HAC Test Report for T-coil IHDT56GW1

Date of test:	June 7, 2006
Date of Report:	June 12, 2006
Laboratory:	Motorola Mobile Devices Business Product Safety & Compliance Laboratory 600 N. US Highway 45 Room: MW113 Libertyville, Illinois 60048
Test Responsible:	Katerina Royzen Engineer
Statement of Compliance:	Motorola declares under its sole responsibility that portable cellular telephone FCC IHDT56GW1 to which this declaration relates, complies with recommendations and guidelines FCC 47 CFR §20.19. The measurements were performed to ensure compliance to the ANSI PC63.19-2001 rd 3.12 standard, which is the same as the ANSI C63.19-2006 per the FCC public notice DA 06-1215. 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 = T3

Table of Contents

1. Introduction

The Motorola Mobile Devices Business Product Safety Laboratory has performed Hearing Aid Compatibility (HAC) measurements for the portable cellular phone (FCC ID IHDT56GW1). The portable cellular phone is tested in accordance with ANSI PC63.19-2001 rd 3.12 standard. The test results presented herein clearly demonstrate compliance FCC 47 CFR § 20.19. This report demonstrates compliance for T-coil performance only and not for near field emissions.

2. Description of the Device Under Test

Table 1: Information for the Device Under Test

FCC ID Number	**IHDT56GW1**								
Serial number	TA81812M20 and TA8180005R								
Mode(s) of Operation*	GSM 850	GSM 900	GSM 1800	GSM 1900	GPRS 850	GPRS 900	GPRS 1800	GPRS 1900	Blue Tooth
Modulation Mode(s)	GMSK	GMSK	GMSK	GMSK	GMSK	GMSK	GMSK	GMSK	GFSK
Maximum Output Power Setting	33.00 dBm	33.00 dBm	30.00 dBm	30.00 dBm	33.00 dBm	33.00 dBm	30.00 dBm	30.00 dBm	19.00 dBm
Duty Cycle	1:8	1:8	1:8	1:8	2:8	2:8	2:8	2:8	1:1
Transmitting Frequency Rang(s)	824.2 - 848.8 MHz	880.2 - 914.8 MHz	1710.2 - 1784.8 MHz	1850.20 - 1909.80 MHz	824.2 - 848.8 MHz	880.2 - 914.8 MHz	1710.2 - 1784.8 MHz	1850.20 - 1909.80 MHz	2400 - 2483.5 MHz
Production Unit or Identical Prototype (47 CFR §2..908)	Identical Prototype								
Device Category	Portable								

Note: If DUT contains Bluetooth Class II or Bluetooth Class I or WLAN device, the secondary transmitter was not enabled during testing. The intended use of the PCS transmitter does not include simultaneous operation when held to ear.

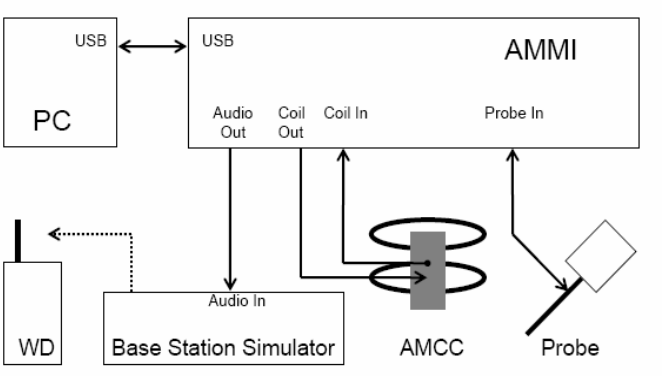
3. Test Equipment Used

The Motorola Mobile Devices Business Product Safety & Compliance Laboratory utilizes a Dosimetric Assessment System (Dasy4™ v4.7) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland. All T-coil measurements are taken within a shielded enclosure. The measurement uncertainty budget is given in Appendix 3. The list of calibrated equipment used for the measurements is shown in Table 2.

