



SAMSUNG ELECTRONICS Co., Ltd.,
Regulatory Compliance Group
IT R&D Center

416, Maetan-3dong,
Yeongtong-gu, Suwon-si,
Gyeonggi-do, Korea 443-742

TEST REPORT ON HAC

Model Tested: SCH-i920
FCC ID (Requested) : A3LSCHI920
Job No : AG-061
Report No : AG-061-M1
Date issued : Jun. 16, 2009
Result Summary : M4 - 2007 (RF EMISSION Category)

- Abstract -

This document reports on HAC Tests carried out in accordance with ANSI C63.19(2007), FCC Rule Part(s) FCC 47 CFR §20.19, §6.3, §7.3

Prepared By

SH ONG – Test Engineer

Authorized By

JD JANG – Technical Manager

Contents

1. GENERAL INFORMATION.....	3
2. DESCRIPTION OF DEVICE.....	3
3. DESCRIPTION OF TEST EQUIPMENT.....	4
3.1 HAC Measurement Setup.....	4
3.2 Probe Description.....	6
3.3 Test Arch Phantom.....	7
3.4 Validation Dipole.....	7
3.5 Equipment Calibration.....	8
4. HAC MEASUREMENT PROCEDURE.....	9
5. DESCRIPTION OF TEST POSITION.....	11
5.1 Measurement reference and plane.....	11
6. MEASUREMENT UNCERTAINTY.....	12
7. SYSTEM VERIFICATION.....	13
7.1 Test System Validation.....	13
8. MODULATION FACTOR.....	14
8.1 Modulation Factors.....	15
8.2 CW and Modulated Signal Zero-span plots.....	15
9. FCC 3G MEASUREMENTS – MAY/JUNE 2006.....	16
9.1 Handset Capabilities*.....	16
9.2 Worst-Case Probe Location Measurements.....	16
10. Test Results.....	17
10.1 Measurement Results(E-field).....	17
10.2 Measurement Results(H-field).....	18
10.3 Worst-case Configuration Evaluation.....	19
11. REFERENCES.....	20



1. GENERAL INFORMATION

Test Sample : Dual-Band CDMA Phone with Bluetooth

Model Number : SCH-i920

Serial Number : Identical prototype (S/N : # AG-061-A)

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.
416 Maetan3-Dong, Yeongtong-gu, Suwon City
Address Gyeonggi-Do, Korea 443-742

Test Standard : ANSI C 63.19 (2007), FCC 47 CFR § 20.19, §6.3, §7.3

FCC Classification Licensed Portable Transmitter Held to Ear (PCE)

Test Dates : June.12 ,2009

Tested for : FCC/TCB Certification

2. DESCRIPTION OF DEVICE

Tx Freq. Range : 824.70 ~ 848.31 MHz(CDMA)
1851.25 ~ 1908.76 MHz(PCS)

Rx Freq. Range : 869.70 ~ 893.31 MHz(CDMA)
1931.25 ~ 1988.76 MHz(PCS)

Antenna Configuration : 2108015

Antenna Manufacturer : TYCO

Antenna Dimensions : 53.1mm*19.8mm*8.9mm

3. DESCRIPTION OF TEST EQUIPMENT

3.1 HAC Measurement Setup

Robotic System

Measurements are performed using the DASY4(or DASY5) automated dosimetric assessment system. Which is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Stäubli), robot controller, measurement server, Samsung computer, near-field probe, probe alignment sensor, and the SAM twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 3.1).

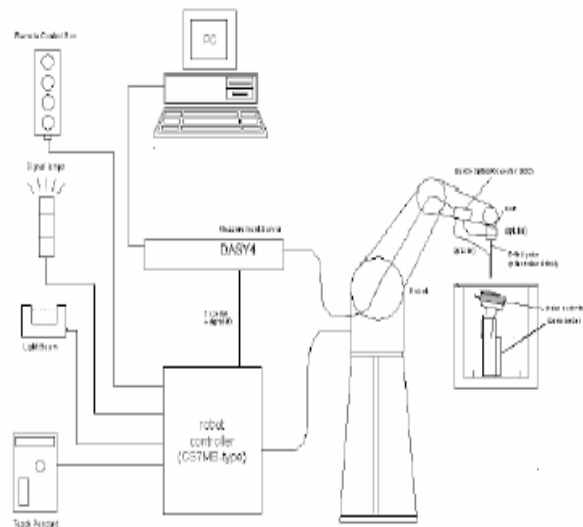


Figure 3.1 HAC Measurement System Setup

System Hardware

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and a remote control is used to drive the robot motors. The PC consists of the Samsung computer with Windows XP system and HAC Measurement Software DASY4(or DASY5), LCD monitor, mouse and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A

data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the measurement server

System Electronics

The DAE4(or DAE3) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

3.2 Probe Description

ER3DV6 E-Field Probe Description

Construction:	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
Calibration:	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, $k=2$)
Frequency:	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	2V/m to 1000V/m (M3 or better device readings fall well below diode compression point)
Linearity :	± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm



Figure 3.2 E-field Probe

H3DV6 H-Field Probe Description

Construction:	Three concentric loop sensors with 3.8 mm loop diameters Resistively loaded detector diodes for linear response Built-in shielding against static charges
Frequency:	200 MHz to 3 GHz (absolute accuracy $\pm 6.0\%$, $k=2$); Output linearized
Directivity:	± 0.25 dB (spherical isotropy error)
Dynamic Range:	10mA/mto2A/mat1 GHz (M3 or better device readings fall well below diode compression point)
Dimensions:	Overall length: 330 mm (Tip: 40 mm) Tip diameter: 6 mm (Body: 12 mm) Distance from probe tip to dipole centers: 3 mm
E-Field Interference	< 10% at 3 GHz (for plane wave)



Figure 3.3 H-field Probe

3.3 Test Arch Phantom

Enables easy and well defined positioning of the phone and calibration dipoles as well as simple teaching of the robot (See Figure 3.4)

Dimensions: 370 x 370 x 370 mm

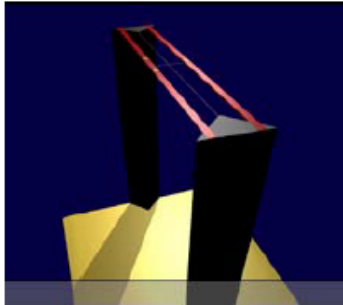


Figure 3.4 Test Arch Phantom

3.4 Validation Dipole

The reference dipole should have a return loss better than -20 dB (measured in the setup) at the resonant frequency to reduce the uncertainty in the power measurement.

Application	- Free space antenna - Hearing Aid susceptibility measurements according to ANSI C 63.19 - Validation of Hearing Aid RF setup for wireless device emission measurement according to ANSI C63.19
Frequency	835 MHz, 1880 MHz, 2450 MHz
Return Loss	< -20 dB at specified validation position
Dimensions	835 MHz : 166 x 330 mm 1880MHz : 80.8 x 330 mm 2450MHz : 59.9 x 330 mm

3.5 Equipment Calibration

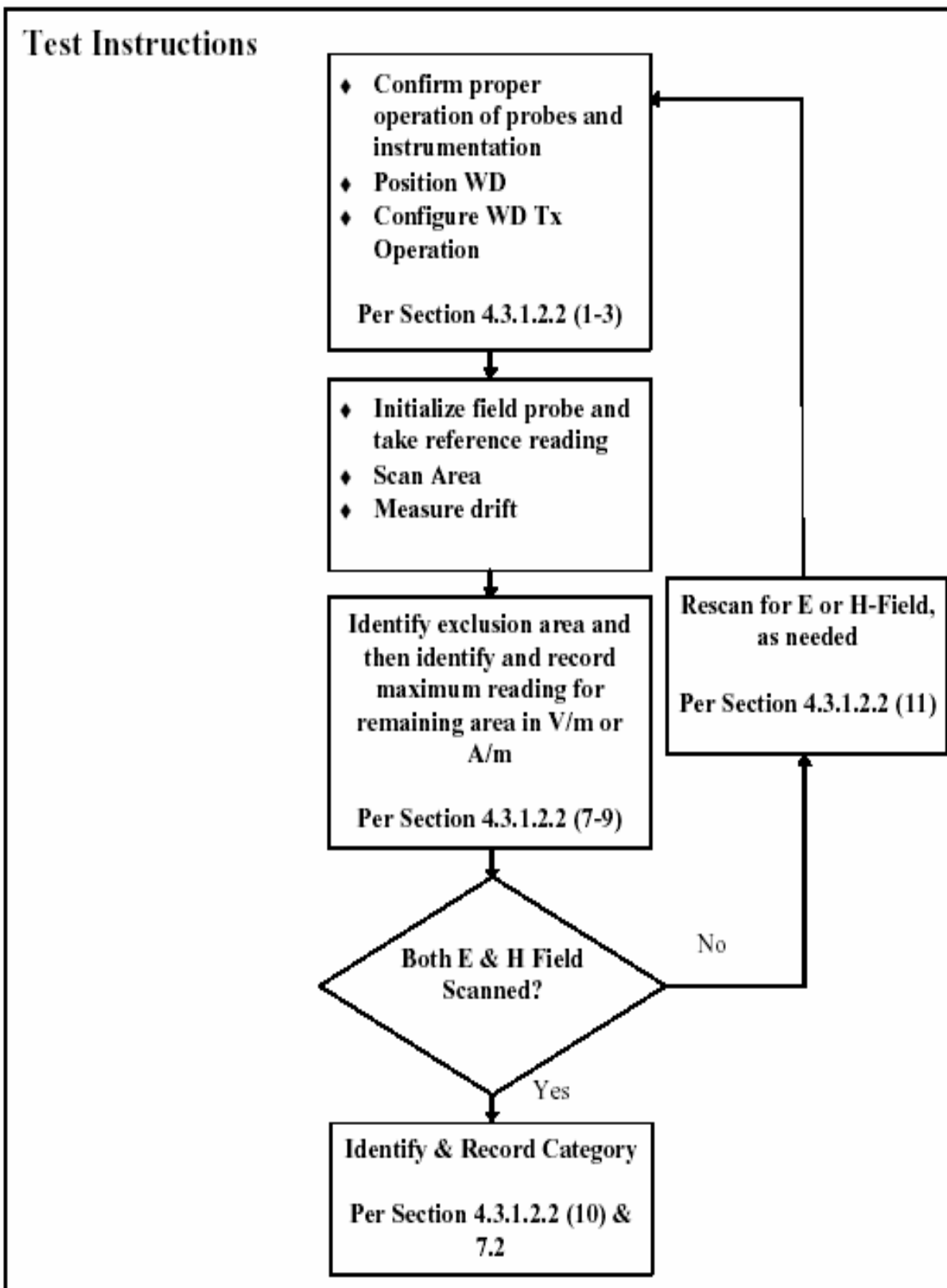
Table 3.2 Test Equipment Calibration

Type	Calibration Due Date	Serial No.
Stäubli Robot RX90BL	Not Required	F05/51G6A1/A/01
HAC Phantom	Not Required	1018
DAE4 V1	2010.04.01	486
SPEAG E-Field Probe ER3DV6	2010.03.10	2370
SPEAG H-Field Probe H3DV6	2010.03.13	6197
SPEAG Validation Dipole CD835 V3	2011.03.16	1021
SPEAG Validation Dipole CD1880 V3	2011.03.10	1016
E4438C Signal Generator	2010.02.11	MY45094010
BBS3Q7ECK Power Amp	2010.01.06	1023
E4419B Power Meter	2010.05.08	MY45101764
E9300B Power Sensor	2010.05.08	MY52505880
E9300B Power Sensor	2010.05.08	MY41495894
DASY4 S/W (ver 4.7)	Not Required	-
Directional Coupler	2010.05.22	18862
Spectrum Analyzer	2010.02.13	MY46186167

NOTE:

The E-field and H-field probe was calibrated by SPEAG,

4. HAC MEASUREMENT PROCEDURE



The evaluation was performed using the following procedure.

1. Confirm proper operation of the field probe, probe measurement system, and other instrumentation.
2. WD is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
3. The WD operation for maximum rated RF output power was configured and confirmed with the base station simulator, at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test.
4. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The WD audio output was positioned tangent (as physically possible) to the measurement plane.
5. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.
6. The measurement system measured the field strength at the reference location.
7. Measurements at 2mm increments in the 5 x 5 cm region were performed and recorded. A 360° rotation about the azimuth axis at the maximum interpolated position was measured. For the worst-case condition, the peak reading from this rotation was used in re-evaluating the HAC category.
8. The system performed a drift evaluation by measuring the field at the reference location.
9. Steps 1-8 were done for both the E and H-Field measurements.
10. The HAC measurement software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5% occurred, the tests were repeated.

5. DESCRIPTION OF TEST POSITION

5.1 Measurement reference and plane

1. The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.
2. The grid is centered on the audio frequency output transducer of the WD (speaker or T-coil).
3. The grid is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the WD handset, which, in normal handset use, rest against the ear.
4. The measurement plane is parallel to, and 1.5 cm in front of, the reference plane.



Figure 5.1 Wireless Device and Measurement Plane

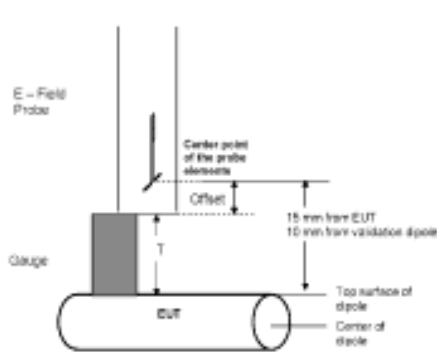


Figure 5.2 Gauge block with E-field probe

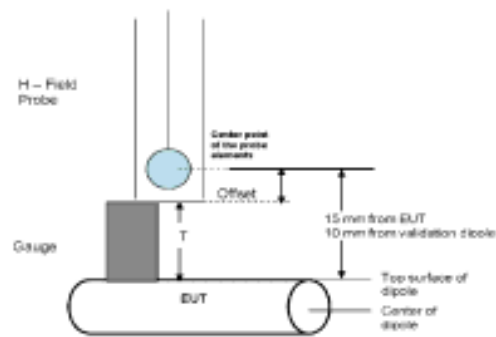


Figure 5.3 Gauge block with H-field probe

6.Measurement Uncertainty

Source of Uncertainty		Value	probability distribution	Divisor	c_i E	c_i H	Standard uncertainty		vi or veff	
							E	H	E	H
Measurement System										
Probe Calibration		5.05	normal	1.000	1	1	5.05	2.55	0	0
Axial Isotropy		4.70	rectangular	1.732	1	1	2.71	2.71	∞	∞
Sensor Displacement		16.50	rectangular	1.732	1	0.145	9.53	1.38	∞	∞
Boundary Effects		2.40	rectangular	1.732	1	1	1.39	1.39	∞	∞
Linearity		4.70	rectangular	1.732	1	1	2.71	2.71	∞	∞
Scaling to Peak Envelop Power		2.00	rectangular	1.732	1	1	1.15	1.15	∞	∞
System Detection Limit		1.00	rectangular	1.732	1	1	0.58	0.58	∞	∞
Readout Electronics		0.30	normal	1.000	1	1	0.30	0.30	∞	∞
Response Time		0.80	rectangular	1.732	1	1	0.46	0.46	∞	∞
Integration time		2.60	rectangular	1.732	1	1	1.50	1.50	∞	∞
RF Ambient condition		3.00	rectangular	1.732	1	1	1.73	1.73	∞	∞
RF Reflections		3.92	normal	1.000	1	1	3.92	3.92	2	2
Probe Positioner		1.20	rectangular	1.732	1	0.67	0.69	0.46	∞	∞
Probe Positioning		4.70	rectangular	1.732	1	0.67	2.71	1.82	∞	∞
Variability between 2mm & 5mm		3.85	normal	1.000	1	1	3.85	3.85	4	4
Extrap. And Interpolation		1.00	rectangular	1.732	1	1	0.58	0.58	∞	∞
Test Sample Related										
Device Positioning		0.57	normal	1.000	1	0.67	0.57	0.38	24	24
Device Holder and Phantom		2.40	rectangular	1.732	1	1	1.39	1.39	∞	∞
Power Drift		5.00	rectangular	1.732	1	1	2.89	2.89	∞	∞
Phantom and Setup Related										
Phantom Thickness		2.40	rectangular	1.732	1	0.7	1.39	0.93	∞	∞
$u_c(F_S)$	Combined Standard Uncertainty		normal				13.82	9.83	211	54
$U(F_S)$	Expanded Uncertainty		normal k=	2.0			27.09	19.26		

7. SYSTEM VERIFICATION

7.1 Test System Validation

Prior to assessment, the system is verified to the $\pm 10\%$ of the specification at 835MHz, 1880MHz, by using the system validation kit(s). (see Appendix C, Graphic Plot Attached)

Table 7.2 System Validation Results Validation was measured with input power 100 mW.

