



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-U340
FCC ID (Requested): A3LSCHU340
Job No: AD-082
Report No: AD-082-M1
Date issued: Jan.05, 2007
Result Summary: M4 (RF EMISSION Category)

- Abstract -

This document reports on HAC Tests carried out in accordance with ANSI C63.19(2006), FCC Rule Part(s) FCC 47 CFR §20.19, §6.3, §7.3

Prepared By

DK LEE – Test Engineer

Checked By

JH NAM – Senior Engineer

Authorized By

SH PARK – Senior 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	21



1. GENERAL INFORMATION

Test Sample : Tri-Band CDMA Mobile Phone
Model Number : SCH-U340
Serial Number : Identical prototype (S/N : #AD-082-A)

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.
Contact : MC PAIK

Phone : +82-54-479-7636
Fax : +82-54-479-7636
Test Standard : ANSI C 63.19 (2006), FCC 47 CFR § 20.19, §6.3, §7.3
FCC Classification : Licensed Portable Transmitter Held to Ear (PCE)
Test Dates : Dec.21, 2007
Tested for : FCC/TCB Certification

2. DESCRIPTION OF DEVICE

Tx Freq. Range : 824.70 ~ 848.31 MHz(CDMA)
1851.25 ~ 1908.75 MHz(PCS)

Rx Freq. Range : 869.70 ~ 893.31 MHz(CDMA)
1931.25 ~ 1988.75 MHz(PCS)

Antenna Configuration : NSB0506-0000800/1900
Antenna Manufacturer : SB TELCOM
Antenna Dimensions : 38.62 ± 0.7 mm

3. DESCRIPTION OF TEST EQUIPMENT

3.1 HAC Measurement Setup

Robotic System

Measurements are performed using the DASY4 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).

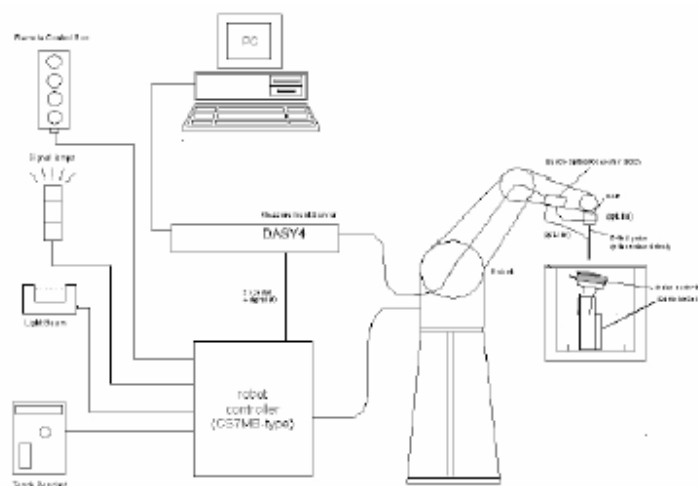


Figure 3.1 HAC Measurement System Setup

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, 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

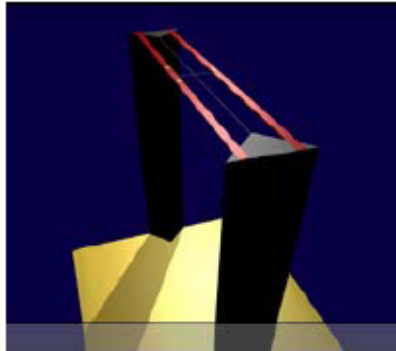


Figure 3.4 Test Arch Phantom

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

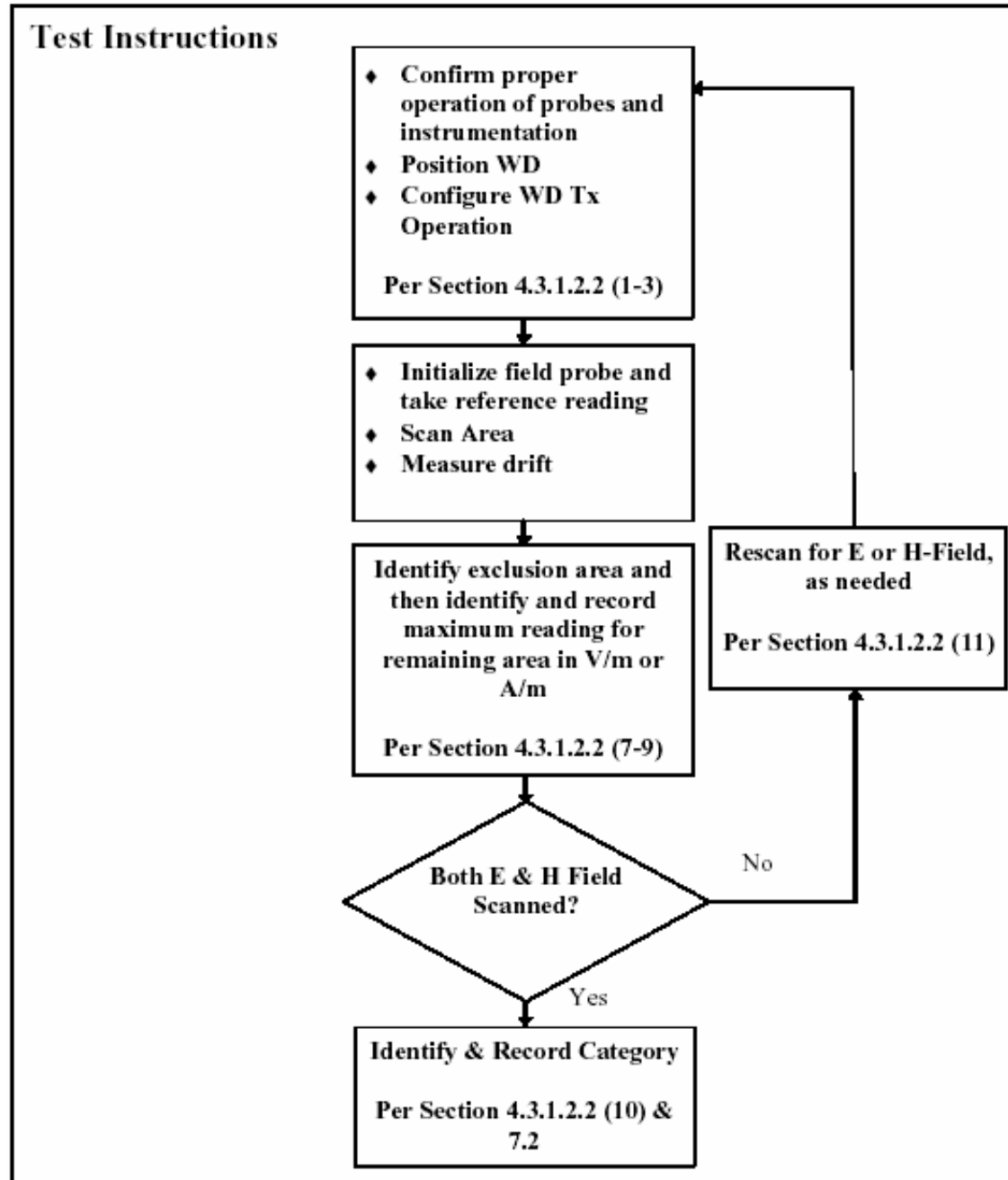
Table 3.2 Test Equipment Calibration

Type	Calibration Due Date	Serial No.
SPEAG DAE4	Jan.27, 2007	468
E-field Free space Probe	May.16, 2007	2370
H-field Free space Probe	May.16, 2007	6197
CD835V3 Free space 835MHz Dipole	Apr.27, 2007	1021
CD1880V3 Free space 1880MHz Dipole	Apr.05, 2007	1016
Stäubli Robot RX90BL	Not Required	F05/51G6A1/A/01
HAC Phantom	Not Required	1018
Spectrum Analyzer	Jan.06, 2007	MY45304704
E4438C Signal Generator	Apr.06, 2007	MY45092224
BBS3Q7ECK Power Amp	Jan.26, 2007	1023
NRVD Power Meter	Feb.16, 2007	836416/020
N1912A Power Meter	Mar.06, 2007	MY45100306
NRV-Z53 Power Sensor	Feb.16, 2007	835324/001
NRV-Z55 Power Sensor	Feb.16, 2007	834558/012
DASY4 S/W (ver 4.7)	Not Required	-
Directional Coupler	May.12, 2007	18843
Wireless Communication System Set	Nov.28, 2007	GB43460148

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.

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 1.0 cm in front of, the reference plane.



Figure 5.1 Wireless Device and Measurement Plane

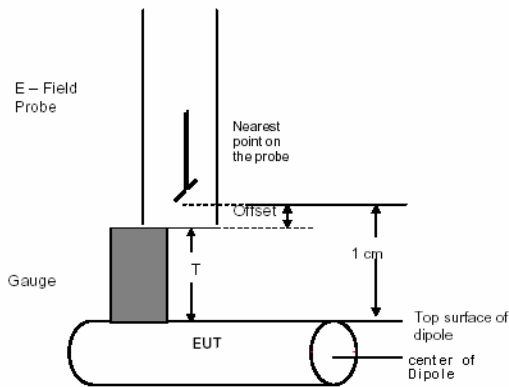


Figure 5.2 Gauge block with E-field probe

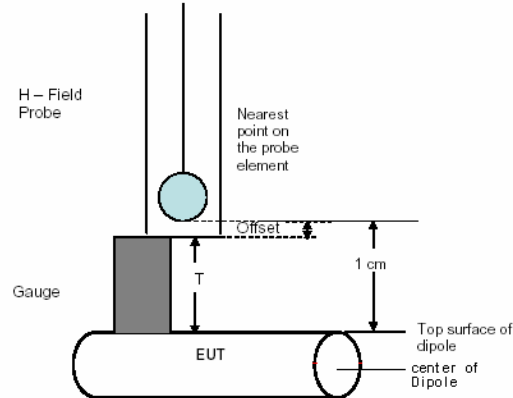


Figure 5.3 Gauge block with H-field probe



6. MEASUREMENT UNCERTAINTY

Source of Uncertainty	Value	Probability distribution	Divisor	C_i E	C_i H	Standard uncertainty		v_i or v_{eff}	
						E	H	E	H
Measurement System									
Probe Calibration	10.20	normal	2.000	0.99	1	5.05	5.10	∞	∞
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	1.74	normal	1.000	1	0.68	1.74	1.19	∞	∞
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	∞	∞
Extrap. And Interpolation	1.00	rectangular	1.732	1	1	0.58	0.58	∞	∞
Test Sample Related									
Device Positioning	1.53	normal	1.000	1	0.94	1.53	1.44	23	23
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	0.67	1.39	0.93	∞	∞
Combined Standard Uncertainty		normal	-	-	-	12.88	8.38	147117	26396
Expanded Uncertainty [95% confidence]						25.76	16.76		
Expanded Uncertainty [95% confidence] on Field						12.88	8.38		

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

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	167.1	178.9	7.03	0.439	0.469	6.83	Dec.21, 2006
1880 MHz	138.6	138.5	-0.07	0.457	0.425	-7.00	Dec.21, 2006

*Validation was measured with input power 100 mW.

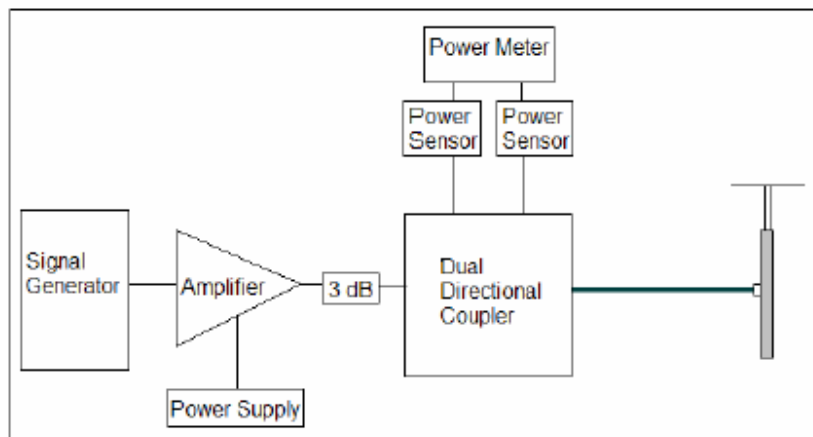


Figure 7.1 Dipole Validation Test Setup

Validations of the DASY4 test system were performed using the measurement equipment listed in Section 3.2. All validations occur in free space using the DASY4 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.

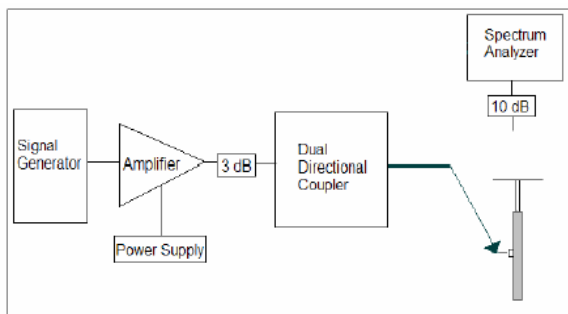


Figure 8.1 Setup to Dipole

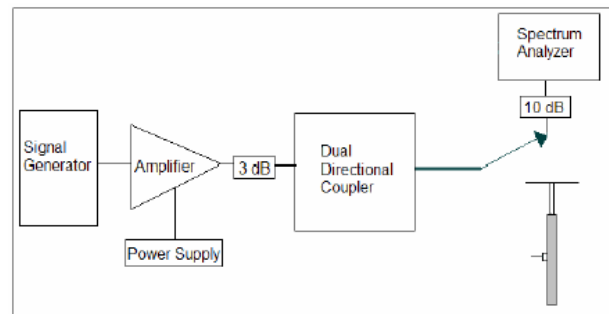


Figure 8.2 Setup to Peak Power using Spectrum Analyzer

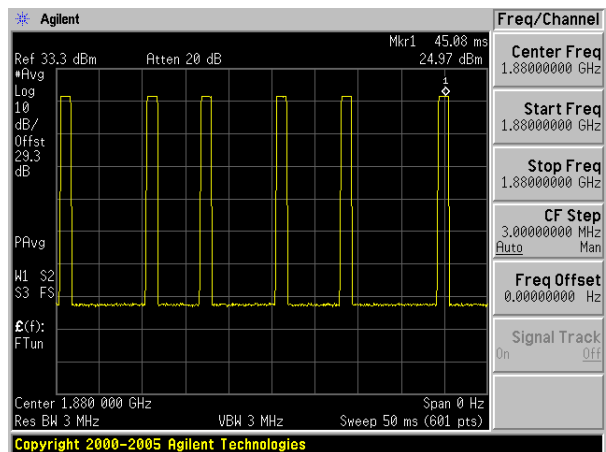
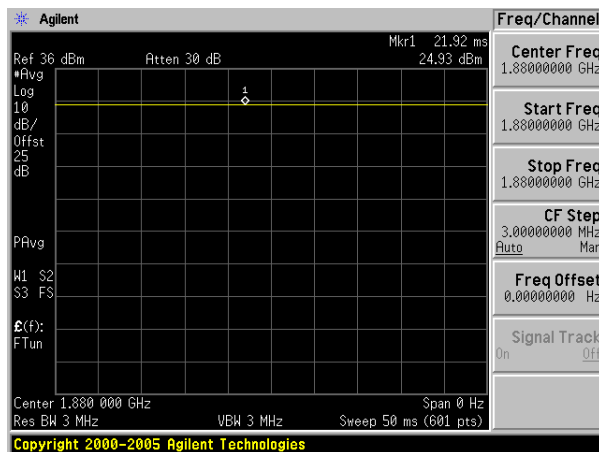
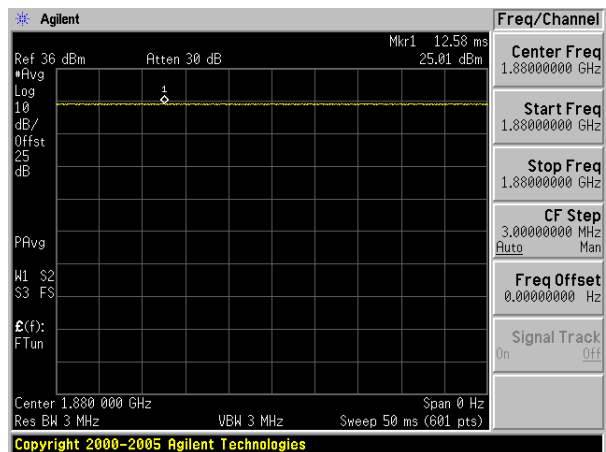
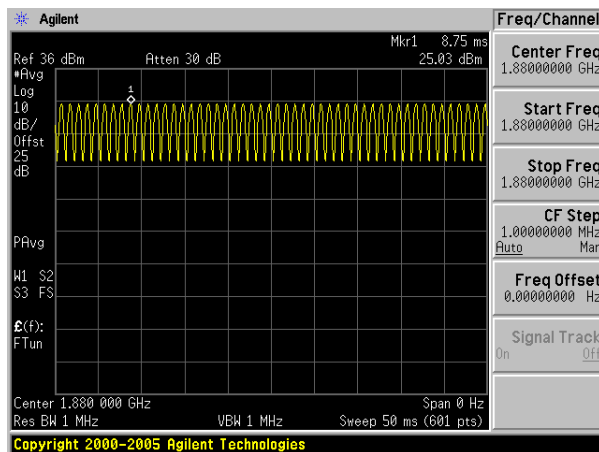