Table 2: Test Equipment

	Description	Serial Number	Cal Due Date
Dosimetric System Equipment	DAE3	437	Nov/28/2006
	Audio Magnetic 1D Field Probe AM1DV2	1003	
	AMMI SE UMS 010 AA	1005	
	AMCC SD HAC P02 AB	1005	
	Test Arch SD HAC D01 BA	1036	
Additional Test Equipment	Rohde & Schwarz CMU 200	108475	Feb/06/2007
	Brüel & Kjær Frequency Analyzer 2144	2102787	Mar/06/2007

Figure 1: T-coil setup and cabling (pictures from DASY manual)



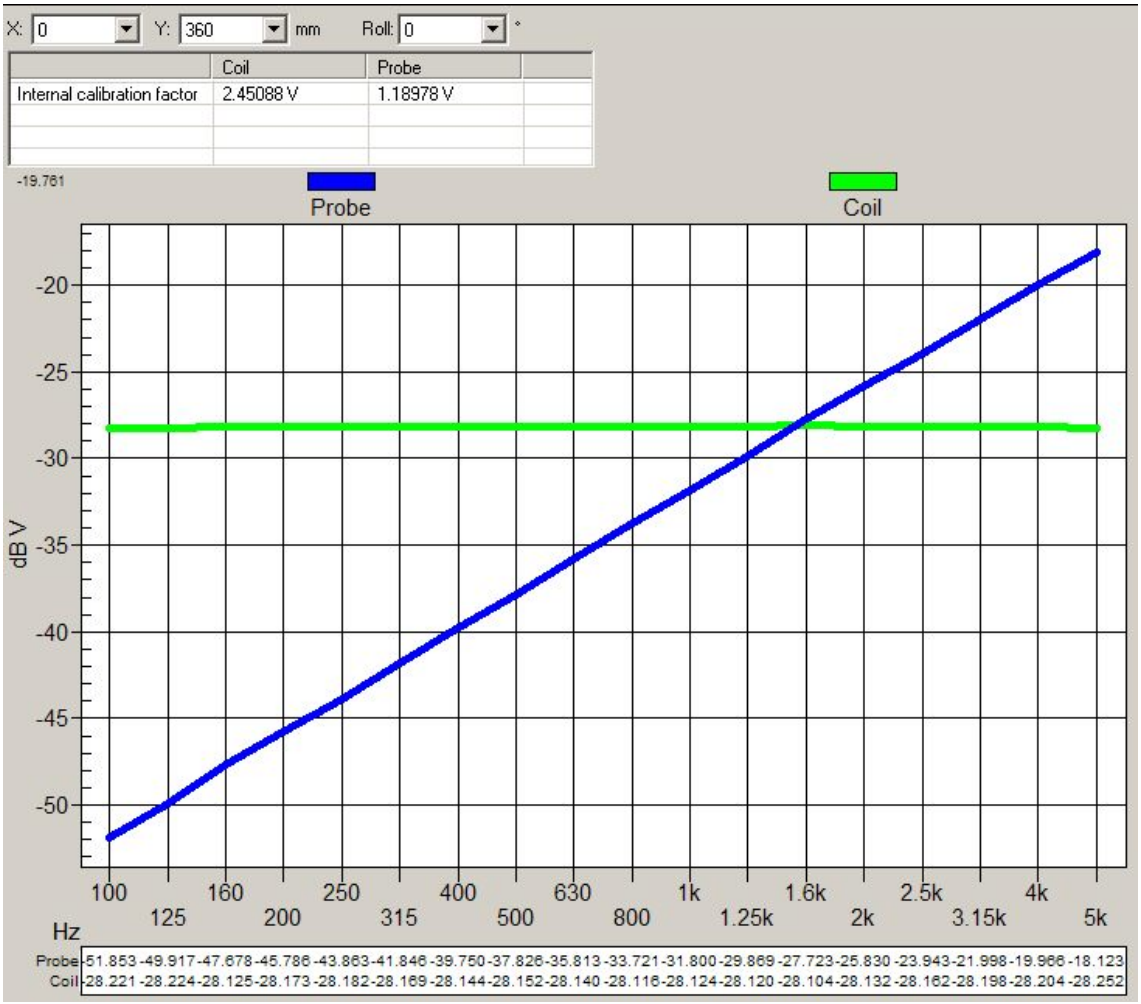
AMMI (Audio Magnetic Measurement Instrument) is a desktop unit containing a sampling unit, a waveform generator for test, calibration signals and a USB interface. Front connectors include: Audio Out - predefined or user definable audio signals for injection into the WD; Probe In - the probe signal is 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 three orthogonal field components (axial, radial 1, radial 2). The probe is rotated to properly orient the coil for each field component. Probe's frequency response, linearity and other characteristics are given in the certificate in Appendix 4.

