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HAC T-Coil Signal Test Report

Test report no.:	Salo_HAC_0633_04	**Date of report:**	2006-Aug-14
Template version:	1.0	**Number of pages:**	21
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Responsible test engineer:	Ari Orte	**Product contact person:**	Jukka Pekkala
Measurements made by:	Ari Orte		
Tested devices:	RM-126 (Hearing aid mode active), HW: 0573		
FCC ID:	PPIRM-126H	**IC:**	661U-RM126
Supplement reports:	Salo_HAC_0633_02.pdf related HAC RF report		
Testing has been carried out in accordance with:	**ANSI C63.19-2006** American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids		
Documentation:	The documentation of the testing performed on the tested devices is archived for 15 years at TCC Nokia.		
Test results:	**The tested device complies with the requirements in respect of all parameters subject to the test.** The test results and statements relate only to the items tested. The test report shall not be reproduced except in full, without written approval of the laboratory.		

Date and signatures: **2006-08-14**

For the contents:

Digitally signed by Ari Orte
DN: CN = Ari Orte, C = FI, O = Nokia, OU = CertMT
Date: 2006.08.14 15:21:25 +03'00'

Ari Orte
Test System Manager

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1. SUMMARY OF HAC T-COIL SIGNAL TEST REPORT

1.1 Test Details

Period of test	2006-Jun-09 – 2006-Jun-12
SN, HW, SW and DUT numbers of tested device	004400/85/172061/3; HWID: 0573; SW: 4.06; DUT#: 11305
Batteries used in testing	BL-4C, DUT#'s: 11061, 11060
State of sample	Prototype unit
Notes	AWF = -5 for GSM

1.2 Summary of T-Coil Test Results

1.2.1 T-Coil Coupling Field Intensity

1.2.1.1 Axial Field Intensity

Mode	Minimum limit [dB (A/m)]	Result [dB (A/m)]	Verdict
GSM 850	-13	8.1	Pass
GSM 1900	-13	8.5	Pass

1.2.1.2 Radial Field Intensity

Mode	Minimum limit [dB (A/m)]	Minimum Result [dB (A/m)]	Verdict
GSM 850	-18	7.1	Pass
GSM 1900	-18	6.8	Pass

1.2.2 Frequency Response at Axial Measurement Point

Mode	Verdict
GSM 850	Pass
GSM 1900	Pass

1.2.3 Signal Quality

Mode	Minimum limit [dB]				Minimum result [dB]	Category
	T1	T2	T3	T4		
GSM 850	-15	-5	5	15	26.8	T4
GSM 1900	-15	-5	5	15	26.8	T4

Mode	RF emissions category at T-coil axial measurement point (E- and H-fields)*	HAC category of the tested device (RF emissions and T-coil requirements combined)
GSM 850	M3	M3/T3
GSM 1900	M3	M3/T3

*See separate report 'Salo_HAC_0633_02.pdf'

1.3 Description of the Device Under Test (DUT)

Modes and Bands of Operation	GSM 850	GSM 1900
Modulation Mode	GMSK	GMSK
Duty Cycle	1/8	1/8
Transmitter Frequency Range (MHz)	824...849	1850...1910

Outside of USA, tested device is also capable of operating in GSM900 and GSM1800 band, which are not part of this test.

1.3.1 Picture of Device

2. TEST CONDITIONS

2.1 Temperature and Humidity

Ambient temperature (°C):	21.5 to 23.5
Ambient humidity (RH %):	35 to 45

2.2 WD Control

The transmitter of the device was put into operation by using a call tester. Communications between the device and the call tester were established by air link. EFR speech codec was used during testing.

The device output power was set to maximum power level for all tests; a fully charged battery was used for every test sequence.

In all operating bands the measurements were performed on middle channel.

