

Hearing Aid Compatibility (HAC)

TEST REPORT

<For RF-Emission Measurement>

Applicant Name	HTC Corporation
Address of Applicant	No.23, Xinghua Rd., Taoyuan Dist., Taoyuan City 330, Taiwan (R.O.C)
EUT Name	Smartphone
Brand Name	HTC
Model No.	2PYR200 / 2PYR210
FCC ID	NM82PYR200
Date of receive	Dec. 01, 2016
Date of Test(s)	Dec. 23, 2016
Date of Issue	Dec. 28, 2016

Standards:

ANSI C63.19-2011

FCC RULE PART(S): 47 CFR PART 20.19(B)

HAC CATEGORY: M4 (M Category)

In the configuration tested, the EUT complied with the standards specified above.

Remarks:

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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Signed on behalf of SGS

Engineer

Matt Kuo

Date: Dec. 28, 2016

Supervisor

John Yeh

Date: Dec. 28, 2016

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Revision History

Report Number	Revision	Description	Issue Date
E5/2016/C0003	Rev.00	Initial creation of document	Dec. 28, 2016

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1. Introduction

The purpose of the Hearing Aid Compatibility is to enable measurements of the near electric fields generated by wireless communication devices in the region controlled for use by a hearing aid in accordance with ANSI-C63.19-2011

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

a) Radio frequency (RF) measurements of the near-field electric fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.

Hence, the following are measurements made for the WD:
RF E-Field emissions

The measurement plane is parallel to, and 1.5cm in front of, the reference plane.

Applications for certification of equipment operation under part 20, that a manufacturer is seeking to certify as hearing aid compatible, as set forth in §20.19 of that part, shall include a statement indicating compliance with the test requirements of §20.19 and indicating the appropriate U-rating for the equipment. The manufacturer of the equipment shall be responsible for maintaining the test results.

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2. Testing Laboratory

Company Name	SGS Taiwan Ltd. Electronics & Communication Laboratory
Company address	No.2, Keji 1st Rd., Guishan Township, Taoyuan County 333, Taiwan (R.O.C.)
Telephone	+886-2-2299-3279
Fax	+886-2-2298-0488
Website	http://www.tw.sgs.com/

3. Details of Applicant

Applicant Name	HTC Corporation
Applicant Address	No.23, Xinghua Rd., Taoyuan Dist., Taoyuan City 330, Taiwan (R.O.C)

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4. Description of EUT

EUT Name	Smartphone	
Brand Name	HTC	
Model No.	2PYR200 / 2PYR210	
FCC ID	NM82PYR200	
Mode of Operation	<input checked="" type="checkbox"/> GSM <input checked="" type="checkbox"/> GPRS <input checked="" type="checkbox"/> EDGE <input checked="" type="checkbox"/> WCDMA <input checked="" type="checkbox"/> HSDPA <input checked="" type="checkbox"/> HSUPA <input checked="" type="checkbox"/> LTE FDD <input checked="" type="checkbox"/> Bluetooth <input checked="" type="checkbox"/> WLAN 802.11 b/g/n(20M/40M)	
Duty Cycle	GSM	1/8.3
	GPRS (support multi class 10 max)	1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)
	EDGE (support multi class 10 max)	1/4.1 (1Dn2UP) 1/8.3 (1Dn1UP)
	WCDMA	1
	LTE FDD (Data only, not support VoLTE)	1
	WLAN 802.11 b/g/n(20M/40M)	1
	Bluetooth	1

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TX Frequency Range (MHz)	GSM850	824	—	849
	GSM1900	1850	—	1910
	WCDMA Band II	1850	—	1910
	WCDMA Band IV	1710	—	1755
	WCDMA Band V	824	—	849
	LTE FDD Band II	1850	—	1910
	LTE FDD Band IV	1710	—	1755
	LTE FDD Band V	824	—	849
	LTE FDD Band XII	699	—	716
	WLAN802.11 b/g/n(20M)	2412	—	2462
	WLAN802.11 n(40M)	2422	—	2452
Bluetooth	2402	—	2480	
Channel Number (ARFCN)	GSM850	128	—	251
	GSM1900	512	—	810
	WCDMA Band II	9262	—	9538
	WCDMA Band IV	1312	—	1513
	WCDMA Band V	4132	—	4233
	LTE FDD Band II	18607	—	19193
	LTE FDD Band IV	19957	—	20393
	LTE FDD Band V	20407	—	20643
	LTE FDD Band XII	23017	—	23173
	WLAN 802.11 b/g/n(20M)	1	—	11
	WLAN802.11 n(40M)	3	—	9
Bluetooth	0	—	78	

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5. Air Interfaces and Bands

Air-Interface	Band	Type Transport	C63.19 tested	Simultaneous Transmitter but not tested	Voice Over Digital Transport OTT capability	Power Reduction
GSM	850	VO	Yes	Yes, WiFi or Bluetooth	No	No
	1900				No	No
WCDMA	II	VO	Yes (Note 1)	Yes, WiFi or Bluetooth	No	No
	IV				No	No
	V				No	No
LTE	II	DT	No	Yes, WiFi or Bluetooth	Yes	No
	IV				Yes	No
	V				Yes	No
	XII				Yes	No
WiFi	2.4G/5G	DT	No	Yes, WWAN or BT	Yes	No
Bluetooth	2.4G	DT	No	Yes, WWAN or BT	No	No
VO= CMRS Voice Service DT= Digital Transport VD=CMRS IP Voice Service and Digital Transport				Note 1.It applies the low power exemption based on ANSI C63.19-2011		

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6. Test Environment

Ambient Temperature	21.7° C
Relative Humidity	<80 %

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7. Description of test system

