Hearing Aid Compatibility (HAC)
T-Coil Test Report
for
Nokia Inc.
on the
CDMA 1xRTT IS2000 Mobile Phone

Report No.	:	HA791904T
Trade Name	:	RH-108
FCC ID	:	QMNRH-108
Date of Testing	:	Sep. 26, 2007
Date of Report	:	Sep. 29, 2007
Date of Review	:	Sep. 29, 2007

- **Results Summary : T Category = T4**
- The test results refer exclusively to the presented test model/sample only.
- Without written approval of SPORTON International Inc., the test report shall not be reproduced
- except in full.
- Report Version: Rev.01

SPORTON International Inc.

No.52, Hwa-Ya 1st RD., Hwa Ya Technology Park, Kwei-Shan Hsiang, TaoYuan Hsien, Taiwan,R.O.C.

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1. Statement of Compliance

The Hearing Aid Compliance (HAC) maximum results found during testing for the Nokia Inc. CDMA 1xRTT IS2000 Mobile Phone RH-108 are as follows (with expanded uncertainly ±8.1% for AMB1 and ±12.3% for AMB2)**:**

Reference (63.19)	Description	Verdict	Section
7.3.1.1	Axial Field Intensity	Pass	9.2.1
7.3.1.2	Radial Field Intensity	Pass	9.2.2
7.3.2	Frequency Response	Pass	9.2.3
7.3.3	Signal Quality	T4	9.2.4
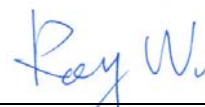
Band	(S+N)/N in dB	T Rating
CDMA2000 Cellular 850	23.0507	T4
CDMA2000 PCS 1900	28.1278	T4

They are in compliance with HAC limits specified in guidelines FCC 47CFR §20.19 and ANSI Standard ANSI PC 63.19 for HAC Rated category.

Results Summary : T Category = T4

Technical Reviewer
Jones Tsai / Manager

Report Reviewer
Roy Wu / Manager

2. Administration Data

2.1 Testing Laboratory

Company Name :   Sporton International Inc.
Department :   Antenna Design/SAR
Address :   No.52, Hwa-Ya 1st RD., Hwa Ya Technology Park, Kwei-Shan Hsiang, TaoYuan Hsien, Taiwan, R.O.C.
Telephone Number :   886-3-327-3456
Fax Number :   886-3-327-0973

2.2 Detail of Applicant

Company Name :   Nokia Inc.
Address :   12278 Scripps Summit Dr. San Diego CA 92131 USA

2.3 Detail of Manufacturer

Company Name :   Foxconn International Holdings Limited
Address: No. 2, 2nd DongHuan Road, 10th YouSong Industrial District, Longhua Town, Baoan, Shenzhen, GuangDong, China

2.4 Application Detail

Date of reception of application: Sep. 19, 2007
Start of test :   Sep. 26, 2007
End of test :   Sep. 26, 2007

3. General Information

3.1 Description of Device Under Test (DUT)

DUT Type :	CDMA 1xRTT IS2000 Mobile Phone
Trade Name :	RH-108
FCC ID :	QMNRH-108
MEID :	A00000011E72DD
Tx Frequency :	CDMA2000 Cellular 850 : 824 ~ 849 MHz CDMA2000 PCS 1900 : 1850 ~1910 MHz
Rx Frequency :	CDMA2000 Cellular 850 : 869 ~ 894 MHz CDMA2000 PCS 1900 : 1930 ~1990 MHz
Antenna Type :	Fixed Internal
HW ID :	3100
SW Version :	SH_0322B_GEN
Maximum Output Power to Antenna :	**(For HAC)** CDMA2000 Cellular 850 : 24.62 dBm CDMA2000 PCS1900 : 23.58 dBm **(For EMC)** CDMA2000 Cellular 850 : 24.49 dBm CDMA2000 PCS1900 : 23.55 dBm
Type of Modulation :	QPSK

3.2 Applied Standards:

The ANSI Standard ANSI PC 63.19 revision draft 3.12 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.

3.3 Test Conditions:

3.3.1 Ambient Condition

Ambient Temperature (^{o}C)	20-24℃
Humidity (%)	<60%
Acoustic Ambient Noise	>10dB below the measurement level

3.3.2 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 air link.

Measurements were performed on the middle channel of both bands.

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

4. Hearing Aid Compliance (HAC)

4.1 Introduction

In September 2006, the T-Coil requirements of ANSI C63.19-2006 Standard went into effect. The federal communication commission (FCC) adopted ANSI PC 63.19 as HAC test standard.

5. *HAC T-Coil Measurement Setup*

5.1 System Configuration

Figure 5.1: T-Coil setup with HAC Test Arch and AMCC

The DASY4 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
➢ DASY4 software
➢ Remove control with teach pendant and additional circuitry for robot safety such as warming 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.