AMCC (Audio Magnetic Calibration Coil) is a Helmoltz coil for calibration of the AM1D probe. The two horizontal coils create a homogeneous magnetic field in the z direction. Refer to Appendix 5 for more details on AMCC coil.

The probe is calibrated in 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

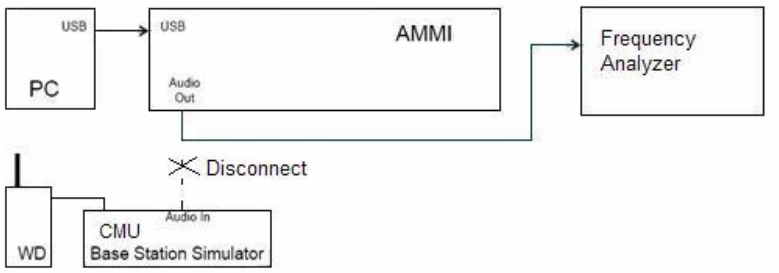


Sensitivity measured in AMCC (includes both probe sensitivity and pre-amplifier sensitivity):
-26.28 V / (A/m)

4. Signal Verification

An Input Level is measured to verify that it is within +/-0.1dB from the Reference Input Level in section 6.3.2.1 of ANSI PC63.19-2001 rd 3.12.

Figure 2: Signal Verification Setup



"Audio Out" of the AMMI is connected to the Bruel & Kjaar 2144 analyzer. On the analyzer, the "Input User Ref" is set to the "0dBm0 Input Reference" value to account for CMU's inherent offset values (refer to Note 1 at the bottom of this page). A signal from AMMI is initiated by running the appropriate DASY template. The template includes both broadband and narrowband signals. The signal is captured on the analyzer. The value from the analyzer is compared to the target given in 6.3.2.1 of ANSI PC63.19-2001 rd 3.12. If it is not within +/-0.1dB, the gain settings in the DASY template are adjusted.

Signal Verification has been conducted on the same days as DUT measurements. The obtained results are displayed in Table 3.

Table 3: Measured Input Level

Modulation	Measured date	Signal	Measured Input Level (dBm0)	Reference Input Level from ANSI PC63.19 (dBm0)
GSM	June 7, 2006	Narrowband	-16.1	-16
		Broadband	-16.0	

Note 1:

Each CMU has a slightly different "0dBm0 Input Reference" value that must be measured. When the CMU box is replaced or externally re-calibrated, an internal calibration procedure must be completed in each transmission mode. On the CMU 200 (SN 108475), the 0dBm0 Input Reference value is 0.73 V for GSM.

5. Test Results

5.1 T-coil SNR Results

The DASY4 v4.7 measurement system specified in section 3.1 was utilized within the intended operations as set by the SPEAG™ setup. The Test Arch provided by SPEAG is used to position the DUT. This phone has one configuration for the ear use – flip open. This configuration is tested at the middle frequency channel of each applicable frequency band. All tests are done via conducted setup with CMU 200. The volume on the phone is adjusted to maximum.

The Cellular Phone model covered by this report has the following battery options:
Battery #1 – SNN5696B is 710 mAH Battery

The tests are performed with telecoil function enabled.
To enable the telecoil function, select "Main Menu - Settings – In-call setup – Hearing Aid – Telecoil On."

The sequence of the measurement is listed in steps below.

1) Geometry & signal check. Probe phantom alignment and check of accuracy.
2) Background noise measurement in the area of the WD
3) Perform coarse resolution axial scan with narrow band signal. For the three orientation positions, using the optimal ABM1 point from the coarse resolution axial scan, perform fine resolution scans in the area of interest with narrow band signal.
4) For the three orientation positions, using the optimal SNR point from corresponding fine resolution area scans, perform point measurement with a narrowband signal - determine ABM1 and SNR. For Axial position, perform point measurement with a broadband signal - determine Frequency Response.