Frequency	Targeted E-field (V/m)	Measured E-field (V/m)	Deviation (%)	Targeted H-field (A/m)	Measured H-field (A/m)	Deviation (%)	Date
835 MHz	165.2	174.5	5.63	0.451	0.433	-3.99	Jun.12, 2009
1880 MHz	138.8	142.5	2.67	0.471	0.444	-5.73	Jun.12, 2009

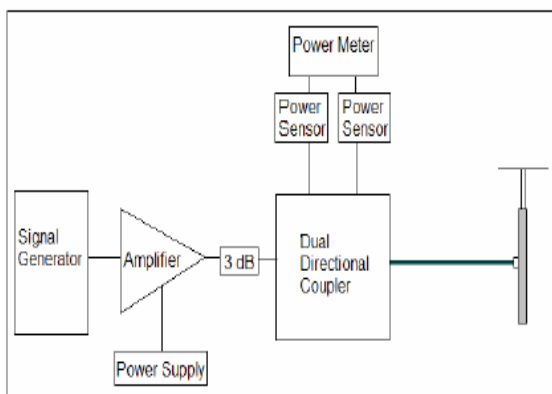


Figure 7.1 Dipole Validation Test Setup

Validations of the DASY4(or DASY5) test system were performed using the measurement equipment listed in Section 3.2. All validations occur in free space using the DASY4(or DASY5) test arch. Note that the 10mm probe to dipole separation is measured from the top edge of the dipole to the calibration reference point of the probe. SPEAG uses the center point of the probe sensor(s) as the reference point when establishing targets for their dipoles. Therefore, because SPEAG's dipoles and targets are used, it is appropriate to measure the 10mm separation distance to the center of the sensors as they do. This reference point was used for validation only. Validations were performed at 835 MHz and/or 1880 MHz. These frequencies are within each operating band and are within 2MHz of the mid-band frequency of the test device. The obtained results from the validations are displayed in the table 7.2.

8. MODULATION FACTOR

After every probe calibration, the response of the probe to each applicable modulated signal (CDMA, GSM, etc) must be assessed at both 835 MHz and 1880 MHz. The response of the probe system to a CW field at the frequency(s) of interest is compared to its response to a modulated signal with equal peak amplitude. For each PMF assessment, a Signal Generator was used to replace the original CW signal with the desired modulated signal. The PMF results are shown in Tables 5.

RF Field Probe Modulation Response was measured with the field probe and associated measurement equipment. The proposed setup corresponds to the procedure as required in the Standard.

1. Install a validation dipole for the appropriate frequency band under the Test Arch Phantom. Move the probe to the field reference point. Do not move the probe between the corresponding CW and modulated measurements.
2. Install the field probe in the setup.
3. The signal to the dipole must be monitored to record peak amplitude. Set a CW signal to the same level (refer to Appendix B)
4. Set the procedure properties (frequency, modulation frequency and crest factor) according to the measured signal. Define a multimeter job for the field reading.
5. Define a second procedure for the evaluation of the CW signal (frequency set as above, modulation frequency = 0, crest factor = 1) and a multimeter job.
6. The ratio of the CW reading to modulated signal reading is the probe modulation factor(PMF) for the modulation and field probe combination. This was repeated for 80% AM.
7. Steps 1-6 were repeated at all frequency bands and for both E and H field probes.

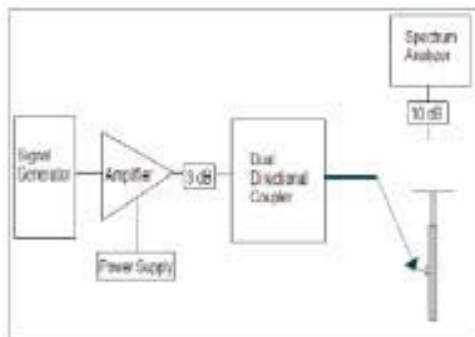


Figure 8.1 Setup to Dipole

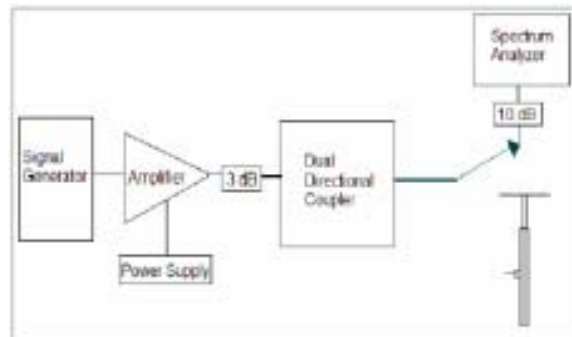


Figure 8.2 Setup to Peak Power using Spectrum Analyzer

8.1 Modulation Factors

Frequency	Protocol	E-field (V/m)	H-field (A/m)	E-Field PMF	H-Field PMF
835 MHz	AM	59.2	0.095	1.47	1.48
835 MHz	CDMA	86.4	0.139	1.01	1.01
835 MHz	CW	87.2	0.141	-	-
1880 MHz	AM	33.5	0.097	1.56	1.54
1880 MHz	CDMA	53.1	0.149	0.98	1.00
1880 MHz	CW	52.3	0.149	-	-
1880 MHz	CDMA/SO3	26.3	-	2.756	-
1880 MHz	CW	72.4	-	-	-

Table 8.1 Modulation Factors

8.2 CW and Modulated Signal Zero-span plots:

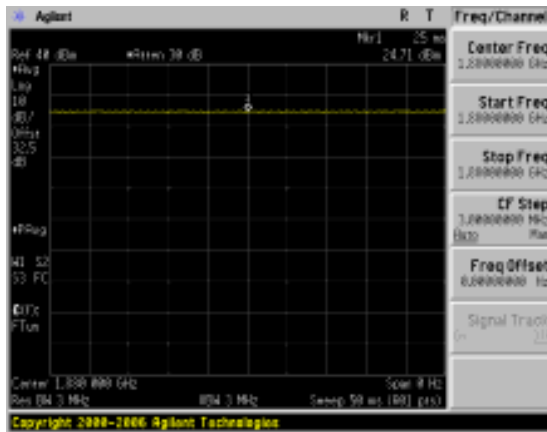


Figure 8.3 CW Signal

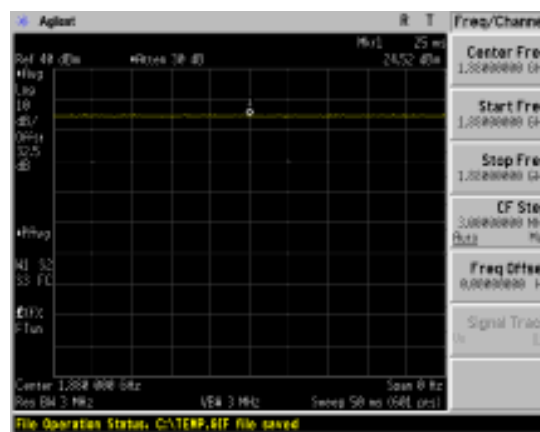


Figure 8.4 PCS Signal

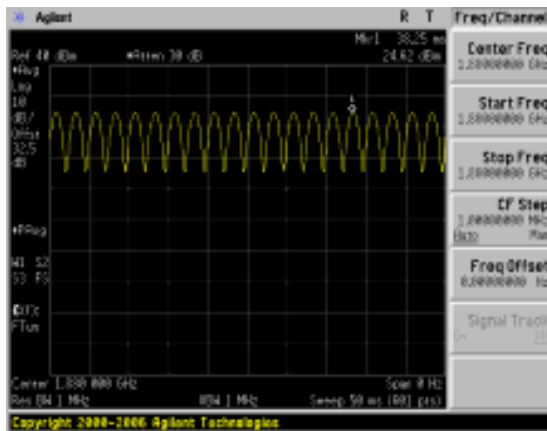


Figure 8.5 AM 80% Signal

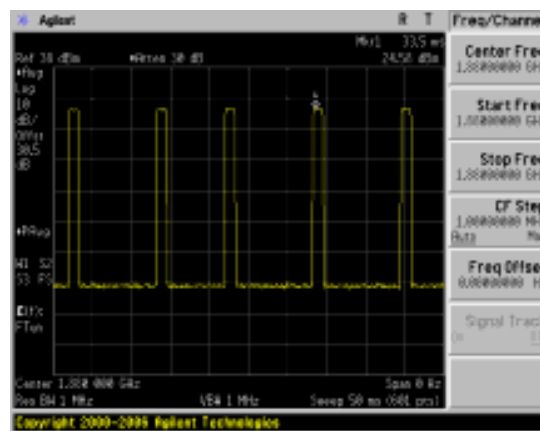


Figure 8.6 1/8 rate Signal

9. FCC 3G MEASUREMENTS – MAY/JUNE 2006

Sample pre-testing of the various modes were performed at the worst case probe location as part of subset testing justification. See below for measured conducted power for applicable device modes.

9.1 Handset Capabilities*

* See Device Capabilities attachment for applicable device modes and powers



9.2 Worst-Case Probe Location Measurements

Below are RC/SO mode investigation results of the device at the worst-case(maximum) field point location.

Mode	Channel	Back light	RC/SO	Battery	Antenna	Conducted Power at BS(dBm)	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]
E-field Emissions												
PCS	25	off	RC3/SO55	Standard	Intenna	24.7	52.2	51.17	34.18	M4	41.0	-6.82
PCS	25	on	RC3/SO55	Standard	Intenna	24.7	51.5	50.50	34.07	M4	41.0	-6.93
PCS	25	off	RC1/SO2	Standard	Intenna	24.7	51.2	50.16	34.01	M4	41.0	-6.99
PCS	25	off	RC3/SO2	Standard	Intenna	24.6	51.5	50.42	34.05	M4	41.0	-6.95
PCS	25	off	RC1/SO55	Standard	Intenna	24.4	51.0	50.01	33.98	M4	41.0	-7.02
PCS	25	off	RC2/SO9	Standard	Intenna	24.5	50.6	49.63	33.91	M4	41.0	-7.09
PCS	25	off	RC1/SO3	Standard	Intenna	24.6	18.1	49.91	33.96	M4	41.0	-7.04
PCS	25	off	RC3/SO3	Standard	Intenna	24.5	52.0	50.91	34.14	M4	41.0	-6.86
PCS	25	off	RC2/SO17	Standard	Intenna	24.7	18.2	50.16	34.01	M4	41.0	-6.99

Table 9-1 Handset 3G mode variation on RF Emission

10. Test Results

10.1 Measurement Results(E-field)

E-FIELD EMISSIONS:

Mode	Channel	Back light	RC/SO	Battery	Antenna	Conducted Power at BS(dBm)	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]	Excl Blocks Per 4.3.1.2.2
E-field Emissions													
CDMA	1013	off	RC3/SO55	Standard	Intenna	24.6	68.7	69.4	36.83	M4	51.0	-14.17	None
CDMA	384	off	RC3/SO55	Standard	Intenna	24.6	61.8	62.4	35.90	M4	51.0	-15.10	None
CDMA	777	off	RC3/SO55	Standard	Intenna	24.6	66.9	67.6	36.60	M4	51.0	-14.40	None
PCS	25	off	RC3/SO55	Standard	Intenna	24.7	53.0	51.9	34.30	M4	41.0	-6.70	None
PCS	600	off	RC3/SO55	Standard	Intenna	24.6	47.0	46.1	33.27	M4	41.0	-7.73	None
PCS	1175	off	RC3/SO55	Standard	Intenna	24.6	43.6	42.7	32.61	M4	41.0	-8.39	None
PCS	25	on	RC3/SO55	Standard	Intenna	24.7	51.8	50.80	34.12	M4	41.0	-6.88	None

NOTES:

- The test data reported are the worst-case HAC value with the test position set in a typical configuration. Test procedures used are according to ANSI C 63.19 (2007).
- All modes of operation were investigated, and the worst-case results are reported.
- Battery is fully charged for all readings.
- *Power Measured ☒ Conducted
- Battery Option ☒ Standard ☐ Extended ☐ Slim
- Bluetooth deactivated (According to customer's request)

Note: Worst-case measurement evaluated for worst-case 1/8 rate gating condition in RC1/SO3; Mute=Yes

10.2 Measurement Results(H-field)

H-FIELD EMISSIONS:

Mode	Channel	Back light	RC/SO	Battery	Antenna	Conducted Power at BS(dBm)	Time Avg. Field [A/m]	Peak Field [A/m]	Peak Field [dBA/m]	Category	FCC limit [dBA/m]	FCC Margin [dB]	Excl Blocks Per 4.3.1.2.2
H-field Emissions													
CDMA	1013	off	RC3/SO55	Standard	Intenna	24.6	0.101	0.101	-19.91	M4	0.6	-20.51	None
CDMA	384	off	RC3/SO55	Standard	Intenna	24.6	0.131	0.131	-17.65	M4	0.6	-18.25	None
CDMA	777	off	RC3/SO55	Standard	Intenna	24.6	0.144	0.144	-16.83	M4	0.6	-17.43	None
PCS	25	off	RC3/SO55	Standard	Intenna	24.7	0.114	0.114	-18.86	M4	-9.4	-9.46	None
PCS	600	off	RC3/SO55	Standard	Intenna	24.6	0.103	0.103	-19.74	M4	-9.4	-10.34	None
PCS	1175	off	RC3/SO55	Standard	Intenna	24.6	0.100	0.100	-20.00	M4	-9.4	-10.60	None

