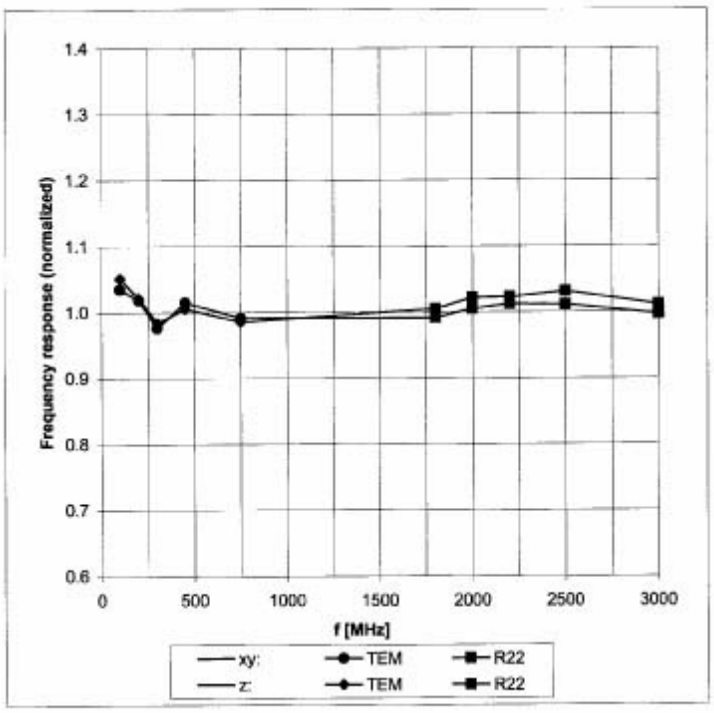
Frequency Response of H-Field

(TEM-Cell:ifi110, Waveguide R22)



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

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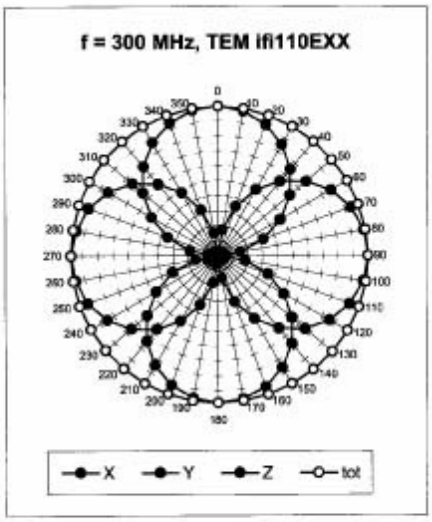
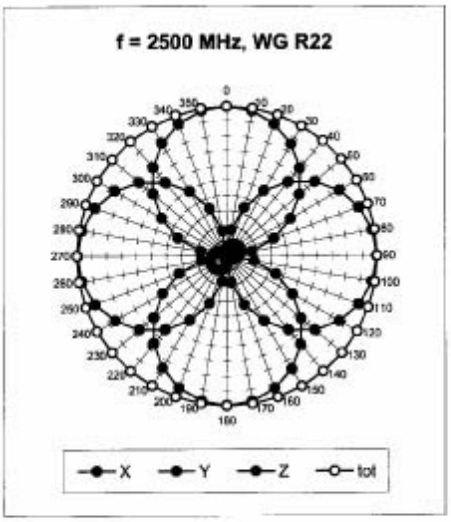
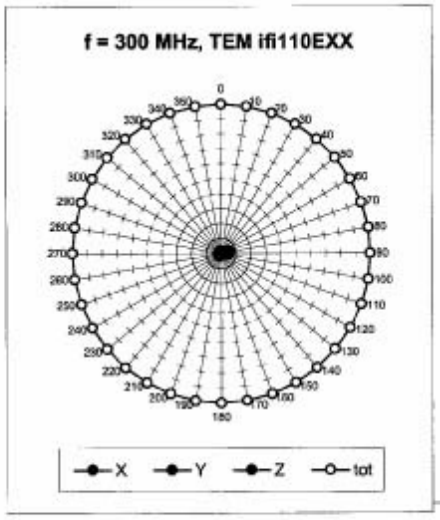
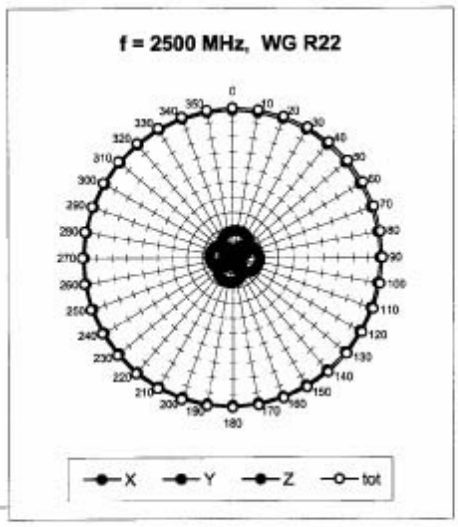
Receiving Pattern (ϕ), ϑ = 90°





