HAC Test Report for Telecoil

Tests Requested By:	Motorola Mobility, LLC 600 N. US Highway 45 Libertyville, IL 60048
Test Report #:	25510-1
Date of Test:	Aug-13-2013
Date of Report:	Sep-06-2013
Test Laboratory:	Motorola Mobility, LLC - ADR Test Service Laboratory 600 N. US Highway 45 Libertyville, IL 60048
Report Author:	Thomas Knipple Senior Staff Test Engineer
Statement of Compliance:	Motorola declares under its sole responsibility that portable cellular telephone FCC ID IHDT56PF3 to which this declaration relates, complies with recommendations and guidelines per FCC 47 CFR §20.19. The measurements were performed to ensure compliance to ANSI C63.19-2011. It also declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices. Any deviations from these standards, guidelines and recommended practices are noted below: (none)
Results Summary:	T Category = **T4**

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Revision History

Revision Version	Date	Notes
Rev. 0	Aug-22-2013	Initial report release
Rev. A	Sep-06-2013	Update per FCC inquiry

1 Introduction

The Motorola Mobility ADR Test Services Laboratory has performed Hearing Aid Compatibility (HAC) measurements for the portable cellular phone (FCC ID IHDT56PF3). The portable cellular phone was tested in accordance with the ANSI C63.19-2011 standard. The test results presented herein clearly demonstrate compliance per FCC 47 CFR § 20.19. This report demonstrates compliance for Telecoil performance only and not for near-field emissions.

2 Description of the Device Under Test

Serial Number(s)	LDXZ230024
Production Unit or Identical Prototype (47 CFR §2..908)	Identical Prototype
Device Category	Portable

2.1 Signaling Capabilities

Air Interface	Frequency Bands	Transport Type	Maximum Output Power Setting (dBm)	CMRS Voice Support on Interface?	Evaluated for HAC?	Concurrent Simultaneous Operation with:	Other Concurrent Operation with:	Voice Support via OTT Capability
CDMA	BCO, BC1, BC10	VOICE/DATA	25.0	YES	**YES**	Wi-Fi, Bluetooth	NONE	YES
Wi-Fi 802.11b/g/n	2.44 GHz	DATA	18.1	YES (1)	**YES** (1)	CDMA	NONE	YES
Bluetooth	2.44 GHz	DATA	12.1	NO	**NO**	CDMA	NONE	NO

Note (1): Carrier-specific software will allow the DUT to support voice calls with the ability to seamlessly transition between the cellular transmitter and the Wi-Fi transmitter for network connectivity. Thus, the Wi-Fi transmitter has been evaluated for HAC as part of a CMRS. For the purpose of this report Wi-Fi was not tested, in accordance with the guidance issued by the OET in KDB publication 285076 D02 *T-Coil testing for CMRS IP*.

2.2 Device Conducted Power Measurements

2.2.1 CDMA

Conducted Power for CDMA modes evaluated for HAC			
Band	**Mode**	**Channel**	**Measured Value (dBm)**
CDMA BC10	RC1 SO3 1/8th Rate	564	25.20
CDMA 800	RC1 SO3 1/8th Rate	1013	24.99
		384	25.20
		777	25.10
CDMA 1900	RC1 SO3 1/8th Rate	25	24.87
		600	25.00
		1175	24.95

2.2.2 Wi-Fi

Mode	Freq [MHz]	Channel	802.11b (2.4 GHz) Conducted Power [dBm] – Data Rate [Mbps] 1	2	5.5	11
802.11b	2412	1*	18.17	18.20	**18.23**	18.21
			20.8	20.83	20.84	20.83
802.11b	2437	6*	18.05	18.04	18.03	18.03
			20.68	20.65	20.67	20.66
802.11b	2462	11*	17.87	17.89	17.86	17.86
			20.6	20.59	20.60	20.60

Mode	Freq [MHz]	Channel	802.11g (2.4 GHz) Conducted Power [dBm] – Data Rate [Mbps] 6	9	12	18	24	36	48	54
802.11g	2412	1	**16.34**	16.34	16.34	16.34	15.38	15.35	15.37	14.39
			22.74	22.75	22.77	22.83	22.47	22.41	22.47	21.97
802.11g	2437	6	16.21	16.22	16.24	16.25	15.23	15.18	15.20	14.22
			22.53	22.52	22.61	22.60	22.26	22.21	22.23	21.85
802.11g	2462	11	16.01	16.07	16.03	16.04	14.93	14.92	14.89	13.82
			22.57	22.64	22.65	22.69	22.24	22.20	22.20	21.75

Mode	Freq [MHz]	Channel	802.11n (2.4 GHz - SGI) Conducted Power [dBm] – Data Rate [Mbps] MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n	2412	1	16.33	16.35	**16.38**	15.41	15.41	14.40	13.43	12.42
			22.76	22.81	22.78	22.46	22.45	22.00	21.38	20.74
802.11n	2437	6	16.37	16.22	16.26	15.23	15.26	14.27	13.31	12.27
			22.59	22.60	22.61	22.23	22.36	21.75	21.36	20.56
802.11n	2462	11	16.03	16.03	16.04	14.96	14.94	13.88	12.93	11.82
			22.61	22.67	22.61	22.25	22.21	21.79	21.40	20.63

Mode	Freq [MHz]	Channel	802.11n (2.4 GHz - LGI) Conducted Power [dBm] – Data Rate [Mbps] MCS0	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
802.11n	2412	1	16.33	16.36	16.34	15.36	15.36	14.39	13.37	12.43
			22.74	22.78	22.80	22.43	22.38	21.90	21.56	20.87
802.11n	2437	6	16.22	16.24	16.22	15.29	15.27	14.26	13.30	12.25
			22.51	22.57	22.58	22.25	22.22	21.82	21.37	20.60
802.11n	2462	11	16.07	16.09	16.09	15.01	14.98	13.87	12.87	11.81
			22.62	22.61	22.66	22.25	22.22	21.77	21.20	20.61

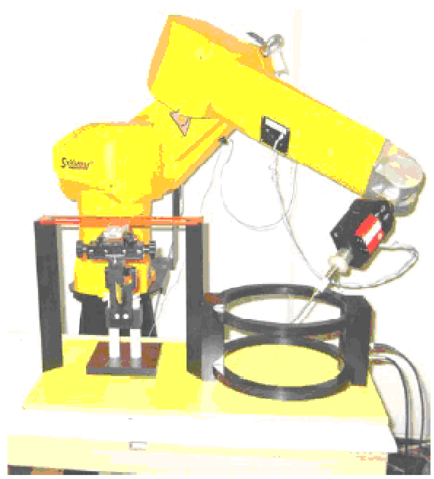
Note: Average power measurements in blue, peak power measurements in black/white.

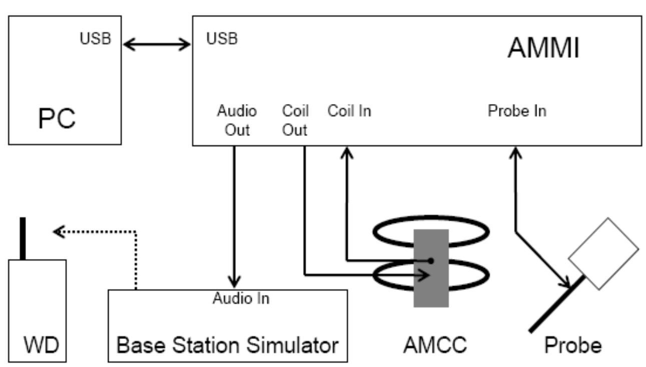
3 Test Equipment Used

The Motorola Mobility ADR Test Services Laboratory utilizes a Dosimetric Assessment System (DASY4™) manufactured by Schmid & Partner Engineering AG (SPEAG™), of Zurich, Switzerland. All Telecoil measurements are taken within a shielded enclosure. The measurement uncertainty budget is given in Appendix 5. The list of calibrated equipment used for the measurements is shown below.