2.3 WD Parameters

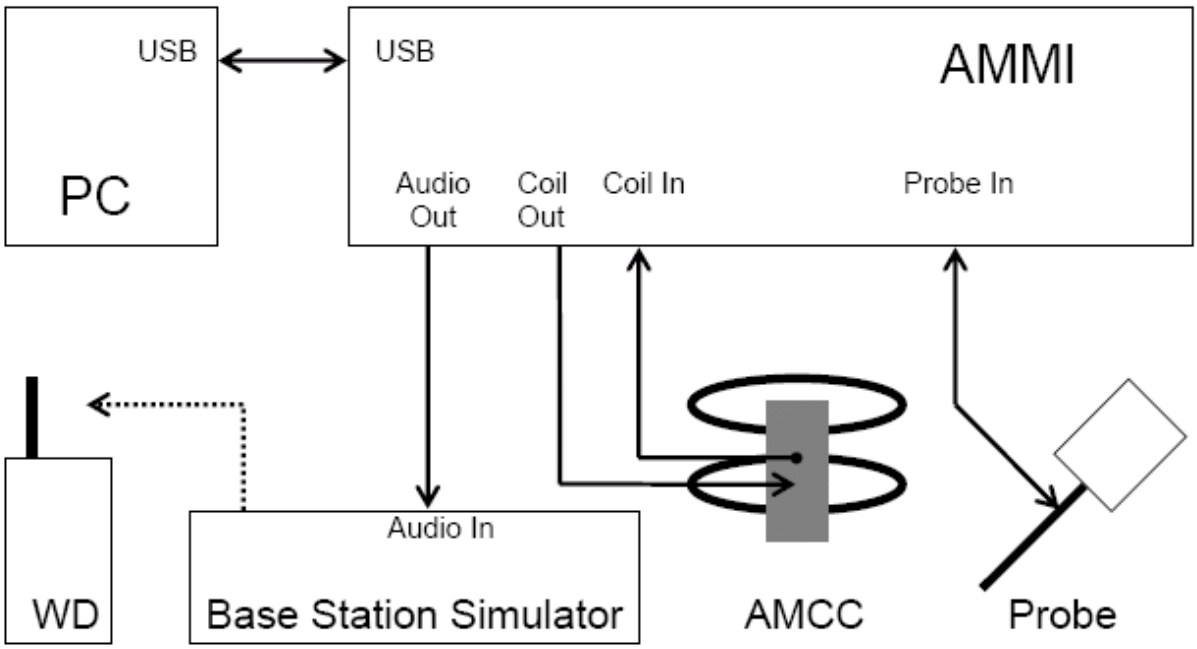
HAC mode was switched on from the WD user interface, volume setting was 1/10 and microphone was muted.

3. DESCRIPTION OF THE TEST EQUIPMENT

3.1 Measurement system and components

The measurements were performed using an automated near-field scanning system, DASY 4 software version 4.7, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland.

Components and signal paths of used measurement system are pictured below:



The following table lists calibration dates of measurement equipment:

Test Equipment	Serial Number	Calibration interval	Calibration expiry
DAE V3	388	12 months	01/07
AMMI Audio Magnetic Measurement Instrument	1002	12 months	02/07
AM1DV2 Audio Magnetic Probe	1001	12 months	02/07
AMCC Helmholtz Audio Magnetic Calibration Coil	1004	12 months	02/07
R&S CMU200 Radio Communication Test Set	101111	12 months	07/06

Additional test equipment used in testing and validation:

Test Equipment	Model	Serial Number	Calibration interval	Calibration expiry
Oscilloscope	TDS 3052	T011185	12 months	07/06

3.1.1 Audio Magnetic Probe AM1DV2

Construction	Fully RF shielded metal construction (RF sensitivity < -100dB)
Calibration	Calibrated using Helmholtz coil
Frequency	0.1 – 20 kHz
Sensitivity	< -50 dB A/m
Dimensions	Overall length: 290 mm; Tip diameter: 6 mm

3.1.2 Audio Magnetic Measurement Instrument AMMI

Sampling Rate	48 kHz / 24 bit
Dynamic Range	85 dB
Test Signal Generation	User selectable and predefined (via PC)
Calibration	Auto-calibration / full system calibration using AMCC with monitor output

3.1.3 Audio Magnetic Calibration Coil AMCC

Dimensions	370 x 370 x 196 mm (ANSI-PC63.19 compliant)

3.1.4 WD positioner

The WD positioner and Test Arch are manufactured by Speag (http://www.dasy4.com/hac). Test arch is used for all tests i.e. for both validation testing and device testing. The positioner and test arch conforms to the requirements of ANSI C63.19.

The SPEAG device holder (see Section 4.1) was used to position the test device in all tests.

