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HAC RF Emissions
R&D Test Report

Test report no.:	Salo_HAC_0537_02	**Date of report:**	2005-09-22
Template version:	1.0	**Number of pages:**	22
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Responsible test engineer:	Virpi Tuominen	**Product contact person:**	Shi Hailun
Measurements made by:	Janne Hirsimäki		
Tested devices:	RH-74 (Hearing aid mode)		
FCC ID:	QTLRH-74	**IC:**	661AB-RH74
Supplement reports:	-		
Testing has been carried out in accordance with:	**ANSI C63.19-2005** 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:

Virpi Tuominen
Senior Design Engineer

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SUMMARY OF HAC RF EMISSION TEST REPORT

1.1 Test Details

Period of test	2005-08-24 to 2005-08-25
SN, HW, SW and DUT numbers of tested device	SN: 001004/00/187698/7, HW: 0404, SW: 05w07_05w29.1, DUT: 10728
Batteries used in testing	BL-5B, DUT: 10733, 10734
State of sample	Prototype unit
Notes	-

1.2 Maximum Results

The maximum measured HAC RF emissions values and categories for electric and magnetic fields are given in section 1.2.1 and 1.2.2 respectively.

1.2.1 Electric field measurements

Mode	Limit of E-field max. value in category M3 [V/m]	Maximum E-field value [V/m]	Category
GSM1900, Hearing aid mode	84.1	75.6	M3

1.2.2 Magnetic field measurements

Mode	Limit of H-field max. value in category M3 [A/m]	Maximum H-field value [A/m]	Category
GSM1900, Hearing aid mode	0.25	0.15	M3

1.2.3 Overall RF emissions category of the tested device

Mode	Combined category (E- and H-fields)	Pass / Fail
GSM1900	**M3(-5dB)**	PASSED

1.2.4 Maximum Drift

Maximum drift during measurements	-0.062 dB

1.2.5 Measurement Uncertainty

Extended Uncertainty (k=2) 95%, E-field	14.7 %
Extended Uncertainty (k=2) 95%, H-field	10.9 %

1.3 Description of THE Device under test (DUT)

Modes and Bands of Operation	GSM 850 / 1900	GPRS 850 / 1900
Modulation Mode	GMSK	GMSK
Duty Cycle	1/8	1/8 or 2/8
Transmitter Frequency Range (MHz)	824 – 849 1850 - 1910	824 – 849 1850 - 1910

1.4 Picture of Device

Device, flip closed

Device, flip open

2. TEST CONDITIONS

2.1 Temperature and Humidity

Ambient temperature (°C):	22.0 to 23.0
Ambient humidity (RH %):	40 to 60

2.2 Test Signal, Frequencies, and Output Power

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.

For all tests Hearing aid mode was switched on and the device output power was set to maximum power level; a fully charged battery was used for every test sequence.

1900MHz band was measured and the measurements were performed on low, middle and high channels.

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 4.5, manufactured by Schmid & Partner Engineering AG (SPEAG) in Switzerland. The following table lists calibration dates of SPEAG components:

Test Equipment	Serial Number	Calibration interval	Calibration expiry
DAE V1	388	12 months	2006-01
E-field Probe ER3DV6	2333	12 months	2006-01
H-field Probe H3DV6	6053	12 months	2006-01
Dipole Validation Kit, CD1880V3	1003	24 months	2007-02

Calibration certificate of the dipole is shown in Appendix D.

Additional test equipment used in testing and validation:

Test Equipment	Model	Serial Number	Calibration interval	Calibration expiry
Signal Generator	SML03	101265	12 months	2005-09
Signal Generator	E4433B	GB40050754	12 months	2005-09
Amplifier	ZHL-42 (SMA)	N072095-5	12 months	2005-07
Power Meter	NRVS	849305/028	12 months	2005-07
Power Sensor	NRV-Z32	839176/020	12 months	2005-07
Radio Communication Tester	CMU 200	101111	-	-

3.1.1 Isotropic E-field probe ER3DV6, SN: 2333

Construction
One dipole parallel, two dipoles normal to probe axis
Built-in shielding against static charges
PEEK enclosure material

Calibration
Calibration certificate in Appendix C

Frequency
In air 100 MHz to >6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)

Directivity
± 0.2 dB in air (rotation around probe axis)
± 0.4 dB in air (rotation normal to probe axis)

Dynamic Range
2 V/m to > 1000 V/m; Linearity: ± 0.2 dB

Dimensions
Overall length: 330 mm
Tip length: 16 mm
Body diameter: 12 mm
Tip diameter: 8 mm
Distance from probe tip to nearest point of dipole: 1.25 mm

Application
Generel near-field measurements up to 6 GHz
Field component measurements
Fast automatic scanning in phantoms

3.1.2 Isotropic H-field probe H3DV6, SN: 6053

Construction	Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges PEEK enclosure material
Calibration	Calibration certificate in Appendix C
Frequency	200 MHz to 3 GHz; Output linearized (absolute accuracy ±6.0%, k=2)
Directivity	± 0.25 dB (spherical isotropy error)
Dynamic Range	10 mA/m to 2 A/m at 1 GHz
Dimensions	Overall length: 330 mm Tip length: 40 mm Body diameter: 12 mm Tip diameter: 6 mm Distance from probe tip to nearest point of dipole: 1.1 mm
Application	Generel magnetic near-field measurements up to 3 GHz Field component measurements, surface current measurements Measurements in air or liquids, low interaction

3.2 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 5.1) was used to position the test device in all tests whilst a dipole holder was used to position the validation dipoles in the test arch.

3.2.1 Validation of the System

The manufacturer calibrates the probes annually. Validation measurements are made regularly using the dipole validation kit. The power level used by manufacturer in dipole calibration, usually 100mW, is supplied to the dipole antenna. The antenna is scanned at 1.0cm distance between top surface of the dipole and calibration point of the probe. The verification results are given in the table below.

System validation, E-field and H-field

f (MHz)	Description	E-field (V/m)	H-field (V/m)
1880	Reference result	133.9	0.444
	±10% window	120.5 – 147.3	0.400 – 0.488
	2005-08-24	134.8	0.444

Plots of the Validation scanss are given in Appendix A.

4. DESCRIPTION OF THE TEST PROCEDURE

4.1 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 positioned under Test Arch.

Device holder and Test Arch supplied by SPEAG

4.2 Test Positions

4.2.1 Scan area centered at the speaker output

The device was positioned such that Device Reference level was touching the bottom of the Test Arch. The scan is centered at the speaker output by aligning the speaker output with the intersection of the Test Arch's middle bar and dielectric wire.

Photo of the device positioned under Test Arch

4.2.2 Scan area centered at the maximum magnetic T-coil coupling

Scanning centered at the maximum magnetic T-coil coupling was not applicable for the tested device.

4.3 Scan Procedures

Near field scans of 5cm x 5cm were used for determination of the field distribution. Measurement plane distance from WD reference plane is 1cm. Scans were performed for both E- and H-field using appropriate probe. DASY software divides detected values into 3 x 3 subgrids as described in the C63.19 standard.

4.4 Probe Modulation Factor

All raw measurements in DASY4 system are RMS values. The measurement software then applies Probe Modulation Factor (PMF) to convert readings to “slot averaged” peak values as described in the C63.19 standard. This Probe Modulation Factor was assessed as described in standard with following results:

1880 MHZ	E-field [V/m]	H-field [A/m]	E-field PMF	H-field PMF
GSM	23.8	0.096	2.85	2.56
CW	67.9	0.247		

4.5 Sub-grid Exclusion

The measurement grid defined in C63.19 consists of 9 evenly sized blocks, which are used to define permissible exclusion areas. For both E- and H-field measurements three contiguous blocks may be excluded from the measurements except center block may never

be excluded. There must be 4 blocks left that are common for both E- and H-field measurements, so maximum of 5 different blocks can be excluded (e.g. 3 blocks excluded from E-field and 2 blocks from H-field).

4.6 Category Limits

From remaining maximum values after exclusion process, Hearing Aid M-category is defined according to the category limits of C63.19.

