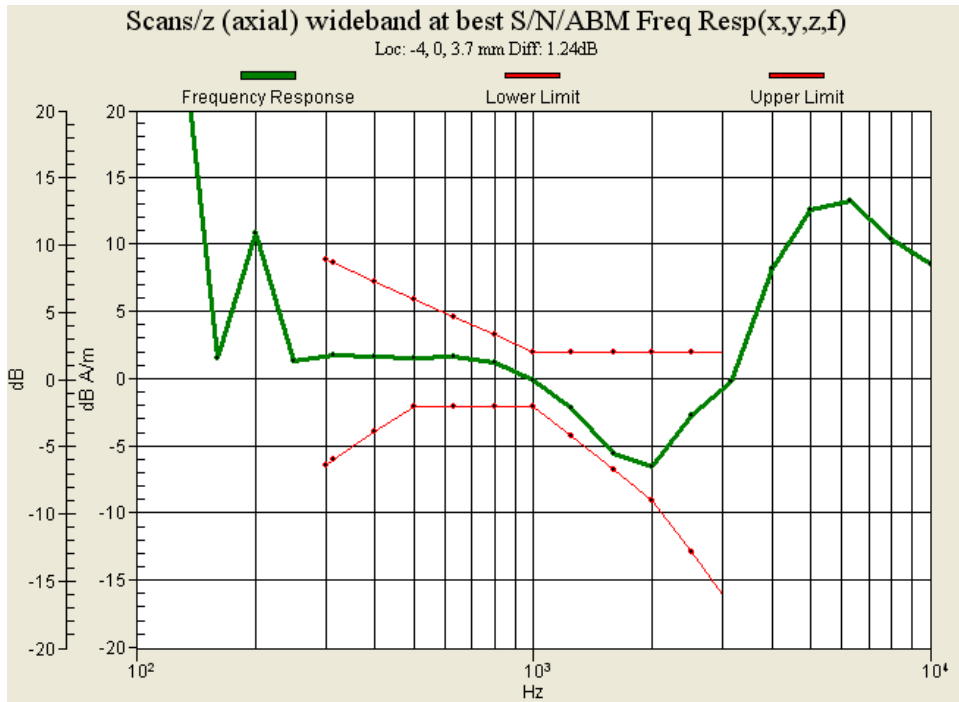


Figure 8.9: Frequency Response of WCDMA Band V for Ch4233

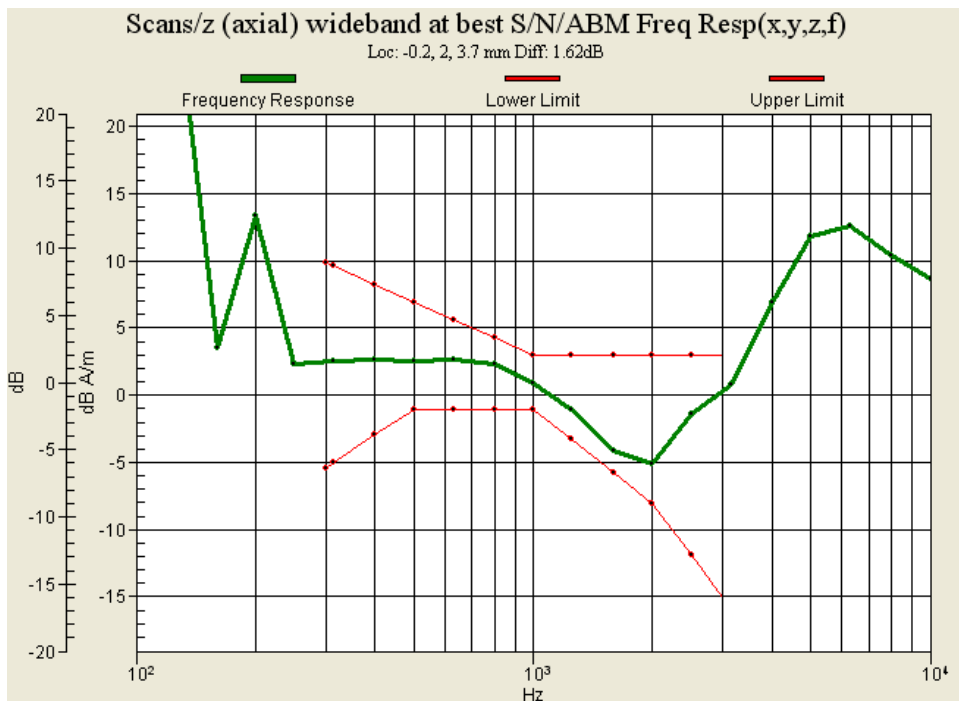


Figure 8.10: Frequency Response of WCDMA Band II for Ch9262

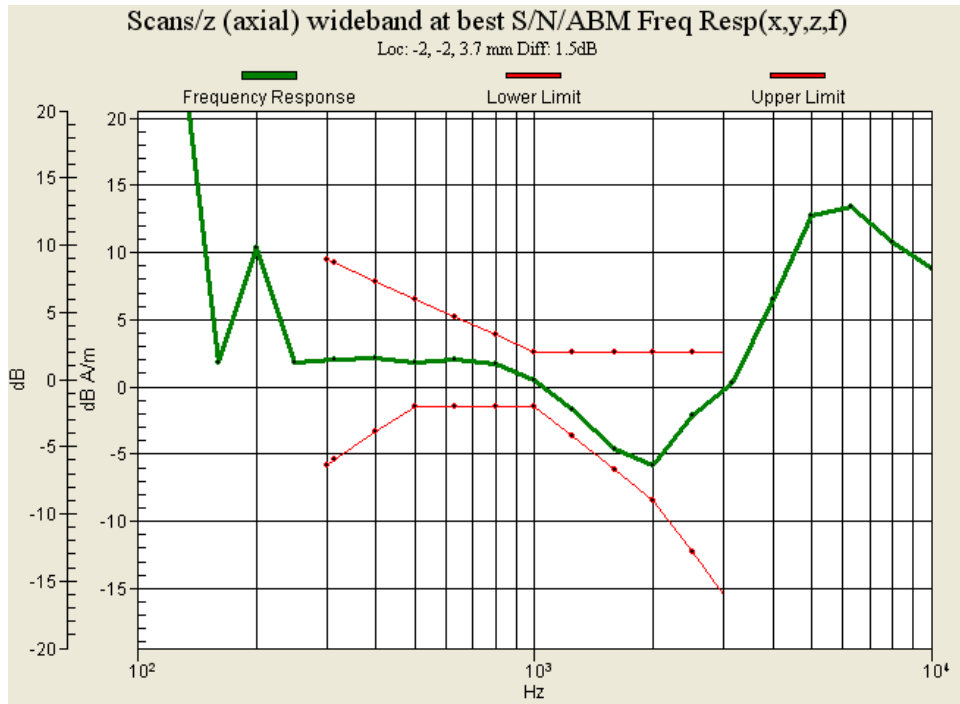


Figure 8.11: Frequency Response of WCDMA Band II for Ch9400