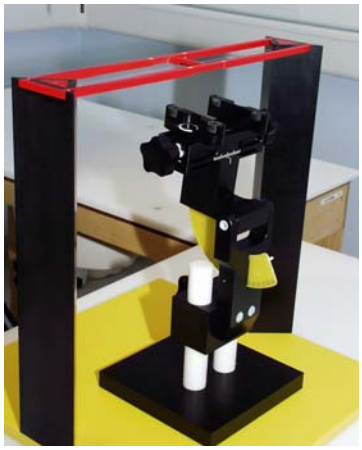
3.2 Verification of the System

Audio Magnetic Probe AM1D is calibrated in AMCC Helmholtz Audio Magnetic Calibration Coil before each measurement procedure using calibration and reference signals.

4. DESCRIPTION OF THE TEST PROCEDURE

4.1 Test Arch and Device Holder

The test device was placed in the Device Holder (illustrated below) that is supplied by SPEAG. Using this positioner the tested device is positioner under Test Arch.



Device holder and Test Arch supplied by SPEAG

4.2 Test Positions

The device was positioned such that Device Reference level was touching the bottom of the Test Arch. The speaker output is aligned with the intersection of the Test Arch's middle bar and dielectric wire. The WD is positioned always this way to ensure repeatability of the measurements. Coordinate system depicted below is used to define exact locations of measurement points relative to the center of the speaker output.

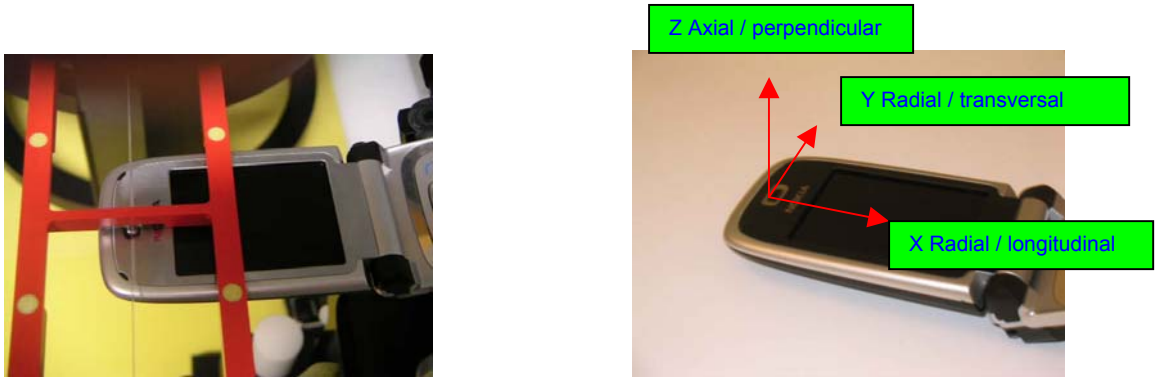


Photo of the device positioned under Test Arch and coordinate system

4.3 T-coil Scan Procedures

Manufacturer can either define measurement locations for WD categorization or optimum locations can be found using following procedure; First, coarse scans in all measurement orientations, centered at the earpiece, are made to find approximate locations of optimum signal. More accurate fine scans are made in these locations to find final measurement points.

4.4 Measurement procedure and used test signals

During measurements signal is fed to WD via communication tester. Proper gain setting is used in software to ensure correct signal level fed to communication tester speech input. Measurement software compares fed signal and signal from measurement probe and applies proper filtering and integration procedures.

Broadband voice-like signals are used during scans and frequency response measurement to ensure proper operation of WD vocoder and audio enhancement algorithms.

Both signal (ABM1) and undesired audio noise (ABM2) are measured consequently to enable determination of signal+noise to noise ratio (SNR).

In final measurement sine signal is used to determine signal strength @ 1 kHz.

4.5 T-coil Requirements and Category Limits

RF Emissions

Wireless device has to fulfill RF emission requirements at the axial measurement location.