NOTES:

1. The test data reported are the worst-case HAC value with the test position set in a typical configuration. Test procedures used are according to ANSI C 63.19 (2007).
2. All modes of operation were investigated, and the worst-case results are reported.
3. Battery is fully charged for all readings.
4. *Power Measured ☒ Conducted
5. Battery Option ☒ Standard ☐ Extended ☐ Slim
6. Bluetooth deactivated (According to customer's request)

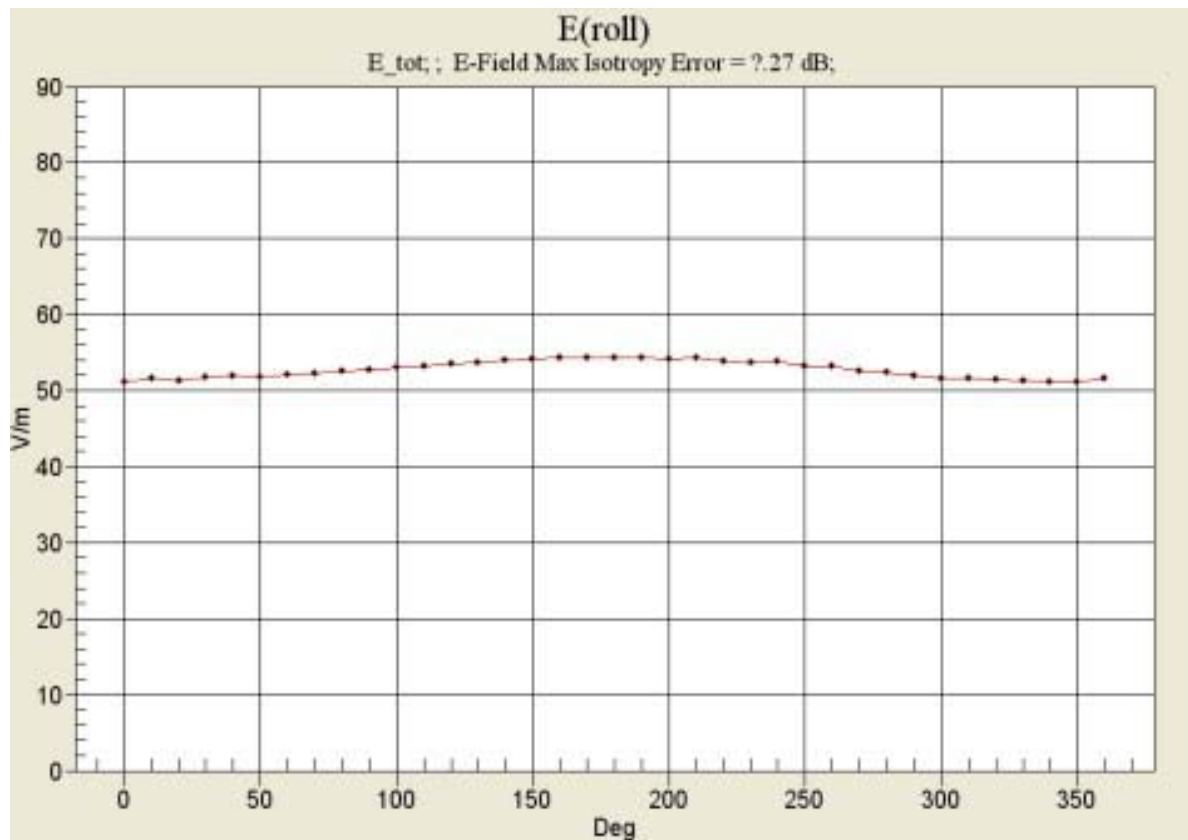
Note: Worst-case measurement evaluated for worst-case 1/8 rate gating condition in RC1/SO3; Mute=Yes

10.3 Worst-case Configuration Evaluation

PCS E-field Emission

Mode	Channel	Back light	RC/SO	Battery	Antenna	Conducted Power at BS(dBm)	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]
E-field Emission												
PCS	25	off	RC3/SO55	Standard	Intenna	24.7	54.4	53.3	34.53	M4	41.0	-6.47

Peak Reading 360 degree Probe Rotation at Azimuth axis



Worst-Case Probe Rotation about Azimuth axis

Note: Location of probe rotation is shown in APPENDIX E

11. REFERENCES

- [1] ANSI C63.19–2007, American National Standard for Methods of Measurement of Compatibility between Wireless communication devices and Hearing Aids.", New York, NY, IEEE, June. 2008.
- [2] Berger, H. S., "Compatibility Between Hearing Aids and Wireless Devices," Electronic Industries Forum, Boston, MA, May, 1997
- [3] Berger, H. S., "Hearing Aid and Cellular Phone Compatibility: Working Toward Solutions," Wireless Telephones and Hearing Aids: New Challenges for Audiology, Gallaudet University, Washington, D.C., May, 1997 (To be reprinted in the American Journal of Audiology).
- [4] Berger, H. S., "Hearing Aid Compatibility with Wireless Communications Devices," IEEE International Symposium on Electromagnetic Compatibility, Austin, TX, August, 1997.
- [5] Bronaugh, E. L., "Simplifying EMI Immunity (Susceptibility) Tests in TEM Cells," in the 1990 IEEE International Symposium on Electromagnetic Compatibility Symposium Record, Washington, D.C., August 1990, pp. 488–491
- [6] Byrne, D. and Dillon, H., The National Acoustics Laboratory (NAL) New Procedure for Selecting the Gain and Frequency Response of a Hearing Aid, Ear and Hearing 7:257–265, 1986.
- [7] Crawford, M. L., "Measurement of Electromagnetic Radiation from Electronic Equipment using TEM Transmission Cells," U.S. Department of Commerce, National Bureau of Standards, NBSIR 73–306, Feb. 1973.
- [8] Crawford, M. L., and Workman, J. L., "Using a TEM Cell for EMC Measurements of Electronic Equipment," U.S. Department of Commerce, National Bureau of Standards. Technical Note 1013, July 1981.
- [9] EHIMA GSM Project, Development phase, Project Report (1st part) Revision A. Technical–Audiological Laboratory and Telecom Denmark, October 1993.
- [10] EHIMA GSM Project, Development phase, Part II Project Report. Technical–Audiological Laboratory and Telecom Denmark, June 1994.
- [11] EHIMA GSM Project Final Report, Hearing Aids and GSM Mobile Telephones: Interference Problems, Methods of Measurement and Levels of Immunity. Technical–Audiological Laboratory and Telecom Denmark, 1995.
- [12] FCC WT Docket No. 01–309 (HAC Waiver 05–166). Cingular Wireless LLC Petition for Waiver of Section 20.19(c)(3)(i)(A) of the Commission's Rules, September 8, 2005.
- [13] HAMPIS Report, Comparison of Mobile phone electromagnetic near field with an upscaled electromagnetic far field, using hearing aid as reference, 21 October 1999.
- [14] Hearing Aids/GSM, Report from OTWIDAM, Technical–Audiological Laboratory and Telecom Denmark, April 1993.
- [15] IEEE 100, The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition.



[16] Joyner, K. H., et. al., Interference to Hearing Aids by the New Digital Mobile Telephone System, Global System for Mobile (GSM) Communication Standard, National Acoustic Laboratory, Australian Hearing Series, Sydney 1993.

[17] Joyner, K. H., et. al., Interference to Hearing Aids by the Digital Mobile Telephone System, Global System for Mobile Communications (GSM), NAL Report #131, National Acoustic Laboratory Australian Hearing Series, Sydney, 1995.

[18] Keeker, W. T., Crawford, M. L., and Wilson, W. A., "Construction of a Transverse Electromagnetic Cell", U.S. Department of Commerce, National Bureau of Standards, Technical Note 1011, Nov. 1978.

[19] Konigstein, D., and Hansen, D., "A New Family of TEM Cells with enlarged bandwidth and Optimized working Volume," in the Proceedings of the 7th International Symposium on EMC, Zurich, Switzerland, March 1987; 50:9, pp. 127-132.

[20] Kuk, F., and Hjorstgaard, N. K., "Factors affecting interference from digital cellular telephones," Hearing Journal, 1997; 50:9, pp 32-34.

[21] Ma, M. A., and Kanda, M., "Electromagnetic Compatibility and Interference Metrology," U.S. Department of Commerce, National Bureau of Standards, Technical Note 1099, July 1986, pp.17-43.

[22] Ma, M. A., Sreenivashiah, I. , and Chang, D. C, "A Method of Determining the Emission and Susceptibility Levels of Electrically Small Objects Using a TEM Cell," U.S. Department of Commerce, National Bureau of Standards, Technical Note 1040, July 1981.

[23] McCandless, G. A., and Lyregaard, P. E., Prescription of Gain/Output (POGO) for Hearing Aids, Hearing Instruments 1:16-21, 1983

[24] Skopec, M., "Hearing Aid Electromagnetic Interference from Digital Wireless Telephones," IEEE Transactions on Rehabilitation Engineering, vol. 6, no. 2, pp. 235-239, June 1998.

[25] Technical Report, GSM 05.90, GSM EMC Considerations, European Telecommunications Standards Institute, January 1993.

[26] Victorian, T. A., "Digital Cellular Telephone Interference and Hearing Aid Compatibility—an Update," Hearing Journal 1998; 51:10, pp. 53-60

[27] Wong, G. S. K., and Embleton, T. F. W., eds., AIP Handbook of Condenser Microphones: Theory, Calibration and Measurements, AIP Press.

APPENDIX A

Probe Modulation Factor

Measurement procedure

1. Modulated signal measurement: Connect the modulated signal with the correct frequency via the cable to the dipole.
2. Run the multimeter in the procedure with the corresponding modulation setting in continuous mode.
3. Adjust the signal amplitude to achieve the same field level display in the multimeter as during the WD field scan. Read the multimeter display and note it together with the probe ID, modulation type and frequency.
4. Read the peak envelope on the monitor in order to adjust the CW signal later to the same level.
5. Switch the signal source off and verify that the ambient and instrumentation noise level is at least 10dB lower.
6. CW measurement: Change the signal to CW at the same center frequency, without touching or moving the dipole or probe in the setup.
7. Adjust the CW signal amplitude to the same peak level on the monitor.
8. Run the multimeter in the CW procedure in continuous mode.
9. Read the multimeter display and note it together with the probe ID, modulation type and frequency.
10. Calculate the Probe Modulation Factor as the ratio between the CW multimeter field reading and the reading for the applicable modulation.
11. Perform the above setup and procedure for E-field and H-field probes.

Spectrum Analyzer setting.

1. Frequency Setting

ex) 835 MHz, 1880MHz, 2450 MHz

2. RBW/VBW/SPAN/Detector Setting.

	CW	GSM	CDMA	WCDMA	AM80%
RBW	Same setting with modulated signal respectively.	1MHz	3MHz	5MHz	1MHz
VBW		1MHz	3MHz	5MHz	1MHz
SPAN		0MHz	0MHz	0MHz	0MHz
DETECTOR		Peak	Average	Average	Peak

3. Trigger: Video or IF trigger, adjusted to give a stable display of the transmission
4. Sweep rate: Sufficiently rapid to permit the transmit pulse to be resolved accurately.

APPENDIX B

ANSI C63.19 (2007)- Telephone near-field categories.

Category	Telephone RF Parameters <960MHz				
Near Field	AWF	E-Field Emissions		H-Field Emissions	
Category M1/T1	0	631.0 to 1122.0	V/m	1.91 to 3.39	A/m
	-5	473.2 to 841.4	V/m	1.43 to 2.54	A/m
Category M2/T2	0	354.8 to 631.0	V/m	1.07 to 1.91	A/m
	-5	266.1 to 473.2	V/m	0.80 to 1.43	A/m
Category M3/T3	0	199.5 to 354.8	V/m	0.60 to 1.07	A/m
	-5	149.6 to 266.1	V/m	0.45 to 0.80	A/m
Category M4/T4	0	< 199.5	V/m	< 0.60	A/m
	-5	< 149.6	V/m	< 0.45	A/m
Category	Telephone RF Parameters >960MHz				
Near Field	AWF	E-Field Emissions		H-Field Emissions	
Category M1/T1	0	199.5 to 354.8	V/m	0.60 to 1.07	A/m
	-5	149.6 to 266.1	V/m	0.45 to 0.80	A/m
Category M2/T2	0	112.2 to 199.5	V/m	0.34 to 0.60	A/m
	-5	84.1 to 149.6	V/m	0.25 to 0.45	A/m
Category M3/T3	0	63.1 to 112.2	V/m	0.19 to 0.34	A/m
	-5	47.3 to 84.1	V/m	0.14 to 0.25	A/m
Category M4/T4	0	<63.1	V/m	<0.19	A/m
	-5	<47.3	V/m	<0.14	A/m

Table B.1 Telephone near-field categories in linear units.

Category	Telephone RF Parameters <960MHz				
Near Field	AWF	E-Field Emissions		H-Field Emissions	
Category M1/T1	0	56 to 61	dB (V/m)	+5.6 to +10.6	dB (A/m)
	-5	53.5 to 58.5	dB (V/m)	+3.1 to +8.1	dB (A/m)
Category M2/T2	0	51 to 56	dB (V/m)	+0.6 to +5.6	dB (A/m)
	-5	48.5 to 53.5	dB (V/m)	-1.9 to +3.1	dB (A/m)
Category M3/T3	0	46 to 51	dB (V/m)	-4.4 to +0.6	dB (A/m)
	-5	43.5 to 48.5	dB (V/m)	-6.9 to -1.9	dB (A/m)
Category M4/T4	0	<46	dB (V/m)	< -4.4	dB (A/m)
	-5	< 43.5	dB (V/m)	< -6.9	dB (A/m)
Category	Telephone RF Parameters >960MHz				
Near Field	AWF	E-Field Emissions		H-Field Emissions	
Category M1/T1	0	46 to 51	dB (V/m)	-4.4 to 0.6	dB (A/m)
	-5	43.5 to 48.5	dB (V/m)	-6.9 to -1.9	dB (A/m)
Category M2/T2	0	41 to 46	dB (V/m)	-9.4 to -4.4	dB (A/m)
	-5	38.5 to 43.5	dB (V/m)	-11.9 to -6.9	dB (A/m)
Category M3/T3	0	36 to 41	dB (V/m)	-14.4 to -9.4	dB (A/m)
	-5	33.5 to 38.5	dB (V/m)	-16.9 to -11.9	dB (A/m)
Category M4/T4	0	<36	dB (V/m)	<-14.4	dB (A/m)
	-5	<33.5	dB (V/m)	<-16.9	dB (A/m)

Table B.2 Telephone near-field categories in logarithmic units.