Receiving Pattern (ϕ), ϑ = 0°





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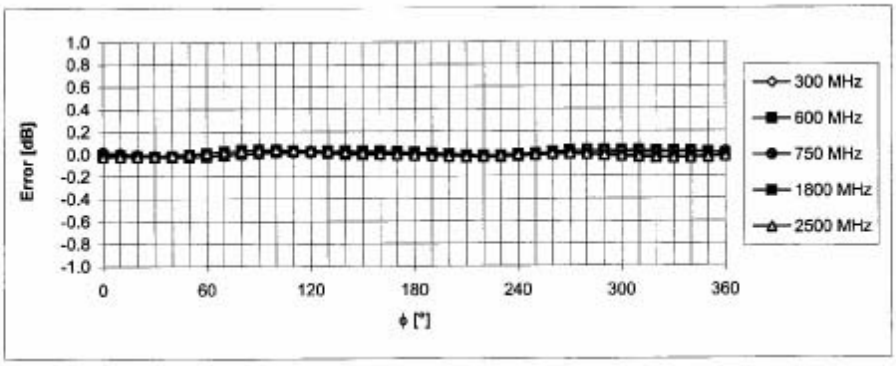
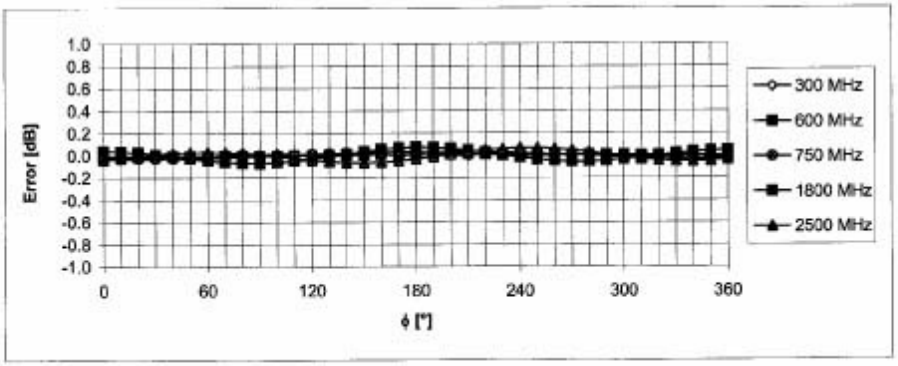
Receiving Pattern (ϕ), ϑ = 90°