Category	AWF (dB)	Limits for E-Field Emissions (V/m)	Limits for H-Field Emissions (A/m)
M1	0	199.5 - 354.8	0.6 - 1.07
	-5	149.6 - 266.1	0.45 - 0.8
M2	0	112.2 - 199.5	0.34 - 0.6
	-5	84.1 - 149.6	0.25 - 0.45
M3	**0**	**63.1 - 112.2**	**0.19 - 0.34**
	-5	**47.3 - 84.1**	**0.15 - 0.25**
M4	0	<63.1	<0.19
	-5	<47.3	<0.15

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5. MEASUREMENT UNCERTAINTY

Source of Uncertainty	Tolerance ±%	Probability Distribution	Div.	ci E	ci H	Standard Uncertainty ±%, E	Standard Uncertainty ±%, H	Remark
Measurement System								
Probe Calibration	5.1	N	1	1	1	5.1	5.1	
Axial Isotropy	4.7	R	√3	1	1	2.7	2.7	
Sensor Displacement	16.5	R	√3	1	0.145	9.5	1.4	
Boundary Effect	2.4	R	√3	1	1	1.4	1.4	
Linearity	4.7	R	√3	1	1	2.7	2.7	SAR
Scaling to Peak Envelope Power	2.0	R	√3	1	1	1.2	1.2	
System Detection Limit	1.0	R	√3	1	1	0.6	0.6	
Readout Electronics	0.3	N	1	1	1	0.3	0.3	SAR
Response Time	0.8	R	√3	1	1	0.5	0.5	
Integration Time	2.6	R	√3	1	1	1.5	1.5	SAR
RF Ambient Conditions	3.0	R	√3	1	1	1.7	1.7	SAR
RF Reflections	12.0	R	√3	1	1	6.9	6.9	
Probe Positioner	1.2	R	√3	1	0.67	0.7	0.5	
Probe Positioning	4.7	R	√3	1	0.67	2.7	1.8	
Extrapolation and Interpolation	1.0	R	√3	1	1	0.6	0.6	SAR
Test Sample Related								
Decice Positioning Vertical	4.7	R	√3	1	0.67	2.7	1.8	
Device Positioning Lateral	1.0	R	√3	1	1	0.6	0.6	
Device Holder and Phantom	2.4	R	√3	1	1	1.4	1.4	
Power Drift	5.0	R	√3	1	1	2.9	2.9	SAR
Phantom and Setup Related								
Phantom Thickness	2.4	R	√3	1	0.67	1.4	0.9	
Combined Standard Uncertainty						**14.7**	**10.9**	
Expanded Uncertainty on Power						**29.4**	**21.8**	
Expanded Uncertainty on Field						**14.7**	**10.9**	

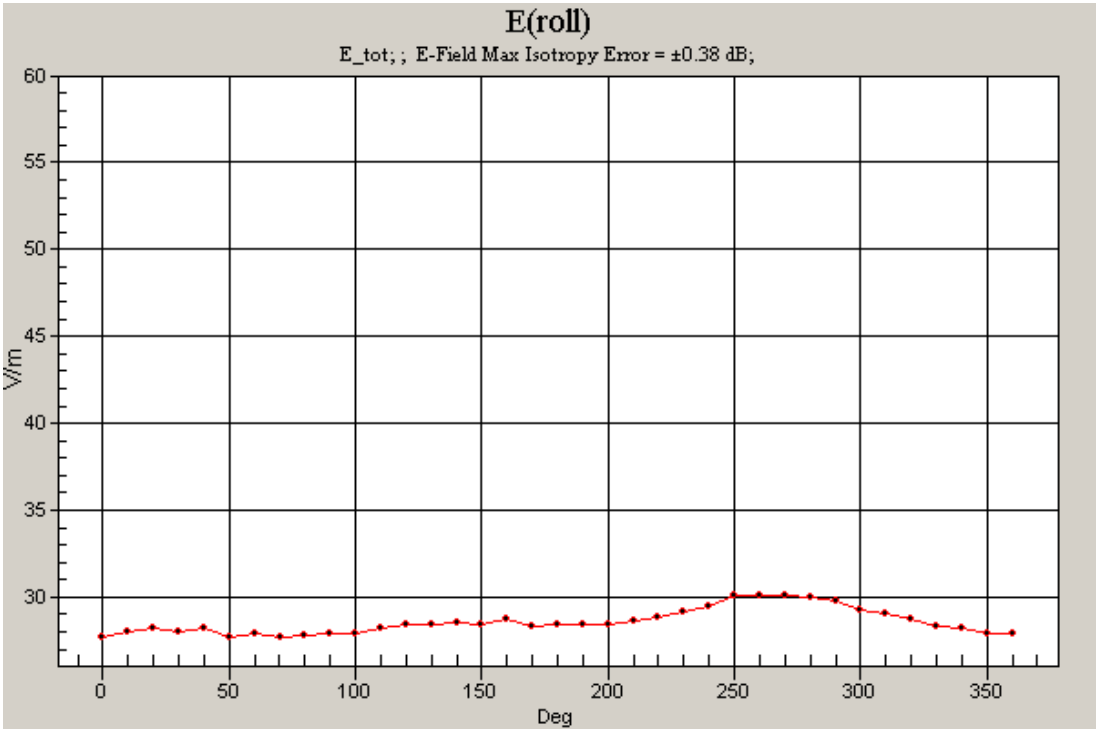
6. RESULTS

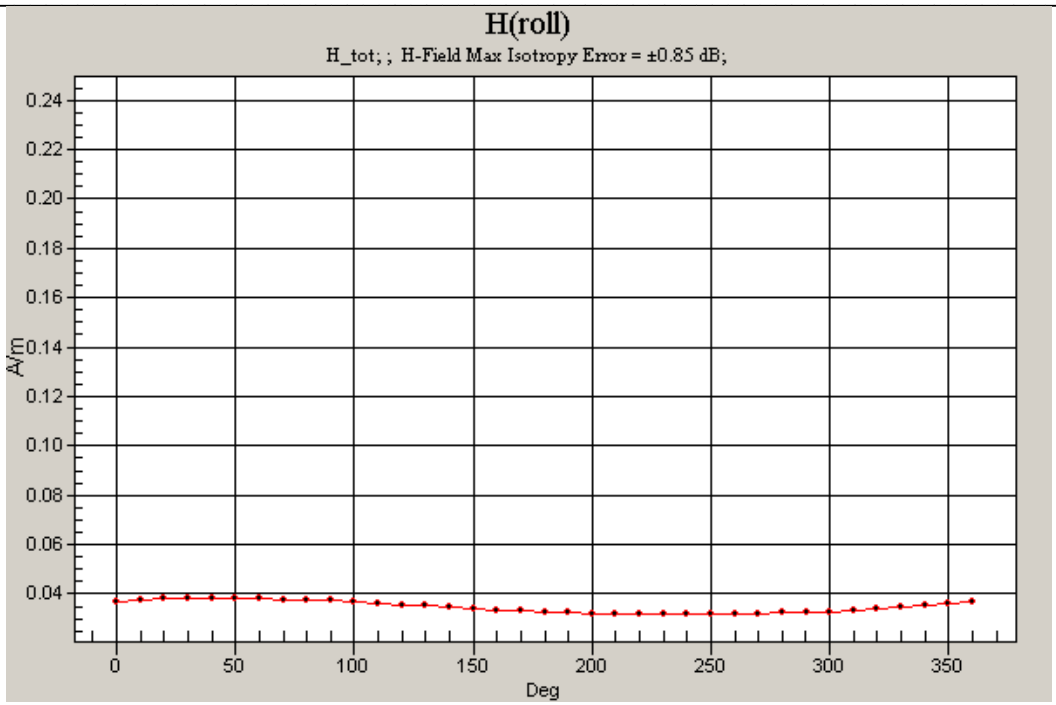
The calculated maximum field values for the test device are tabulated below:

GSM1900, E and H RF emissions results

Mode	Flip option	Test configuration	Ch 512 1850.2 MHz	Ch 661 1880.0 MHz	Ch 810 1909.8 MHz
GSM1900	Flip open	E-field (V/M)	70.9	72.1	75.6
		H-field (A/m)	0.128	0.132	0.146
		Category	M3(-5dB)	M3(-5dB)	M3(-5dB)

Probe rotation on the worst case configuration (flip open, ch 810):





Plots of the measurement scans are given in Appendix B.

APPENDIX A: VALIDATION SCANS

Date/Time: 24.08.2005 12:08:34
Test Laboratory: TCC Nokia
HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1003, Program Name: HAC E Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Dipole Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2333; ConvF(1, 1, 1); Calibrated: 31.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

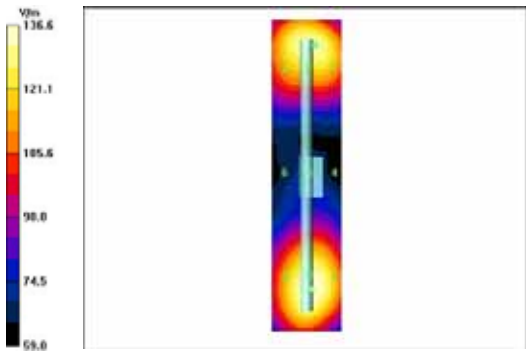
E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 136.6 V/m
Reference Value = 138.6 V/m; Power Drift = -0.028 dB
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1 **131.7**	Grid 2 **133.0**	Grid 3 **129.0**
Grid 4 **90.5**	Grid 5 **91.0**	Grid 6 **85.2**
Grid 7 **133.6**	Grid 8 **136.6**	Grid 9 **127.1**

E in V/m (Slot averaged)

Grid 1 **131.7**	Grid 2 **133.0**	Grid 3 **129.0**
Grid 4 **90.5**	Grid 5 **91.0**	Grid 6 **85.2**
Grid 7 **133.6**	Grid 8 **136.6**	Grid 9 **127.1**



Date/Time: 24.08.2005 14:57:28
Test Laboratory: TCC Nokia
HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1003, Program Name: HAC H Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6053; ; Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