APPENDIX C

The Validation Measurements

DUT: HAC Dipole 835 MHz; Serial: SN:1021
Program Name: HAC H-field Dipole, Date : 2009/06/12
Procedure Name: H Scan 10mm above CD 835 MHz

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: H Dipole Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn486; Calibrated: 2009-04-01
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1021
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.437 A/m

Probe Modulation Factor = 1.00

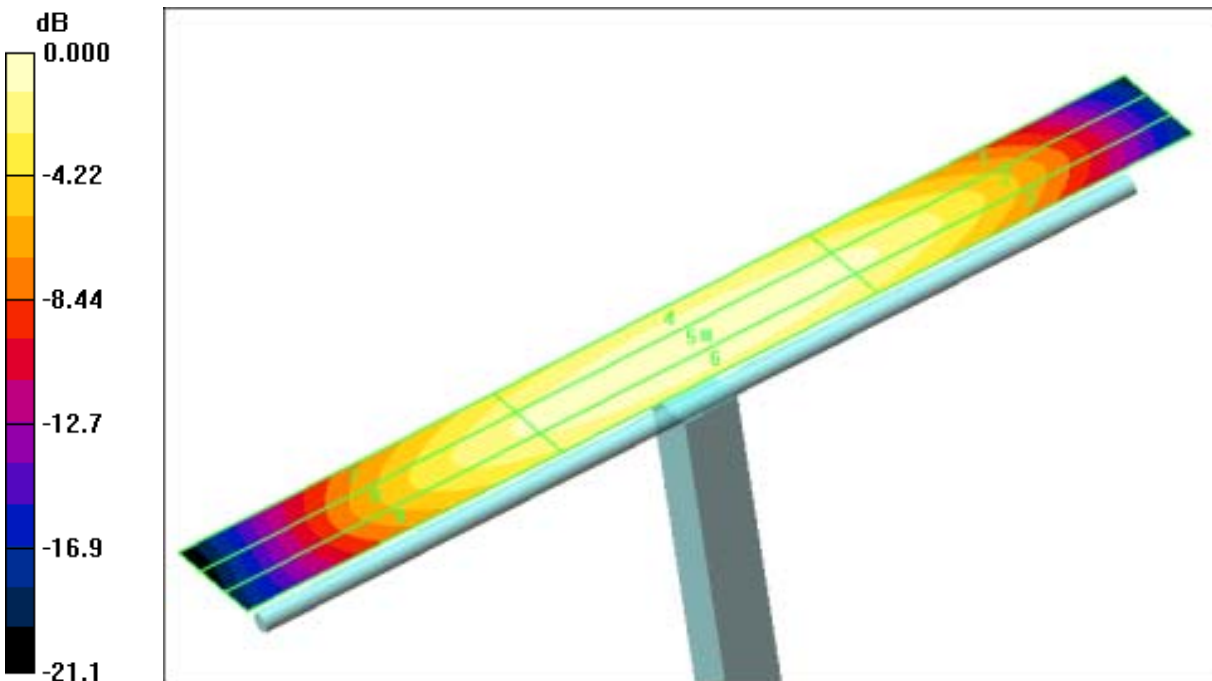
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 0.463 A/m; Power Drift = 0.015 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.369 M4	Grid 2 0.394 M4	Grid 3 0.379 M4
Grid 4 0.411 M4	Grid 5 0.437 M4	Grid 6 0.424 M4
Grid 7 0.361 M4	Grid 8 0.386 M4	Grid 9 0.375 M4



0 dB = 0.437A/m

DUT: HAC Dipole 835 MHz; Serial: SN:1021
Program Name: HAC E-field Dipole, Date : 2009/06/12
Procedure Name: E Scan 10mm above CD 835 MHz

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: E Dipole Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn486; Calibrated: 2009-04-01
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

E Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 176.0 V/m

Probe Modulation Factor = 1.00

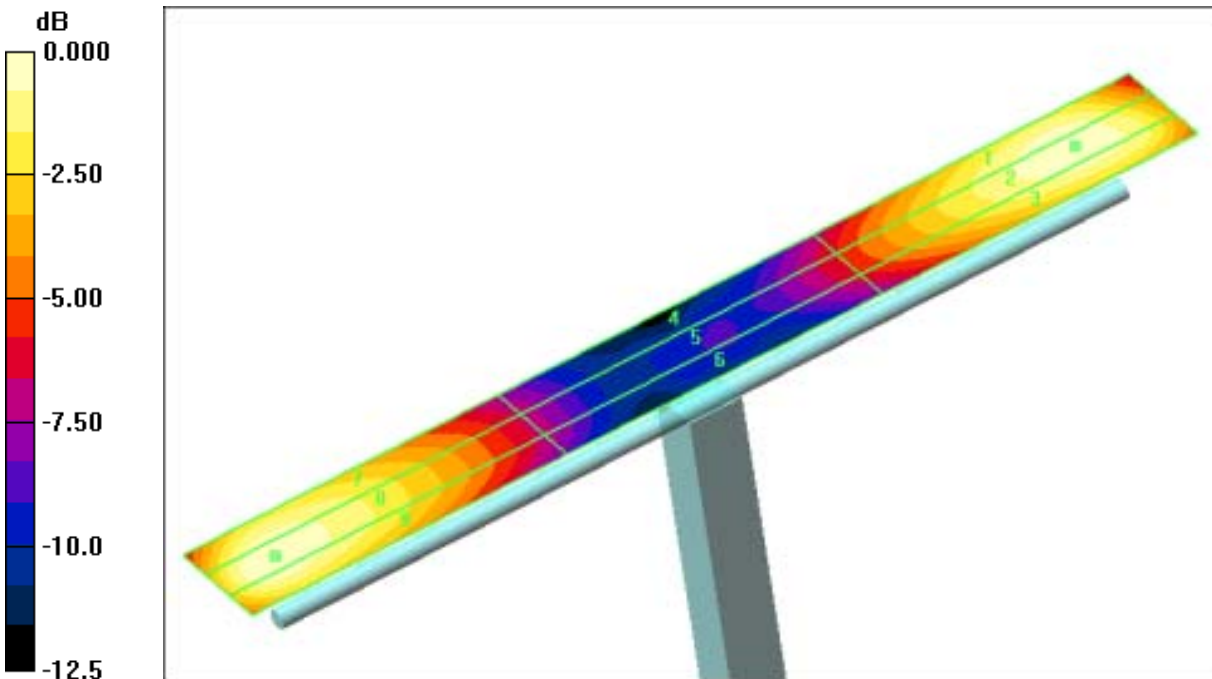
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 114.0 V/m; Power Drift = -0.037 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1 170.9 M4	Grid 2 173.3 M4	Grid 3 166.5 M4
Grid 4 90.0 M4	Grid 5 91.5 M4	Grid 6 87.8 M4
Grid 7 168.9 M4	Grid 8 176.0 M4	Grid 9 170.8 M4



0 dB = 176.0V/m

DUT: HAC Dipole 1880 MHz; Serial: SN:1016
Program Name: HAC H-field Dipole, Date : 2009/06/12
Procedure Name: H Scan 10mm above CD 1880 MHz

Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: H Dipole Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn486; Calibrated: 2009-04-01
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.444 A/m

Probe Modulation Factor = 1.00

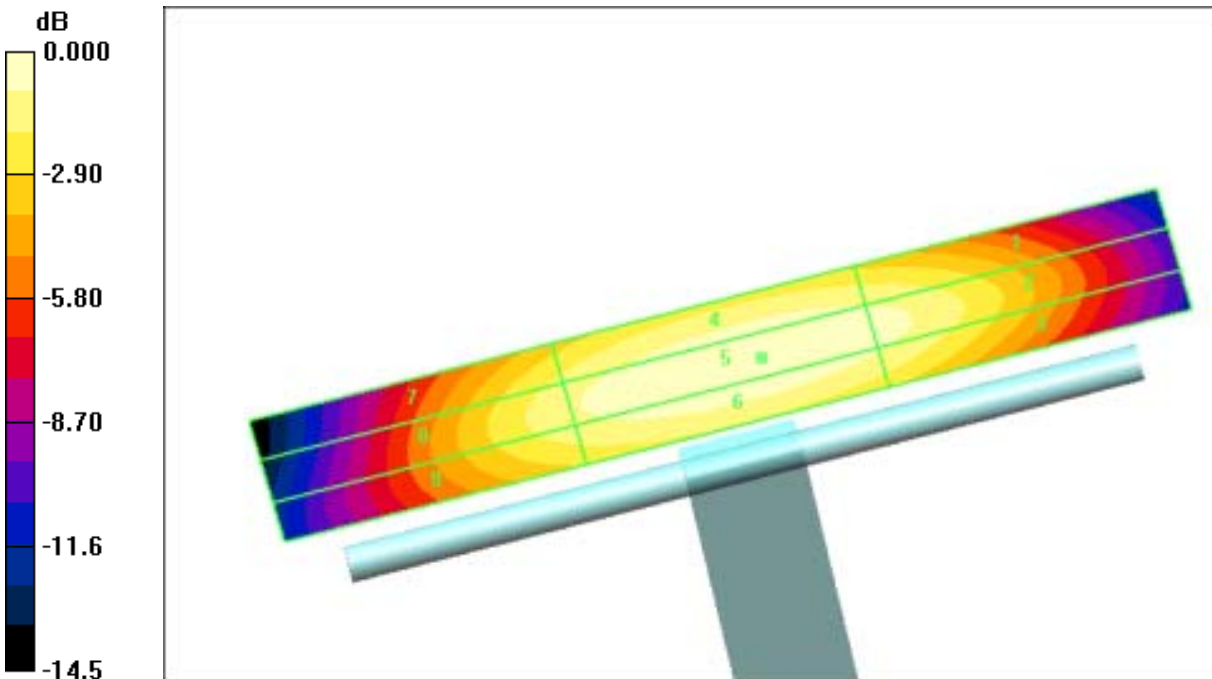
Device Reference Point: 0.000, 0.000, 354.7 mm

Reference Value = 0.442 A/m; Power Drift = -0.015 dB

Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.397 M2	Grid 2 0.419 M2	Grid 3 0.403 M2
Grid 4 0.421 M2	Grid 5 0.444 M2	Grid 6 0.428 M2
Grid 7 0.368 M2	Grid 8 0.391 M2	Grid 9 0.381 M2



0 dB = 0.444A/m

D : HAC Dipole 1880 MHz; Serial: SN:1016
ro ra Na e: HAC iel Dipole Da e : 2009 06 12
ro e ure Na e: S a 10 a o e CD 1880 MHz

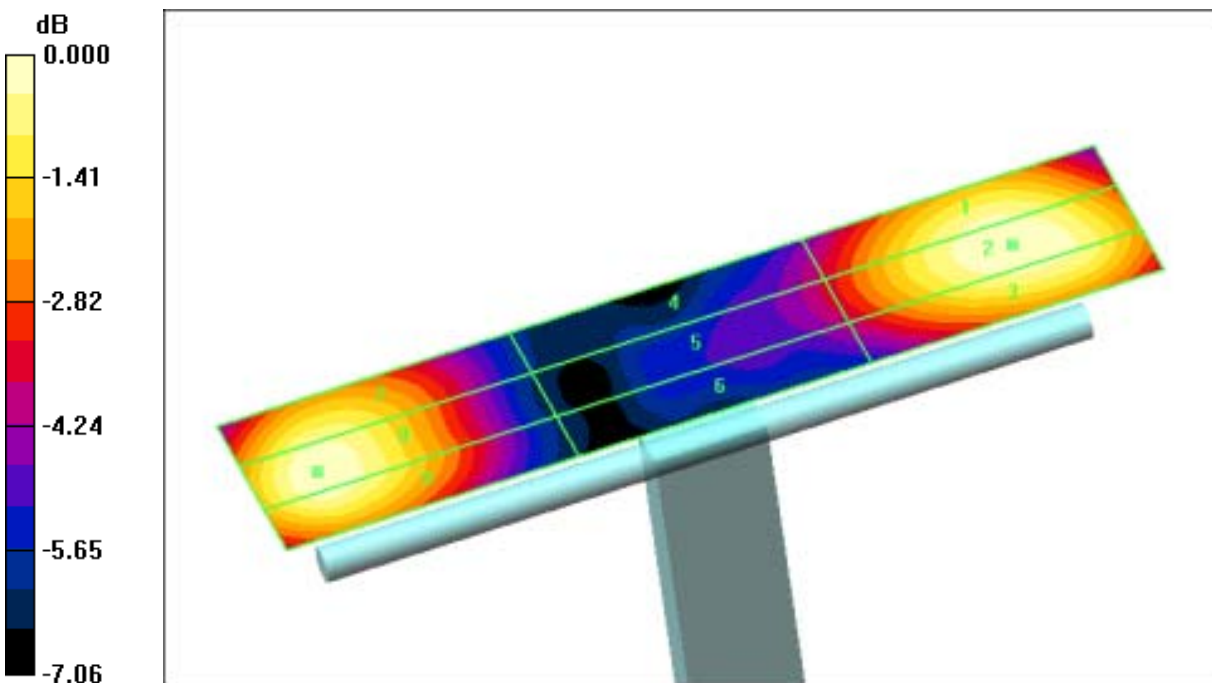
Communication System: CW; Frequency: 1880 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: E Dipole Section

DASY4 Configuration:
- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn486; Calibrated: 2009-04-01
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

S a 10 a o e CD 1880 MHz Heari Ai Co pa i ili e 1 181 1 : Measurement
grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 143.0 V/m
Probe Modulation Factor = 1.00
Device Reference Point: 0.000, 0.000, 354.7 mm
Reference Value = 160.9 V/m; Power Drift = 0.006 dB
Heari Ai Near iel Ca e or : M2 A 0

Peak E-field in V/m

Grid 1 139 1 M2	Grid 2 1 2 1 M2	Grid 3 138 5 M2
Grid 4 9 5 M3	Grid 5 95 8 M3	Grid 6 91 2 M3
Grid 7 135 M2	Grid 8 1 3 0 M2	Grid 9 1 0 2 M2



0 dB = 143.0V/m



APPENDIX D

Plots of The HAC Measurements

D : SCH i920; Serial: AG 061 A

ro ra Na e: SCH i920 CDMA iel Da e:2009 06 12

ro e ure Na e: Ch 1013 A I e a a S a ar RC3 SO55

Communication System: CDMA(HAC); Frequency: 824.7 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch 1013 A I e a a S a ar RC3 SO55 Heari Ai Co pa i ili e