Axial Field Intensity

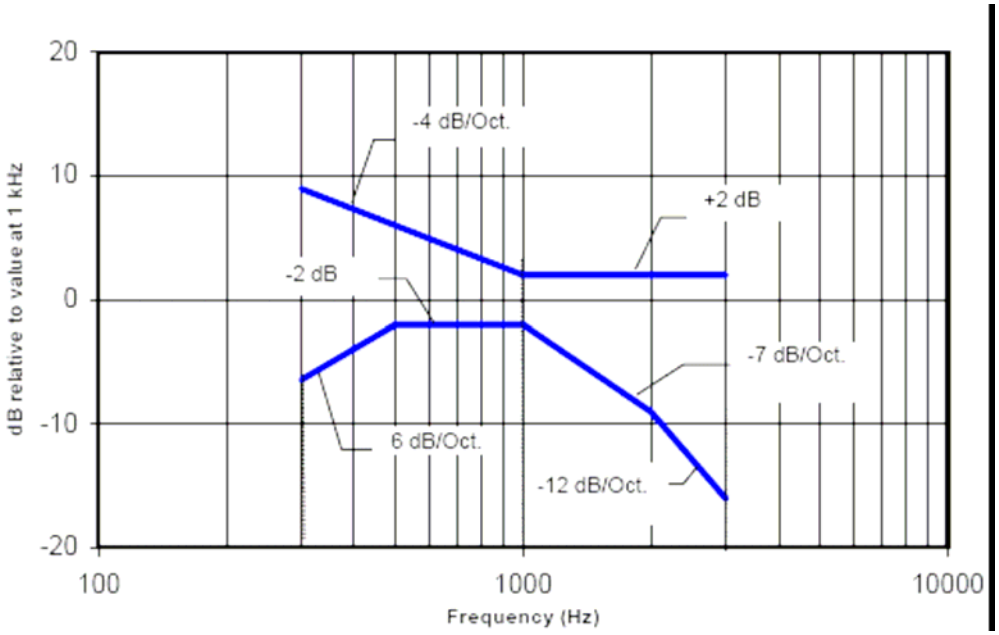
The axial component of the magnetic field shall be ≥-13dB(A/m) at 1 kHz, in 1/3 octave band filter.

Radial Field Intensity

The radial components of the magnetic field shall be ≥-18dB(A/m) at 1 kHz, in 1/3 octave band filter.

Frequency Response

Frequency response of the axial component must follow the frequency curve depicted below:



Frequency response window applicable for devices with axial field strength > -10dB(A/m)

Signal Quality

The worst result of three T-coil signal measurements is used to define WD Hearing Aid T-category according to the category limits:

Category	AWF [dB]	Limits for Signal Quality [dB]
T1	0	-20
	-5	-15
T2	0	-10
	-5	-5
T3	**0**	**0**
	-5	**5**
T4	0	10
	-5	15

5. MEASUREMENT UNCERTAINTY

Measurement uncertainty budget presented in Appendix B.

6. RESULTS

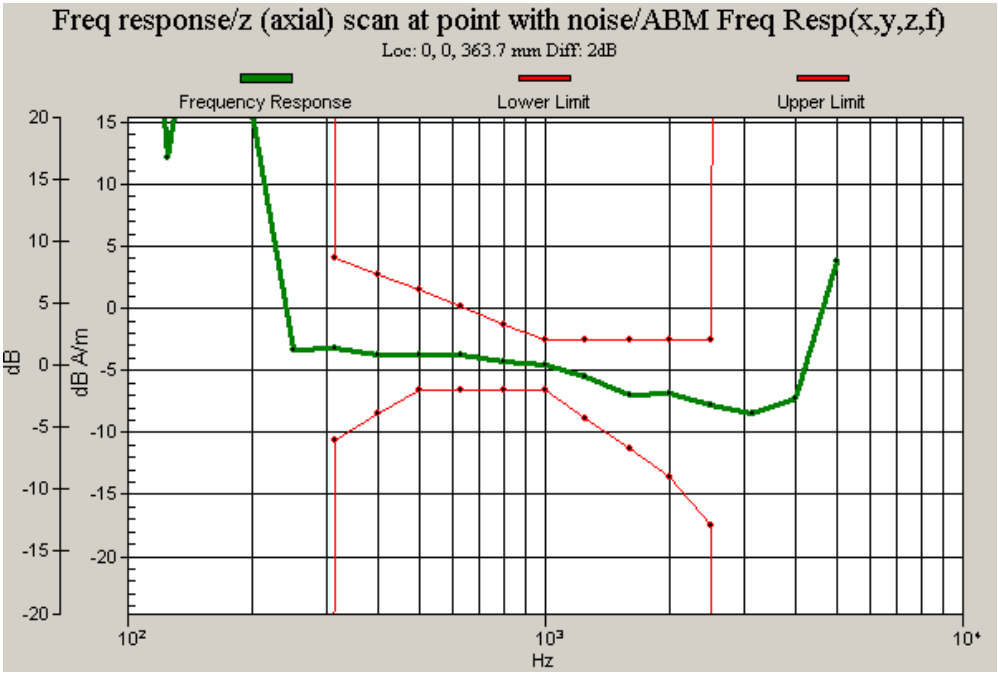
Measurement position coordinates are defined as deviation from earpiece center in millimeters. Coordinate system is defined in chapter 4.2