8.1 Modulation Factors

Frequency	Protocol	E-field (V/m)	H-field (A/m)	E-Field PMF	H-Field PMF
835MHz	AM	60.15	0.103	1.56	1.51
835MHz	CDMA	92.63	0.152	1.02	1.03
835MHz	CW	94.12	0.156	-	-
1880 MHz	AM	36.3	0.106	1.55	1.56
1880 MHz	CDMA	54.34	0.162	1.03	1.01
1880 MHz	CW	56.12	0.165	-	-
Frequency	Protocol	E-Field (V/m)	E-Field PMF	E-Field PMF	H-Field PMF
835 MHz	CDMA/SO3	23.75	-	2.80	-
835 MHz	CW	66.41	-	-	-

Table 8.1 Modulation Factors

8.2 CW and Modulated Signal Zero-span plots:



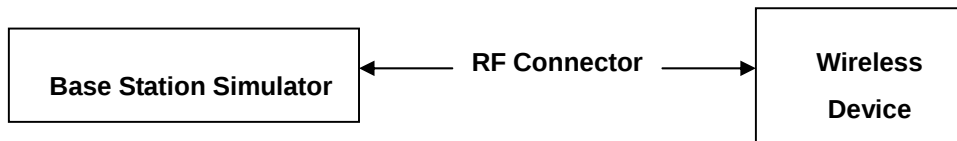


9. FCC 3G MEASUREMENTS – MAY/JUNE 2006

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	25.25	55.93	57.61	35.21	M4	41.0	-5.79
PCS	25	on	RC3/SO55	Standard	Intenna	25.25	55.69	57.36	35.17	M4	41.0	-5.83
PCS	25	off	RC1/SO2	Standard	Intenna	25.25	55.38	57.04	35.12	M4	41.0	-5.88
PCS	25	off	RC3/SO2	Standard	Intenna	25.24	56.36	58.05	35.28	M4	41.0	-5.72
PCS	25	off	RC1/SO55	Standard	Intenna	25.21	56.04	57.72	35.23	M4	41.0	-5.77
PCS	25	off	RC2/SO9	Standard	Intenna	25.21	56.11	57.79	35.24	M4	41.0	-5.76
PCS	25	off	RC1/SO3	Standard	Intenna	25.16	20.09	56.25	35.00	M4	41.0	-6.00
PCS	25	off	RC3/SO3	Standard	Intenna	25.30	55.02	56.67	35.07	M4	41.0	-5.93
PCS	25	off	RC2/SO17	Standard	Intenna	25.52	20.26	56.73	35.08	M4	41.0	-5.92

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



10. Test Results

10.1 Measurement Results(E-field)

E-FIELD EMISSIONS:

Mode	Channel	RC/SO	Back light	Battery	Conducted Power [dBm]	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]	Excl Blocks
CDMA	1013	RC3/SO2	off	Standard	25.03	116.4	118.7	41.5	M4	51.0	-9.51	None
CDMA	384	RC3/SO2	off	Standard	25.16	104.2	106.3	40.5	M4	51.0	-10.47	None
CDMA	777	RC3/SO2	off	Standard	25.10	104.4	106.5	40.5	M4	51.0	-10.45	None
PCS	25	RC3/SO2	on	Standard	25.24	59.2	61.0	35.7	M4	41.0	-5.29	None
PCS	25	RC3/SO2	off	Standard	25.24	61.0	62.8	36.0	M4	41.0	-5.04	None
PCS	600	RC3/SO2	off	Standard	25.21	52.0	53.6	34.6	M4	41.0	-6.42	None
PCS	1175	RC3/SO2	off	Standard	25.05	50.3	51.8	34.3	M4	41.0	-6.71	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 (2006).
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



10.2 Measurement Results(H-field)

H-FIELD EMISSIONS:

Mode	Channel	RC/SO	Back light	Battery	Conducted Power [dBm]	Time Avg. Field [A/m]	Peak Field [A/m]	Peak Field [dBA/m]	Category	FCC limit [dBA/m]	FCC Margin [dB]	Excl Blocks
CDMA	1013	RC3/SO2	off	Standard	25.03	0.192	0.198	-14.1	M4	0.6	-14.67	None
CDMA	384	RC3/SO2	off	Standard	25.16	0.150	0.155	-16.2	M4	0.6	-16.79	None
CDMA	777	RC3/SO2	off	Standard	25.1	0.173	0.178	-15.0	M4	0.6	-15.59	None
PCS	25	RC3/SO2	off	Standard	25.24	0.176	0.178	-15.0	M4	-9.4	-5.59	None
PCS	600	RC3/SO2	off	Standard	25.21	0.183	0.185	-14.7	M4	-9.4	-5.26	None
PCS	1175	RC3/SO2	off	Standard	25.05	0.155	0.156	-16.1	M4	-9.4	-6.74	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 (2006).
- 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)

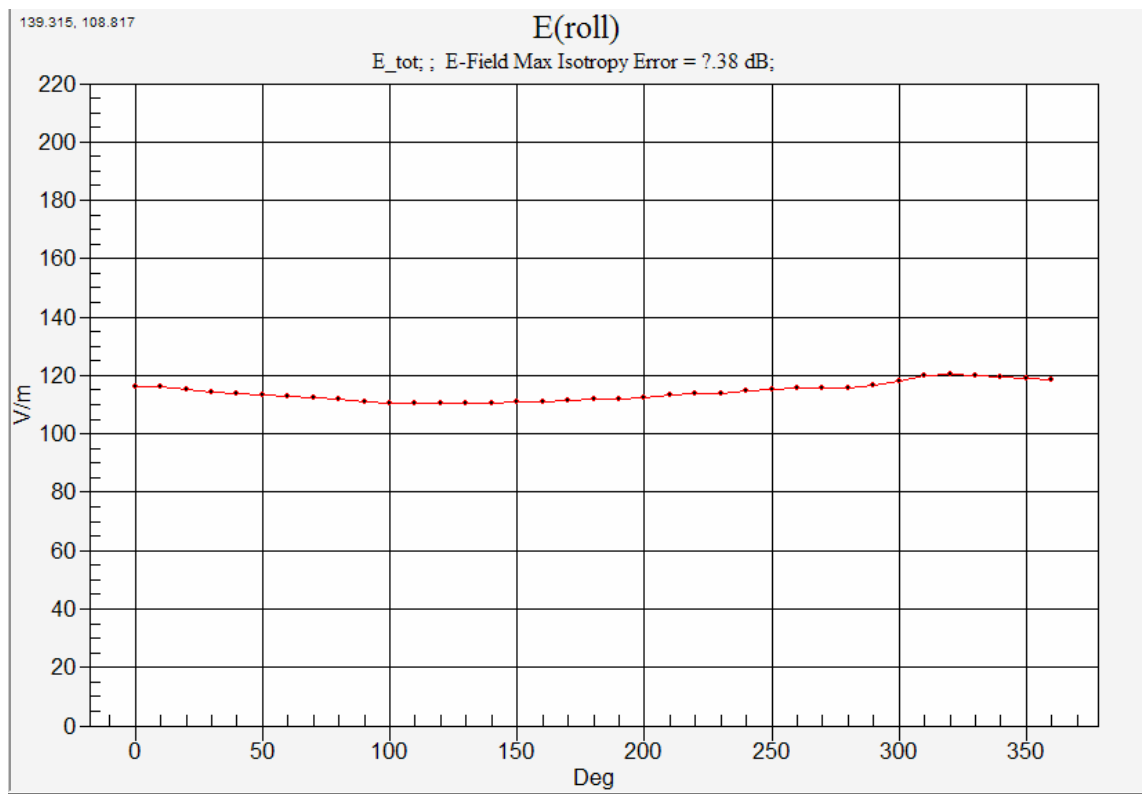


10.3 Worst-case Configuration Evaluation

CDMA E-field Emission

Mode	Channel	RC/SO	Back light	Battery	Conducted Power [dBm]	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]	Excl Blocks
CDMA	1013	RC3/SO2	Off	Standard	25.03	120.3	122.7	41.8	M4	51.0	-9.22	none

Peak Reading 360 degree Probe Rotation at Azimuth axis



Worst-Case Probe Rotation about Azimuth axis

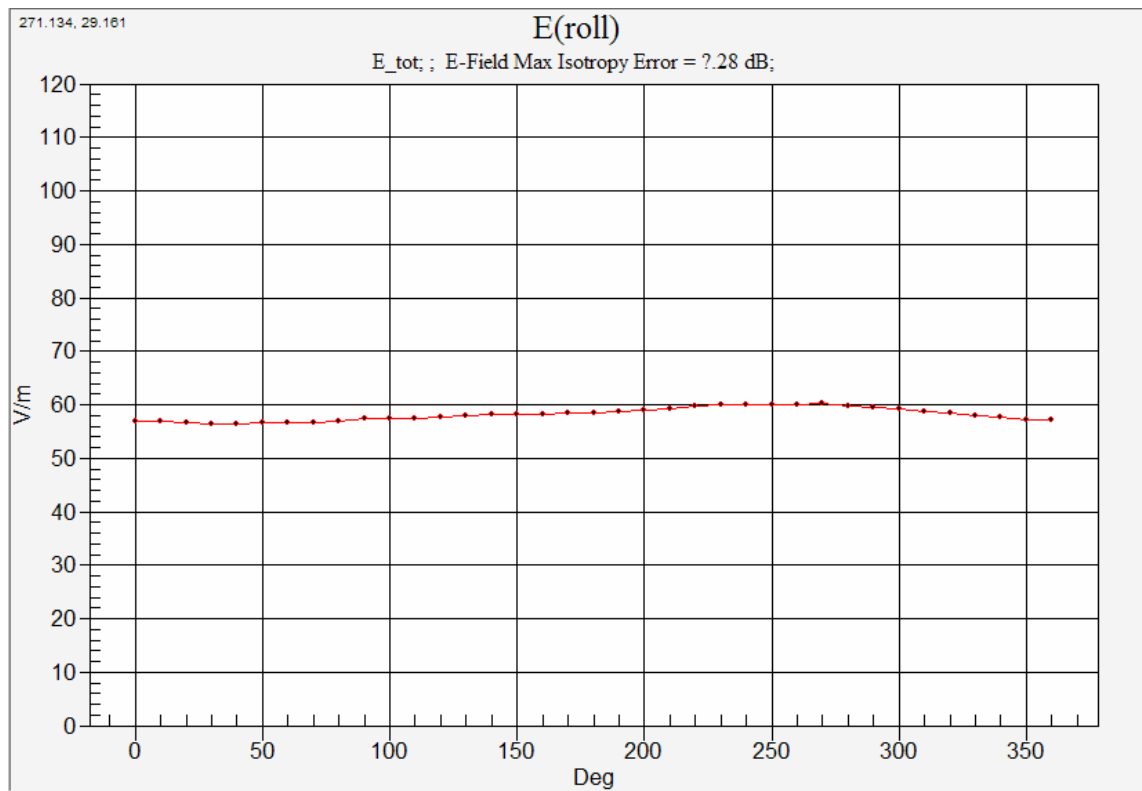
Note: Location of probe rotation is shown in APPENDIX E



PCS E-field Emission

Mode	Channel	RC/SO	Back light	Battery	Conducted Power [dBm]	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]	Excl Blocks
PCS	25	RC3/SO2	Off	Standard	25.24	60.1	61.9	35.8	M4	41.0	-5.17	none

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 C63.19-2006, American National Standard for Methods of Measurement of Compatibility between Wireless communication devices and Hearing Aids.", New York, NY, IEEE, April 2005.
- [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	AM 80%
RBW	Same setting with modulated signal respectively.	1 MHz	3 MHz	5 MHz	1 MHz
VBW		1 MHz	3 MHz	5 MHz	1 MHz
SPAN		0 MHz	0 MHz	0 MHz	0 MHz
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 (2006)- 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 E Dipole, Date: Dec/21/2006
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: 2006-05-16
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn468; Calibrated: 2006-01-27
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

E Scan 10mm above CD 835 MHz 2/Hearing Aid Compatibility Test (41x361x1):

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

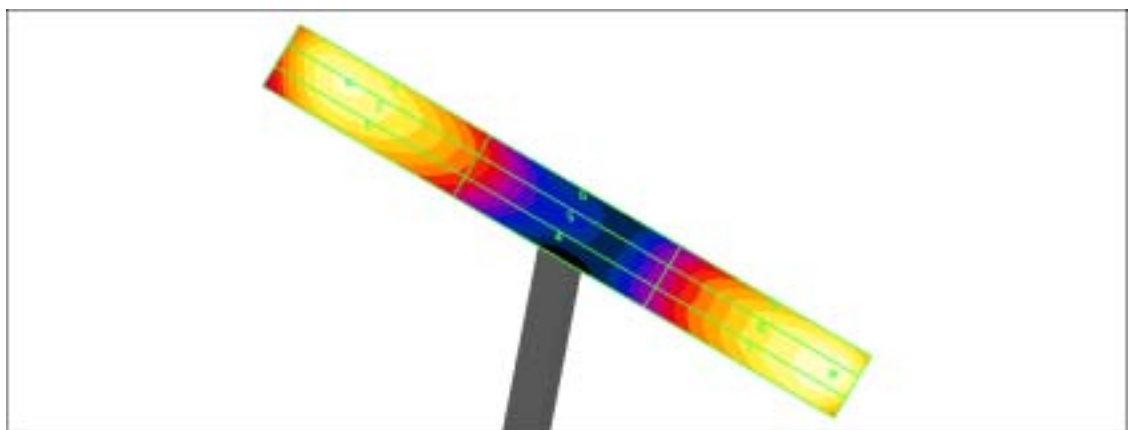
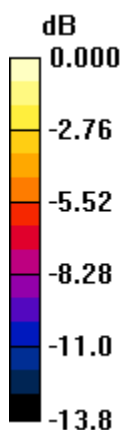
Maximum value of peak Total field = 186.5 V/m

Probe Modulation Factor = 1.00

Reference Value = 110.0 V/m; Power Drift = 0.129 dB

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
162.5	171.1	170.9
Grid 4	Grid 5	Grid 6
93.4	98.2	97.6
Grid 7	Grid 8	Grid 9
179.4	186.5	181.6



0 dB = 186.5V/m

DUT: HAC-Dipole 835 MHz; Serial: SN:1021
Program Name: HAC H Dipole, Date: Dec/21/2006
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: 2006-05-16
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn468; Calibrated: 2006-01-27
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1):

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

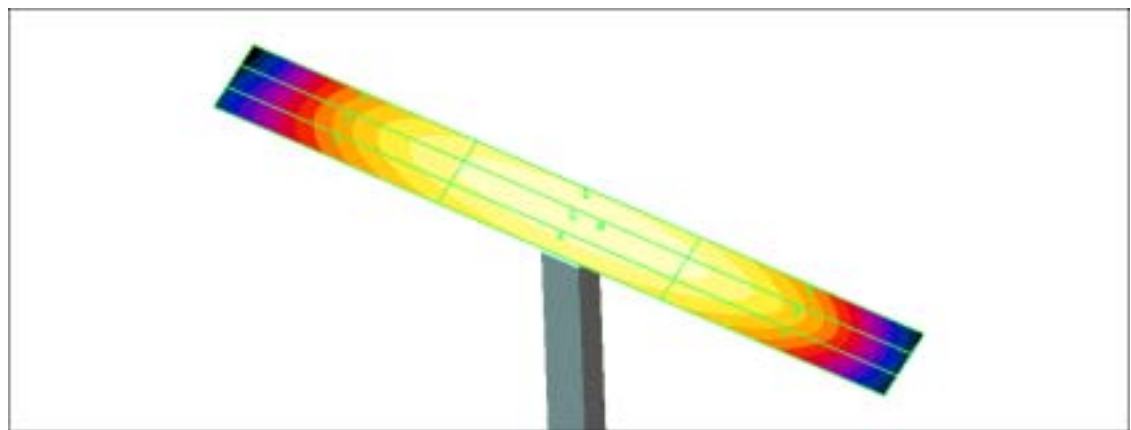
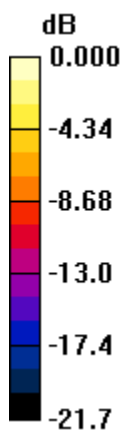
Maximum value of peak Total field = 0.469 A/m

