



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-R220
FCC ID (Requested) :	A3LSCHR220
Job No :	AI-076
Report No :	AI-076-M1
Date issued :	Jan. 27, 2012
Result Summary :	M4-2007 (RF EMISSION Category)

- Abstract -

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

Prepared By _____
MK YOUN – Test Engineer

Authorized By JD JANG – Technical Manager

Contents

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



1. GENERAL INFORMATION

Test Sample : Single-Band PCS CDMA Phone with Bluetooth

Model Number : SCH-R220

Serial Number : Identical prototype (S/N : # AI-076-B)

Manufacturer : SAMSUNG ELECTRONICS Co., Ltd.

Contact : Yang Kuan

Phone : +86-89-2245-0933

Fax : None

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

FCC Classification : Licensed Portable Transmitter Held to Ear (PCE)

Test Dates : Dec.30 ,2011

Tested for : FCC/TCB Certification

2. DESCRIPTION OF DEVICE

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

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

Antenna Configuration : Gen4-0526

Antenna Manufacturer : Max Skylink

Antenna Dimensions : 38 X 15 X 6.7 (mm)

Indicating Operating modes for Air Interfaces/Bands

Air Interface	Band(MHz)	Type	C63.19-2007 Tested	Simultaneous Transmissions Note:Not to be tested	Reduced Power 20.19 (c)(1)	Voice Over Digital Transport (Data)
CDMA	835	Voice or Data	Yes	Yes: BT	No	N/A
PCS	1900	Voice or Data	Yes	Yes: BT	No	N/A
BT	2450	Data	N/A	N/A	N/A	N/A

* HAC Rating was not based on concurrent voice and data mode.

Standalone mode was found to represent worst case rating for both M and T rating

3. DESCRIPTION OF TEST EQUIPMENT

3.1 HAC Measurement Setup

Robotic System

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

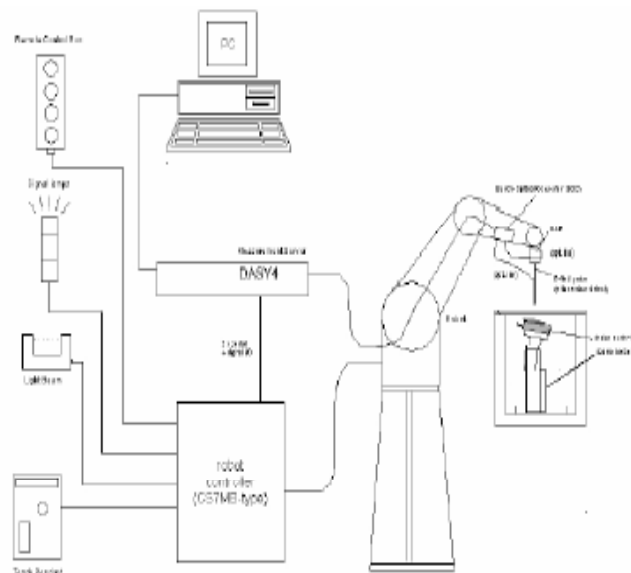


Figure 3.1 HAC Measurement System Setup

System Hardware

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

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

System Electronics

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

3.2 Probe Description

ER3DV6 E-Field Probe Description

Construction:	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
Calibration:	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, $k=2$)
Frequency:	100 MHz to > 6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range	2V/m to 1000V/m (M3 or better device readings fall well below diode compression point)
Linearity :	± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm



Figure 3.2 E-field Probe

H3DV6 H-Field Probe Description

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



Figure 3.3 H-field Probe

3.3 Test Arch Phantom

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

Dimensions: 370 x 370 x 370 mm

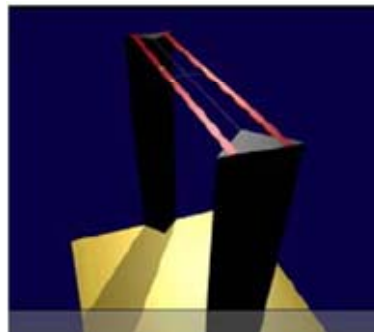


Figure 3.4 Test Arch Phantom

3.4 Validation Dipole

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

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

3.5 Equipment Calibration

Table 3.2 Test Equipment Calibration

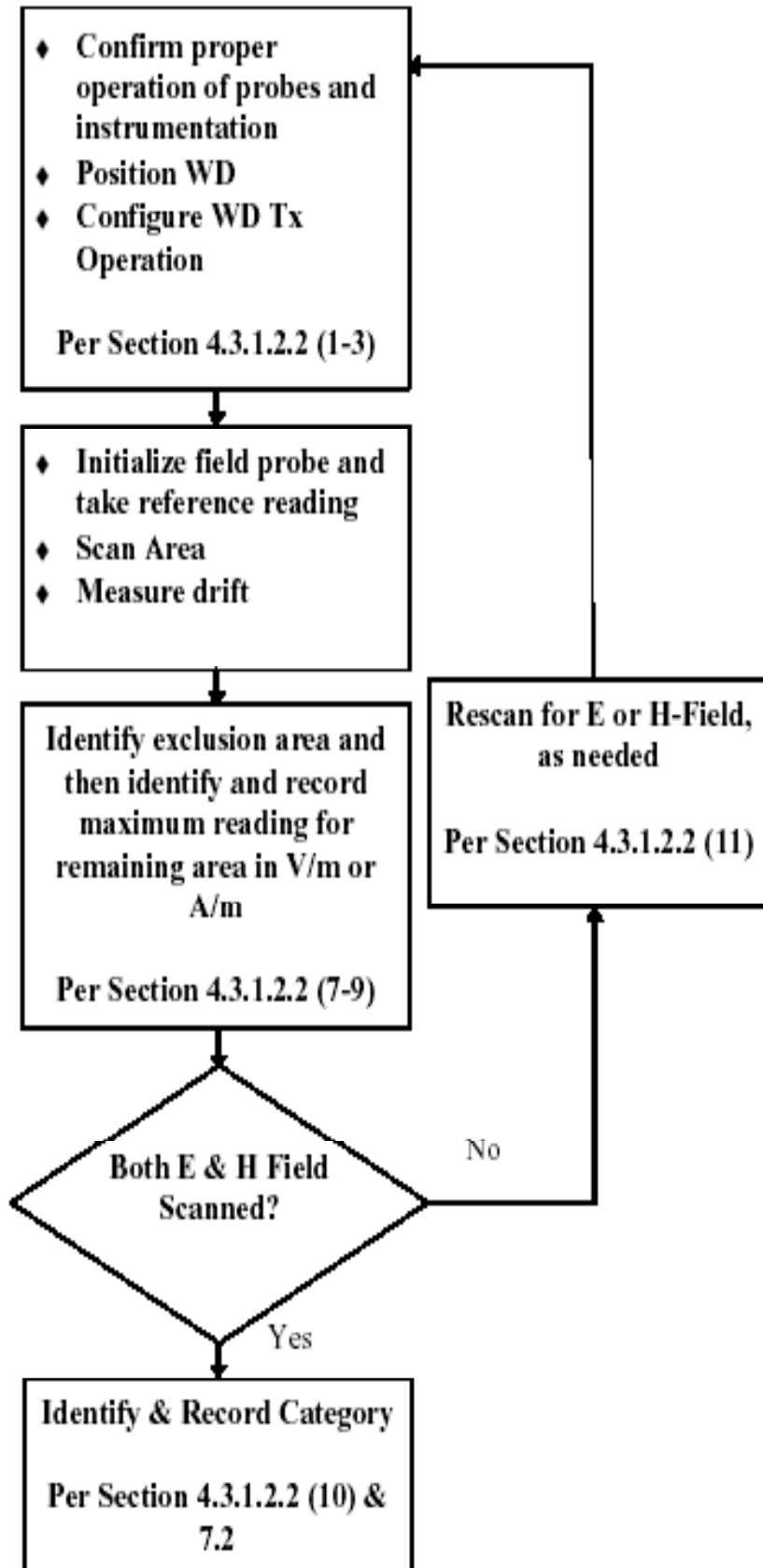
Type	Calibration Due Date	Serial No.
Stäubli Robot TX90XL	Not Required	F10/5FN5A1/A/01
HAC Phantom	Not Required	1018
E4438C Signal Generator	2012.04.14	MY47271094
BBS3Q7ECK Power Amp	2012.12.02	1024
N1912A P-Series Power Meter	2012.04.01	MY45100306
N1912A Wideband Power Sensor	2012.04.01	MY45240464
N1912A Wideband Power Sensor	2012.04.01	MY45240463
DASY52 S/W (ver 52.6)	Not Required	-
778D Directional Coupler	2012.07.05	18843
E4440A Spectrum Analyzer	2012.01.26	MY46186167
Base Station Simulator	2012.02.09	GB43460148

NOTE:

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

4. HAC MEASUREMENT PROCEDURE

Test Instructions



The evaluation was performed using the following procedure.

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

5. DESCRIPTION OF TEST POSITION

5.1 Measurement reference and plane

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



Figure 5.1 Wireless Device and Measurement Plane

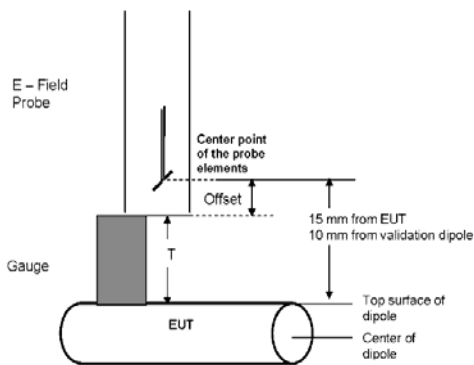


Figure 5.2 Gauge block with E-field probe

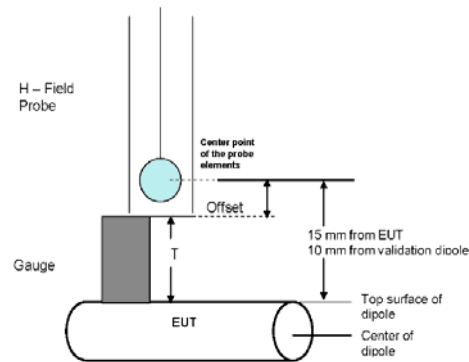


Figure 5.3 Gauge block with H-field probe

6.Measurement Uncertainty

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

7. SYSTEM VERIFICATION

7.1 Test System Validation

Prior to assessment, the system is verified to the $\pm 10\%$ of the specification at 835MHz and 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 (%)	Date	Targeted H-field (A/m)	Measured H-field (A/m)	Deviation (%)	Date
835 MHz	171.5	161.75	-5.69	2011.12.30	0.468	0.455	-2.78	2011.12.30
1880 MHz	139.2	134.8	-3.16	2011.12.30	0.471	0.44	-6.58	2011.12.30

*Validation was measured with input power 100 mW.

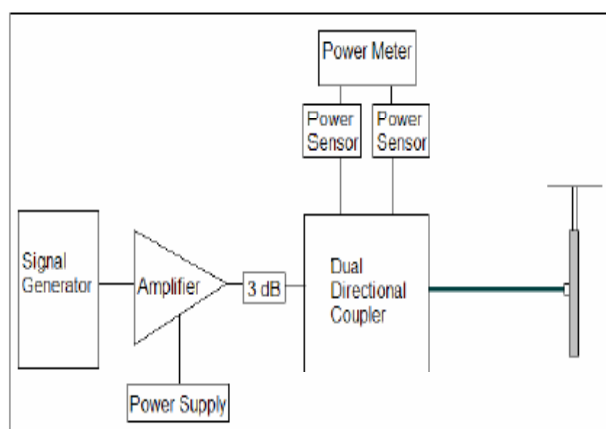


Figure 7.1 Dipole Validation Test Setup

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

8. MODULATION FACTOR

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

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

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

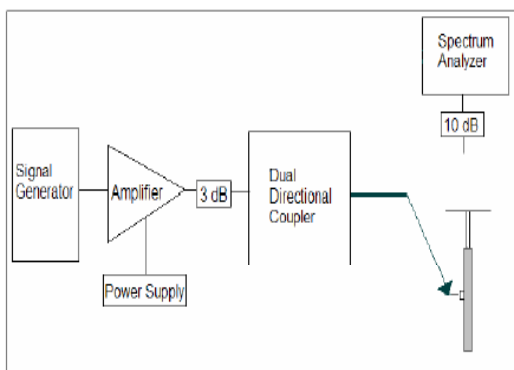


Figure 8.1 Setup to Dipole

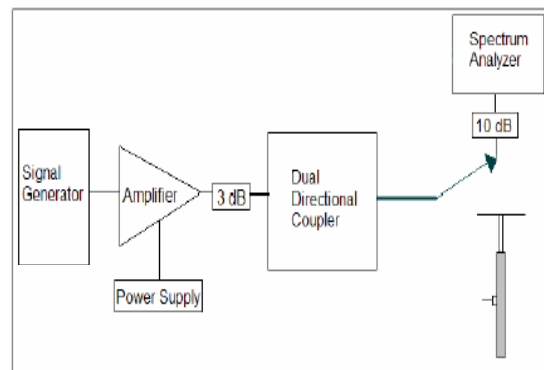


Figure 8.2 Setup to Peak Power using Spectrum Analyzer

8.1 Modulation Factors

Frequency	Protocol	E-field (V/m)	H-field (A/m)	E-Field PMF	H-Field PMF
835 MHz	AM	31.6	0.116	1.57	1.58
835 MHz	CDMA	48.5	0.182	1.02	1.01
835 MHz	CW	49.5	0.183	-	-
1880 MHz	AM	17.3	0.059	1.55	1.55
1880 MHz	CDMA	26.6	0.093	1.01	0.99
1880 MHz	CW	26.9	0.092	-	-
1880 MHz	CW	26.9	0.164	-	-
1880 MHz	RC1/SO3	9.6	0.033	2.79	2.79

