

**HAC RF E-Field CDMA BC1 Middle**
**Date: 2017-4-26**

Electronics: DAE4 Sn777

Medium: Air

 Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature: 22.0°C

Communication System: CDMA 1900; Frequency: 1880 MHz; Duty Cycle: 1:1

Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 2/Hearing Aid Compatibility Test (101x101x1):**

 Interpolated grid:  $dx=0.5000 \text{ mm}$ ,  $dy=0.5000 \text{ mm}$ 

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 13.03 V/m; Power Drift = -0.05 dB

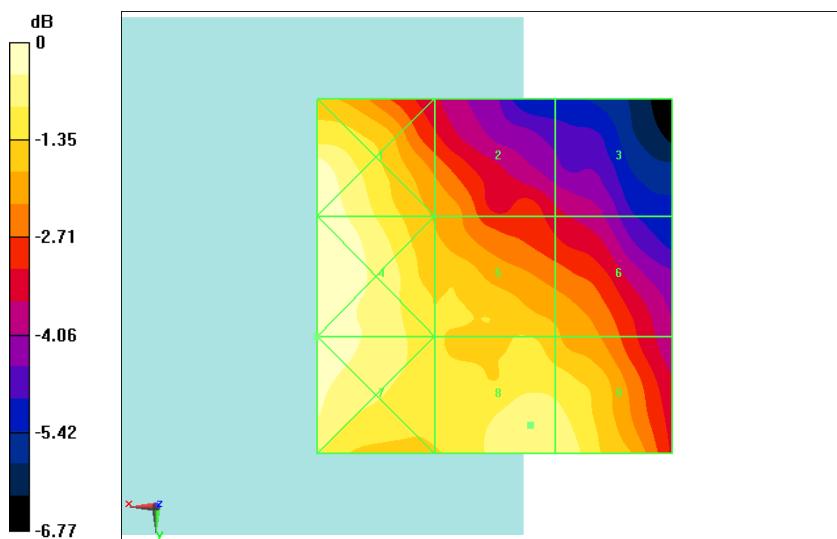
Applied MIF = 2.99 dB

RF audio interference level = 25.41 dBV/m

**Emission category: M4**

MIF scaled E-field

Grid 1 M4 25.82 dBV/m	Grid 2 M4 24.06 dBV/m	Grid 3 M4 22.51 dBV/m
Grid 4 M4 25.91 dBV/m	Grid 5 M4 24.64 dBV/m	Grid 6 M4 24.19 dBV/m
Grid 7 M4 25.91 dBV/m	Grid 8 M4 25.41 dBV/m	Grid 9 M4 25.34 dBV/m



0 dB = 19.74 V/m = 25.91 dBV/m

**Fig B.11 HAC RF E-Field CDMA BC1 Middle**

**HAC RF E-Field CDMA BC1 Low**
**Date: 2017-4-26**

Electronics: DAE4 Sn777

Medium: Air

 Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature: 22.0°C

Communication System: CDMA 1900; Frequency: 1851.25 MHz; Duty Cycle: 1:1

Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 3/Hearing Aid Compatibility Test (101x101x1):**

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 15.73 V/m; Power Drift = 0.04 dB

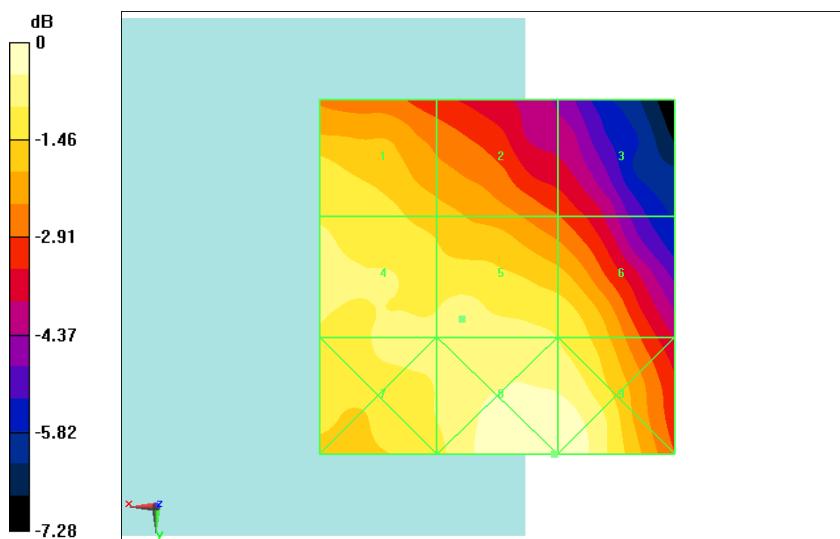
Applied MIF = 2.99 dB

RF audio interference level = 26.20 dBV/m

**Emission category: M4**

MIF scaled E-field

Grid 1 <b>M4</b> <b>25.88 dBV/m</b>	Grid 2 <b>M4</b> <b>25.22 dBV/m</b>	Grid 3 <b>M4</b> <b>24.08 dBV/m</b>
Grid 4 <b>M4</b> <b>26.19 dBV/m</b>	Grid 5 <b>M4</b> <b>26.2 dBV/m</b>	Grid 6 <b>M4</b> <b>25.96 dBV/m</b>
Grid 7 <b>M4</b> <b>26.16 dBV/m</b>	Grid 8 <b>M4</b> <b>26.94 dBV/m</b>	Grid 9 <b>M4</b> <b>26.93 dBV/m</b>



