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

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Accreditation No.: SCS 108

Client **SGS USA**

Certificate No: ER3-2308_Jan14

CALIBRATION CERTIFICATE

Object	ER3DV6 - SN:2308
Calibration procedure(s)	QA CAL-02.v8, QA CAL-25.v6 Calibration procedure for E-field probes optimized for close near field evaluations in air
Calibration date:	January 17, 2014

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	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ER3DV6	SN: 2328	10-Oct-13 (No. ER3-2328_Oct13)	Oct-14
DAE4	SN: 789	15-May-13 (No. DAE4-789_May13)	May-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: January 17, 2014

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Glossary:

NORMx,y,z	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	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., ϑ = 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
b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 for XY sensors and ϑ = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart).
- *DCPx,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.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* 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 *NORMx* (no uncertainty required).

Probe ER3DV6

SN:2308

Manufactured: February 27, 2003
Calibrated: January 17, 2014

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

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2308

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (µV/(V/m)^2)	1.53	1.63	1.73	± 10.1 %
DCP (mV)[B]	99.4	98.6	96.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√µV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	158.3	±1.9 %
		Y	0.0	0.0	1.0		152.8	
		Z	0.0	0.0	1.0		148.6	
10011-CAA	UMTS-FDD (WCDMA)	X	3.28	66.8	18.8	2.91	126.9	±0.5 %
		Y	3.20	66.2	18.5		123.4	
		Z	3.08	64.9	17.3		118.9	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.79	67.4	18.4	1.87	130.3	±0.5 %
		Y	2.93	68.4	19.0		126.1	
		Z	2.92	67.3	17.7		121.6	
10013-CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	11.26	70.7	23.8	9.46	86.4	±3.0 %
		Y	10.82	69.2	22.7		84.1	
		Z	10.50	67.9	21.6		79.6	
10021-DAA	GSM-FDD (TDMA, GMSK)	X	22.32	99.6	29.0	9.39	99.9	±1.2 %
		Y	21.06	99.3	29.4		98.0	
		Z	25.11	99.5	29.3		102.5	
10024-DAA	GPRS-FDD (TDMA, GMSK, TN 0-1)	X	31.45	99.8	26.4	6.56	123.1	±2.2 %
		Y	31.93	99.4	26.2		121.9	
		Z	38.25	99.9	26.3		126.3	
10025-DAA	EDGE-FDD (TDMA, 8PSK, TN 0)	X	14.30	98.5	39.4	12.62	99.9	±3.5 %
		Y	14.62	98.8	39.5		99.4	
		Z	16.75	99.1	38.6		102.8	
10026-DAA	EDGE-FDD (TDMA, 8PSK, TN 0-1)	X	17.38	99.7	35.8	9.55	125.1	±3.3 %
		Y	17.22	98.9	35.4		126.1	
		Z	20.66	100.0	35.0		124.2	
10039-CAA	CDMA2000 (1xRTT, RC1)	X	4.91	66.9	19.3	4.57	129.3	±1.2 %
		Y	5.03	67.5	19.8		127.1	
		Z	4.72	65.6	18.3		114.9	
10056-CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	X	16.15	99.3	37.1	11.01	113.8	±2.7 %
		Y	16.25	99.4	37.3		112.2	
		Z	18.83	99.9	36.5		117.8	
10062-CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	X	10.45	69.3	22.4	8.68	85.2	±2.5 %
		Y	10.50	69.4	22.4		83.9	
		Z	10.83	69.8	22.4		117.3	

10081-CAA	CDMA2000 (1xRTT, RC3)	X	3.98	66.0	18.7	3.97	124.6	±0.7 %
		Y	3.97	65.9	18.8		122.9	
		Z	3.87	65.0	17.9		116.0	
10103-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	X	10.36	75.5	26.5	9.29	91.3	±2.5 %
		Y	10.60	75.9	26.7		91.1	
		Z	10.09	73.2	24.7		87.6	
10104-CAB	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	X	11.44	75.7	27.3	9.97	100.5	±3.0 %
		Y	10.85	73.4	25.7		99.6	
		Z	11.17	73.4	25.4		96.8	
10109-CAB	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	X	7.22	67.3	20.2	6.43	105.2	±3.0 %
		Y	7.75	69.1	21.4		147.5	
		Z	7.52	67.9	20.4		139.7	
10111-CAB	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	X	7.46	68.7	21.2	6.44	146.3	±3.0 %
		Y	7.50	68.8	21.3		143.2	
		Z	7.24	67.5	20.2		135.5	
10143-CAB	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	X	7.23	68.6	21.1	6.35	143.5	±2.7 %
		Y	7.23	68.5	21.0		141.0	
		Z	7.05	67.5	20.1		133.2	
10146-CAB	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	X	6.98	68.5	21.1	6.41	138.2	±2.7 %
		Y	6.97	68.3	20.9		135.2	
		Z	6.76	67.1	20.0		129.2	
10149-CAB	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	X	7.22	67.3	20.2	6.42	105.6	±3.0 %
		Y	7.71	69.0	21.3		146.9	
		Z	7.52	67.9	20.4		139.8	
10155-CAB	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	X	7.45	68.7	21.2	6.43	146.7	±3.0 %
		Y	7.46	68.7	21.2		143.2	
		Z	7.26	67.6	20.3		135.9	
10157-CAB	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	X	7.22	68.5	21.1	6.49	142.5	±3.0 %
		Y	7.21	68.3	21.1		138.7	
		Z	7.01	67.3	20.2		131.6	
10167-CAB	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	X	6.36	68.1	20.7	6.21	131.9	±2.5 %
		Y	6.41	68.1	20.8		129.1	
		Z	6.23	66.8	19.7		123.2	
10169-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	X	5.25	67.1	20.2	5.73	122.8	±1.7 %
		Y	5.28	67.1	20.2		119.6	
		Z	5.12	65.6	19.0		114.7	
10170-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	X	6.19	68.5	21.3	6.52	124.0	±2.5 %
		Y	6.23	68.4	21.2		121.3	
		Z	6.06	67.0	20.1		115.9	
10175-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	X	5.27	67.2	20.2	5.72	123.0	±1.7 %
		Y	5.24	66.8	20.1		119.7	
		Z	5.16	65.8	19.2		114.7	
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	X	6.17	68.5	21.2	6.52	124.1	±2.7 %
		Y	6.23	68.4	21.3		121.3	
		Z	6.05	66.9	20.0		115.8	