Probe Modulation Factor = 1.00

Reference Value = 0.494 A/m; Power Drift = -0.070 dB

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.365	0.403	0.400
Grid 4	Grid 5	Grid 6
0.427	0.469	0.464
Grid 7	Grid 8	Grid 9
0.386	0.426	0.419



0 dB = 0.469 A/m

DUT: HAC Dipole 1880 MHz; Serial: SN:1016
Program Name: HAC E Dipole, Date: Dec/21/2006
Procedure Name: E Scan 10mm above CD 1880 MHz

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Dipole Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn468; Calibrated: 2006-01-27
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1):

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

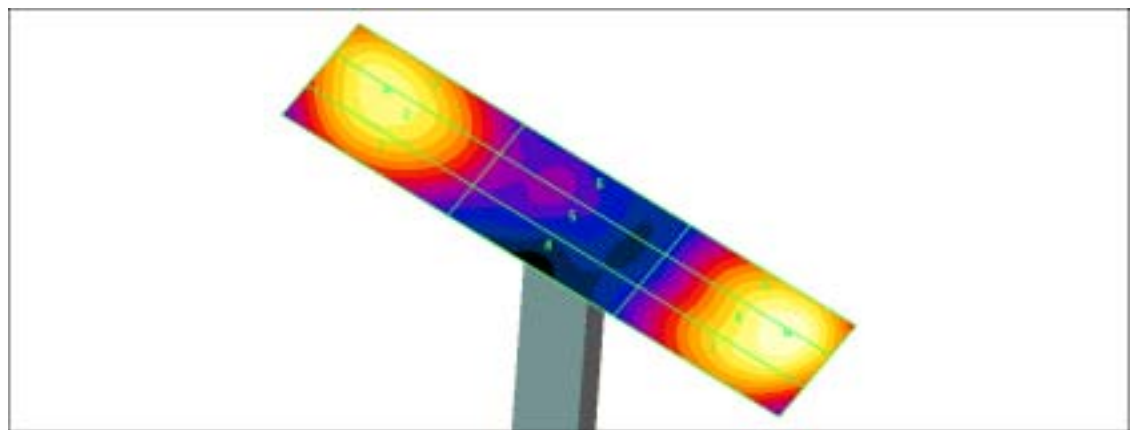
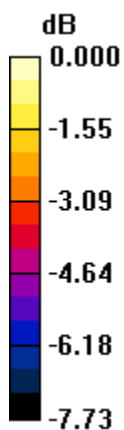
Maximum value of peak Total field = 143.5 V/m

Probe Modulation Factor = 1.00

Reference Value = 155.0 V/m; Power Drift = 0.048 dB

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
126.3	133.5	133.3
Grid 4	Grid 5	Grid 6
83.1	86.4	85.1
Grid 7	Grid 8	Grid 9
132.2	143.5	143.4



0 dB = 143.5V/m

DUT: HAC Dipole 1880 MHz; Serial: SN:1016
Program Name: HAC H Dipole, Date: Dec/21/2006
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: 2006-05-16
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn468; Calibrated: 2006-01-27
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1):

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

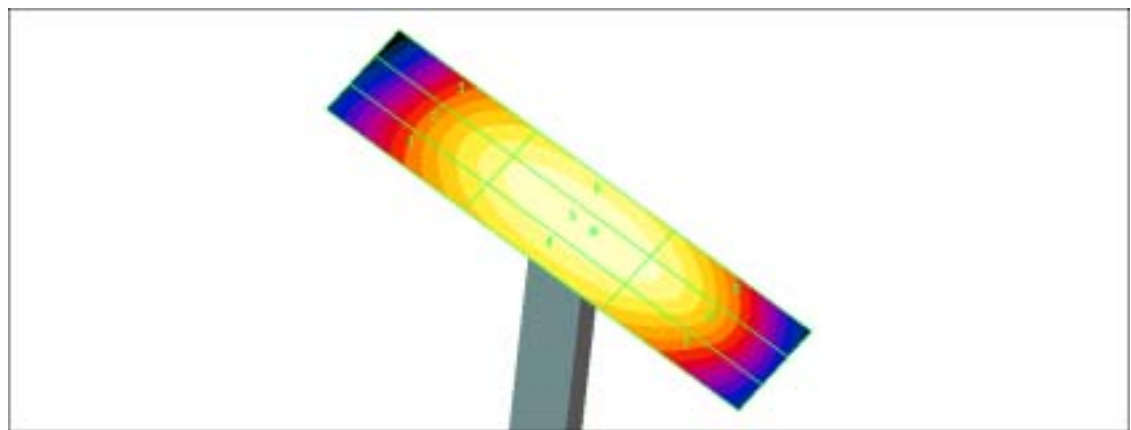
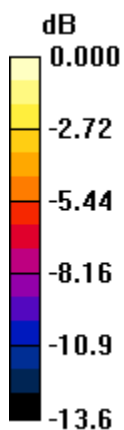
Maximum value of peak Total field = 0.425 A/m

Probe Modulation Factor = 1.00

Reference Value = 0.441 A/m; Power Drift = 0.044 dB

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.355	0.378	0.372
Grid 4	Grid 5	Grid 6
0.394	0.425	0.416
Grid 7	Grid 8	Grid 9
0.369	0.404	0.395



0 dB = 0.425A/m

APPENDIX D

Plots of The HAC Measurements

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) E-field, Date: Dec/21/2006

Procedure Name: Ch.1013, Ant, Intenna, Bat. Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.1013, Ant, Intenna, Bat. Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 118.7 V/m

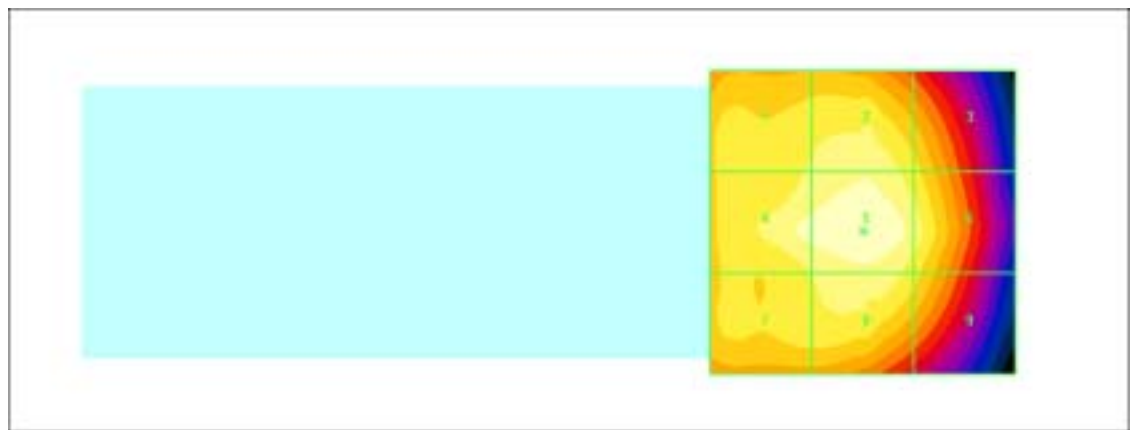
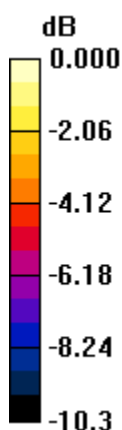
Probe Modulation Factor = 1.02

Reference Value = 127.8 V/m; Power Drift = 0.032 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
102.8	107.6	96.3
Grid 4	Grid 5	Grid 6
113.2	118.7	105.5
Grid 7	Grid 8	Grid 9
101.7	109.2	96.6



0 dB = 118.7V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) E-field, Date: Dec/21/2006

Procedure Name: Ch.384, Ant, Intenna, Bat. Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.384, Ant, Intenna, Bat. Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 106.3 V/m

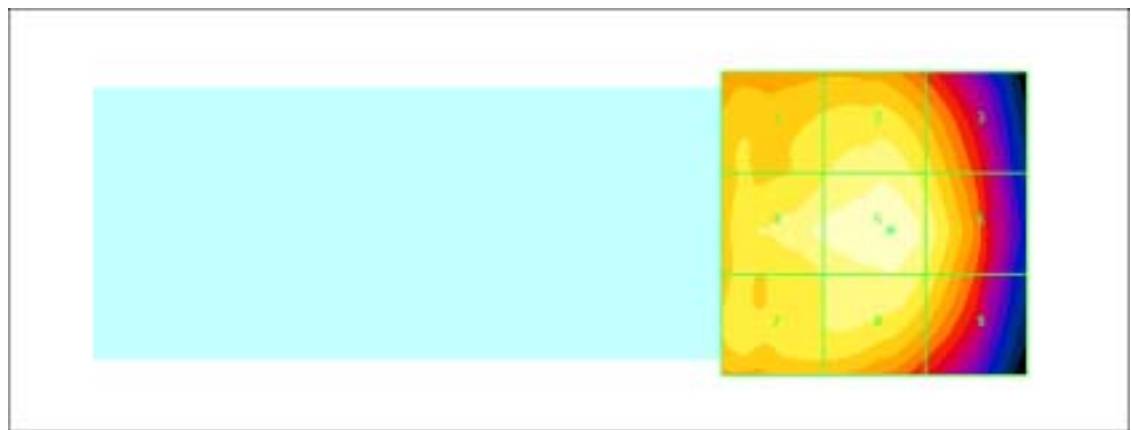
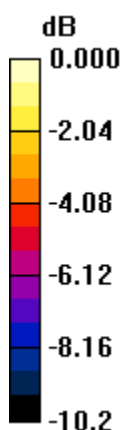
Probe Modulation Factor = 1.02

Reference Value = 112.1 V/m; Power Drift = 0.003 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
90.0	96.8	87.1
Grid 4	Grid 5	Grid 6
100.2	106.3	96.2
Grid 7	Grid 8	Grid 9
91.7	98.2	89.3



0 dB = 106.3V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) E-field, Date: Dec/21/2006

Procedure Name: Ch.777, Ant, Intenna, Bat. Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16
- Sensor-Surface: (Fix Surface)
- Electronics: DAE3 Sn468; Calibrated: 2006-01-27
- Phantom: HAC Test Arch with Coil; Type: SD HAC P01 BA; Serial: 1018
- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.777, Ant, Intenna, Bat. Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 106.5 V/m

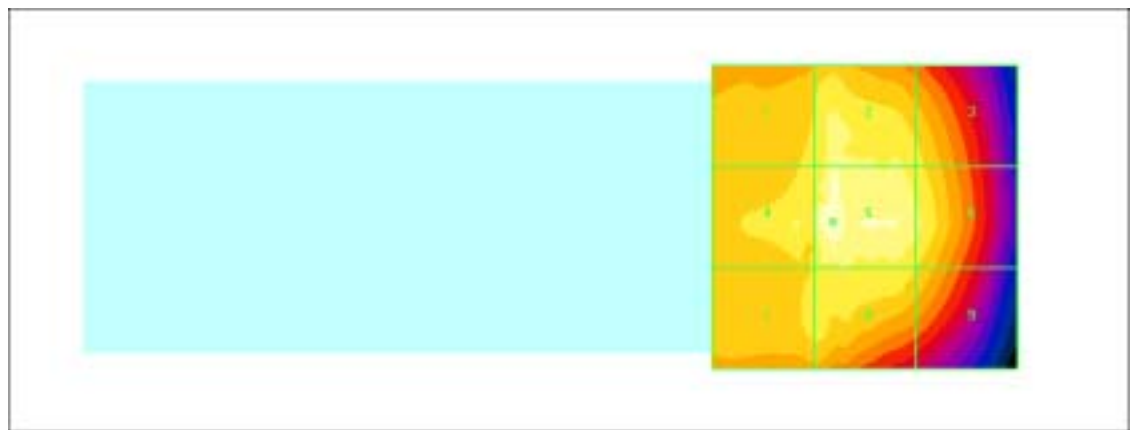
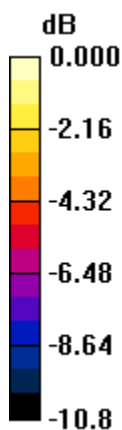
Probe Modulation Factor = 1.02

Reference Value = 98.3 V/m; Power Drift = 0.039 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
85.5	98.1	86.1
Grid 4	Grid 5	Grid 6
90.9	106.5	92.1
Grid 7	Grid 8	Grid 9
87.2	90.6	83.3



0 dB = 106.5V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(PCS) E-field, Date: Dec/21/2006

Procedure Name: Ch.25, Ant, Intenna, Battery Standard Backlight On

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.25, Ant, Intenna, Battery Standard Backlight On/Hearing Aid Compatibility Test (251x251x1): Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 61.0 V/m

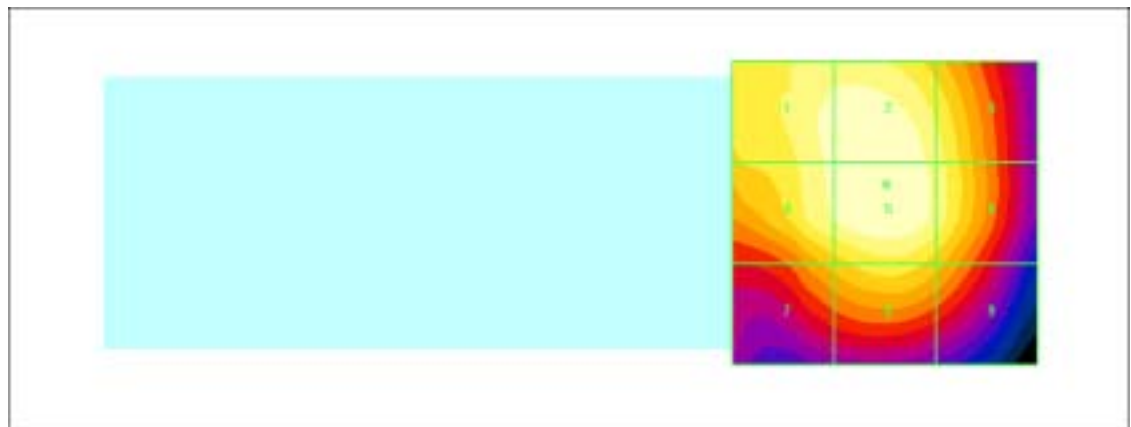
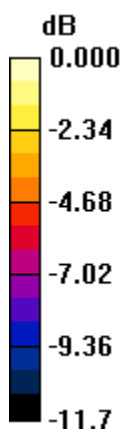
Probe Modulation Factor = 1.03

Reference Value = 62.7 V/m; Power Drift = -0.076 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
57.4	60.5	53.1
Grid 4	Grid 5	Grid 6
57.2	61.0	54.4
Grid 7	Grid 8	Grid 9
44.3	49.4	44.3



0 dB = 61.0V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(PCS) E-field, Date: Dec/21/2006

Procedure Name: Ch.25, Ant, Intenna, Battery Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.25, Ant, Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 62.8 V/m