Axial measurement location was defined by the manufacturer of the device.

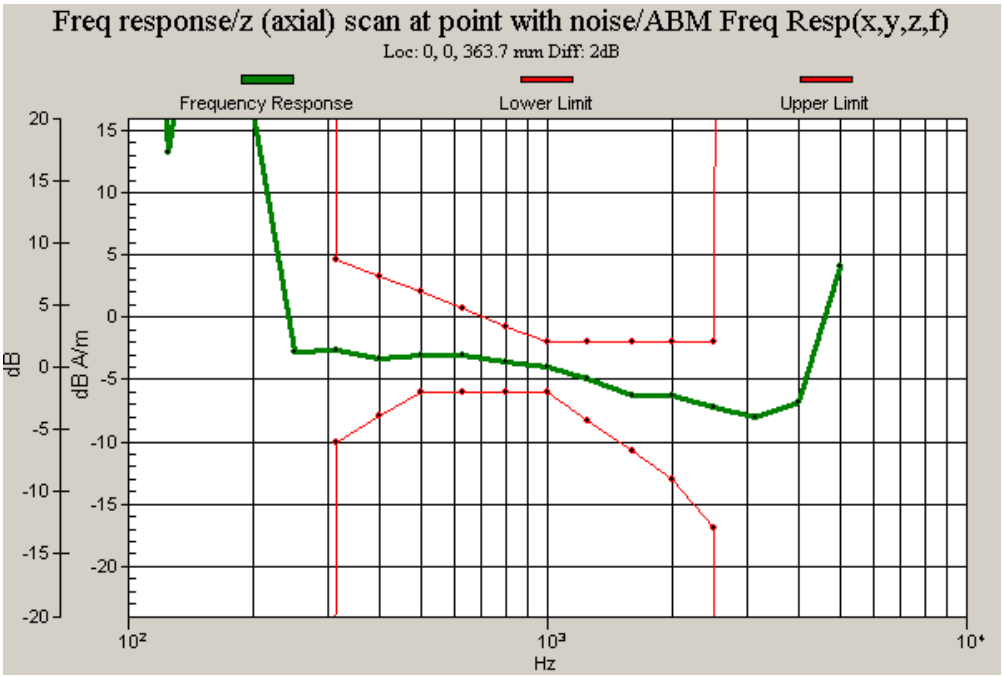
	Radial 1 (longitudinal)		Radial 2 (transversal)		Axial	
Mode	850	1900	850	1900	850	1900
Measurement position (x,y) [mm]	(-4,16)	(-2,16)	(-2,12)	(0,12)	(0,0)	(0,0)
Signal strength [dB A/m]	7.1	6.8	11.4	11.2	8.1	8.5
Ambient backround noise ABM [dB A/m]	-52.1	-51.9	-52.7	-52.3	-52.2	-52.6
ABM2 [dB A/m]	-19.8	-20.1	-15.5	-15.6	-18.8	-18.3
Signal quality [dB]	26.9	26.9	26.8	26.8	26.8	26.8

Plots of the signal strength Measurement scans are presented in Appendix A.