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

Receiving Pattern (ϕ), ϑ = 0°



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

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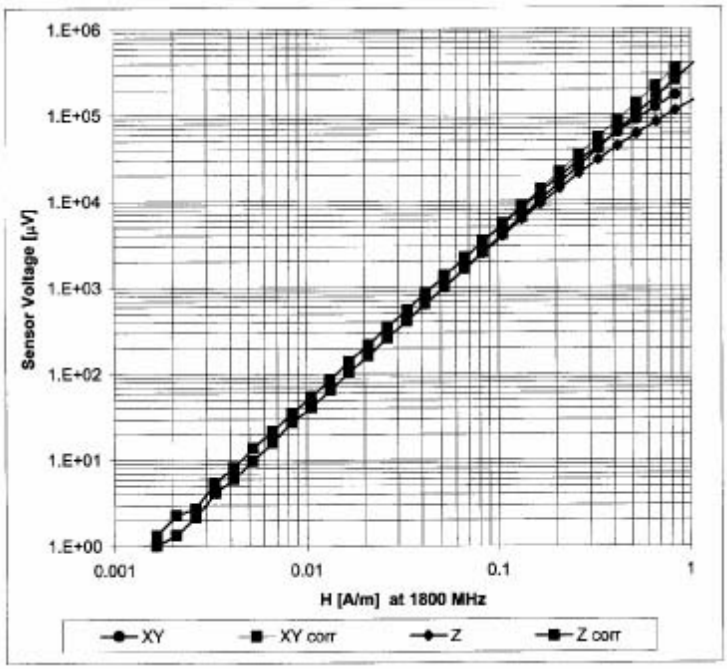
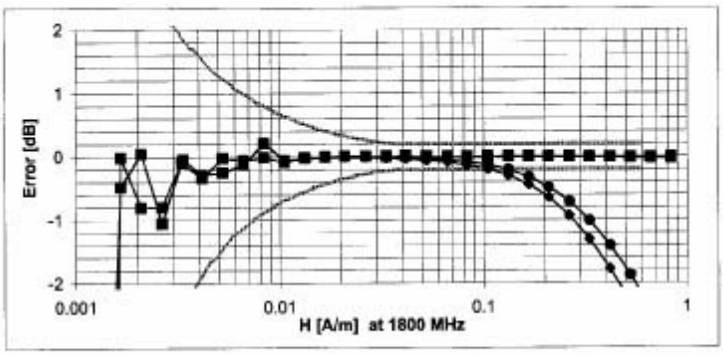
Dynamic Range f(H-field)

(Waveguide R22, f = 1800 MHz)





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

Certificate No: H3-6180_Oct04 Page 8 of 8

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Zeughausstrasse 43, 8004 Zurich, Switzerland

Client PC TEST

Certificate No: CD1880V3-1002_Feb05

CALIBRATION CERTIFICATE

Object	CD1880V3 - SN: 1002
Calibration procedure(s)	QA CAL-20.v2 Calibration procedure for dipoles in air
Calibration date:	February, 23, 2005
Condition of the calibrated item	In Tolerance

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E442	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Reference 20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference 10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference Probe ER3DV6	SN 2328	06-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN 601	07-Jan-05 (SPEAG, No. DAE4-601_Jan05)	Jan-06

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

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

Issued: February 27, 2005

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

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

References

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

Methods Applied and Interpretation of Parameters:

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

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1 Measurement Conditions

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

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

2 Maximum Field values

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW forward power	**0.450 A/m**

Uncertainty for H-field measurement: 19.5% (k=2)

E-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured above high end	100 mW forward power	146.0 V/m
Maximum measured above low end	100 mW forward power	145.6 V/m
Averaged maximum above arm	100 mW forward power	145.8 **V/m**

Uncertainty for E-field measurement: 21.7% (k=2)

3 Appendix

3.1 Antenna Parameters

Frequency	**Return Loss**	**Impedance**
1710 MHz	23.4 dB	(55.2 + j6.1) Ohm
1880 MHz	**21.4 dB**	**(53.9 + j7.4) Ohm**
1900 MHz	20.9 dB	(55.8 + j6.7) Ohm
1950 MHz	28.0 dB	(54.1 + j1.9) Ohm
2000 MHz	18.9 dB	(51.2 + j11.9) 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.

