HAC T-Coil Signal Test Report

Test report no.:	T-Coil_RM-877_02	**Date of report:**	2013-04-15
Template version:	8.0	**Number of pages:**	30
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Responsible test engineer:	Janne Hirsimäki	**Product contact person:**	Tero Huhtala
Measurements made by:	Janne Hirsimäki, Juha-Matti Varjonen		
Tested devices:	(Hearing aid mode active)		
FCC ID:	PDNB	**IC:**	661R-B
Supplement reports:	RF_RM-877_01, HAC_Photo_RM-877_03		
Testing has been carried out in accordance with:	**ANSI C63.19-2007** 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:

For the contents:

Digitally signed by Janne Hirsimäki
DN: cn=Janne Hirsimäki, o=Nokia, ou, email=janne.hirsimaki@nokia.com, c=FI
Date: 2013.04.15 14:38:58 +03'00'

CONTENTS

1. SUMMARY OF HAC T-COIL SIGNAL TEST REPORT

1.1 Test Details

Period of test	2013-04-10 to 2013-04-11
SN, HW, SW and DUT numbers of tested device	SN: 004402/47/126342/0, HW: 1000, SW: 3032.0000.1312.0000, DUT: 17269
Batteries used in testing	-
State of sample	Prototype unit
Notes	AWF = -5 for GSM, 0 for WCDMA

1.2 Summary of T-Coil Test Results

1.2.1 T-Coil Coupling Field Intensity

1.2.1.1 Axial Field Intensity (z)

Mode	Minimum limit [dB (A/m)]	Result [dB (A/m)]	Verdict
GSM850	-18	10.56	Pass
WCDMA850	-18	8.29	Pass
GSM1900	-18	10.83	Pass
WCDMA1900	-18	9.33	Pass

1.2.1.2 Longitudal Field Intensity (x)

Mode	Minimum limit [dB (A/m)]	Result [dB (A/m)]	Verdict
GSM850	-18	27.88	Pass
WCDMA850	-18	26.86	Pass
GSM1900	-18	28.10	Pass
WCDMA1900	-18	27.14	Pass

1.2.1.3 Transversal Field Intensity (y)

Mode	Minimum limit [dB (A/m)]	Result [dB (A/m)]	Verdict
GSM850	-18	18.13	Pass
WCDMA850	-18	16.96	Pass
GSM1900	-18	18.24	Pass
WCDMA1900	-18	17.50	Pass

1.2.2 Frequency Response at Axial Measurement Point

Mode	Verdict
GSM850	Pass
WCDMA850	Pass
GSM1900	Pass
WCDMA1900	Pass

1.2.3 Signal Quality

Mode	Minimum limit [dB]				Minimum result [dB]	Category assessment
	T1	T2	T3	T4		
GSM850	0	10	20	30	31.07	T4
WCDMA850	0	10	20	30	59.37	T4
GSM1900	0	10	20	30	36.76	T4
WCDMA1900	0	10	20	30	60.06	T4

1.2.4 Overall HAC rating of the tested device

Mode	RF emissions category at T-coil axial measurement point (E- and H-fields)*	Category assessment, T-Coil signal quality	Combined HAC category of the tested device
GSM850	M3	T4	M3/T4
WCDMA850	M4	T4	
GSM1900	M3	T4	
WCDMA1900	M4	T4	

*See separate HAC RF report

2. DESCRIPTION OF THE DEVICE UNDER TEST (DUT)

Air-interface	Band (MHz)	Type	C63.19/ tested	Simultaneous Transmissions Note: not to be tested	Concurrent single transmission	Reduced power 20.19 (c) (1)	Voice Over Digital Transport (Data)
GSM	850	VO	Yes	Yes BT, WLAN	Yes: WCDMA Rated	No	NA
	1900				GPRS/EDGE, BT, WLAN Not rated	No	NA
	GPRS/EDGE	DT	NA	Yes BT, WLAN	Yes: * see note	NA*	YES
WCDMA	850 1900	V/D	Yes	Yes BT, WLAN	Yes: GSM Rated	No	YES
LTE	700 850 1700/2100 1900	DT	NA	Yes BT, WLAN	Yes: GSM, WCDMA Rated	NA*	YES
BT	2450	DT	NA	Yes GSM, GPRS/EDGE, WCDMA, LTE	NA*	NA*	NO
WLAN	2450 5000	DT	NA	Yes GSM, GPRS/EDGE, WCDMA, LTE	NA*	NA*	YES

VO Voice CMRS/PSTN Service Only
V/D Voice CMRS/PSTN and Data Service
DT Digital Transport

*HAC Rating was not based on concurrent voice and data modes, Non current mode was found to represent worst case rating for both M and T rating.

Outside of USA the transmitter of the device is capable of operating also in 900MHz, 1800MHz and 2100MHz bands, which are not part of this filing.

This device also has the capability of operation in WCDMA1700/2100, but this mode has been disabled in this variant of the product.