	Description	Serial Number	Cal Date	Cal Due Date
Dosimetric System Equipment	DAE4	699	Sep-12-2012	Sep-12-2013
	Audio Magnetic 1D Field Probe AM1DV2	1049		
	AMMI SE UMS 010 AA	1005		
	AMCC SD HAC P02 AB	1005		
	Test Arch SD HAC D01 BA	1073		
Additional Test Equipment	Rohde & Schwarz CMU 200	106338	Oct-10-2012	Oct-10-2013

Figure 1: Telecoil setup and cabling (pictures from DASY manual)





AMMI (Audio Magnetic Measurement Instrument) is a desktop unit containing a sampling unit, a waveform generator for test, calibration signals and a USB interface. Front connectors include: Audio Out - predefined or user definable audio signals for injection into the WD; Probe In - the probe signal is evaluated by AMMI; Coil Out - test and calibration signal to the AMCC; Coil In - monitor signal from the AMCC.

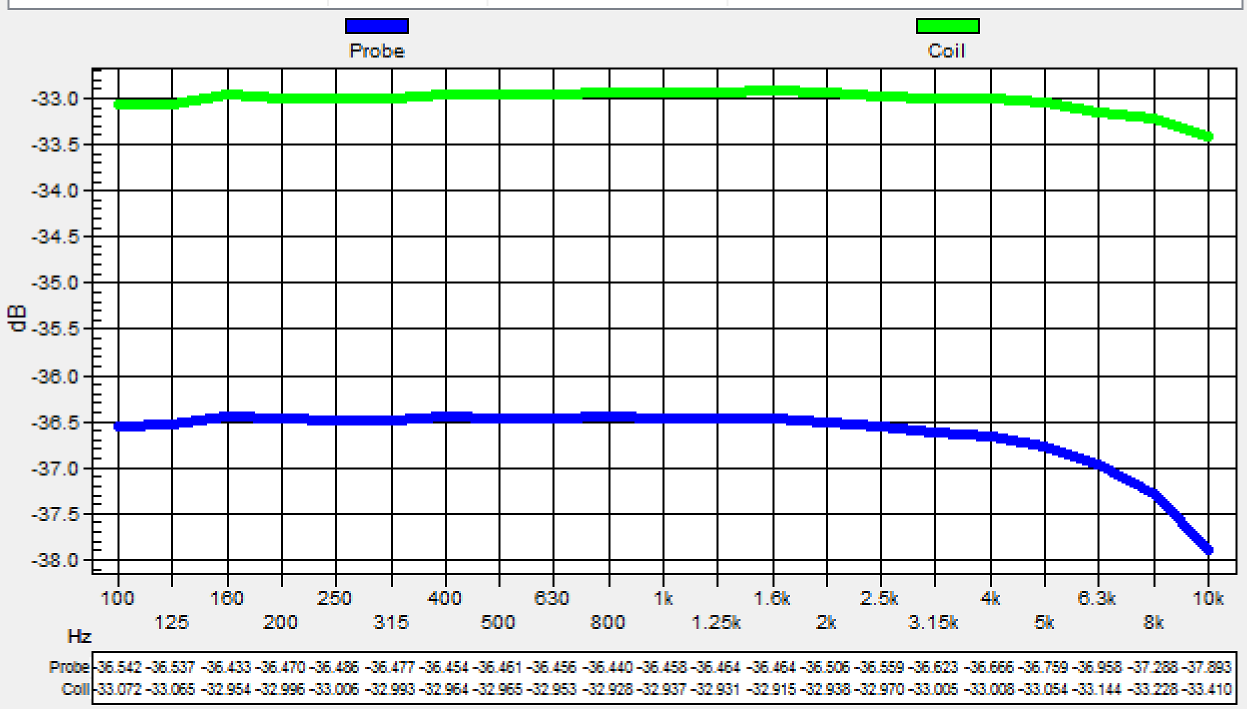
Audio Magnetic Probe (AM1DV2) is an active probe with a single sensor. The same probe coil is used to measure two orthogonal field components (perpendicular and transverse). The probe is rotated to properly orient the coil for each field component. The probe's frequency response, linearity and other characteristics are given in the certificate in Appendix 6.

AMCC (Audio Magnetic Calibration Coil) is a Helmholtz coil for calibration of the AM1D probe. The two horizontal coils create a homogeneous magnetic field in the z-direction. Refer to Appendix 7 for more details on AMCC coil.

The probe is calibrated in the AMCC coil. The frequency response and sensitivity are measured and stored. Sensitivity includes both probe sensitivity and pre-amplifier sensitivity.

Graph 1: Frequency Response measured in AMCC

	Coil	Probe	
Internal calibration factor	2.3746 V	1.1483 V	
Probe sensitivity at 1 kHz		0.06557 V/(A/m)	



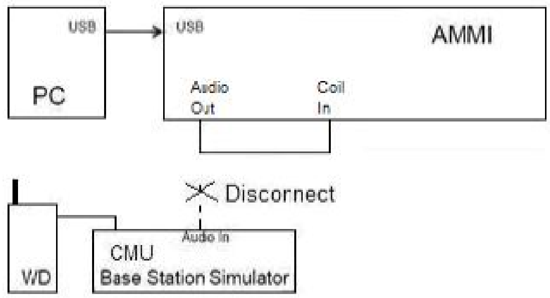
Sensitivity measured in AMCC: 0.06557 $^{V}/_{(A/m)}$

The sensitivity is for a 1 kHz sine signal. The sensitivity includes both probe sensitivity and pre-amplifier sensitivity. It is the total calibration, and there are no additional probe calibration factors. The voltage into the Helmholtz coil is across the shunt resistor.

4 Signal Verification

The signal input level is measured to verify that it is within ±0.2 dB of the Reference Input Level, as defined in subclause 7.4.2.1 of ANSI C63.19-2011.

Figure 2: Signal Verification Setup



In Figure 2, the “Audio Out” of the AMMI is connected to the “Coil In” of the AMMI. The “Audio Out” of the AMMI is measured using 1 V as the reference.

Subclause 7.4.2.1 of ANSI C63.19-2011 specifies the reference input level to be -18 0dBm0 for CDMA and -16 0dBm0 for GSM/WCDMA. Each CMU has a slightly different “0dBm0 Input Reference” value that must be measured. When the CMU is replaced or externally re-calibrated, an internal calibration procedure must be completed in each transmission mode. On the CMU 200 (SN 106338), the 0dBm0 Input Reference value is 0.73 V for CDMA and 0.73 V for GSM/WCDMA. For more information on “0dBm0 Input Reference” measurements, refer to Appendix 3-5.

The target level for the “Audio Out” of the AMMI is shown in the table below. This target level takes into account the difference between the reference levels of the AMMI and the CMU.

Modulation	Reference Input Level from ANSI C63.19 (dBm0)	CMU’s 0dBm0 Input Reference Value (dB)	Target Level for “Audio Out” of AMMI (dBm0)
CDMA	-18	-2.73	-20.73

The signal level for the “Audio Out” of the AMMI is measured before DUT testing. Signal Verification is conducted on the same days as DUT measurements. If the result is not within ±0.2 dB of the target value, the gain settings in the DASY measurement template are adjusted. The measured results are provided in the table below.

Modulation	Measured date	Signal	Measured Level for “Audio Out” of AMMI (dBm0)	Target Level for “Audio Out” of AMMI (dBm0)
CDMA	August 13, 2013	Narrowband	-20.71	-20.73
		Broadband	-20.77	

5 Test Methodology and Results

5.1 DUT and DASY Setup for Telecoil HAC Testing

The phone was tested in normal configurations for against-the-ear use. The DASY4 measurement system specified in section 3 was utilized within the intended operating parameters as set by the SPEAG™ setup. The Test Arch provided by SPEAG is used to position the DUT. All tests are executed via conducted connection with the CMU 200. The volume on the DUT is adjusted to maximum. The DUT display backlight was off during testing. HAC compliance will be explained in the manual.

The tests are performed with a telecoil function enabled. To enable the telecoil function, select:

Phone Dialer → Vertical Ellipsis Button → Settings → Hearing Aids → [Check box to enable]

The proper test distance is established by positioning the device beneath the test arch phantom so that it is touching the frame. The location and thickness of the arch, and the location/orientation of the coil within the probe housing, are precisely known values in the DASY software. The height of the measurement plane is further fine-tuned by performing a Surface Detection job at the beginning of each test. The end result is that the probe sensor is very precisely located 10 mm above the device reference plane.

ABM2 investigation is carried out to determine the worst-case channel of each applicable frequency band. At the measurement reference location, ABM2 is measured in the perpendicular probe position for each frequency, as shown in the table below. For each band, the channel with the highest ABM2 value is highlighted in **bold**.