101 101 1 : Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 69.4 V/m

Probe Modulation Factor = 1.01

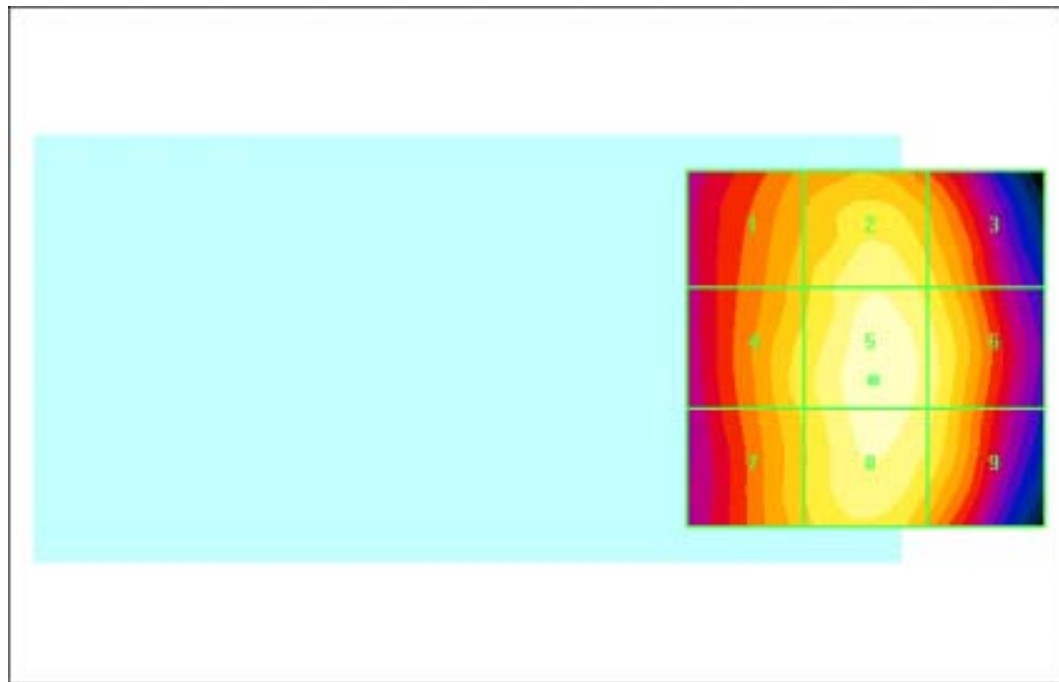
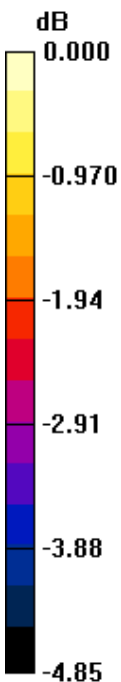
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 87.7 V/m; Power Drift = 0.173 dB

Heari Ai Near iel Ca e or : M A 0

Peak E-field in V/m

Grid 1 61 5 M	Grid 2 66 M	Grid 3 63 6 M
Grid 4 63 8 M	Grid 5 69 M	Grid 6 66 1 M
Grid 7 62 8 M	Grid 8 68 M	Grid 9 65 M



0 dB = 69.4V/m

D : SCH i920; Serial: AG 061 A

ro ra Na e: SCH i920 CDMA iel Da e:2009 06 12

ro e ure Na e: Ch 038 A I e a a S a ar RC3 SO55

Communication System: CDMA(HAC); Frequency: 836.52 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch 038 A I e a a S a ar RC3 SO55 Heari Ai Co pa i ili e

101 101 1 : Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 62.4 V/m

Probe Modulation Factor = 1.01

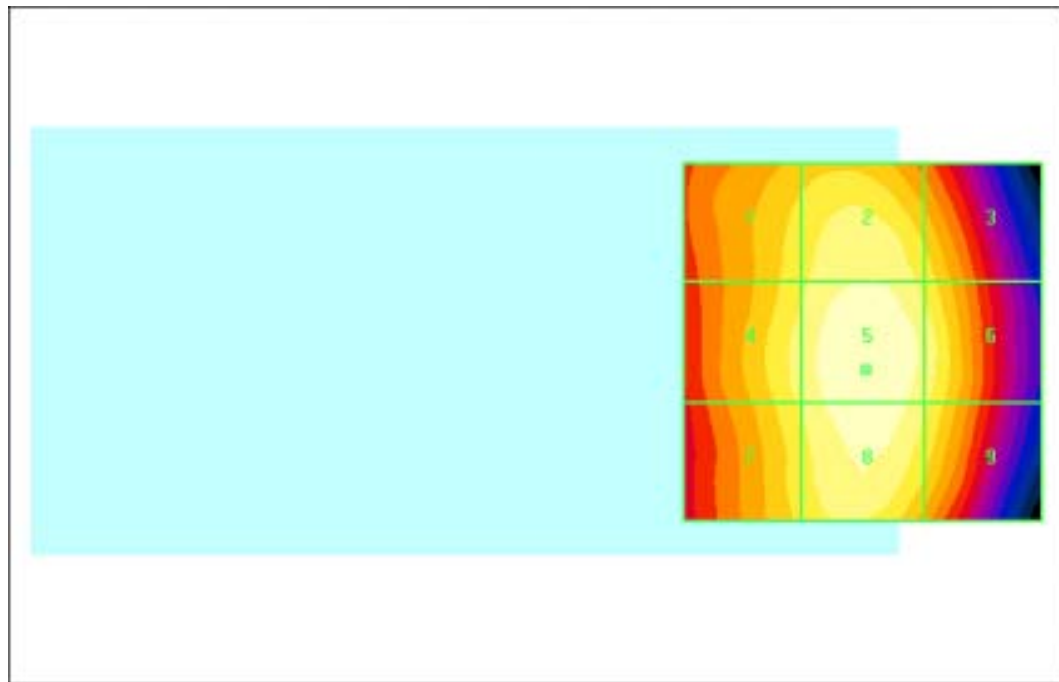
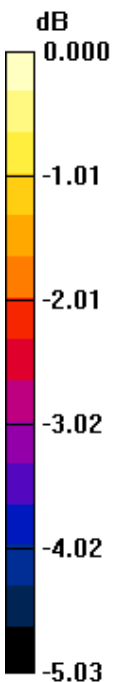
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 80.3 V/m; Power Drift = -0.013 dB

Heari Ai Near iel Ca e or : M A 0

Peak E-field in V/m

Grid 1 5 3 M	Grid 2 60 1 M	Grid 3 5 1 M
Grid 4 58 9 M	Grid 5 62 M	Grid 6 59 5 M
Grid 7 58 2 M	Grid 8 61 5 M	Grid 9 58 M



0 dB = 62.4V/m

D : SCH i920; Serial: AG 061 A

ro ra Na e: SCH i920 CDMA iel Da e:2009 06 12

ro e ure Na e: Ch 0 A I e a a S a ar RC3 SO55

Communication System: CDMA(HAC); Frequency: 848.31 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch 0 A I e a a S a ar RC3 SO55 Heari Ai Co pa i ili e

101 101 1 : Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 67.6 V/m

Probe Modulation Factor = 1.01

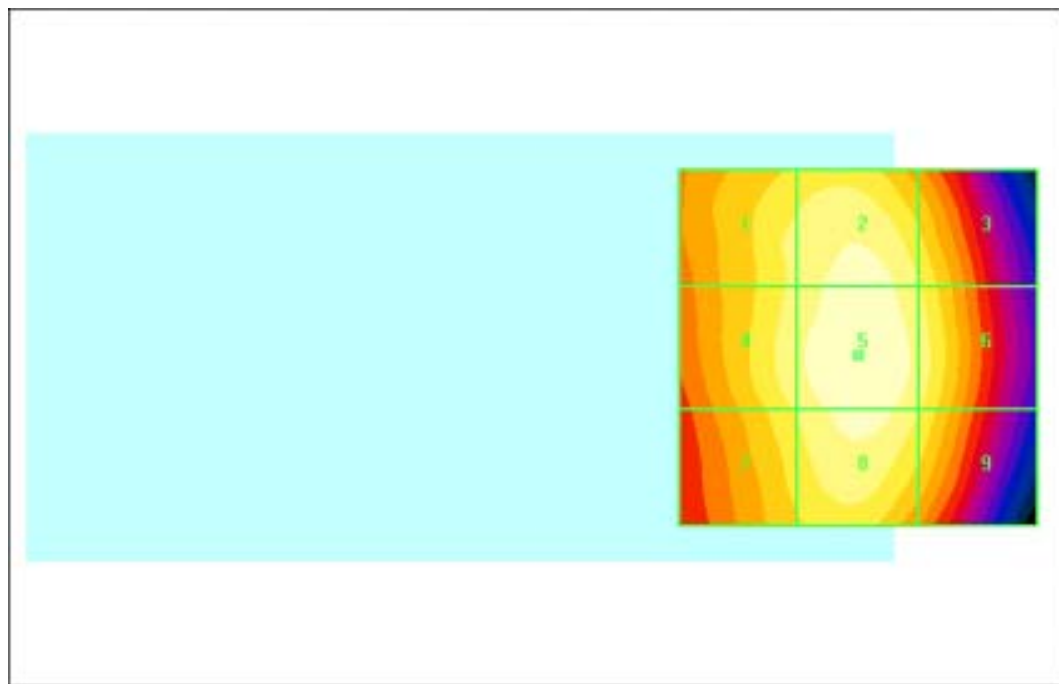
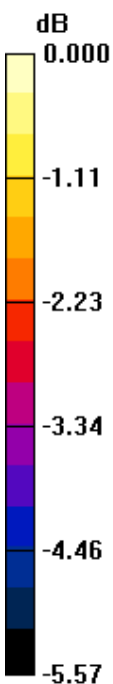
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 88.0 V/m; Power Drift = -0.030 dB

Heari Ai Near iel Ca e or : M A 0

Peak E-field in V/m

Grid 1 63 0 M	Grid 2 66 1 M	Grid 3 62 3 M
Grid 4 6 1 M	Grid 5 6 6 M	Grid 6 63 M
Grid 7 62 5 M	Grid 8 66 2 M	Grid 9 62 2 M



0 dB = 67.6V/m

D : SCH i920; Serial: AG 061 A

ro ra Na e: SCH i920 CS iel Da e:2009 06 12

ro e ure Na e: Ch 25 A I e a a S a ar RC3 SO55

Communication System: PCS; Frequency: 1851.25 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.25, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1):

Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 51.9 V/m

Probe Modulation Factor = 0.980

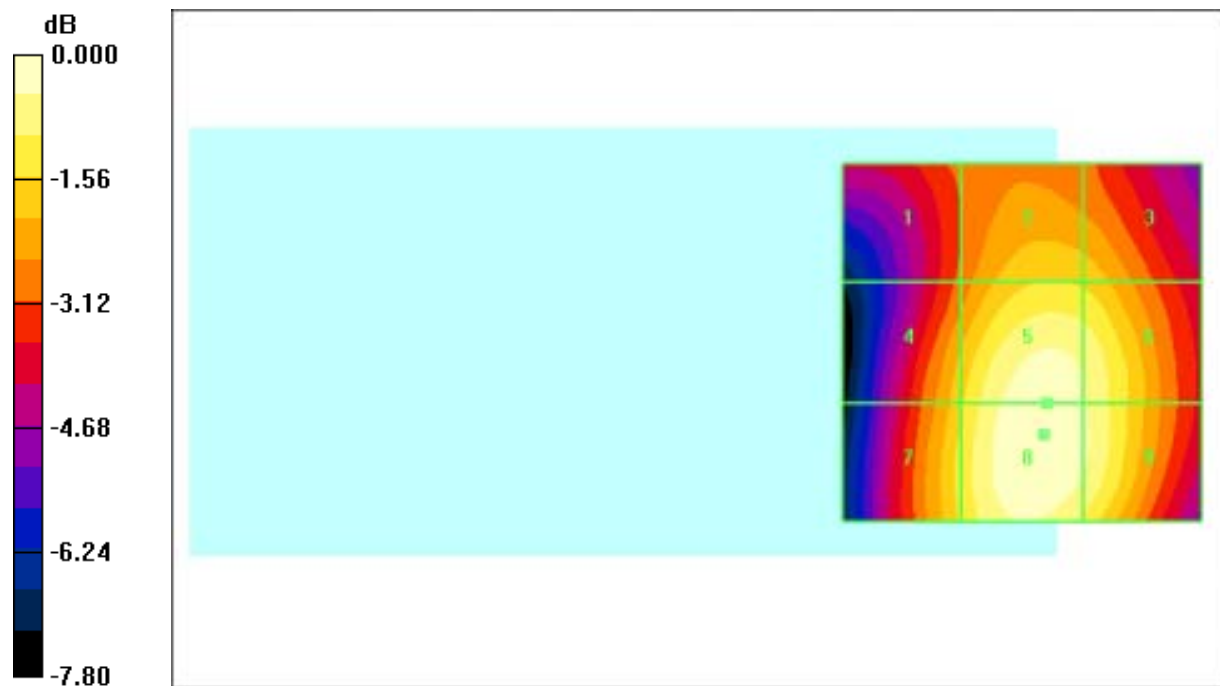
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 62.4 V/m; Power Drift = 0.021 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
37.1 M4	43.5 M4	42.9 M4
Grid 4	Grid 5	Grid 6
42.9 M4	51.6 M4	49.4 M4
Grid 7	Grid 8	Grid 9
44.3 M4	51.9 M4	49.7 M4



DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS), E-Field, Date:2009/06/12

Procedure Name: Ch.600, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.600, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test

(101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 46.1 V/m

Probe Modulation Factor = 0.980

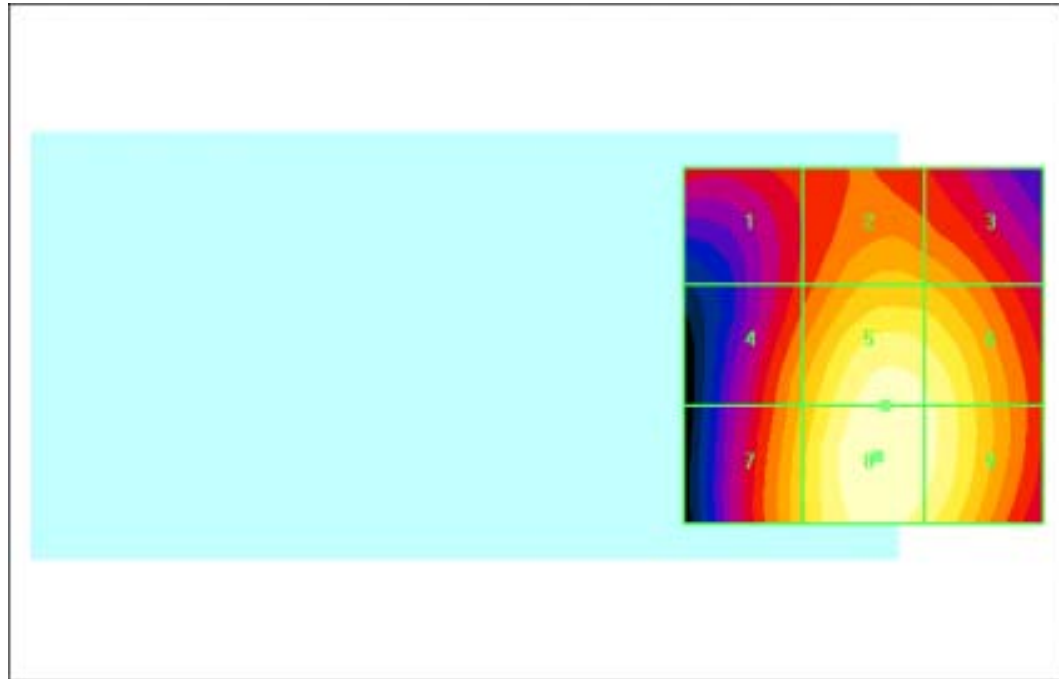
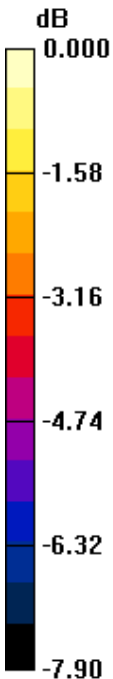
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 54.1 V/m; Power Drift = -0.149 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
31.3 M4	37.2 M4	36.4 M4
Grid 4	Grid 5	Grid 6
36.5 M4	44.9 M4	44.1 M4
Grid 7	Grid 8	Grid 9
38.2 M4	46.1 M4	44.5 M4