0 dB = 22.24 V/m = 26.94 dBV/m

**Fig B.12 HAC RF E-Field CDMA BC1 Low**

## HAC RF E-Field CDMA BC10 High

Date: 2017-4-26

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature: 22.0°C

Communication System: CDMA 835; Frequency: 832.1 MHz; Duty Cycle: 1:1

Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

### E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 12.19 V/m; Power Drift = -0.12 dB

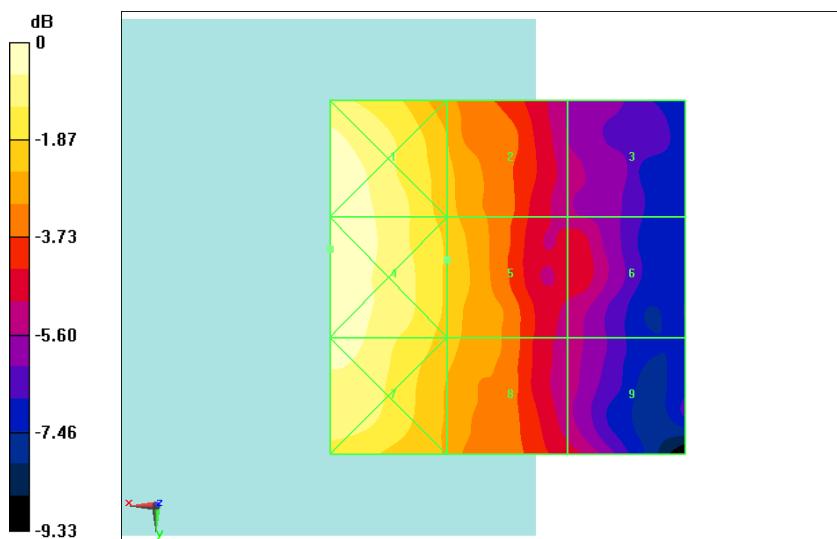
Applied MIF = 3.03 dB

RF audio interference level = 24.71 dBV/m

**Emission category: M4**

MIF scaled E-field

Grid 1 <b>M4</b> <b>26.51 dBV/m</b>	Grid 2 <b>M4</b> <b>24.48 dBV/m</b>	Grid 3 <b>M4</b> <b>21.38 dBV/m</b>
Grid 4 <b>M4</b> <b>26.65 dBV/m</b>	Grid 5 <b>M4</b> <b>24.71 dBV/m</b>	Grid 6 <b>M4</b> <b>22.24 dBV/m</b>
Grid 7 <b>M4</b> <b>26.37 dBV/m</b>	Grid 8 <b>M4</b> <b>24.48 dBV/m</b>	Grid 9 <b>M4</b> <b>22.09 dBV/m</b>



0 dB = 21.49 V/m = 26.64 dBV/m

**Fig B.13 HAC RF E-Field CDMA BC10 High**

**HAC RF E-Field CDMA BC10 Middle**
**Date: 2017-4-26**

Electronics: DAE4 Sn777

Medium: Air

 Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature: 22.0°C

Communication System: CDMA 835; Frequency: 820.5 MHz; Duty Cycle: 1:1

Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 2/Hearing Aid Compatibility Test (101x101x1):**

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 12.09 V/m; Power Drift = 0.05 dB

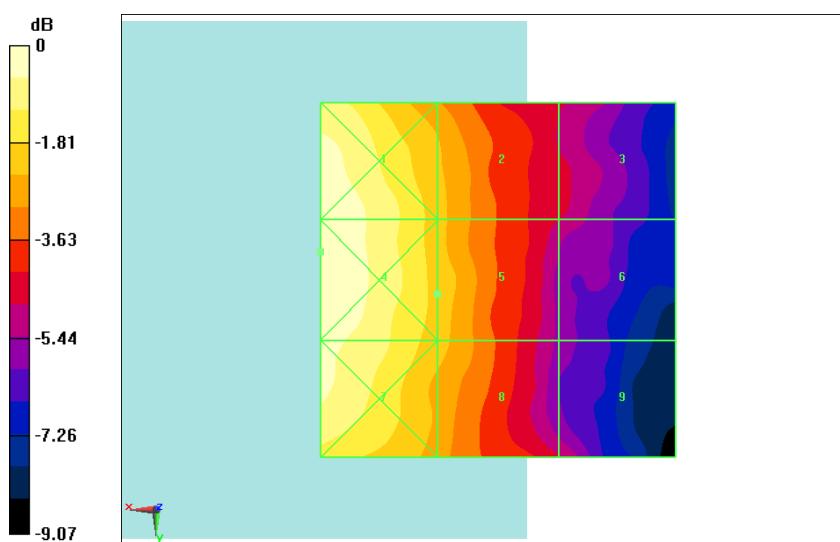
Applied MIF = 2.98 dB

RF audio interference level = 24.53 dBV/m

**Emission category: M4**

MIF scaled E-field

Grid 1 M4 26.41 dBV/m	Grid 2 M4 24.41 dBV/m	Grid 3 M4 21.96 dBV/m
Grid 4 M4 26.55 dBV/m	Grid 5 M4 24.53 dBV/m	Grid 6 M4 21.74 dBV/m
Grid 7 M4 26.15 dBV/m	Grid 8 M4 24.38 dBV/m	Grid 9 M4 21.88 dBV/m


**Fig B.14 HAC RF E-Field CDMA BC10 Middle**

**HAC RF E-Field CDMA BC10 Low**
**Date: 2017-4-26**

Electronics: DAE4 Sn777

Medium: Air

 Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Ambient Temperature: 22.0°C

Communication System: CDMA 835; Frequency: 817.9 MHz; Duty Cycle: 1:1

Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

**E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 3/Hearing Aid Compatibility Test (101x101x1):**

 Interpolated grid:  $dx=0.5000 \text{ mm}$ ,  $dy=0.5000 \text{ mm}$ 

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 11.73 V/m; Power Drift = 0.01 dB

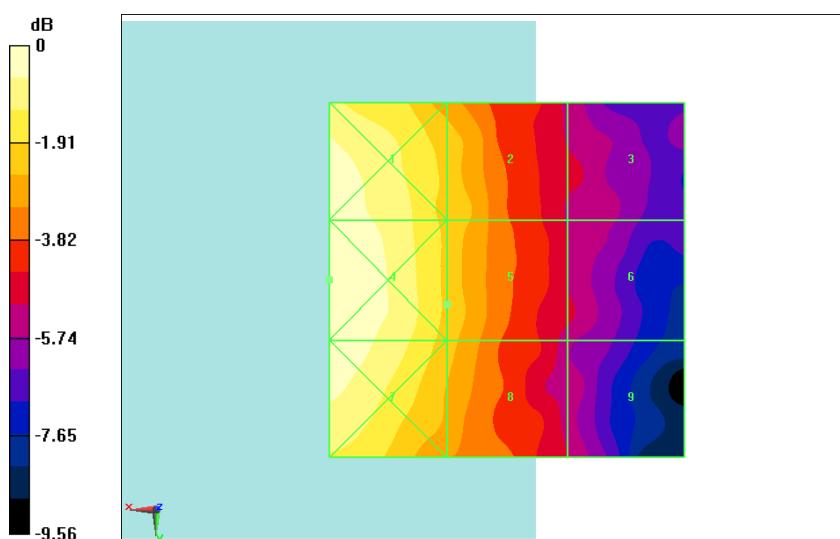
Applied MIF = 2.99 dB

RF audio interference level = 24.49 dBV/m

**Emission category: M4**

MIF scaled E-field

Grid 1 M4 26.46 dBV/m	Grid 2 M4 24.45 dBV/m	Grid 3 M4 21.72 dBV/m
Grid 4 M4 26.53 dBV/m	Grid 5 M4 24.49 dBV/m	Grid 6 M4 21.6 dBV/m
Grid 7 M4 26.33 dBV/m	Grid 8 M4 24.32 dBV/m	Grid 9 M4 21.53 dBV/m