Table 8.1 Modulation Factors

8.2 CW and Modulated Signal Zero-span plots:

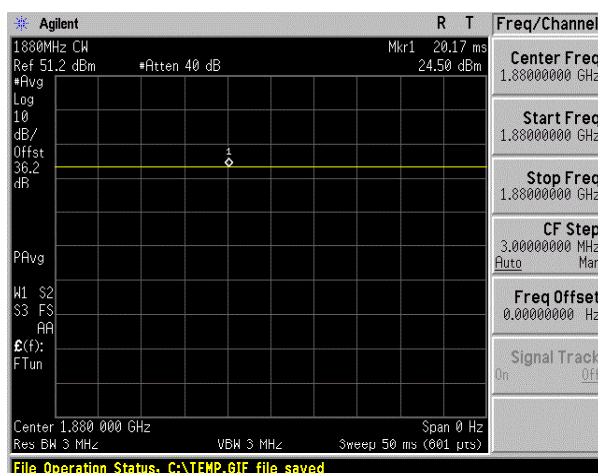


Figure 8.3 CW Signal

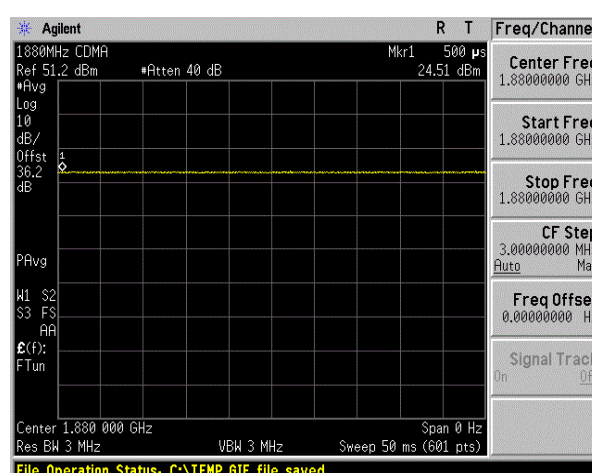


Figure 8.4 CDMA Signal

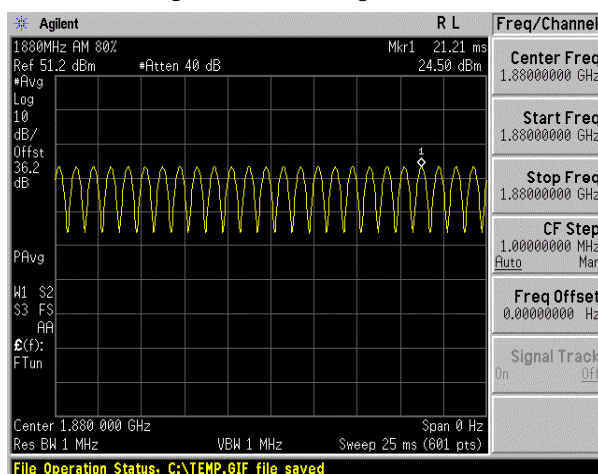


Figure 8.5 AM 80% Signal

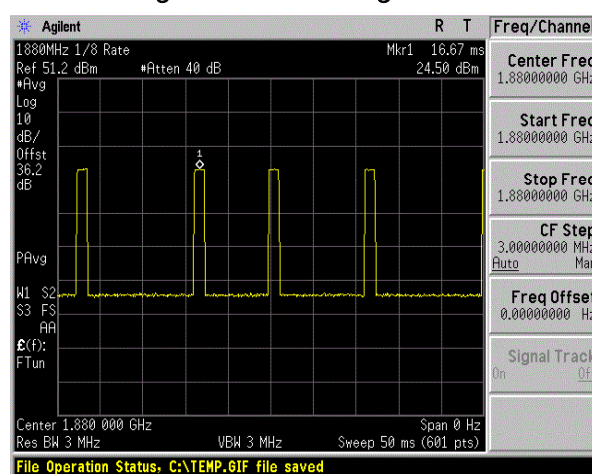


Figure 8.6 1/8 rate Signal

9. FCC 3G MEASUREMENTS – MAY/JUNE 2006

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

9.1 Handset Capabilities

* See Device Capabilities attachment for applicable device modes and powers



9.2 Worst-Case Probe Location Measurements

Below are RC/SO mode investigation results of the device at the worst-case(maximum) field point location with multimeter function of DASY4

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	600	on	RC3/SO55	Standard	Intenna	24.49	30.6	30.87	29.79	M4	41.0	-11.21
PCS	600	off	RC3/SO55	Standard	Intenna	24.49	30.7	31.04	29.84	M4	41.0	-11.16
PCS	600	off	RC1/SO2	Standard	Intenna	24.62	30.7	31.03	29.83	M4	41.0	-11.17
PCS	600	off	RC3/SO2	Standard	Intenna	24.55	30.2	30.48	29.68	M4	41.0	-11.32
PCS	600	off	RC1/SO55	Standard	Intenna	24.61	30.6	30.93	29.81	M4	41.0	-11.19
PCS	600	off	RC2/SO9	Standard	Intenna	24.68	29.4	29.72	29.46	M4	41.0	-11.54
PCS	600	off	RC5/SO9	Standard	Intenna	24.68	30.1	30.40	29.66	M4	41.0	-11.34
PCS	600	off	RC1/SO3	Standard	Intenna	24.67	11.0	30.58	29.71	M4	41.0	-11.29
PCS	600	off	RC3/SO3	Standard	Intenna	24.61	30.4	30.68	29.74	M4	41.0	-11.26
PCS	600	off	RC4/SO3	Standard	Intenna	24.61	29.2	29.44	29.38	M4	41.0	-11.62
PCS	600	off	RC2/SO17	Standard	Intenna	24.61	11.1	30.89	29.80	M4	41.0	-11.20
PCS	600	off	RC5/SO17	Standard	Intenna	24.61	30.4	30.73	29.75	M4	41.0	-11.25

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

10. Test Results

10.1 Measurement Results(E-field)

E-FIELD EMISSIONS:

Mode	Channel	Back light	RC/SO	Battery	Scan Center	Conducted Power at BS(dBm)	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]	Excl Blocks Per 4.3.1.2.2
E-field Emissions													
CDMA	1013	off	RC3/SO55	Standard	Acoustic	24.61	56.6	57.7	35.23	M4	51.0	-15.77	None
CDMA	384	off	RC3/SO55	Standard	Acoustic	24.48	44.0	44.9	33.05	M4	51.0	-17.95	None
CDMA	777	off	RC3/SO55	Standard	Acoustic	24.66	55.6	56.7	35.07	M4	51.0	-15.93	None
PCS	25	off	RC3/SO55	Standard	Acoustic	24.60	30.5	30.8	29.77	M4	41.0	-11.23	None
PCS	600	off	RC3/SO55	Standard	Acoustic	24.49	28.8	29.1	29.29	M4	41.0	-11.71	None
PCS	1175	off	RC3/SO55	Standard	Acoustic	24.59	31.5	31.8	30.05	M4	41.0	-10.95	None
PCS	1175	off	RC3/SO55	Standard	T-coil	24.59	31.5	31.8	30.05	M4	41.0	-10.95	None

NOTES:

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

10.2 Measurement Results(H-field)

H-FIELD EMISSIONS:

Mode	Channel	Back light	RC/SO	Battery	Scan Center	Conducted Power at BS(dBm)	Time Avg. Field [A/m]	Peak Field [A/m]	Peak Field [dBA/m]	Category	FCC limit [dBA/m]	FCC Margin [dB]	Excl Blocks Per 4.3.1.2.2
H-field Emissions													
CDMA	1013	off	RC3/SO55	Standard	Acoustic	24.61	0.117	0.118	-18.56	M4	0.6	-19.16	None
CDMA	384	off	RC3/SO55	Standard	Acoustic	24.48	0.095	0.096	-20.35	M4	0.6	-20.95	None
CDMA	777	off	RC3/SO55	Standard	Acoustic	24.66	0.119	0.120	-18.42	M4	0.6	-19.02	None
PCS	25	on	RC3/SO55	Standard	Acoustic	24.60	0.076	0.075	-22.50	M4	-9.4	-13.10	None
PCS	600	off	RC3/SO55	Standard	Acoustic	24.49	0.077	0.076	-22.38	M4	-9.4	-12.98	None
PCS	1175	off	RC3/SO55	Standard	Acoustic	24.59	0.075	0.074	-22.62	M4	-9.4	-13.22	None

NOTES:

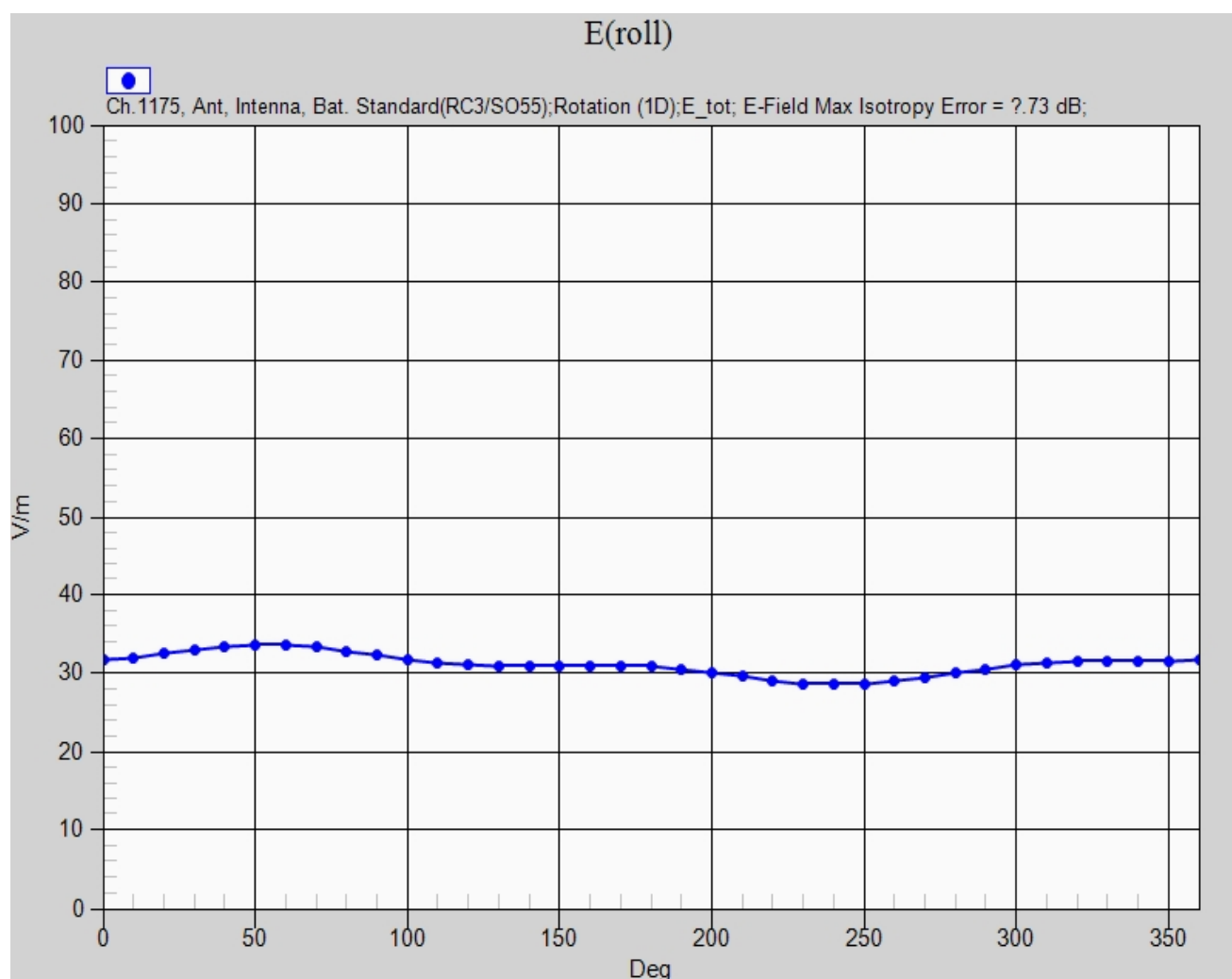
1. The test data reported are the worst-case HAC value with the test position set in a typical configuration. Test procedures used are according to ANSI C 63.19 (2007).
2. All modes of operation were investigated, and the worst-case results are reported.
3. Battery is fully charged for all readings.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