2.1 Picture Of The Device

See separate report HAC_Photo_RM-877_03.

3. TEST CONDITIONS

3.1 Temperature and Humidity

Ambient temperature (°C):	21.0 to 23.0
Ambient humidity (RH %):	40 to 60

3.2 Device Control and Parameters

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. Speech coding was processed with EFR speech codec for GSM and with AMR 12.2 kbps for WCDMA.

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

T-Coil mode was switched on from the device user interface, volume setting was set to maximum and microphone was muted.

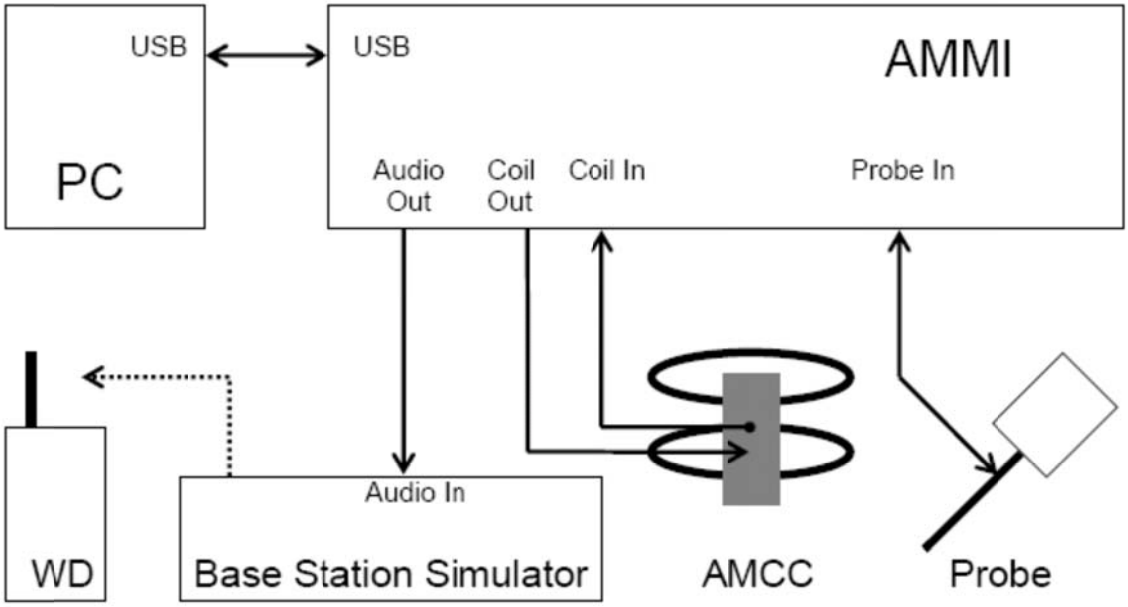
In all operating bands the measurements were performed on middle channel.

4. DESCRIPTION OF THE TEST EQUIPMENT

4.1 Measurement System and Components

The measurements were performed using an automated near-field scanning system, DASY52 version 52.6, 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
R&S CMU200 Radio Communication Test Set	101111	-	-
AM1DV3 Audio Magnetic Probe	3057	12 months	2014-01
AMMI Audio Magnetic Measurement Instrument	1002	-	-
AMCC Helmholtz Audio Magnetic Calibration Coil	1004	-	-

4.1.1 Audio Magnetic Probe AM1DV3

Construction	Fully RF shielded metal construction (RF sensitivity < -100dB)
System calibration	Calibrated using Helmholtz coil according to manufacturers instructions
Frequency range	0.1 – 20 kHz (HOX! test signal is limited to required BW of 300 to 3000 Hz, ANSI C63.19)
Sensitivity	< -50 dB A/m
Dimensions	Overall length: 290 mm; Tip diameter: 6 mm

4.1.2 Audio Magnetic Measurement Instrument AMMI

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

4.1.3 Audio Magnetic Calibration Coil AMCC

Dimensions	370 x 370 x 196 mm (ANSI-C63.19 compliant)

4.1.4 Device Holder

The device holder and Test Arch are manufactured by Speag (www.speag.com). Test arch is used for all tests i.e. for both validation testing and device testing. The holder and test arch conforms to the requirements of ANSI C63.19.

The SPEAG device holder (see Section 5.1) was used to position the test device in all tests.

4.2 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.

R&S CMU200 audio codec and SPEAG AMMI audio paths (gain) were calibrated according to manufacturer's instructions.

5. DESCRIPTION OF THE TEST PROCEDURE

5.1 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

5.2 Test Positions

The device was positioned such that Device Reference Plane was touching the bottom of the Test Arch. The acoustic 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 acoustic output.