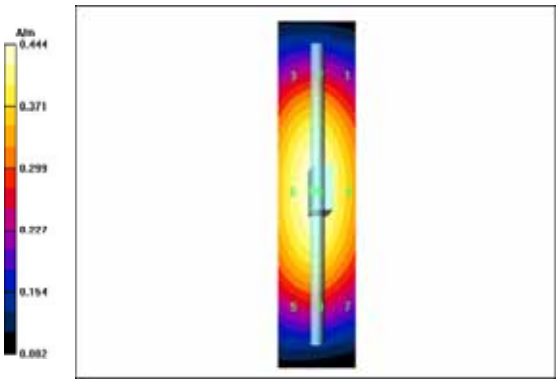
H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.444 A/m
Reference Value = 0.135 A/m; Power Drift = -0.035 dB
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1 **0.377**	Grid 2 **0.406**	Grid 3 **0.396**
Grid 4 **0.413**	Grid 5 **0.444**	Grid 6 **0.433**
Grid 7 **0.366**	Grid 8 **0.395**	Grid 9 **0.386**

H in A/m (Slot averaged)

Grid 1 **0.377**	Grid 2 **0.406**	Grid 3 **0.396**
Grid 4 **0.413**	Grid 5 **0.444**	Grid 6 **0.433**
Grid 7 **0.366**	Grid 8 **0.395**	Grid 9 **0.386**



APPENDIX B: MEASUREMENT SCANS

Date/Time: 25.08.2005 17:54:50
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC E Device

Communication System: GSM1900; Frequency: 1850.2 MHz;
Duty Cycle: 1:8.1
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: E Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2333; ConvF(1, 1, 1); Calibrated: 31.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

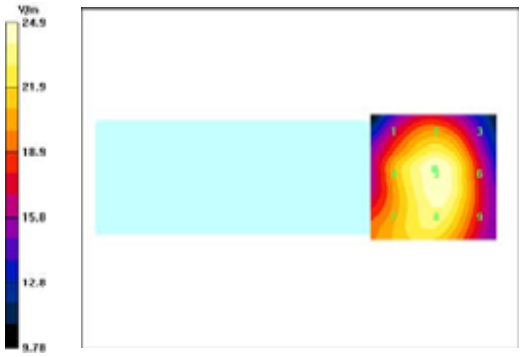
E Scan 10mm above Device Reference 2/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 70.9 V/m
Reference Value = 26.7 V/m; Power Drift = -0.038 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

E in V/m (Time averaged)

Grid 1 **21.5**	Grid 2 **23.3**	Grid 3 **21.9**
Grid 4 **23.0**	Grid 5 **24.9**	Grid 6 **23.4**
Grid 7 **22.3**	Grid 8 **24.3**	Grid 9 **22.9**

E in V/m (Slot averaged)

Grid 1 **61.1**	Grid 2 **66.2**	Grid 3 **62.4**
Grid 4 **65.5**	Grid 5 **70.9**	Grid 6 **66.5**
Grid 7 **63.5**	Grid 8 **69.1**	Grid 9 **65.2**



Date/Time: 24.08.2005 17:23:17
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC H Device

Communication System: GSM1900; Frequency: 1850.2 MHz;
Duty Cycle: 1:6.6
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1 kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6053; ; Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA; - Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

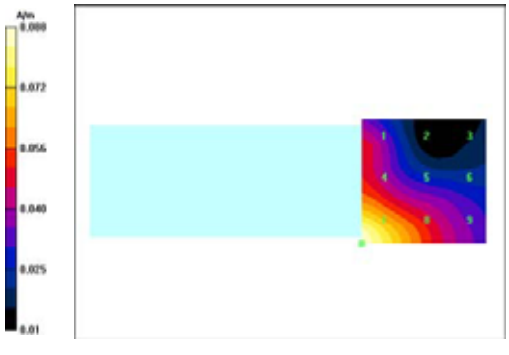
H Scan 10mm above Device Reference 2/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.227 A/m
Reference Value = 0.029 A/m; Power Drift = -0.010 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

H in A/m (Time averaged)

Grid 1 **0.050**	Grid 2 **0.027**	Grid 3 **0.019**
Grid 4 **0.061**	Grid 5 **0.046**	Grid 6 **0.036**
Grid 7 **0.088**	Grid 8 **0.066**	Grid 9 **0.045**

H in A/m (Slot averaged)

Grid 1 **0.128**	Grid 2 **0.069**	Grid 3 **0.049**
Grid 4 **0.157**	Grid 5 **0.117**	Grid 6 **0.093**
Grid 7 **0.227**	Grid 8 **0.171**	Grid 9 **0.116**



Date/Time: 25.08.2005 17:46:48
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC E Device

Communication System: GSM1900; Frequency: 1880 MHz;
Duty Cycle: 1:8.1
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m³
Phantom section: E Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2333; ConvF(1, 1, 1); Calibrated: 31.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

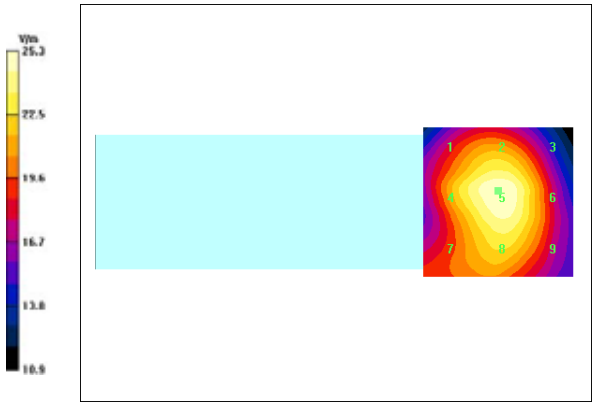
E Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 72.1 V/m
Reference Value = 27.0 V/m; Power Drift = -0.043 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

E in V/m (Time averaged)

Grid 1 22.5	Grid 2 23.9	Grid 3 22.3
Grid 4 23.8	Grid 5 25.3	Grid 6 23.5
Grid 7 21.7	Grid 8 23.8	Grid 9 22.5

E in V/m (Slot averaged)

Grid 1 64.0	Grid 2 68.0	Grid 3 63.4
Grid 4 67.7	Grid 5 72.1	Grid 6 67.0
Grid 7 61.8	Grid 8 67.9	Grid 9 64.1



Date/Time: 24.08.2005 17:12:05
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC H Device

Communication System: GSM1900; Frequency: 1880 MHz;Duty Cycle: 1:6.6
Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1 kg/m³
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6053; ; Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA; - Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

H Scan 10mm above Device Reference/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.232 A/m
Reference Value = 0.033 A/m; Power Drift = -0.034 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

H in A/m (Time averaged)

Grid 1 0.047	Grid 2 0.025	Grid 3 0.022
Grid 4 0.061	Grid 5 0.049	Grid 6 0.042
Grid 7 0.090	Grid 8 0.072	Grid 9 0.051

H in A/m (Slot averaged)

Grid 1 0.120	Grid 2 0.063	Grid 3 0.056
Grid 4 0.158	Grid 5 0.125	Grid 6 0.108
Grid 7 0.232	Grid 8 0.184	Grid 9 0.132

Date/Time: 25.08.2005 17:59:03
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC E Device

Communication System: GSM1900; Frequency: 1909.8 MHz;
Duty Cycle: 1:8.1
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Device Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2333; ConvF(1, 1, 1); Calibrated: 31.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

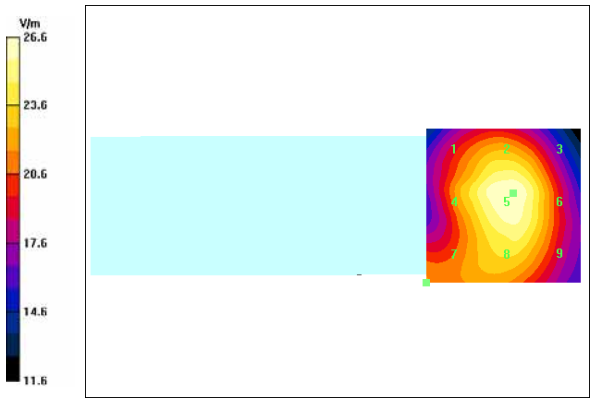
E Scan 10mm above Device Reference 2 2/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 75.6 V/m
Reference Value = 28.0 V/m; Power Drift = 0.041 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

E in V/m (Time averaged)

Grid 1 **23.3**	Grid 2 **25.4**	Grid 3 **24.0**
Grid 4 **24.4**	Grid 5 **26.6**	Grid 6 **25.2**
Grid 7 **22.6**	Grid 8 **25.2**	Grid 9 **24.1**

E in V/m (Slot averaged)

Grid 1 **66.2**	Grid 2 **72.2**	Grid 3 **68.4**
Grid 4 **69.5**	Grid 5 **75.6**	Grid 6 **71.7**
Grid 7 **64.5**	Grid 8 **71.7**	Grid 9 **68.5**



Date/Time: 24.08.2005 17:27:31
Test Laboratory: TCC Nokia
Type: RH-74; Serial: 001004/00/187698/7
Program Name: HAC H Device

Communication System: GSM1900; Frequency: 1909.8 MHz;
Duty Cycle: 1:6.6
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Device Section

DASY4 Configuration:
- Probe: H3DV6 - SN6053; ; Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn388; Calibrated: 07.01.2005
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 150