5.2 AM1D probe

The AM1D 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:

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

5.2.1 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.
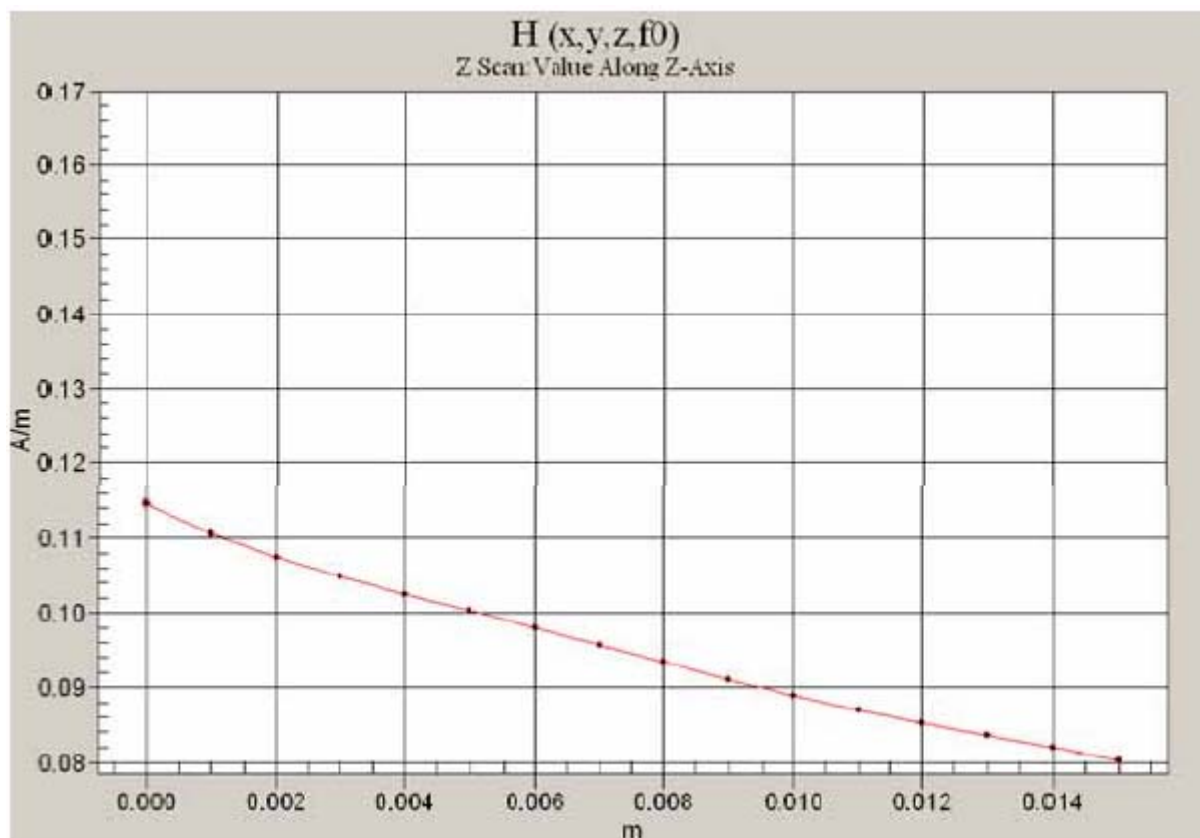
Fig. 5.2: Z-Axis Scan at maximum point above a typical wireless device for H-field

5.3 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	10Ohm ±1%(100mV corresponding to 1 A/m)

Specification:

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

5.4 AMMI

Figure 5.3: 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:

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

5.5 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.

5.6 Robot

The DASY4 system uses the high precision robots RX90BL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASYS system, the CS7MB robot controller version from Stäubli is used. The RX robot series have many features that are important for our application:

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

5.7 Measurement Server

The DASY4 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.