7.1 Measurement system Diagram for SPEAG Robotic

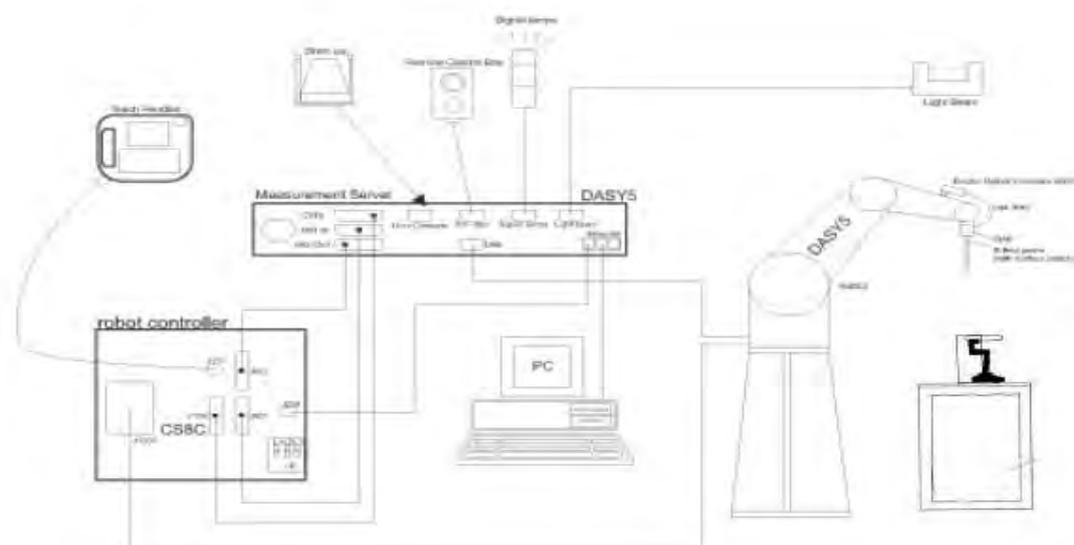


Fig.1 The SPEAG Robotic Diagram

The DASY5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Staubli RX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- E Field probe.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.

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- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The Test Arch phantom.
- The device holder for handheld mobile phones.
- Validation dipole kits allowing to validate the proper functioning of the system.

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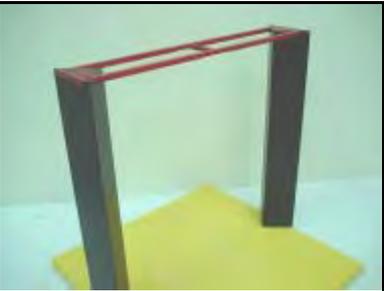
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7.2 E Field Probe

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material	 <p>ER3DV6 E-Field Probe</p>
Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, $k=2$)	
Frequency	(extended to 20 MHz for MRI), Linearity: ± 0.2 dB (100 MHz to 3 GHz)	
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)	
Dynamic Range	2 V/m to > 1000 V/m; Linearity: ± 0.2 dB	
Dimensions	Tip diameter: 8 mm Distance from probe tip to dipole centers: 2.5 mm	

7.3 Test Arch

Description	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.	 <p>Test Arch</p>
Dimensions	length: 370 mm width: 370 mm height: 370 mm	

7.4 Phone Holder

Description	Supports accurate and reliable positioning of any phone Effect on near field $< \pm 0.5$ dB	 <p>Phone Holder</p>
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8. Test Procedure

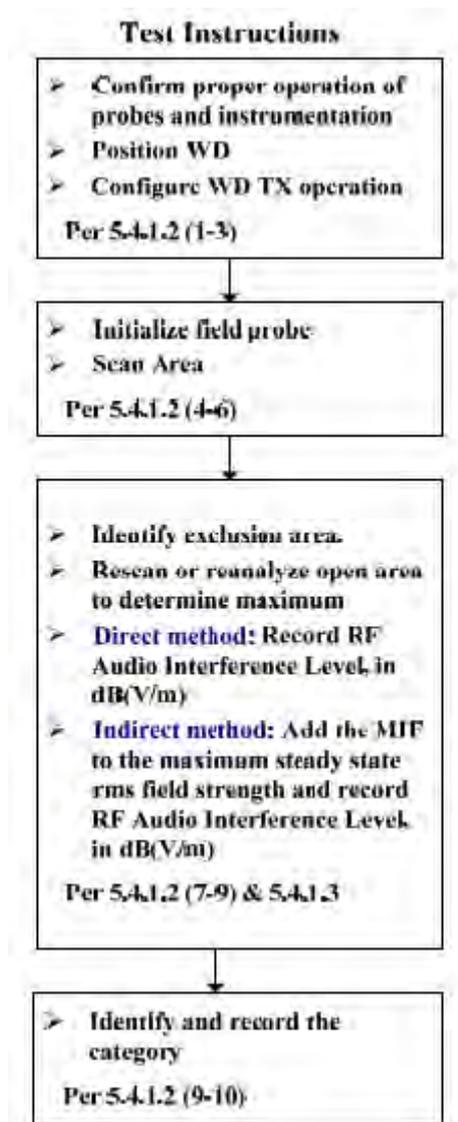


Fig.2 RF emission flow chart

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The following illustrate a typical RF emissions test scan over a wireless communications device (Indirect method):

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

Note.

Per KDB 285076 D01 v04r01 2.d) 1), handsets that that have the ability to support concurrent connections using simultaneous transmissions shall be independently tested for each air interface/band given in ANSI C63.19-2011. At the present time ANSI C63.19 does not provide simultaneous transmission test procedures.

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9. System Verification

A dipole antenna meeting the requirements given in ANSI C63.19-2011 was placed in the position normally occupied by the WD.

The length of the dipole was scanned by E-field probes and the maximum values for each were recorded.

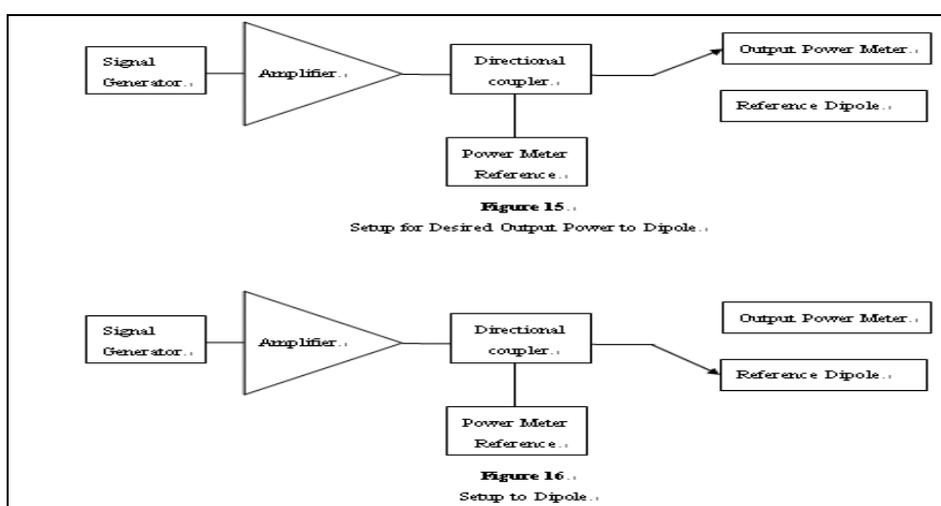


Fig.3 System verification

For E-Field Scan

Mode	Frequency (MHz)	Input Power(dBm)	E-Field 1 (V/m)	E-Field 2(V/m)	Target Value(V/m)	Deviation	Measured Date
CW	835	20	115.8	108.5	108.5	3.36%	Dec.23, 2016
CW	1880	20	94.66	92.08	87.8	6.34%	Dec.23, 2016