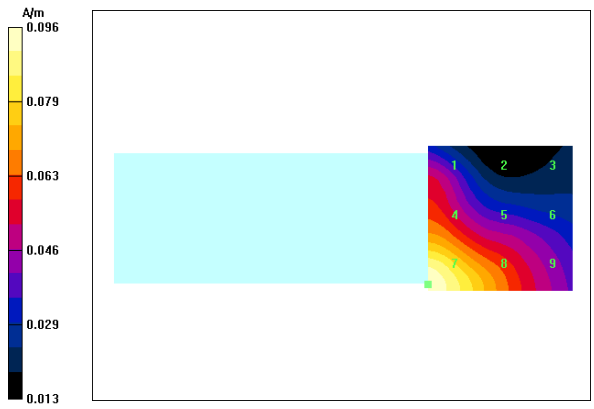
H Scan 10mm above Device Reference 2 2/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of Total field (slot averaged) = 0.247 A/m
Reference Value = 0.038 A/m; Power Drift = -0.062 dB
Hearing Aid Near-Field Category: M3 (AWF -5 dB)

H in A/m (Time averaged)

Grid 1 **0.056**	Grid 2 **0.033**	Grid 3 **0.024**
Grid 4 **0.073**	Grid 5 **0.057**	Grid 6 **0.046**
Grid 7 **0.096**	Grid 8 **0.078**	Grid 9 **0.056**

H in A/m (Slot averaged)

Grid 1 **0.145**	Grid 2 **0.086**	Grid 3 **0.062**
Grid 4 **0.188**	Grid 5 **0.146**	Grid 6 **0.118**
Grid 7 **0.247**	Grid 8 **0.200**	Grid 9 **0.144**



APPENDIX C: PROBE CALIBRATION REPORTS

E-field probe, SN: 2333
H-field probe, SN: 6053

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 Federal Office of Metrology and Accreditation
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: H3-6053_Jan05

CALIBRATION CERTIFICATE

Object	H3DV6 - SN:6053
Calibration procedure(s)	QA CAL-03.v4 Calibration procedure for H-field probes optimized for close near field evaluations in air
Calibration date:	January 20, 2005
Condition of the calibrated item	In Tolerance

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe H3DV6	SN: 6182	6-Oct-04 (SPEAG, No. H3-6182_Oct04)	Oct-05
DAE4	SN: 617	29-Sep-04 (SPEAG, No. DAE4-617_Sep04)	Sep-05

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

	Name	Function	Signature
Calibrated by:	Nico Vetterli	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 20, 2005

DASY - Parameters of Probe: H3DV6 SN:6053

Sensitivity in Free Space [A/m / √(μV)]

	a0	a1	a2	
X	**2.716E-03**	**-6.885E-5**	**-4.497E-5**	± 5.1 % (k=2)
Y	**2.563E-03**	**-1.866E-4**	**6.857E-5**	± 5.1 % (k=2)
Z	**2.906E-03**	**-3.590E-4**	**5.491E-5**	± 5.1 % (k=2)

Diode Compression[1]

DCP X	**86** mV
DCP Y	**86** mV
DCP Z	**86** mV

Sensor Offset (Probe Tip to Sensor Center)

X	**3.0** mm
Y	**3.0** mm
Z	**3.0** mm

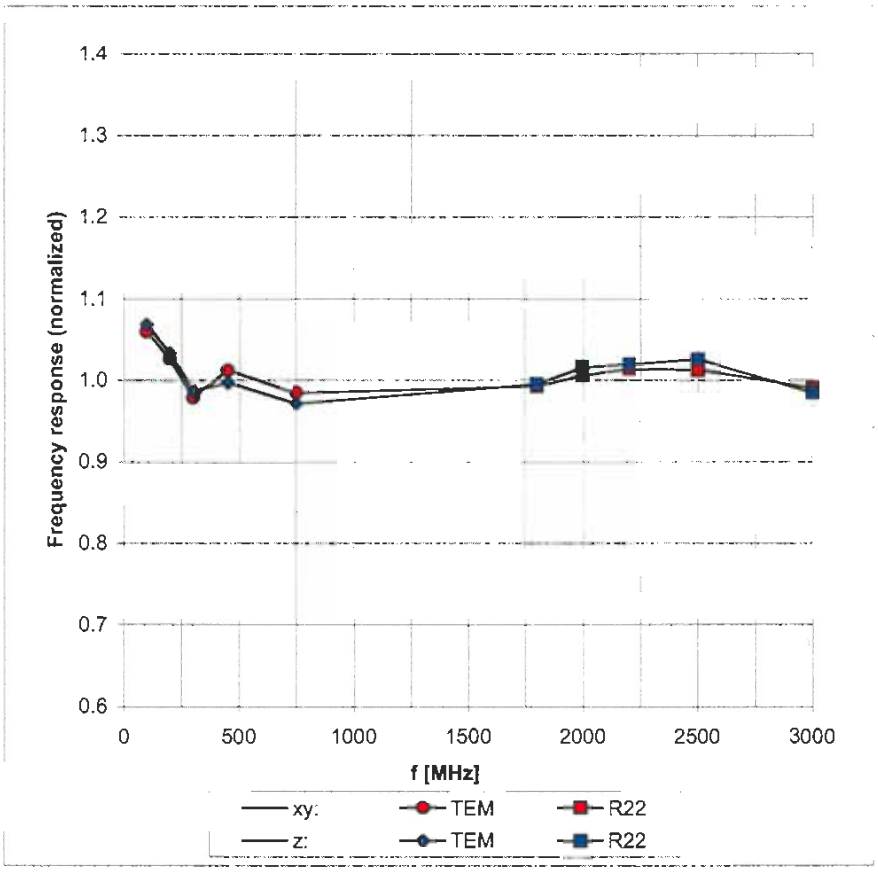
Connector Angle **33** °

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[1] numerical linearization parameter: uncertainty not required

Frequency Response of H-Field

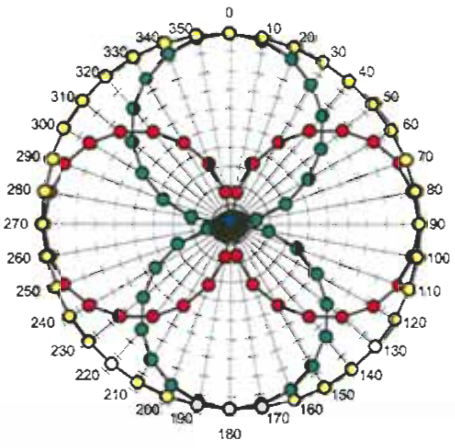
(TEM-Cell:ifi110, Waveguide R22)



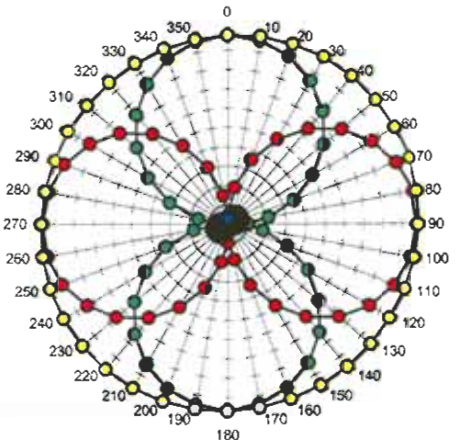
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), ϑ = 90°