10.3 Worst-case Configuration Evaluation

PCS E-Field Emission

Mode	Channel	Back light	RC/SO	Battery	Antenna	Conducted Power at BS(dBm)	Time Avg. Field [V/m]	Peak Field [V/m]	Peak Field [dBV/m]	Category	FCC limit [dBV/m]	FCC Margin [dB]
E-field Emissions												
PCS	1175	off	RC/SO55	standard	Intenna	24.61	33.59	33.93	30.61	M4	41.0	-10.39

Peak Reading 360 degree Probe Rotation at Azimuth axis



Worst-Case Probe Rotation about Azimuth axis

Note: Location of probe rotation is shown in APPENDIX E

11. REFERENCES

- [1] ANSI C63.19–2007, American National Standard for Methods of Measurement of Compatibility between Wireless communication devices and Hearing Aids.", New York, NY, IEEE, 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	AM80%
RBW	Same setting with modulated signal respectively.	1MHz	3MHz	5MHz	1MHz
VBW		1MHz	3MHz	5MHz	1MHz
SPAN		0MHz	0MHz	0MHz	0MHz
DETECTOR		Peak	Average	Average	Peak

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

APPENDIX B

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

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

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

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

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

APPENDIX C

The Validation Measurements

DUT: CD835V3; Serial: 1105
Program Name: HAC 835MHz E-field Validation , Date: 2011/12/30
Procedure Name: E Scan 10mm above Dipole

Communication System: CW; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

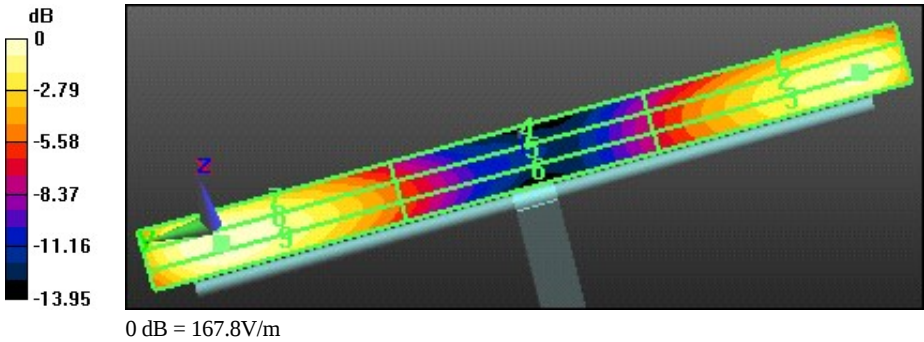
- Probe: ER3DV6 - SN2342; ConvF(1, 1, 1); Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

835MHz E-Field Validation @ 100mW (2011.12.30)/E Scan 10mm above Dipole/Hearing Aid Compatibility Test (41x361x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 167.8 V/m
Probe Modulation Factor = 1.000
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 125.1 V/m; Power Drift = -0.05 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
139.4 M4	155.7 M4	155.4 M4
Grid 4	Grid 5	Grid 6
84.367 M4	89.704 M4	88.854 M4
Grid 7	Grid 8	Grid 9
161.0 M4	167.8 M4	165.6 M4



DUT: Dipole 835 MHz; Serial: 1021
Program Name: HAC 835MHz H-field Validation , Date: 2011/12/30
Procedure Name: H Scan 10mm above Dipole

Communication System: CW; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

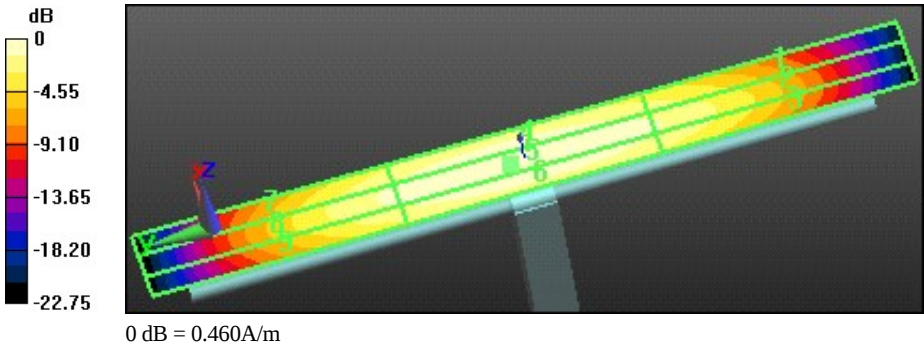
- Probe: H3DV6 - SN6159; ; Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

835MHz H-Field Validation @100mW (2011.12.30)/H Scan 10mm above Dipole/Hearing Aid Compatibility Test (41x361x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 0.455 A/m
Probe Modulation Factor = 1.000
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 0.480 A/m; Power Drift = 0.00065 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.367 M4	0.394 M4	0.385 M4
Grid 4	Grid 5	Grid 6
0.432 M4	0.455 M4	0.438 M4
Grid 7	Grid 8	Grid 9
0.388 M4	0.406 M4	0.387 M4



DUT: CD1880V3; Serial: 1016
Program Name: HAC 835MHz H-field Validation , Date: 2011/12/30
Procedure Name: E Scan 10mm above Dipole

Communication System: CW; Frequency: 1880 MHz
Medium parameters used: $\sigma = 0 \text{ mho/m}$, $\epsilon_r = 1$; $\rho = 1000 \text{ kg/m}^3$
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

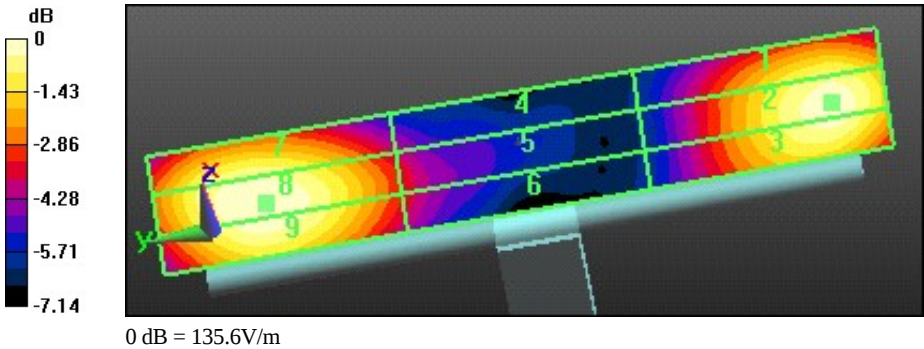
- Probe: ER3DV6 - SN2342; ConvF(1, 1, 1); Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

1880MHz E-Field Validation @ 100mW (2011.12.30)/E Scan 10mm above Dipole/Hearing Aid Compatibility Test (41x181x1):

Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 135.6 V/m
Probe Modulation Factor = 1.000
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 136.1 V/m; Power Drift = -0.02 dB
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
125.3 M2	134.0 M2	132.3 M2
Grid 4	Grid 5	Grid 6
86.577 M3	93.076 M3	92.645 M3
Grid 7	Grid 8	Grid 9
128.6 M2	135.6 M2	134.1 M2



DUT: CD1880V3; Serial: 1016
Program Name: HAC 835MHz H-field Validation , Date: 2011/12/30
Procedure Name: H Scan 10mm above Dipole

Communication System: CW; Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

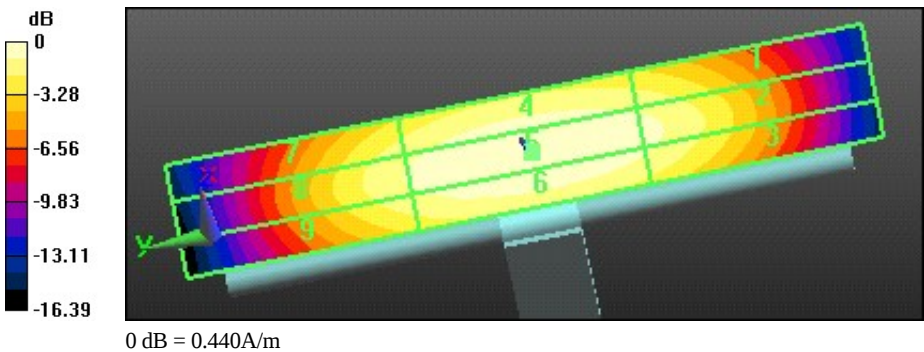
DASY5 Configuration:

- Probe: H3DV6 - SN6159; ; Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

1880MHz H-Field Validation (2011.12.30)/H Scan 10mm above Dipole/Hearing Aid Compatibility Test (41x181x1): Measurement
grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 0.440 A/m
Probe Modulation Factor = 1.000
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 0.463 A/m; Power Drift = 0.05 dB
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.379 M2	0.406 M2	0.397 M2
Grid 4	Grid 5	Grid 6
0.415 M2	0.440 M2	0.428 M2
Grid 7	Grid 8	Grid 9
0.372 M2	0.393 M2	0.380 M2



APPENDIX D

Plots of The HAC Measurements

DUT: SCH-R220; Serial: AI-076-B
Program Name: SCH-R220(E-Field), Date: 2011/12/30
Procedure Name: Ch.1013, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA&PCS; Frequency: 824.7 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

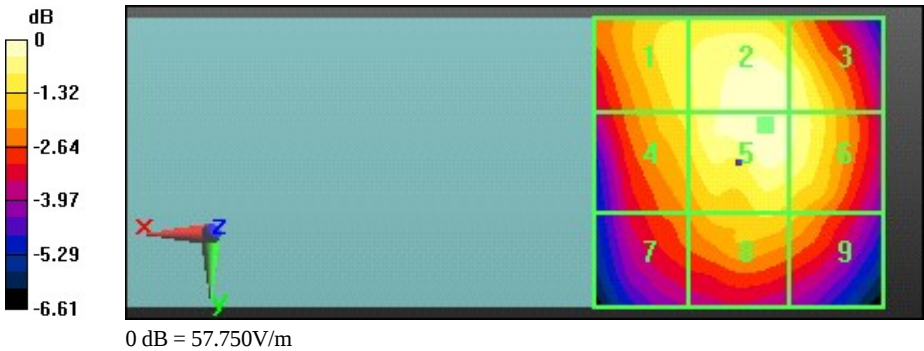
DASY5 Configuration:

- Probe: ER3DV6 - SN2342; ConvF(1, 1, 1); Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

SCH-R220 RF-Emission E-Field Test (Job No.: AI-076)/Ch.1013, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid
Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 57.749 V/m
Probe Modulation Factor = 1.020
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 73.071 V/m; Power Drift = 0.10 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
52.140 M4	57.622 M4	55.909 M4
Grid 4	Grid 5	Grid 6
51.363 M4	57.749 M4	56.014 M4
Grid 7	Grid 8	Grid 9
45.270 M4	50.138 M4	48.740 M4



DUT: SCH-R220; Serial: AI-076-B
Program Name: SCH-R220(H-Field), Date: 2011/12/30
Procedure Name: Ch.0777, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA&PCS; Frequency: 848.31 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6159; ; Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

SCH-R220 RF-Emission H-Field Test (Job No.: AI-076)/Ch.0777, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 0.120 A/m
Probe Modulation Factor = 1.010
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 0.062 A/m; Power Drift = 0.05 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.116 M4	0.076 M4	0.046 M4
Grid 4	Grid 5	Grid 6
0.120 M4	0.083 M4	0.051 M4
Grid 7	Grid 8	Grid 9
0.120 M4	0.084 M4	0.052 M4



DUT: SCH-R220; Serial: AI-076-B
Program Name: SCH-220(E-Field), Date: 2011/12/30
Procedure Name: Ch.1175, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA&PCS; Frequency: 1908.75 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2342; ConvF(1, 1, 1); Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

SCH-R220 RF-Emission E-Field Test (Job No.: AI-076)/Ch.1175, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid
Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 31.802 V/m
Probe Modulation Factor = 1.010
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 63.401 V/m; Power Drift = 0.12 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak E-field in V/m

Grid 1	Grid 2	Grid 3
31.554 M4	30.062 M4	23.636 M4
Grid 4	Grid 5	Grid 6
31.802 M4	30.951 M4	26.712 M4
Grid 7	Grid 8	Grid 9
28.986 M4	23.273 M4	24.754 M4



DUT: SCH-R220; Serial: AI-076-B
Program Name: SCH-R220(H-Field), Date: 2011/12/30
Procedure Name: Ch.600, Ant, Intenna, Bat. Standard(RC3/SO55)