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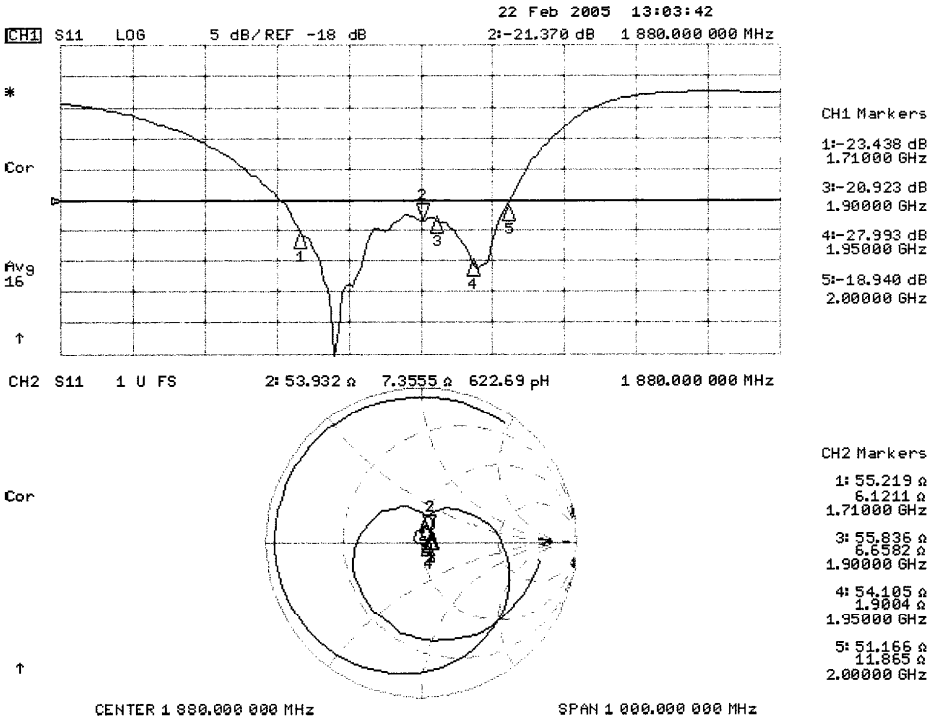
3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field result

See page 5

3.3.3 DASY4 E-Field result

See page 6

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Date/Time: 23.02.2005 11:02:39

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: H_CD1880_1002_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1002
Program Name: HAC H Dipole

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

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

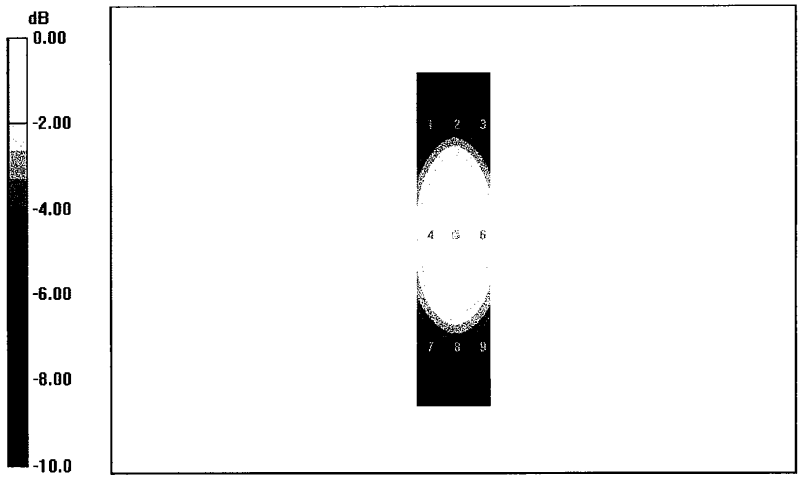
H Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 0.450 A/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.385	**0.413**	**0.395**
Grid 4	Grid 5	Grid 6
0.421	**0.450**	**0.432**
Grid 7	Grid 8	Grid 9
0.376	**0.401**	**0.386**

H in A/m (Slot averaged)

Grid 1	Grid 2	Grid 3
0.385	**0.413**	**0.395**
Grid 4	Grid 5	Grid 6
0.421	**0.450**	**0.432**
Grid 7	Grid 8	Grid 9
0.376	**0.401**	**0.386**



0 dB = 0.450A/m

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Date/Time: 23.02.2005 16:30:33

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: E_CD1880_1002_050223.da4

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: 1002
Program Name: HAC E Dipole