f = 300 MHz, TEM ifi110EXX

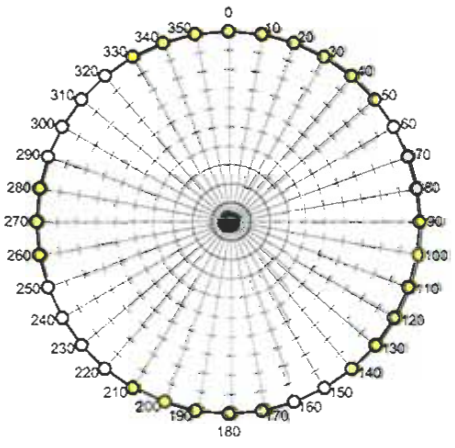


f = 2500 MHz, WG R22

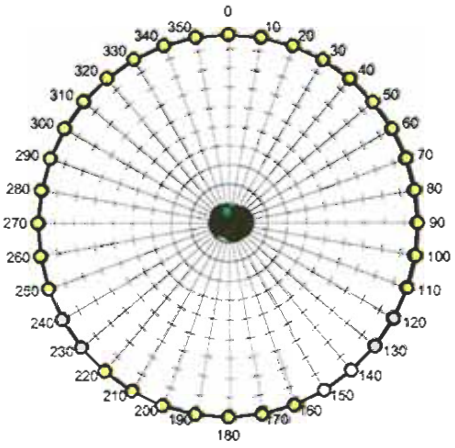


Receiving Pattern (ϕ), ϑ = 0°

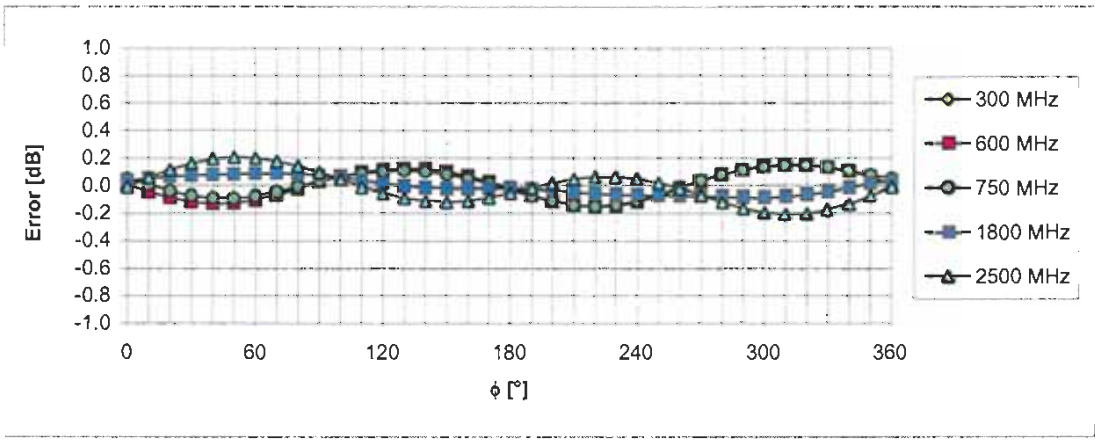
f = 300 MHz, TEM ifi110EXX



f = 2500 MHz, WG R22

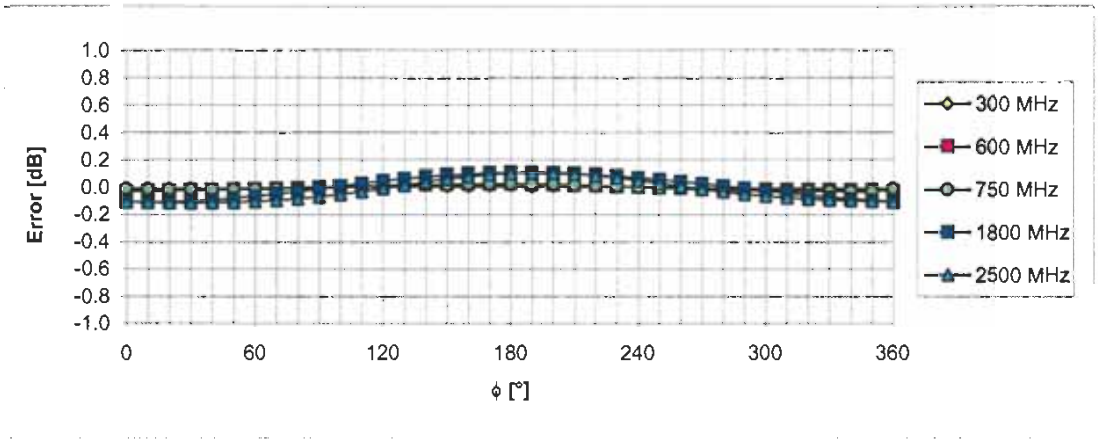


Receiving Pattern (ϕ), ϑ = 90°



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

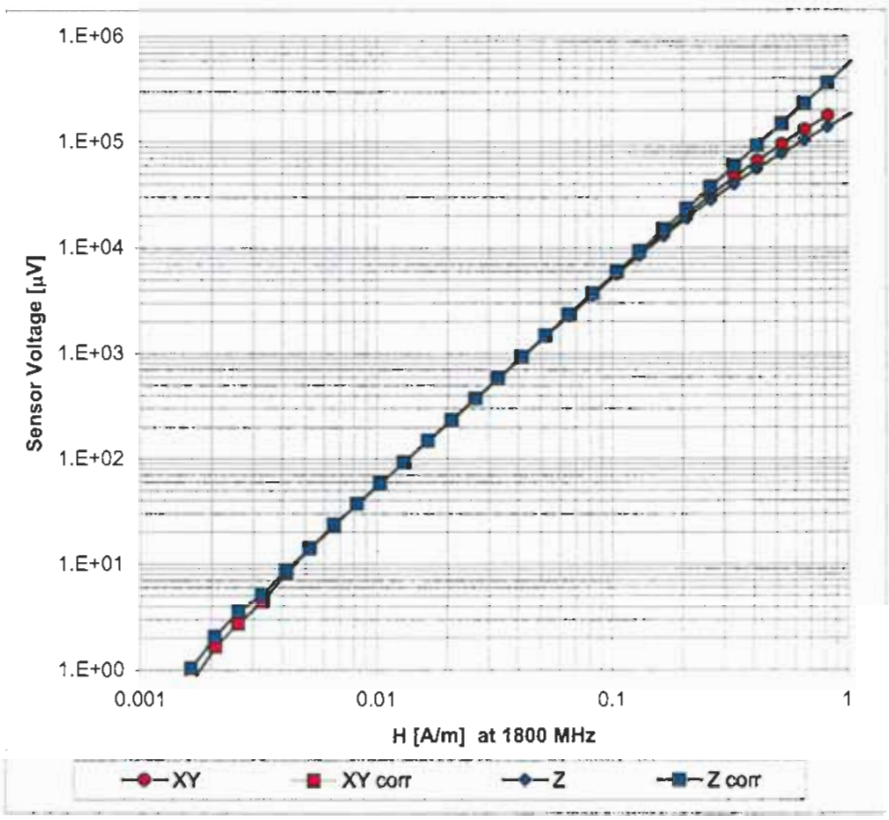
Receiving Pattern (ϕ), ϑ = 0°

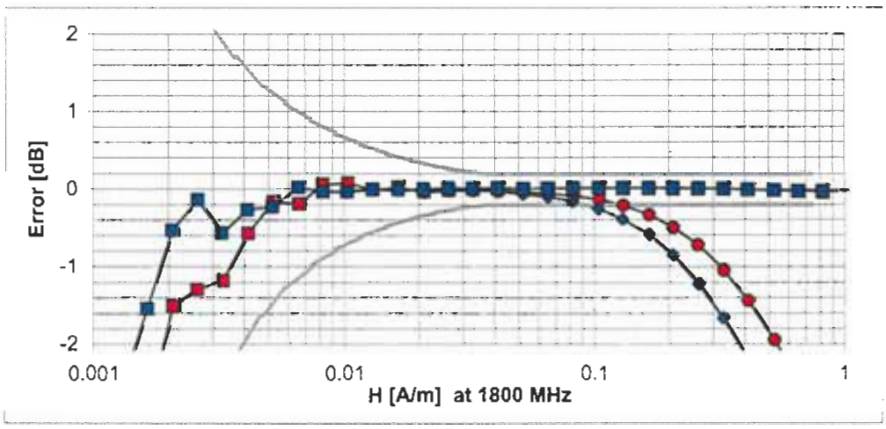


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(H-field)

(Waveguide R22, f = 1800 MHz)





Uncertainty of Linearity Assessment: ± 0.6% (k=2)

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 Federal Office of Metrology and Accreditation
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: ER3-2333_Jan05

CALIBRATION CERTIFICATE

Object	ER3DV6 - SN:2333
Calibration procedure(s)	QA CAL-02.v4 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date:	January 31, 2005
Condition of the calibrated item	In Tolerance

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-May-04 (METAS, No. 251-00388)	May-05
Power sensor E4412A	MY41495277	5-May-04 (METAS, No. 251-00388)	May-05
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-04 (METAS, No. 251-00403)	Aug-05
Reference 20 dB Attenuator	SN: S5086 (20b)	3-May-04 (METAS, No. 251-00389)	May-05
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-04 (METAS, No. 251-00404)	Aug-05
Reference Probe ER3DV6	SN: 2328	6-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN: 617	19-Jan-05 (SPEAG, No. DAE4-617_Jan05)	Jan-06

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092180	18-Sep-02 (SPEAG, in house check Oct-03)	In house check: Oct 05
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Dec-03)	In house check: Dec-05
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov 05

	Name	Function	Signature
Calibrated by:	Katja Pokovic	Technical Manager	
Approved by:	Niels Kuster	Quality Manager	

Issued: February 19, 2005

DASY - Parameters of Probe: ER3DV6 SN:2333

Sensitivity in Free Space [μV/(V/m)^2] Diode Compression[A]

NormX	**1.42** ± 10.1 % (k=2)	DCP X	**95** mV
NormY	**1.48** ± 10.1 % (k=2)	DCP Y	**95** mV
NormZ	**1.45** ± 10.1 % (k=2)	DCP Z	**100** mV

Frequency Correction

X	**0.0**
Y	**0.0**
Z	**0.0**

Sensor Offset (Probe Tip to Sensor Center)