ABM2 Measurements (dB A/m)		
CDMA BC10	Ch 564	**-44.3274**
CDMA 800	Ch 1013	-44.3210
	Ch 384	-44.5595
	Ch 777	**-44.2602**
CDMA 1900	Ch 25	-44.7097
	Ch 600	-44.3810
	Ch 1175	**-43.3871**

For the channels highlighted in bold in the table above, Telecoil SNR measurements are shown in the results table in section 5.2. The sequence of the Telecoil SNR measurement is listed in the steps below.

a) Geometry & signal check
b) Background noise measurement. The background noise is measured at the measurement reference location.
c) Coarse-resolution perpendicular scan (narrowband signal, 1 s measurement times, 50 x 50 mm grid with 5.55 mm spacing). Only ABM1 is measured, in order to find the location of the Telecoil source.
d) Fine-resolution perpendicular and transverse scans, positioned appropriately based on the ABM1 of the coarse-resolution perpendicular scan (narrowband signal, 1 s measurement times, variable grid size with 2 mm spacing). Both ABM1 and ABM2 are measured in order to find the location of the SNR point.
e) ABM1 & ABM2 point measurements in perpendicular and transverse coil orientations, positioned appropriately based on the optimal signal quality of the fine-resolution scans (narrowband signal, 2 s measurement times). SNR is calculated for each coil orientation.
f) Frequency Response point measurement in perpendicular coil orientation, positioned appropriately based on optimal signal quality of the fine-resolution perpendicular scan (broadband signal, 12 s measurement time)

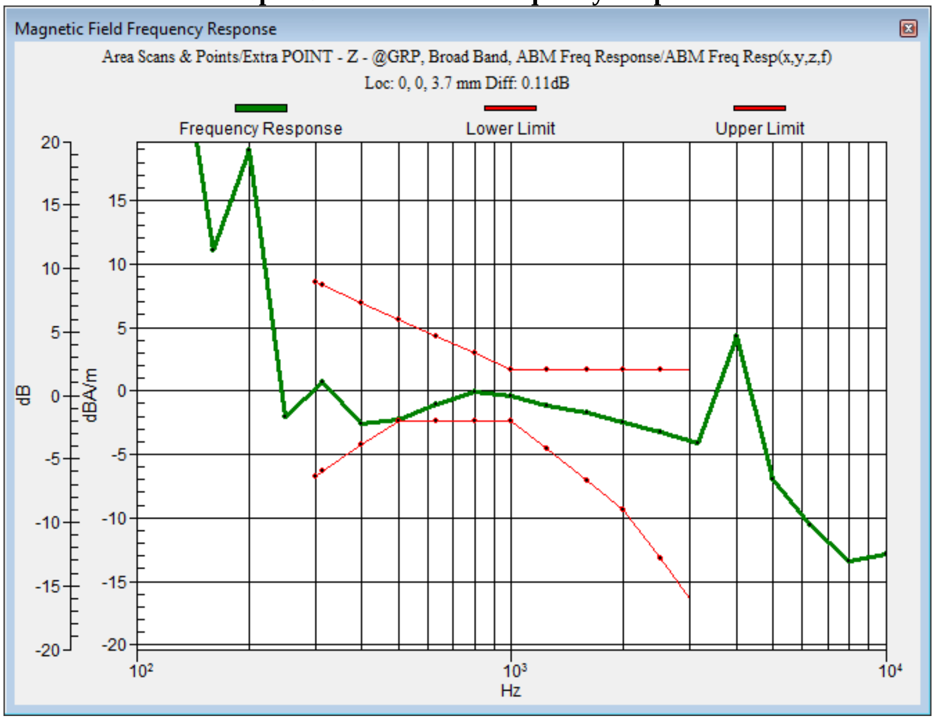
The ABM1, SNR and Telecoil Rating results are shown in the results table in section 5.2. Also shown are the location of the measured point, ambient noise and ABM2. The delta between the ambient noise measurement and the ABM2 measurement should be greater than 10 dB. However, in cases where the ABM2 is very low, it is suitable for the delta to be less than 10 dB. For the two probe positions, contour plots for the lowest SNR, indicated in **bold numbers**, are given in Appendix 1. For the two probe positions, noise spectrum plots for the highest ambient noise, indicated with **bold numbers**, are given in Appendix 2. These noise spectrum plots are half band integrated with an A-weighting filter applied.

5.2 Telecoil HAC Test Limits and Measurement Results

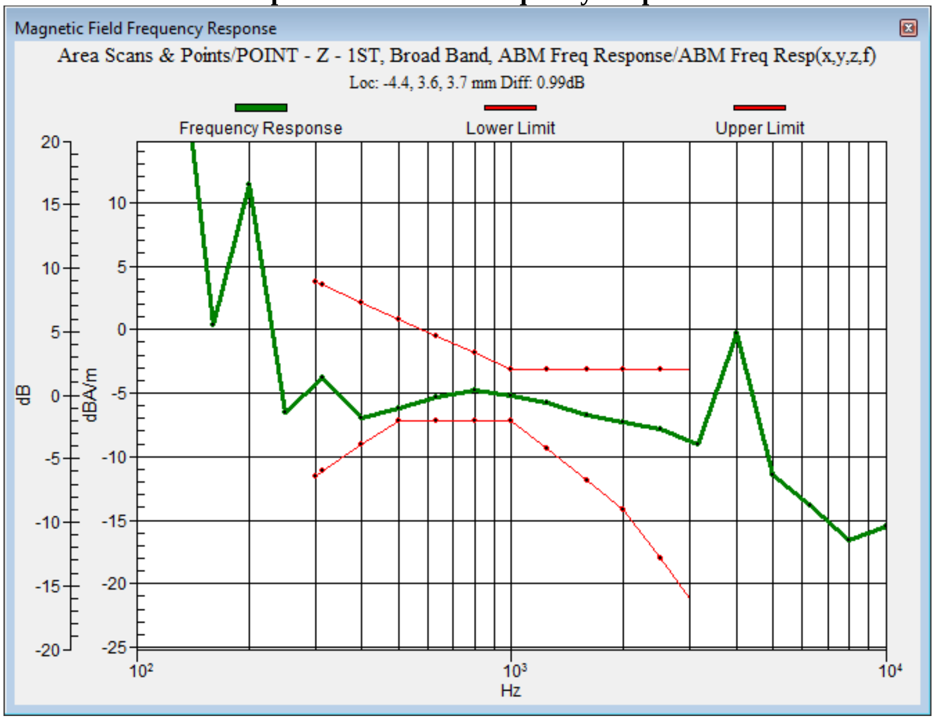
Telecoil SNR Limits		
ABM1	Greater or equal to -18 dB A/m	
SNR	T3	Greater than 20 dB
	T4	Greater than 30 dB

Probe Position	Frequency Band (MHz)	Channel	Conducted Output Power (dBm)	Measured Point Location (x mm, y mm)	Ambient Noise (dB A/m)	ABM2 (dB A/m)	ABM2 – Ambient Noise (dB)	ABM1 (dB A/m)	SNR (dB)	Telecoil SNR Rating
Perpendicular	CDMA BC10	564	25.20	0, 0	-55.1495	-45.6300	9.5195	-0.3500	**45.28**	T4
	CDMA 800	777	25.10	-4.4, 3.6	**-54.0509**	-54.3756	-0.3247	-5.1558	49.22	T4
	CDMA 1900	1175	24.95	0, 0	-55.0346	-45.7800	9.2546	0.5100	46.29	T4
Transverse	CDMA BC10	564	25.20	-2.8, -4.8	**-58.7790**	-54.3506	4.4284	-9.9446	44.41	T4
	CDMA 800	777	25.10	-5.5, -7.2	-59.2471	-57.2926	1.9545	-11.4775	45.82	T4
	CDMA 1900	1175	24.95	-7.2, -8.0	-59.0687	-57.5340	1.5347	-13.1435	**44.39**	T4