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

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

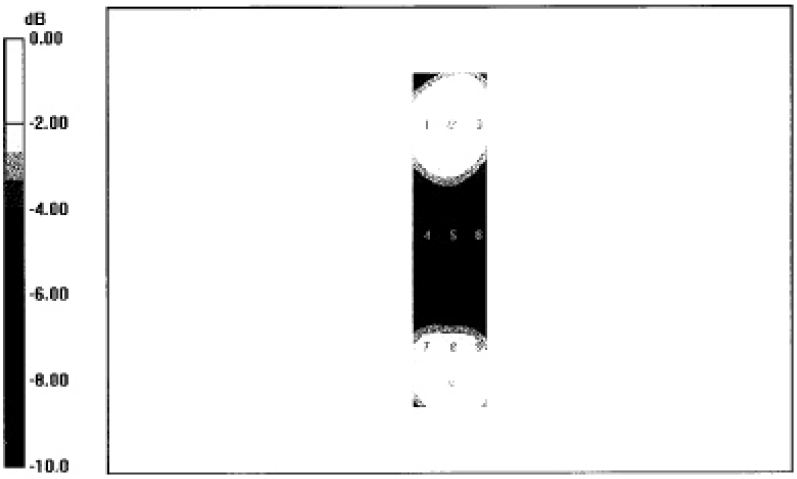
E Scan 10mm above CD 1880 MHz/Hearing Aid Compatibility Test (41x181x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 146.0 V/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
128.7	**145.6**	**130.5**
Grid 4	Grid 5	Grid 6
90.1	**92.4**	**88.8**
Grid 7	Grid 8	Grid 9
126.7	**146.0**	**131.8**

E in V/m (Slot averaged)

Grid 1	Grid 2	Grid 3
128.7	**145.6**	**130.5**
Grid 4	Grid 5	Grid 6
90.1	**92.4**	**88.8**
Grid 7	Grid 8	Grid 9
126.7	**146.0**	**131.8**



0 dB = 146.0V/m

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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

Client PC TEST

Certificate No: CD835V3-1003_Feb05

CALIBRATION CERTIFICATE

Object	CD835V3 - SN: 1003
Calibration procedure(s)	QA CAL-20.v2 Calibration procedure for dipoles in air
Calibration date:	February, 23, 2005
Condition of the calibrated item	In Tolerance

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter EPM E442	GB37480704	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Power sensor HP 8481A	US37292783	12-Oct-04 (METAS, No. 251-00412)	Oct-05
Reference 20 dB Attenuator	SN: 5086 (20g)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference 10 dB Attenuator	SN: 5047.2 (10r)	10-Aug-04 (METAS, No 251-00402)	Aug-05
Reference Probe ER3DV6	SN 2328	06-Oct-04 (SPEAG, No. ER3-2328_Oct04)	Oct-05
DAE4	SN 601	07-Jan-05 (SPEAG, No. DAE4-601_Jan05)	Jan-06

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

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

Issued: February 27, 2005

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

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

References

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

Methods Applied and Interpretation of Parameters:

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

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1 Measurement Conditions

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

DASY Version	DASY4	V4.5 B13
DASY PP Version	SEMCAD	V1.8 B144
Phantom	HAC Test Arch	SD HAC P01 BA, #1002
Distance Dipole Top - Probe Center	10 mm	
Scan resolution	dx, dy = 5 mm	area = 20 x 180 mm
Frequency	**835 MHz** ± 1 MHz	
Forward power at dipole connector	20.0 dBm = 100mW	
Input power drift	< 0.05 dB	

2 Maximum Field values

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW forward power	**0.470 A/m**

Uncertainty for H-field measurement: 19.5% (k=2)

E-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured above high end	100 mW forward power	187.0 V/m
Maximum measured above low end	100 mW forward power	183.2 V/m
Averaged maximum above arm	100 mW forward power	**185.1 V/m**

Uncertainty for E-field measurement: 21.7% (k=2)

3 Appendix

3.1 Antenna Parameters

Frequency	**Return Loss**	**Impedance**
800 MHz	16.6 dB	(40.5 - j9.6) Ohm
835 MHz	**25.2 dB**	**(55.3 + j2.4) Ohm**
900 MHz	16.6 dB	(52.7 - j15.2) Ohm
950 MHz	25.1 dB	(50.9 + j5.5) Ohm
960 MHz	17.2 dB	(61.0 + j10.9) 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.