0 dB = 46.1V/m

DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS), E-Field, Date:2009/06/12

Procedure Name: Ch.1175, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: PCS; Frequency: 1908.75 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.1175, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 42.7 V/m

Probe Modulation Factor = 0.980

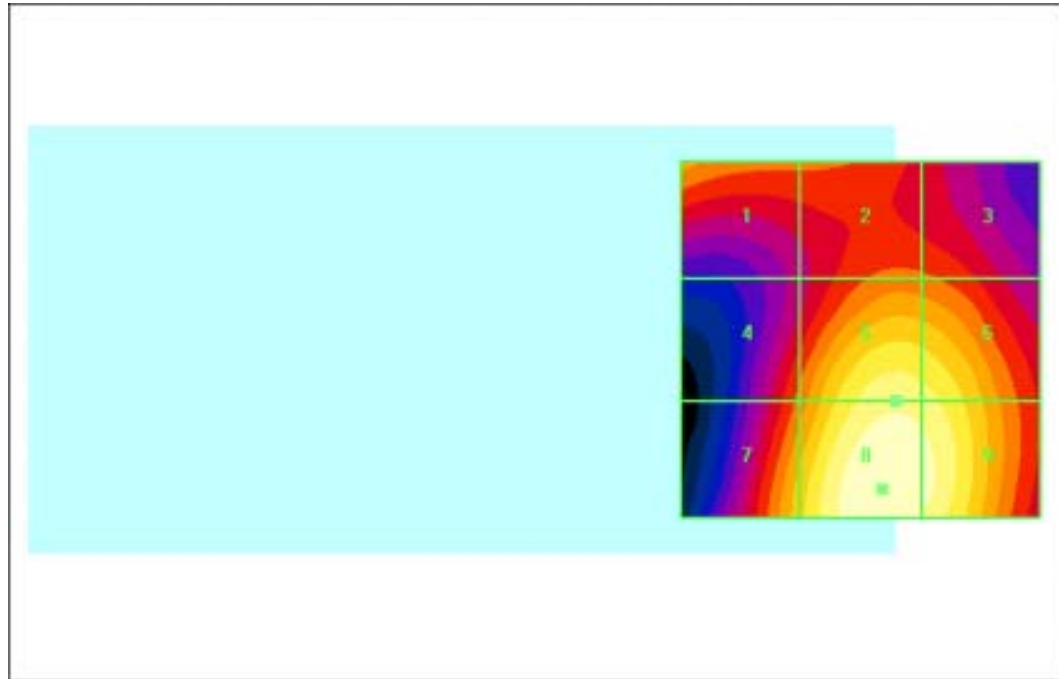
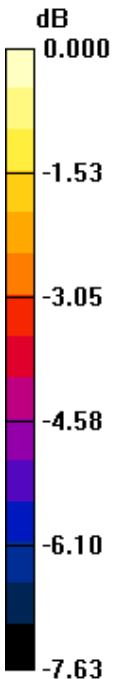
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 45.8 V/m; Power Drift = -0.080 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
32.9 M4	30.8 M4	30.6 M4
Grid 4	Grid 5	Grid 6
30.8 M4	39.6 M4	39.0 M4
Grid 7	Grid 8	Grid 9
35.2 M4	42.7 M4	41.4 M4



0 dB = 42.7V/m

DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS), E-Field, Date:2009/06/12

Procedure Name: Ch.25, Ant, Intenna, Bat. Standard(RC3/SO55) BackLight ON

Communication System: PCS; Frequency: 1851.25 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2009-03-10

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.25, Ant, Intenna, Bat. Standard(RC3/SO55) BackLight ON/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 50.8 V/m

Probe Modulation Factor = 0.980

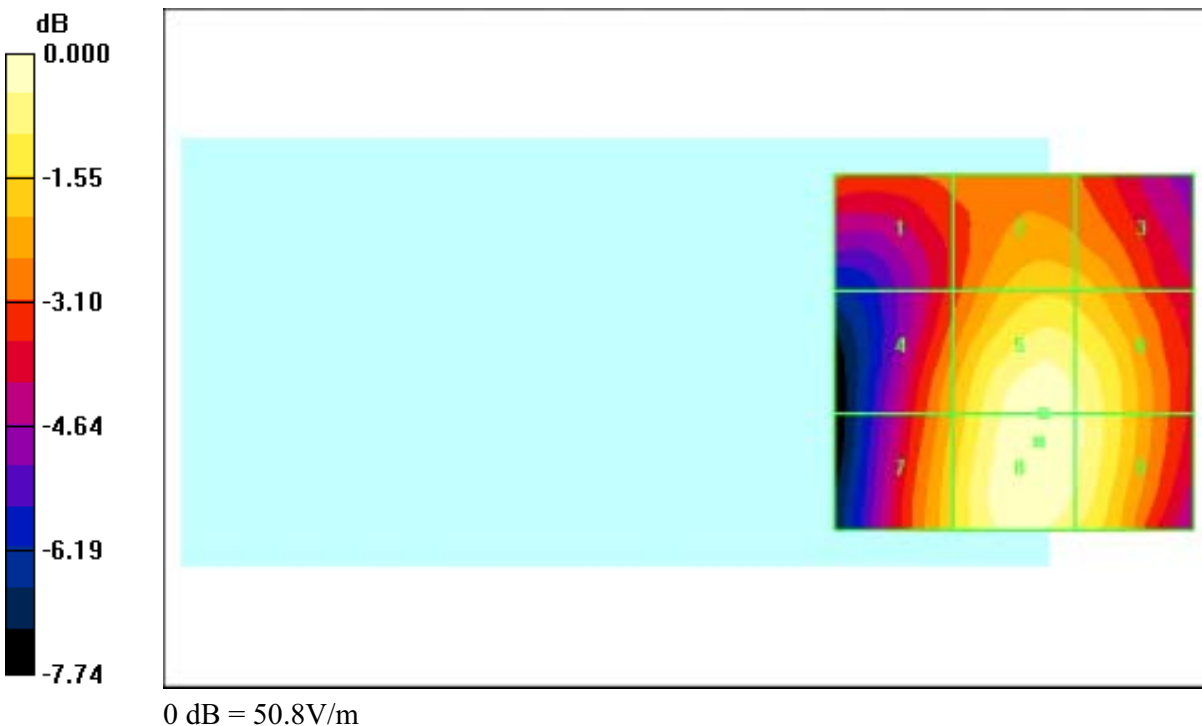
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 61.2 V/m; Power Drift = 0.120 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1 36.4 M4	Grid 2 42.2 M4	Grid 3 41.6 M4
Grid 4 40.3 M4	Grid 5 50.4 M4	Grid 6 48.6 M4
Grid 7 42.5 M4	Grid 8 50.8 M4	Grid 9 48.8 M4



DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(CDMA) H-Field, Date:2009/06/12

Procedure Name: Ch.1013, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA(HAC); Frequency: 824.7 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.1013, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.139 A/m

Probe Modulation Factor = 1.01

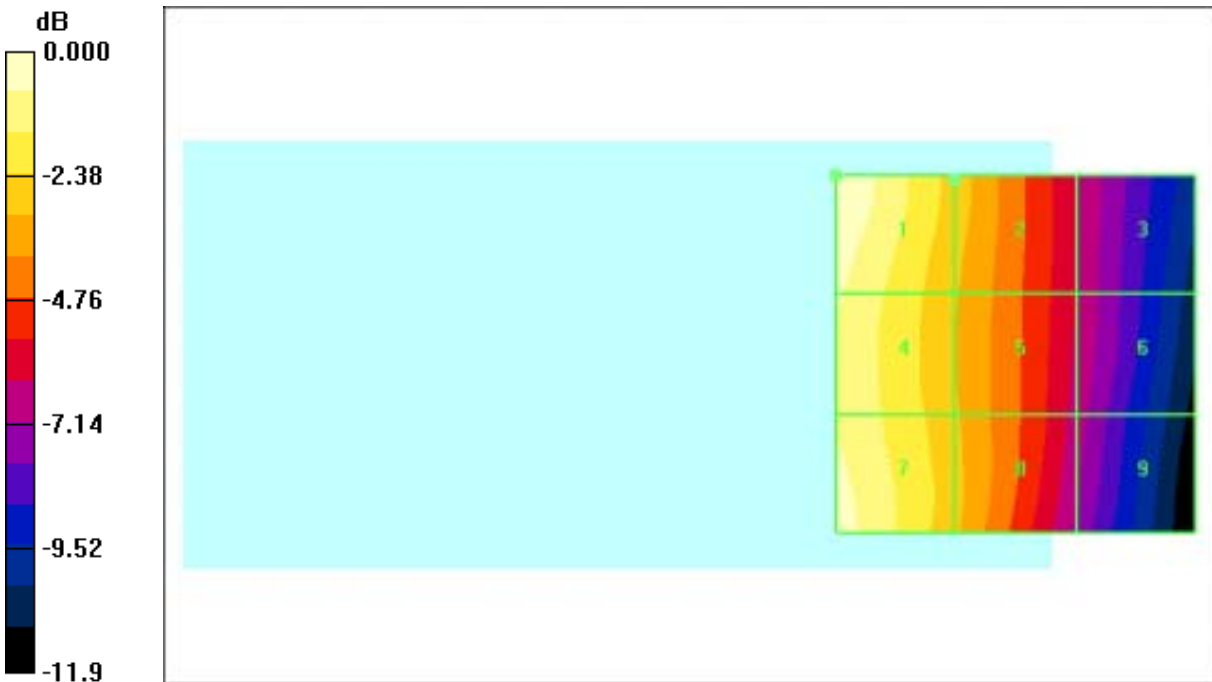
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.089 A/m; Power Drift = -0.049 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.139 M4	Grid 2 0.102 M4	Grid 3 0.067 M4
Grid 4 0.129 M4	Grid 5 0.098 M4	Grid 6 0.067 M4
Grid 7 0.133 M4	Grid 8 0.100 M4	Grid 9 0.064 M4



0 dB = 0.139A/m

DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(CDMA) H-Field, Date:2009/06/12

Procedure Name: Ch.0384, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA(HAC); Frequency: 836.52 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.0384, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.133 A/m

Probe Modulation Factor = 1.01

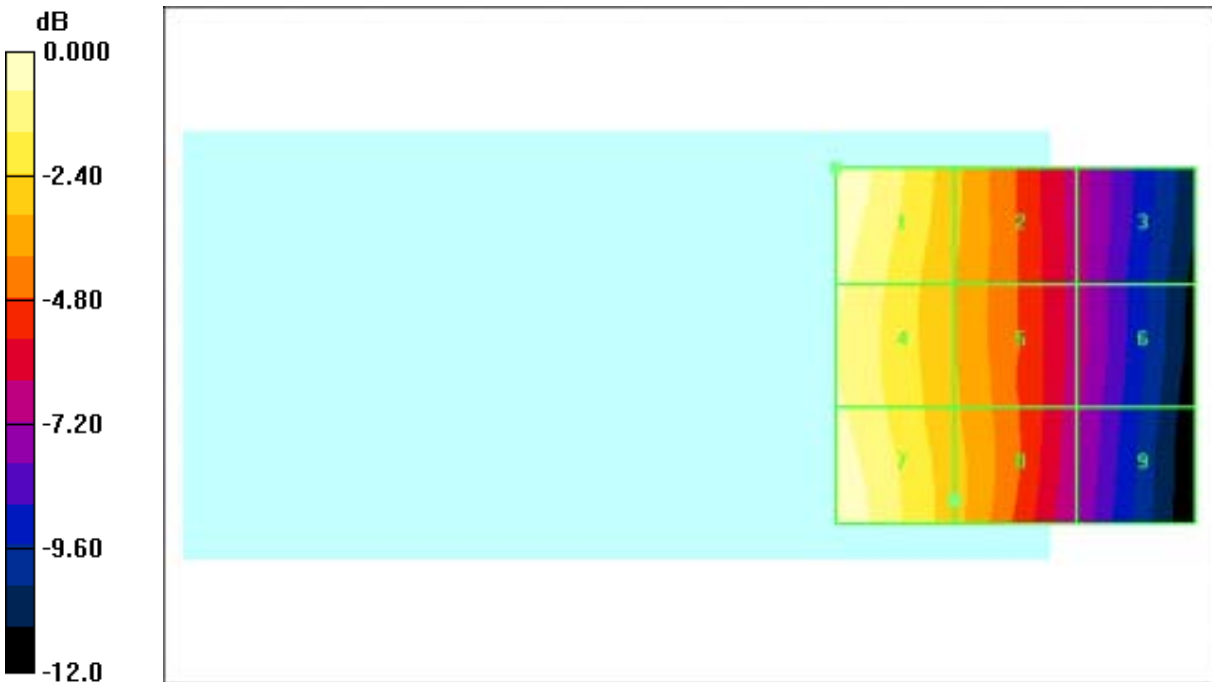
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.083 A/m; Power Drift = 0.026 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.133 M4	Grid 2 0.095 M4	Grid 3 0.061 M4
Grid 4 0.124 M4	Grid 5 0.093 M4	Grid 6 0.061 M4
Grid 7 0.131 M4	Grid 8 0.095 M4	Grid 9 0.060 M4



DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(CDMA) H-Field, Date:2009/06/12

Procedure Name: Ch.0777, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA(HAC); Frequency: 848.31 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.0777, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.147 A/m