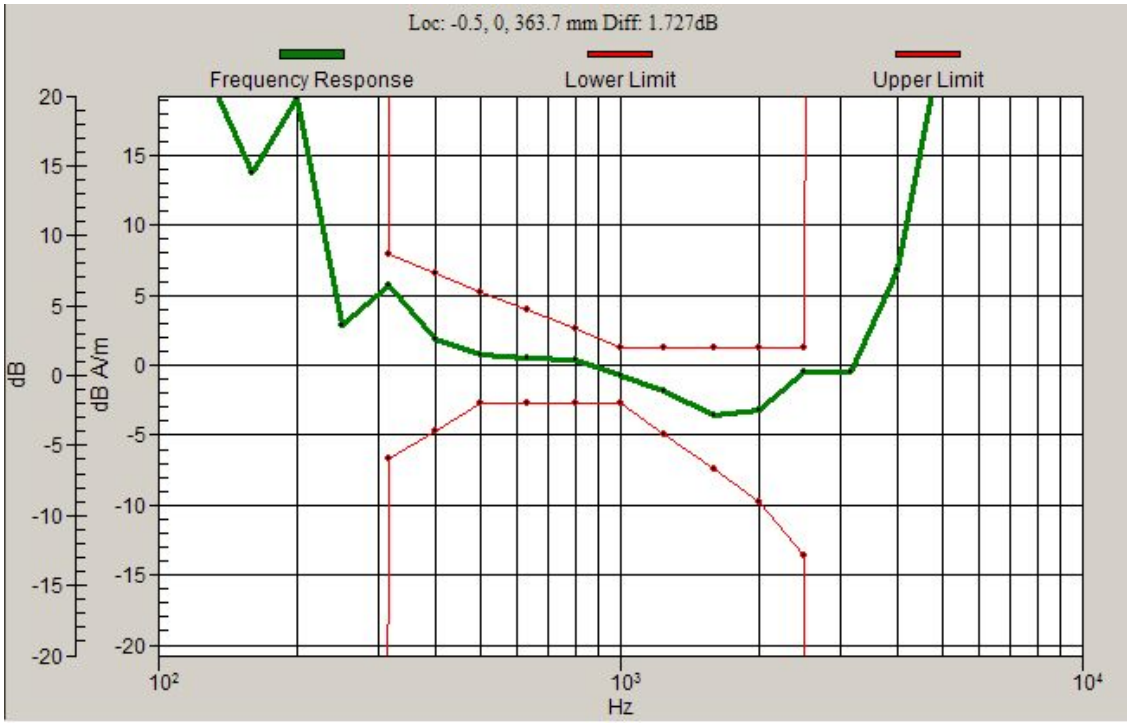
The ABM1, SNR and T-coil Rating results are shown in Table 4. Also shown are the location of the measured point, noise and ABM2. The delta between Ambient Noise measurement and ABM2 measurement should be greater than 10 dB. However, in cases where ABM2 is very low, it is suitable for the delta to be less than 10 dB. For the three probe positions, noise spectrum plots for the highest ambient noise, indicated with **bold numbers**, are given in Appendix 1. These noise spectrum plots are half band integrated with an A-weight filter applied.

T-coil SNR Limits for AWF = -5		
ABM 1	Greater or equal to -13 dB A/m (axial) Greater or equal to -18 dB A/m (radial)	
SNR	T3	Greater than 5 dB
	T4	Greater than 15 dB

Table 4: T-coil SNR measurement results
for the portable cellular telephone at highest possible output power

Probe Position	Frequency Band (MHz)	Channel	Conducted Output Power (dBm)	Location of the Measured Point (x,y)	Ambient Noise (dB A/m)	ABM2 (dB A/m)	ABM2 – Ambient Noise (dB)	ABM1 (dB A/m)	SNR (dB)	T-coil SNR Rating
Axial	GSM 850	190	32.88	-0.5, 0	-58.06	-40.70	17.36	-0.731	39.97	T4
	GSM 1900	661	29.91	-0.5, 0.5	**-56.10**	-40.76	15.34	-0.102	40.66	T4
Radial 1	GSM 850	190	32.88	-8.5, -2.0	-58.16	-40.84	17.32	-9.733	31.10	T4
	GSM 1900	661	29.91	-10.5, -0.5	**-57.95**	-42.85	15.10	-10.090	32.76	T4
Radial 2	GSM 850	190	32.88	-2.5, 8.0	**-58.35**	-40.79	17.56	-9.820	30.97	T4
	GSM 1900	661	29.91	-2.5, 8.5	-58.49	-42.14	16.35	-9.254	32.89	T4