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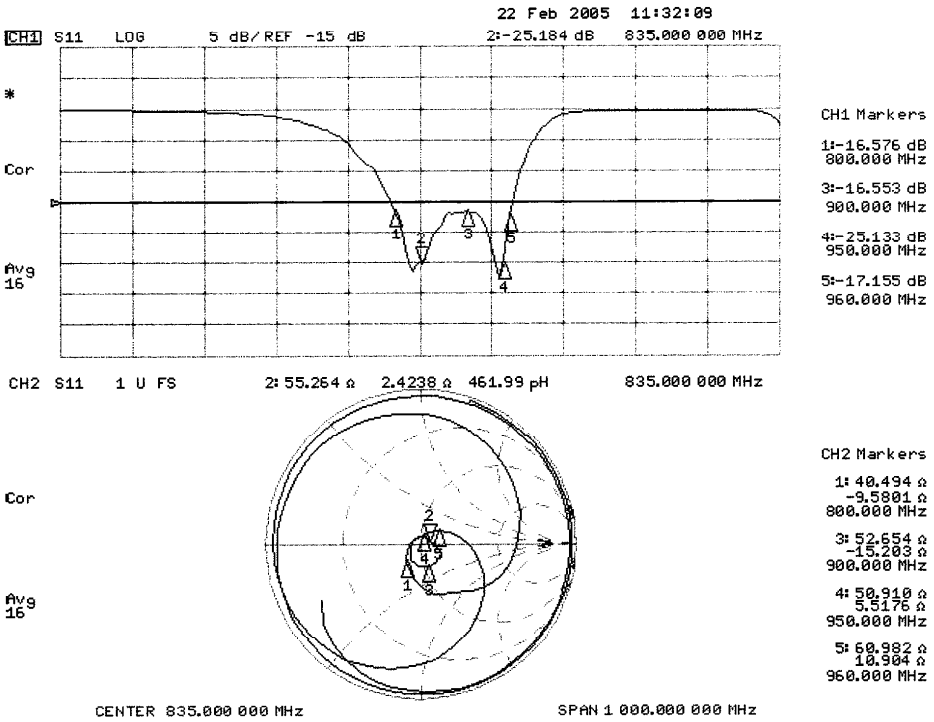
3.3 Measurement Sheets

3.3.1 Return Loss and Smith Chart



3.3.2 DASY4 H-field result

See page 5

3.3.3 DASY4 E-Field result

See page 6

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Date/Time: 22.02.2005 17:22:00

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: H_CD835_1003_050222.da4

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1003
Program Name: HAC H Dipole

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: H Dipole Section

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

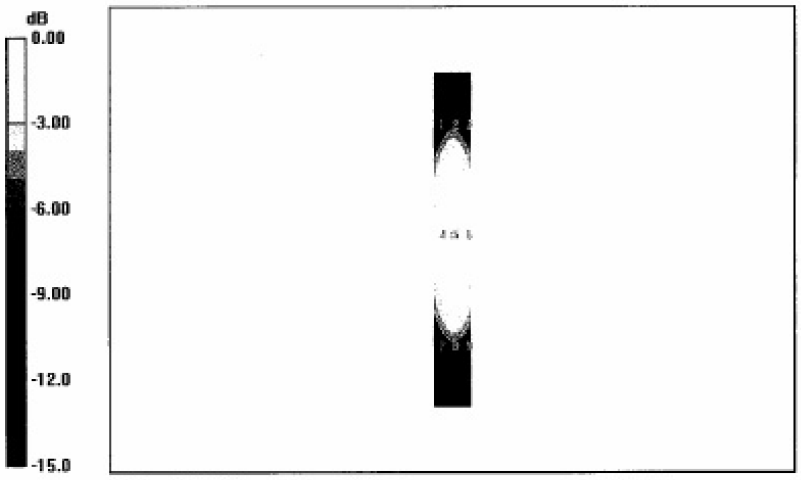
H Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 0.470 A/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