Communication System: CDMA&PCS; Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ mho/m, $\epsilon_r = 1$; $\rho = 1$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

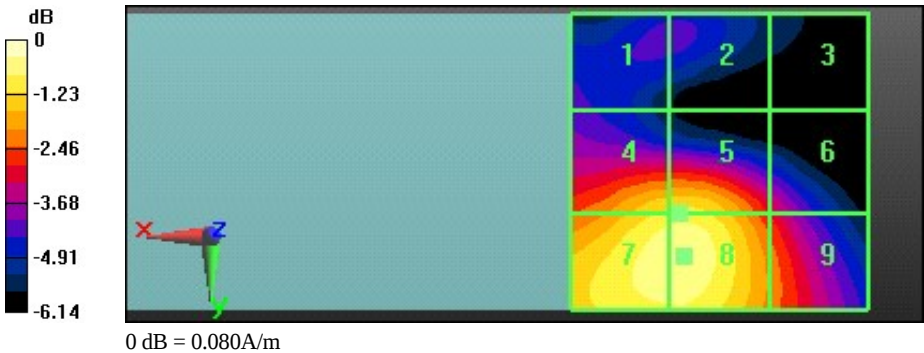
DASY5 Configuration:

- Probe: H3DV6 - SN6159; ; Calibrated: 2011-08-29
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn670; Calibrated: 2011-02-22
- Phantom: HAC Test Arch #1; Type: SD HAC P01 BA; Serial: 1078
- Measurement SW: DASY52, Version 52.6 (2); SEMCAD X Version 14.4.5 (3634)

SCH-R220 RF-Emission H-Field Test (Job No.: AI-076)/Ch.600, Ant, Intenna, Bat. Standard(RC3/SO55)/Hearing Aid Compatibility Test (101x101x1): Measurement grid: dx=5mm, dy=5mm
Maximum value of peak Total field = 0.076 A/m
Probe Modulation Factor = 0.990
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 0.078 A/m; Power Drift = -0.02 dB
Hearing Aid Near-Field Category: M4 (AWF 0 dB)

Peak H-field in A/m

Grid 1	Grid 2	Grid 3
0.049 M4	0.049 M4	0.043 M4
Grid 4	Grid 5	Grid 6
0.070 M4	0.071 M4	0.057 M4
Grid 7	Grid 8	Grid 9
0.075 M4	0.076 M4	0.063 M4



APPENDIX E

Probe Calibration(E-field)



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

The Swiss Accreditation Service is one of the signatories to the EA

Multilateral Agreement for the recognition of calibration certificates

Client **Samsung (Dymstec)**

Certificate No: **ER3-2370_Mar11**

CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2370**

Calibration procedure(s) **QA CAL-02.v6, QA CAL-25.v3**
 Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **March 21, 2011**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	01-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe ER3DV6	SN: 2328	4-Oct-10 (No. ER3-2328_Oct10)	Oct-11
DAE4	SN: 789	16-Feb-11 (No. DAE4-789_Feb11)	Feb-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

Calibrated by:	Name	Function	Signature
	Claudio Leubler	Laboratory Technician	
Approved by:	Name	Function	Signature
	Katja Pokovic	Technical Manager	
			Issued: March 21, 2011
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

2011.6.13



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- *NORM_{x,y,z}*: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- *NORM(f)_{x,y,z}* = *NORM_{x,y,z}* * *frequency_response* (see Frequency Response Chart).
- *DCP_{x,y,z}*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}; A, B, C* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *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: March 21, 2011

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2370

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$)	1.76	1.66	2.00	$\pm 10.1 \%$
DCP (mV) ^B	96.7	97.9	100.6	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	93.5	$\pm 2.5 \%$
			Y	0.00	0.00	1.00	113.5	
			Z	0.00	0.00	1.00	115.6	

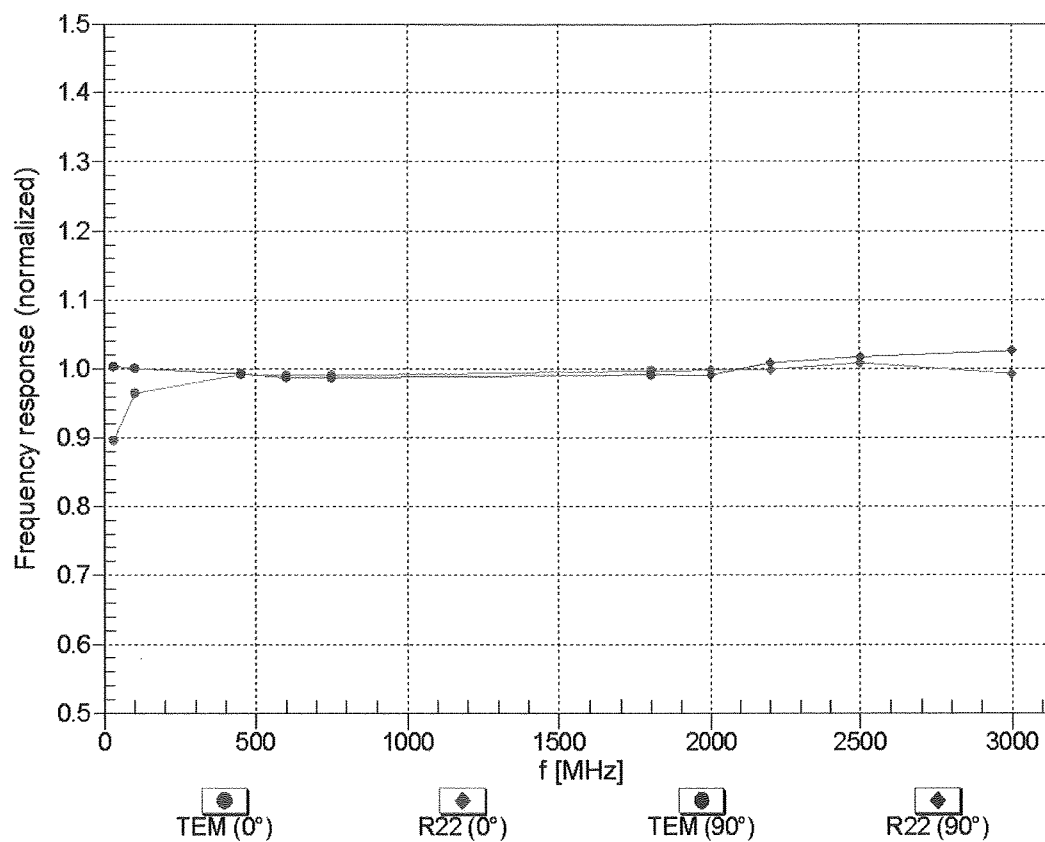
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Frequency Response of E-Field

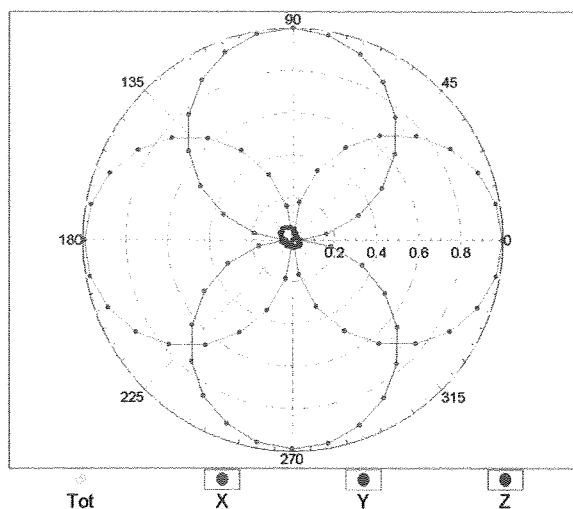
(TEM-Cell:ifi110 EXX, Waveguide: R22)



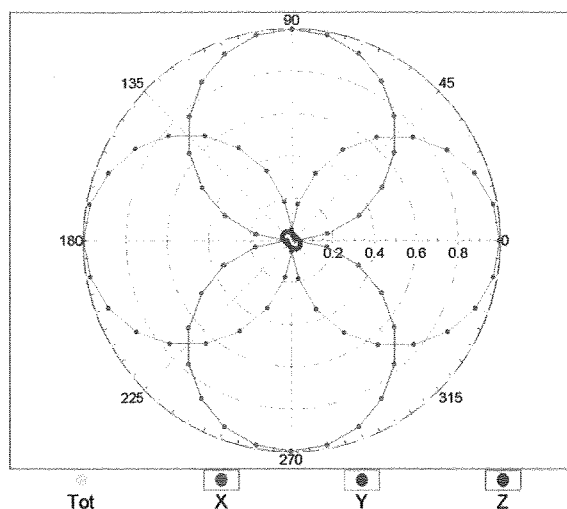
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