5.8 Phone Positioner

The phone positioner shown in Fig. 5.4 is used to adjust DUT to the suitable position.
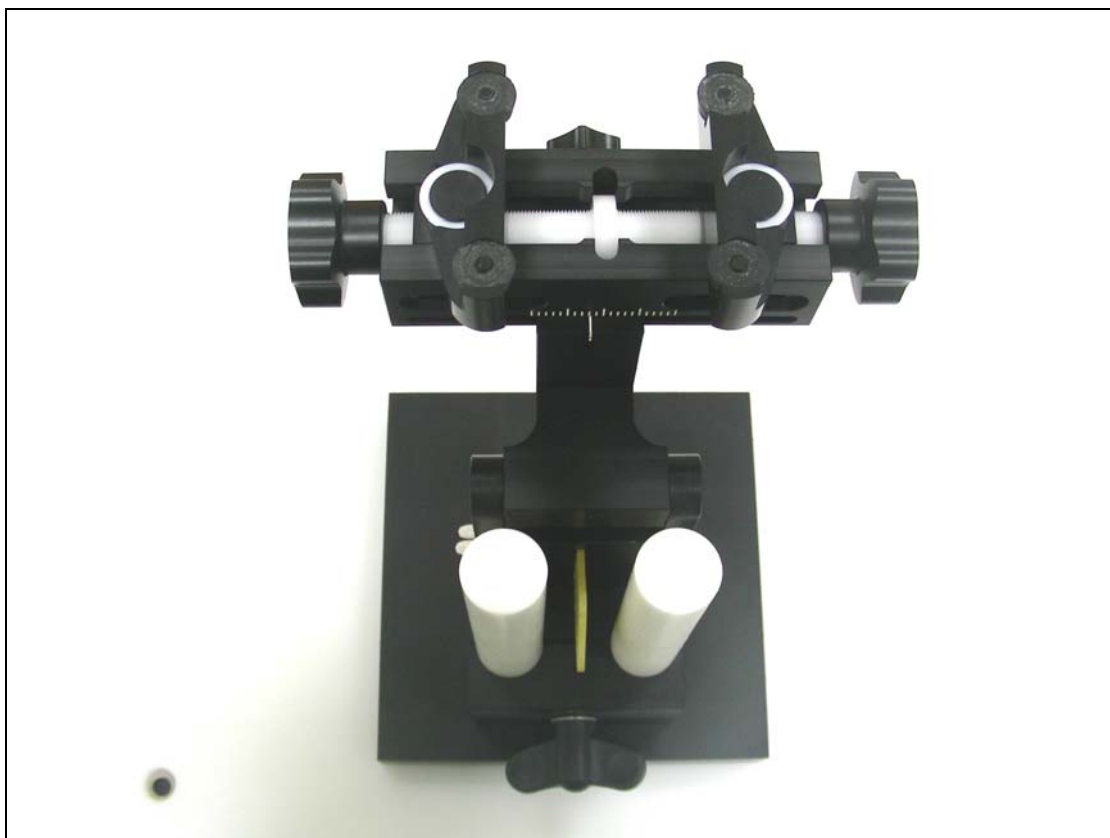
Fig. 5.4: Phone Positioner

5.8.1 Test Arch Phantom

Construction	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
Dimensions	370 x 370 x 370 mm
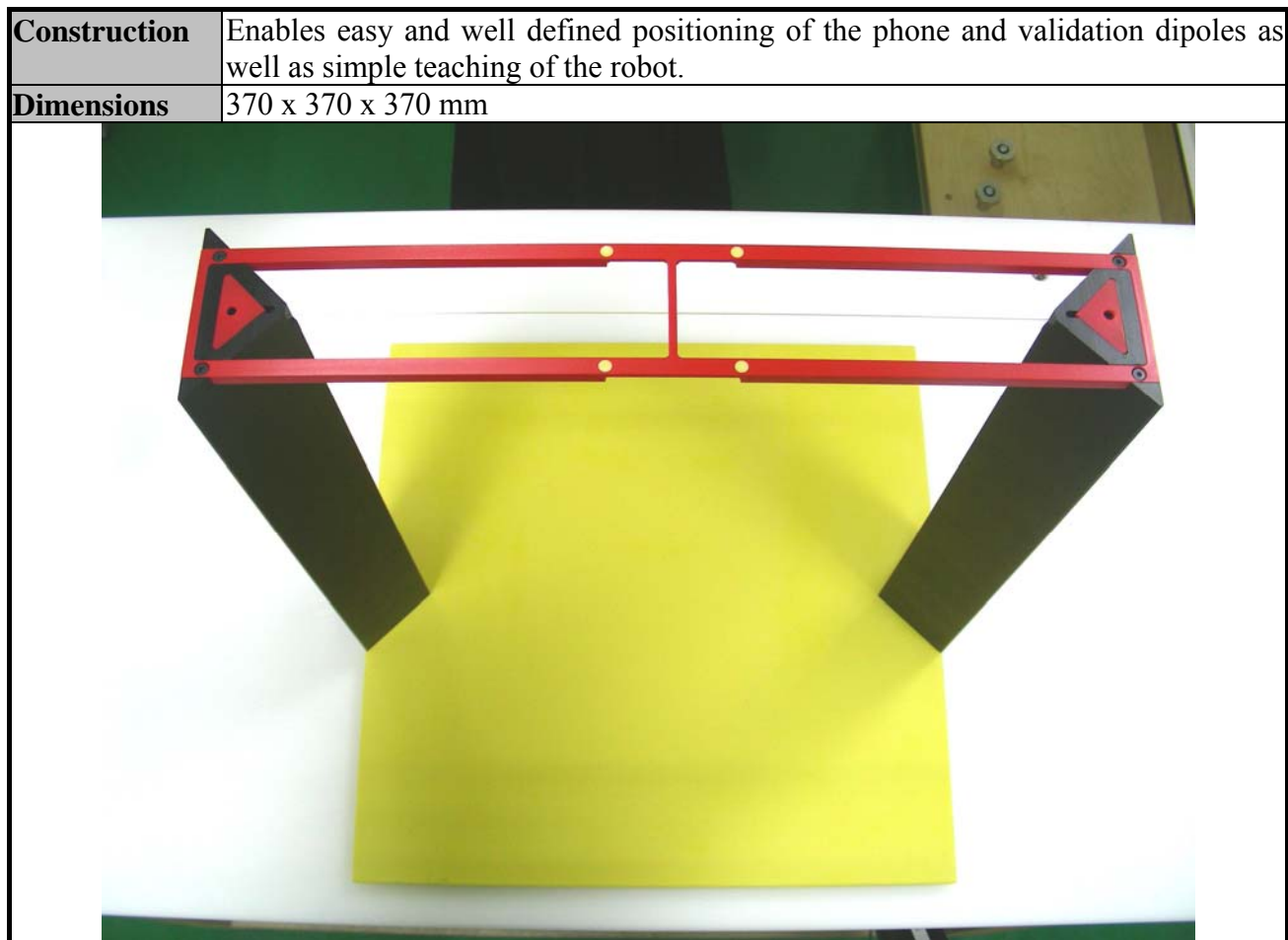
Fig. 5.5: Test Arch Phantom