Note:

For E-Field, the deviation is $[(E\text{-Field } 1 + E\text{-Field } 2) / 2 - \text{Target value}] / \text{Target value} \times 100\%$

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10. Modulation Interference Factor

For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be developed that relates its interference potential to its steady-state rms signal level or average power level. This factor is a function only of the audio-frequency amplitude modulation characteristics of the signal and is the same for field-strength and conducted power measurements. It is important to emphasize that the MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic. Any change in modulation characteristic requires determination and application of a new MIF

The MIF may be determined using a radiated RF field or a conducted RF signal,

- b) Using RF illumination or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range.
- c) Measure the steady-state rms level at the output of the fast probe or sensor.
- d) Measure the steady-state average level at the weighting output.
- e) Without changing the square-law detector or weighting system, and using RF illumination or conducted coupling, substitute for the specific modulated signal a 1 kHz, 80% amplitude modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the step d) measurement.
- f) Without changing the carrier level from step e), remove the 1 kHz modulation and again measure the steady-state rms level indicated at the output of the fast probe or sensor.
- g) The MIF for the specific modulation characteristic is provided by the ratio of the step f) measurement to the step c) measurement, expressed in dB ($20 \times \log(\text{step f})/\text{step c}$).

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Based on the KDB285076 D01, the handset can also use the MIF values predetermined by the test equipment manufacturer, and the following table lists the MIF values evaluated by DASY manufacturer (SPEAG), and the test result will be calculated with the MIF parameter automatically.

SPEAG UID	UID version	Communication system	MIF(dB)
10021	DAB (10.14.2015)	GSM-FDD (TDMA, GMSK)	3.63
10011	CAB (10.14.2015)	UMTS-FDD (WCDMA)	-27.23

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11. Measured conducted output power

Band	Channel	Average power(dBm)
GSM 850 (GMSK)	128	32.27
	190	32.38
	251	32.42
GSM 1900 (GMSK)	512	29.43
	661	29.72
	810	29.65
WCDMA Band II	9262	23.87
	9400	23.79
	9538	23.83
WCDMA Band IV	1312	23.86
	1412	23.88
	1513	23.84
WCDMA Band V	4132	23.37
	4183	23.44
	4133	23.31

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12. Justification of held to ear modes tested

I. Analysis of RF air interface technologies

a. OTT data services are outside the current definition of a managed CMRS service and are currently not required to be evaluated.

b. Based on ANSI. C63.19-2011. An RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤ 17 dBm for any of its operating modes. If a device supports multiple RF air interfaces, each RF air interface shall be evaluated individually.

The MIF plus the worst case average power for all modes are investigated below to determine the testing requirements for this device.

II. Low power exemption

Air interference	Maximum power(dB)	MIF(dB)	Power + MIF (dB)	ANSI C63.19 2011 test required
GSM850	32.42	3.63	36.05	Yes
GSM1900	29.72	3.63	33.35	Yes
WCDMA B2	23.87	-27.23	-3.36	No
WCDMA B4	23.88	-27.23	-3.35	No
WCDMA B5	23.44	-27.23	-3.79	No

We used the predetermined MIF to evaluate the low power exemption.

Based on ANSI. C63.19 2011, RF emission testing for WCDMA is exempted.

Based on ANSI. C63.19 2011, WCDMA that is exempted from testing shall be rated as M4.

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13. ANSI C63.19-2011 performance and categories

The measurements were performed to ensure compliance to the ANSI C63.19-2011 standard,

Category	E-Field Emissions dB(V/m) < 960MHz
M1	50-55
M2	45-50
M3	40-45
M4	<40

Category	E-Field Emissions dB(V/m) > 960MHz
M1	40-45
M2	35-40
M3	30-35
M4	<30

WD RF audio interference level categories in logarithmic units

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14. Instruments List

Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
Schmid & Partner Engineering AG	E-Field Probe	ER3DV6	2306	Nov.23,2016	Nov.22,2017
Schmid & Partner Engineering AG	System Validation Dipole	CD835V3	1052	Mar.17,2016	Mar.16,2017
		CD1880V3	1044	Mar.17,2016	Mar.16,2017
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	1374	Aug.23,2016	Aug.22,2017
Schmid & Partner Engineering AG	Software	DASY52 52.8.8	N/A	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	778D	MY48220468	Jul.06,2016	Jul.05,2017
Agilent	RF Signal Generator	N5181A	MY50145142	Feb.19,2016	Feb.18,2017
R&S	Radio Communication Test	CMU200	113505	Aug.19,2016	Aug.18,2017
Schmid & Partner Engineering AG	Test Arch SD HAC	P01	1047	Calibration not required	Calibration not required
Agilent	Power Meter	E4417A	MY51410006	Jan.07,2016	Jan.06,2017
Agilent	Power Sensor	E9301H	MY51470001	Jan.07,2016	Jan.06,2017
Agilent	Power Sensor	E9301H	MY52200004	Jan.07,2016	Jan.06,2017

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15. Summary of Results

E-Field

E-Field Emission	Channel	Modulation Interference Factor	Conducted Power (dBm)	Power Drift(dB)	Audio Interference Level dB(V/m)	RESULT	Excl Blocks per 4.3.1.2.2
GSM 850	128	3.63	32.27	0.02	34.88	M4	789
	190	3.63	32.38	0.00	34.90	M4	789
	251	3.63	32.42	0.00	34.44	M4	789
E-Field Emission	Channel	Modulation Interference Factor	Conducted Power (dBm)	Power Drift(dB)	Audio Interference Level dB(V/m)	RESULT	Excl Blocks per 4.3.1.2.2
GSM 1900	512	3.63	29.43	0.04	24.59	M4	123
	661	3.63	29.72	-0.06	23.88	M4	123
	810	3.63	29.65	-0.12	23.35	M4	123