Graph 2: GSM 850 Frequency Response



Graph 3: GSM 1900 Frequency Response

5.2 T-coil Environment Results

T-coil Environment is determined by analysis of both E-Field scan and H-Field scans in the area of the T-coil location. The T-coil location is the earpiece speaker area. The 5cm x 5cm measurement grid is centered on the acoustic output of the device. The probe is raised 10mm from the highest point of the phone's contour to the nearest point of the probe element. The phone was tested in all normal configurations for the ear use. When applicable, each configuration is tested with the antenna in its fully extended and fully retracted positions. These configurations are tested at the high, middle and low frequency channels of each applicable frequency band. For more information on the near field measurements, refer to "HAC Test Report for Near Field Emissions IHDT56GW1" from June 12, 2006.

The measurements for section 5.2 are performed on TA8180005R unit.

Conducted Output Power Measured on TA8180005R unit		
GSM 850	Ch 128	32.94 dBm
	Ch 190	32.95 dBm
	Ch 251	32.94 dBm
GSM 1900	Ch 512	29.95 dBm
	Ch 661	29.97 dBm
	Ch 810	30.00 dBm

Table 5: T-coil Environment measurement results for the portable cellular telephone at highest possible output power.

GSM 850 Emissions Limits		
Rating	E-Field	H-Field
T3	149.6 – 266.1 V/m	0.45 – 0.80 A/m
T4	< 149.6 V/m	< 0.45 A/m

Location	E-Field (V/m)			H-Field (A/m)		
	Antenna fixed			Antenna fixed		
	Ch 128	Ch 190	Ch 251	Ch 128	Ch 190	Ch 251
Axial, Grid 5 (-0.5, 0)	257.4	233.8	204.3	0.375	0.308	0.292
Radial 1, Grid 6 (-8.5, -2)	256.8	233.7	203.7	0.208	0.173	0.162
Radial 2, Grid 5 (-2.5, 8)	257.4	233.8	204.3	0.375	0.308	0.292

GSM 1900 Emissions Limits		
Rating	E-Field	H-Field
T3	47.3 – 84.1 V/m	0.14 – 0.25 A/m
T4	< 47.3 V/m	< 0.14 A/m

Location	E-Field (V/m)			H-Field (A/m)		
	Antenna fixed			Antenna fixed		
	Ch 512	Ch 661	Ch 810	Ch 512	Ch 661	Ch 810
Axial, Grid 5 (-0.5, 0.5)	60.4	63.4	72.6	0.131	0.130	0.179
Radial 1, Grid 6 (-10.5, -1.5)	62.7	66.4	77.5	0.130	0.130	0.179
Radial 2, Grid 8 (-2.5, 8.5)	41.2	46.9	60.4	0.130	0.129	0.178

5.3 T-Rating Results

Both T-coil SNR (Table 4) and T-coil Environment (Table 5) determine the T-rating. Table 6 summarizes the T-coil SNR rating and the T-coil Environment rating. For each probe position and frequency band, the T-rating is determined from lower of T-coil SNR and T-coil Environment.

Table 6: T-Rating results

Probe Position	Frequency Band (MHz)	ABM1	Frequency Response	T-coil SNR Rating (from section 5.1)	T-coil Env Rating (from section 5.2)	T-rating
Axial	GSM 850	pass	pass	T4	T3	T3
	GSM 1900	pass	pass	T4	T3	T3
Radial 1	GSM 850	pass		T4	T3	T3
	GSM 1900	pass		T4	T3	T3
Radial 2	GSM 850	pass		T4	T3	T3
	GSM 1900	pass		T4	T3	T3