5.9 Cabling of System

The principal cabling of the T-Coil setup is shown in Figure 5.6. All cables provided with the basic setup have a length of approximately 5 m.
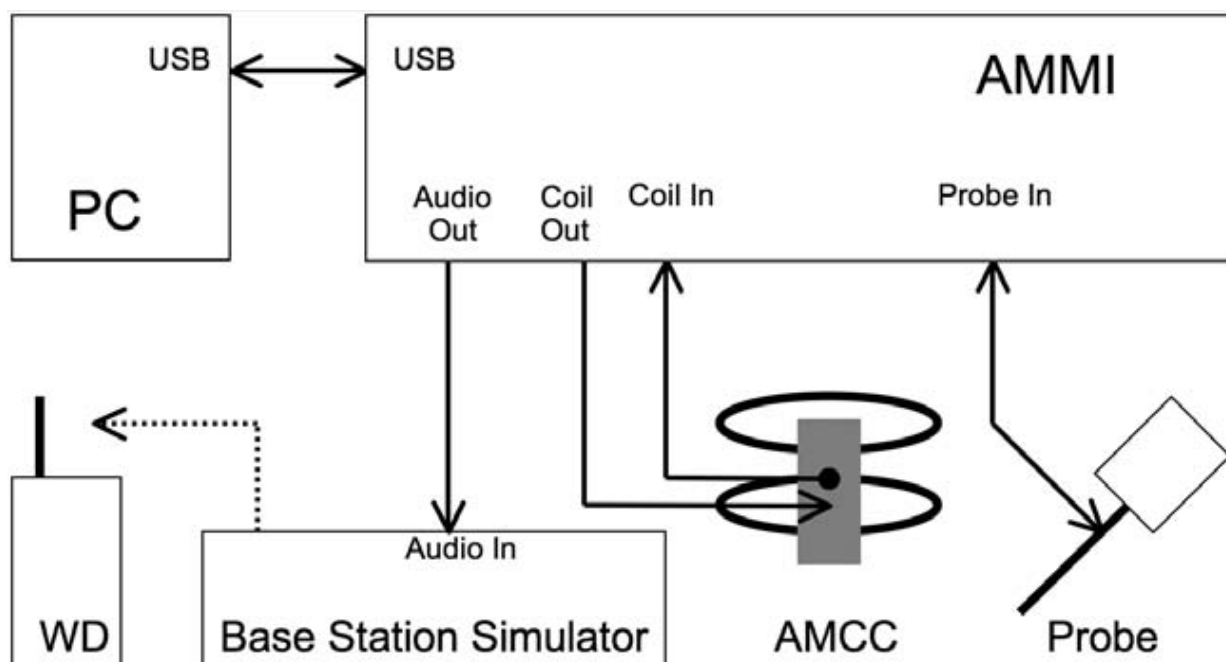
Fig. 5.6: T-Coil setup cabling

5.10 HAC Extension Software for DASY4

Specification:

Precise teaching	Easy teaching with adaptive distance verification
Measurement area	Flexible selection of measurement area, predefined according to ANSI-PC63.19
Evaluation	ABM: spectral processing, filtering, weighting and evaluation according to ANSI-PC63.19
Report	Documentation ready for compliance report

5.11 Test Equipment List

| Manufacture	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	**Due Date**
SPEAG	Audio Magnetic 1D Field Probe	AM1DV2	1038	Jan. 1, 2007	Jan. 1, 2008
SPEAG	Audio Magnetic Calibration Coil	AMCC	1049	NCR	NCR
SPEAG	Audio Measuring Instrument	AMMI	1041	NCR	NCR
SPEAG	HAC Test Arch	N/A	1041	NCR	NCR
SPEAG	Data Acquisition Electronics	DAE3	577	Nov. 21, 2006	Nov. 21, 2007
SPEAG	Software	DASY4 V4.7 Build 53	N/A	NCR	NCR
SPEAG	Software	SEMCAD V1.8 Build 172	N/A	NCR	NCR
R&S	Universal Radio Communication Tester	CMU200	103937	Oct. 20, 2006	Oct. 20, 2007

Table 5.1: Test Equipment List

6. Description for DUT Testing Position

Figure 6.1 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.