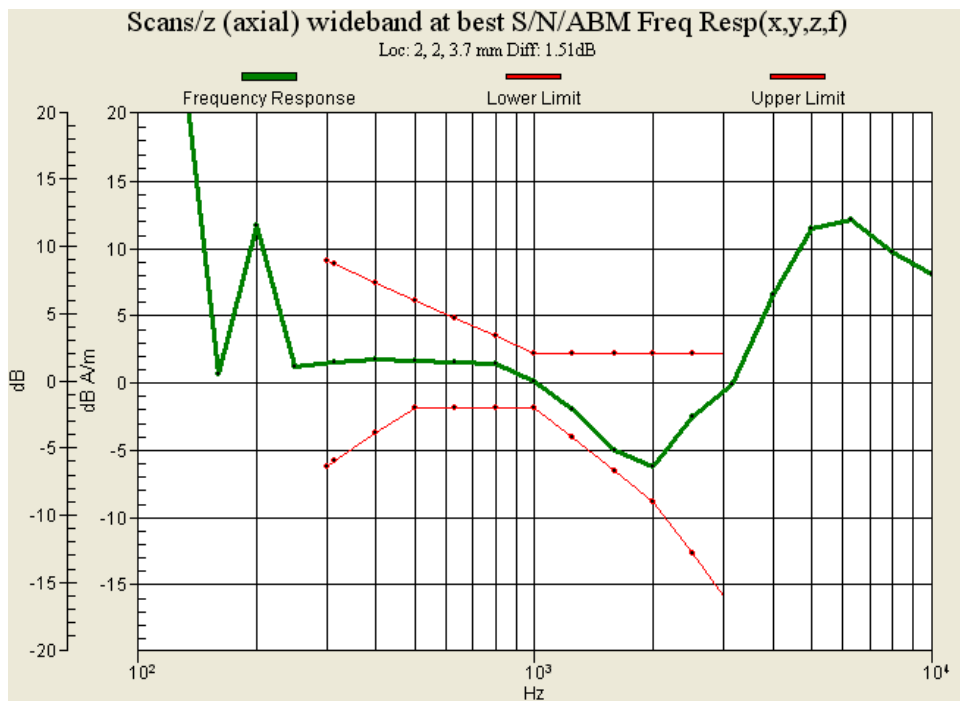


Figure 8.12: Frequency Response of WCDMA Band II for Ch9538



9.2 **T-Coil Coupling Field Intensity**

9.2.1 **Axial Field Intensity**

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-13	2.157	Pass
GSM1900	-13	1.533	Pass
WCDMA Band V	-13	-1.092	Pass
WCDMA Band II	-13	1.783	Pass