X	**2.5** mm
Y	**2.5** mm
Z	**2.5** mm

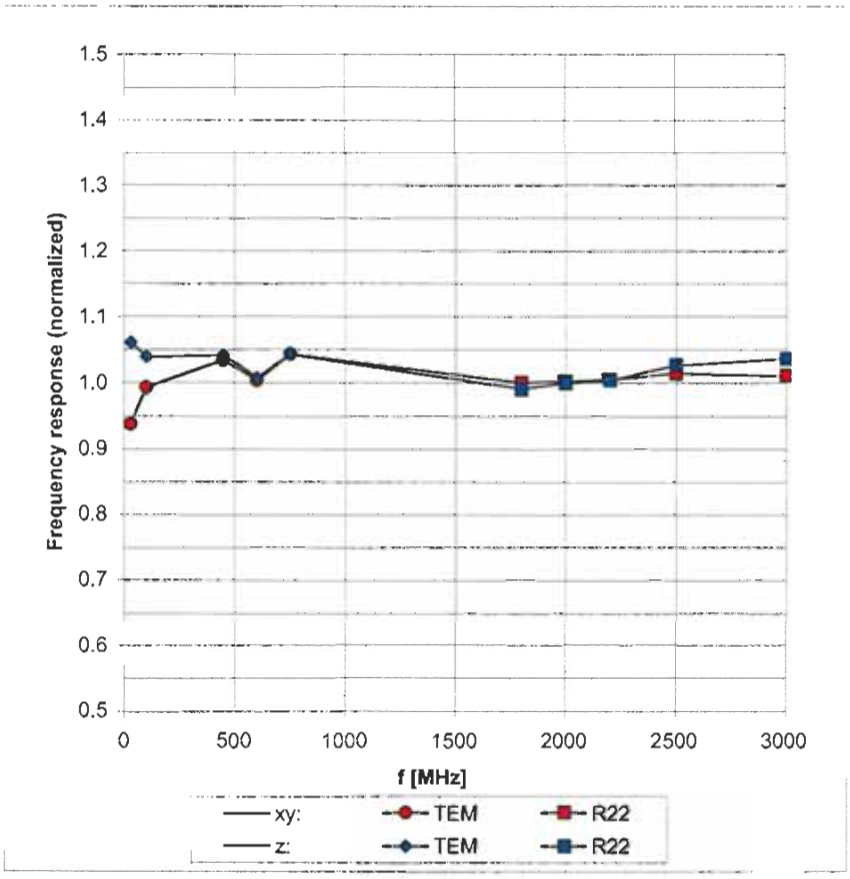
Connector Angle **123** °

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] numerical linearization parameter: uncertainty not required

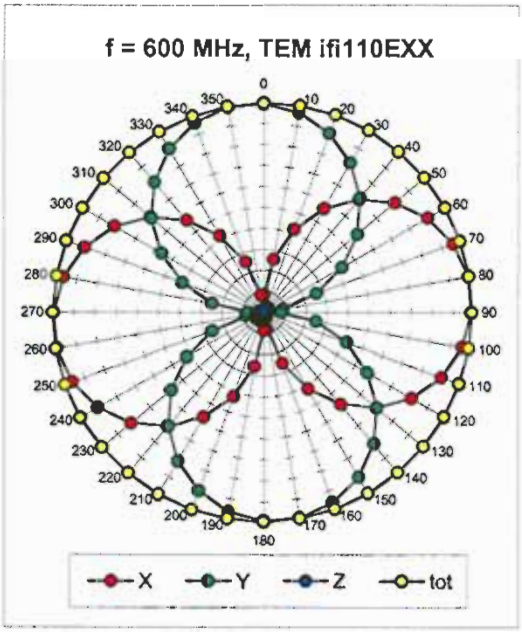
Frequency Response of E-Field

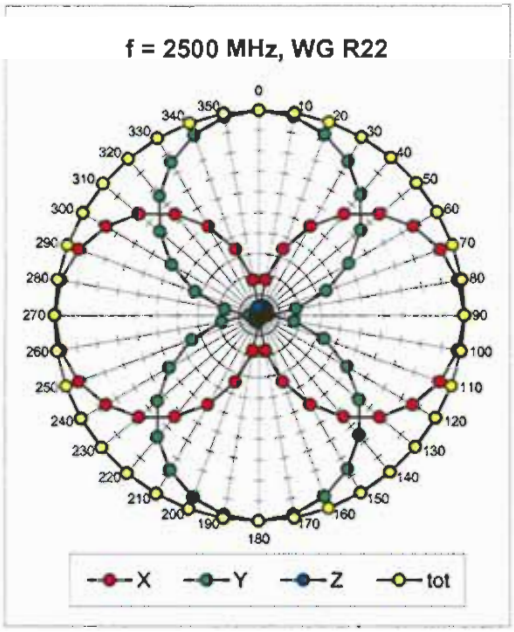
(TEM-Cell:ifi110 EXX, Waveguide R22)



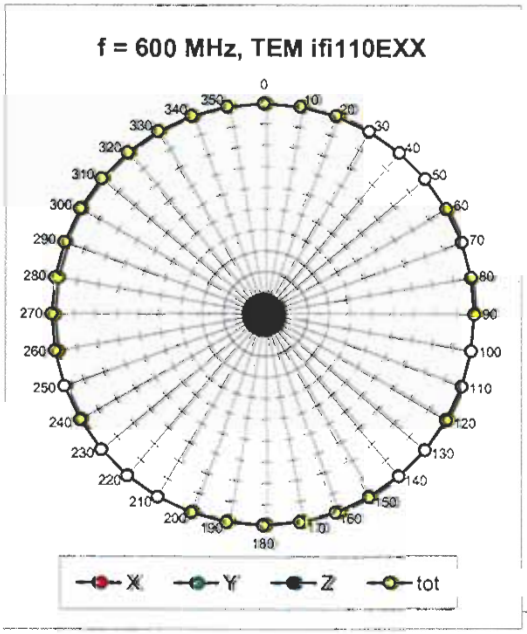
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