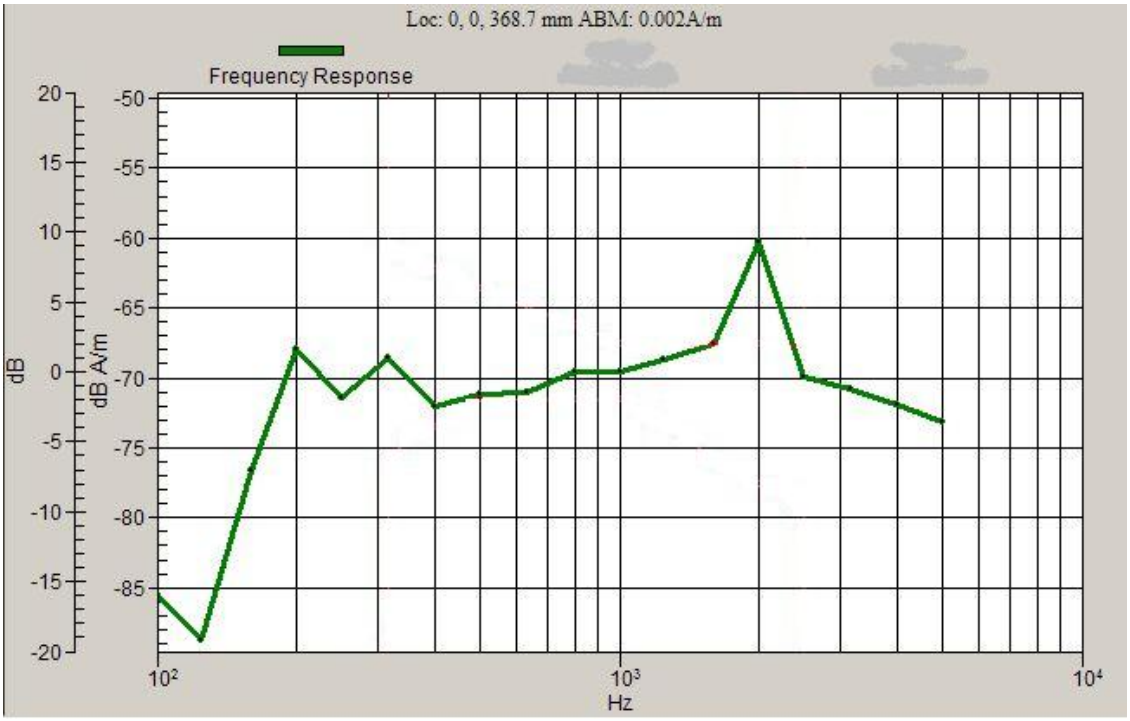
The final T-rating for the portable cellular phone (FCC ID IHDT56GW1) is the lowest T-rating from Table 6 (last column). This rating is the lowest category across probe positions and frequency bands.