Frequency responses:



Frequency response in GSM850 mode



Frequency response in GSM1900 mode

APPENDIX A: MEASUREMENT SCANS

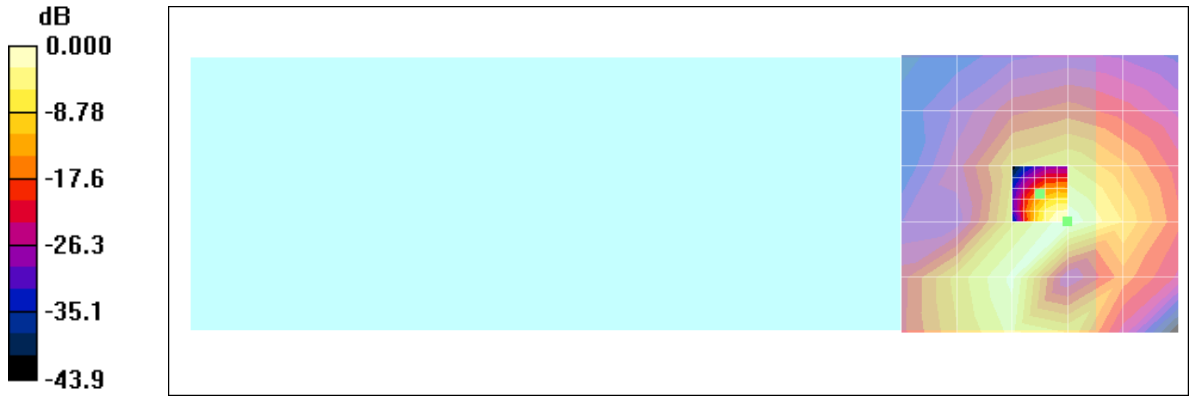
Date/Time: 12.06.2006 15:26:11
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM850
Frequency: 836.6 MHz; Duty Cycle: 1:7
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/z (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -0.542699 dB A/m
BWC Factor = 10.8 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 = 0.261273 dB A/m
BWC Factor = 10.8 dB
Location: -5, 5, 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 = 8.05639 dB A/m
BWC Factor = -0.207 dB
Location: 0, 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 = 26.8425 dB
BWC Factor = -0.207 dB
Location: 0, 0, 363.7 mm



0 dB = 1.00A/m

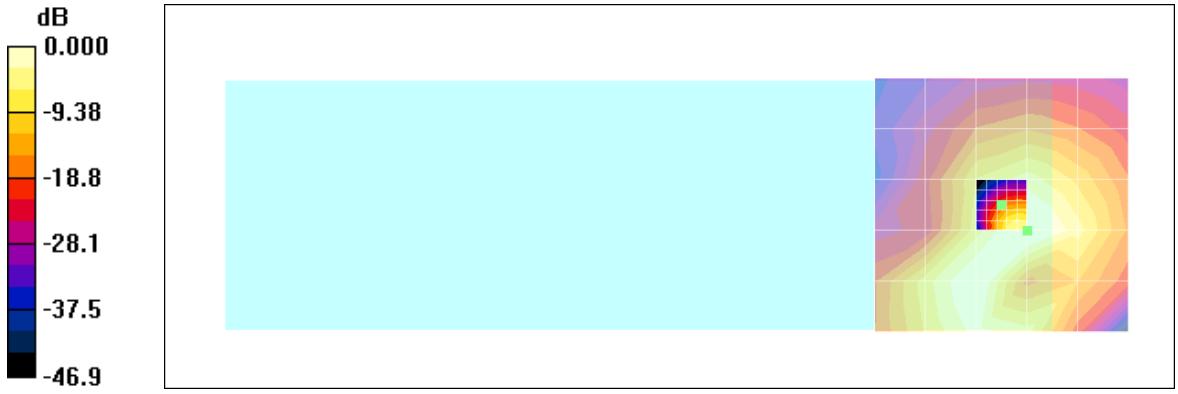
Date/Time: 12.06.2006 13:33:17
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM1900
Frequency: 1880 MHz; Duty Cycle: 1:8.3
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/z (axial) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = 3.08573 dB A/m
BWC Factor = 10.8 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 = -0.51833 dB A/m
BWC Factor = 10.8 dB
Location: -5, 5, 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 = 8.51702 dB A/m
BWC Factor = -0.207 dB
Location: 0, 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 = 26.8355 dB
BWC Factor = -0.207 dB
Location: 0, 0, 363.7 mm