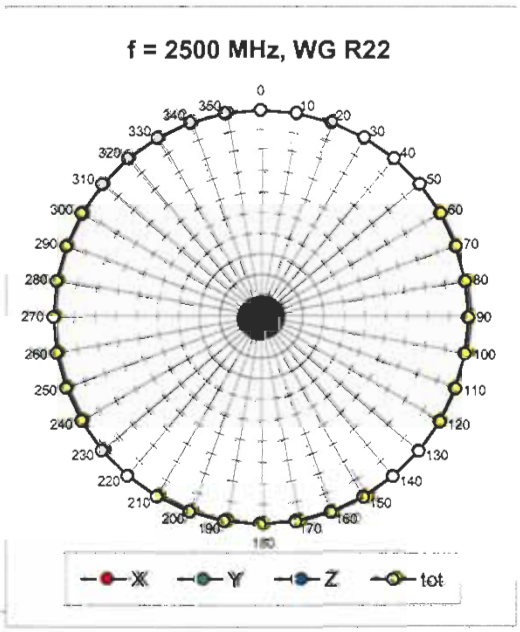
Receiving Pattern (ϕ), ϑ = 0°



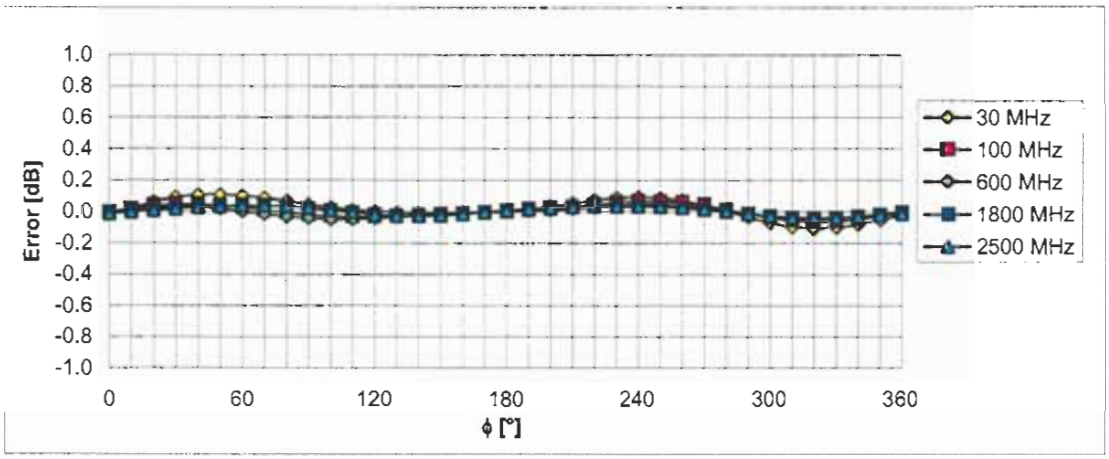


Receiving Pattern (ϕ), ϑ = 90°



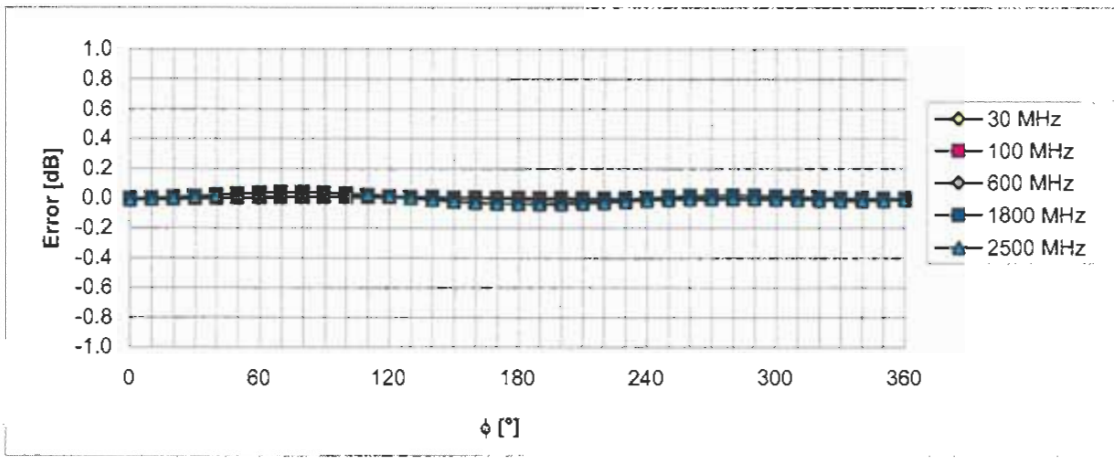


Receiving Pattern (ϕ), ϑ = 0°



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

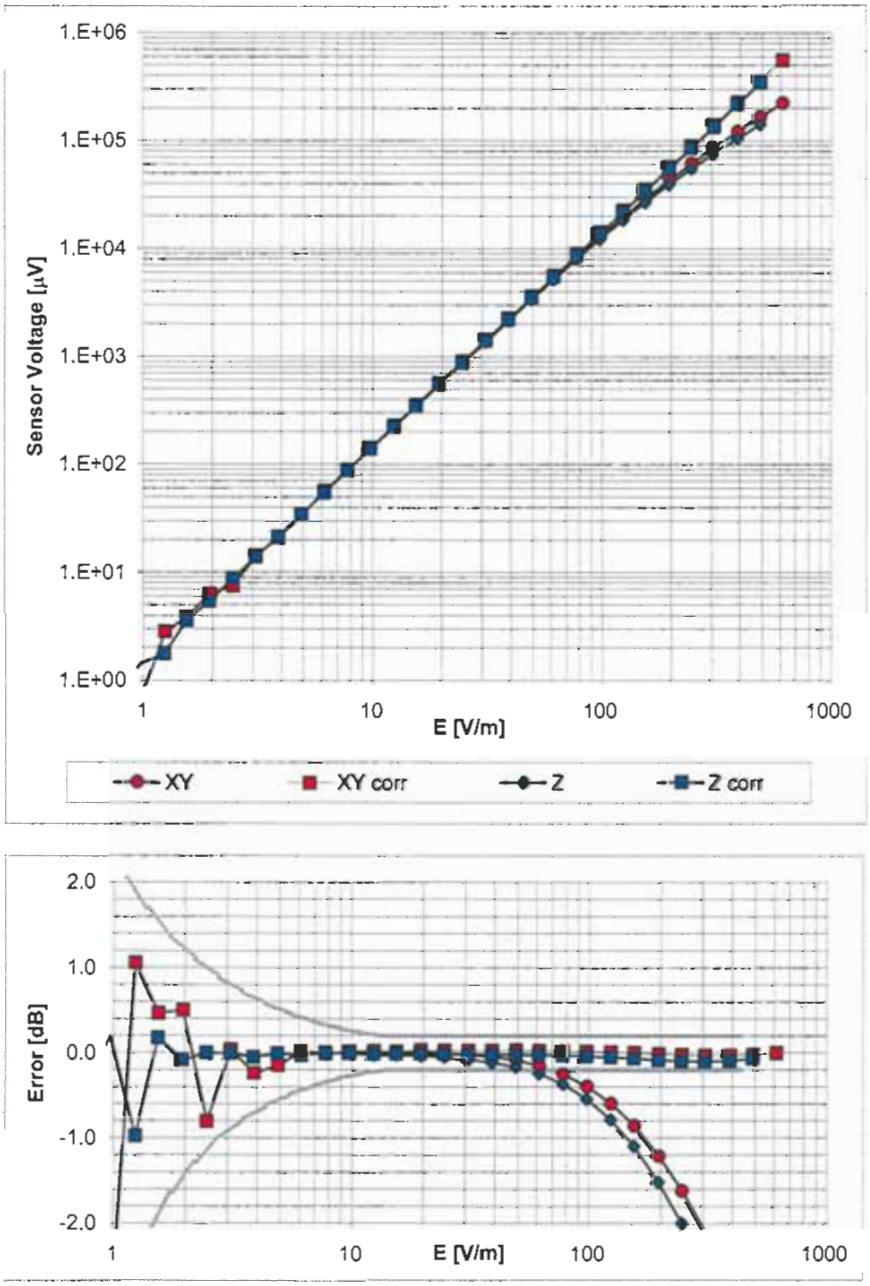
Receiving Pattern (ϕ), ϑ = 90°



Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

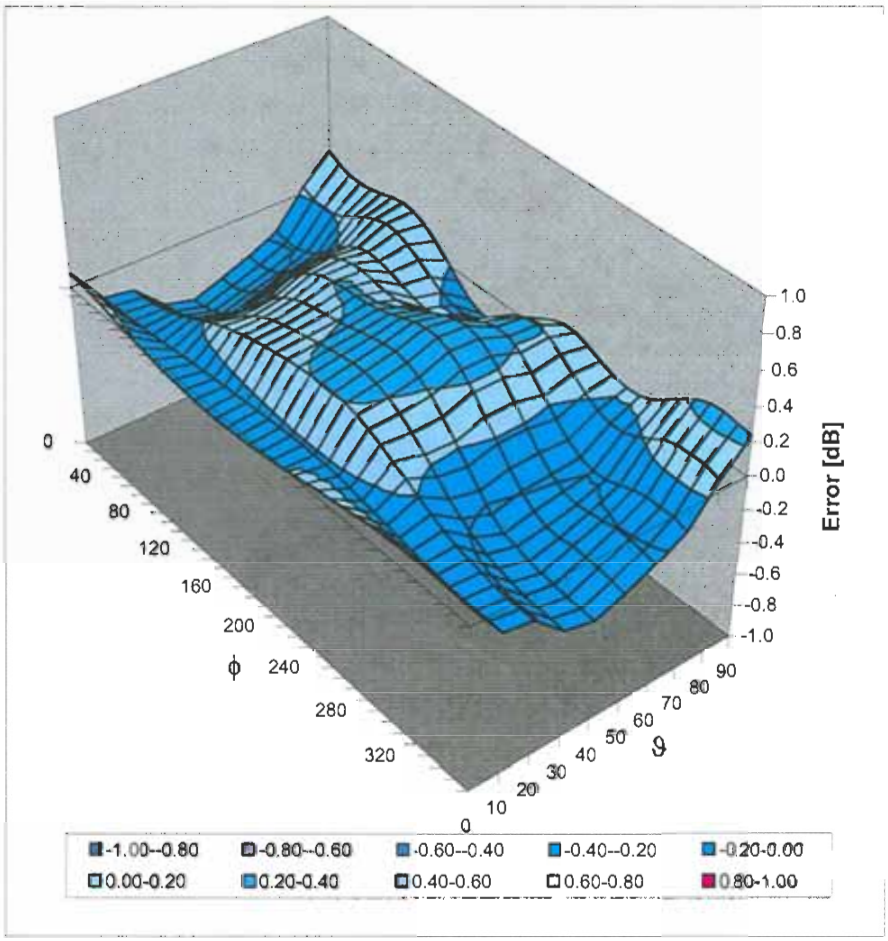
Dynamic Range f(E-field)

(Waveguide R22, f = 1800 MHz)



Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Deviation from Isotropy in Air
Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

APPENDIX D: DIPOLE CALIBRATION REPORTS

1880MHz dipole, SN: 1003

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

Client NOKIA TCC SALO

Certificate No: **CD1880V3-1003_Feb05**

CALIBRATION CERTIFICATE

Object	CD1880V3 - SN: 1003
Calibration procedure(s)	QA CAL-20.v2 Calibration procedure for dipoles in air
Calibration date:	February, 23, 2005
Condition of the calibrated item	In Tolerance

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E442	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Reference 20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference 10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference Probe ER3DV6	SN 2328	06-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN 601	07-Jan-05 (SPEAG, No. DAE4-601_Jan05)	Jan-06

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092312	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
Power sensor HP 8481A	MY41093315	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
RF generator Agilent E8251A	US41140111	4-Aug-03 (Agilent)	In house check: Aug-05
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov-05
Probe H3DV6	SN: 6065	10-Oct-04 (SPEAG, No. H3-6065-Oct04)	Calibration, Oct-05

	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	
Approved by:	Fin Bomholt	Technical Director	

Issued: February 27, 2005

This calibration certificate is issued as an intermediate solution until the specific calibration procedure is submitted and accepted in the frame of the accreditation of the Calibration Laboratory of Schmid & Partner Engineering AG (based on ISO/IEC 17025 International Standard)

1 Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY4	V4.5 B13
DASY PP Version	SEMCAD	V1.8 B144
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	area = 20 x 90 mm
Frequency	**1880 MHz** ± 1 MHz	
Forward power at dipole connector	20.0 dBm = 100mW	
Input power drift	< 0.05 dB	

2 Maximum Field values

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW forward power	**0.444 A/m**

Uncertainty for H-field measurement: 8.2% (k=2)

E-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured above high end	100 mW forward power	134.0 V/m
Maximum measured above low end	100 mW forward power	133.8 V/m
Averaged maximum above arm	100 mW forward power	**133.9 V/m**

Uncertainty for E-field measurement: 12.8% (k=2)

3 Appendix

3.1 Antenna Parameters

Frequency	**Return Loss**	**Impedance**
1710 MHz	18.6 dB	(57.4 + j11.4) Ohm
1880 MHz	**18.9 dB**	**(61.9 + j4.6) Ohm**
1900 MHz	19.4 dB	(60.8 + j0.3) Ohm
1950 MHz	23.5 dB	(54.1 - j4.2) Ohm
2000 MHz	25.0 dB	(46.3 + j4.1) Ohm