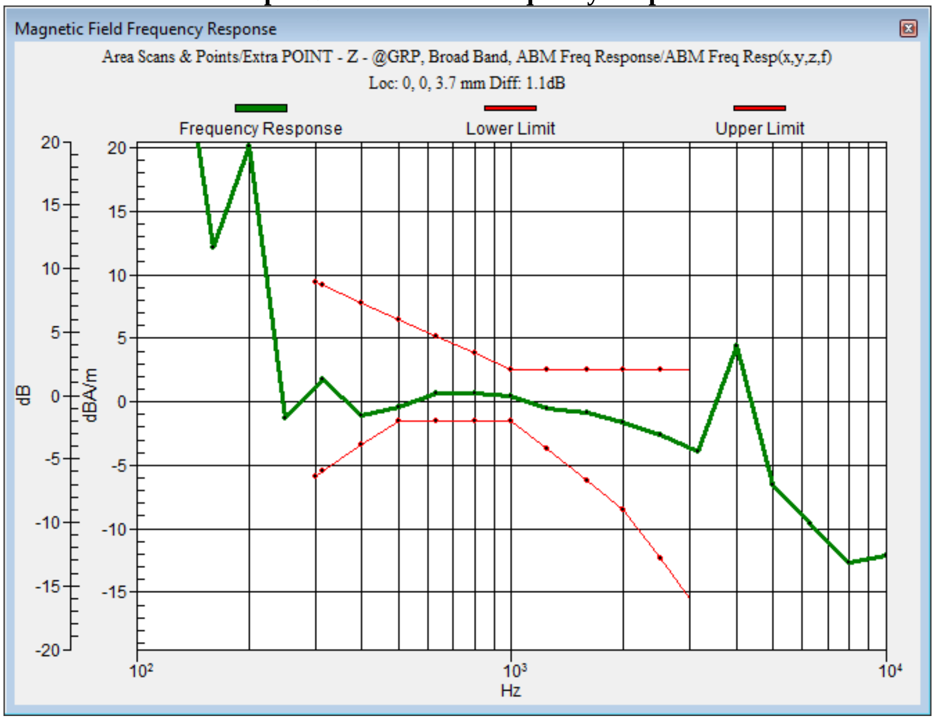
Graph 2: CDMA BC10 Frequency Response



Graph 3: CDMA 800 Frequency Response



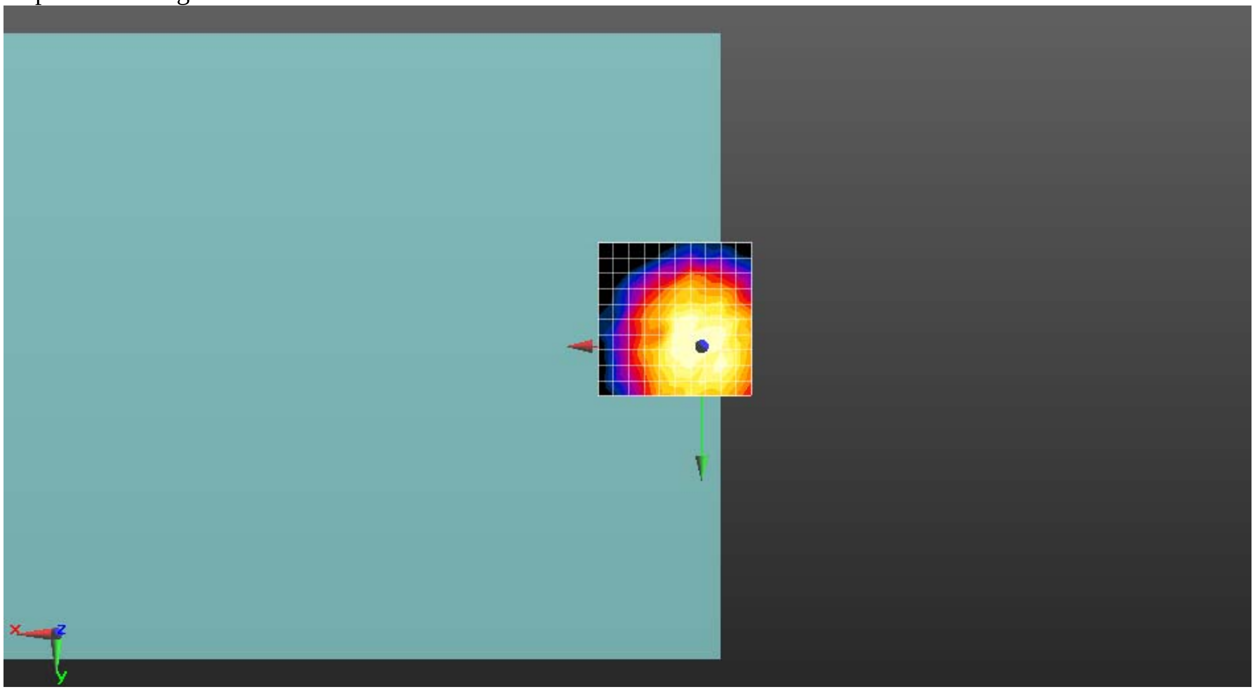
Graph 4: CDMA 1900 Frequency Response



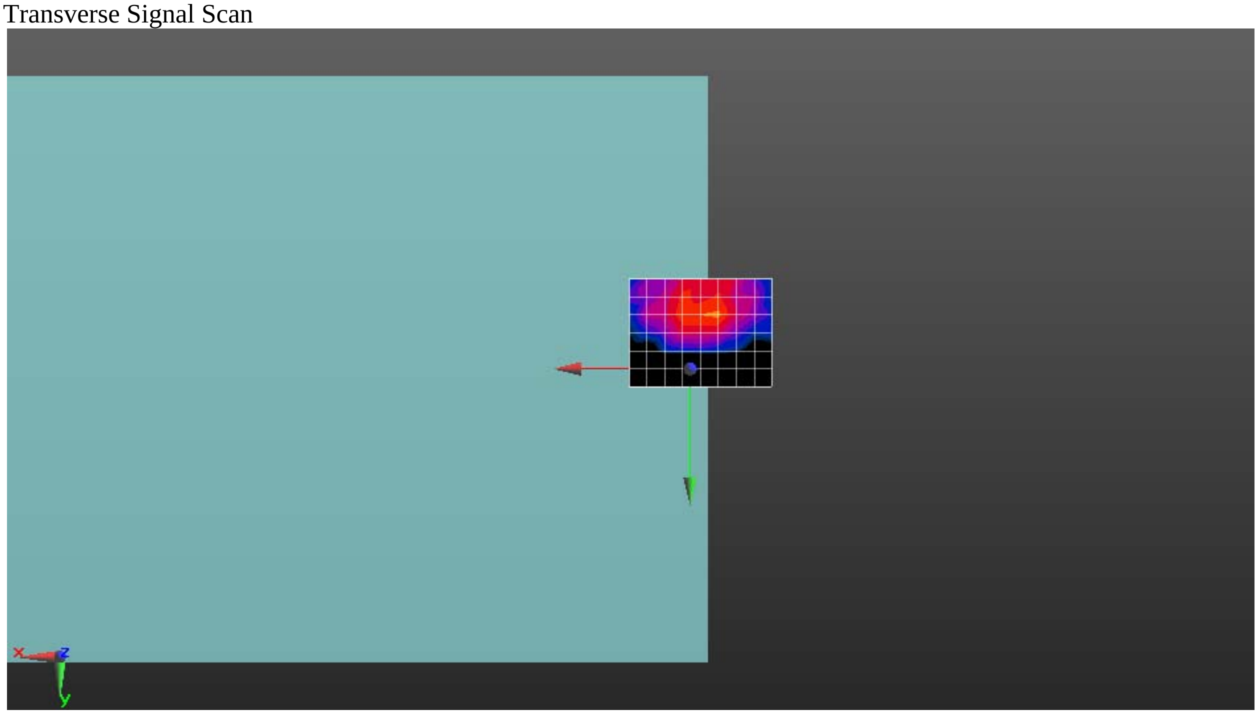