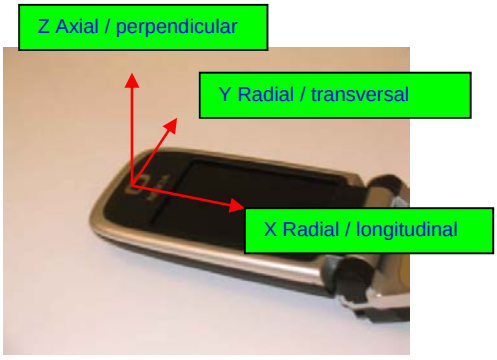


Photo of the device positioned under Test Arch and coordinate system (The EUT in picture is generic phone sample and does not represent the actual equipment under test)

5.3 T-Coil Scan Procedures and Used Test Signals

Manufacturer can either define measurement locations for WD categorization or optimum locations can be found using following procedure: First, large scans in all measurement orientations with dense grid step size are made to find locations of optimum signal. Point scans are made in these locations.

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 signal (300...3000Hz) is used during scans and frequency response measurement to ensure proper operation of WD vocoder and audio enhancement algorithms.

In final measurement sine signal is used to determine signal strength @ 1kHz. Both signal (ABM1) and undesired audio noise (ABM2) are measured consequently to enable determination of signal to noise ratio (SNR).

5.4 T-Coil Requirements and Category Limits

RF Emissions

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

Axial, Longitudal and Transversal Field Intensity

T-Coil signal magnetic field shall be ≥-18dB(A/m) at 1 kHz, in 1/3 octave band filter for all orientations.

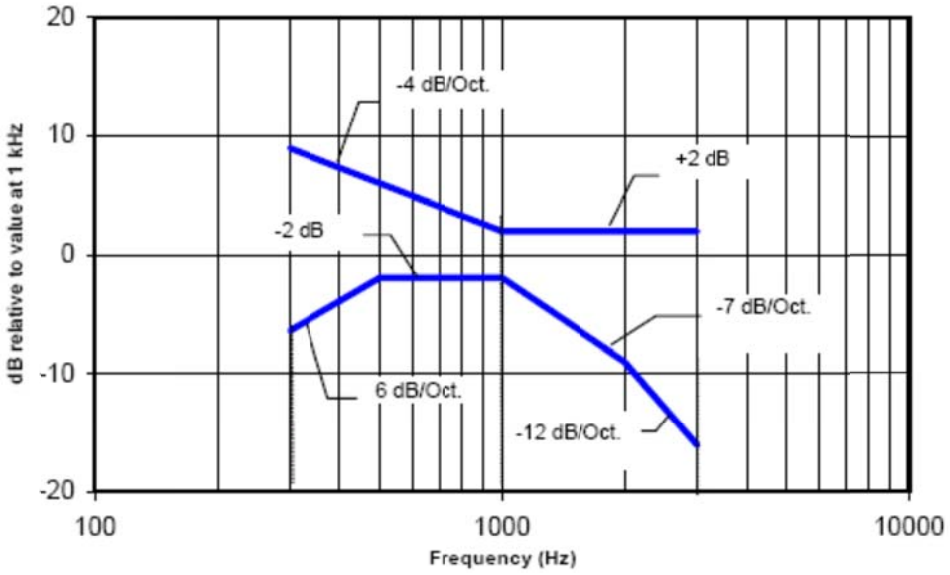
Signal Quality

The worst result of three T-Coil signal measurements is used to determine the T-Coil mode category:

Category	T1	T2	T3	T4
Limits for Signal Quality	0	10	20	30

Frequency Response

Frequency response of the axial component must be between the limits pointed by frequency curves below:



Magnetic field frequency response for devices with a field that exceeds -15dB (A/m) @ 1kHz.

6. MEASUREMENT UNCERTAINTY

Source of Uncertainty	Tolerance ±%	Probability Distribution	Div.	c ABM1	c ABM2	Standard Uncertainty ±%, ABM1	Standard Uncertainty ±%, ABM2
PROBE SENSITIVITY							
Reference level	3.0	N	1.0	1	1	3.0	3.0
AMCC geometry	0.4	R	√3	1	1	0.2	0.2
AMCC current	0.6	R	√3	1	1	0.4	0.4
Probe positioning during calibration	0.1	R	√3	1	1	0.1	0.1
Noise contribution	0.7	R	√3	0.0143	1	0.0	0.4
Frequency slope	5.9	R	√3	0.1	1.0	0.3	3.5
PROBE SYSTEM							
Repeatability / Drift	1.0	R	√3	1	1	0.6	0.6
Linearity / Dynamic range	0.6	R	√3	1	1	0.4	0.4
Acoustic noise	1.0	R	√3	0.1	1	0.1	0.6
Probe angle	2.3	R	√3	1	1	1.4	1.4
Spectral processing	0.9	R	√3	1	1	0.5	0.5
Integration time	0.6	N	1.0	1	5	0.6	3.0
Field disturbation	0.2	R	√3	1	1	0.1	0.1
TEST SIGNAL							
Reference signal spectral response	0.6	R	√3	0	1	0.0	0.4
POSITIONING							
Probe positioning	1.9	R	√3	1	1	1.1	1.1
Phantom thickness	0.9	R	√3	1	1	0.5	0.5
EUT Positioning	1.9	R	√3	1	1	1.1	1.1
EXTERNAL CONTRIBUTIONS							
RF interference	0.0	R	√3	1	1	0.0	0.0
Test signal variation	2.0	R	√3	1	1	1.2	1.2
COMBINED UNCERTAINTY							
Combined Standard Uncertainty (ABM field)						4.1	6.1
Expanded Standard Uncertainty [%]						**8.1**	**12.3**