f=600 MHz,TEM,0°

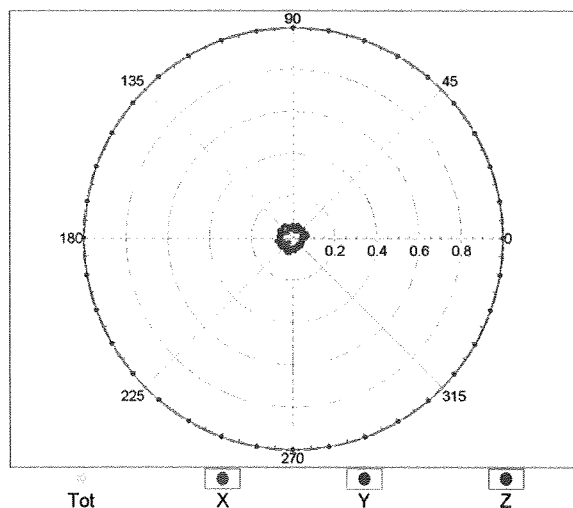


f=2500 MHz,R22,0°

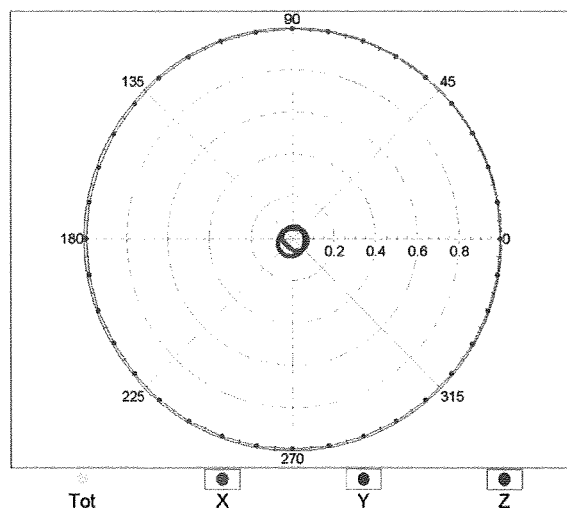


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

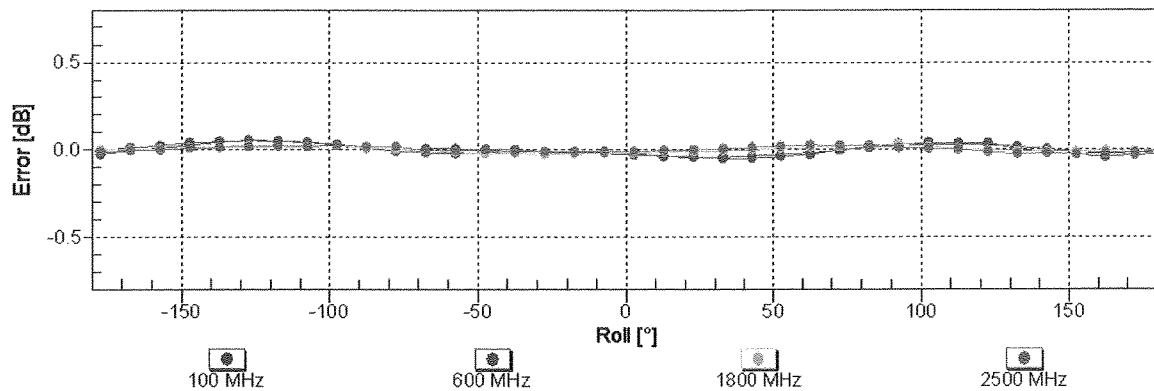
f=600 MHz,TEM,90°



f=2500 MHz,R22,90°

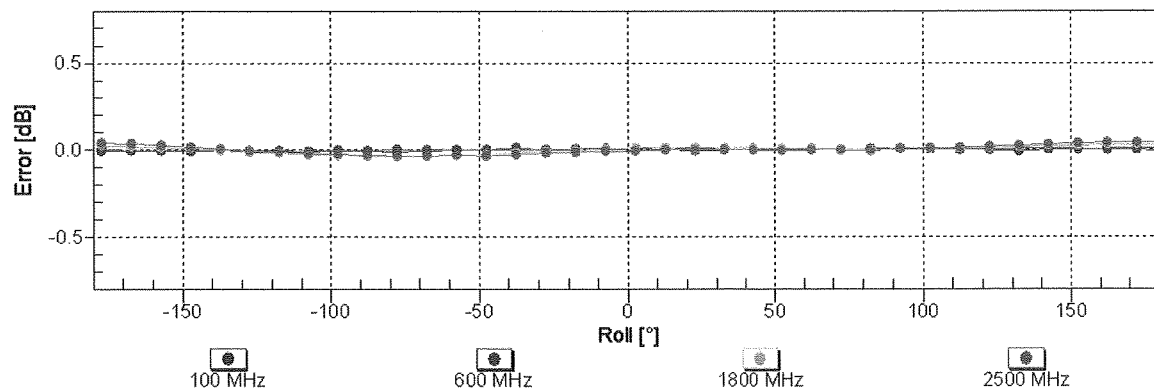


Receiving Pattern (ϕ), $\vartheta = 0^\circ$



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

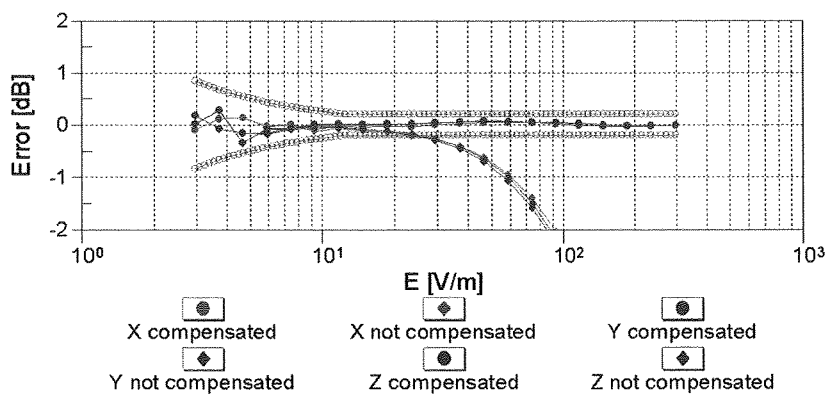
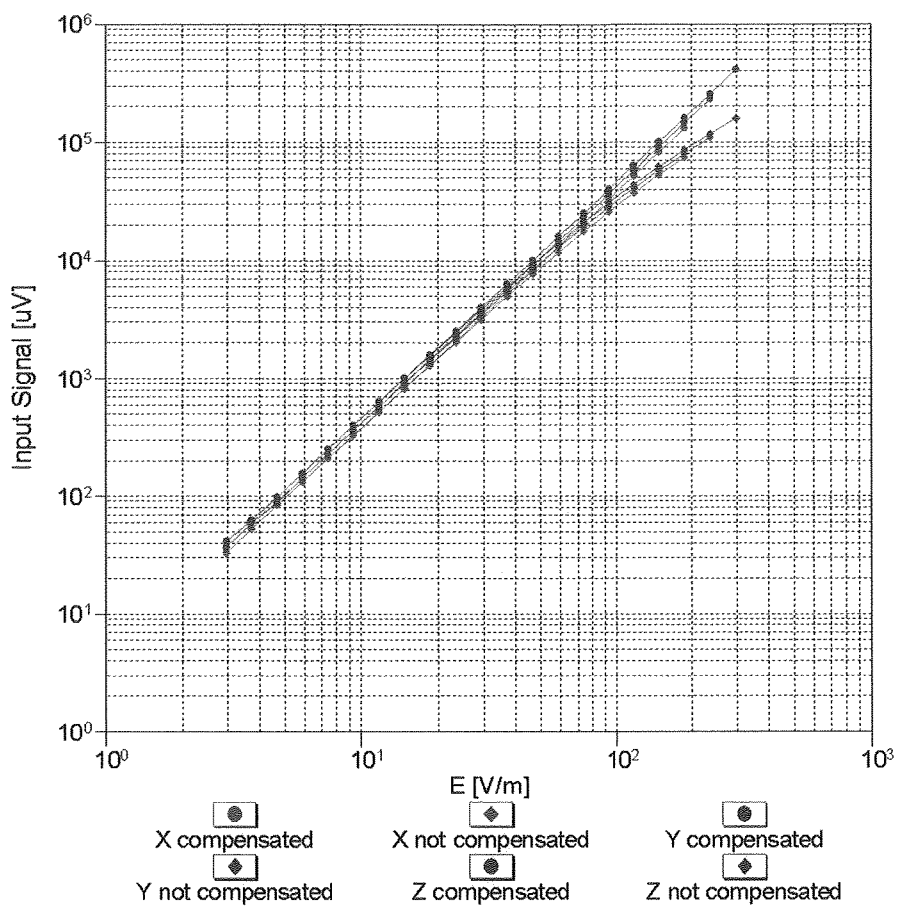
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



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

Dynamic Range f(E-field)

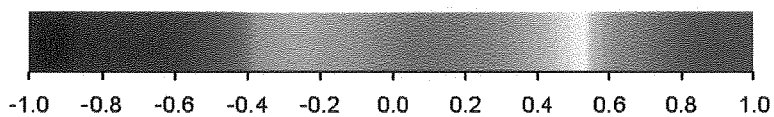
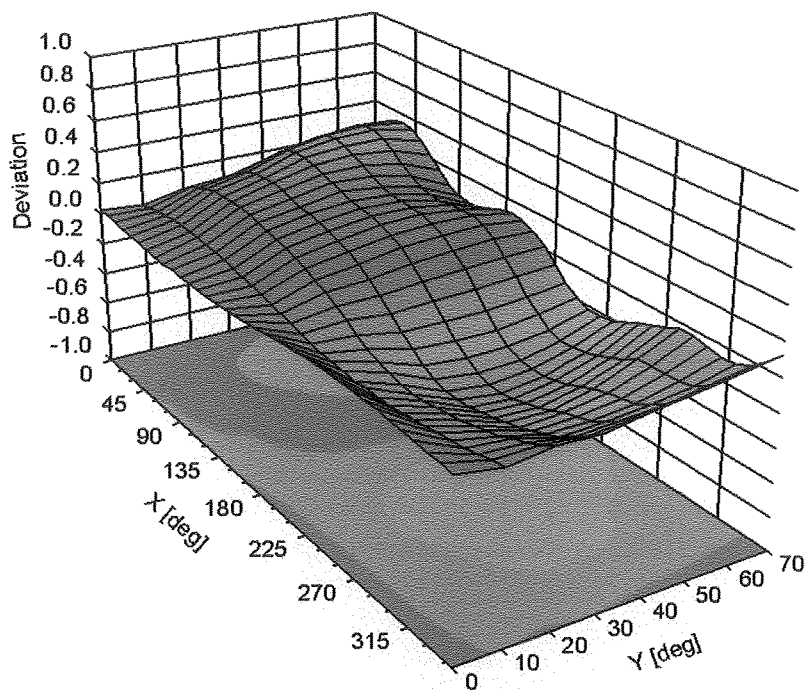
(TEM cell , f = 900 MHz)



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

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2370

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	132.5
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	8 mm
Probe Tip to Sensor X Calibration Point	2.5 mm
Probe Tip to Sensor Y Calibration Point	2.5 mm
Probe Tip to Sensor Z Calibration Point	2.5 mm



Probe Calibration(H-field)



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Client **Samsung (Dymstec)**

Certificate No: **H3-6197_Mar11**

CALIBRATION CERTIFICATE

Object **H3DV6 - SN:6197**

Calibration procedure(s) **QA CAL-03.v6, QA CAL-25.v3**
Calibration procedure for H-field probes optimized for close near field evaluations in air

Calibration date: **March 15, 2011**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41495277	01-Apr-10 (No. 217-01136)	Apr-11
Power sensor E4412A	MY41498087	01-Apr-10 (No. 217-01136)	Apr-11
Reference 3 dB Attenuator	SN: S5054 (3c)	30-Mar-10 (No. 217-01159)	Mar-11
Reference 20 dB Attenuator	SN: S5086 (20b)	30-Mar-10 (No. 217-01161)	Mar-11
Reference 30 dB Attenuator	SN: S5129 (30b)	30-Mar-10 (No. 217-01160)	Mar-11
Reference Probe H3DV6	SN: 6182	4-Oct-10 (No. H3-6182_Oct10)	Oct-11
DAE4	SN: 789	16-Feb-11 (No. DAE4-789_Feb11)	Feb-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Oct-09)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11

Calibrated by:	Name Jeton Kastrati	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature

Issued: March 18, 2011

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 108**

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

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
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:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ for XY sensors and $\vartheta = 90$ for Z sensor ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide).
- X, Y, Z(f)_a0a1a2** = **X, Y, Z_a0a1a2** * frequency_response (see Frequency Response Chart).
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}; A, B, C** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- 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: March 15, 2011

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

DASY/EASY - Parameters of Probe: H3DV6 - SN:6197

Basic Calibration Parameters

		Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (A/m / $\sqrt{\text{mV}}$)	a0	2.42E-003	2.37E-003	2.83E-003	$\pm 5.1 \%$
Norm (A/m / $\sqrt{\text{mV}}$)	a1	1.77E-004	2.72E-004	4.03E-005	$\pm 5.1 \%$
Norm (A/m / $\sqrt{\text{mV}}$)	a2	1.25E-004	1.29E-004	1.16E-004	$\pm 5.1 \%$
DCP (mV) ^B		91.6	92.6	94.6	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^E (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	93.3	$\pm 2.7 \%$
			Y	0.00	0.00	1.00	92.7	
			Z	0.00	0.00	1.00	96.8	

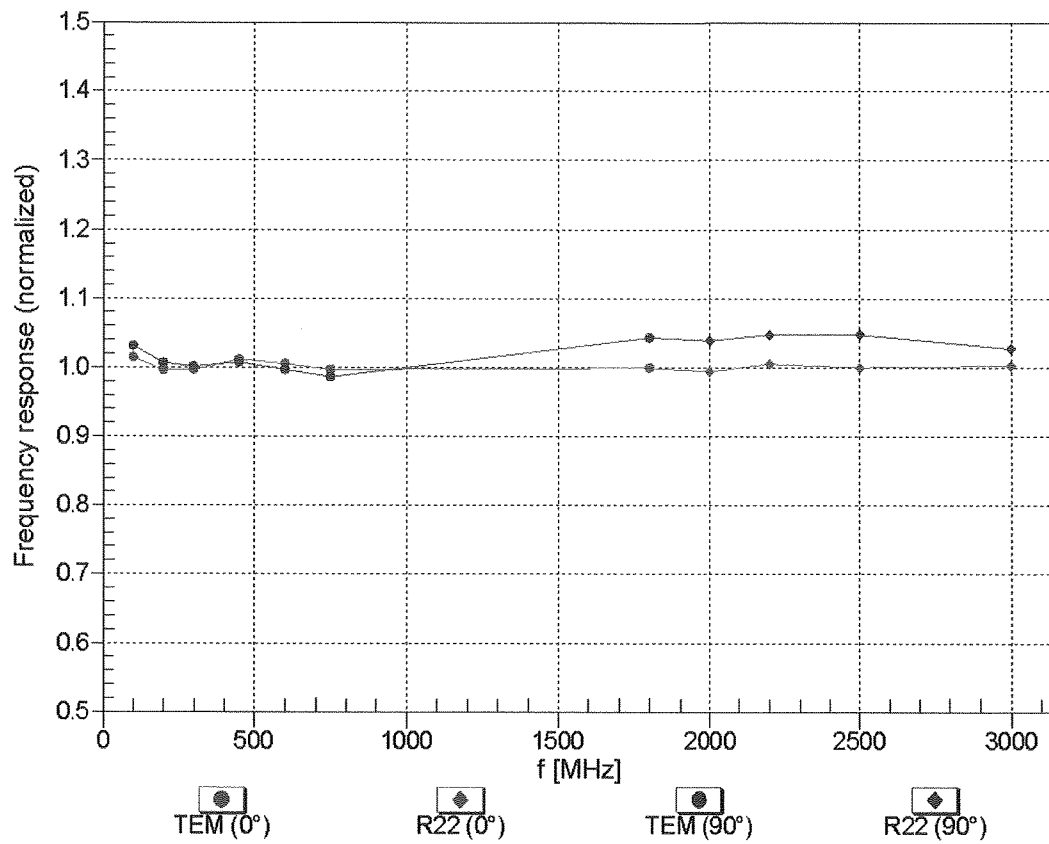
The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^B Numerical linearization parameter: uncertainty not required.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Frequency Response of H-Field