H in A/m (Time averaged)

Grid 1	Grid 2	Grid 3
0.365	**0.397**	**0.380**
Grid 4	Grid 5	Grid 6
0.408	**0.470**	**0.425**
Grid 7	Grid 8	Grid 9
0.350	**0.380**	**0.368**

H in A/m (Slot averaged)

Grid 1	Grid 2	Grid 3
0.365	**0.397**	**0.380**
Grid 4	Grid 5	Grid 6
0.408	**0.470**	**0.425**
Grid 7	Grid 8	Grid 9
0.350	**0.380**	**0.368**



0 dB = 0.470 A/m

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Date/Time: 23.02.2005 14:29:23

Test Laboratory: SPEAG, Zurich, Switzerland
File Name: E_CD835_1003_050223.da4

DUT: HAC-Dipole 835 MHz; Type: D835V3; Serial: 1003
Program Name: HAC E Dipole

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1
Medium parameters used: $\sigma = 0$; mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: E Dipole Section

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

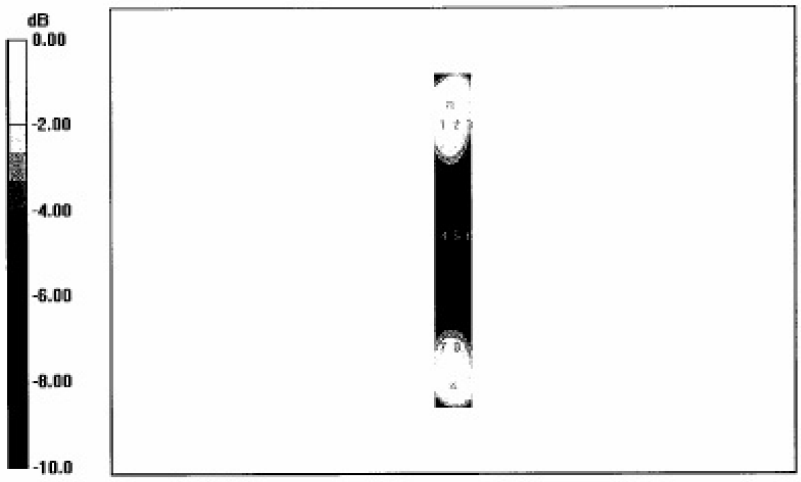
E Scan 10mm above CD 835 MHz/Hearing Aid Compatibility Test (41x361x1): Measurement grid: dx=5mm, dy=5mm, dz=5.5555mm
Maximum value of Total field (slot averaged) = 187.0 V/m
Hearing Aid Near-Field Category: M2 (AWF 0 dB)

E in V/m (Time averaged)

Grid 1	Grid 2	Grid 3
156.0	**187.0**	**150.1**
Grid 4	Grid 5	Grid 6
83.6	**84.8**	**80.4**
Grid 7	Grid 8	Grid 9
148.0	**183.2**	**149.5**

E in V/m (Slot averaged)

Grid 1	Grid 2	Grid 3
156.0	**187.0**	**150.1**
Grid 4	Grid 5	Grid 6
83.6	**84.8**	**80.4**
Grid 7	Grid 8	Grid 9
148.0	**183.2**	**149.5**



0 dB = 187.0 V/m

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15. CONCLUSION

The measurements indicate that the wireless communications device complies with the HAC limits specified in accordance with the ANSI PC63.19 Standard and FCC WT Docket No. 01-309 RM-8658. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters specific to the test. The test results and statements relate only to the item(s) tested.

Please note that the M-rating for this equipment only represents the field interference possible against a hypothetical and typical hearing aid. The measurement system and techniques presented in this evaluation are proposed in the ANSI standard as a means of best approximating wireless device compatibility with a hearing-aid. The literature is under continual re-construction.

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