7. RESULTS

Measurement location 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 as the center of the earpiece. Maximum values for axial field are listed for informative purposes although results at earpiece center were used in evaluating T-category of the device.

GSM850 results

	Longitudinal (x)		Transversal (y)		Axial (z)			
					Max signal		**Earpiece**	
	x	y	x	y	x	y	x	y
Measurement location (x,y) [mm]	5.5	15.5	-2.0	8.5	-1.0	15.5	0.0	0.0
Signal strength [dB A/m]	27.88		18.13		27.97		10.56	
ABM2 [dB A/m]	-13.80		-38.02		-20.84		-20.51	
Signal quality [dB]	41.68		56.15		48.81		31.07	
Ambient background noise at point (0,0) ABM [dB A/m]	-54.48		-54.03		-54.04		-54.04	

WCDMA850 results

	Longitudinal (x)		Transversal (y)		Axial (z)			
					Max signal		**Earpiece**	
	x	y	x	y	x	y	x	y
Measurement location (x,y) [mm]	5.0	15.5	-2.0	8.5	-1.0	15.5	0.0	0.0
Signal strength [dB A/m]	26.86		16.96		27.56		8.29	
ABM2 [dB A/m]	-39.56		-49.81		-40.95		-51.08	
Signal quality [dB]	66.42		66.77		68.51		59.37	
Ambient background noise at point (0,0) ABM [dB A/m]	-54.48		-54.03		-54.04		-54.04	

GSM1900 results

	Longitudinal (x)		Transversal (y)		Axial (z)			
					Max signal		**Earpiece**	
	x	y	x	y	x	y	x	y
Measurement location (x,y) [mm]	5.5	15.5	-2.0	8.5	-1.0	15.5	0.0	0.0
Signal strength [dB A/m]	28.10		18.24		28.28		10.83	
ABM2 [dB A/m]	-19.04		-42.68		-26.10		-25.93	
Signal quality [dB]	47.14		60.92		54.38		36.76	
Ambient background noise at point (0,0) ABM [dB A/m]	-54.48		-54.03		-54.04		-54.04	

WCDMA1900 results

	Longitudinal (x)		Transversal (y)		Axial (z)			
					Max signal		**Earpiece**	
	x	y	x	y	x	y	x	y
Measurement location (x,y) [mm]	5.5	15.5	-2.0	8.5	-1.0	15.5	0.0	0.0
Signal strength [dB A/m]	27.14		17.50		27.60		9.33	
ABM2 [dB A/m]	-39.50		-49.58		-41.55		-50.73	
Signal quality [dB]	66.64		67.08		68.61		60.06	
Ambient background noise at point (0,0) ABM [dB A/m]	-54.48		-54.03		-54.04		-54.04	

Plots of the measurement scans are presented in Appendix A.

APPENDIX A: MEASUREMENT SCANS

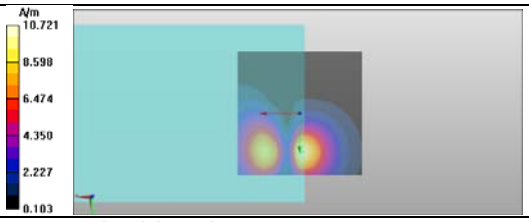
Axial Measurements, GSM850

Date/Time: 2013-04-10 16:03:22 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM850 Frequency: 836.6 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM850/General Scans/z (axial) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.60 dBA/m
BWC Factor = 10.80 dB
Location: -1, 15.5, 3.7 mm

T-Coil GSM850/General Scans/point scan at best SNR(z)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 48.81 dB
ABM1 comp = 27.97 dBA/m
BWC Factor = 0.0023 dB
Location: -1, 15.5, 3.7 mm

T-Coil GSM850/General Scans/point scan at ACOUSTIC OUTPUT location/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 31.07 dB
ABM1 comp = 10.56 dBA/m
BWC Factor = 0.0023 dB
Location: 0, 0, 3.7 mm



T-Coil/Background Noise/z (axial) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.04 dBA/m
Location: 0, 0, 13 mm