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16. Measurement Data

Date: 2016/12/23

HAC-E_GSM 850_CH 128

Communication System: GSM Frequency: 824.2 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 44.72 V/m; Power Drift = 0.02 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.88 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 33.49 dBV/m	Grid 2 M4 33.79 dBV/m	Grid 3 M4 33.13 dBV/m
Grid 4 M4 34.37 dBV/m	Grid 5 M4 34.88 dBV/m	Grid 6 M4 34.51 dBV/m
Grid 7 M4 35.17 dBV/m	Grid 8 M4 35.64 dBV/m	Grid 9 M4 35.1 dBV/m

Cursor:

Total = 35.64 dBV/m

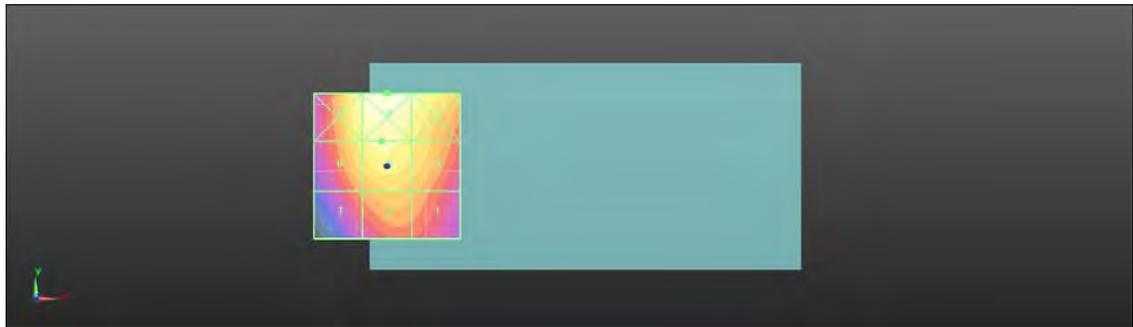
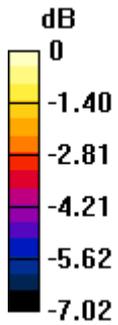
E Category: M4

Location: 0, 25, 8.7 mm

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0 dB = 60.52 V/m = 35.64 dBV/m

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Date: 2016/12/23

HAC-E_GSM 850_CH 190

Communication System: GSM Frequency: 836.6 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 44.88 V/m; Power Drift = 0.00 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.90 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 33.53 dBV/m	Grid 2 M4 33.9 dBV/m	Grid 3 M4 33.36 dBV/m
Grid 4 M4 34.33 dBV/m	Grid 5 M4 34.9 dBV/m	Grid 6 M4 34.57 dBV/m
Grid 7 M4 35.02 dBV/m	Grid 8 M4 35.56 dBV/m	Grid 9 M4 35.05 dBV/m

Cursor:

Total = 35.56 dBV/m

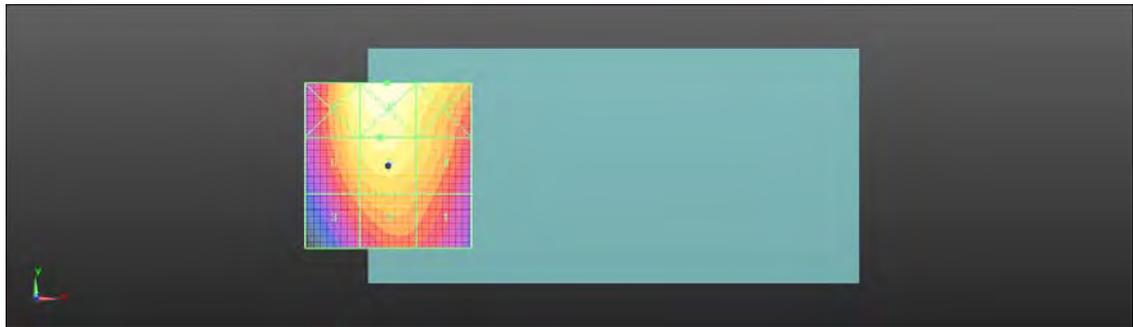
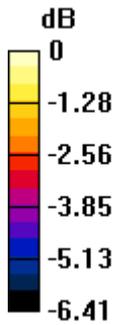
E Category: M4

Location: -0.5, 25, 8.7 mm

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0 dB = 59.95 V/m = 35.56 dBV/m

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Date: 2016/12/23

HAC-E_GSM 850_CH 251

Communication System: GSM Frequency: 848.6 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 42.33 V/m; Power Drift = 0.00 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.44 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 33.02 dBV/m	Grid 2 M4 33.46 dBV/m	Grid 3 M4 33.02 dBV/m
Grid 4 M4 33.79 dBV/m	Grid 5 M4 34.44 dBV/m	Grid 6 M4 34.13 dBV/m
Grid 7 M4 34.51 dBV/m	Grid 8 M4 35.1 dBV/m	Grid 9 M4 34.63 dBV/m

Cursor:

Total = 35.10 dBV/m

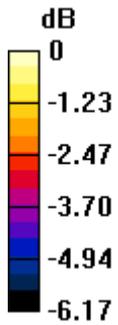
E Category: M4

Location: -1, 25, 8.7 mm

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0 dB = 56.88 V/m = 35.10 dBV/m

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Date: 2016/12/23

HAC-E_GSM 1900_CH 512

Communication System: GSM Frequency: 1850.2 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 8.460 V/m; Power Drift = 0.04 dB

Applied MIF = 3.63 dB

RF audio interference level = 24.59 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 25.64 dBV/m	Grid 2 M4 25.91 dBV/m	Grid 3 M4 25.16 dBV/m
Grid 4 M4 21.88 dBV/m	Grid 5 M4 23.16 dBV/m	Grid 6 M4 22.42 dBV/m
Grid 7 M4 22.69 dBV/m	Grid 8 M4 24.59 dBV/m	Grid 9 M4 23.99 dBV/m

Cursor:

Total = 25.91 dBV/m

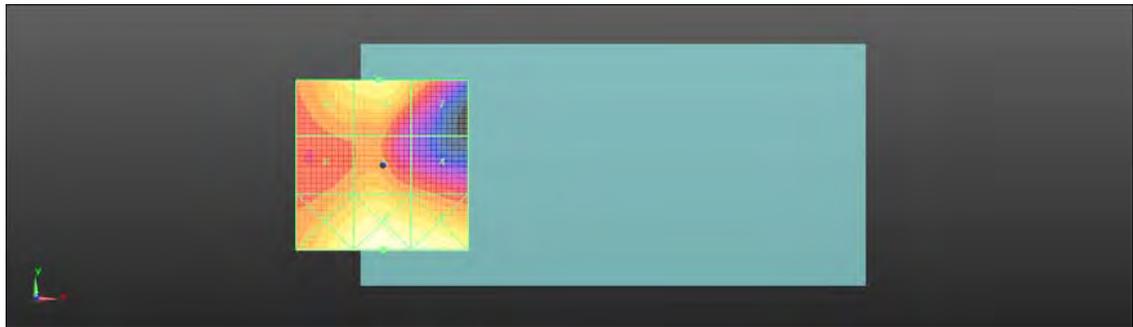
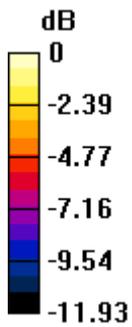
E Category: M4

Location: 0.5, -25, 8.7 mm

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

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Date: 2016/12/23

HAC-E_GSM 1900_CH 661

Communication System: GSM Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 7.935 V/m; Power Drift = -0.06 dB

Applied MIF = 3.63 dB

RF audio interference level = 23.88 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 25.68 dBV/m	Grid 2 M4 25.84 dBV/m	Grid 3 M4 25.23 dBV/m
Grid 4 M4 21.69 dBV/m	Grid 5 M4 22.41 dBV/m	Grid 6 M4 22.17 dBV/m
Grid 7 M4 22.32 dBV/m	Grid 8 M4 23.88 dBV/m	Grid 9 M4 23.62 dBV/m

Cursor:

Total = 25.84 dBV/m

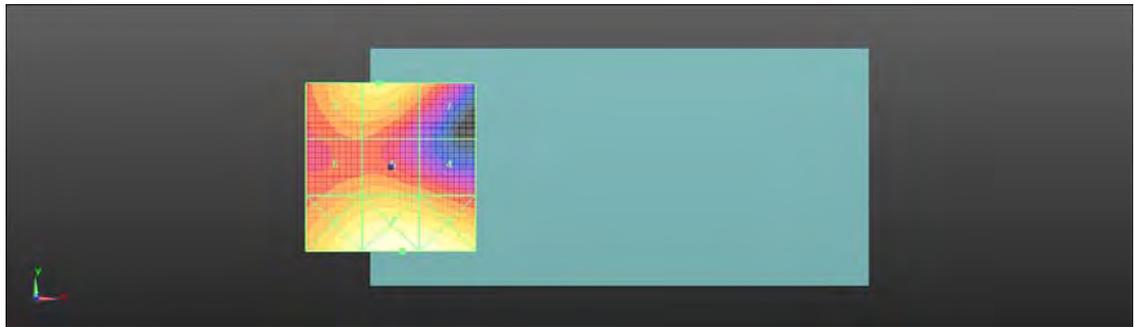
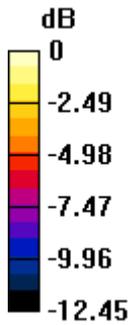
E Category: M4

Location: 3.5, -25, 8.7 mm

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0 dB = 19.58 V/m = 25.84 dBV/m

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Date: 2016/12/23

HAC-E_GSM 1900_CH 810

Communication System: GSM Frequency: 1909.8 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Device E-Field measurement E Scan: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 8.631 V/m; Power Drift = -0.12 dB

Applied MIF = 3.63 dB

RF audio interference level = 23.35 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 M4 24.93 dBV/m	Grid 2 M4 25.63 dBV/m	Grid 3 M4 25.48 dBV/m
Grid 4 M4 21.42 dBV/m	Grid 5 M4 23.11 dBV/m	Grid 6 M4 23.05 dBV/m
Grid 7 M4 21.14 dBV/m	Grid 8 M4 23.35 dBV/m	Grid 9 M4 23.26 dBV/m

Cursor:

Total = 25.63 dBV/m

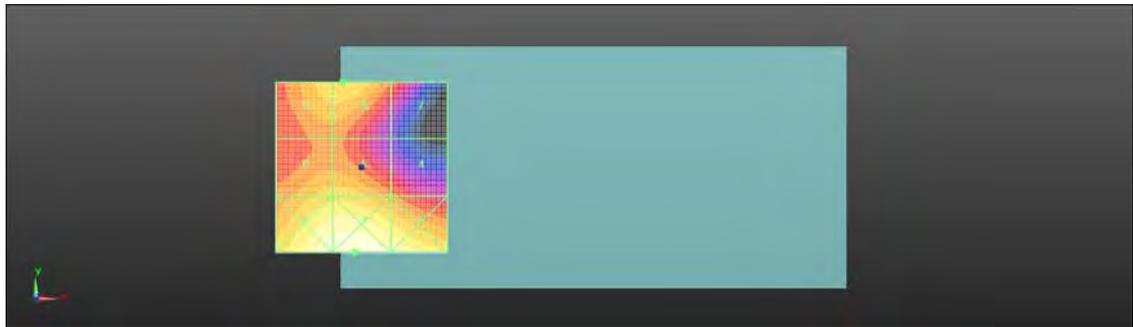
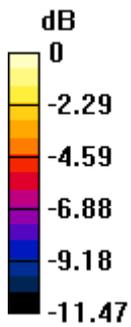
E Category: M4

Location: -2, -25, 8.7 mm

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0 dB = 19.13 V/m = 25.63 dBV/m

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17. System Verification

Date: 2016/12/23

Dipole CD835_SN:1052

Communication System: CW; Frequency: 835 MHz

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

Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Dipole E-Field measurement: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 112.5 V/m; Power Drift = -0.03 dB

E-field emissions = 108.5 V/m

Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 M4 107.3 V/m	Grid 2 M4 108.5 V/m	Grid 3 M4 105.4 V/m
Grid 4 M4 65.16 V/m	Grid 5 M4 65.30 V/m	Grid 6 M4 63.11 V/m
Grid 7 M4 115.7 V/m	Grid 8 M4 115.8 V/m	Grid 9 M4 109.0 V/m

Cursor:

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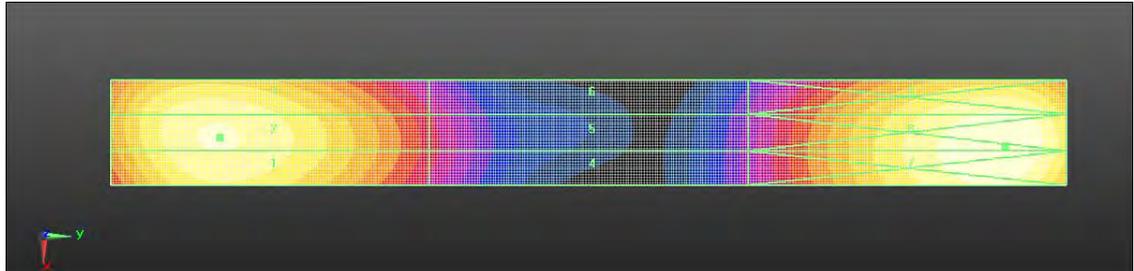
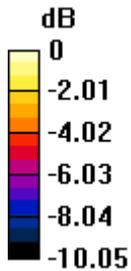
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Total = 115.8 V/m

E Category: M4

Location: 2.5, 78.5, 9.7 mm



0 dB = 115.8 V/m = 41.27 dBV/m

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Date: 2016/12/23

Dipole CD1880_SN:1044

Communication System: CW; Frequency: 1880 MHz

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

Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2016/11/23;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1374; Calibrated: 2016/8/23
- Phantom: HAC Test Arch
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7373)

Dipole E-Field measurement: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 164.8 V/m; Power Drift = 0.01 dB

E-field emissions = 92.08 V/m

Near-field category: M3 (AWF 0 dB)

PMF scaled E-field

Grid 1 M3 93.33 V/m	Grid 2 M3 94.66 V/m	Grid 3 M3 93.06 V/m
Grid 4 M3 72.54 V/m	Grid 5 M3 72.99 V/m	Grid 6 M3 71.72 V/m
Grid 7 M3 90.82 V/m	Grid 8 M3 92.08 V/m	Grid 9 M3 90.31 V/m

Cursor:

Total = 94.66 V/m

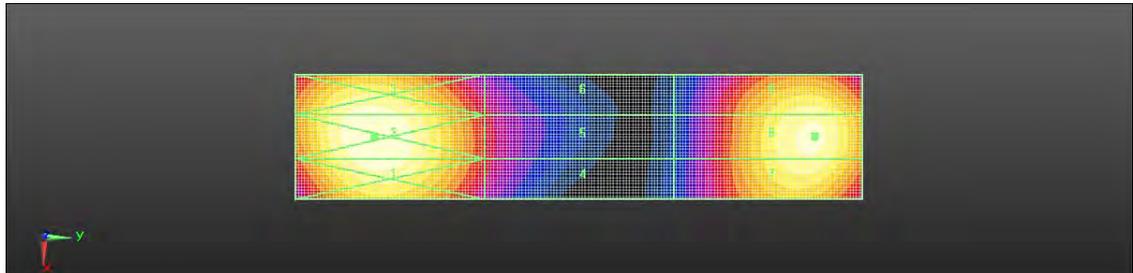
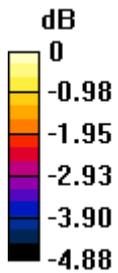
E Category: M3

Location: 0, -32.5, 9.7 mm

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0 dB = 94.66 V/m = 39.52 dBV/m

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18. DAE & Probe Calibration Certificate

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



S Schweizerischer Kalibrierdienst
S Service suisse d'étalonnage
S Servizio svizzero di tarature
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 SGS-TW (Auden)

Certificate No: DAE4-1374_Aug16

CALIBRATION CERTIFICATE			
Object	DAE4 - SD-000 D04-BM - SN: 1374		
Calibration procedure(s)	QA-CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)		
Calibration date	August 23, 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 ± 3)°C and humidity < 70%.			
Calibration Equipment used (M&PE critical for calibration)			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Kentley Multimeter Type 2001	SN: 0810278	04-Sep-15 (No.17153)	Sep-16
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UNYS 003 AA 1001	05-Jan-16 (in house check)	In house check: Jan-17
Calibrator Box V2.1	SE UMS 005 AA 1002	05-Jan-16 (in house check)	In house check: Jan-17
Calibrated by:	Name Dominique Stoffen	Function Technician	Signature
Approved by:	Name Fr. Böhler	Function Deputy Technical Manager	Signature
			Issued: August 23, 2016
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: DAE4-1374_Aug16

Page 1 of 5

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**Calibration Laboratory of
Schmid & Partner
Engineering AG**
Zeughausstrasse 43, 8604 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
S Service suisse d'étalonnage
C 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

DAE data acquisition electronics
Connector angle information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- **DC Voltage Measurement:** Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range
- **Connector angle:** The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
 - **DC Voltage Measurement Linearity:** Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
 - **Common mode sensitivity:** Influence of a positive or negative common mode voltage on the differential measurement.
 - **Channel separation:** Influence of a voltage on the neighbor channels not subject to an input voltage.
 - **AD Converter Values with Inputs shorted:** Values on the internal AD converter corresponding to zero input voltage
 - **Input Offset Measurement:** Output voltage and statistical results over a large number of zero voltage measurements.
 - **Input Offset Current:** Typical value for information; Maximum channel input offset current, not considering the input resistance.
 - **Input resistance:** Typical value for information; DAE input resistance at the connector, during internal auto-zeroing and during measurement.
 - **Low Battery Alarm Voltage:** Typical value for information. Below this voltage, a battery alarm signal is generated.
 - **Power consumption:** Typical value for information. Supply currents in various operating modes.

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DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1µV, full range = -100...+300 mV
Low Range: 1LSB = 61nV, full range = -1...+3mV

DASY measurement parameters: Auto Zero Time: 3 sec. Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.637 ± 0.02% (k=2)	403.886 ± 0.02% (k=2)	404.160 ± 0.02% (k=2)
Low Range	3.98275 ± 1.50% (k=2)	3.96719 ± 1.50% (k=2)	3.98036 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY-system	42.5° ± 1°
---	------------

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Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	200039.11	0.18	0.00
Channel X + Input	20005.23	0.57	0.00
Channel X - Input	-20004.46	1.52	-0.01
Channel Y + Input	200041.10	3.98	0.00
Channel Y + Input	-20002.96	-1.76	-0.01
Channel Y - Input	-20007.46	-1.33	0.01
Channel Z + Input	200039.71	2.56	0.00
Channel Z + Input	20002.57	-2.04	-0.01
Channel Z - Input	-20008.39	-2.20	0.01

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2001.14	0.37	0.02
Channel X + Input	200.90	0.07	0.03
Channel X - Input	-198.75	0.41	-0.20
Channel Y + Input	2000.82	0.06	0.00
Channel Y + Input	200.17	-0.51	-0.25
Channel Y - Input	-199.47	-0.29	0.15
Channel Z + Input	2000.50	-0.29	-0.01
Channel Z + Input	199.36	-1.24	-0.62
Channel Z - Input	-200.79	-1.45	0.73

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec.