Probe Modulation Factor = 1.01

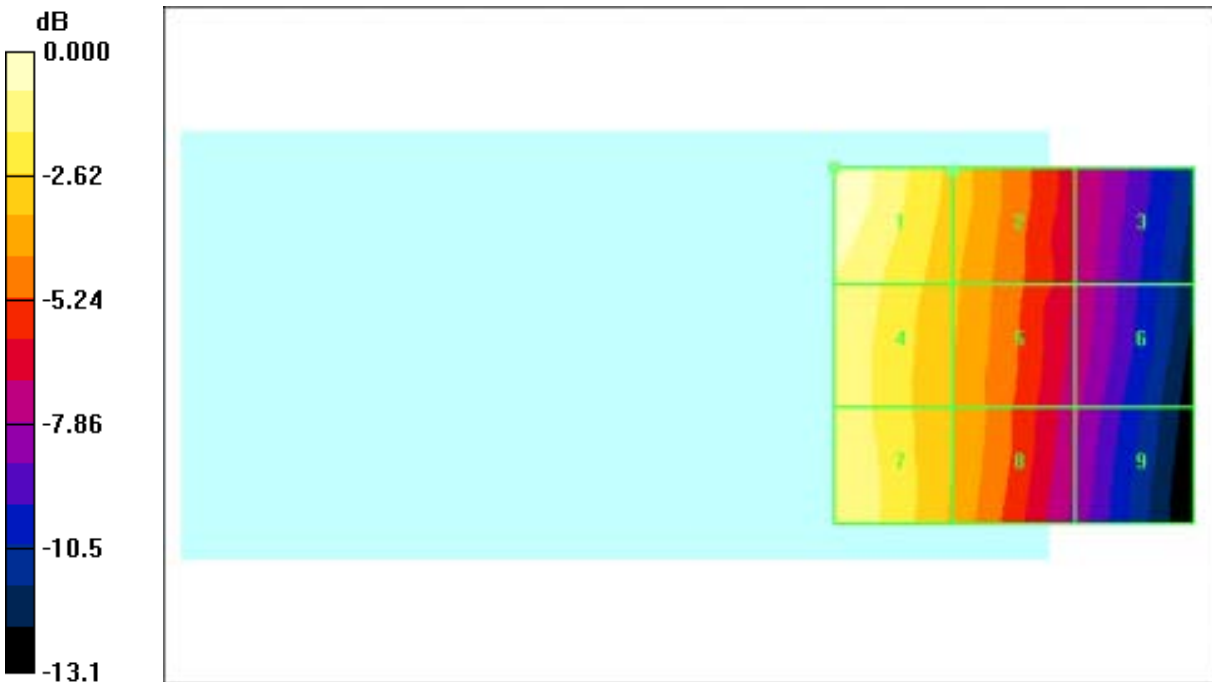
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.088 A/m; Power Drift = 0.012 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.147 M4	Grid 2 0.105 M4	Grid 3 0.067 M4
Grid 4 0.134 M4	Grid 5 0.100 M4	Grid 6 0.066 M4
Grid 7 0.133 M4	Grid 8 0.098 M4	Grid 9 0.062 M4



DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS) H-Field, Date:2009/06/12

Procedure Name: Ch.0025, Ant. Intenna, Bat. Standard(RC3/SO55)

Communication System: PCS; Frequency: 1851.25 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.0025, Ant. Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test

(101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.152 A/m

Probe Modulation Factor = 1.00

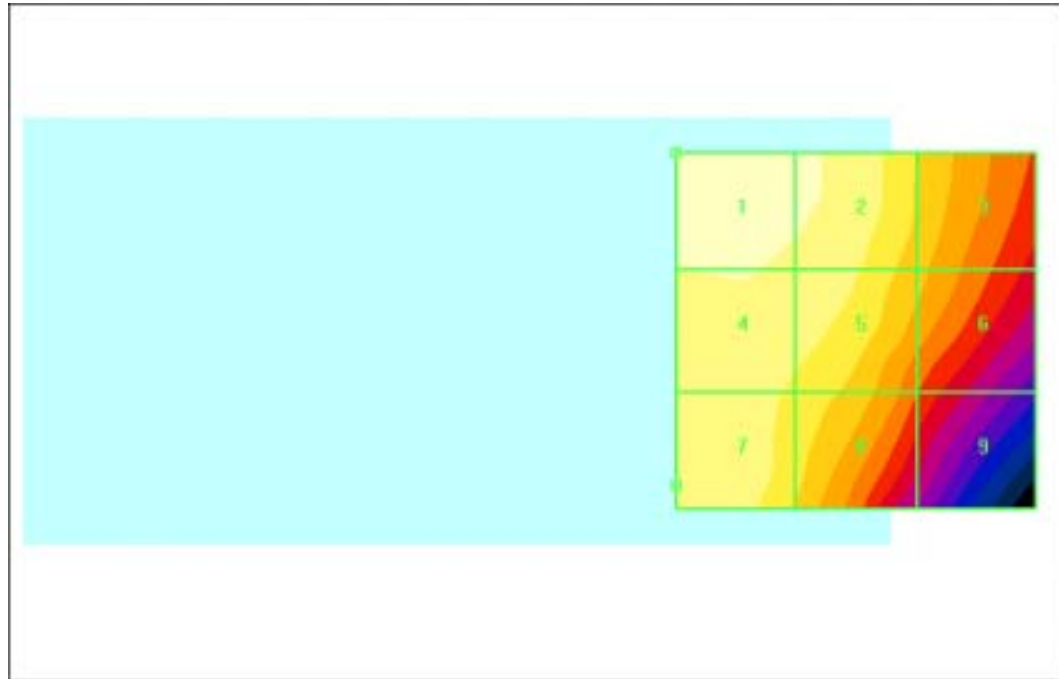
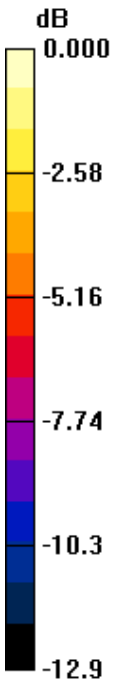
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.124 A/m; Power Drift = -0.144 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.152 M4	Grid 2 0.143 M4	Grid 3 0.113 M4
Grid 4 0.139 M4	Grid 5 0.134 M4	Grid 6 0.106 M4
Grid 7 0.138 M4	Grid 8 0.122 M4	Grid 9 0.085 M4



0 dB = 0.152A/m

DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS) H-Field, Date:2009/06/12

Procedure Name: Ch.0600, Ant. Intenna, Bat. Standard(RC3/SO55)

Communication System: PCS; Frequency: 1880 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.0600, Ant. Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test

(101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.132 A/m

Probe Modulation Factor = 1.00

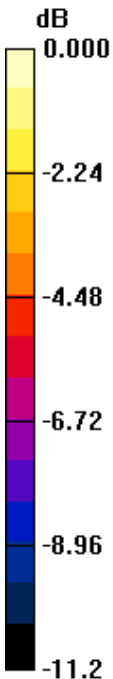
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.110 A/m; Power Drift = -0.032 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.122 M4	Grid 2 0.116 M4	Grid 3 0.097 M4
Grid 4 0.125 M4	Grid 5 0.115 M4	Grid 6 0.094 M4
Grid 7 0.132 M4	Grid 8 0.111 M4	Grid 9 0.079 M4



0 dB = 0.132A/m

DUT: SCH-i920; Serial: AG-061-A

Program Name: SCH-i920(PCS) H-Field, Date:2009/06/12

Procedure Name: Ch.1175, Ant. Intenna, Bat. Standard(RC3/SO55)

Communication System: PCS; Frequency: 1908.75 MHz;Duty Cycle: 1:1

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³

Phantom section: H Device Section

DASY4 Configuration:

- Probe: H3DV6 - SN6197; ; Calibrated: 2009-03-13

- Sensor-Surface: (Fix Surface)

- Electronics: DAE4 Sn486; Calibrated: 2009-04-01

- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018

- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Ch.1175, Ant. Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm

Maximum value of peak Total field = 0.116 A/m

Probe Modulation Factor = 1.00

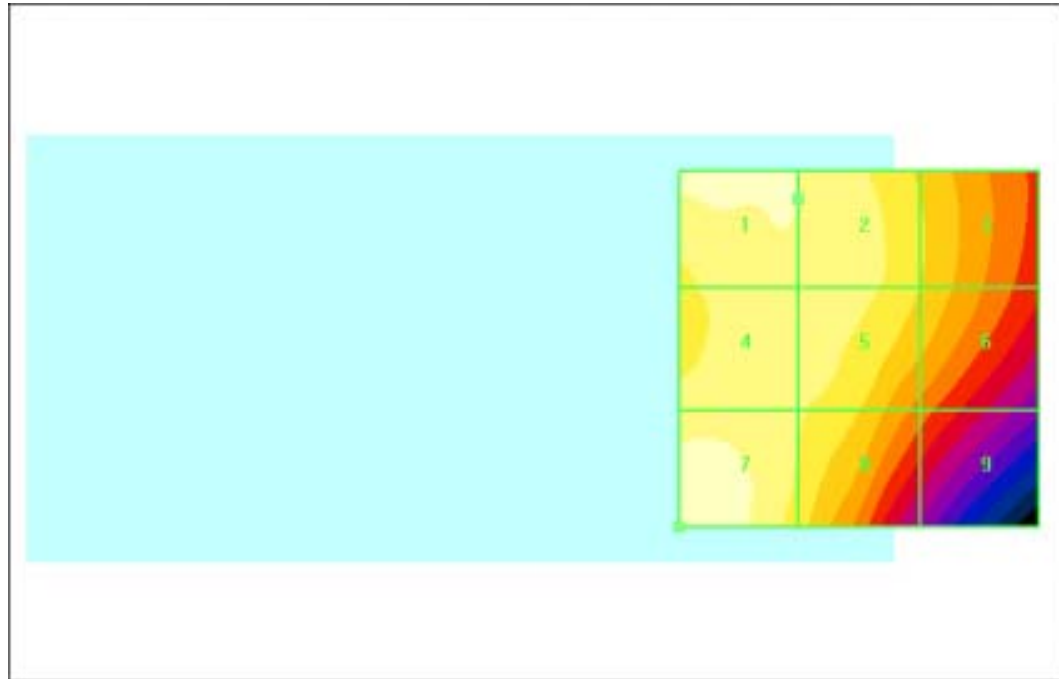
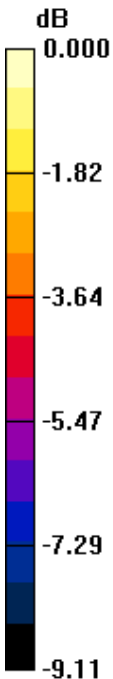
Device Reference Point: 0.000, 0.000, 353.7 mm

Reference Value = 0.107 A/m; Power Drift = -0.090 dB

Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1 0.111 M4	Grid 2 0.108 M4	Grid 3 0.095 M4
Grid 4 0.106 M4	Grid 5 0.106 M4	Grid 6 0.094 M4
Grid 7 0.116 M4	Grid 8 0.102 M4	Grid 9 0.079 M4



0 dB = 0.116A/m



APPENDIX E

Probe Calibration(E-field)



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA
 Multilateral Agreement for the recognition of calibration certificates

Client **Samsung (Dymstec)**

Certificate No: **ER3-2370_Mar09**

CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2370**

Calibration procedure(s) **QA CAL-02.v5**
Calibration procedure for E-field probes optimized for close near field
evaluations in air

Calibration date: **March 10, 2009**

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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41495277	1-Apr-08 (No. 217-00788)	Apr-09
Power sensor E4412A	MY41498087	1-Apr-08 (No. 217-00788)	Apr-09
Reference 3 dB Attenuator	SN: S5054 (3c)	1-Jul-08 (No. 217-00865)	Jul-09
Reference 20 dB Attenuator	SN: S5086 (20b)	31-Mar-08 (No. 217-00787)	Apr-09
Reference 30 dB Attenuator	SN: S5129 (30b)	1-Jul-08 (No. 217-00866)	Jul-09
Reference Probe ER3DV6	SN: 2328	1-Oct-08 (No. ER3-2328_Oct08)	Oct-09
DAE4	SN: 789	19-Dec-08 (No. DAE4-789_Dec08)	Dec-09
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-07)	In house check: Oct-09
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-08)	In house check: Oct-09

Calibrated by: **Name** **Function** **Signature**
Katja Pokovic **Technical Manager**

Approved by: **Fin Bomholt** **R&D Director**

Issued: March 16, 2009

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

OK
 2009.06.12



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**

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005.

Methods Applied and Interpretation of Parameters:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart).
- *DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency.
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORM_x* (no uncertainty required).

Probe ER3DV6

SN:2370

Manufactured:	October 12, 2005
Last calibrated:	April 21, 2008
Recalibrated:	March 10, 2009

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ER3DV6 SN:2370Sensitivity in Free Space [$\mu\text{V}/(\text{V}/\text{m})^2$]

NormX	1.76 $\pm$ 10.1 % (k=2)
NormY	1.64 $\pm$ 10.1 % (k=2)
NormZ	1.95 $\pm$ 10.1 % (k=2)

Diode Compression^A

DCP X	97 mV
DCP Y	95 mV
DCP Z	97 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

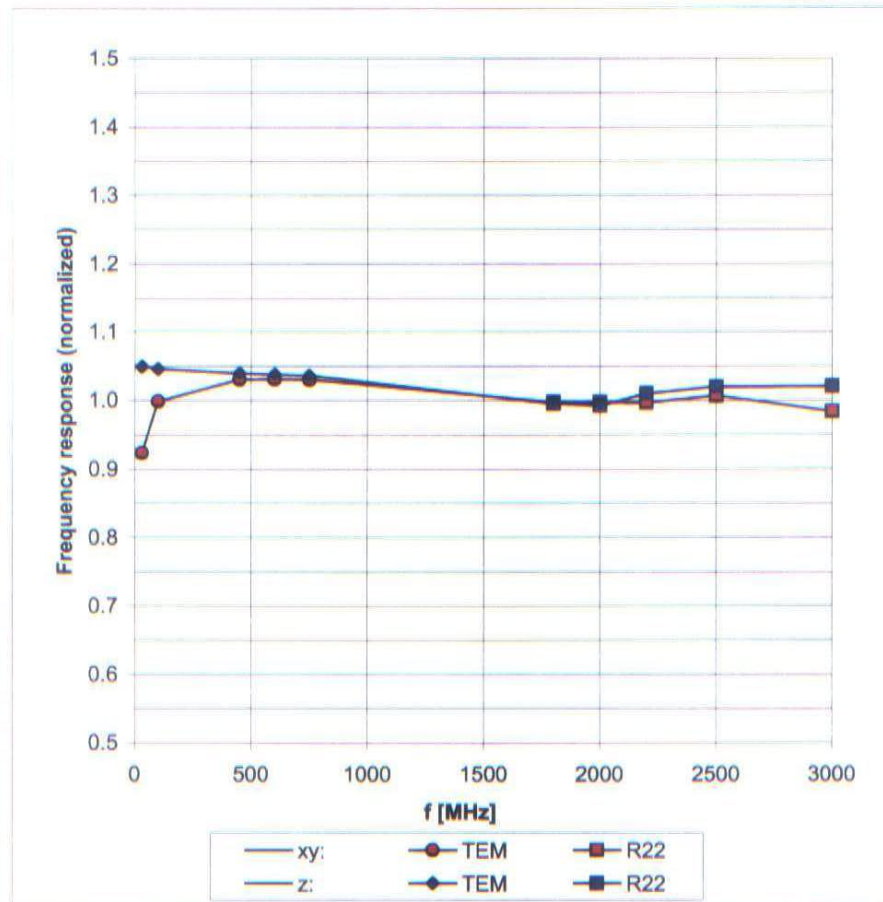
-228 °

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%.