Appendix 1

Contour Plots

Perpendicular Signal Scan

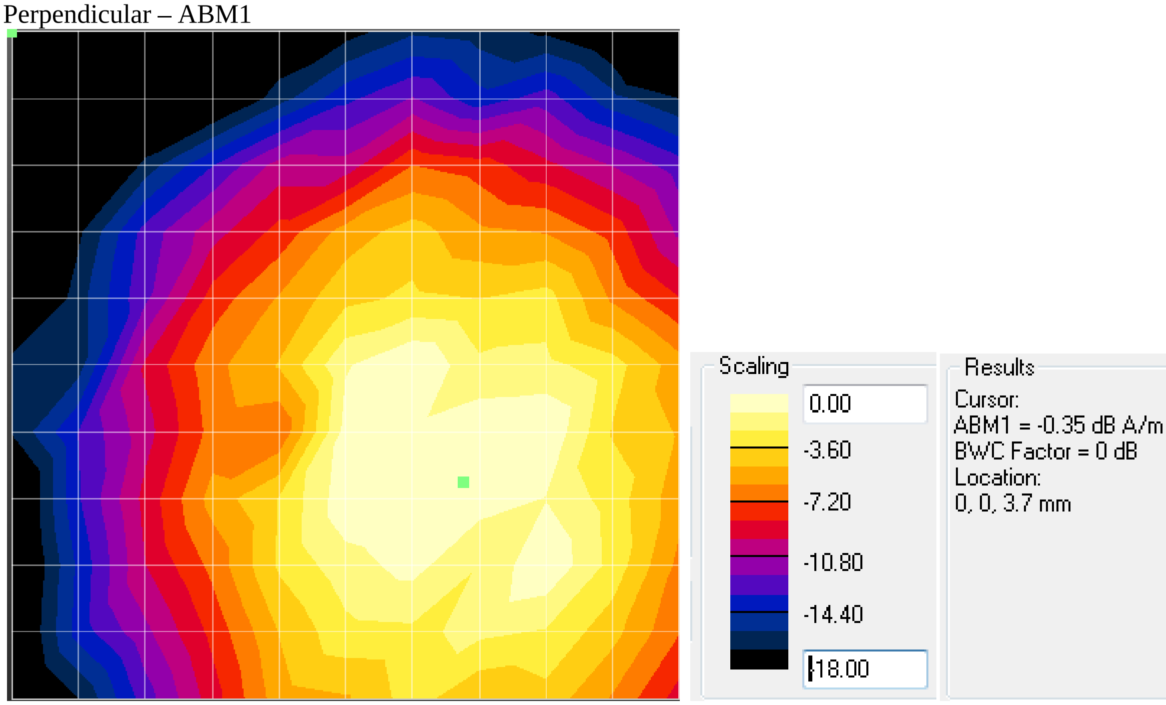


Transverse Signal Scan

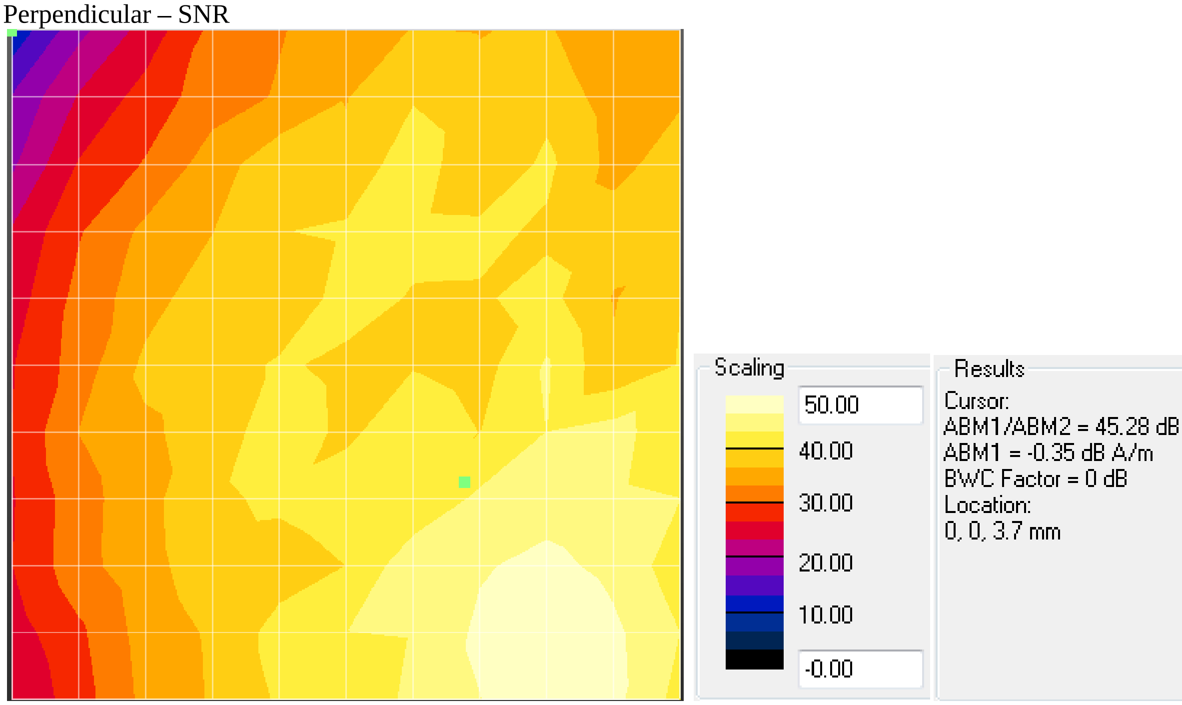


Note: The blue dot designates the device reference point.