Fig 6.1: A typical DUT reference and plane for HAC measurements

7. T-Coil Test Procedure

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

1. Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.
2. DUT is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
3. The DUT operation for maximum rated RF output power was configured and confirmed with 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.
4. 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.
5. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the test Arch.
6. The measurement system measured the field strength at the reference location.
7. Measurements at 2 mm increments in the 5 x 5 cm region were performed and recorded. A 360 degrees rotation about the azimuth axis at the maximum interpolated position was measured. For the worst-case condition, the peak reading from this rotation was used in re-evaluating the HAC category.
8. The system performed a drift evaluation by measuring the field at the reference location.

8. T-Coil Articulation Weighting Factor and Signal Quality Categories

8.1 Articulation weighting factor (AWF)
The following AWF factors shall be used for the standard transmission protocols:

Standard	Technology	AWF (dB)
TIA/EIA/IS-2000	CDMA	0
TIA/EIA-136	TDMA (50Hz)	0
J-STD-007	GSM (217)	-5
T1/P1P1/3GPP	UMTS (WCDMA)	0
iDEN^{TM}	TDMA (22 and 11 Hz)	0

8.2 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 8.1. 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 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
(Note: For cases where it can be shown that the audio-band interference is not dominated by the RF pulse rate of the phone, AWF does not apply)		

Table 8.1: T-Coil signal quality categories

9. Summary of Measurement Result

9.1 Test Result

9.1.1 Magnitude Result

The Table 9.1 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. Signal strength measurement scans are presented in Annex A.

Probe Position	Band	Measurement Position (x mm, y mm)	Ambient Background Noise (dB A/m)	ABM2 (dB A/m)	ABM1 (dB A/m)	AWF	SNR (dB)
Radial 1 (Longitudinal)	Cellular	(6, -4)	-44.58	-32.65	-9.59859	0	23.0507
	PCS	(-12, -4)	-44.37	-40.08	-11.9568	0	28.1278
Radial 2 (Transversal)	Cellular	(-2, -8)	-43.05	-42.26	-9.26091	0	32.9956
	PCS	(0, -8)	-43.11	-41.00	-7.81589	0	33.1816
Axial	Cellular	(-4, 0)	-51.33	-34.25	0.273696	0	34.5192
	PCS	(0, -4)	-51.35	-27.76	1.8822	0	29.6465

Table 9.1: Test Result for Various Positions

9.1.2 Frequency Response

Point measurement/z (axial) 300-3k response at max/ABM Freq Resp(x,y,z,f)
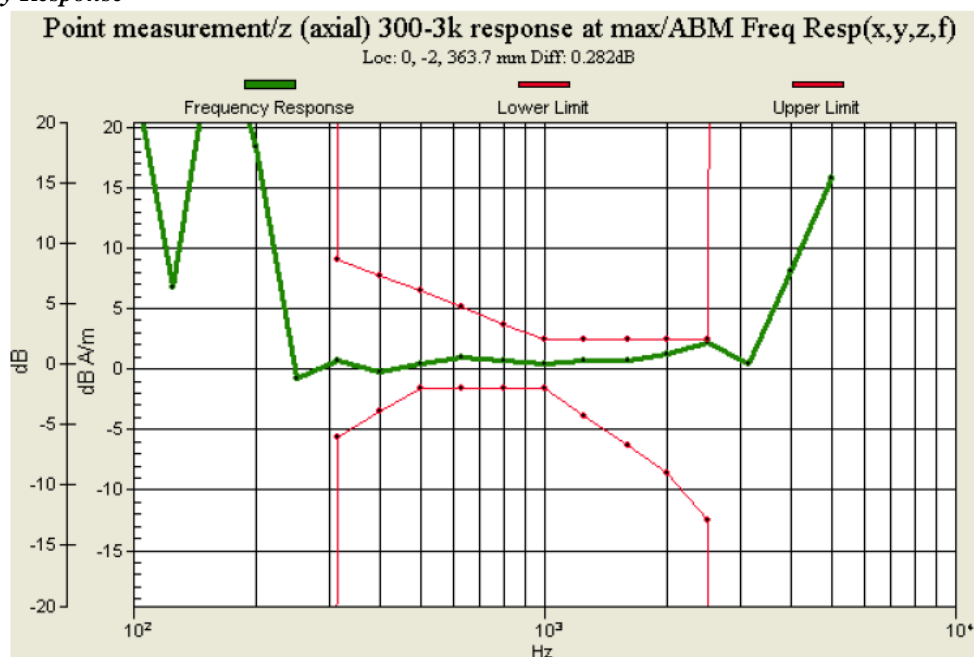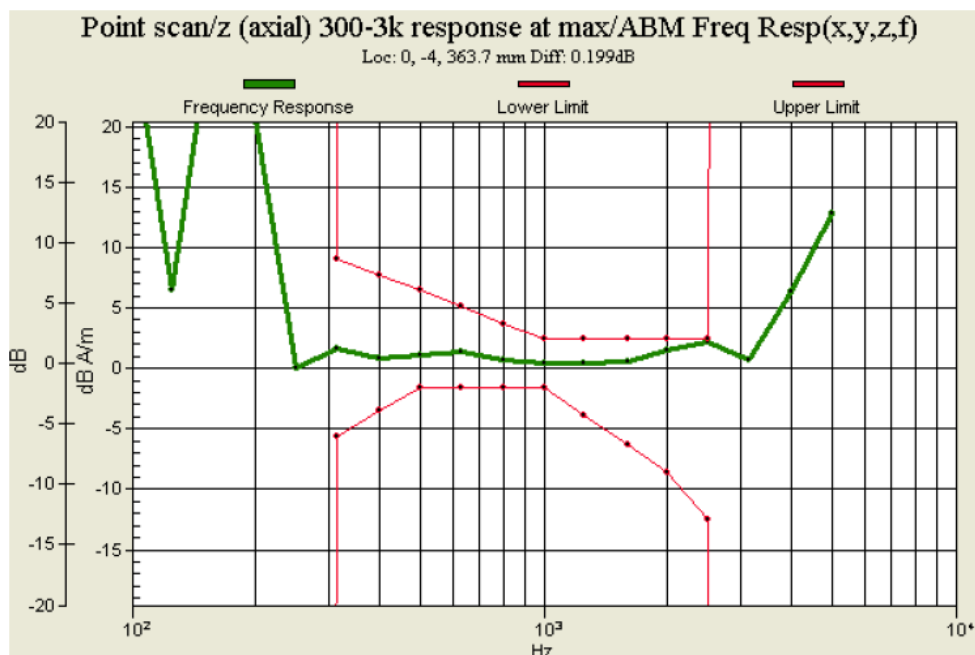Loc: 0, -2, 363.7 mm Diff: 0.282dB