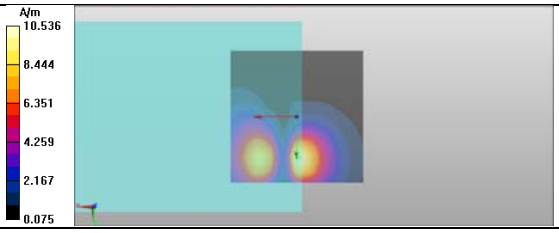
Axial Measurements, WCDMA850

Date/Time: 2013-04-11 07:31:59 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA850 Frequency: 835 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil WCDMA5/General Scans/z (axial) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.45 dBA/m
BWC Factor = 10.80 dB
Location: -1, 15.5, 3.7 mm

T-Coil WCDMA5/General Scans/point scan at best SNR(z)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 68.51 dB
ABM1 comp = 27.56 dBA/m
BWC Factor = 0.0023 dB
Location: -1, 15.5, 3.7 mm

T-Coil WCDMA5/General Scans/point scan at ACOUSTIC OUTPUT location/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 59.37 dB
ABM1 comp = 8.29 dBA/m
BWC Factor = 0.0023 dB
Location: 0, 0, 3.7 mm



T-Coil/Background Noise/z (axial) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.04 dBA/m
Location: 0, 0, 13 mm

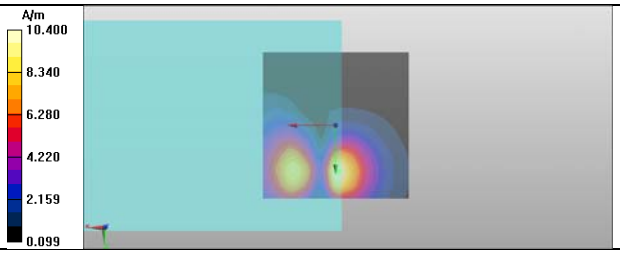
Axial Measurements, GSM1900

Date/Time: 2013-04-10 14:11:09 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM1900 Frequency: 1880 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM1900/General Scans/z (axial) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.34 dBA/m
BWC Factor = 10.80 dB
Location: -1, 15.5, 3.7 mm

T-Coil GSM1900/General Scans/point scan at best SNR(z)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 54.38 dB
ABM1 comp = 28.28 dBA/m
BWC Factor = 0.0044 dB
Location: -1, 15.5, 3.7 mm

T-Coil GSM1900/General Scans/point scan at ACOUSTIC OUTPUT location/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 36.76 dB
ABM1 comp = 10.83 dBA/m
BWC Factor = 0.0044 dB
Location: 0, 0, 3.7 mm



T-Coil/Background Noise/z (axial) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.04 dBA/m
Location: 0, 0, 13 mm

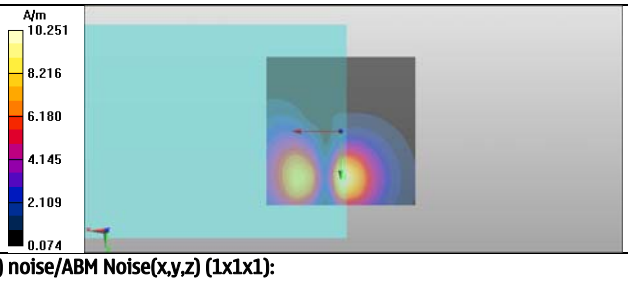
Axial Measurements, WCDMA1900

Date/Time: 2013-04-10 18:18:46 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA1900 Frequency: 1880 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil WCDMA2/General Scans/z (axial) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.22 dBA/m
BWC Factor = 10.80 dB
Location: -1, 15.5, 3.7 mm

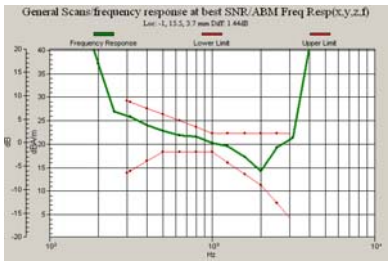
T-Coil WCDMA2/General Scans/point scan at best SNR(z)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 68.61 dB
ABM1 comp = 27.60 dBA/m
BWC Factor = 0.0044 dB
Location: -1, 15.5, 3.7 mm

T-Coil WCDMA2/General Scans/point scan at ACOUSTIC OUTPUT location/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 60.06 dB
ABM1 comp = 9.33 dBA/m
BWC Factor = 0.0044 dB
Location: 0, 0, 3.7 mm

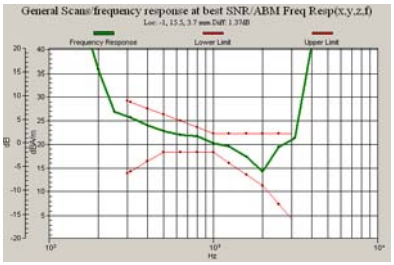


T-Coil/Background Noise/z (axial) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.04 dBA/m
Location: 0, 0, 13 mm