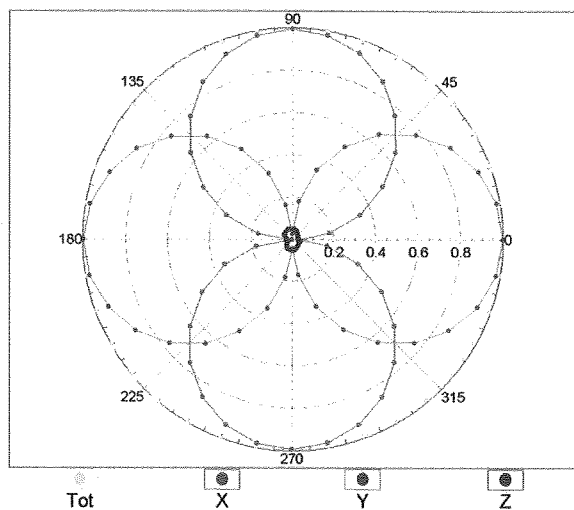
(TEM-Cell:ifi110 EXX, Waveguide: R22)



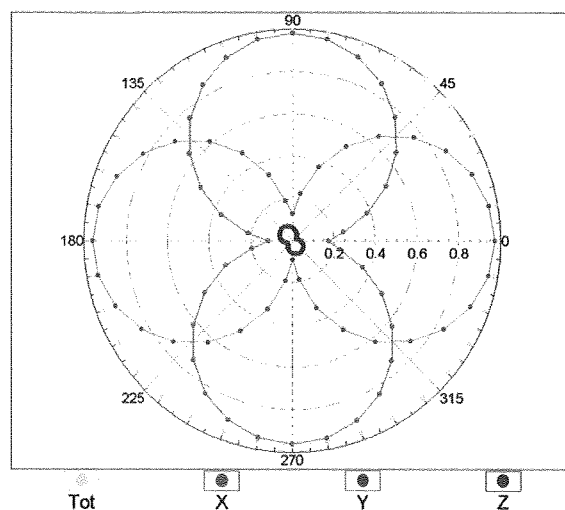
Uncertainty of Frequency Response of H-field: $\pm 6.3\%$ ($k=2$)

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

$f=600\text{ MHz, TEM, }0^\circ$

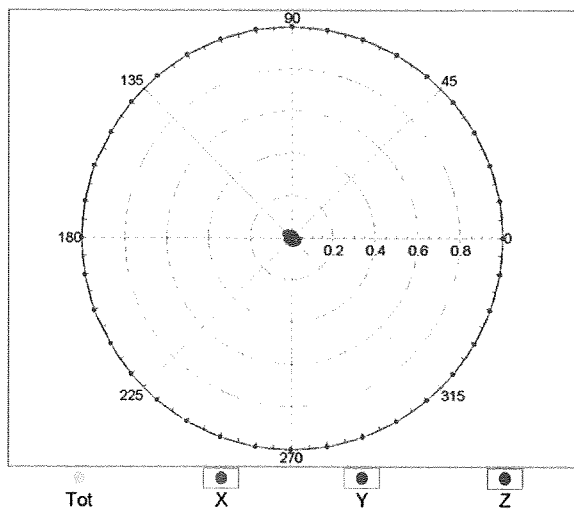


$f=2500\text{ MHz, R22, }0^\circ$

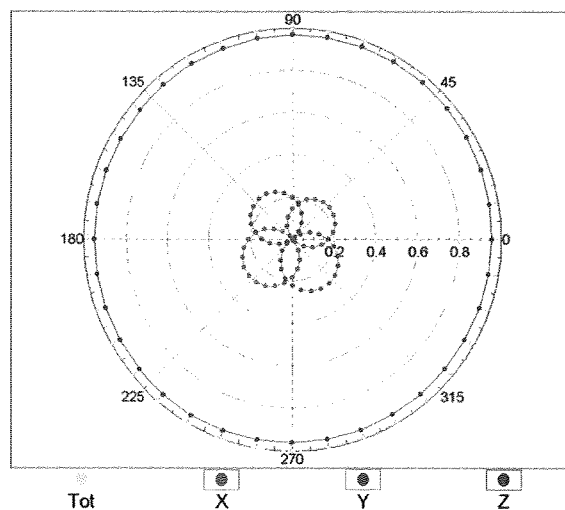


Receiving Pattern (ϕ), $\vartheta = 90^\circ$

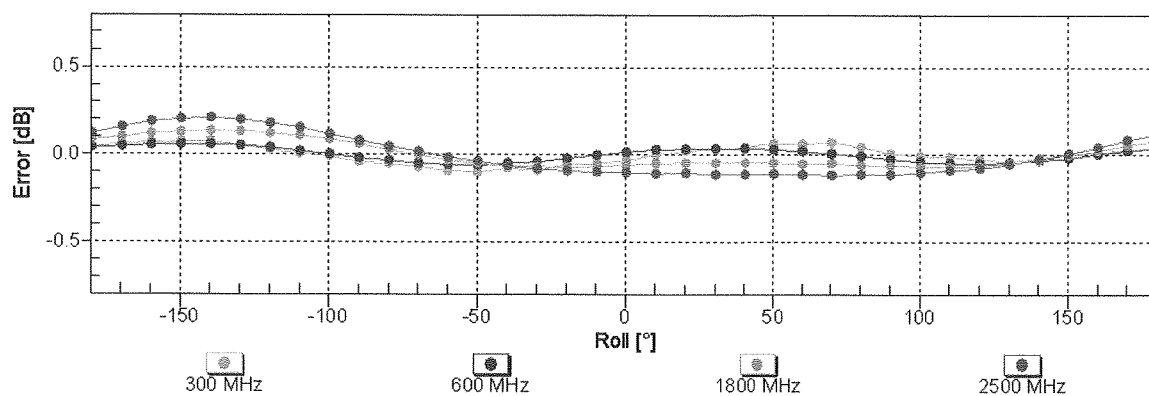
$f=600\text{ MHz, TEM, }90^\circ$



$f=2500\text{ MHz, R22, }90^\circ$

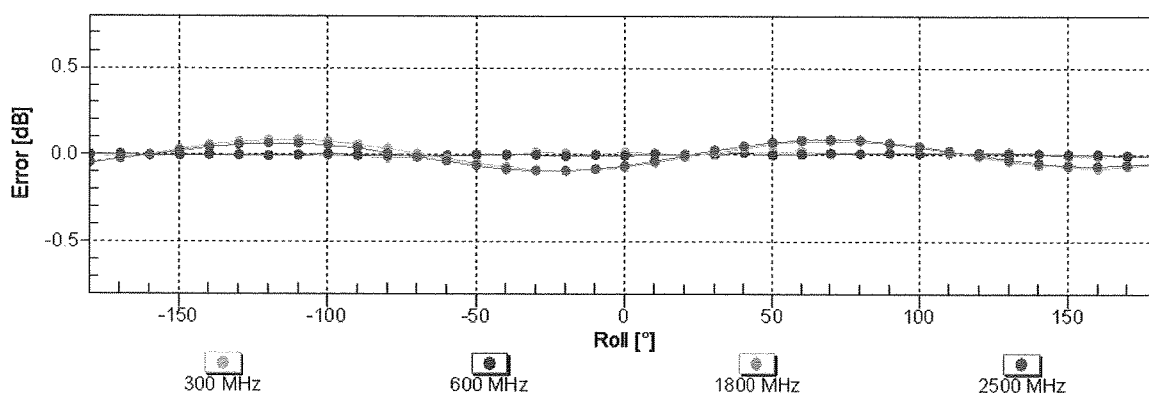


Receiving Pattern (ϕ), $\vartheta = 0^\circ$



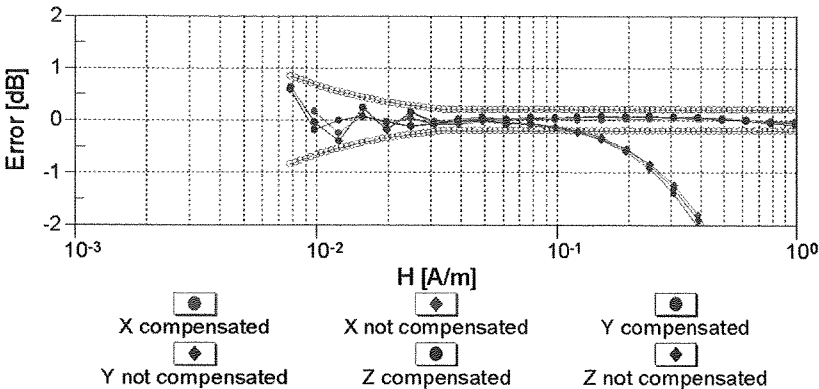
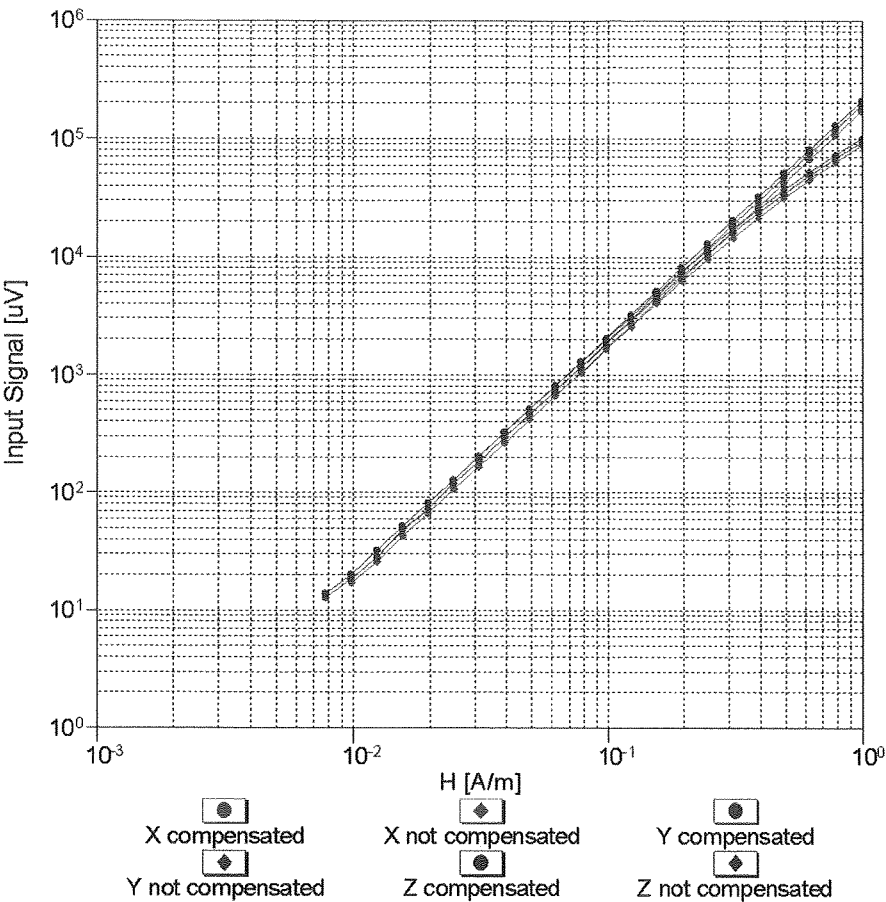
Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

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



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

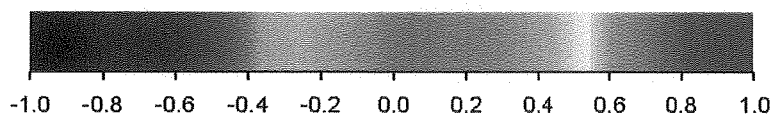
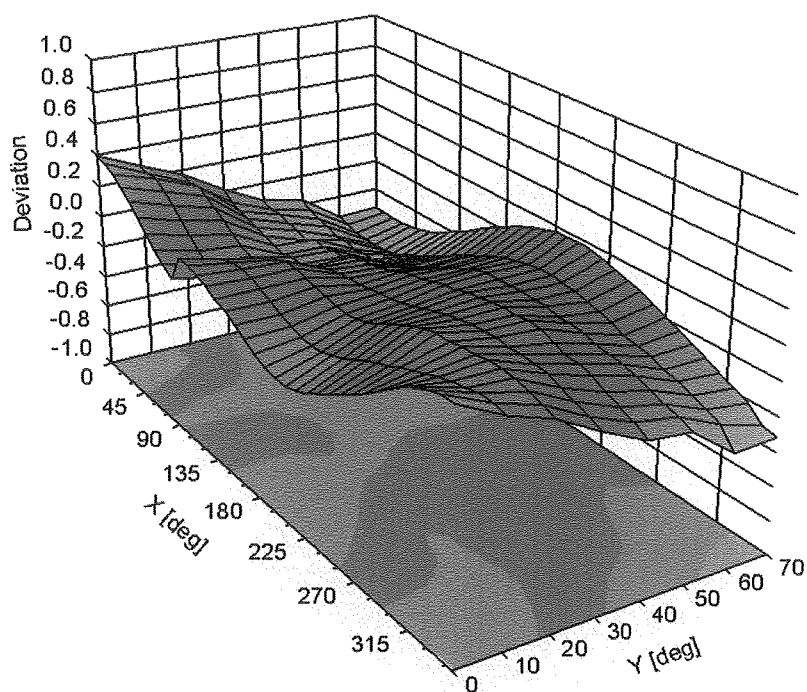
Dynamic Range f(H-field)
(TEM cell, f = 900 MHz)