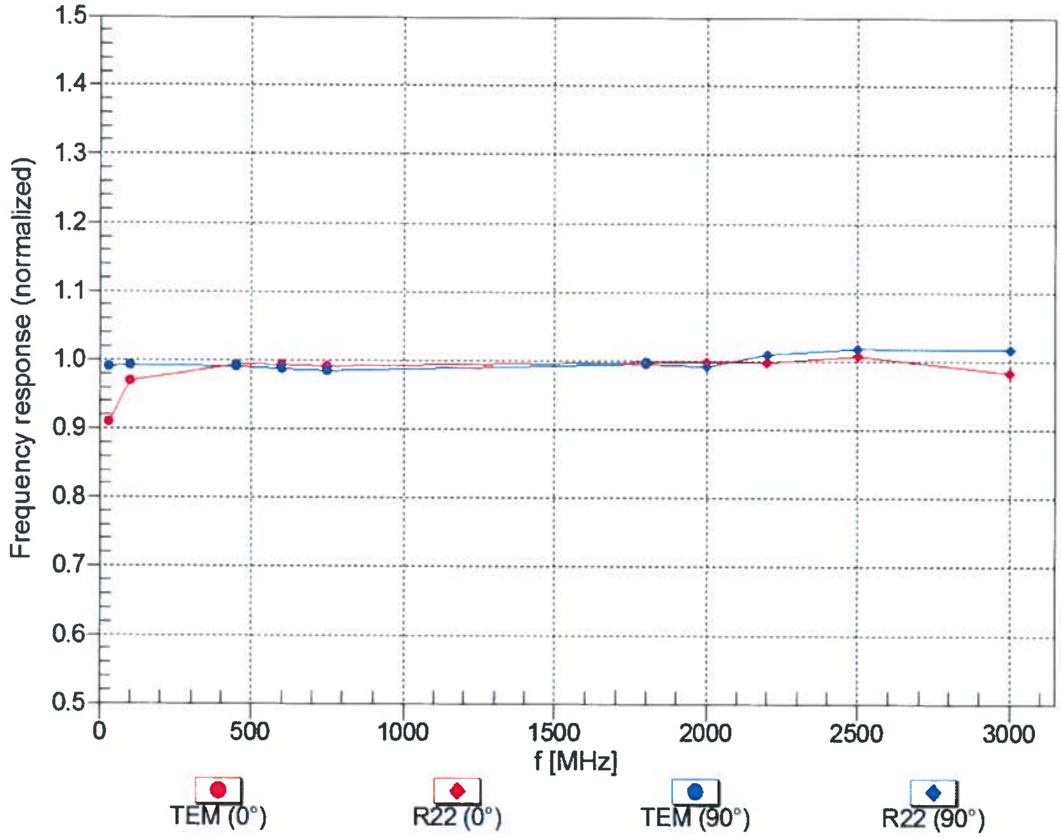
10177-CAC	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	X	5.24	67.0	20.2	5.73	122.8	±1.7 %
		Y	5.15	66.3	19.7		119.8	
		Z	5.15	65.7	19.1		114.7	
10178-CAB	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	X	6.21	68.6	21.3	6.52	124.1	±2.5 %
		Y	6.23	68.4	21.3		121.1	
		Z	6.08	67.1	20.1		115.9	
10181-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	X	5.24	67.0	20.1	5.72	122.5	±1.7 %
		Y	5.17	66.3	19.7		120.2	
		Z	5.17	65.9	19.1		114.8	
10182-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	X	6.21	68.7	21.4	6.52	124.1	±2.5 %
		Y	6.09	67.7	20.7		121.8	
		Z	6.04	66.9	20.0		115.1	
10184-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	X	5.21	66.8	20.0	5.73	122.6	±1.4 %
		Y	5.17	66.3	19.7		120.1	
		Z	5.16	65.7	19.1		114.1	
10185-CAB	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	X	6.19	68.6	21.3	6.51	124.1	±2.5 %
		Y	6.08	67.6	20.7		121.9	
		Z	6.07	67.0	20.1		115.3	
10187-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	X	5.26	67.0	20.1	5.73	123.0	±1.7 %
		Y	5.18	66.4	19.8		120.3	
		Z	5.12	65.6	19.0		114.0	
10188-CAB	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	X	6.15	68.3	21.2	6.52	124.0	±2.5 %
		Y	6.11	67.7	20.7		122.3	
		Z	6.07	67.0	20.1		115.1	
10403-AAA	CDMA2000 (1xEV-DO, Rev. 0)	X	4.64	66.7	18.3	3.76	136.6	±0.7 %
		Y	4.64	66.5	18.3		133.8	
		Z	4.54	65.7	17.5		124.7	