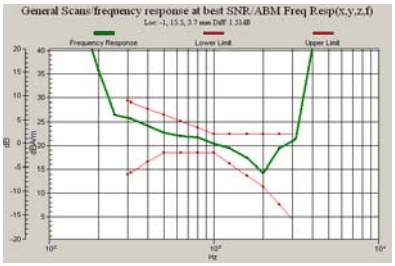
Frequency response in the point of maximum signal strength (axial)



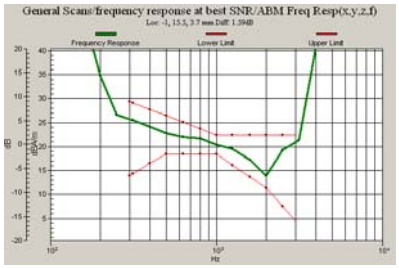
GSM850



GSM1900

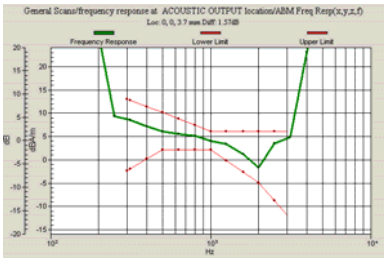


WCDMA850

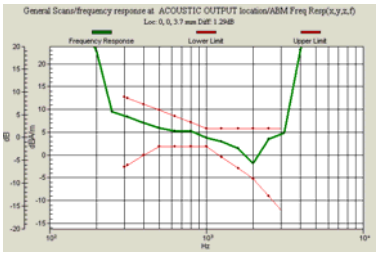


WCDMA1900

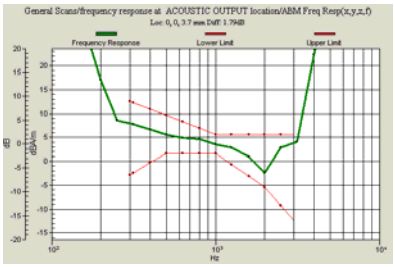
Frequency response over earpiece, point 0,0 (axial)



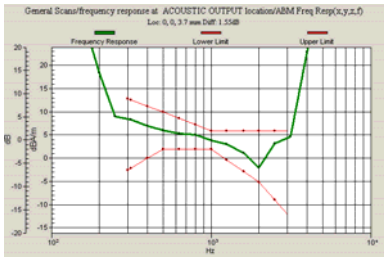
GSM850



GSM1900



WCDMA850



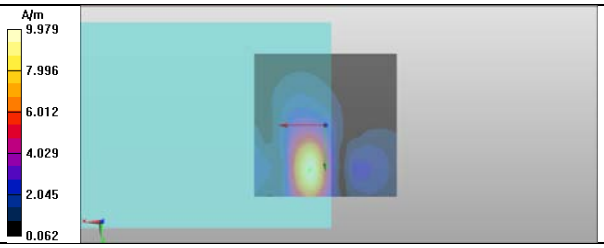
WCDMA1900

Longitudinal Measurements, GSM850

Date/Time: 2013-04-10 16:24:21 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM850 Frequency: 836.6 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM850/General Scans/x (longitudinal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 19.98 dBA/m
BWC Factor = 10.80 dB
Location: 5.5, 15.5, 3.7 mm

T-Coil GSM850/General Scans/point scan (x)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 41.68 dB
ABM1 comp = 27.88 dBA/m
BWC Factor = 0.0023 dB
Location: 5.5, 15.5, 3.7 mm



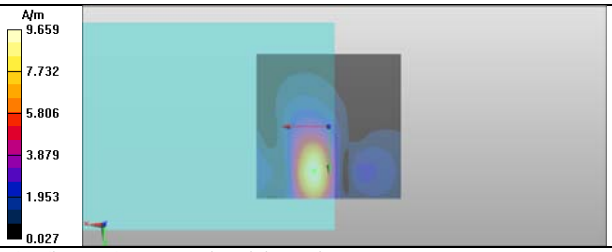
T-Coil/Background Noise/x (longitudinal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.48 dBA/m
Location: 0, 0, 13 mm

Longitudinal Measurements, WCDMA850

Date/Time: 2013-04-11 07:53:08 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA850 Frequency: 835 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil WCDMA5/General Scans/x (longitudinal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 19.70 dBA/m
BWC Factor = 10.80 dB
Location: 5, 15.5, 3.7 mm

T-Coil WCDMA5/General Scans/point scan (x)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 66.42 dB
ABM1 comp = 26.86 dBA/m
BWC Factor = 0.0023 dB
Location: 5, 15.5, 3.7 mm



T-Coil/Background Noise/x (longitudinal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.48 dBA/m
Location: 0, 0, 13 mm

Longitudinal Measurements, GSM1900

Date/Time: 2013-04-10 14:32:02 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM1900 Frequency: 1880 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM1900/General Scans/x (longitudinal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.02 dBA/m
BWC Factor = 10.80 dB
Location: 5.5, 15.5, 3.7 mm