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

Deviation from Isotropy in Air

Error (ϕ , θ), $f = 900$ MHz



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

DASY/EASY - Parameters of Probe: H3DV6 - SN:6197

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	170.4
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	20 mm
Tip Diameter	6 mm
Probe Tip to Sensor X Calibration Point	3 mm
Probe Tip to Sensor Y Calibration Point	3 mm
Probe Tip to Sensor Z Calibration Point	3 mm

APPENDIX F

Calibration of The Validation Dipole



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

Accreditation No.: **SCS 108**

Client **Samsung (Dymstec)**

Certificate No: **CD835V3-1021_Apr11**

CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1021**

Calibration procedure(s) **QA CAL-20.v5
Calibration procedure for dipoles in air**

Calibration date: **April 12, 2011**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	06-Oct-10 (No. 217-01266)	Oct-11
Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11
Probe ER3DV6	SN: 2336	29-Dec-10 (No. ER3-2336_Dec10)	Dec-11
Probe H3DV6	SN: 6065	29-Dec-10 (No. H3-6065_Dec10)	Dec-11
DAE4	SN: 781	20-Oct-10 (No. DAE4-781_Oct10)	Oct-11
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Power sensor HP 8482H	SN: 3318A09450	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11
RF generator E4433B	MY 41000675	03-Nov-04 (in house check Oct-09)	In house check: Oct-11

Calibrated by: **Claudio Leubler** Name: **Claudio Leubler** Function: **Laboratory Technician**

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

Signature

Issued: April 12, 2011

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

[Handwritten signature]
2011.6.13



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

Accreditation No.: **SCS 108**

References

- [1] ANSI-C63.19-2007
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 the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above 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 DASY5 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 eliminated 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	DASY5	V52.6.2 (424)
DASY PP Version	SEMCAD X	V14.4.4 (2829)
Phantom	HAC Test Arch	SD HAC P01 BA, #1070
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	0.468 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	172.1 V/m
Maximum measured above low end	100 mW forward power	170.8 V/m
Averaged maximum above arm	100 mW forward power	171.5 V/m

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

3 Appendix

3.1 Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	15.9 dB	(42.1 – j12.6) Ohm
835 MHz	23.3 dB	(49.1 + j6.7) Ohm
900 MHz	17.0 dB	(57.1 – j13.5) Ohm
950 MHz	21.4 dB	(44.3 + j5.7) Ohm
960 MHz	17.0 dB	(50.0 + j14.8) 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.

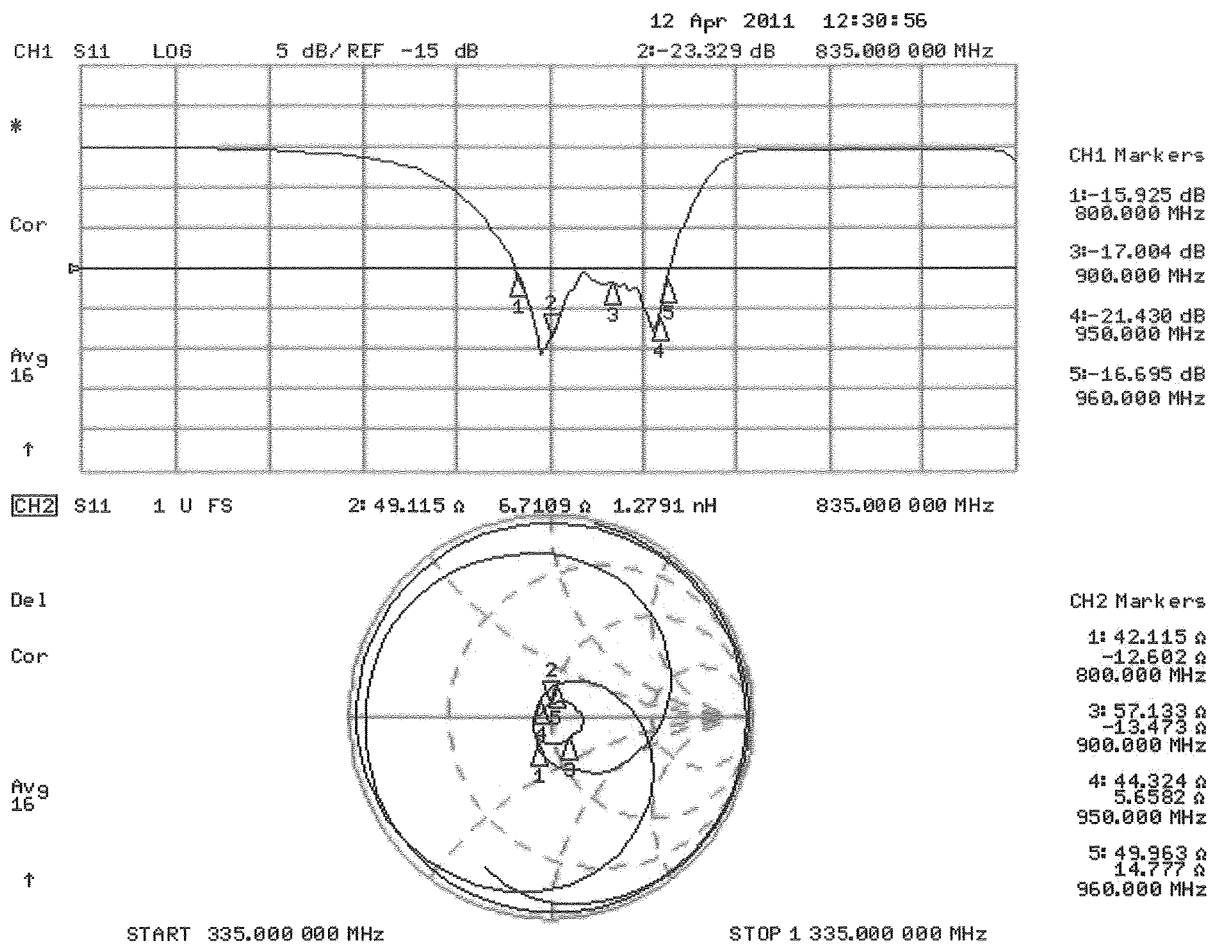
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

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



3.3.3 DASY4 H-field Result

Date/Time: 12.04.2011 11:54:39

Test Laboratory: SPEAG Lab2

HAC RF_CD835_1021_H_110412_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: 1021

Communication System: CW; Frequency: 835 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole H-Field measurement @ 835MHz/H Scan - measurement distance from the probe sensor center to CD835

Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 0.468 A/m

Probe Modulation Factor = 1.000

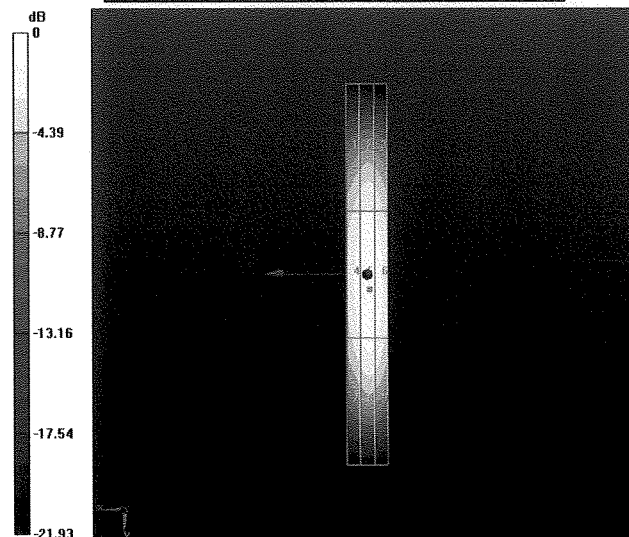
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.495 A/m; Power Drift = 0.0096 dB

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

Peak H-field in A/m

Grid 1 0.374 M4	Grid 2 0.404 M4	Grid 3 0.390 M4
Grid 4 0.432 M4	Grid 5 0.468 M4	Grid 6 0.454 M4
Grid 7 0.391 M4	Grid 8 0.425 M4	Grid 9 0.411 M4



0 dB = 0.470A/m

3.3.2 DASY4 E-field Result

Date/Time: 12.04.2011 16:27:13

Test Laboratory: SPEAG Lab2

HAC RF_CD835_1021_E_110412_CL

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: 1021

Communication System: CW; Frequency: 835 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole E-Field measurement @ 835MHz/E Scan - measurement distance from the probe sensor center to CD835

Dipole = 10mm/Hearing Aid Compatibility Test (41x361x1):

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

Maximum value of peak Total field = 172.1 V/m

Probe Modulation Factor = 1.000

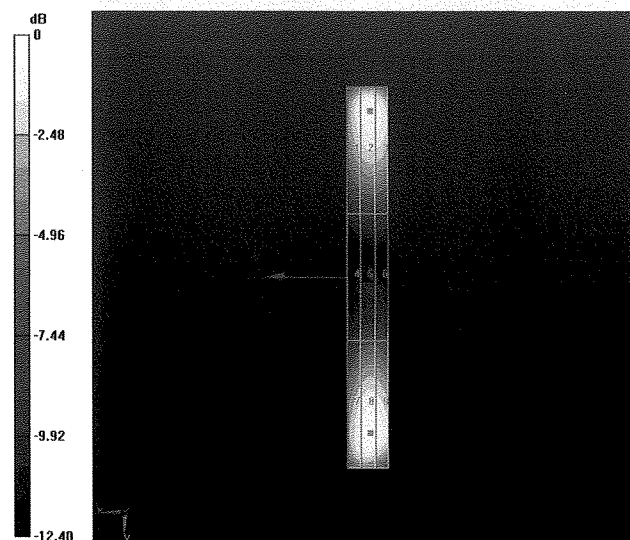
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 128.3 V/m; Power Drift = 0.0079 dB

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

Peak E-field in V/m

Grid 1 158.1 M4	Grid 2 172.1 M4	Grid 3 169.3 M4
Grid 4 86.327 M4	Grid 5 93.060 M4	Grid 6 92.017 M4
Grid 7 159.5 M4	Grid 8 170.8 M4	Grid 9 168.0 M4



0 dB = 172.1V/m



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

Accreditation No.: **SCS 108**

Client **Samsung C (Dymstec)**

Certificate No: **CD1880V3-1016_Mar11**

CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1016**

Calibration procedure(s) **QA CAL-20.v5
Calibration procedure for dipoles in air**

Calibration date: **March 15, 2011**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	06-Oct-10 (No. 217-01266)	Oct-11
Power sensor HP 8481A	US37292783	06-Oct-10 (No. 217-01266)	Oct-11
Probe ER3DV6	SN: 2336	29-Dec-10 (No. ER3-2336_Dec10)	Dec-11
Probe H3DV6	SN: 6065	29-Dec-10 (No. H3-6065_Dec10)	Dec-11
DAE4	SN: 781	20-Oct-10 (No. DAE4-781_Oct10)	Oct-11
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Power sensor HP 8482H	SN: 3318A09450	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-10)	In house check: Oct-11
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-10)	In house check: Oct-11
RF generator E4433B	MY 41000675	03-Nov-04 (in house check Oct-09)	In house check: Oct-11

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	

	Name	Function
Approved by:	Fin Bomholt	Technical Director

Issued: March 16, 2011

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



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

Accreditation No.: **SCS 108**

References

- [1] ANSI-C63.19-2007
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 the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above 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 DASY5 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	DASY5	V52.6.2 (424)
DASY PP Version	SEMCAD X	V14.4.4 (2829)
Phantom	HAC Test Arch	SD HAC P01 BA, #1070
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	0.471 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	141.6 V/m
Maximum measured above low end	100 mW forward power	136.7 V/m
Averaged maximum above arm	100 mW forward power	139.2 V/m

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

3. Appendix

3.1 Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	24.2 dB	(52.2 + j5.9) Ohm
1880 MHz	22.2 dB	(49.8 + j7.8) Ohm
1900 MHz	22.2 dB	(52.5 + j7.6) Ohm
1950 MHz	34.0 dB	(52.0 + j0.2) Ohm
2000 MHz	20.0 dB	(41.2 + j2.1) Ohm