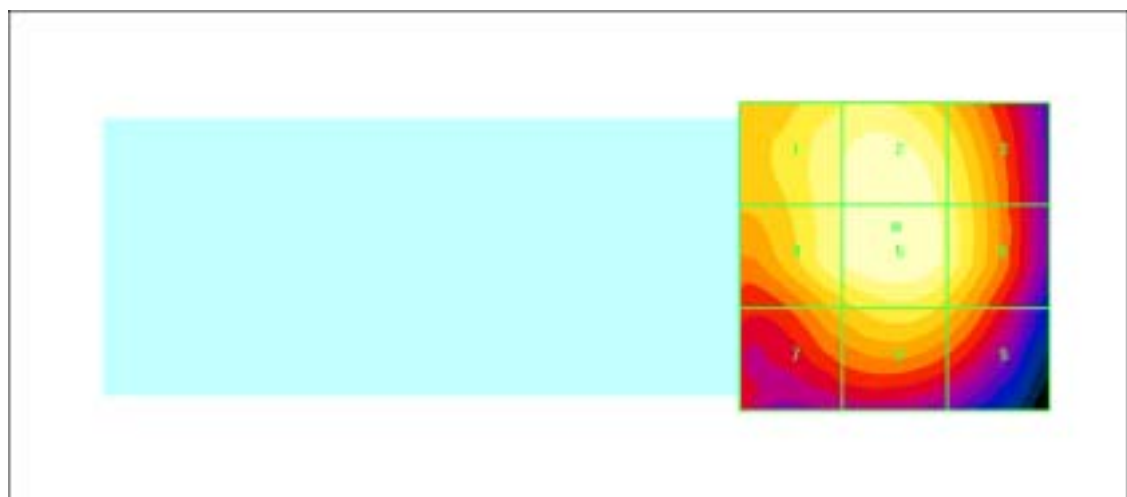
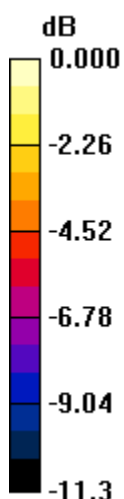
Probe Modulation Factor = 1.03

Reference Value = 66.8 V/m; Power Drift = 0.040 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
58.2	62.3	55.2
Grid 4	Grid 5	Grid 6
58.2	62.8	56.6
Grid 7	Grid 8	Grid 9
46.6	51.5	46.5



0 dB = 62.8V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(PCS) E-field, Date: Dec/21/2006

Procedure Name: Ch.600, Ant, Intenna, Battery Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.600, Ant, Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 53.6 V/m

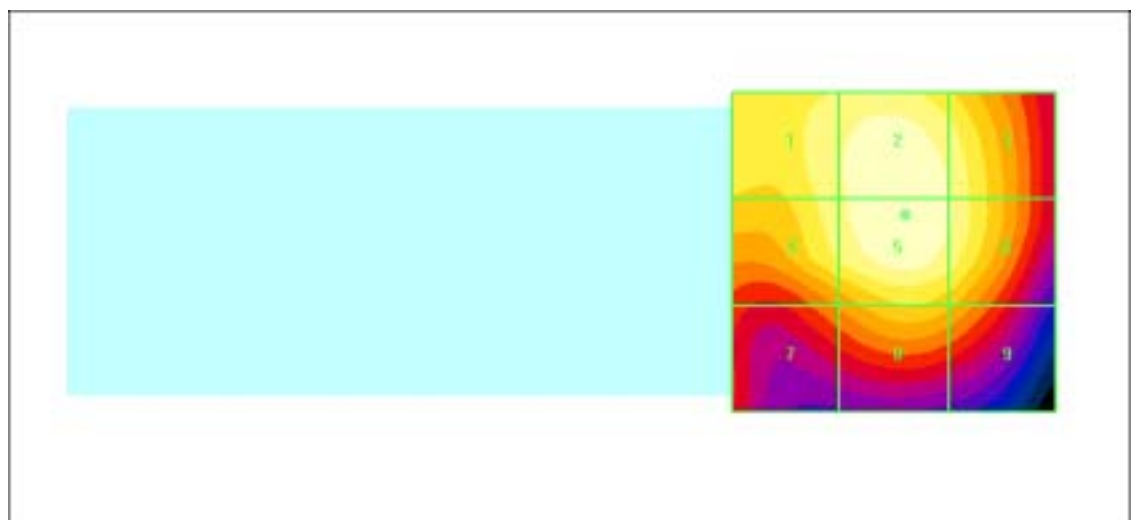
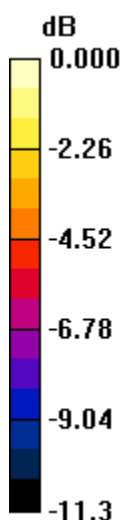
Probe Modulation Factor = 1.03

Reference Value = 56.7 V/m; Power Drift = -0.095 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
49.0	53.5	49.5
Grid 4	Grid 5	Grid 6
48.3	53.6	49.8
Grid 7	Grid 8	Grid 9
35.5	41.2	38.7



0 dB = 53.6V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(PCS) E-field, Date: Dec/21/2006

Procedure Name: Ch.1175, Ant, Intenna, Battery Standard

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

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Device Section

DASY4 Configuration:

- Probe: ER3DV6 - SN2370; ConvF(1, 1, 1); Calibrated: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.1175, Ant, Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 51.8 V/m

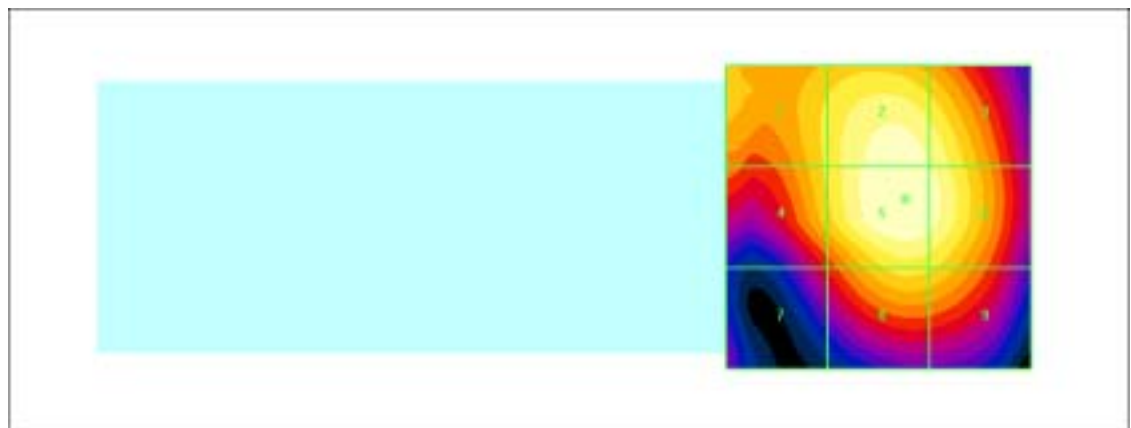
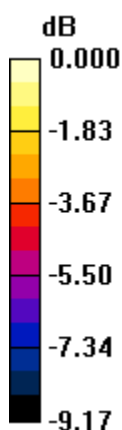
Probe Modulation Factor = 1.03

Reference Value = 55.5 V/m; Power Drift = -0.085 dB

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

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
43.0	50.9	48.5
Grid 4	Grid 5	Grid 6
42.7	51.8	49.9
Grid 7	Grid 8	Grid 9
32.1	43.4	42.4



0 dB = 51.8V/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) H-field, Date: Dec/21/2006

Procedure Name: Ch.1013, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.1013, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.198 A/m

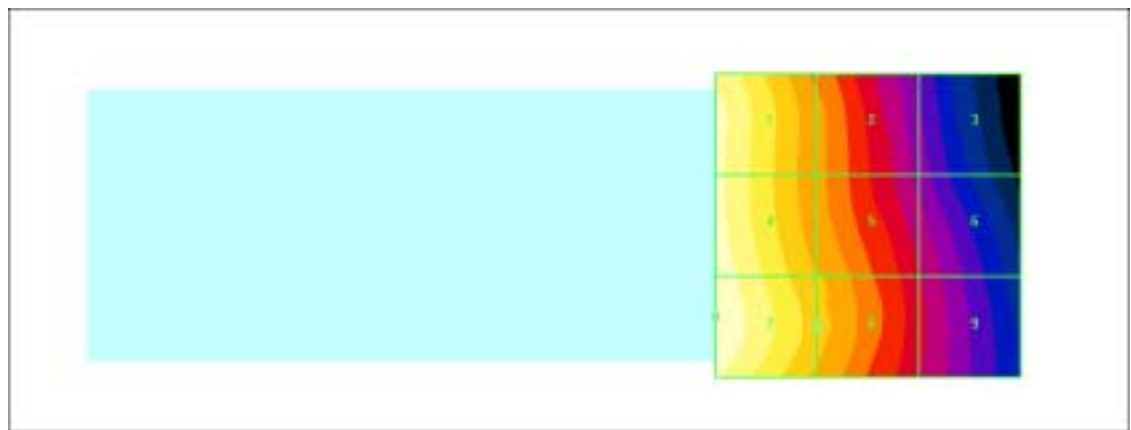
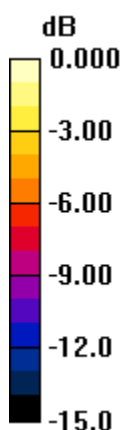
Probe Modulation Factor = 1.03

Reference Value = 0.093 A/m; Power Drift = 0.116 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.185	0.115	0.068
Grid 4	Grid 5	Grid 6
0.193	0.126	0.080
Grid 7	Grid 8	Grid 9
0.198	0.132	0.082



0 dB = 0.198A/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) H-field, Date: Dec/21/2006

Procedure Name: Ch.384, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.384, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.155 A/m

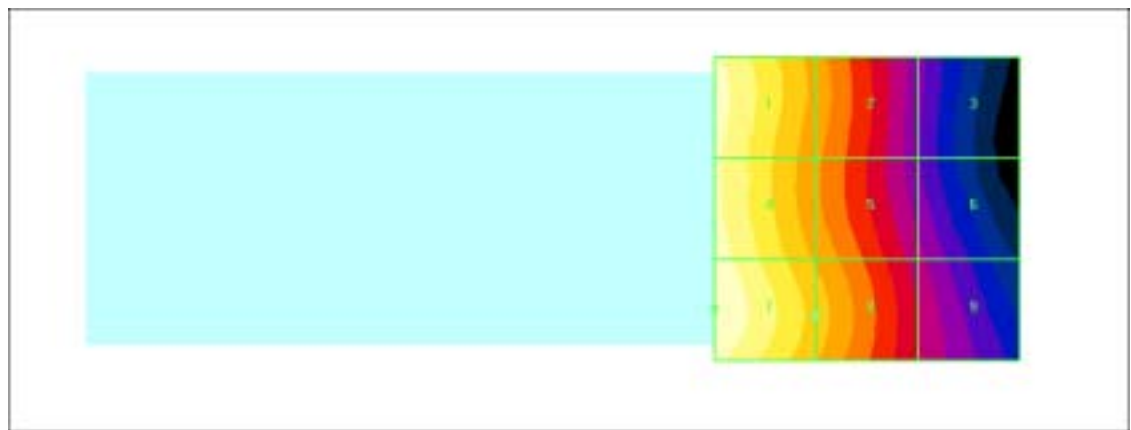
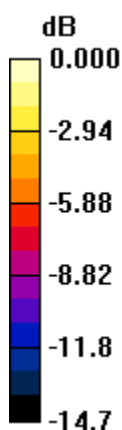
Probe Modulation Factor = 1.03

Reference Value = 0.071 A/m; Power Drift = 0.138 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.146	0.095	0.053
Grid 4	Grid 5	Grid 6
0.149	0.097	0.059
Grid 7	Grid 8	Grid 9
0.155	0.105	0.064



0 dB = 0.155A/m

DUT: SCH-U340; Serial: AD-082-A

Program Name: SCH-U340(CDMA) H-field, Date: Dec/21/2006

Procedure Name: Ch.777, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.777, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.178 A/m

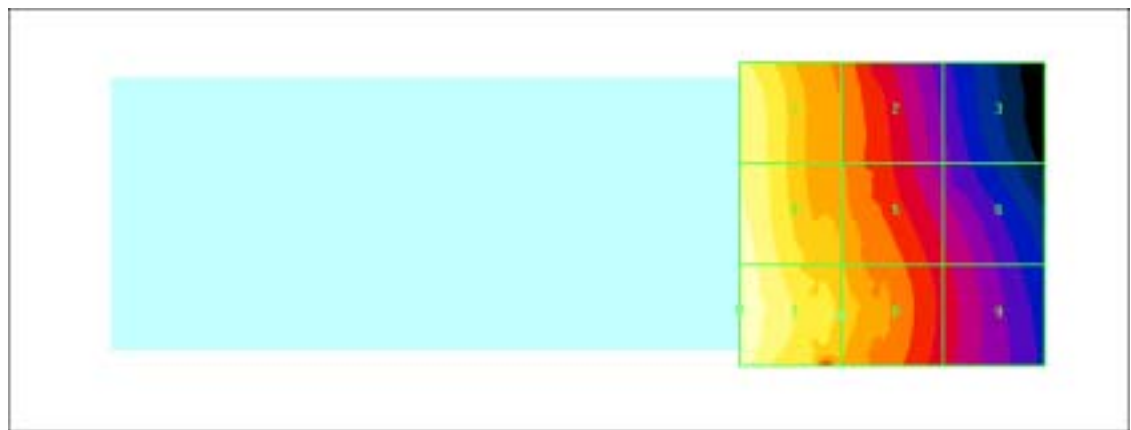
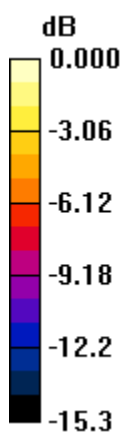
Probe Modulation Factor = 1.03

Reference Value = 0.084 A/m; Power Drift = -0.066 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.160	0.100	0.058
Grid 4	Grid 5	Grid 6
0.171	0.114	0.073
Grid 7	Grid 8	Grid 9
0.178	0.121	0.076



0 dB = 0.178A/m

DUT: SCH-U340; Serial: AD-068-A

Program Name: SCH-U340(PCS) H-field, Date: Dec/21/2006

Procedure Name: Ch.25, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.25, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.178 A/m

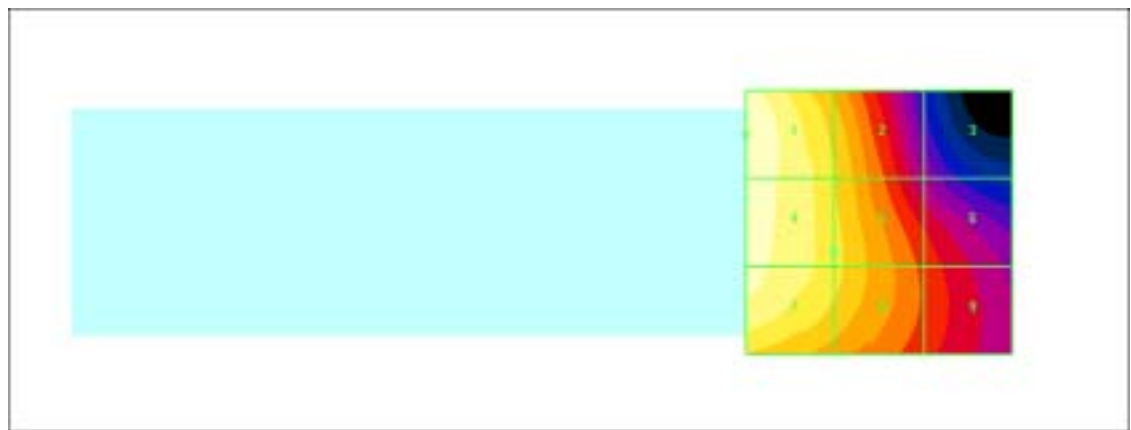
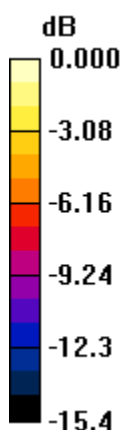
Probe Modulation Factor = 1.01

Reference Value = 0.101 A/m; Power Drift = 0.142 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.178	0.125	0.062
Grid 4	Grid 5	Grid 6
0.174	0.130	0.085
Grid 7	Grid 8	Grid 9
0.165	0.130	0.087



0 dB = 0.178A/m

DUT: SCH-U340; Serial: AD-068-A

Program Name: SCH-U340(PCS) H-field, Date: Dec/21/2006

Procedure Name: Ch.0600, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.0600, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.185 A/m