0 dB = 21.21 V/m = 26.53 dBV/m

**Fig B.15 HAC RF E-Field CDMA BC10 Low**

## ANNEX C SYSTEM VALIDATION RESULT

### E SCAN of Dipole 835 MHz

Date: 2017-4-26

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$

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

Probe: ER3DV6 - SN2428; ConvF(1, 1, 1)

**E Scan - measurement distance from the probe sensor center to CD835 Dipole =**

**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 = 105.9 V/m; Power Drift = -0.02 dB

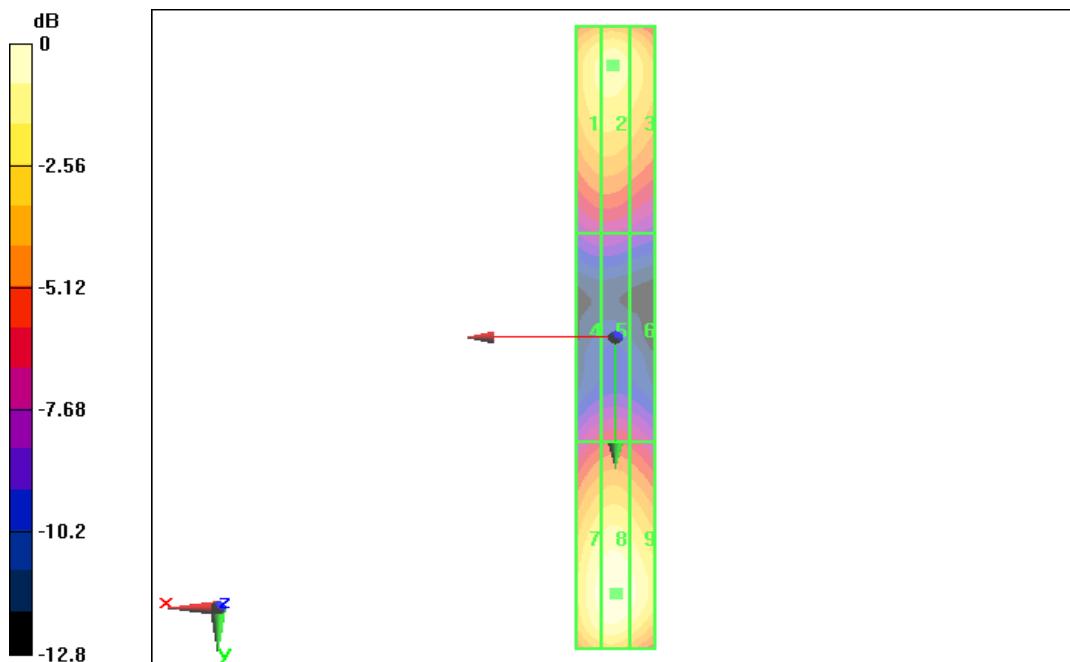
Applied MIF = 0.00 dB

RF audio interference level = 40.50 dBV/m

**Emission category: M3**

MIF scaled E-field

Grid 1 M3	Grid 2 M3	Grid 3 M3
<b>40.30 dBV/m</b>	<b>40.50 dBV/m</b>	<b>40.38 dBV/m</b>
Grid 4 M4	Grid 5 M4	Grid 6 M4
<b>35.49 dBV/m</b>	<b>35.80 dBV/m</b>	<b>35.79 dBV/m</b>
Grid 7 M3	Grid 8 M3	Grid 9 M3
<b>39.91 dBV/m</b>	<b>40.21 dBV/m</b>	<b>40.14 dBV/m</b>



0 dB = 40.50 dBV/m

**E SCAN of Dipole 1880 MHz**
**Date: 2017-4-26**

Electronics: DAE4 Sn777

Medium: Air

 Medium parameters used:  $\sigma = 0 \text{ mho/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

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

Probe: ER3DV6 - SN2428; ConvF(1, 1, 1)

**E Scan - measurement distance from the probe sensor center to CD1880 Dipole =**
**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 = 94.1 V/m; Power Drift = -0.06 dB

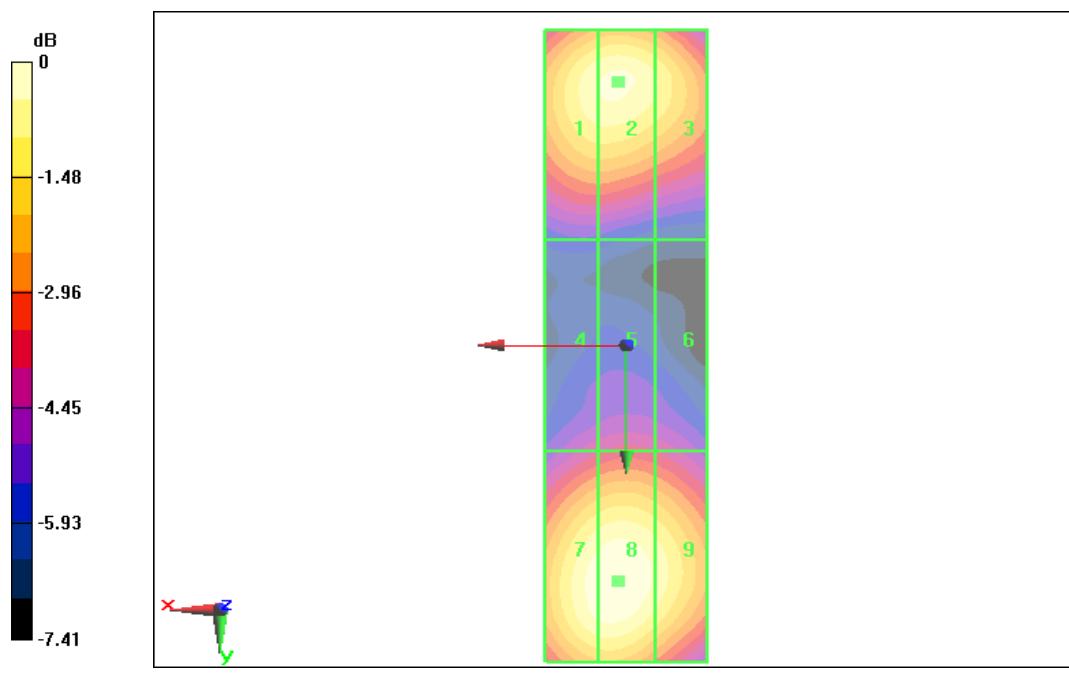
Applied MIF = 0.00 dB

RF audio interference level = 39.47 dBV/m

**Emission category: M2**

MIF scaled E-field

Grid 1M2	Grid 2M2	Grid 3M2
<b>39.24 dBV/m</b>	<b>39.47 dBV/m</b>	<b>39.34 dBV/m</b>
Grid 4M2	Grid 5M2	Grid 6M2
<b>36.91 dBV/m</b>	<b>37.09 dBV/m</b>	<b>37.02 dBV/m</b>
Grid 7M2	Grid 8M2	Grid 9M2
<b>39.27 dBV/m</b>	<b>39.41 dBV/m</b>	<b>39.31 dBV/m</b>