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

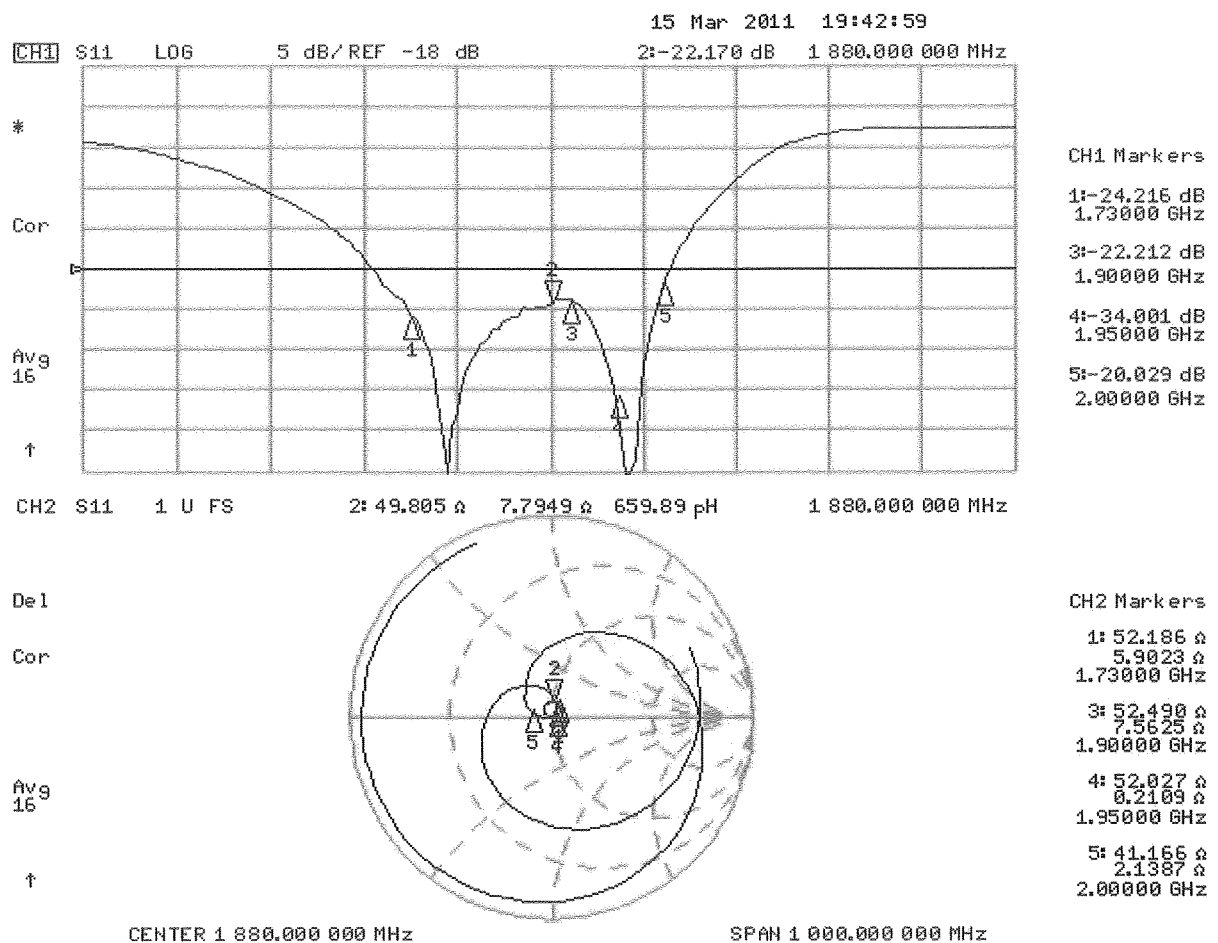
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-Field Result

Date/Time: 15.03.2011 17:11:00

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1016_H_110315_CL

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

Communication System: CW; Frequency: 1880 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole H-Field measurement @ 1880MHz/H Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 0.471 A/m

Probe Modulation Factor = 1.000

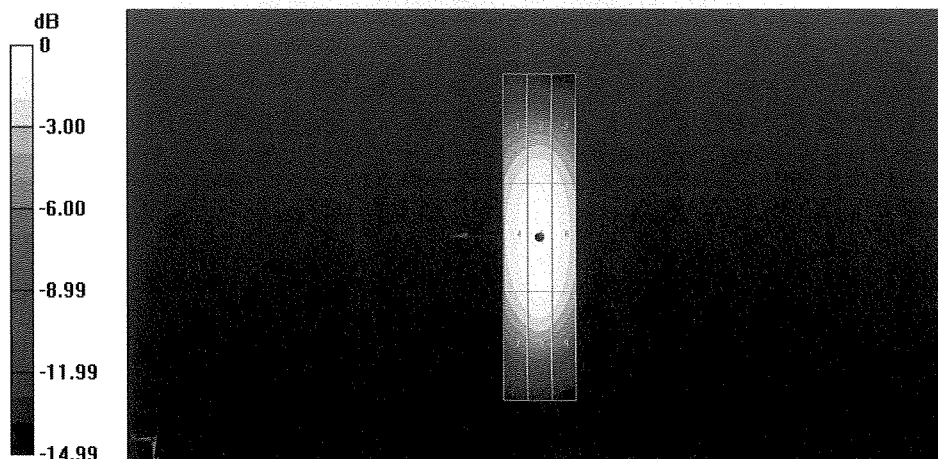
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.499 A/m; Power Drift = 0.02 dB

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

Peak H-field in A/m

Grid 1 0.411 M2	Grid 2 0.429 M2	Grid 3 0.409 M2
Grid 4 0.450 M2	Grid 5 0.471 M2	Grid 6 0.449 M2
Grid 7 0.412 M2	Grid 8 0.435 M2	Grid 9 0.411 M2



0 dB = 0.470A/m

3.3.3 DASY4 E-Field Result

Date/Time: 15.03.2011 15:05:06

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1016_E_110315_CL

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

Communication System: CW; Frequency: 1880 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole E-Field measurement @ 1880MHz/E Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 141.6 V/m

Probe Modulation Factor = 1.000

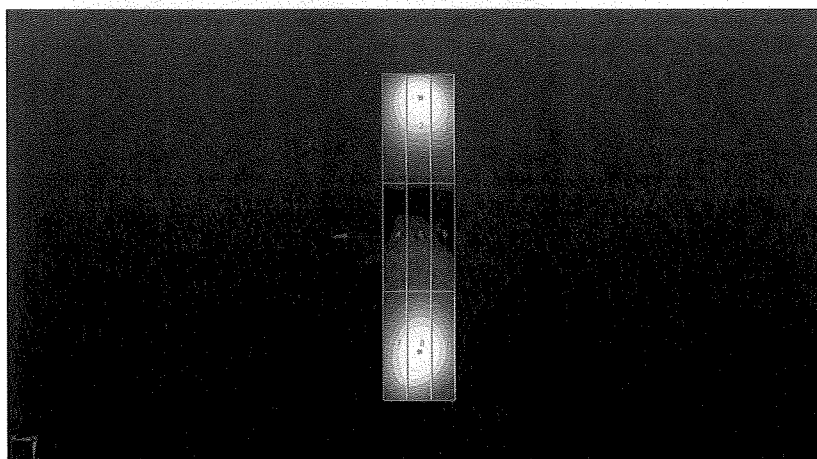
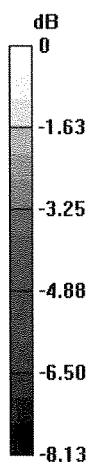
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 135.5 V/m; Power Drift = 0.01 dB

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

Peak E-field in V/m

Grid 1 134.0 M2	Grid 2 141.6 M2	Grid 3 137.0 M2
Grid 4 88.457 M3	Grid 5 92.910 M3	Grid 6 90.833 M3
Grid 7 132.7 M2	Grid 8 136.7 M2	Grid 9 132.4 M2



0 dB = 141.6V/m

4. Additional Measurements

4.1 Measurement Conditions

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

DASY Version	DASY5	V52.6.2 (424)
DASY PP Version	SEMCAD X	V14.4.4 (2829)
Phantom	HAC Test Arch	SD HAC P01 BA, #1070
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	area = 20 x 90 mm
Frequency	1730 MHz $\pm$ 1 MHz	
Forward power at dipole connector	20.0 dBm = 100mW	
Input power drift	< 0.05 dB	

4.1.1 Maximum Field values

H-field 10 mm above dipole surface	condition	interpolated maximum
Maximum measured	100 mW forward power	0.488 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	149.4 V/m
Maximum measured above low end	100 mW forward power	145.9 V/m
Averaged maximum above arm	100 mW forward power	147.7 V/m

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

4.1.2 DASY4 H-field result

Date/Time: 15.03.2011 17:05:04

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1016_H_1730_110315_CL

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

Communication System: CW; Frequency: 1730 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole H-Field measurement @ 1880MHz/H Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm @ 1730 MHz/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 0.488 A/m

Probe Modulation Factor = 1.000

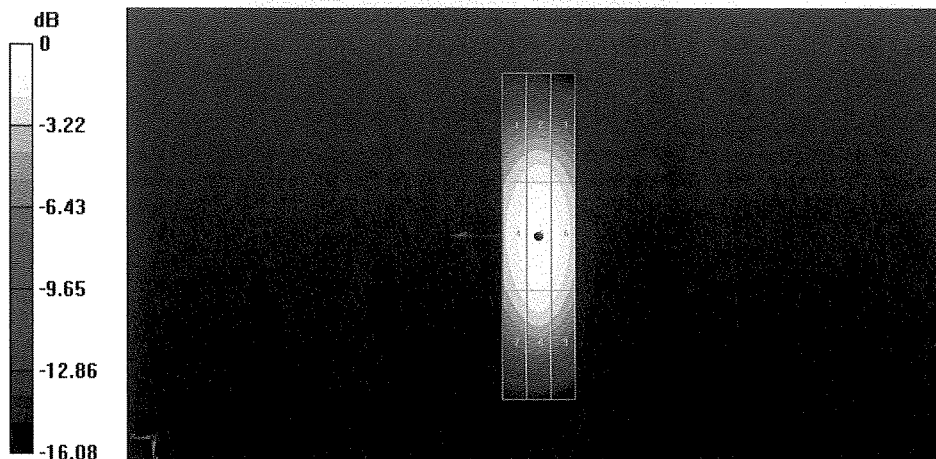
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 0.519 A/m; Power Drift = 0.02 dB

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

Peak H-field in A/m

Grid 1 0.405 M2	Grid 2 0.425 M2	Grid 3 0.407 M2
Grid 4 0.462 M2	Grid 5 0.488 M2	Grid 6 0.466 M2
Grid 7 0.410 M2	Grid 8 0.435 M2	Grid 9 0.411 M2



0 dB = 0.490A/m

4.1.3 DASY4 E-field result

Date/Time: 15.03.2011 15:14:58

Test Laboratory: SPEAG Lab2

HAC_RF_CD1880_1016_E_1730_110315_CL

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

Communication System: CW; Frequency: 1730 MHz

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

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2010
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 20.10.2010
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- Measurement SW: DASY52, V52.6 Build 2, Version 52.6.2 (424)
- Postprocessing SW: SEMCAD X, V14.4 Build 4, Version 14.4.4 (2829)

Dipole E-Field measurement @ 1880MHz/E Scan - measurement distance from the probe sensor center to CD1880

Dipole = 10mm @ 1730 MHz/Hearing Aid Compatibility Test (41x181x1):

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

Maximum value of peak Total field = 149.4 V/m

Probe Modulation Factor = 1.000

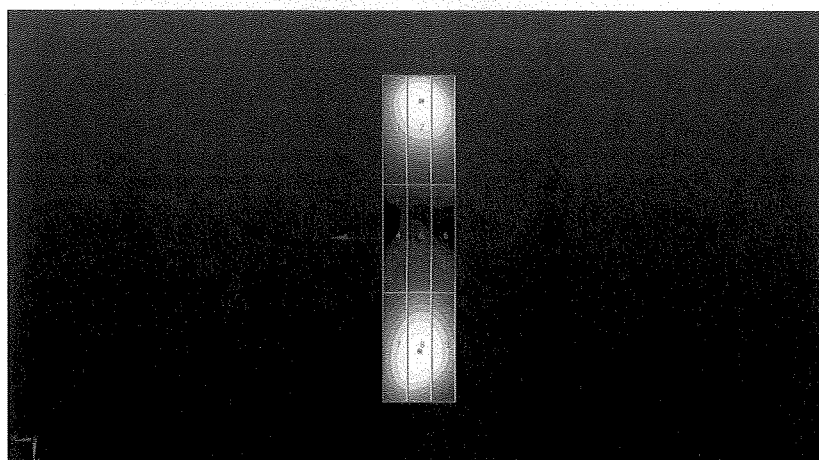
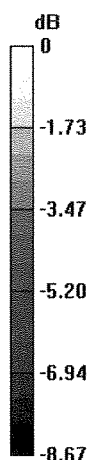
Device Reference Point: 0, 0, -6.3 mm

Reference Value = 144.7 V/m; Power Drift = 0.01 dB

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

Peak E-field in V/m

Grid 1 140.4 M2	Grid 2 149.4 M2	Grid 3 145.2 M2
Grid 4 99.237 M3	Grid 5 104.6 M3	Grid 6 102.5 M3
Grid 7 140.9 M2	Grid 8 145.9 M2	Grid 9 141.9 M2



0 dB = 149.4V/m