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	6.08	3.93
	-200	-2.69	-4.73
Channel Y	200	7.56	7.12
	200	-8.69	-8.88
Channel Z	200	5.83	5.98
	-200	-8.94	-9.16

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec.

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-2.29	-1.91
Channel Y	200	4.65	-	-1.13
Channel Z	-200	10.99	2.02	-

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4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec;

	High Range (LSB)	Low Range (LSB)
Channel X	15938	14709
Channel Y	16155	14846
Channel Z	16005	15566

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec;

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	1.17	0.20	1.90	0.33
Channel Y	0.61	-0.17	1.24	0.30
Channel Z	-1.30	-2.42	-0.33	0.37

6. Input Offset Current

Nominal input circuitry offset current on all channels: <251A

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	-0.01	-6	-6

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**Calibration Laboratory of
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Engineering AG**
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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client: **SGS-TW (Auden)**

Certificate No: **ER3-2306_Nov16**

CALIBRATION CERTIFICATE

Object: **ER3DV6 - SN 2306**

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: **November 23, 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 ± 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. 217-0228802288)	Apr-17
Power sensor NRP-ZB1	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-ZB1	SN: 103246	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-16
Power sensor E4412A	SN: MY41493087	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
Power sensor E4412A	SN: 005110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-16
RF generator HP 8648C	SN: US3642U01700	04-Aug-08 (in house check Jun-16)	In house check: Jun-16
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

Calibrated by: **Michael Weber** (Name), **Laboratory Technician** (Function), *M. Weber* (Signature)

Approved by: **Kajsa Pokovic** (Name), **Technical Manager** (Function), *K. Pokovic* (Signature)

Issued: **November 23, 2016**

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Glossary:

NORM_{x,y,z}	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/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 (a 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:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2008
- b) 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; RZ2 waveguide).
- **NORM(θ)_{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).

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ER3DV6 - SN:2306

November 23, 2016

Probe ER3DV6

SN:2306

Manufactured: December 17, 2002
Calibrated: November 23, 2016

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

Certificate No: ER3-2306_Nov16

Page 3 of 10

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ER3DV6 - SN:2306

NOVEMBER 23, 2016

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2306

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)	1.05	1.08	1.19	$\pm 10.1\%$
DCP (mV) ²	102.1	101.9	104.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB/ μV	C	D dB	VR mV	Unc ¹ (k=2)
0	CW	X	0.0	0.0	1.0	0.00	163.2	$\pm 3.3\%$
		Y	0.0	0.0	1.0		166.4	
		Z	0.0	0.0	1.0		156.4	
10010- CAA	SAR Validation (Square, 100ms, 10ms)	X	0.33	50.6	4.6	10.00	36.4	$\pm 2.7\%$
		Y	0.34	49.4	4.6		37.8	
		Z	0.42	50.7	4.4		36.0	
10021- DAC	GSM-FDD (TDMA, GMSK)	X	2.39	60.1	15.0	9.39	131.5	$\pm 2.5\%$
		Y	3.16	76.0	18.5		139.0	
		Z	2.56	69.6	15.1		130.6	
10295- AAB	CDMA2000, RC1, 3Q3, 1.80M Rate 25 ft	X	5.49	70.6	26.6	12.49	80.6	$\pm 1.4\%$
		Y	5.73	72.3	26.6		87.7	
		Z	6.01	72.1	27.0		84.7	

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%.

¹ Numerical (measurement parameter) uncertainty not required.

² Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the test value.

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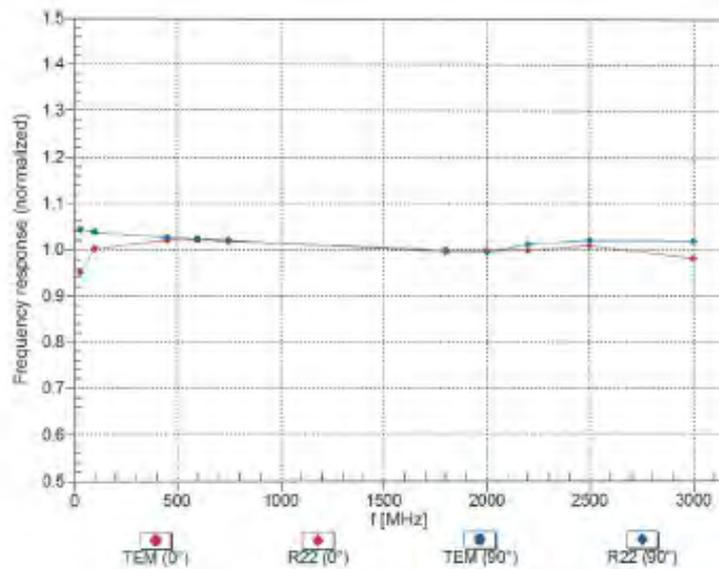
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ER3DV6 - SN:2306

November 23, 2016

Frequency Response of E-Field (TEM-Cell: If110 EXX, Waveguide: R22)