## ANNEX D PROBE CALIBRATION CERTIFICATE

### E\_Probe ER3DV6

**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  
**S** 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 0108**

Client **CTTL (Auden)**

Certificate No: **ER3-2428\_Jan17**

### CALIBRATION CERTIFICATE

Object **ER3DV6 - SN:2428**

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 19, 2017**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ER3DV6	SN: 2328	14-Oct-16 (No. ER3-2328_Oct16)	Oct-17
DAE4	SN: 789	11-Nov-16 (No. DAE4-789_Nov16)	Nov-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: January 21, 2017

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

**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  
**S** 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 0108**

**Glossary:**

NORM <sub>x,y,z</sub>	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 $\varphi$	$\varphi$ rotation around probe axis
Polarization $\theta$	$\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ 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
- CTIA Test Plan for Hearing Aid Compatibility, Rev 3.0, November 2013

**Methods Applied and Interpretation of Parameters:**

- $NORM_{x,y,z}$ : Assessed for E-field polarization  $\theta = 0$  for XY sensors and  $\theta = 90$  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.
- $PAR$ : PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- $A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}$ : 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  $NORM_x$  (no uncertainty required).



ER3DV6 – SN:2428

January 19, 2017

# Probe ER3DV6

**SN:2428**

Manufactured: September 11, 2007  
Calibrated: January 19, 2017

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

ER3DV6 – SN:2428

January 19, 2017

## DASY/EASY - Parameters of Probe: ER3DV6 - SN:2428

### Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ )	1.47	1.54	1.78	$\pm 10.1 \%$
DCP (mV) <sup>B</sup>	98.8	98.8	99.7	

### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	X	0.0	0.0	1.0	0.00	203.6	$\pm 3.5 \%$
		Y	0.0	0.0	1.0		189.7	
		Z	0.0	0.0	1.0		198.1	
10011-CAB	UMTS-FDD (WCDMA)	X	3.12	65.9	18.2	2.91	120.0	$\pm 0.5 \%$
		Y	3.12	65.8	18.2		114.3	
		Z	3.15	66.1	18.1		116.8	
10021-DAC	GSM-FDD (TDMA, GMSK)	X	21.68	99.3	28.7	9.39	133.5	$\pm 1.9 \%$
		Y	20.43	99.7	28.9		119.5	
		Z	25.63	99.4	28.4		143.4	
10039-CAB	CDMA2000 (1xRTT, RC1)	X	4.75	66.2	19.0	4.57	121.7	$\pm 0.9 \%$
		Y	4.78	66.5	19.1		115.3	
		Z	4.59	65.8	18.5		117.6	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.92	65.8	18.6	3.97	117.3	$\pm 0.7 \%$
		Y	3.78	64.9	18.1		112.1	
		Z	3.80	65.3	18.1		116.3	

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%.

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

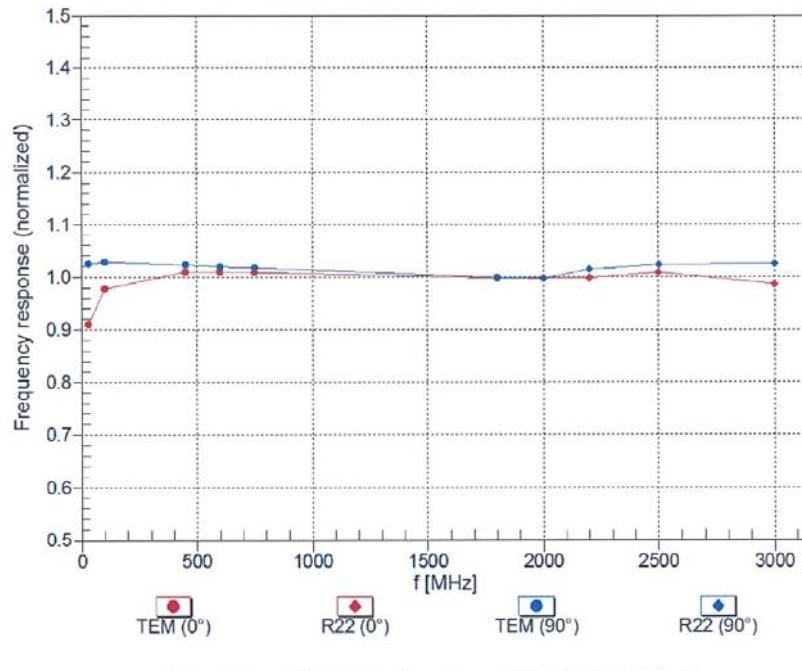
<sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ER3DV6 – SN:2428

January 19, 2017

### Frequency Response of E-Field

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

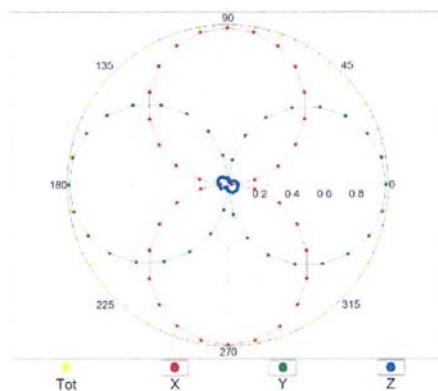
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