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

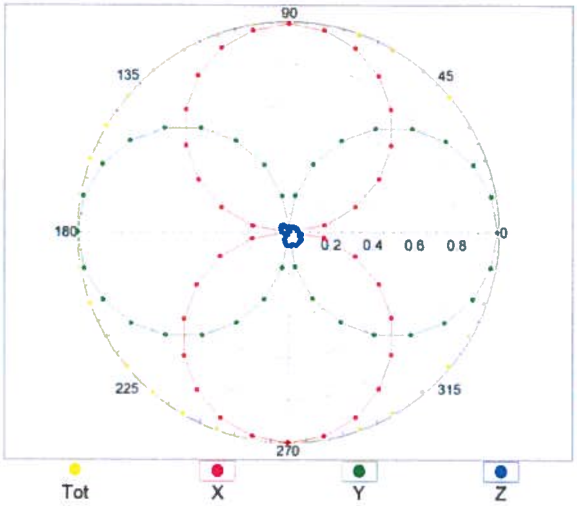
(TEM-Cell:ifi110 EXX, Waveguide: R22)



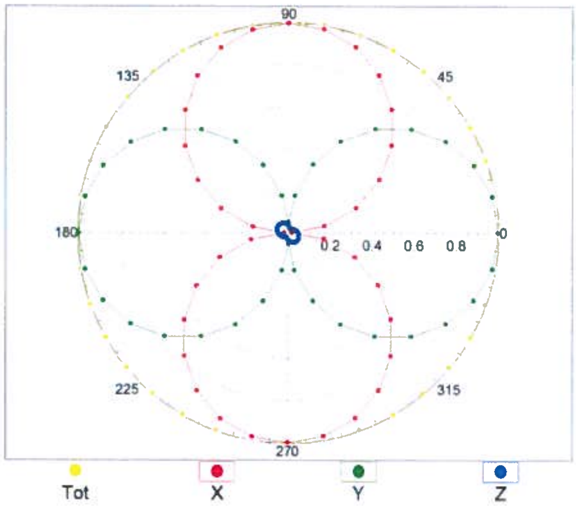
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM,0°