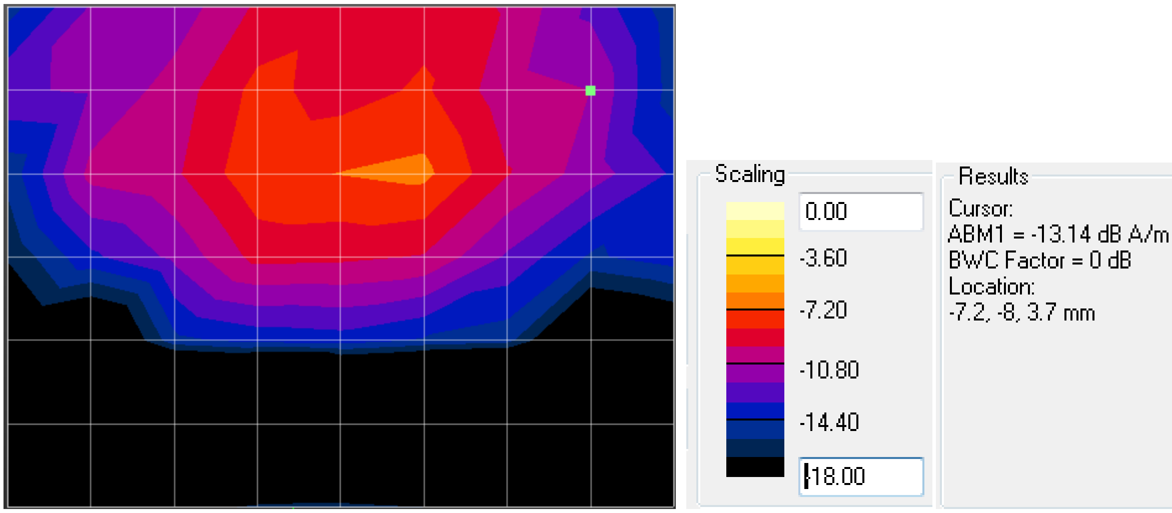
Perpendicular – ABM1



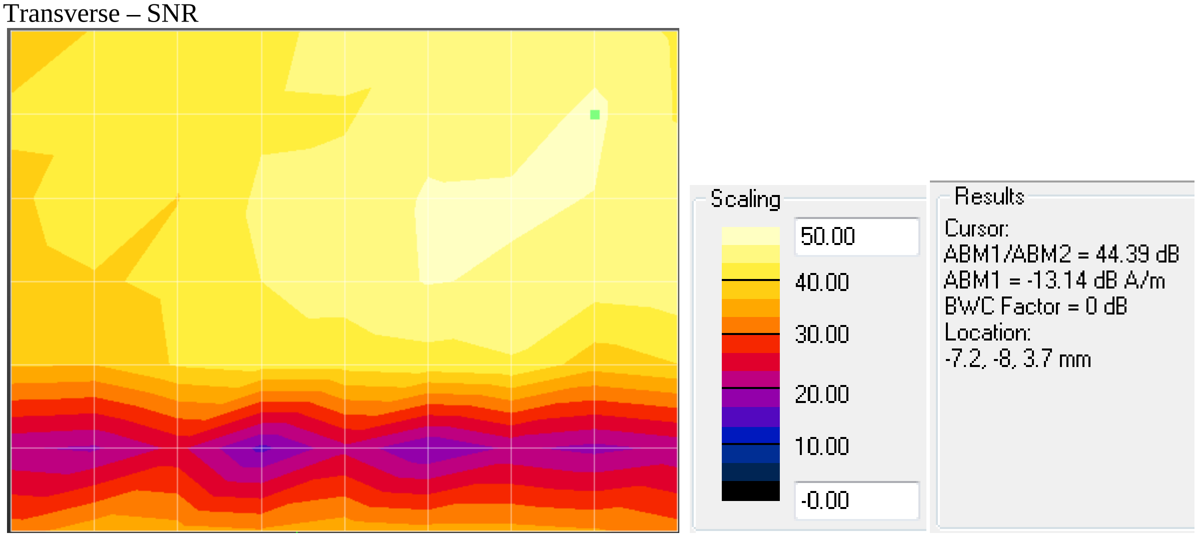
Perpendicular – SNR



Transverse – ABM1



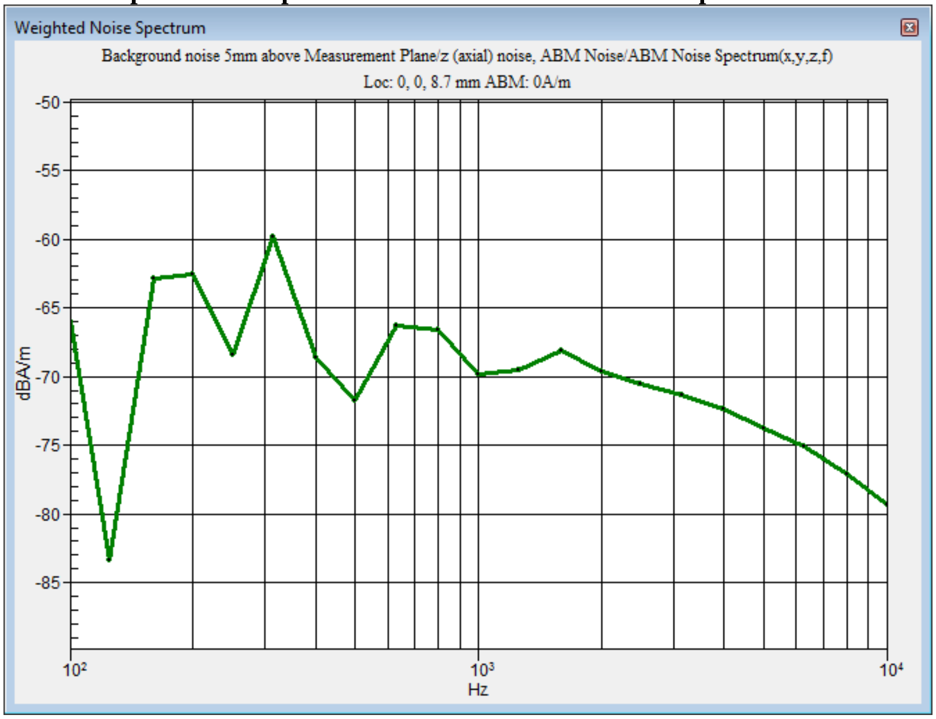
Transverse – SNR



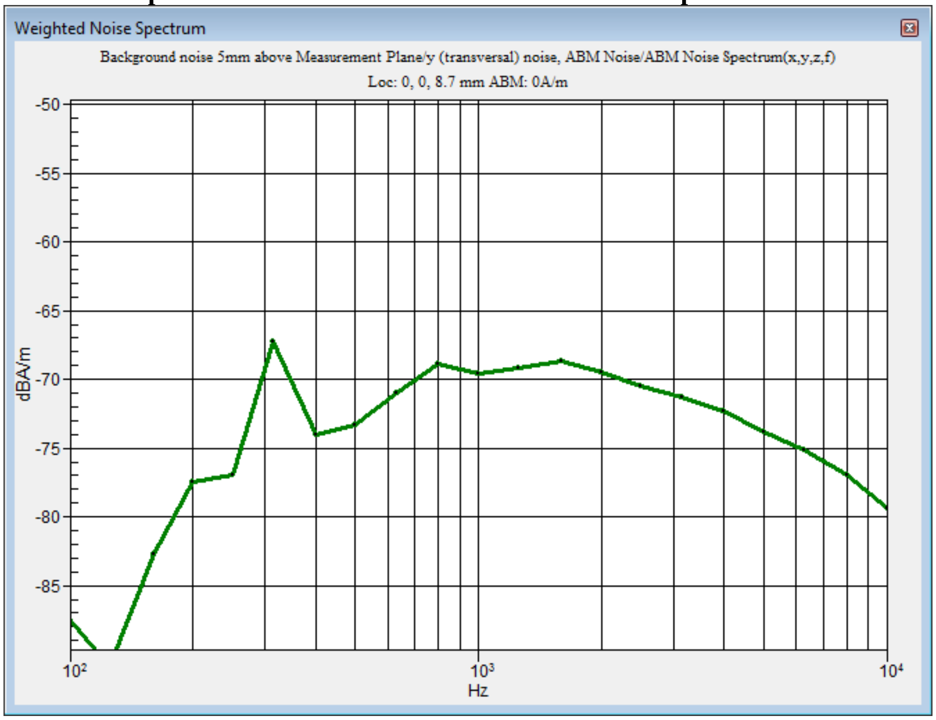
Appendix 2

Ambient Noise Spectrum Plots

Graph A2-1. Perpendicular Position Ambient Noise Spectrum Plot



Graph A2-2. Transverse Position Ambient Noise Spectrum Plot



Appendix 3

Details of the Measurement System

3-1) Details on ABM2 measurements by the system

(Description provided by Schmid & Partner Engineering, AG):

The processing applies a convolution in the time domain. This filtering is composed of integrator (straight-forward), Half-Band filter (first-order filter) and A-weighting. The convolved data stream is then integrated over the desired period and represented and stored numerically in DASY4 as the ABM Noise (= ABM2).

During the validation process of our system, the functionality of this process has been verified by debugging the filters step-by-step progressively and comparing the results also with a Rohde & Schwarz UPL Analyzer. The intermediate steps are not accessible in the final software code operated by the end user. In addition, the following verification has been made, using a single frequency (sine) signal: at the reference frequency of 1 kHz, the signal is equivalent to ABM1. ABM1 is visible from the calibration job, inclusive its frequency slope from 100 Hz to 5 kHz. This function (conversion of the coil voltage to the field) is the same integration function.

The verification of the probe linearity and the linearity of the integrator has been determined and documented in the certificate 880-SP AM1 001 A, inclusive the integrator, over the required frequency range (exceeding 5 kHz). The additional frequency slope of the Half-Band filter and the A-weighting have also been tested by changing the applied frequency over the full range. The attenuation was verified for each third-octave-band and up to > 10 kHz. In addition, the correct processing of multiple sine-wave signals was verified.

The convolutions work over the full frequency range available in the analog path, only limited by AC-coupling at the low end and anti-aliasing filter at the high frequency end. White noise signal without band limitation has not been used for filter measurements. Pink noise, decreasing with frequency, resulting in a frequency independent response of the third-octave filter bank was used to optically verify the correct filtering function. Precision measurements were however made with pure sine signals.

Frequency components beyond the visible range of 5 kHz are contained in the ABM2 figure.

(Measurements made by Motorola):

Comparison of 1kHz narrowband signal driven extenally into TMFS coil

ABM1 @ 1kHz	ABM2 @ 1kHz	difference
-25.122	-25.124	0.002 dB

Frequency dependent ABM1 - ABM2 with broadband noise and narrowband tones driven externally into TMFS coil

Frequency	dB difference ABM1-ABM2 broadband signal	dB difference ABM1-ABM2 single frequency signals	ideal value for ABM1-ABM2	variance from ideal boadband	variance from ideal single frequencies
200		22.062	22.35		0.288
250			17.89		
315			14.03		
400		10.371	10.39		0.019
500	6.852		7.18	0.328	
630	4.228		4.36	0.132	
800	1.587	1.881	1.88	0.293	-0.001
1000	0.013	0.013	0	-0.013	-0.013
1250	-1.473		-1.46	0.013	
1600	-2.72		-2.58	0.14	
2000	-3.535	-3.235	-3.24	0.295	-0.005
2500	-3.738		-3.67	0.068	
3150	-3.837		-3.79	0.047	
4000	-3.733	-3.744	-3.75	-0.017	-0.006
5000	-3.283	-3.336	-3.34	-0.057	-0.004
	maximum variation from ideal:			0.328 dB	

3-2) Details on the compliancy of the frequency and linearity response

(Description provided by Schmid & Partner Engineering, AG):
See also probe certificate of conformity in Appendix 6, titled 880-SP AM1 001 A-A
See also coil certificate of conformity in Appendix 7, titled 880-SD HAC P02 A-A

Frequency response has been tested to be within ±0.5 dB of ideal differentiator from 100 Hz to 10 kHz. The test was made with the real integrator and deducting the ideal integrator values. Reference signal was the Helmholtz calibration coil current which is equivalent to the field. The coil is qualified according to certificate 880-SD HAC P02 A-A.