ER3DV6 – SN:2428

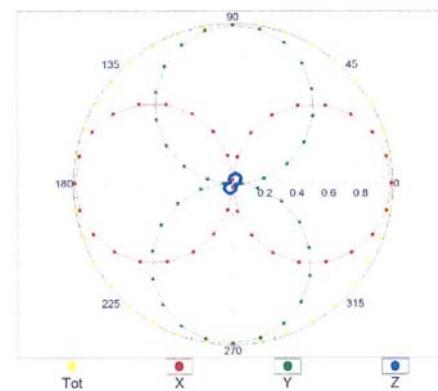
January 19, 2017

### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$

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

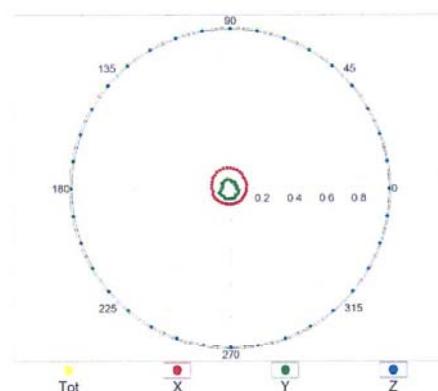


$f=2500 \text{ MHz, R22, } 0^\circ$

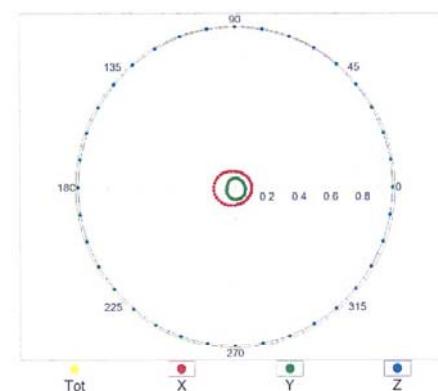


### Receiving Pattern ( $\phi$ ), $\theta = 90^\circ$

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

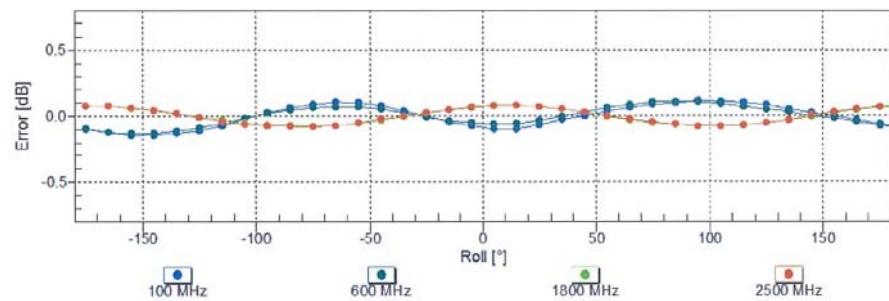
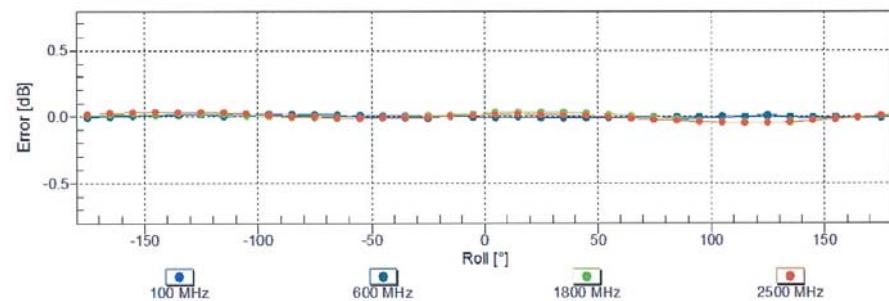


$f=2500 \text{ MHz, R22, } 90^\circ$



ER3DV6 – SN:2428

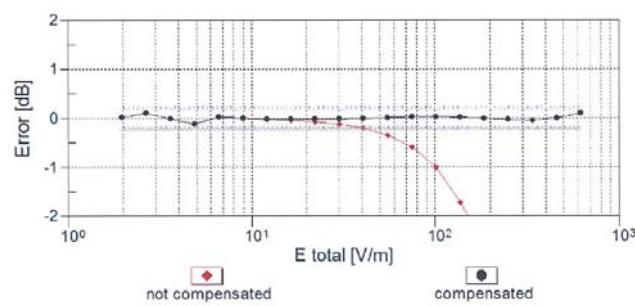
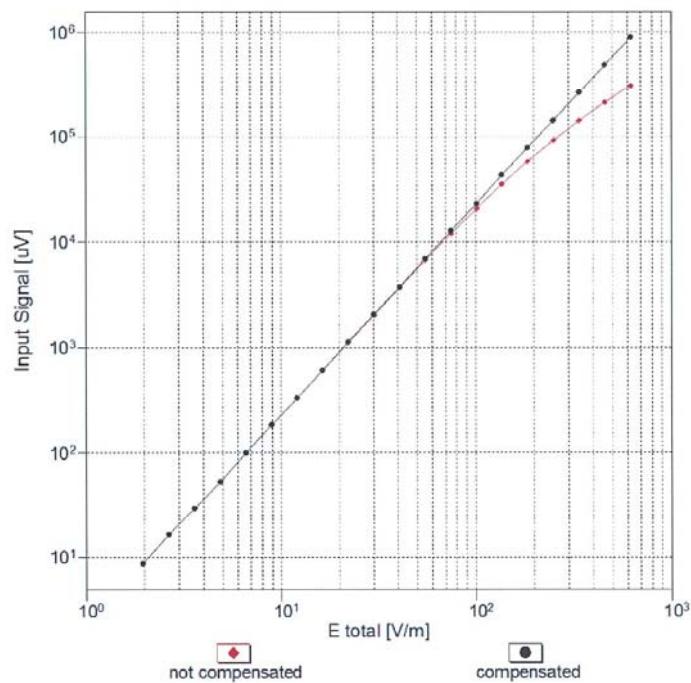
January 19, 2017

**Receiving Pattern ( $\phi$ ),  $\theta = 0^\circ$** Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )**Receiving Pattern ( $\phi$ ),  $\theta = 90^\circ$** Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

ER3DV6 – SN:2428

January 19, 2017

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



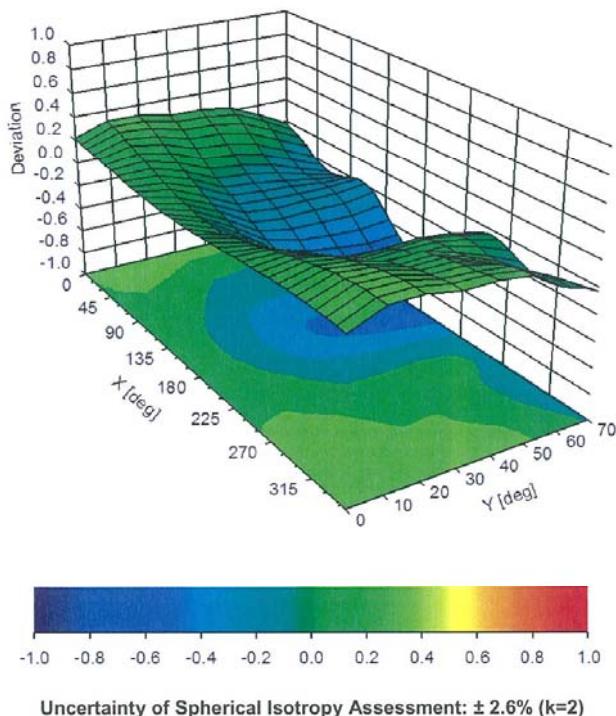
Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