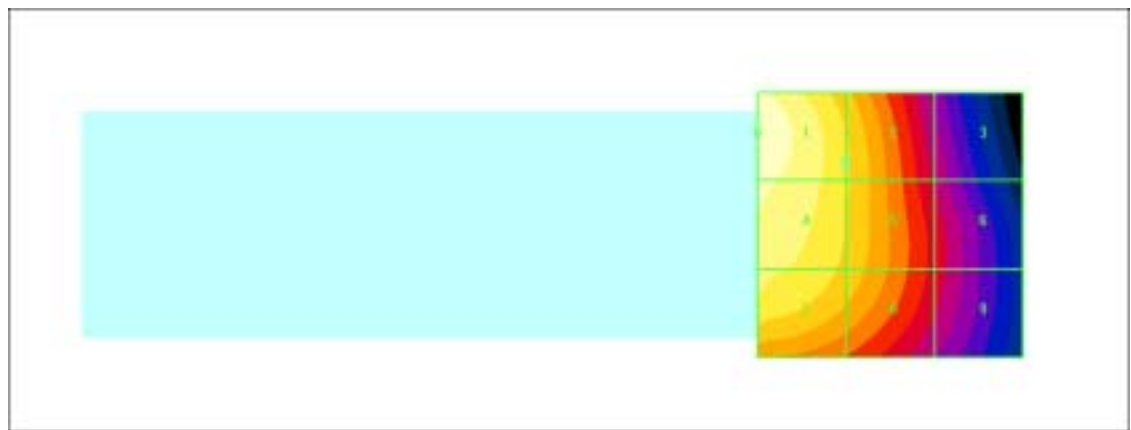
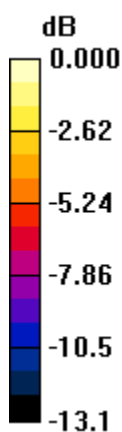
Probe Modulation Factor = 1.01

Reference Value = 0.116 A/m; Power Drift = 0.145 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.185	0.139	0.082
Grid 4	Grid 5	Grid 6
0.175	0.139	0.088
Grid 7	Grid 8	Grid 9
0.157	0.133	0.088



0 dB = 0.185A/m

DUT: SCH-U340; Serial: AD-068-A

Program Name: SCH-U340(PCS) H-field, Date: Dec/21/2006

Procedure Name: Ch.1175, Ant. Intenna, Battery Standard

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: 2006-05-16

- Sensor-Surface: (Fix Surface)

- Electronics: DAE3 Sn468; Calibrated: 2006-01-27

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

- Measurement SW: DASY4, V4.7 Build 44; Postprocessing SW: SEMCAD, V1.8 Build 171

Ch.1175, Ant. Intenna, Battery Standard/Hearing Aid Compatibility Test (251x251x1):

Measurement grid: dx=2mm, dy=2mm

Maximum value of peak Total field = 0.156 A/m

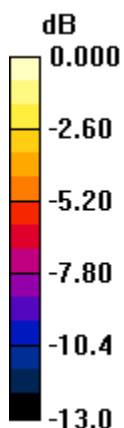
Probe Modulation Factor = 1.01

Reference Value = 0.093 A/m; Power Drift = -0.068 dB

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

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.156	0.125	0.072
Grid 4	Grid 5	Grid 6
0.144	0.121	0.068
Grid 7	Grid 8	Grid 9
0.128	0.111	0.069



0 dB = 0.156A/m

APPENDIX E

Probe Calibration(E-field)



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 **Samsung (Dymstec)**

Certificate No: **ER3-2370_May06**

CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2370**

Calibration procedure(s) **QA CAL-02.v4
Calibration procedure for E-field probes optimized for close near field
evaluations in air**

Calibration date: **May 16, 2006**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Power sensor E4412A	MY41495277	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Power sensor E4412A	MY41498087	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Reference 3 dB Attenuator	SN: S5054 (3c)	11-Aug-05 (METAS, No. 251-00499)	Aug-06
Reference 20 dB Attenuator	SN: S5086 (20b)	4-Apr-06 (METAS, No. 251-00558)	Apr-07
Reference 30 dB Attenuator	SN: S5129 (30b)	11-Aug-05 (METAS, No. 251-00500)	Aug-06
Reference Probe ER3DV6	SN: 2328	3-Oct-05 (SPEAG, No. ER3-2328_Oct05)	Oct-06
DAE4	SN: 654	2-Feb-06 (SPEAG, No. DAE4-654_Feb06)	Feb-07

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Nov-05)	In house check: Nov-07
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-05)	In house check: Nov 06

Calibrated by: **Katja Pokovic** **Technical Manager**

Approved by: **Niels Kuster** **Quality Manager**

Signature

Issued: May 18, 2006

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

Handwritten signature and date: 2006.6.14



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**

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 1309-1996, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

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
Calibrated:	May 16, 2006

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: ER3DV6 SN:2370Sensitivity in Free Space [$\mu\text{V}/(\text{V}/\text{m})^2$]Diode Compression^ANormX **1.71 $\pm$ 10.1 % (k=2)**DCP X **95 mV**NormY **1.61 $\pm$ 10.1 % (k=2)**DCP Y **95 mV**NormZ **1.96 $\pm$ 10.1 % (k=2)**DCP Z **98 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

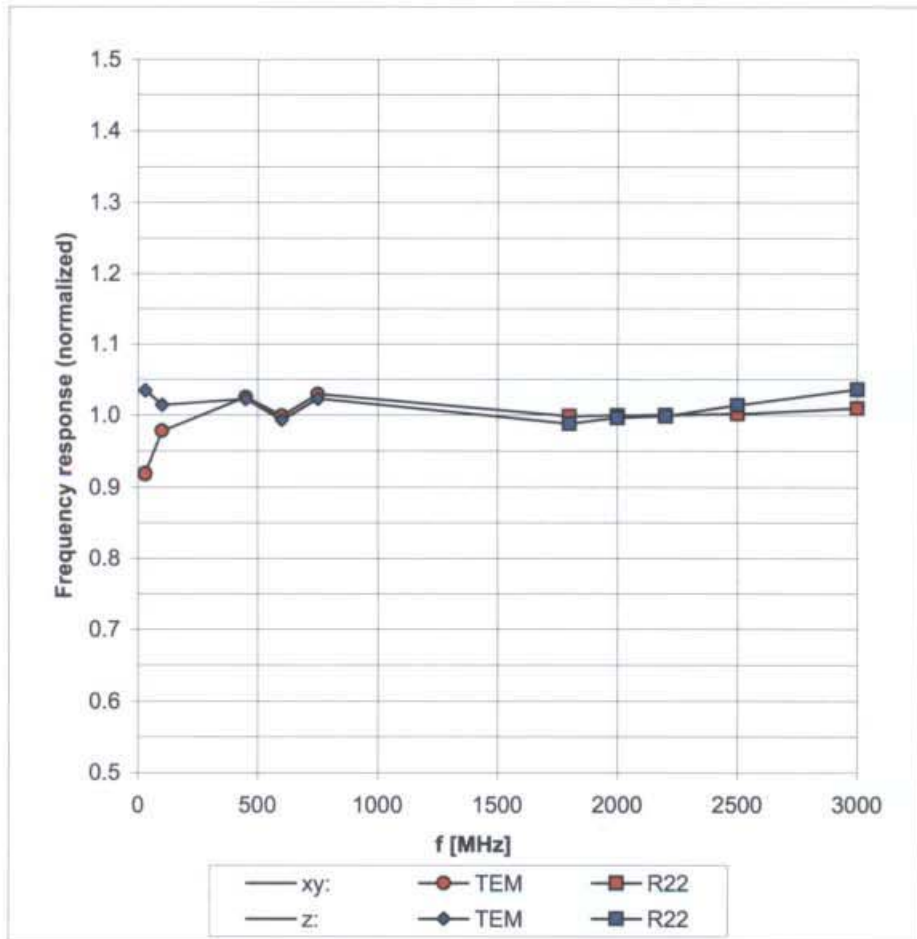
133 °

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%.

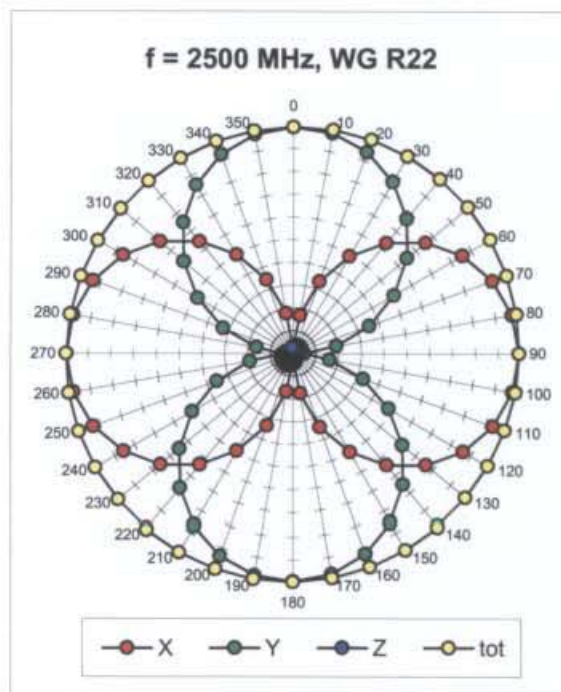
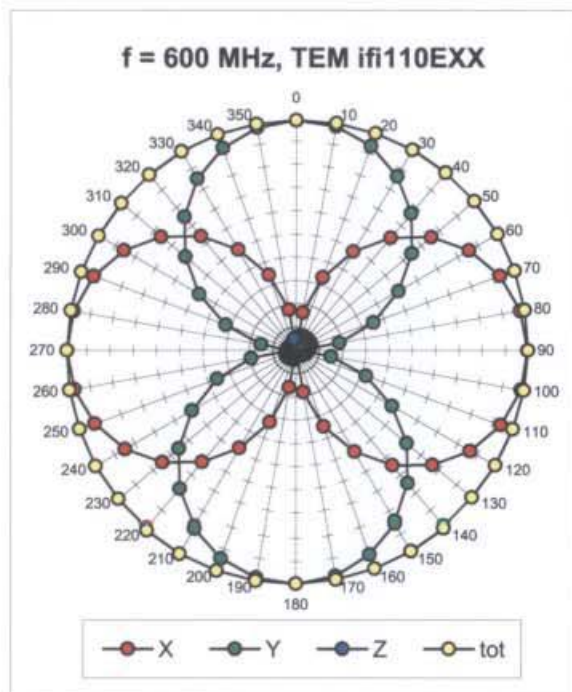
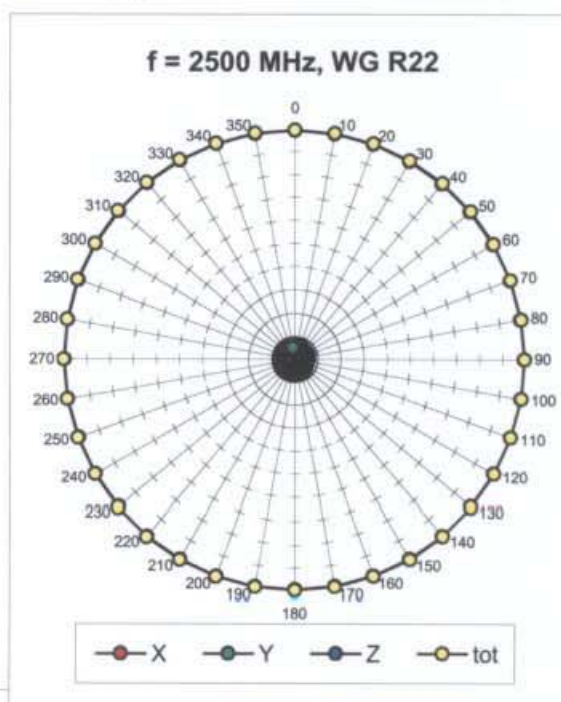
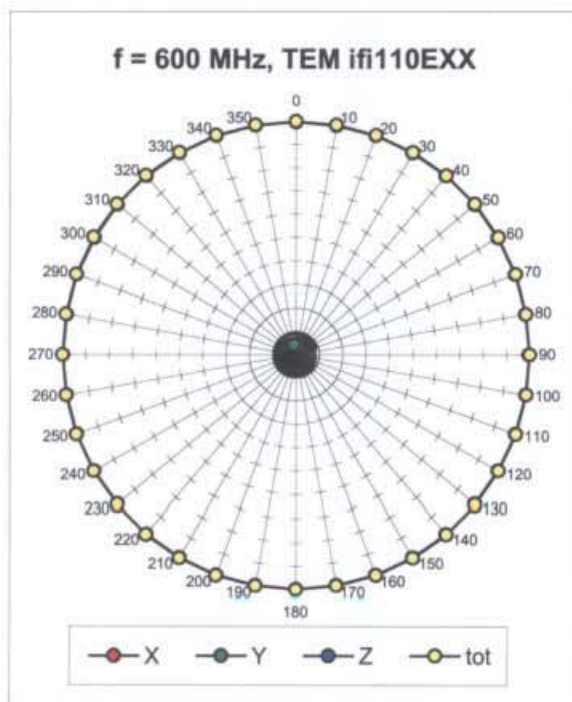
^A numerical linearization parameter: uncertainty not required

Frequency Response of E-Field

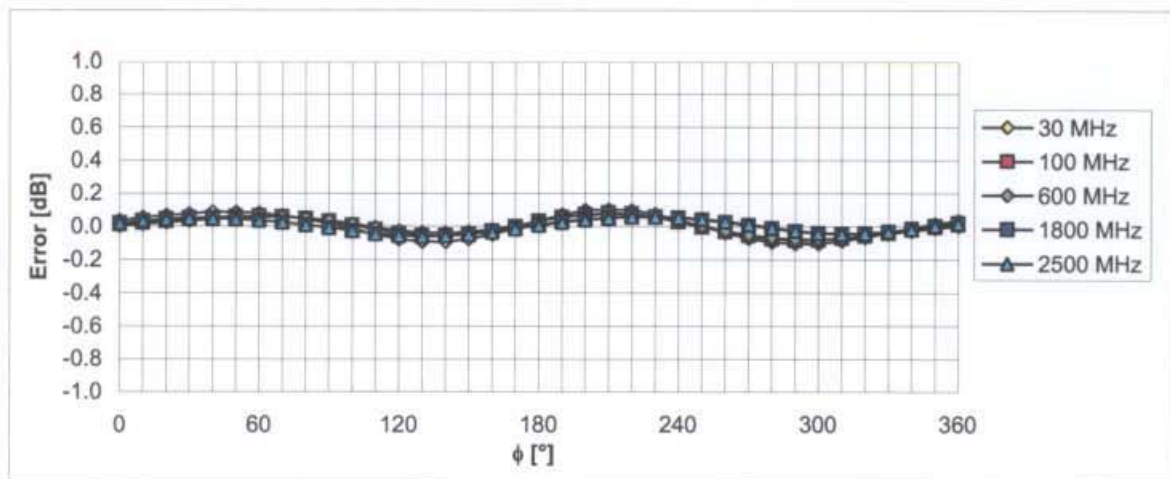
(TEM-Cell:ifi110 EXX, Waveguide R22)



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

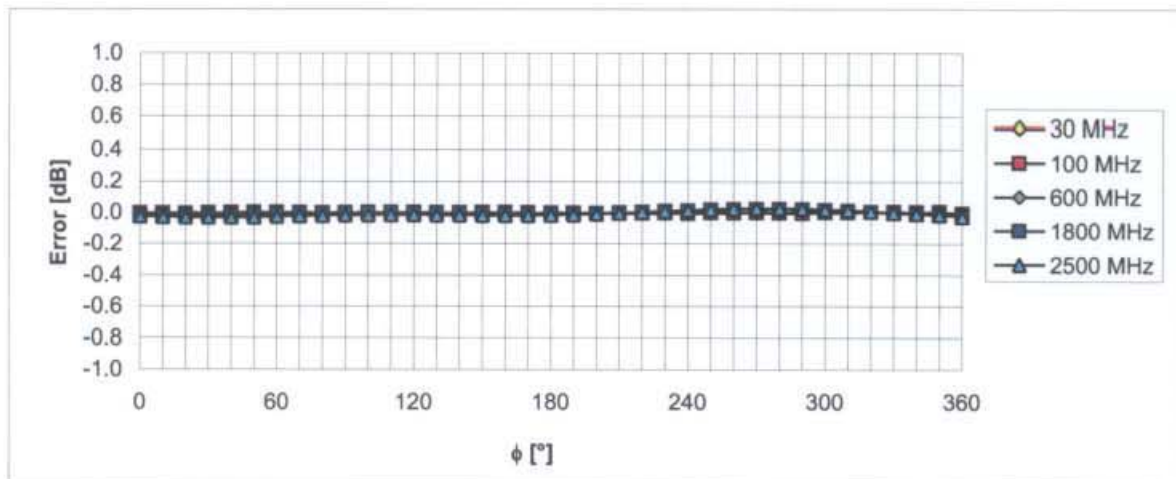
Receiving Pattern (ϕ), $\vartheta = 0^\circ$ Receiving Pattern (ϕ), $\vartheta = 90^\circ$ 