T-rating for DUT (lowest rating from Table 6, last column)	T3

Appendix 1

Ambient Noise Spectrum Plots

Graph A1-1. Axial Position Ambient Noise Spectrum Plot



Graph A1-2. Radial 1 Position Ambient Noise Spectrum Plot

Graph A1-3. Radial 2 Position Ambient Noise Spectrum Plot

Appendix 2

Pictures of Test Setup

Figure A2-1. Phone Closed

Figure A2-2. Phone Open – Coordinate Axis for T-coil Measured Point Location

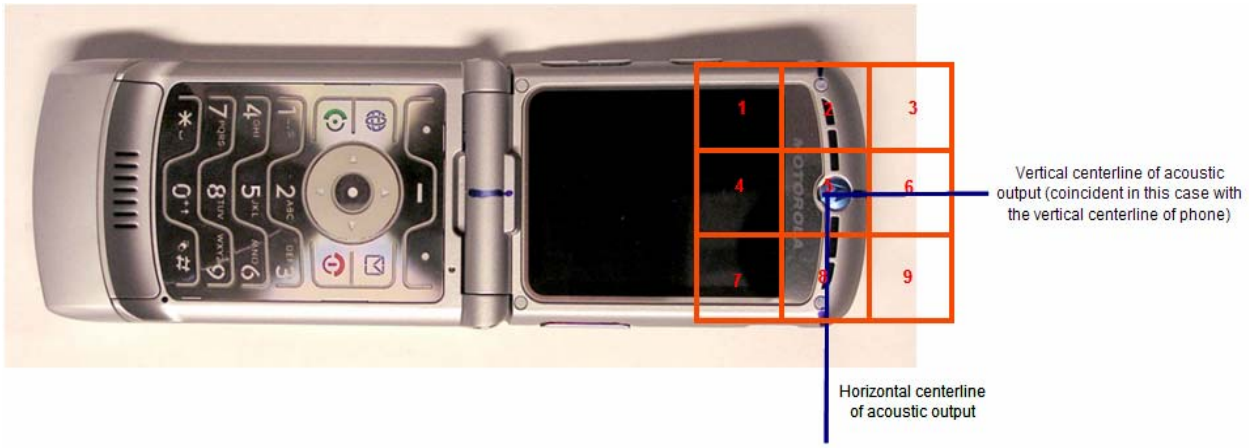


Figure A2-3. Phone Open – 5cm x 5cm grid for Near Field Measurements

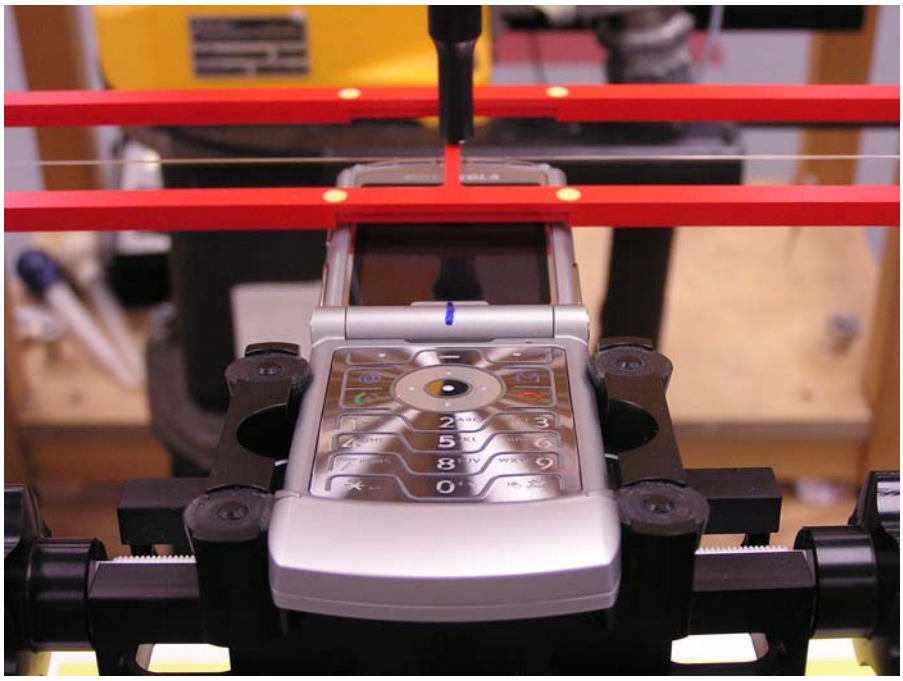


Figure A2-4. View from the front

Figure A2-5. View from the side

Appendix 3

Motorola Uncertainty Budget

Table A3-1: Draft T-Coil Uncertainty Budget, provided by SPEAG 7-June-06

Error Description	Uncertainty value [%]	Prob. Dist.	Div.	c ABM1	c ABM2	Std. Unc. ABM1	Std. Unc. ABM2
PROBE SENSITIVITY							
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
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	1.0	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	1.9	R	1.7	1	1	1.1	1.1
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. uncertainty (ABM field)						4.1	6.2
Expanded Std. uncertainty [%]						**8.2**	**12.3**

Appendix 4

Audio Magnetic Probe Certificate

Schmid & Partner Engineering AG

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	**SP AM1 001 A**
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 betwen +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

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

Schmid & Partner Engineering AG

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

Certificate of test and configuration

Item	Audio Magnetic 1D Field Probe **AM1DV2**
Type No	SP AM1 001 A
Series No	**1003**
Manufacturer / Origin	Schmid & Partner Engineering AG Zurich, 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 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

The probe configuration data were evaluated after a functional test including amplification, dynamic range and RF immunity.

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	
Connector rotation	Evaluated in homogeneous 1 kHz magnetic field generated with AMCC Helmholtz Calibration Coil	**92**	°

Standards

[1] ANSI PC63.19-2006 Draft 3.12

Date 22.2.2006

Signature

Appendix 5

AMCC Certificate (Helmholz Coil)

Schmid & Partner Engineering AG

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

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