ER3DV6 – SN:2428

January 19, 2017

### Deviation from Isotropy in Air

Error ( $\phi, \theta$ ),  $f = 900$  MHz





ER3DV6 – SN:2428

January 19, 2017

## DASY/EASY - Parameters of Probe: ER3DV6 - SN:2428

### Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	144.9
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

## ANNEX E DIPOLE CALIBRATION CERTIFICATE

Dipole 835 MHz

**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  
**S** 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 0108

Client **CTTL-BJ (Auden)**

Certificate No: **CD835V3-1023\_Aug16**

### CALIBRATION CERTIFICATE

Object CD835V3 - SN: 1023

Calibration procedure(s) QA CAL-20.v6  
Calibration procedure for dipoles in air

Calibration date: August 31, 2016

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Probe ER3DV6	SN: 2336	31-Dec-15 (No. ER3-2336_Dec15)	Dec-16
Probe H3DV6	SN: 6065	31-Dec-15 (No. H3-6065_Dec15)	Dec-16
DAE4	SN: 781	04-Sep-15 (No. DAE4-781_Sep15)	Sep-16

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Sep-14)	In house check: Oct-17
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Oct-17
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Oct-17
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-15)	In house check: Oct-17
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by:	Name	Function	Signature
	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 1, 2016

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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

#### References

- [1] ANSI-C63.19-2007  
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] 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 10 mm (15 mm for [2]) 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 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] and [2], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (15 mm for [2]) (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.
- *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.

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	V52.8.8
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10, 15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

### Maximum Field values at 835 MHz

H-field 10 mm above dipole surface	condition	interpolated maximum
Maximum measured	100 mW input power	0.450 A/m ± 8.2 % (k=2)
<b>E-field 10 mm above dipole surface</b>		
Maximum measured above high end	100 mW input power	166.0 V/m = 44.40 dBV/m
Maximum measured above low end	100 mW input power	159.9 V/m = 44.08 dBV/m
Averaged maximum above arm	100 mW input power	162.9 V/m ± 12.8 % (k=2)
E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	106.4 V/m = 40.54 dBV/m
Maximum measured above low end	100 mW input power	104.5 V/m = 40.38 dBV/m
Averaged maximum above arm	100 mW input power	105.5 V/m ± 12.8 % (k=2)

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters**

Frequency	Return Loss	Impedance
800 MHz	17.6 dB	$40.9 \Omega - 7.8 j\Omega$
835 MHz	24.6 dB	$53.4 \Omega + 5.0 j\Omega$
900 MHz	16.0 dB	$52.5 \Omega - 16.3 j\Omega$
950 MHz	21.8 dB	$49.2 \Omega + 8.0 j\Omega$
960 MHz	16.4 dB	$60.1 \Omega + 13.4 j\Omega$

**3.2 Antenna Design and Handling**

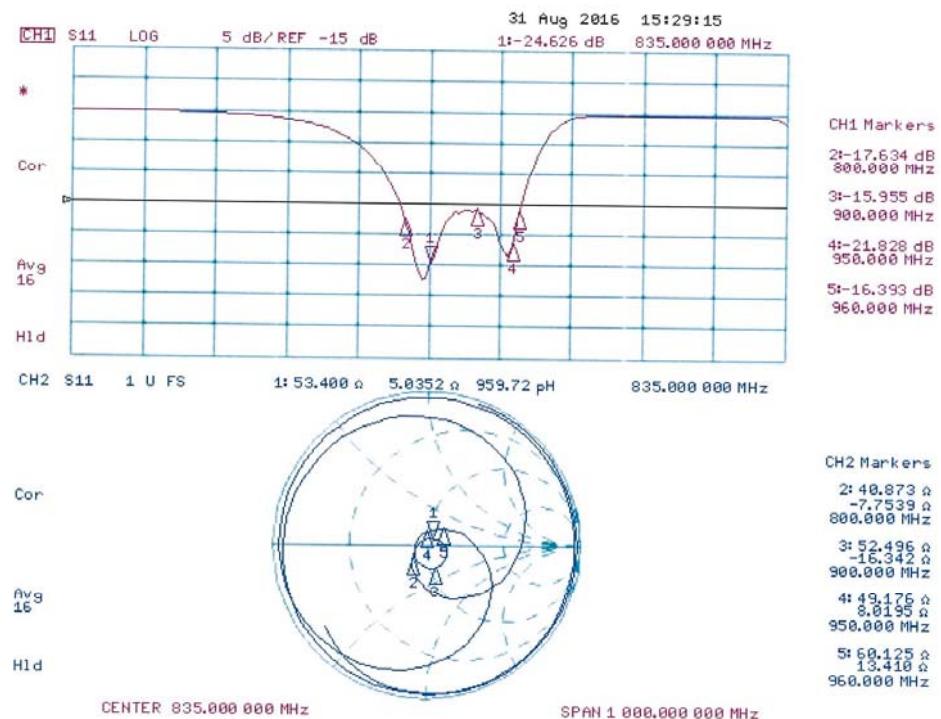
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

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 H-field Result

Date: 31.08.2016

Test Laboratory: SPEAG Lab2

**DUT:** HAC-Dipole 835 MHz; **Type:** CD835V3; **Serial:** CD835V3 - SN: 1023

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $\sigma = 0 \text{ S/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1 \text{ kg/m}^3$

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 31.12.2015
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

#### Dipole H-Field measurement @ 835MHz/H-Scan - 835MHz d=10mm/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 = 0.4780 A/m; Power Drift = -0.01 dB

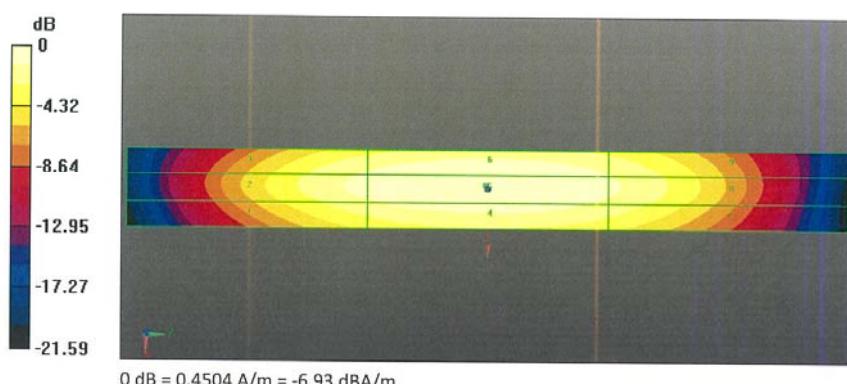
PMR not calibrated. PMF = 1.000 is applied.