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



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

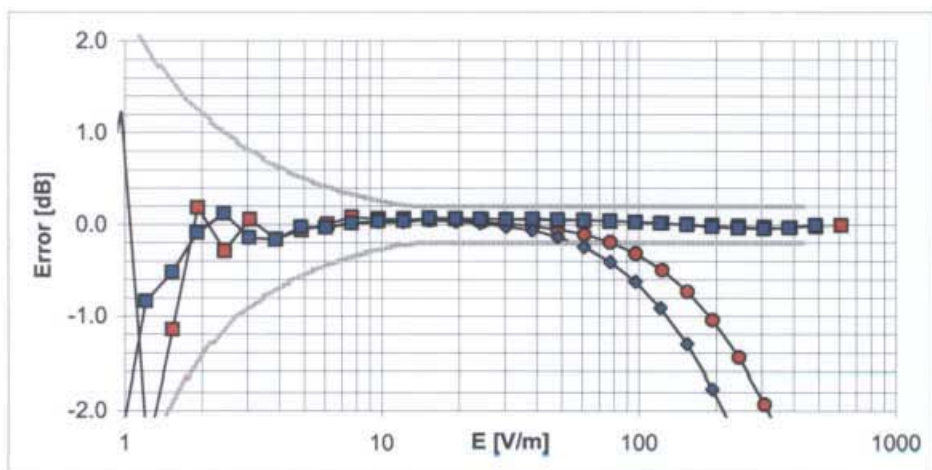
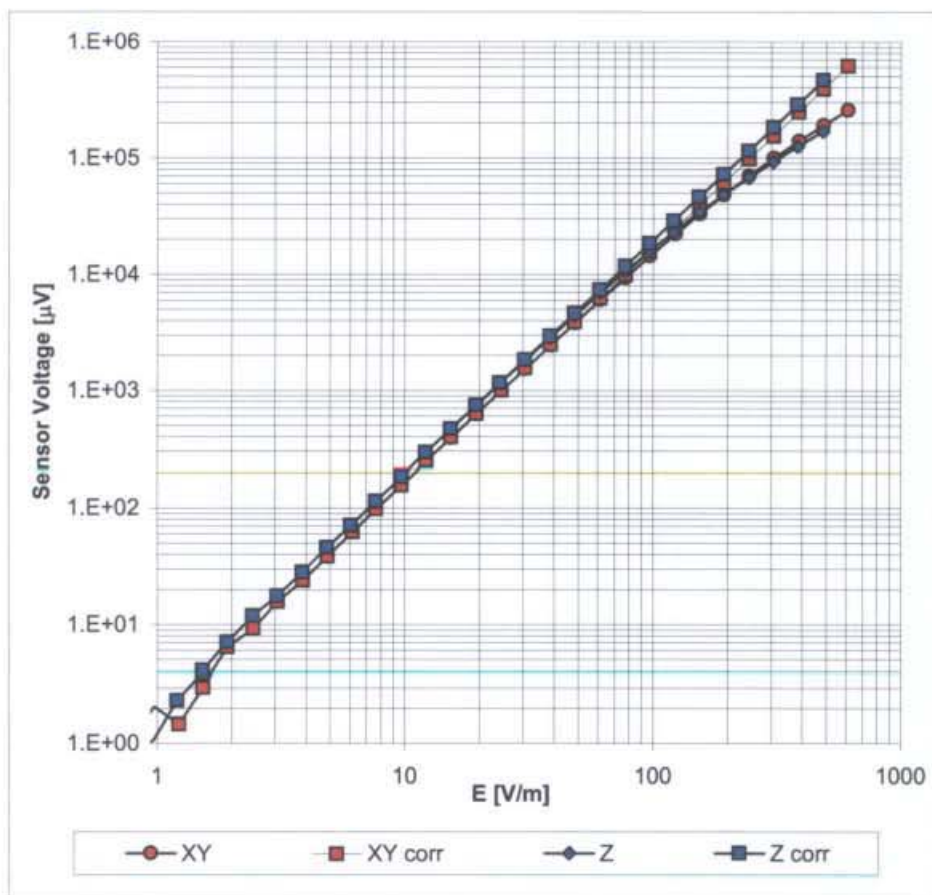
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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

Dynamic Range f(E-field)

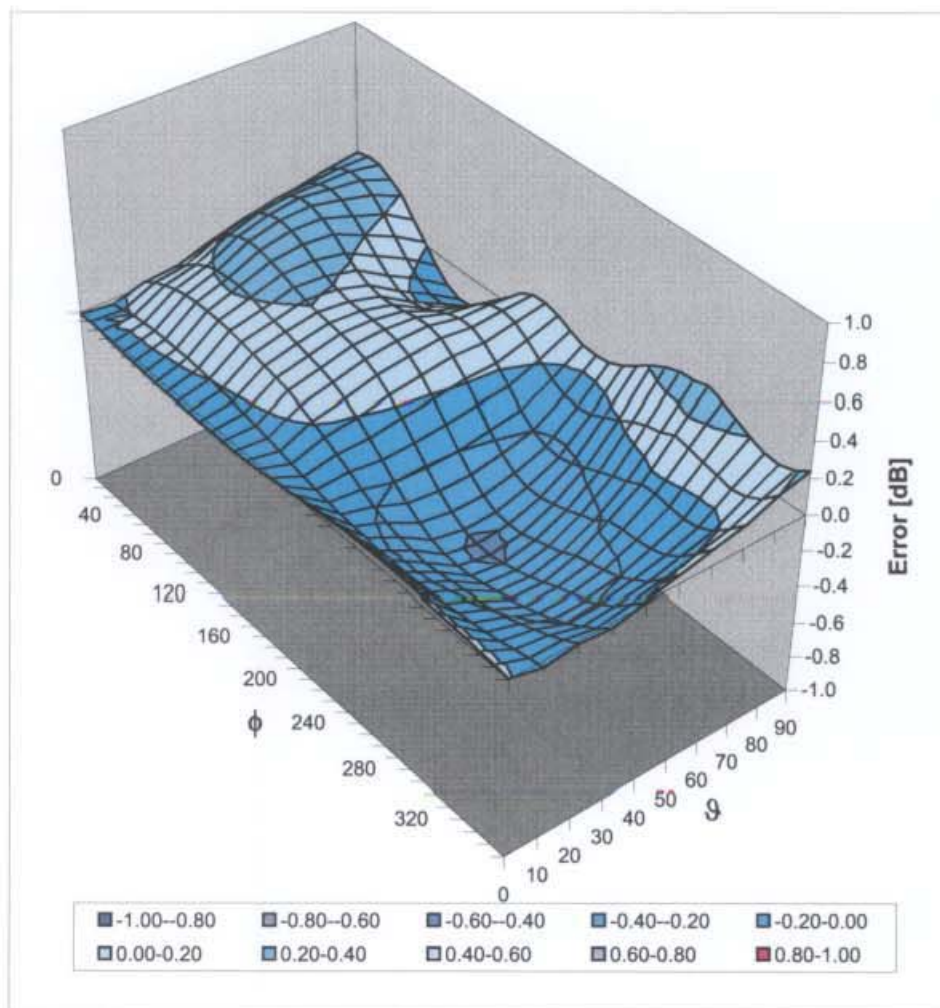
(Waveguide R22, $f = 1800$ MHz)



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: $\pm 2.6\%$ ($k=2$)

APPENDIX F

Probe Calibration(H-field)



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 **Samsung (Dymstec)**

Certificate No: **H3-6197_May06**

CALIBRATION CERTIFICATE

Object **H3DV6 - SN:6197**

Calibration procedure(s) **QA CAL-03.v4**
Calibration procedure for H-field probes optimized for close near field
evaluations in air

Calibration date: **May 16, 2006**

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 (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Power sensor E4412A	MY41495277	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Power sensor E4412A	MY41498087	5-Apr-06 (METAS, No. 251-00557)	Apr-07
Reference 3 dB Attenuator	SN: S5054 (3c)	11-Aug-05 (METAS, No. 251-00499)	Aug-06
Reference 20 dB Attenuator	SN: S5086 (20b)	4-Apr-06 (METAS, No. 251-00558)	Apr-07
Reference 30 dB Attenuator	SN: S5129 (30b)	11-Aug-05 (METAS, No. 251-00500)	Aug-06
Reference Probe H3DV6	SN: 6182	3-Oct-05 (SPEAG, No. H3-6182_Oct05)	Oct-06
DAE4	SN: 654	2-Feb-06 (SPEAG, No. DAE4-654_Feb06)	Feb-07
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Nov-05)	In house check: Nov-07
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-05)	In house check: Nov 06

Calibrated by: **Katja Pokovic** Technical Manager

Approved by: **Niels Kuster** Quality Manager

Issued: May 18, 2006

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

Handwritten signature and date: 2006.6.14



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**

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 1309-1996, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", 1996.

Methods Applied and Interpretation of Parameters:

- X, Y, Z_{a0a1a2} : Assessed for E-field polarization $\vartheta = 90$ for XY sensors and $\vartheta = 0$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- $X, Y, Z(f)_{a0a1a2} = X, Y, Z_{a0a1a2} * \text{frequency_response}$ (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 X_{a0a1a2} (no uncertainty required).

Probe H3DV6

SN:6197

Manufactured:	April 18, 2006
Calibrated:	May 16, 2006

Calibrated for DASY Systems

(Note: non-compatible with DASY2 system!)

DASY - Parameters of Probe: H3DV6 SN:6197Sensitivity in Free Space [A/m / $\sqrt{(\mu\text{V})}$]

	a0	a1	a2
X	2.390E-03	9.236E-5	9.180E-5 $\pm$ 5.1 % (k=2)
Y	2.352E-03	1.475E-4	9.683E-5 $\pm$ 5.1 % (k=2)
Z	2.787E-03	3.864E-5	7.638E-5 $\pm$ 5.1 % (k=2)

Diode Compression¹

DCP X	85 mV
DCP Y	85 mV
DCP Z	85 mV

Sensor Offset (Probe Tip to Sensor Center)

X	3.0 mm
Y	3.0 mm
Z	3.0 mm

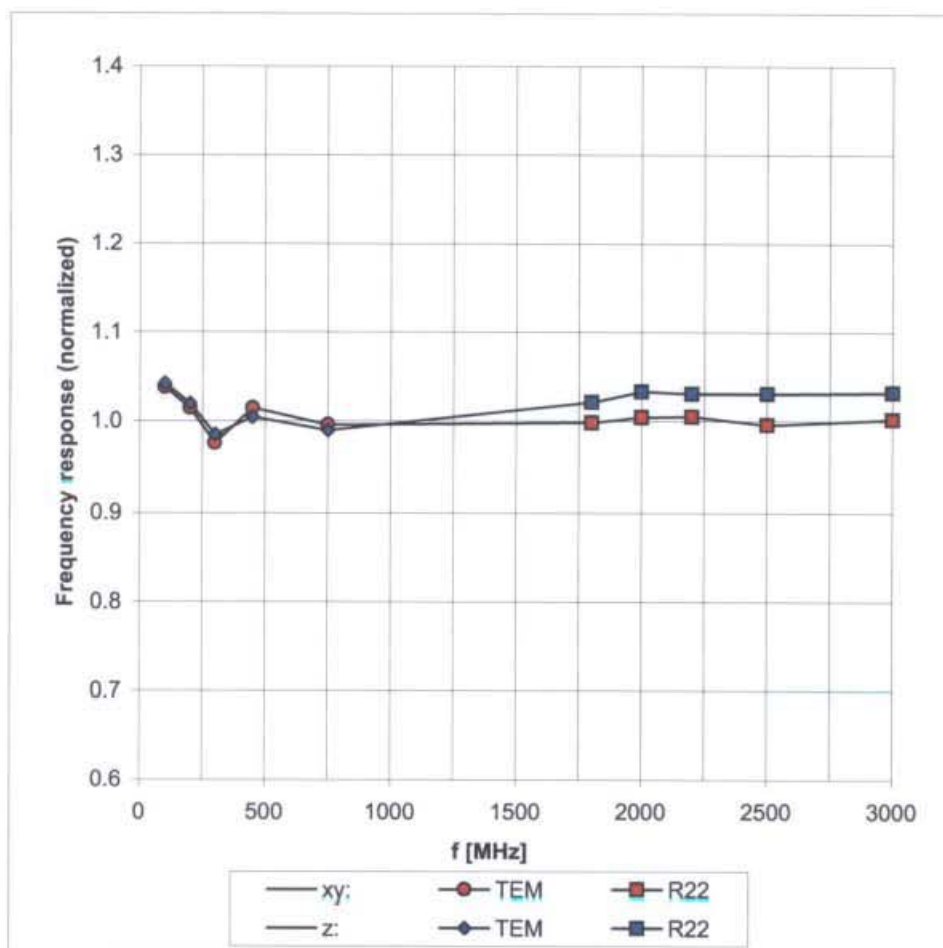
Connector Angle -24 °

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%.

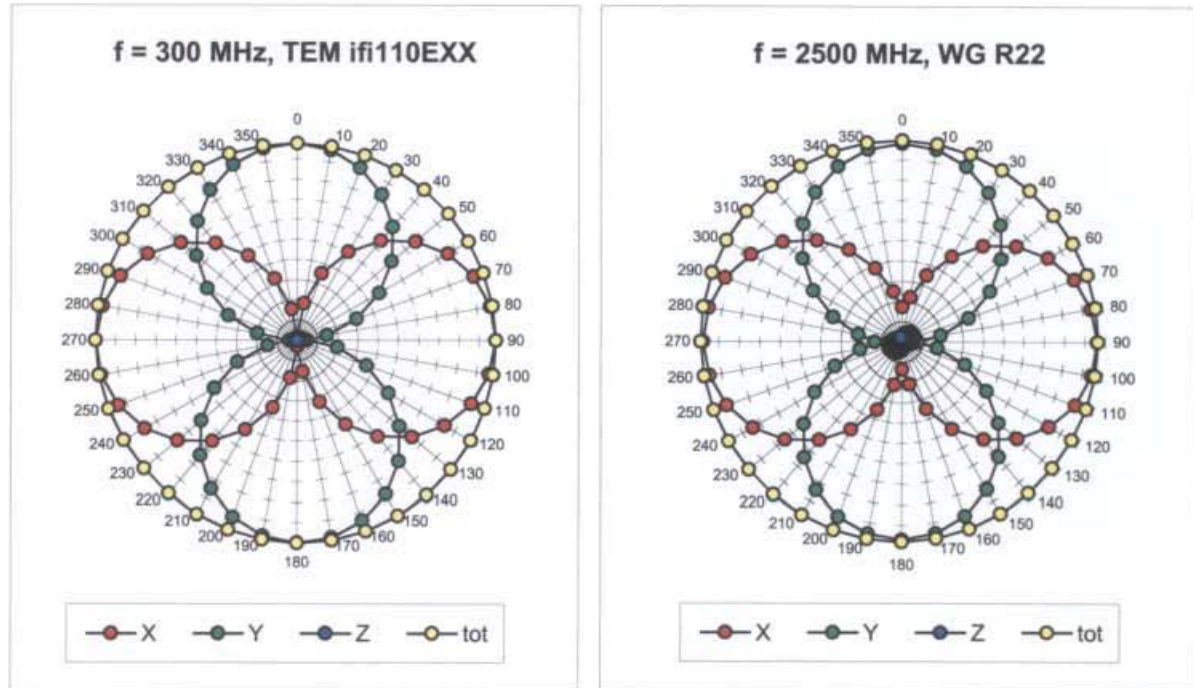
¹ numerical linearization parameter: uncertainty not required