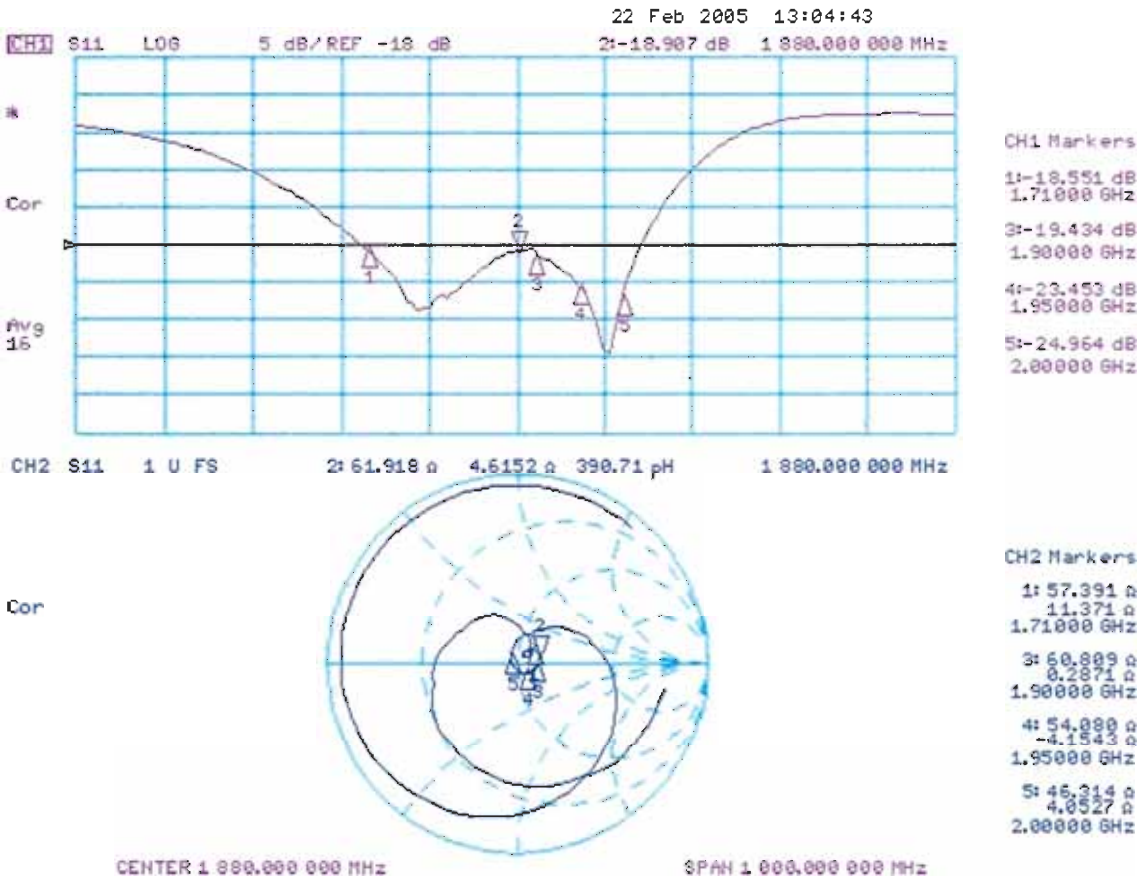
3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field result

See page 5

3.3.3 DASY4 E-Field result

See page 6

Date/Time: 23.02.2005 11:21:45

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: H_CD1880_1003_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1003
Program Name: HAC H Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Dipole Section

DASY4 Configuration:
- Probe: H3DV6 - SN6065; ; Calibrated: 10.12.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901: Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

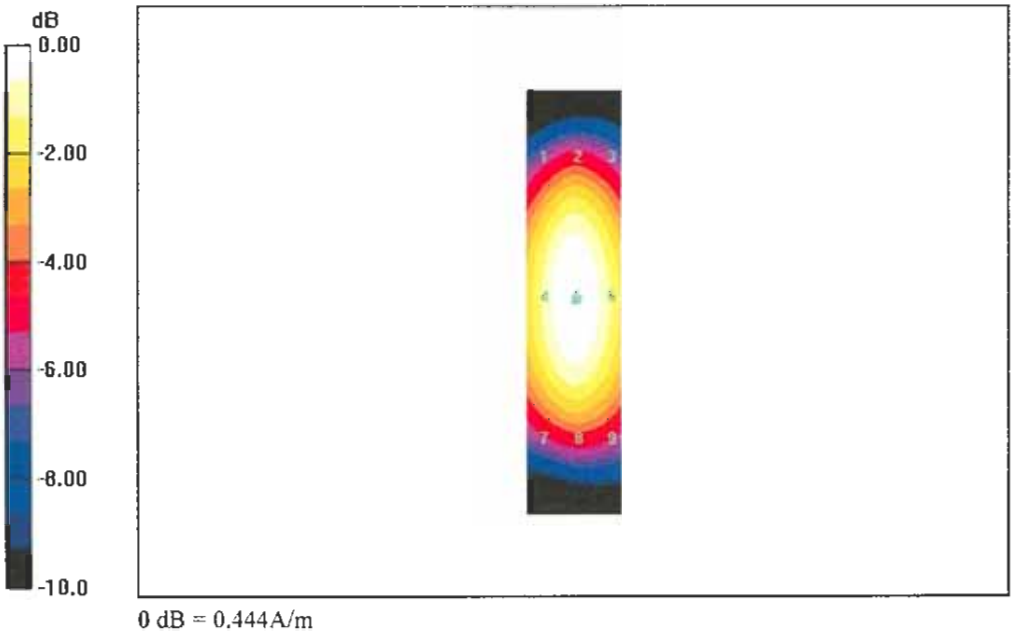
H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 0.444 A/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.377	**0.406**	**0.389**
Grid 4	Grid 5	Grid 6
0.416	**0.444**	**0.427**
Grid 7	Grid 8	Grid 9
0.375	**0.400**	**0.385**

H in A/m (Slot averaged)

Grid 1	Grid 2	Grid 3
0.377	**0.406**	**0.389**
Grid 4	Grid 5	Grid 6
0.416	**0.444**	**0.427**
Grid 7	Grid 8	Grid 9
0.375	**0.400**	**0.385**



0 dB = 0.444A/m

Date/Time: 23.02.2005 16:48:43

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: E_CD1880_1003_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1003
Program Name: HAC E Dipole

Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Dipole Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2328; ConvF(1, 1, 1); Calibrated: 06.10.2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 13; Postprocessing SW: SEMCAD, V1.8 Build 144

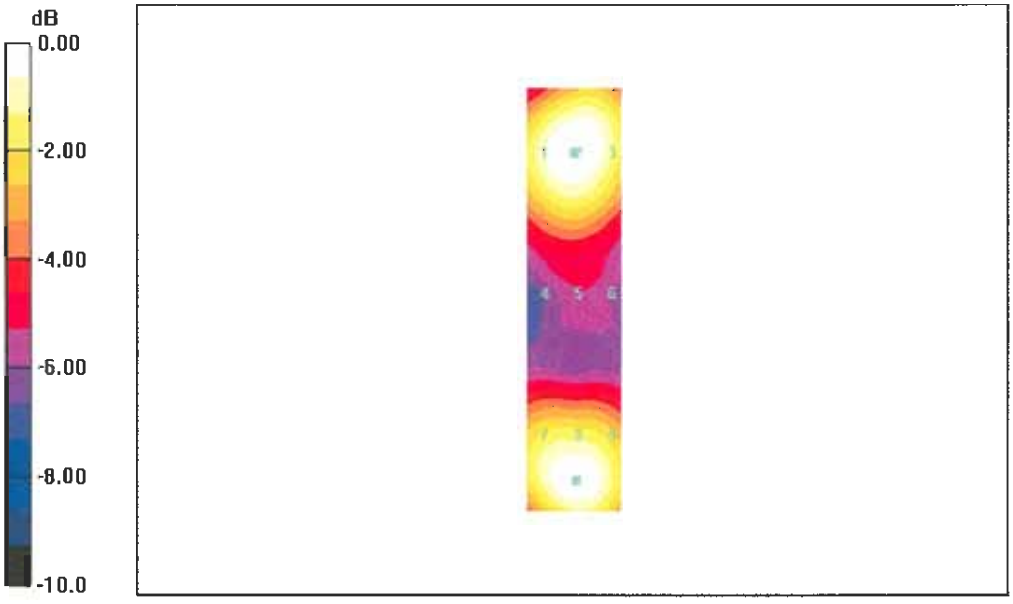
E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 134.0 V/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
128.7	**133.8**	**131.0**
Grid 4	Grid 5	Grid 6
89.7	**92.3**	**88.8**
Grid 7	Grid 8	Grid 9
127.5	**134.0**	**131.4**

E in V/m (Slot averaged)

Grid 1	Grid 2	Grid 3
128.7	**133.8**	**131.0**
Grid 4	Grid 5	Grid 6
89.7	**92.3**	**88.8**
Grid 7	Grid 8	Grid 9
127.5	**134.0**	**131.4**



0 dB = 134.0V/m