H-field emissions = 0.4504 A/m

Near-field category: M4 (AWF 0 dB)

PMF scaled H-field

Grid 1 M4	Grid 2 M4	Grid 3 M4
0.370 A/m	0.405 A/m	0.391 A/m
Grid 4 M4	Grid 5 M4	Grid 6 M4
0.415 A/m	0.450 A/m	0.438 A/m
Grid 7 M4	Grid 8 M4	Grid 9 M4
0.364 A/m	0.395 A/m	0.384 A/m



**DASY5 E-field Result**

Date: 31.08.2016

Test Laboratory: SPEAG Lab2

**DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1023**

Communication System: UID 0 - CW ; Frequency: 835 MHz

Medium parameters used:  $\sigma = 0 \text{ S/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$ 

Phantom section: RF Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2015;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=10mm/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 = 108.1 V/m; Power Drift = -0.01 dB

Applied MIF = 0.00 dB

RF audio interference level = 44.40 dBV/m

Emission category: M3

MIF scaled E-field

Grid 1 M3 43.84 dBV/m	Grid 2 M3 44.08 dBV/m	Grid 3 M3 43.83 dBV/m
Grid 4 M4 38.57 dBV/m	Grid 5 M4 38.79 dBV/m	Grid 6 M4 38.51 dBV/m
Grid 7 M3 43.98 dBV/m	Grid 8 M3 44.4 dBV/m	Grid 9 M3 44.21 dBV/m

**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 = 108.0 V/m; Power Drift = -0.02 dB

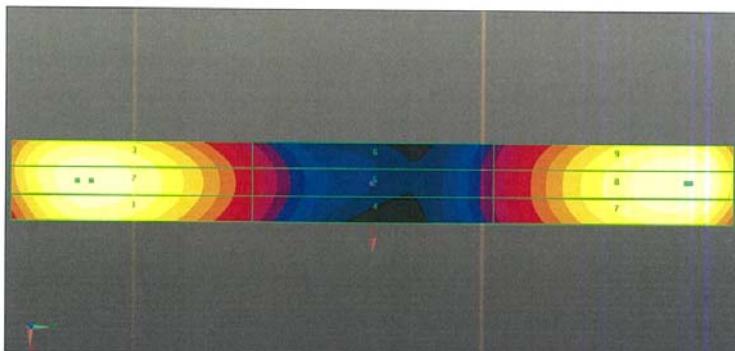
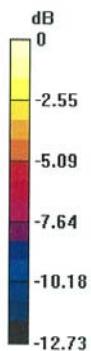
Applied MIF = 0.00 dB

RF audio interference level = 40.54 dBV/m

Emission category: M3

MIF scaled E-field

Grid 1 M3	Grid 2 M3	Grid 3 M3
40.24 dBV/m	40.38 dBV/m	40.23 dBV/m
Grid 4 M4	Grid 5 M4	Grid 6 M4
35.79 dBV/m	35.88 dBV/m	35.73 dBV/m
Grid 7 M3	Grid 8 M3	Grid 9 M3
40.35 dBV/m	40.54 dBV/m	40.4 dBV/m



0 dB = 166.0 V/m = 44.40 dBV/m

## Dipole 1880 MHz

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Accreditation No.: SCS 0108

Client **CTTL-BJ (Auden)**

Certificate No: **CD1880V3-1018\_Aug16**

## CALIBRATION CERTIFICATE

Object CD1880V3 - SN: 1018

Calibration procedure(s) QA CAL-20.v6  
Calibration procedure for dipoles in air

Calibration date: August 31, 2016

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	06-Apr-16 (No. 217-02289/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Probe ER3DV6	SN: 2336	31-Dec-15 (No. ER3-2336_Dec15)	Dec-16
Probe H3DV6	SN: 6065	31-Dec-15 (No. H3-6065_Dec15)	Dec-16
DAE4	SN: 781	04-Sep-15 (No. DAE4-781_Sep15)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Sep-14)	In house check: Oct-17
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Oct-17
Power sensor HP 4842A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Oct-17
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-15)	In house check: Oct-17
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

Calibrated by:	Name	Function	Signature
	Leif Klysner	Laboratory Technician	

Approved by:	Name	Function	Signature
	Katja Pokovic	Technical Manager	

Issued: September 1, 2016

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**SCS** Swiss Calibration Service

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#### References

- [1] ANSI-C63.19-2007 American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.
- [2] 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 10 mm (15 mm for [2]) 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 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] and [2], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (15 mm for [2]) (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-parallelism 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.
- *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.

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	V52.8.8
<b>Phantom</b>	HAC Test Arch	
<b>Distance Dipole Top - Probe Center</b>	10, 15 mm	
<b>Scan resolution</b>	dx, dy = 5 mm	
<b>Frequency</b>	1880 MHz ± 1 MHz	
<b>Input power drift</b>	< 0.05 dB	

### Maximum Field values at 1880 MHz

H-field 10 mm above dipole surface	condition	interpolated maximum
Maximum measured	100 mW input power	0.457 A/m ± 8.2 % (k=2)

E-field 10 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	142.3 V/m = 43.06 dBV/m
Maximum measured above low end	100 mW input power	137.7 V/m = 42.78 dBV/m
Averaged maximum above arm	100 mW input power	140.0 V/m ± 12.8 % (k=2)

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	92.8 V/m = 39.35 dBV/m
Maximum measured above low end	100 mW input power	87.5 V/m = 38.84 dBV/m
Averaged maximum above arm	100 mW input power	90.2 V/m ± 12.8 % (k=2)

**Appendix (Additional assessments outside the scope of SCS 0108)****Antenna Parameters**

Frequency	Return Loss	Impedance
1730 MHz	28.6 dB	$53.8 \Omega + 0.5 j\Omega$
1880 MHz	21.9 dB	$55.2 \Omega + 6.6 j\Omega$
1900 MHz	22.5 dB	$56.5 \Omega + 4.6 j\Omega$
1950 MHz	34.6 dB	$51.9 \Omega + 0.0 j\Omega$
2000 MHz	18.9 dB	$47.2 \Omega + 10.7 j\Omega$