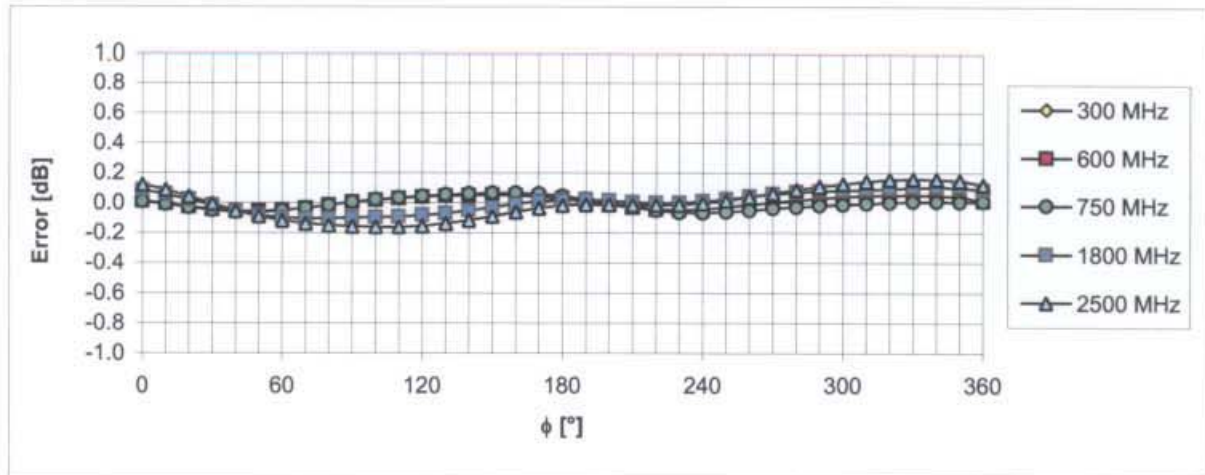
Frequency Response of H-Field

(TEM-Cell:ifi110, Waveguide R22)

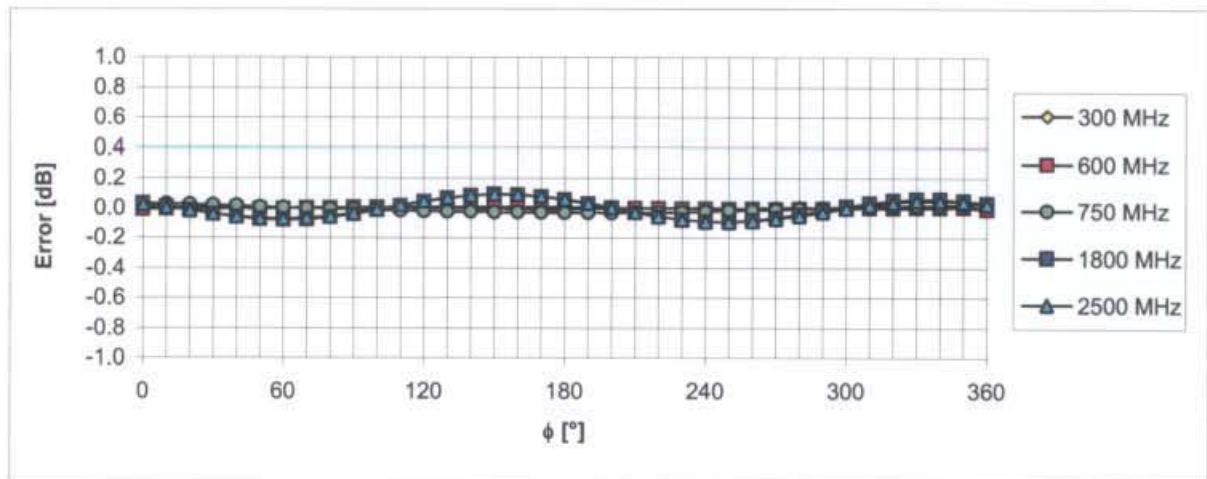


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

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

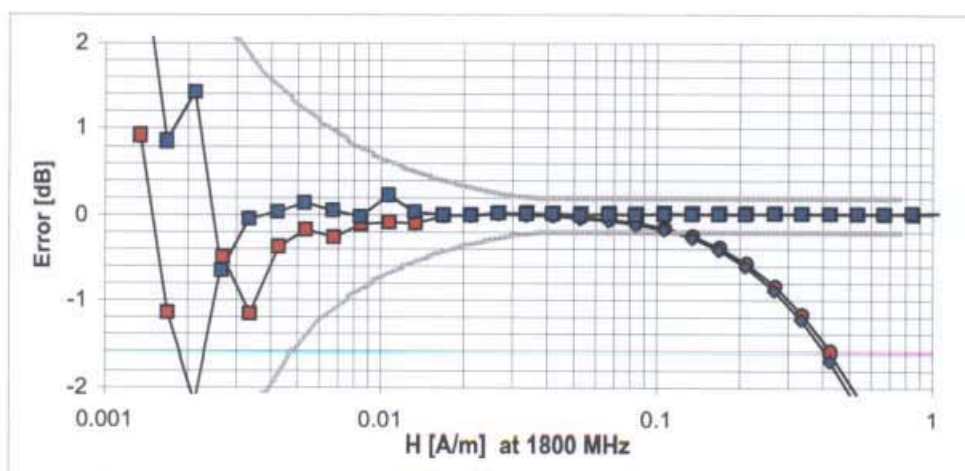
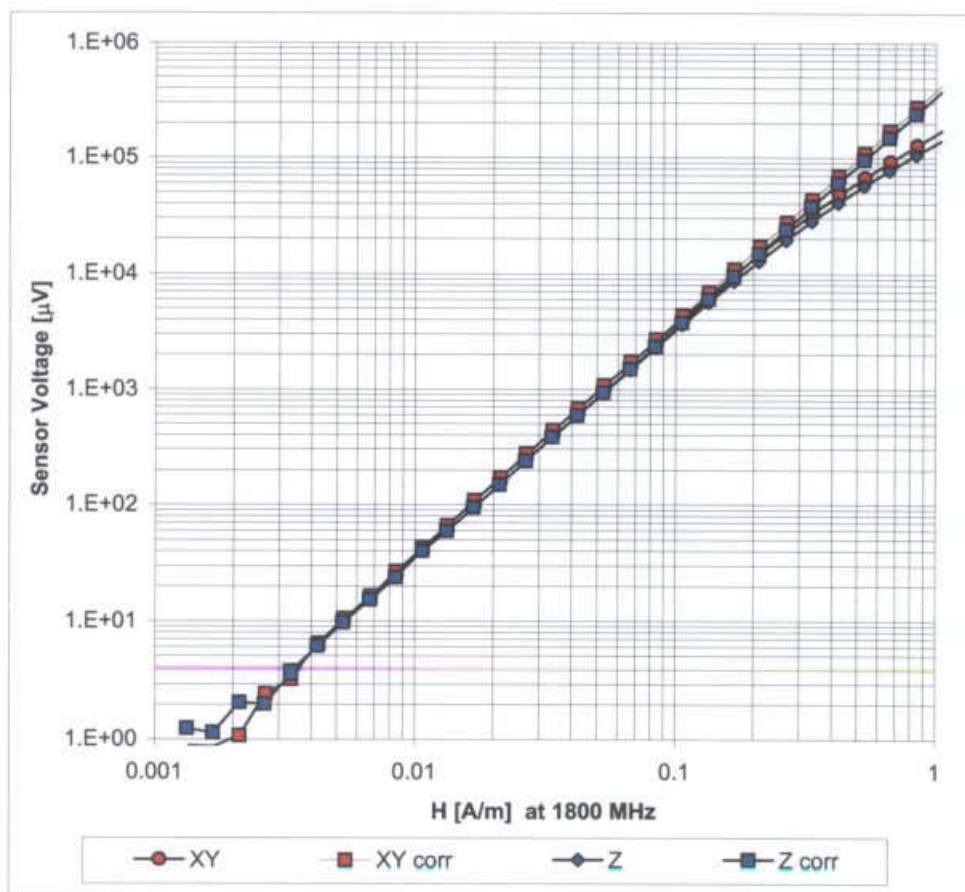
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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

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

Dynamic Range f(H-field)

(Waveguide R22, $f = 1800$ MHz)



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

APPENDIX G

Calibration of The Validation Dipole

5091

Client **Samsung Suwon (Dymstec)**

Certificate No: **CD835V3-1021_Apr05**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1021**

Calibration procedure(s) **QA CAL-20.v3**
Calibration procedure for dipoles in air

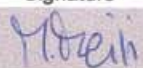
Calibration date: **April 27, 2005**

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

Calibration Equipment used (M&TE critical for calibration)

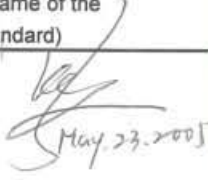
Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-4419B	GB43310788	10-Aug-03 (SPEAG, in house check Jan-04)	In house check: Oct-05
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
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Nov-04)	In house check: Nov-05
RF generator R&S SMT06	1039.2000.06	26-Jul-04 (SPEAG, in house check Jul-04)	In house check: Jan-06
DAE4	SN: 901	29-Jun-04 (SPEAG, No. DAE4-901_Jun04)	Calibration, Jun-05
Probe ER3DV6	SN: 2336	20-Jan-05 (SPEAG, No. ER3-2336_Jan05)	Calibration, Jan-06
Probe H3DV6	SN: 6065	10-Dec-04 (SPEAG, No. H3-6065-Dec04)	Calibration, Dec-05

	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	

	Name	Function	Signature
Approved by:	Fin Bornholt	Technical Director	

Issued: May 2, 2005

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


 May 23, 2005

References

- [1] ANSI-PC63.19-2003 (Draft)
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the the top edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY4 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- *E- field distribution:* E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1 Measurement Conditions

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

DASY Version	DASY4	V4.5 B19
DASY PP Version	SEMCAD	V1.8 B146
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 180 mm
Frequency	835 MHz $\pm$ 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	0.439 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	163.6 V/m
Maximum measured above low end	100 mW forward power	170.5 V/m
Averaged maximum above arm	100 mW forward power	167.1 V/m

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

3 Appendix

3.1 Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	16.8 dB	(40.9 – j9.6) Ohm
835 MHz	23.9 dB	(53.8 + j5.5) Ohm
900 MHz	15.9 dB	(50.9 - j16.4) Ohm
950 MHz	21.5 dB	(45.9 + j6.9) Ohm
960 MHz	16.8 dB	(55.9 + j14.3) 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.

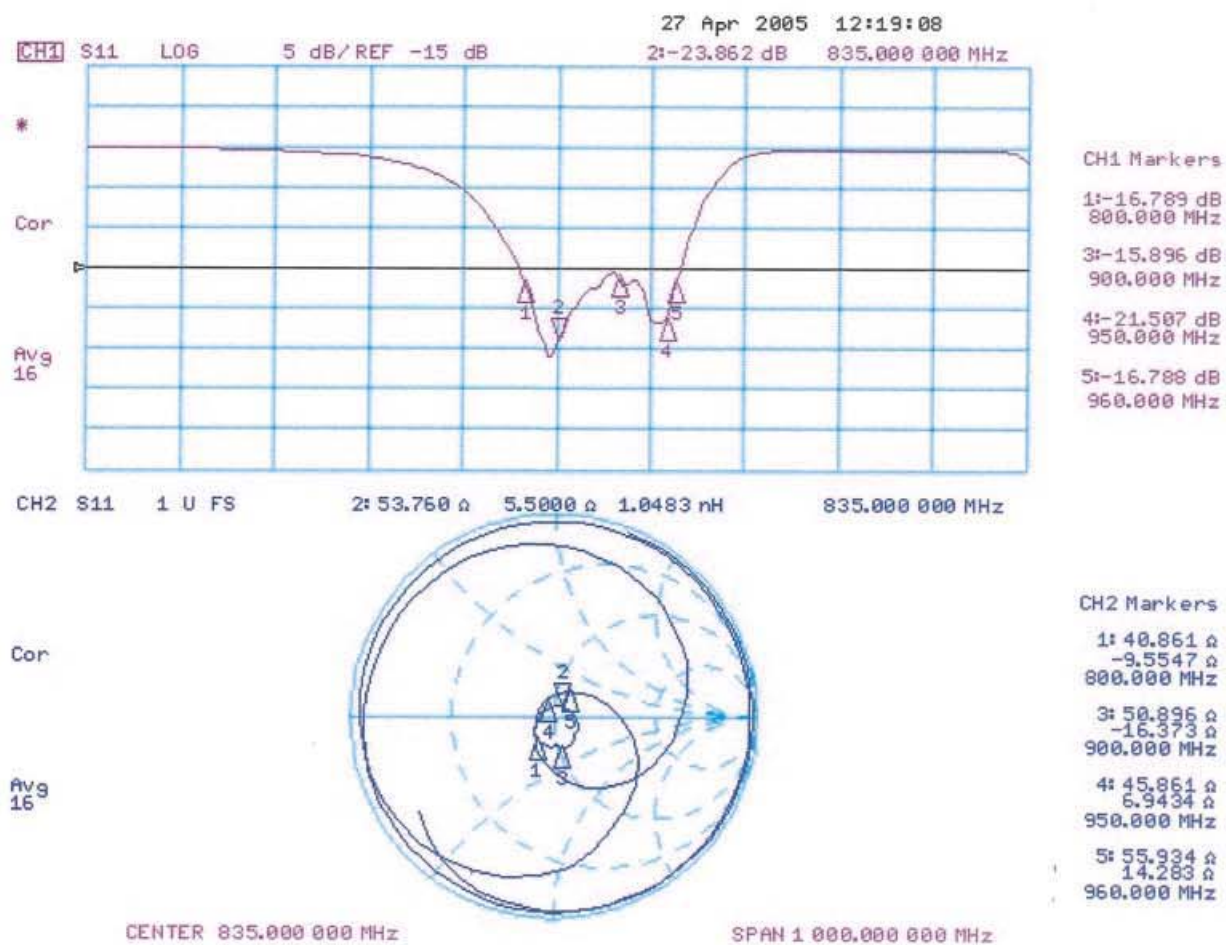
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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

Date/Time: 4/27/2005 12:18:42 PM

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1021

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: Air

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

Phantom section: H Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 12/10/2004
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 6/29/2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of Total field (slot averaged) = 0.439 A/m

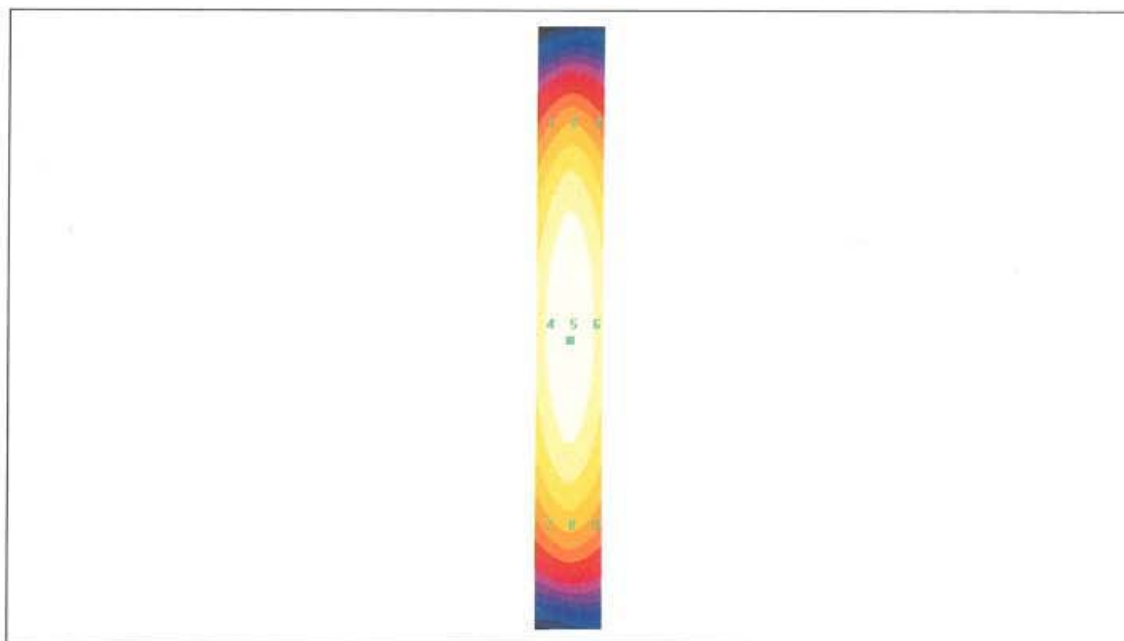
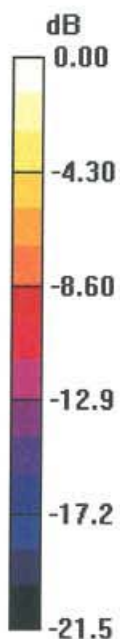
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.362	0.390	0.372
Grid 4	Grid 5	Grid 6
0.410	0.439	0.421
Grid 7	Grid 8	Grid 9
0.364	0.390	0.373

H in A/m (Slot averaged)