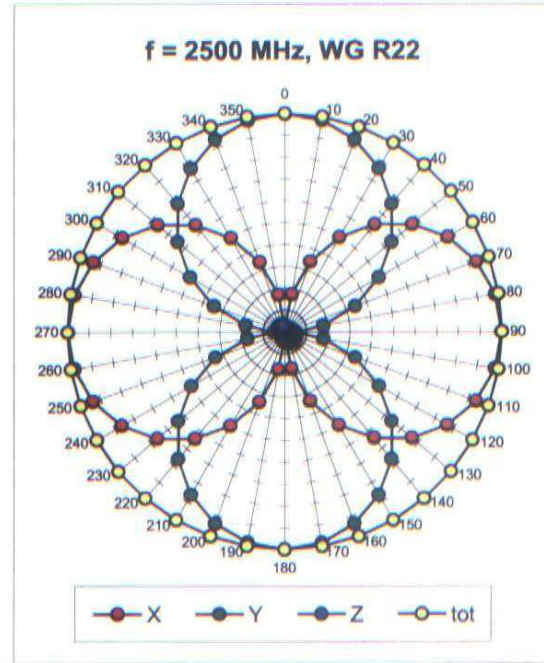
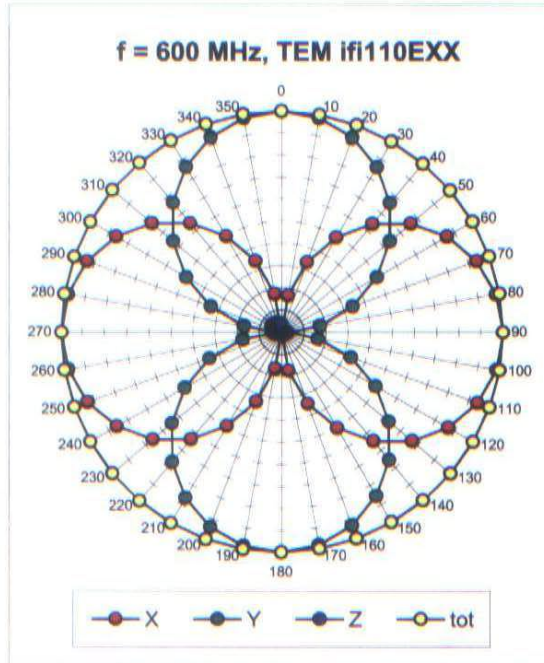
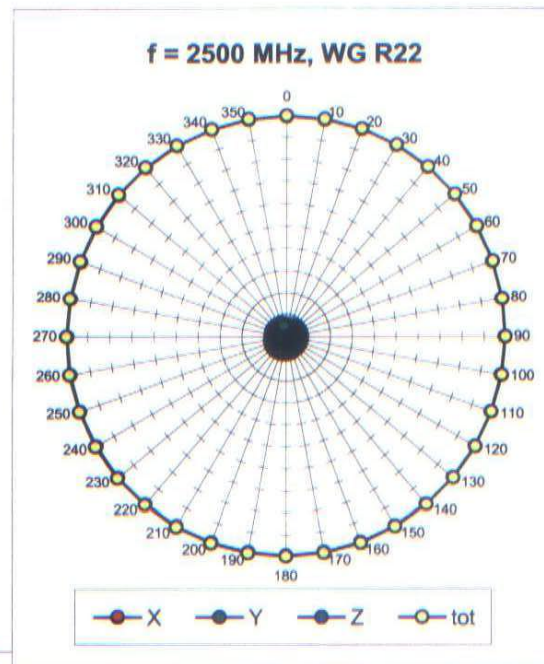
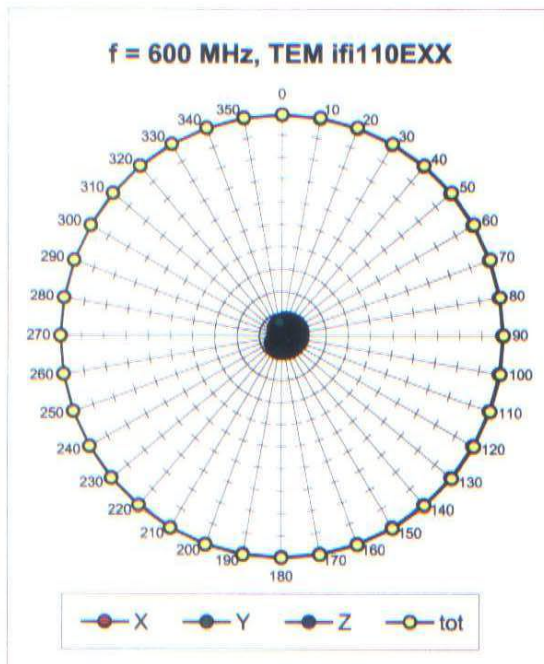
^A numerical linearization parameter: uncertainty not required

Frequency Response of E-Field

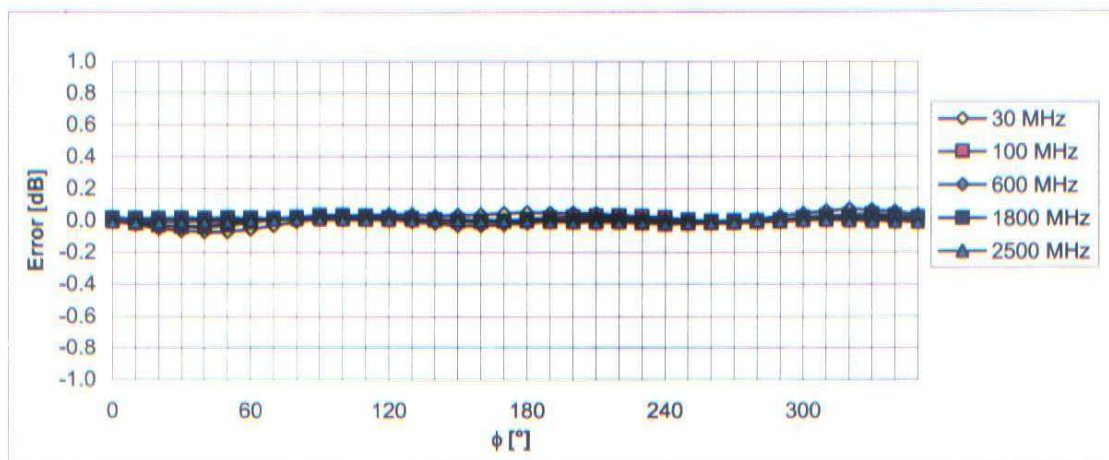
(TEM-Cell:ifi110 EXX, Waveguide R22)



Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

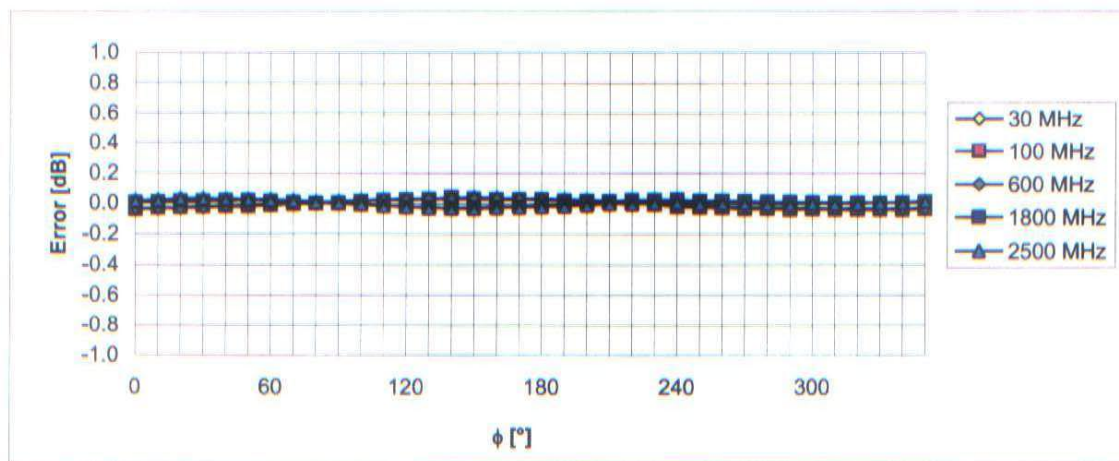
Receiving Pattern (ϕ), $\vartheta = 0^\circ$ **Receiving Pattern (ϕ), $\vartheta = 90^\circ$** 

Receiving Pattern (ϕ), $\vartheta = 0^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

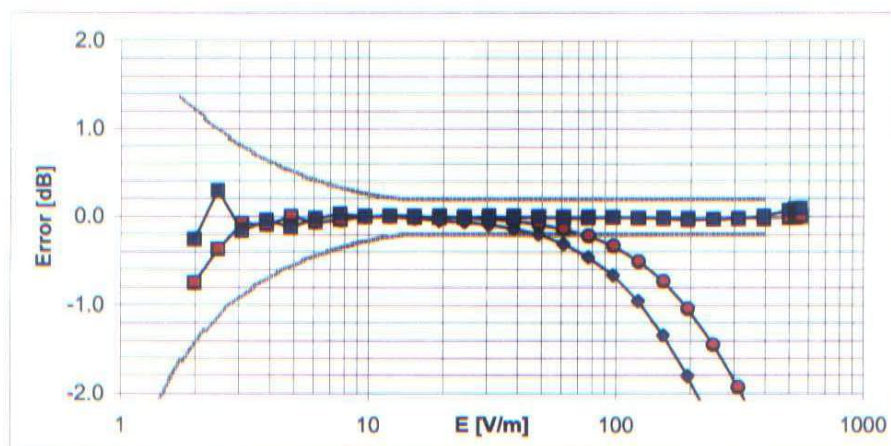
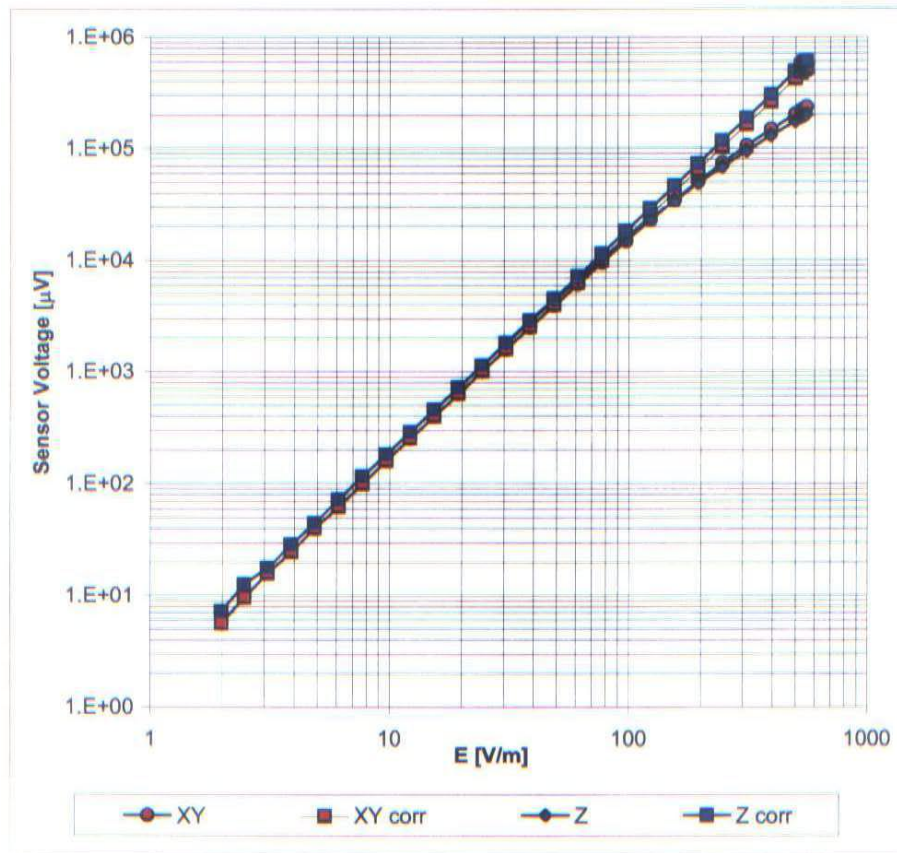
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Dynamic Range f(E-field)

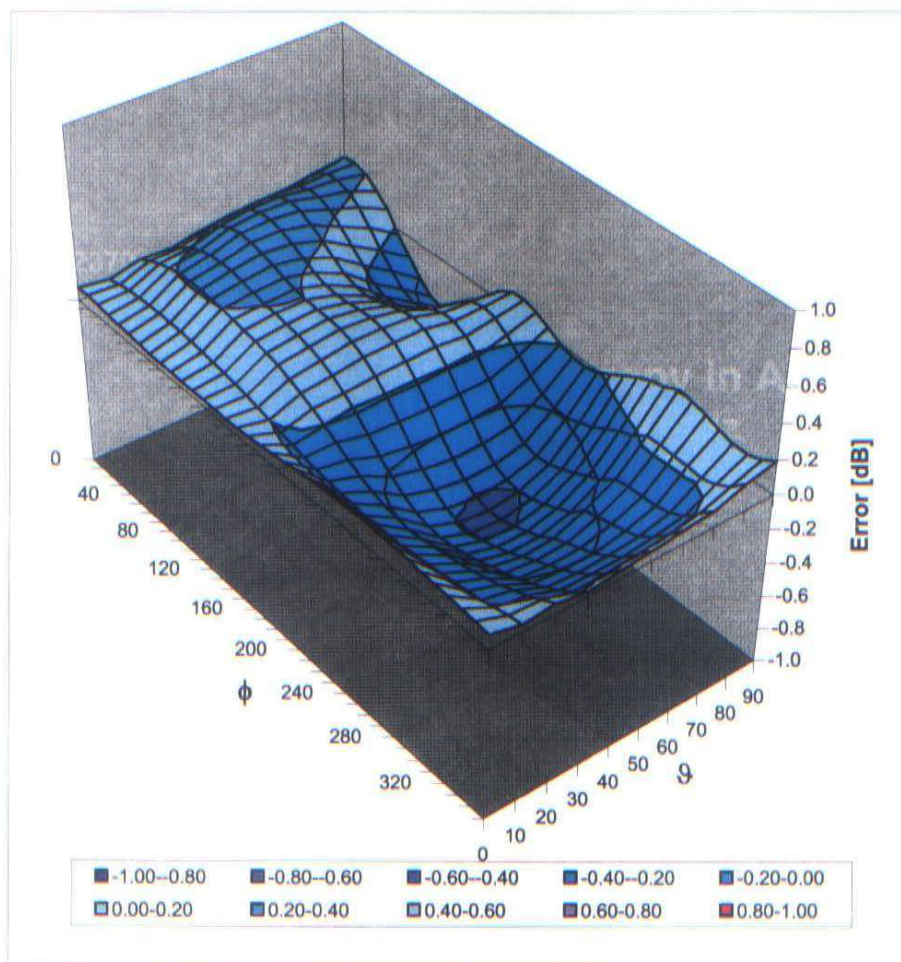
(Waveguide R22, $f = 1800$ MHz)



Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Deviation from Isotropy in Air

Error (ϕ , ϑ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)