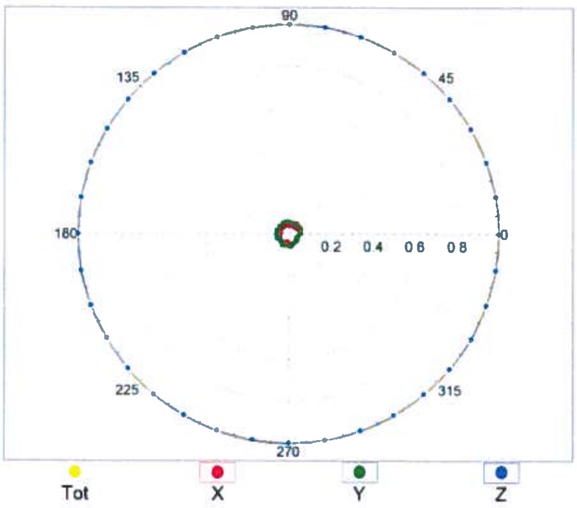


f=2500 MHz,R22,0°

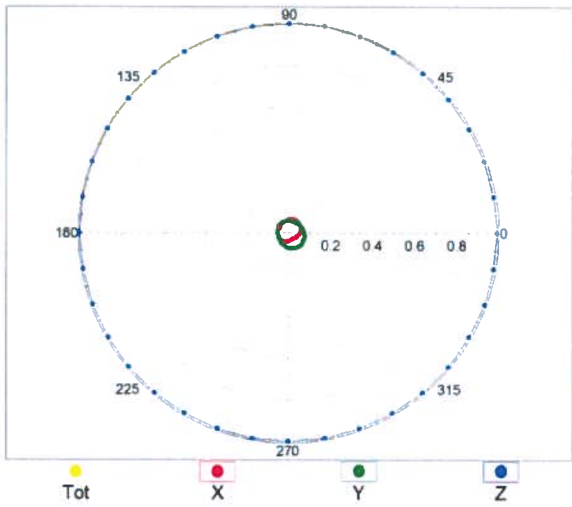


Receiving Pattern (ϕ), ϑ = 90°

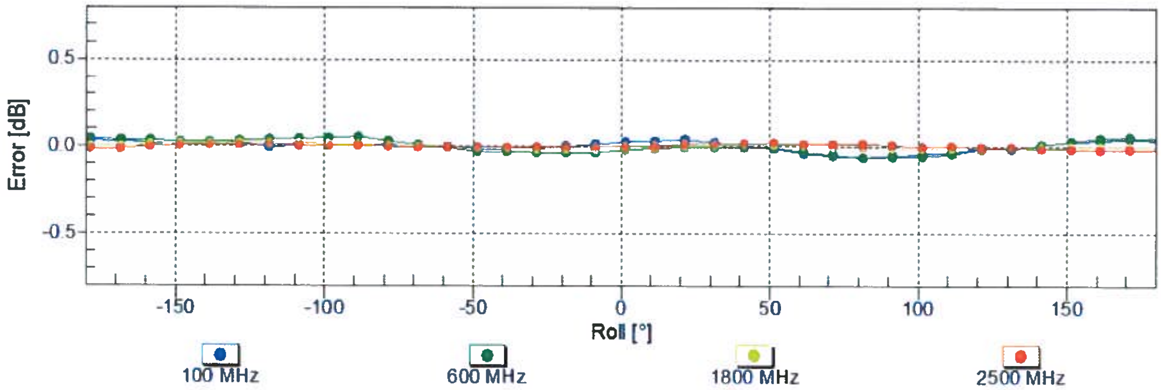
f=600 MHz,TEM,90°



f=2500 MHz,R22,90°

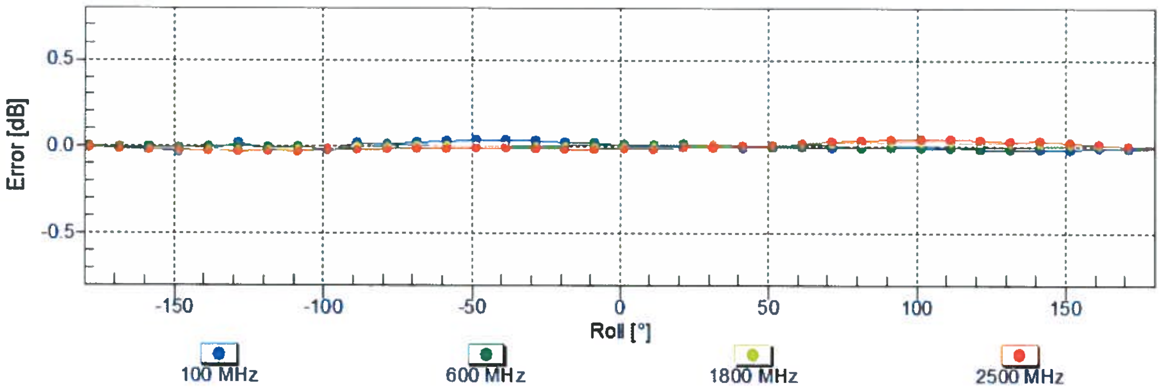


Receiving Pattern (φ), ϑ = 0°



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

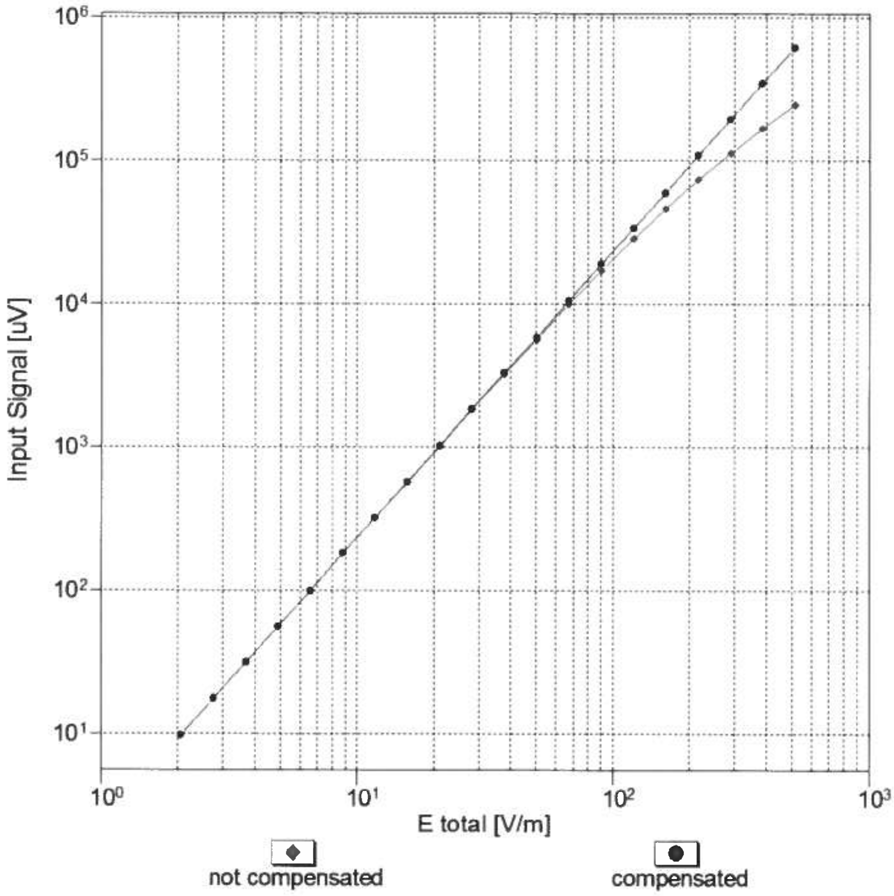
Receiving Pattern (φ), ϑ = 90°

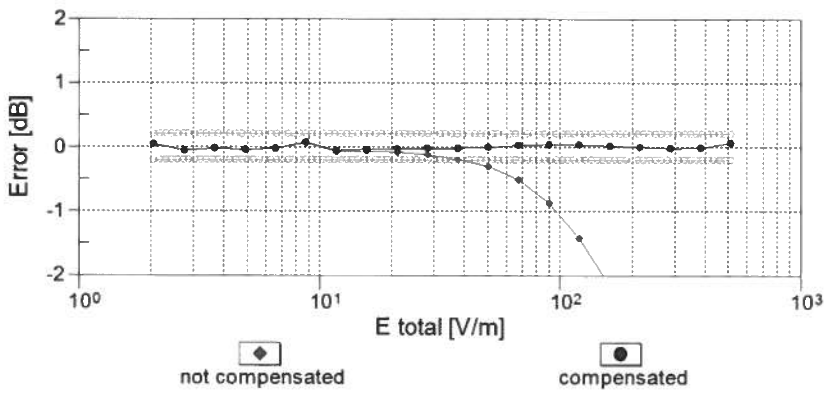


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(E-field)

(TEM cell , f = 900 MHz)

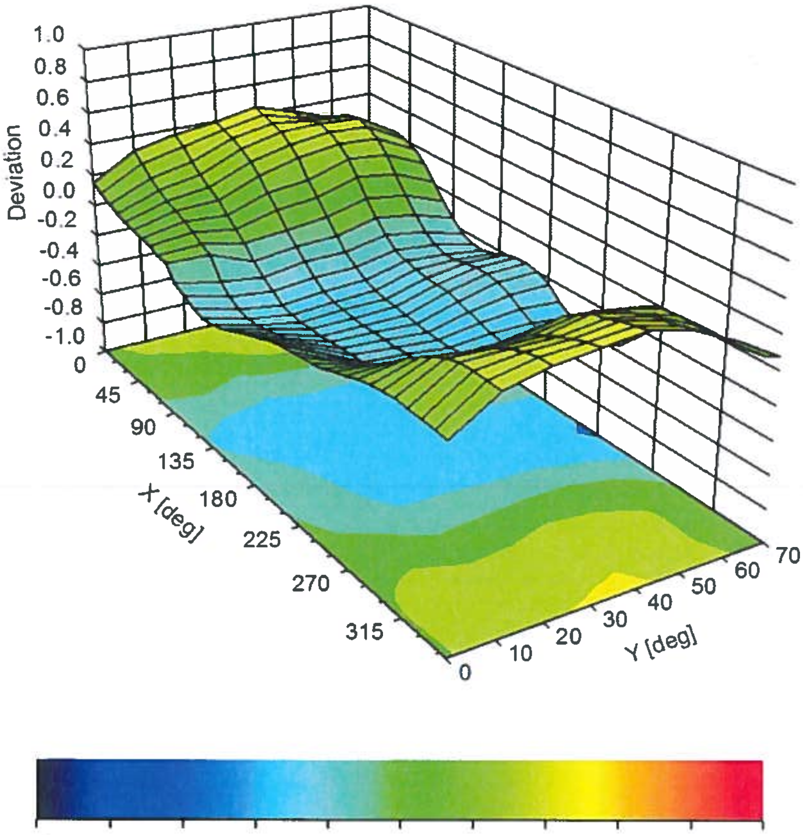




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Deviation from Isotropy in Air

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2308

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	1.4
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

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Accreditation No.: SCS 108

Client **SGS USA**

Certificate No: CD835V3-1060_Jan14

CALIBRATION CERTIFICATE

Object	CD835V3 - SN: 1060
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air
Calibration date:	January 16, 2014

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 EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 10 dB Attenuator	SN: 5047.2 (10q)	04-Apr-13 (No. 217-01731)	Apr-14
Probe ER3DV6	SN: 2336	30-Dec-13 (No. ER3-2336_Dec13)	Dec-14
Probe H3DV6	SN: 6065	30-Dec-13 (No. H3-6065_Dec13)	Dec-14
DAE4	SN: 781	13-Sep-13 (No. DAE4-781_Sep13)	Sep-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Power sensor HP E4412A	SN: MY41495277	01-Apr-08 (in house check Oct-13)	In house check: Oct-15
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-13)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	F. Bomholt

Issued: January 17, 2014

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Accreditation No.: SCS 108

References

[1] ANSI-C63.19-2011
American National Standard, 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 15 mm above the top metal 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 15 mm (in z) above the metal 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, in the plane above the dipole surface.