The test data up to 5 kHz are visible directly in the calibration job result (coil current / shunt voltage, and probe voltage). Separate measurements were made for a very wide frequency range, including higher frequencies. For 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.

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.

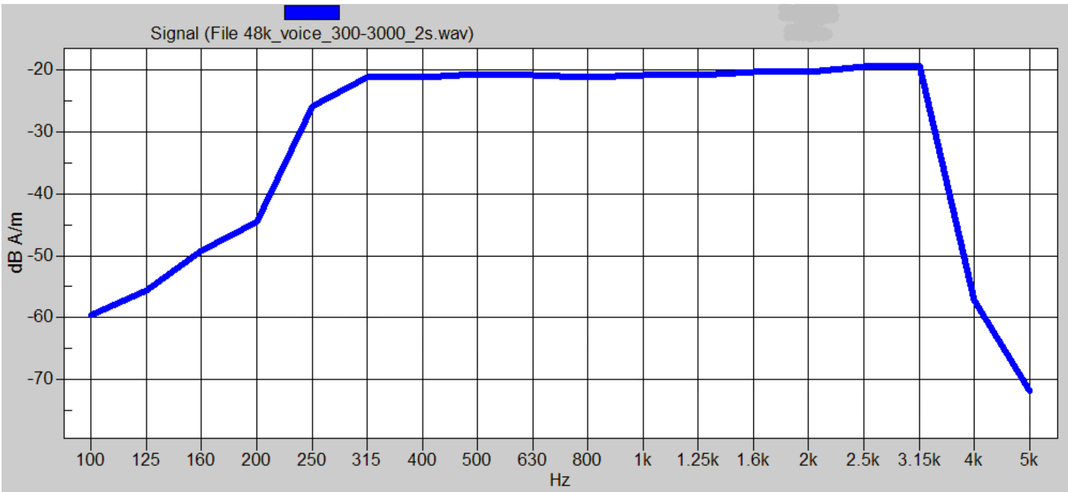
Significant noise contribution beyond 10 kHz will be attenuated by the convoluting A-filter as explained in answer #2. Such interferences contribute also to ABM2 represented as numerical value from the integration.

3-3) Details on Measurements by the systems

Details regarding timing and averaging of the reported final measured points are as follows:

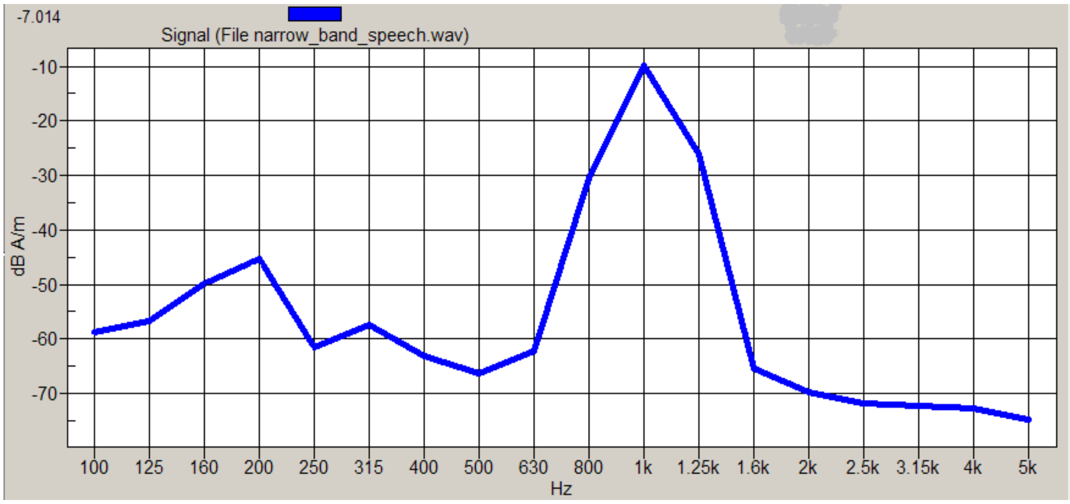
	Narrowband Signal	Broadband Signal
Signal Length (sec):	1	2
Total Data Acquisition Time per Location (sec):	2	12
	Averaging is over 2 signal repetitions	Averaging is over 6 signal repetitions

The broadband signal utilized is shown in the following plot:



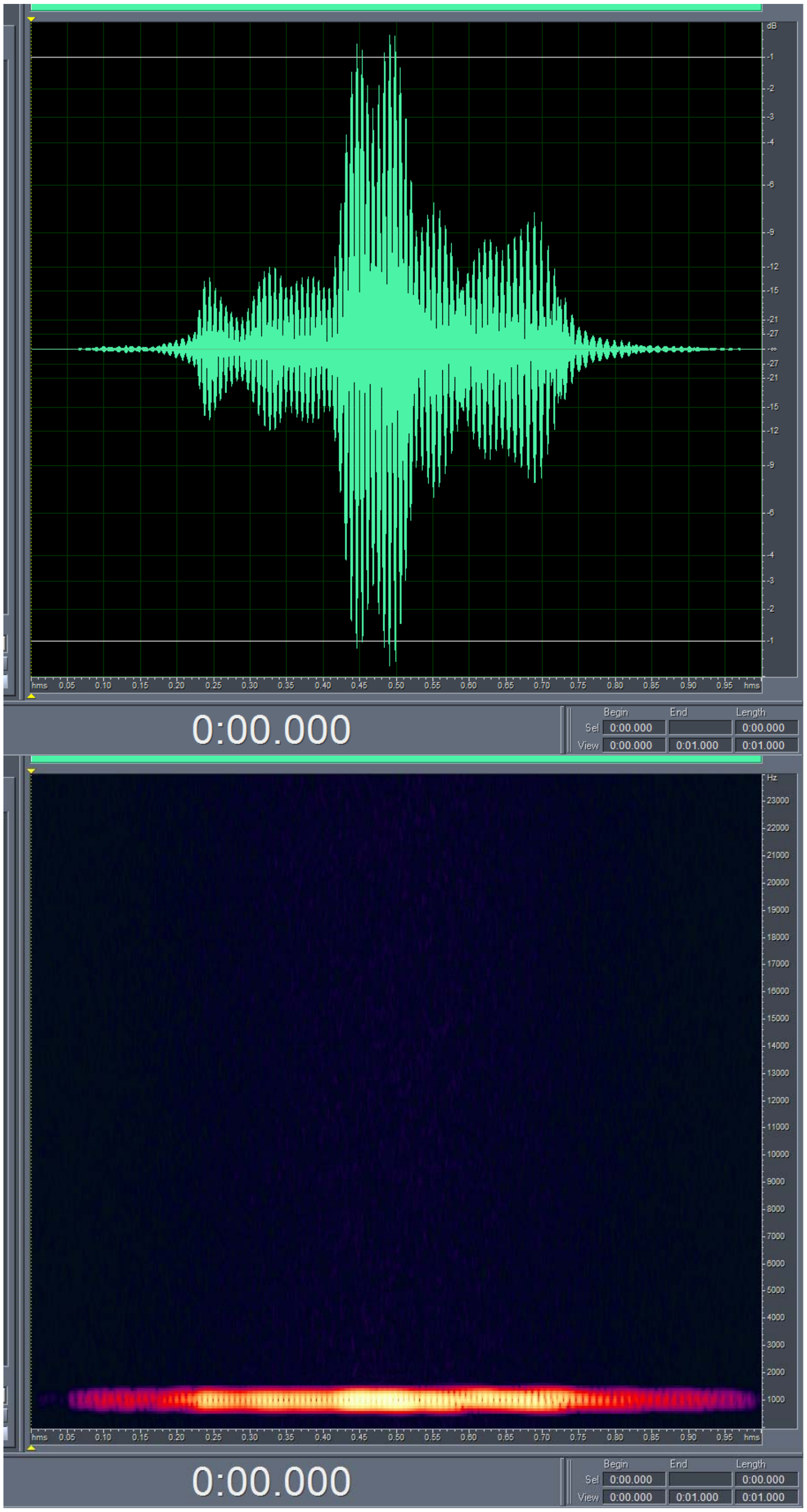
Mathematical processing is not required because the preferred method (as described in ANSI C63.19-2011 section 7.4) is utilized. The broadband audio signal is used only for assessment of frequency response. The DASY4 system corrects for the spectral response after measurement since it knows the spectrum of the input signal. However, please note that for the signal that we use, the spectrum is flat when measured in 1/3 octave bands, covering the range up to 3 kHz.