Fig 9.1: Frequency Response of CDMA2000 Cellular 850

Fig 9.2: Frequency Response of CDMA2000 PCS 1900

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
CDMA2000 Cellular 850	-13	0.273696	**Pass**
CDMA2000 PCS 1900	-13	1.8822	**Pass**

9.2.2 Radial Field Intensity

Cell Phone Mode	Minimum limit (dB A/m)	Result (dB A/m)	Verdict
CDMA2000 Cellular 850	-18	-9.59859	**Pass**
CDMA2000 PCS 1900	-18	-11.9568	**Pass**

9.2.3 Frequency Response at Axial Measurement Point

Cell Phone Mode	Verdict
CDMA2000 Cellular 850	**Pass**
CDMA2000 PCS 1900	**Pass**

9.2.4 Signal Quality

Cell Phone Mode	Minimum limit (dB)				Minimum Result (dB)	Verdict
	T1	T2	T3	T4		
CDMA2000 Cellular 850	-20	-10	0	10	23.0507	**T4**
CDMA2000 PCS 1900	-20	-10	0	10	28.1278	**T4**

10. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly 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 10.1

Uncertainty Distributions	Normal	Rectangular	Triangular	U-shape
Multiplying factor[(a)]	$1/k$ [(b)]	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

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

(b) κ is the coverage factor

Table 10.1: 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 DASY4 uncertainty Budget is showed in Table 10.2.

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

Table 10.2: Uncertainty of audio band magnetic measurements

11. References

[1] ANSI-PC 63.19 D3.12, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", January 10, 2006

[2] DASY4 System Hand book.

[3] SAR Measurement Procedures for 3G Devices CDMA 2000/Ev-Do/WCDMA/HSDPA, June 2006 Laboratory Division Office of Engineering and Technology Federal Communications Commission

[4] 3.1.2.3.4 Maximum RF Output Power 3GPP2 C.S0033-0 Version 2.0, Date: 12 December 2003 Recommended Minimum Performance Standards for cdma2000 High Rate Packet Data Access Terminal

[5] May 9, 2006 Preliminary Guidance for Reviewing Applications for Certification of 3G Devices.