Grid 1	Grid 2	Grid 3
0.362	0.390	0.372
Grid 4	Grid 5	Grid 6
0.410	0.439	0.421
Grid 7	Grid 8	Grid 9
0.364	0.390	0.373



0 dB = 0.439 A/m

3.3.3 DASY4 E-Field result

Date/Time: 4/27/2005 4:57:58 PM

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1021

Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1

Medium: Air

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

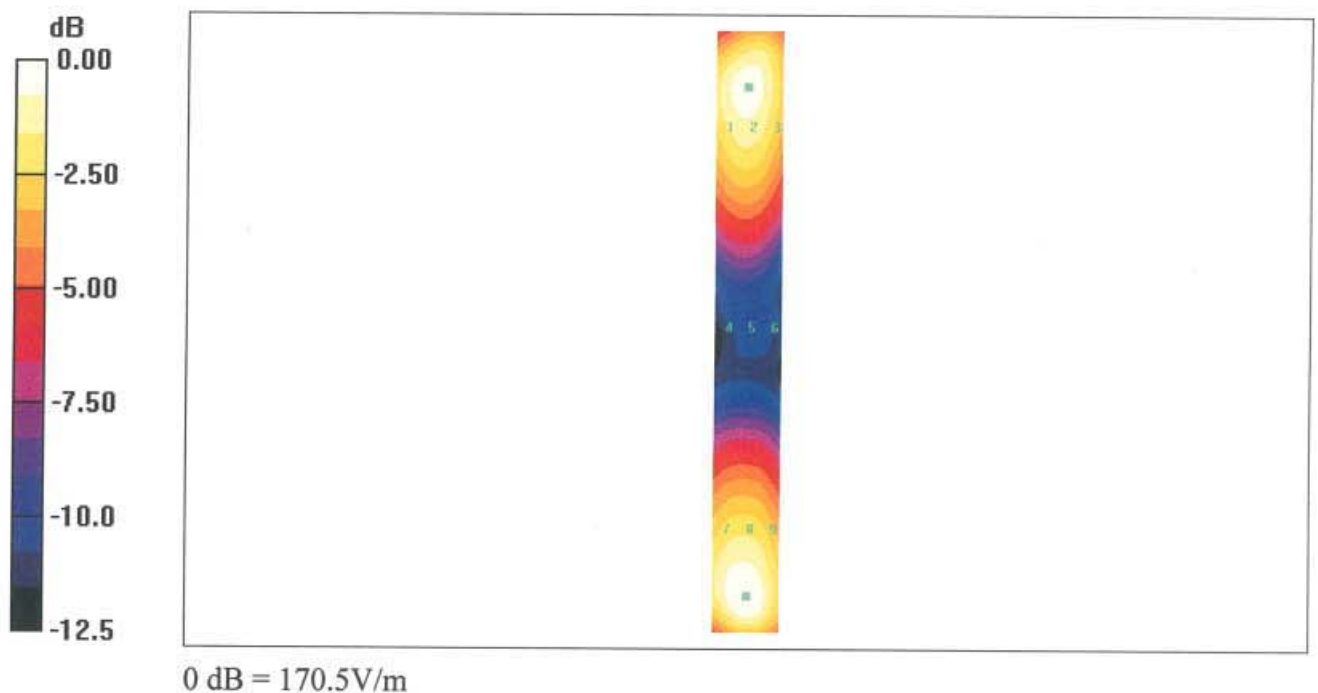
- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 1/20/2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 6/29/2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA; Serial: 1002
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

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

Maximum value of Total field (slot averaged) = 170.5 V/m

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

E in V/m (Time averaged)			E in V/m (Slot averaged)		
Grid 1	Grid 2	Grid 3	Grid 1	Grid 2	Grid 3
159.9	163.6	156.4	159.9	163.6	156.4
Grid 4	Grid 5	Grid 6	Grid 4	Grid 5	Grid 6
86.0	88.0	83.6	86.0	88.0	83.6
Grid 7	Grid 8	Grid 9	Grid 7	Grid 8	Grid 9
163.7	170.5	164.4	163.7	170.5	164.4



Client **Samsung Suwon (Dymstec)**

Certificate No: **CD1880V3-1016_Apr05**

CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1016**

Calibration procedure(s) **QA CAL-20.v3
Calibration procedure for dipoles in air**

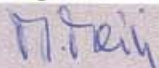
Calibration date: **April 5, 2005**

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 at an environment temperature $(22 \pm 3)^\circ\text{C}$ 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
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	1926A29113	(in house check Apr-05)	In house check: Apr-06
Powermeter HP 436A	1949U00953	(in house check Apr-05)	In house check: Apr-06
Power sensor HP 8482A	1551A02446	cal. 13-Jun-2000 (in house check Apr-05)	In house check: Apr-06
Powermeter HP 436A	2410U02600	(in house check Apr-05)	In house check: Apr-06
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
Reference Probe ER3DV6	SN 2336	20-Jan-05 (SPEAG, No. ER3-2336_Jan05)	Calibration, Jan-06
Probe H3DV6	SN 6065	10-Oct-04 (SPEAG, No. H3-6065-Oct04)	Calibration, Oct-05
DAE4	SN 901	29-Jun-04 (SPEAG, No. DAE4-901_Jun04)	Calibration, Jun-05

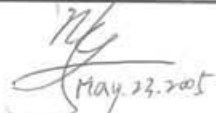
	Name	Function	Signature
Calibrated by:	Mike Meili	Laboratory Technician	
Approved by:	Fin Bornholt	Technical Director	

Issued: May 11, 2005

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

Certificate No: CD1880V3-1016_Apr05

Page 1 of 6


May 23, 2005

(C)10-11-1985

References

- [1] ANSI-PC63.19-2003 (Draft)
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with standard [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the the top edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY4 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- *E- field distribution:* E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

1 Measurement Conditions

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

DASY Version	DASY4	V4.5 B19
DASY PP Version	SEMCAD	V1.8 B146
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 $\pm$ 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	0.457 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	137.2 V/m
Maximum measured above low end	100 mW forward power	139.9 V/m
Averaged maximum above arm	100 mW forward power	138.6 V/m

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

3 Appendix

3.1 Antenna Parameters

Frequency	Return Loss	Impedance
1710 MHz	20.4 dB	(57.0 + j7.6) Ohm
1880 MHz	22.0 dB	(56.0 + j5.9) Ohm
1900 MHz	23.4 dB	(56.2 + j3.5) Ohm
1950 MHz	33.1 dB	(51.4 – j1.8) Ohm
2000 MHz	18.5 dB	(44.5 + j9.8) 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.

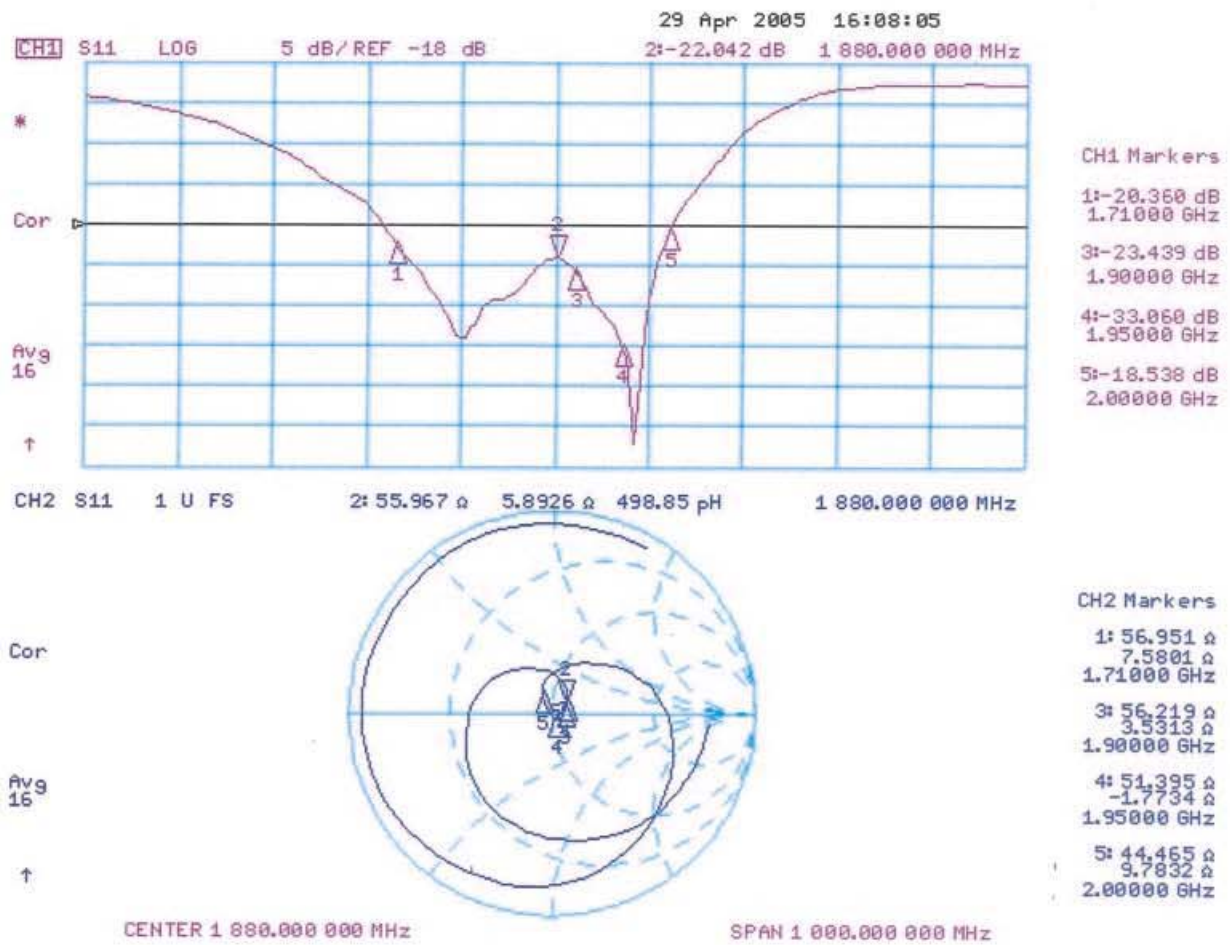
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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

Date/Time: 05.04.2005 15:42:58

Test Laboratory: IT'IS

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1016

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

Medium: Air

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

Phantom section: H Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

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;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

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) = 0.457 A/m

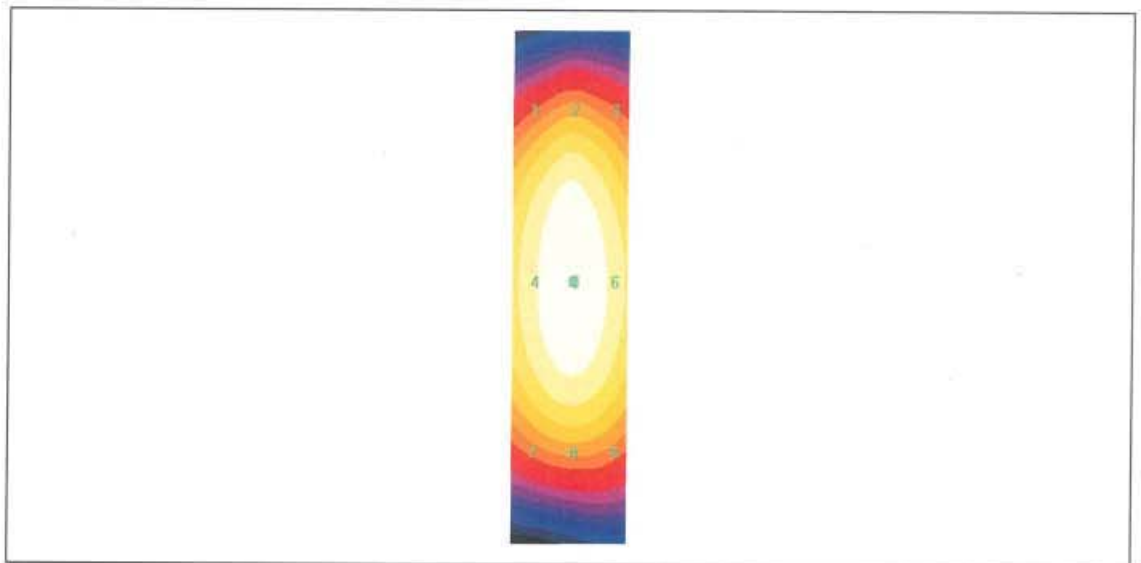
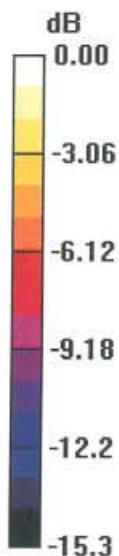
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.396	0.427	0.406
Grid 4	Grid 5	Grid 6
0.428	0.457	0.440
Grid 7	Grid 8	Grid 9
0.385	0.411	0.397

H in A/m (Slot averaged)

Grid 1	Grid 2	Grid 3
0.396	0.427	0.406
Grid 4	Grid 5	Grid 6
0.428	0.457	0.440
Grid 7	Grid 8	Grid 9
0.385	0.411	0.397



0 dB = 0.457 A/m

3.3.3 DASY4 E-Field result

Date/Time: 05.04.2005 10:48:21

Test Laboratory: IT'IS

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1016

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

Medium: Air

Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³

Phantom section: E Dipole Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 20.01.2005
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn901; Calibrated: 29.06.2004
- Phantom: HAC Phantom; Type: SD HAC P01 BA;
- Measurement SW: DASY4, V4.5 Build 19; Postprocessing SW: SEMCAD, V1.8 Build 146

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) = 139.9 V/m

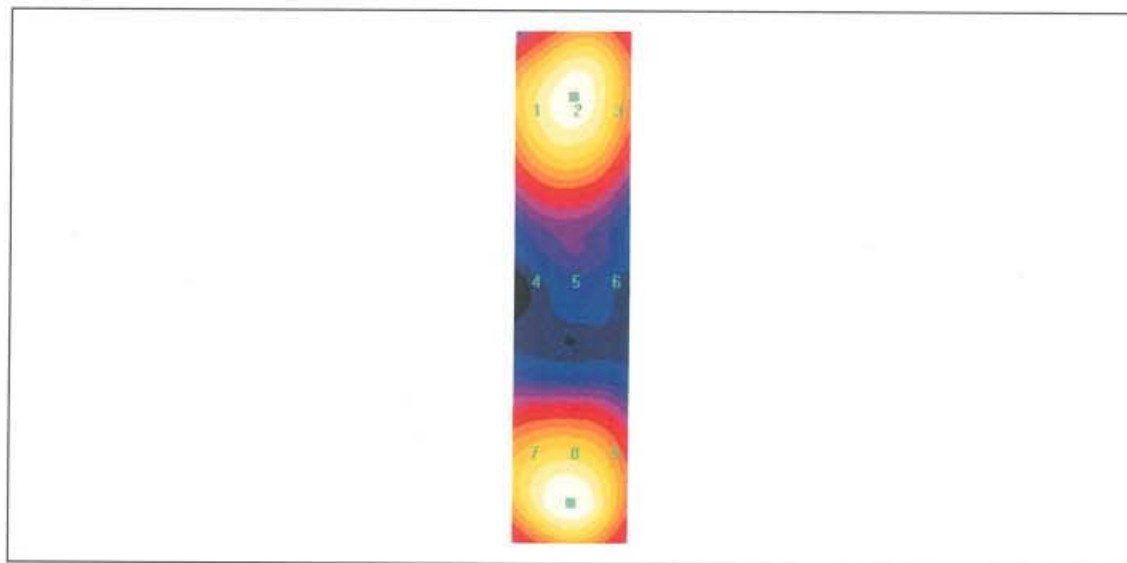
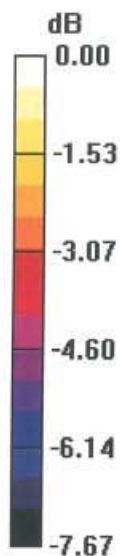
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
132.2	137.2	132.8
Grid 4	Grid 5	Grid 6
89.8	91.0	87.3
Grid 7	Grid 8	Grid 9
133.9	139.9	134.7

E in V/m (Slot averaged)

Grid 1	Grid 2	Grid 3
132.2	137.2	132.8
Grid 4	Grid 5	Grid 6
89.8	91.0	87.3
Grid 7	Grid 8	Grid 9
133.9	139.9	134.7



0 dB = 139.9V/m