The narrowband signal utilized is shown in the following plot:

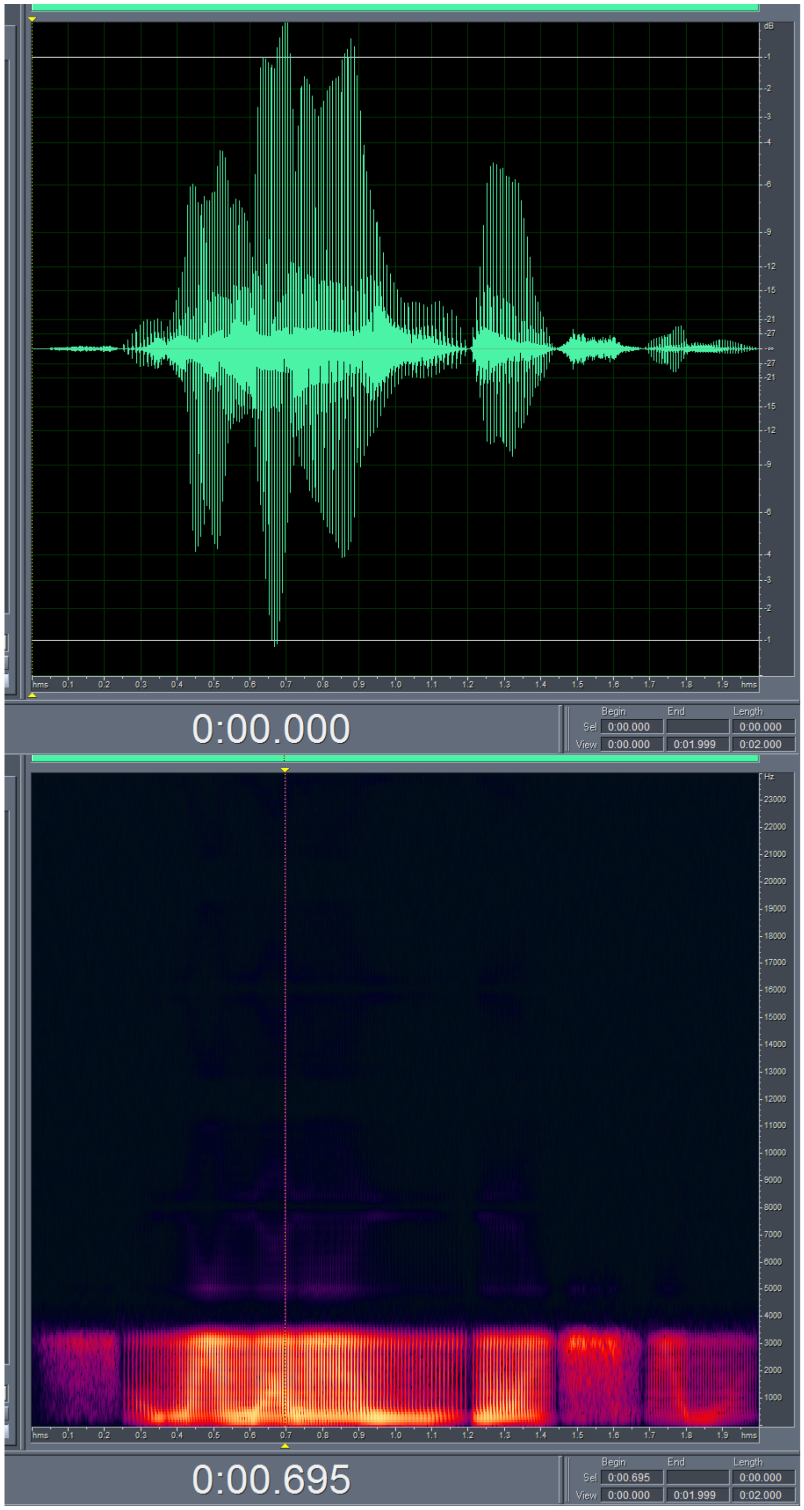


3-4) Details of the source audio signals for all aspects of the test

Here is the temporal response of the narrow band signal. The signal is one second of the standard P.50 speech band-limited to the ANSI 1 kHz 1/3 octave band. The signal is Hann windowed to ensure continuity of the signal.



Here is the temporal response of the 300 Hz - 3 kHz broadband signal. The signal is a 2 second segment of the standard P.50 speech that is equalized flat (for ANSI 1/3 octaves) over the 300 Hz to 3 kHz range. The signal is Hann windowed to ensure continuity of the signal.



3-5) Details of the CMU-200 "0dBm0 Input Reference value"

Measure "Ref Input Level"

a) Generate a 1 kHz Sine Signal using AMMI.
b) Capture a signal level using AMMI.
c) Record the value as the "Ref Input Level"

Measure Value "X"

d) Connect CMU to AMMI.
e) Connect a phone which operates in the desired modulation to the CMU. Establish a call to the CMU. Select Decoder Cal on CMU.
f) Capture a signal level from CMU using AMMI.
g) Record the value as the "Value X".

Measure Value "M"

h) Make another connection from AMMI to CMU. Change to Encoder Cal on CMU.
i) Generate a 1 kHz Sine Signal using AMMI
j) Capture a signal from CMU using AMMI.
k) Record the value as the "Value M".

Calculate the resulting Input Correction Factor & the 0dBm0 Input Reference

Relevant Equations:
Measured values from above: Ref Input Level, X, M

Input Correction Factor = Ref Input Level + X – M
0dBm0 Input Reference = 10^(Input Corr Factor/20) * CMU-200 manual ref value

Appendix 4

Pictures of Test Setup

See Exhibit 7B

Appendix 5

Motorola Uncertainty Budget

Table A5-1: Telecoil Uncertainty Budget, provided by SPEAG

Error Description	Uncertainty value (%)	Prob. Dist.	Div.	c ABM1	c ABM2	St.Unc ABM1 (%)	St.Unc ABM2 (%)
PROBE SENSITIVITY							
Reference level	3.0	N	1	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	0.1	R	1.7	1	1	0.1	0.1
Noise contribution	0.7	R	1.7	0.0143	1	0.0	0.4
Frequency slope	5.9	R	1.7	0.1	1	0.3	3.5
PROBE SYSTEM							
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	1	5	0.6	3.0
Field disturbation	0.2	R	1.7	1	1	0.1	0.1
TEST SIGNAL							
Reference signal spectral response	0.6	R	1.7	0	1	0.0	0.4
POSITIONING							
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 **	4.0	R	1.7	1	1	2.4	2.4
EXTERNAL CONTRIBUTIONS							
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
COMBINED UNCERTAINTY							
Combined Std.Uncert. (ABM field)						4.6	6.5
Expanded Std. Uncertainty, k=2 (%)						9.1	12.9

** based on repeat measurements of reference unit

Appendix 6

Audio Magnetic Probe Certificate

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

Client Motorola MDb

Certificate of test and configuration

Item	**AM1DV2** Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Series No	**1049**
Manufacturer / Origin	Schmid & Partner Engineering AG, Zürich, Switzerland

Description of the item

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 and Sensor angle stated 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.

Handling of the item

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).

Functional test, configuration data and sensitivity

The probe configuration data were evaluated after a functional test including noise level and RF immunity. Connector rotation, sensor angle and sensitivity are specific for this probe.

DASY4 configuration data for the probe

Configuration item	Condition	Configuration Data	Dimension
Overall length	mounted on DAE in DASY4 system	296	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	**-39.6**	°
Sensor angle		**0.06**	°
Sensitivity	at 1 kHz	**0.0660**	V / (A/m)

Standards

[1] ANSI-C63.19-2006

Test date 23.04.2007 / MM

Issue date 24.04.2007

Signature M. Meili

Appendix 7

AMCC Certificate (Helmholtz Coil)

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 measurment	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 $Hc = (U / R) * N / r / (1.25^{1.5})$	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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END OF REPORT