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 835 MHz

E-field 15 mm above dipole surface	condition	**Interpolated maximum**
Maximum measured above high end	100 mW input power	106.6 V / m
Maximum measured above low end	100 mW input power	106.0 V / m
Averaged maximum above arm	100 mW input power	**106.3 V / m ± 12.8 % (k=2)**

Appendix

Antenna Parameters

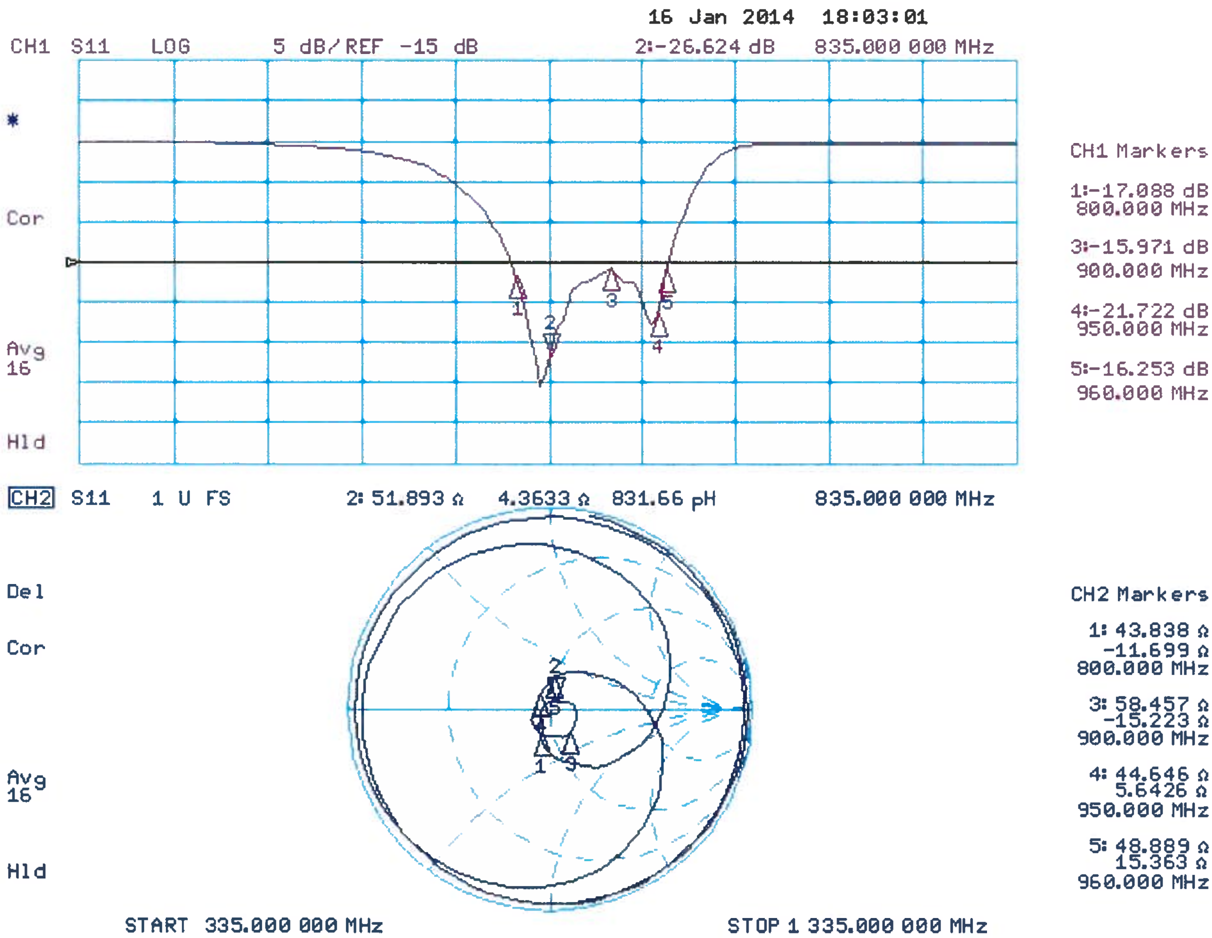
Frequency	**Return Loss**	**Impedance**
800 MHz	17.1 dB	43.8 Ω - 11.7 jΩ
835 MHz	26.6 dB	51.9 Ω + 4.4 jΩ
900 MHz	16.0 dB	58.5 Ω - 15.2 jΩ
950 MHz	21.7 dB	44.6 Ω + 5.6 jΩ
960 MHz	16.3 dB	48.9 Ω + 15.4 jΩ

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.