**3.2 Antenna Design and Handling**

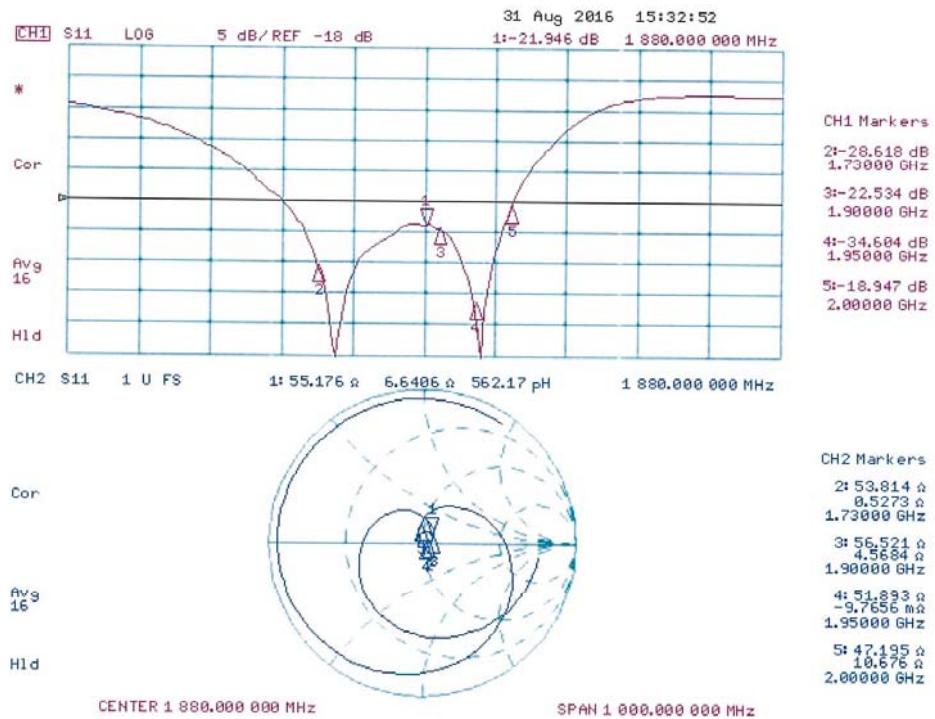
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

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 H-field Result

Date: 31.08.2016

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1018

Communication System: UID 0 - CW ; Frequency: 1880 MHz  
 Medium parameters used:  $\sigma = 0 \text{ S/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1 \text{ kg/m}^3$   
 Phantom section: RF Section  
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

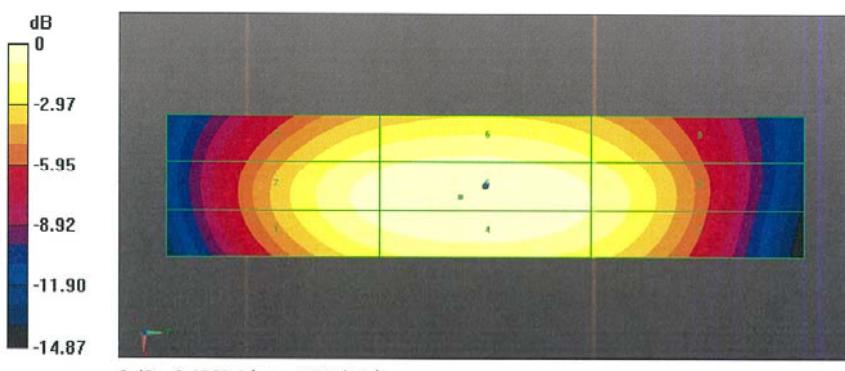
DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 31.12.2015
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**Dipole H-Field measurement @ 1880MHz/H-Scan - 1880MHz d=10mm/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 = 0.4760 A/m; Power Drift = 0.01 dB  
 PMR not calibrated. PMF = 1.000 is applied.  
 H-field emissions = 0.4569 A/m  
 Near-field category: M2 (AWF 0 dB)

PMF scaled H-field

Grid 1 M2 0.428 A/m	Grid 2 M2 0.433 A/m	Grid 3 M2 0.394 A/m
Grid 4 M2 0.451 A/m	Grid 5 M2 0.457 A/m	Grid 6 M2 0.419 A/m
Grid 7 M2 0.406 A/m	Grid 8 M2 0.410 A/m	Grid 9 M2 0.371 A/m



**DASY5 E-field Result**

Date: 31.08.2016

Test Laboratory: SPEAG Lab2

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1018**

Communication System: UID 0 - CW ; Frequency: 1880 MHz  
Medium parameters used:  $\sigma = 0 \text{ S/m}$ ,  $\epsilon_r = 1$ ;  $\rho = 1000 \text{ kg/m}^3$   
Phantom section: RF Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2015;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

**Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=10mm/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 = 154.2 V/m; Power Drift = -0.03 dB

Applied MIF = 0.00 dB

RF audio interference level = 43.06 dBV/m

Emission category: M1

MIF scaled E-field

Grid 1 M1 42.82 dBV/m	Grid 2 M1 43.06 dBV/m	Grid 3 M1 42.75 dBV/m
Grid 4 M2 38.9 dBV/m	Grid 5 M2 39.06 dBV/m	Grid 6 M2 38.62 dBV/m
Grid 7 M1 42.56 dBV/m	Grid 8 M1 42.78 dBV/m	Grid 9 M1 42.25 dBV/m

**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 = 153.7 V/m; Power Drift = 0.01 dB

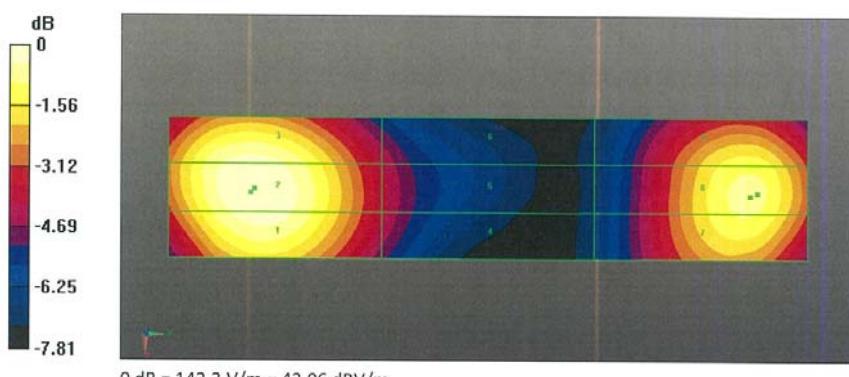
Applied MIF = 0.00 dB

RF audio interference level = 39.35 dBV/m

Emission category: M2

MIF scaled E-field

Grid 1 M2	Grid 2 M2	Grid 3 M2
39.24 dBV/m	39.35 dBV/m	39.19 dBV/m
Grid 4 M2	Grid 5 M2	Grid 6 M2
36.92 dBV/m	36.98 dBV/m	36.81 dBV/m
Grid 7 M2	Grid 8 M2	Grid 9 M2
38.75 dBV/m	38.84 dBV/m	38.62 dBV/m



**The photos of HAC test are presented in the additional document:**

Appendix to test report No.I17Z60505-SEM02/03

The photos of HAC test