0 dB = 1.00A/m

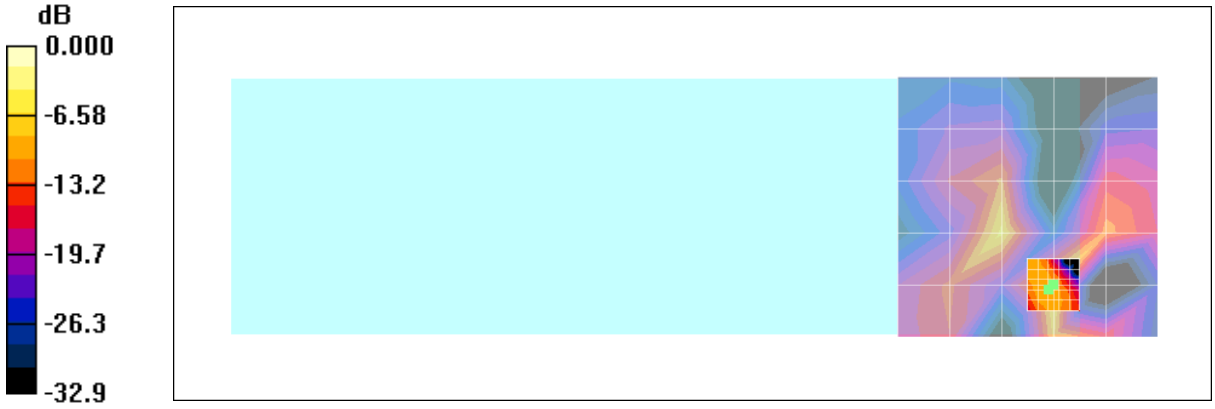
Date/Time: 12.06.2006 15:30:56
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM850
Frequency: 836.6 MHz; Duty Cycle: 1:7
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/x (longitudinal) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -7.43821 dB A/m
BWC Factor = 10.8 dB
Location: -5, 15, 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 = -5.74781 dB A/m
BWC Factor = 10.8 dB
Location: -4, 16, 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 = 7.08488 dB A/m
BWC Factor = -0.207 dB
Location: -4, 16, 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 = 26.8718 dB
BWC Factor = -0.207 dB
Location: -4, 16, 363.7 mm



0 dB = 1.00A/m

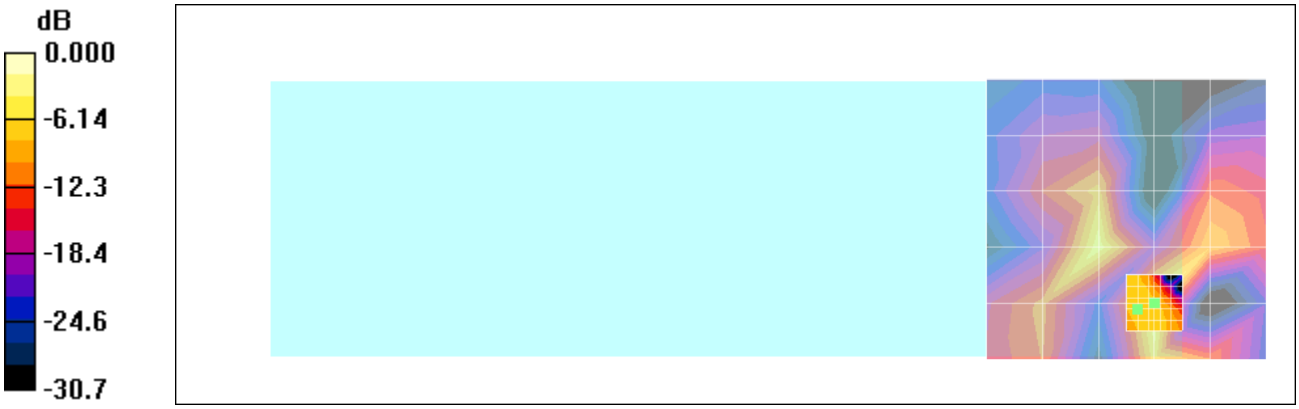
Date/Time: 12.06.2006 13:37:59
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM1900
Frequency: 1880 MHz; Duty Cycle: 1:8.3
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/x (longitudinal) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -3.30756 dB A/m
BWC Factor = 10.8 dB
Location: -5, 15, 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 = -6.06769 dB A/m
BWC Factor = 10.8 dB
Location: -2, 16, 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 = 6.77044 dB A/m
BWC Factor = -0.207 dB
Location: -2, 16, 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 = 26.8628 dB
BWC Factor = -0.207 dB
Location: -2, 16, 363.7 mm