Impedance Measurement Plot



DASY5 E-field Result

Date: 16.01.2014

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1060

Communication System: UID 0; CW, Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

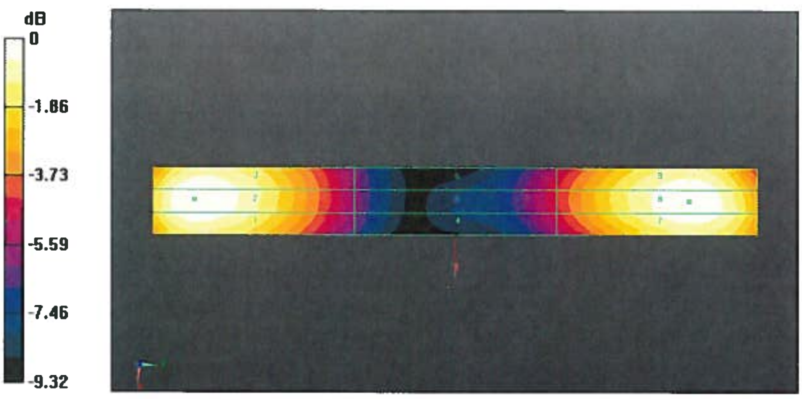
DASY Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 30.12.2013;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 13.09.2013
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=15mm/Hearing Aid Compatibility Test (41x361x1):
Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 122.9 V/m; Power Drift = -0.03 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 106.6 V/m
Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M4** **103.9 V/m**	Grid 2 **M4** **106.6 V/m**	Grid 3 **M4** **105.6 V/m**
Grid 4 **M4** **63.07 V/m**	Grid 5 **M4** **64.62 V/m**	Grid 6 **M4** **64.17 V/m**
Grid 7 **M4** **104.2 V/m**	Grid 8 **M4** **106.0 V/m**	Grid 9 **M4** **104.6 V/m**



0 dB = 106.6 V/m = 40.56 dBV/m

B085941

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

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

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

Accreditation No.: SCS 108

Client SGS USA

Certificate No: CD1880V3-1047_Jan14

CALIBRATION CERTIFICATE

Object	CD1880V3 - SN: 1047
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air
Calibration date:	January 16, 2014

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 EPM-442A	GB37480704	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	US37292783	09-Oct-13 (No. 217-01827)	Oct-14
Power sensor HP 8481A	MY41092317	09-Oct-13 (No. 217-01828)	Oct-14
Reference 10 dB Attenuator	SN: 5047.2 (10q)	04-Apr-13 (No. 217-01731)	Apr-14
Probe ER3DV6	SN: 2336	30-Dec-13 (No. ER3-2336_Dec13)	Dec-14
Probe H3DV6	SN: 6065	30-Dec-13 (No. H3-6065_Dec13)	Dec-14
DAE4	SN: 781	13-Sep-13 (No. DAE4-781_Sep13)	Sep-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Power sensor HP E4412A	SN: MY41495277	01-Apr-08 (in house check Oct-13)	In house check: Oct-15
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-13)	In house check: Oct-15

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	F. Bomholt

Issued: January 17, 2014

References

[1] ANSI-C63.19-2011
American National Standard, 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 15 mm above the top metal 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 15 mm (in z) above the metal 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, in the plane above the dipole surface.

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%.

Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1880 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 1880 MHz

E-field 15 mm above dipole surface	condition	**Interpolated maximum**
Maximum measured above high end	100 mW input power	93.2 V / m
Maximum measured above low end	100 mW input power	91.5 V / m
Averaged maximum above arm	100 mW input power	**92.3 V / m ± 12.8 % (k=2)**