T-Coil GSM1900/General Scans/point scan (x)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 47.14 dB
ABM1 comp = 28.10 dBA/m
BWC Factor = 0.0044 dB
Location: 5.5, 15.5, 3.7 mm

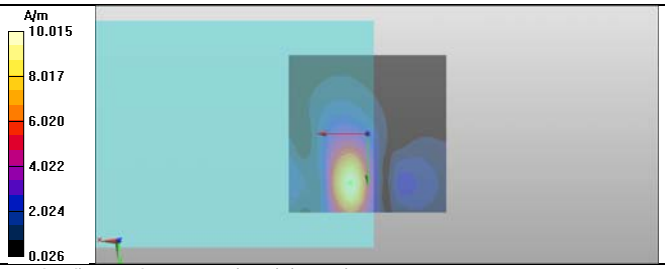
T-Coil/Background Noise/x (longitudinal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.48 dBA/m
Location: 0, 0, 13 mm

Longitudinal Measurements, WCDMA1900

Date/Time: 2013-04-10 18:39:51 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA1900 Frequency: 1880 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil WCDMA2/General Scans/x (longitudinal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 20.01 dBA/m
BWC Factor = 10.80 dB
Location: 5.5, 15.5, 3.7 mm

T-Coil WCDMA2/General Scans/point scan (x)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 66.64 dB
ABM1 comp = 27.14 dBA/m
BWC Factor = 0.0044 dB
Location: 5.5, 15.5, 3.7 mm



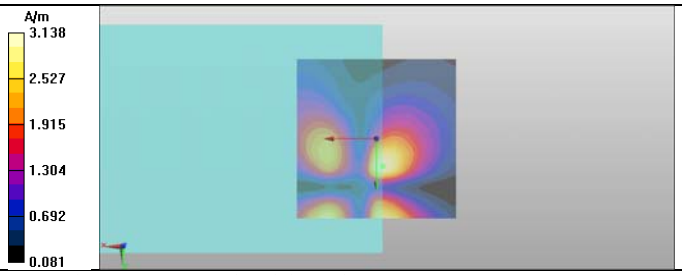
T-Coil/Background Noise/x (longitudinal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.48 dBA/m
Location: 0, 0, 13 mm

Transversal Measurements, GSM850

Date/Time: 2013-04-10 16:45:45 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM850 Frequency: 836.6 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM850/General Scans/y (transversal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 9.93 dBA/m
BWC Factor = 10.80 dB
Location: -2, 8.5, 3.7 mm

T-Coil GSM850/General Scans/point scan (y)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 56.15 dB
ABM1 comp = 18.13 dBA/m
BWC Factor = 0.0023 dB
Location: -2, 8.5, 3.7 mm



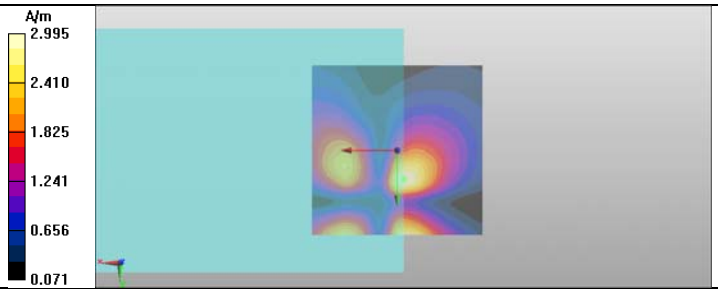
T-Coil/Background Noise/y (transversal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.03 dBA/m
Location: 0, 0, 13 mm

Transversal Measurements, WCDMA850

Date/Time: 2013-04-11 08:14:51 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA850 Frequency: 835 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil WCDMA5/General Scans/y (transversal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 9.53 dBA/m
BWC Factor = 10.80 dB
Location: -2, 8.5, 3.7 mm

T-Coil WCDMA5/General Scans/point scan (y)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 66.77 dB
ABM1 comp = 16.96 dBA/m
BWC Factor = 0.0023 dB
Location: -2, 8.5, 3.7 mm



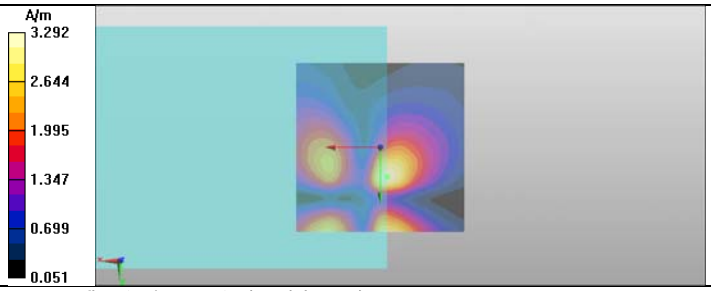
T-Coil/Background Noise/y (transversal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.03 dBA/m
Location: 0, 0, 13 mm