9.2.2 **Radial Field Intensity**

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
GSM850	-18	-11.28	Pass
GSM1900	-18	-9.069	Pass
WCDMA Band V	-18	-6.262	Pass
WCDMA Band II	-18	-6.931	Pass

9.2.3 **Frequency Response at Axial Measurement Point**

Cell Phone Mode	Verdict
GSM850	Pass
GSM1900	Pass
WCDMA Band V	Pass
WCDMA Band II	Pass

9.2.4 **Signal Quality**

Cell Phone Mode	Minimum limit (dB)				Minimum Result (dB)	Verdict
	T1	T2	T3	T4		
GSM850	0	10	20	30	20.10	T3
GSM1900	0	10	20	30	21.10	T3
WCDMA Band V	0	10	20	30	36.10	T4
WCDMA Band II	0	10	20	30	36.00	T4



### 9. Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience and knowledge of the behavior and properties of relevant materials and instruments, manufacture’s specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 9.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-shape
<b>Multiplying factor<sup>(a)</sup></b>	1/k <sup>(b)</sup>	1/√	1/√	1/√ 2

- (a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity
- (b) **K** is the coverage factor

**Table 9.1: Uncertainty classification**

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY5 uncertainty Budget is showed in Table 9.2.





Error Description	Uncertainty Value ( $\pm$ %)	Probability Distribution	Divisor	(Ci) ABM1	(Ci) ABM2	Std. Unc. ABM1	Std. Unc. ABM2
<b>Probe Sensitivity</b>							
Reference Level	$\pm 3.0\%$	Normal	1	1	1	$\pm 3.0\%$	$\pm 3.0\%$
AMCC Geometry	$\pm 0.4\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$
AMCC Current	$\pm 0.6\%$	Rectangular	$\sqrt{3}$	1	0.145	$\pm 0.4\%$	$\pm 0.4\%$
Probe Positioning during Calibration	$\pm 0.1\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.1\%$	$\pm 0.1\%$
Noise Contribution	$\pm 0.7\%$	Rectangular	$\sqrt{3}$	0.0143	1	$\pm 0.0\%$	$\pm 0.4\%$
Frequency Slope	$\pm 5.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.3\%$	$\pm 3.5\%$
<b>Probe System</b>							
Repeatability/Drift	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$
Linearity/Dynamic Range	$\pm 0.6\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.4\%$	$\pm 0.4\%$
Acoustic Noise	$\pm 1.0\%$	Rectangular	$\sqrt{3}$	0.1	1	$\pm 0.1\%$	$\pm 0.6\%$
Probe Angle	$\pm 2.3\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.4\%$	$\pm 1.4\%$
Spectral Processing	$\pm 0.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$
Integration Time	$\pm 0.6\%$	Normal	1	1	5	$\pm 0.6\%$	$\pm 3.0\%$
Field Distribution	$\pm 0.2\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.1\%$	$\pm 0.1\%$
<b>Test Signal</b>							
Ref. Signal Spectral Response	$\pm 0.6\%$	Rectangular	$\sqrt{3}$	0	1	$\pm 0.0\%$	$\pm 0.4\%$
<b>Positioning</b>							
Probe Positioning	$\pm 1.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.1\%$	$\pm 1.1\%$
Phantom Thickness	$\pm 0.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$
DUT Positioning	$\pm 1.9\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.1\%$	$\pm 1.1\%$
<b>External Contributions</b>							
RF Interference	$\pm 0.0\%$	Rectangular	$\sqrt{3}$	1	0.3	$\pm 0.0\%$	$\pm 0.0\%$
Test Signal Variation	$\pm 2.0\%$	Rectangular	$\sqrt{3}$	1	1	$\pm 1.2\%$	$\pm 1.2\%$
<b>Combined Uncertainty</b>							
Combined Std. Uncertainty (ABM Field)						$\pm 4.1\%$	$\pm 6.1\%$
Expanded Std. Uncertainty						$\pm 8.1\%$	$\pm 12.3\%$

Table 9.2: Uncertainty of audio band magnetic measurements



**10. References**

- [1] ANSI C63.19 2007, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”
- [2] DASY5 System Hand book.

**11. Attachments**

No.	Contents
1	T-coil Test Plot
2	Certificate of AM1DV2 Probe SN:1080
3	Certificate of System Validation Dipole CD835V3 SN:1031
4	Certificate of System Validation Dipole CD1880V3 SN:1024