Appendix

Antenna Parameters

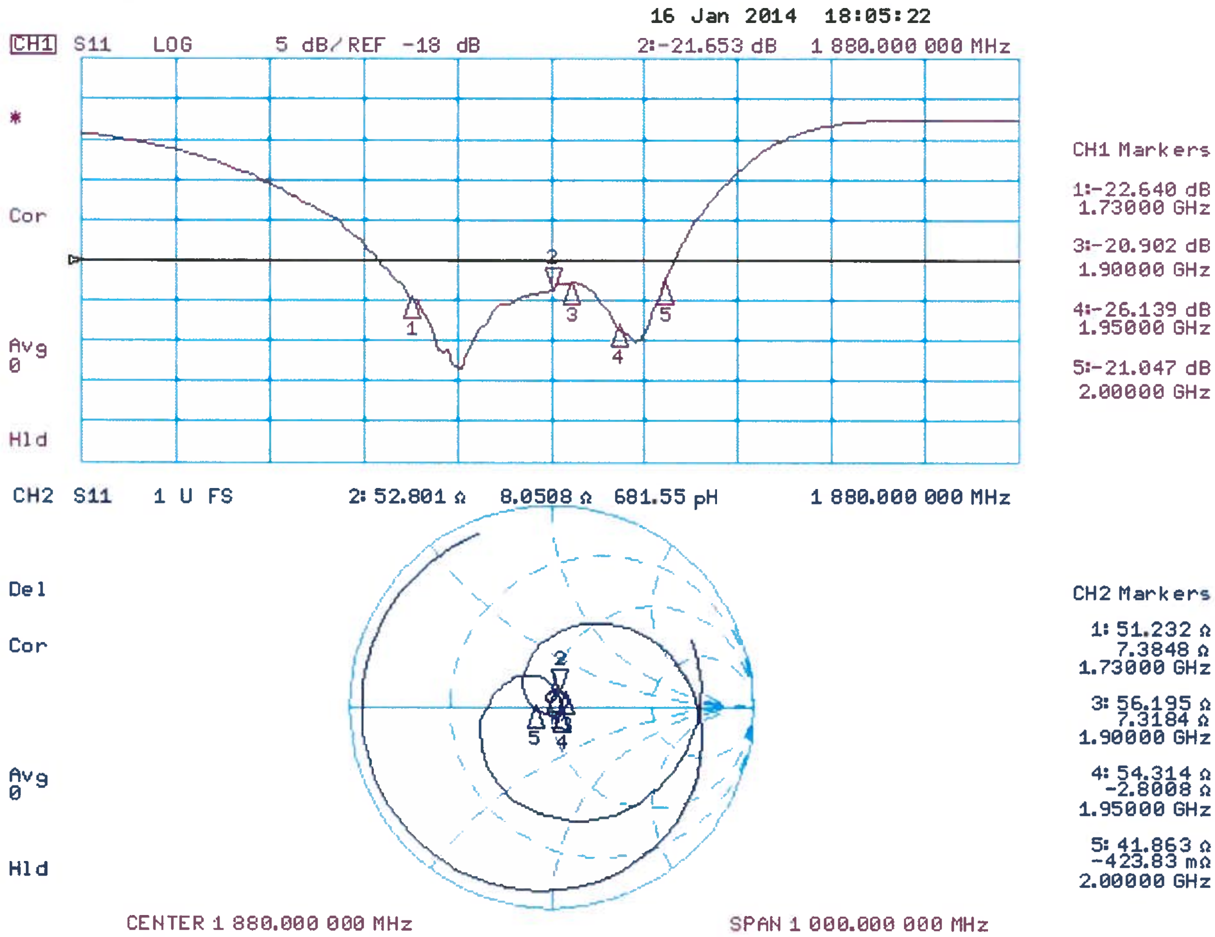
Frequency	**Return Loss**	**Impedance**
1730 MHz	22.6 dB	51.2 Ω + 7.4 jΩ
1880 MHz	21.7 dB	52.8 Ω + 8.1 jΩ
1900 MHz	20.9 dB	56.2 Ω + 7.3 jΩ
1950 MHz	26.1 dB	54.3 Ω - 2.8 jΩ
2000 MHz	21.0 dB	41.9 Ω - 0.4 jΩ

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.

Impedance Measurement Plot



DASY5 E-field Result

Date: 16.01.2014

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1047

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

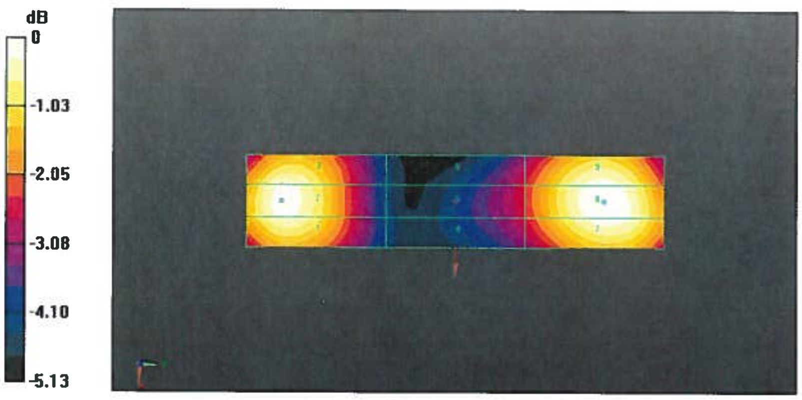
DASY Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 30.12.2013;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 13.09.2013
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):
Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 146.8 V/m; Power Drift = 0.01 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 93.18 V/m
Near-field category: M3 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M3** **89.84 V/m**	Grid 2 **M3** **91.51 V/m**	Grid 3 **M3** **89.69 V/m**
Grid 4 **M3** **70.11 V/m**	Grid 5 **M3** **71.34 V/m**	Grid 6 **M3** **70.66 V/m**
Grid 7 **M3** **91.65 V/m**	Grid 8 **M3** **93.18 V/m**	Grid 9 **M3** **91.51 V/m**



0 dB = 93.18 V/m = 39.39 dBV/m