0 dB= 1.00A/m

Date/Time: 12.06.2006 15:35:22
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM850
Frequency: 836.6 MHz; Duty Cycle: 1:7
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/y (transversal) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -3.5765 dB A/m
BWC Factor = 10.8 dB
Location: -5, 15, 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 = -1.29689 dB A/m
BWC Factor = 10.8 dB
Location: -2, 12, 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 = 11.3725 dB A/m
BWC Factor = -0.207 dB
Location: -2, 12, 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 = 26.8302 dB
BWC Factor = -0.207 dB
Location: -2, 12, 363.7 mm

0 dB = 1.00A/m

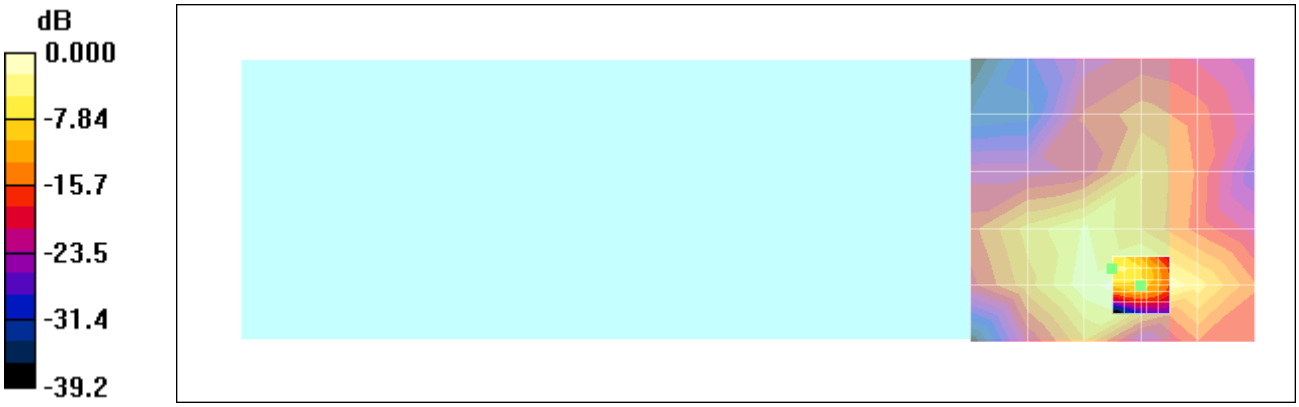
Date/Time: 12.06.2006 13:42:25
Test Laboratory: TCC Nokia, Salo Laboratory
Type: RM-126; Serial: 004400/85/172061/3
Communication System: GSM1900
Frequency: 1880 MHz; Duty Cycle: 1:8.3
Medium: Air; Medium Notes: Not Specified
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: AMB with Coil Section
DASY4 Configuration:
- Probe: AM1DV2 - 1001; Probe Notes:
- ; Calibrated: 22.02.2006
- Sensor-Surface: 0mm (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 19.01.2006
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1004
- Measurement SW: DASY4, V4.7 Build 21; Postprocessing SW: SEMCAD, V1.8 Build 170

Coarse scan/y (transversal) scan 50 x 50 (grid 10) with noise/ABM Signal(x,y,z) (6x6x1):
Measurement grid: dx=10mm, dy=10mm
Cursor:
ABM1 comp = -0.252464 dB A/m
BWC Factor = 10.8 dB
Location: -5, 15, 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 = -1.74228 dB A/m
BWC Factor = 10.8 dB
Location: 0, 12, 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 = 11.2471 dB A/m
BWC Factor = -0.207 dB
Location: 0, 12, 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 = 26.8156 dB
BWC Factor = -0.207 dB
Location: 0, 12, 363.7 mm



0 dB = 1.00A/m

APPENDIX B: MEASUREMENT UNCERTAINTY

Measurement uncertainty budget is currently under evaluation.