Appendix A – HAC Measurement Data

Test Laboratory: Sporton International Inc. SAR Testing Lab   Date : 9/26/2007

T-Coil_CDMA2000 CH384_Radial 1

DUT: 791904

Communication System: CDMA ; Frequency: 836.52 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1 kg/m^3
Ambient Temperature：22.9 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/x (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -12.7278 dB A/m
BWC Factor = 0.151969 dB
Location: 5, -5, 363.7 mm

Fine scan/x (longitudinal) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -7.80592 dB A/m
BWC Factor = 0.15103 dB
Location: 6, -4, 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 = -9.59859 dB A/m
BWC Factor = 0.151969 dB
Location: 6, -4, 363.7 mm

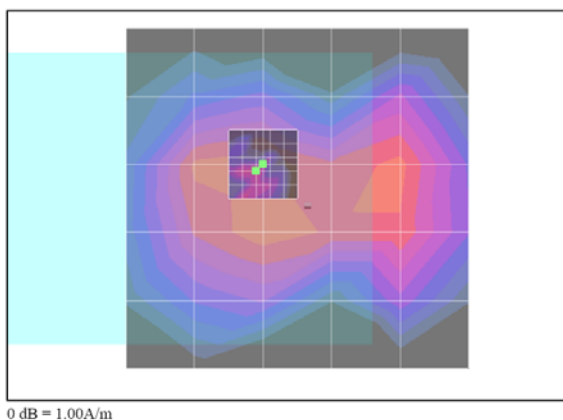**Point scan/x (longitudinal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 23.0507 dB
BWC Factor = 0.151969 dB
Location: 6, -4, 363.7 mm

0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR Testing Lab   Date : 9/26/2007

T-Coil_CDMA2000 CH384_Radial 2

DUT: 791904

Communication System: CDMA ; Frequency: 836.52 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：22.9 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/y (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -10.2403 dB A/m
BWC Factor = 0.151969 dB
Location: -5, -5, 363.7 mm

Fine scan/y (transversal) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -8.59077 dB A/m
BWC Factor = 0.15103 dB
Location: -2, -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 = -9.26091 dB A/m
BWC Factor = 0.151969 dB
Location: -2, -8, 363.7 mm

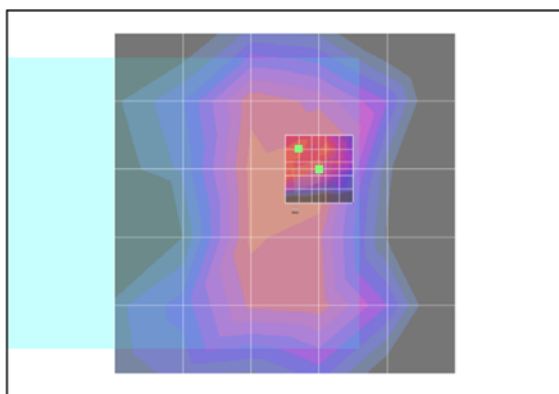**Point scan/y (transversal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 32.9956 dB
BWC Factor = 0.151969 dB
Location: -2, -8, 363.7 mm

0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR Testing Lab   Date : 9/26/2007

T-Coil_CDMA2000 CH384_Axial

DUT: 791904

Communication System: CDMA ; Frequency: 836.52 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：23.0 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/z (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -3.10891 dB A/m
BWC Factor = 0.151969 dB
Location: -5, 5, 363.7 mm

Fine scan/z (axial) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = 2.25626 dB A/m
BWC Factor = 0.15103 dB
Location: -4, 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 = 0.273696 dB A/m
BWC Factor = 0.151969 dB
Location: -4, 0, 363.7 mm

Point scan/z (axial) scan at point with noise/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 34.5192 dB
BWC Factor = 0.151969 dB
Location: -4, 0, 363.7 mm

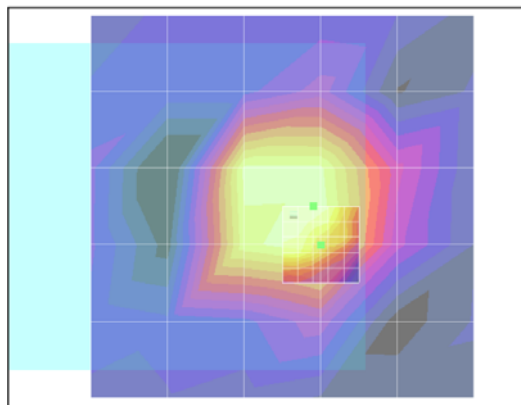**Point scan/z (axial) 300-3k response at max/ABM Freq Resp(x,y,z,f) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
Diff = -0.189967 dB
BWC Factor = 10.8 dB
Location: -4, 0, 363.7 mm

0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR Testing Lab　　　　　Date : 9/26/2007

T-Coil_CDMA2000 CH600_Radial 1

DUT: 791904

Communication System: CDMA ; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：23.0 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/x (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -10.6445 dB A/m
BWC Factor = 0.151969 dB
Location: -15, -5, 363.7 mm

Fine scan/x (longitudinal) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -8.94543 dB A/m
BWC Factor = 0.151969 dB
Location: -12, -4, 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 = -11.9568 dB A/m
BWC Factor = 0.15103 dB
Location: -12, -4, 363.7 mm