Transversal Measurements, GSM1900

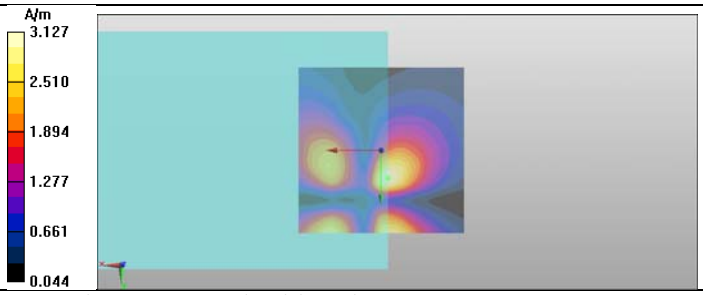
Date/Time: 2013-04-10 14:53:22 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: GSM1900 Frequency: 1880 MHz; Duty Cycle: 1:8.30042 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)

T-Coil GSM1900/General Scans/y (transversal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1):
Interpolated grid: dx=1.000 mm, dy=1.000 mm
Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav
Output Gain: 73.62
Device Reference Point: 0, 0, -6.3 mm
ABM1 = 10.35 dBA/m
BWC Factor = 10.80 dB
Location: -2, 8.5, 3.7 mm

T-Coil GSM1900/General Scans/point scan (y)/ABM SNR(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: 1 kHz Sine
Output Gain: 9.99
Device Reference Point: 0, 0, -6.3 mm
ABM1/ABM2 = 60.92 dB
ABM1 comp = 18.24 dBA/m
BWC Factor = 0.0044 dB
Location: -2, 8.5, 3.7 mm



T-Coil/Background Noise/y (transversal) noise/ABM Noise(x,y,z) (1x1x1):
Measurement grid: dx=10mm, dy=10mm
Signal Type: Off
Output Gain: 0
Device Reference Point: 0, 0, -6.3 mm
ABM2 = -54.03 dBA/m
Location: 0, 0, 13 mm

Transversal Measurements, WCDMA1900	
Date/Time: 2013-04-10 19:15:59 Test Laboratory: TCC Nokia **Type: RM-877; Serial: 004402/47/126342/0** Communication System: WCDMA1900 Frequency: 1880 MHz; Duty Cycle: 1:1 Medium: Air; Medium Notes: - Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1 kg/m^3 Phantom section: TCoil Section	DASY Configuration: - Probe: AM1DV3 - 3057 - ; Calibrated: 2013-01-10 - Sensor-Surface: 0mm (Fix Surface) - Electronics: DAE4 Sn1309; Calibrated: 2013-01-11 - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; - Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.6.8 (7028)
T-Coil WCDMA2/General Scans/y (transversal) coarse scan/ABM Interpolated Signal(x,y,z) (101x101x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm Signal Type: Audio File (.wav) 48k_voice_300-3000_2s.wav Output Gain: 73.62 Device Reference Point: 0, 0, -6.3 mm ABM1 = 9.90 dBA/m BWC Factor = 10.80 dB Location: -2, 8.5, 3.7 mm	
T-Coil WCDMA2/General Scans/point scan (y)/ABM SNR(x,y,z) (1x1x1): Measurement grid: dx=10mm, dy=10mm Signal Type: 1 kHz Sine Output Gain: 9.99 Device Reference Point: 0, 0, -6.3 mm ABM1/ABM2 = 67.08 dB ABM1 comp = 17.50 dBA/m BWC Factor = 0.0044 dB Location: -2, 8.5, 3.7 mm	
	
T-Coil/Background Noise/y (transversal) noise/ABM Noise(x,y,z) (1x1x1): Measurement grid: dx=10mm, dy=10mm Signal Type: Off Output Gain: 0 Device Reference Point: 0, 0, -6.3 mm ABM2 = -54.03 dBA/m Location: 0, 0, 13 mm	

APPENDIX B: AUDIO MAGNETIC PROBE AM1DV3 CALIBRATION DOCUMENT

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 108

Client **Nokia Salo TCC**

Certificate No: AM1DV3-3057_Jan13

CALIBRATION CERTIFICATE

Object	AM1DV3 - SN: 3057
Calibration procedure(s)	QA CAL-24.v3 Calibration procedure for AM1D magnetic field probes and TMFS in the audio range
Calibration date:	January 10, 2013

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	02-Oct-12 (No:12728)	Oct-13
Reference Probe AM1DV2	SN: 1008	10-Jan-13 (No. AM1D-1008_Jan13)	Jan-14
DAE4	SN: 781	29-May-12 (No. DAE4-781_May12)	May-13

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
AMCC	1050	12-Oct-11 (in house check Oct-11)	Oct-13
AMMI Audio Measuring Instrument	1062	26-Sep-12 (in house check Sep-12)	Sep-14

	Name	Function	Signature
Calibrated by:	Dimce Iliev	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: January 10, 2013