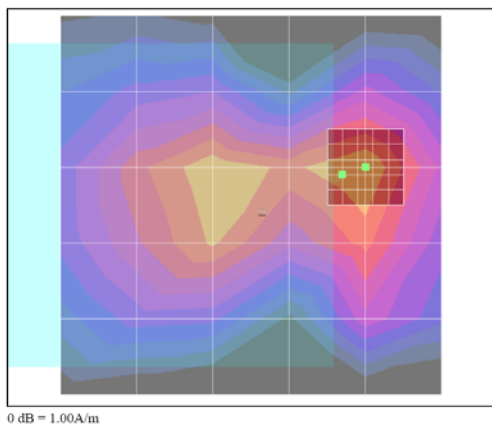**Point scan/x (longitudinal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 28.1278 dB
BWC Factor = 0.15103 dB
Location: -12, -4, 363.7 mm

0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR Testing Lab   Date : 9/26/2007

T-Coil_CDMA2000 CH600_Radial 2

DUT: 791904

Communication System: CDMA ; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：23.0 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/y (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -10.8364 dB A/m
BWC Factor = 0.151969 dB
Location: -5, -5, 363.7 mm

Fine scan/y (transversal) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -7.56047 dB A/m
BWC Factor = 0.151969 dB
Location: 0, -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 = -7.81589 dB A/m
BWC Factor = 0.15103 dB
Location: 0, -8, 363.7 mm

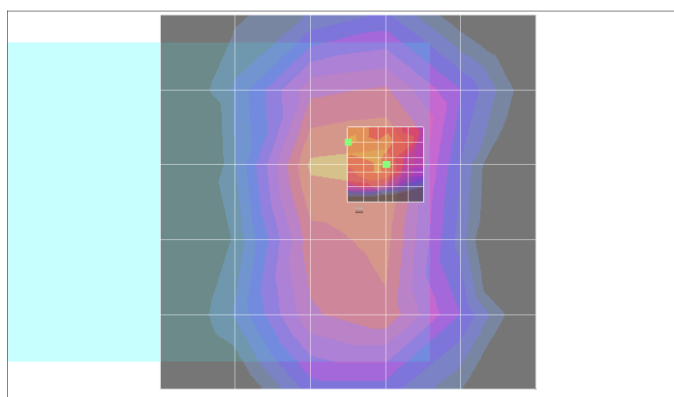**Point scan/y (transversal) scan at point with noise/ABM SNR(x,y,z) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 33.1816 dB
BWC Factor = 0.15103 dB
Location: 0, -8, 363.7 mm

0 dB = 1.00A/m

Test Laboratory: Sporton International Inc. SAR Testing Lab   Date : 9/26/2007

T-Coil_CDMA2000 CH600_Axial

DUT: 791904

Communication System: CDMA ; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium: Air Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Ambient Temperature：23.0 ℃

DASY4 Configuration:
- Probe: AM1DV2 - 1038; ; Calibrated: 1/18/2007
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn577; Calibrated: 11/21/2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 100x
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Coarse Scans/z (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -4.40567 dB A/m
BWC Factor = 0.151969 dB
Location: -5, -5, 363.7 mm

Fine scan/z (axial) scan 10 x 10 (grid 2) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = 1.1424 dB A/m
BWC Factor = 0.151969 dB
Location: 0, -4, 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 = 1.8822 dB A/m
BWC Factor = 0.15103 dB
Location: 0, -4, 363.7 mm

Point scan/z (axial) scan at point with noise/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1/ABM2 = 29.6465 dB
BWC Factor = 0.15103 dB
Location: 0, -4, 363.7 mm

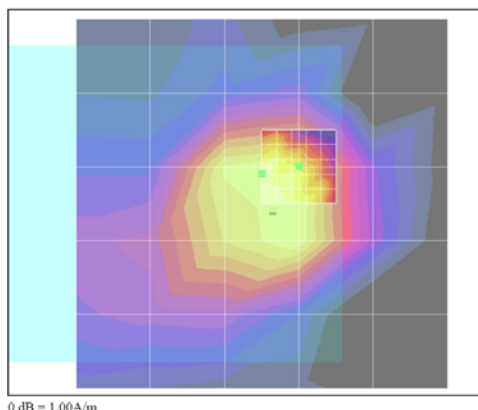**Point scan/z (axial) 300-3k response at max/ABM Freq Resp(x,y,z,f) (1x1x1):**
Measurement grid: dx=10mm, dy=10mm
Cursor:
Diff = 0.199018 dB
BWC Factor = 10.8 dB
Location: 0, -4, 363.7 mm

0 dB = 1.00A/m

Appendix B – Calibration Data

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

Client   *Auden-Sporton*

Certificate of test and configuration

Item	AM1DV2 Audio Magnetic 1D Field Probe
Type No	SP AM1 001 AF
Series No	**1038**
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	38.6	°
Sensor angle		2.35	°
Sensitivity	at 1 kHz	0.06551	V / (A/m)

Standards
[1] ANSI-C63.19-2006

Test date   18.01.2007

Issue date   30.01.2007

Signature   *F. Breubolt*

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Schmid & Partner Engineering AG

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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

s p e a g

Stamp / Signature

Schmid & Partner Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 1 206 9700, Fax +41 1 245 9779
Info@speag.com, http://www.speag.com

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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 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

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

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