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

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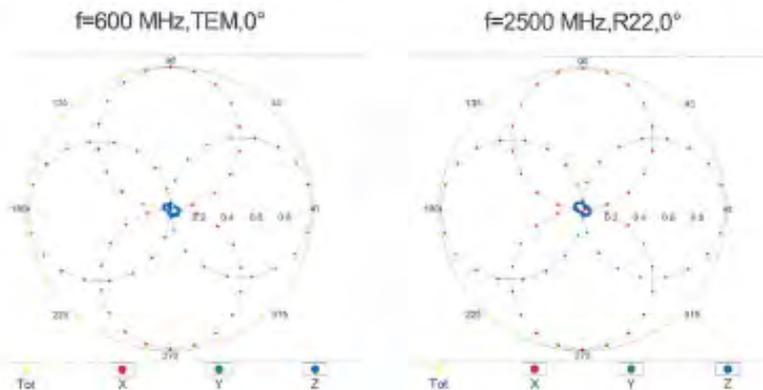
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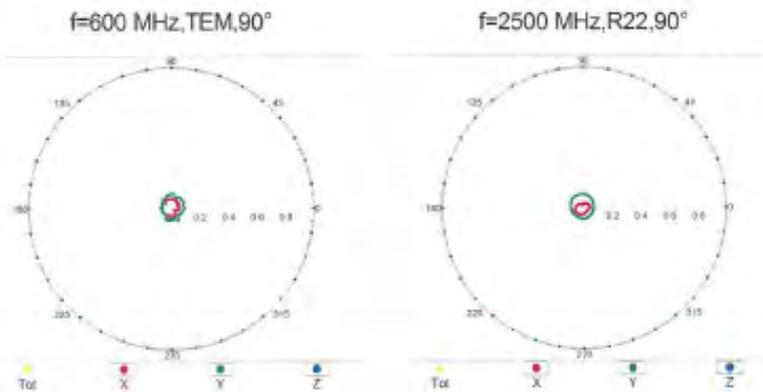
ER3DV6 - SN:2306

November 23, 2016

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



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



Certificate No: ER3-2306_Nov16

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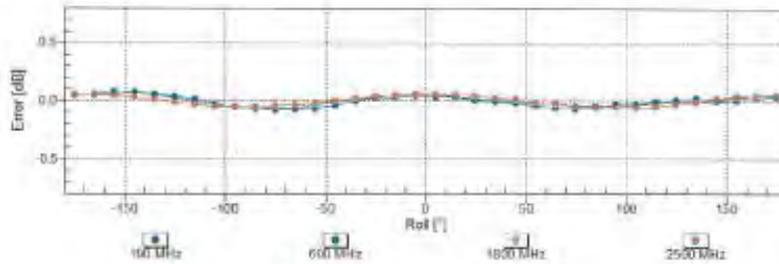
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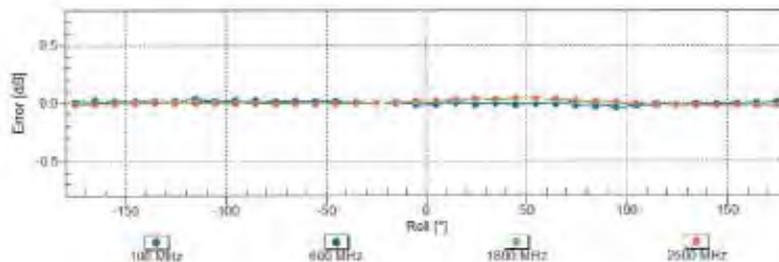
November 23, 2016

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



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

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



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

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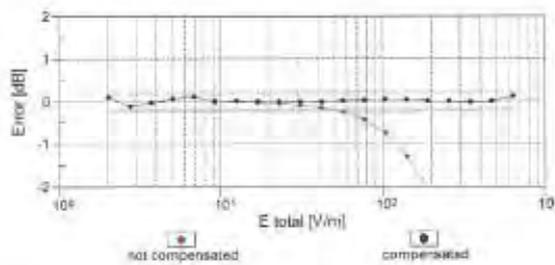
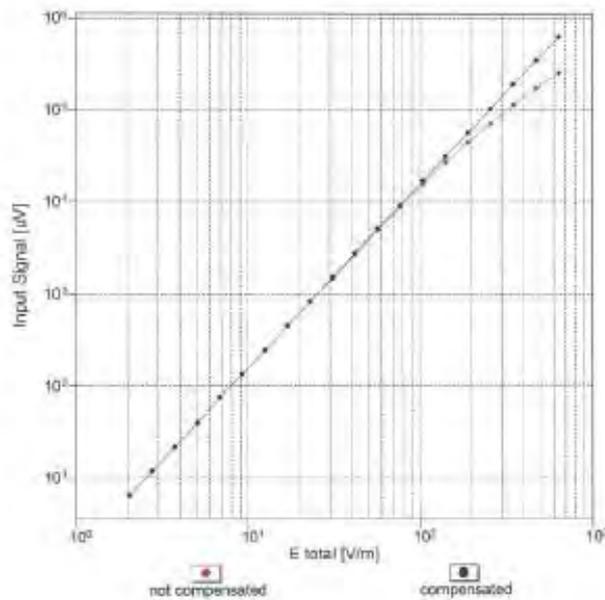
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ER3DV6 – SN-2306

November 23, 2016

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



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

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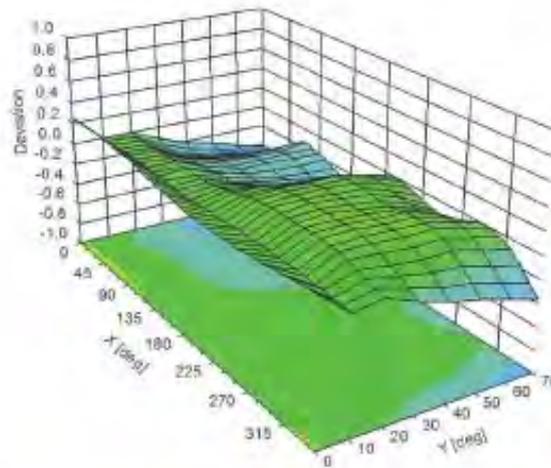
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ER3DV5 - SN 2306

November 23, 2016

Deviation from Isotropy in Air

Error (ϕ , θ), $f = 900$ MHz



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

Certificate No: ER3-2306_Nov16

Page 9 of 10

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ER3DV6 - SN:2306

November 23, 2016

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2306

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	134.7
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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19. Uncertainty Budget

HAC Uncertainty Budget According to ANSI C63.19 [1], [2]							
Error Description	Uncert. value	Prob. Dist.	Div.	(c _i) E	(c _i) H	Std. Unc. E	Std. Unc. H
Measurement System							
Probe Calibration	±5.1 %	N	1	1	1	±5.1 %	±5.1 %
Axial Isotropy	±4.7 %	R	√3	1	1	±2.7 %	±2.7 %
Sensor Displacement	±16.5 %	R	√3	1	0.145	±9.5 %	±1.4 %
Boundary Effects	±2.4 %	R	√3	1	1	±1.4 %	±1.4 %
Phantom Boundary Effect	±7.2 %	R	√3	1	0	±4.1 %	±0.0 %
Linearity	±4.7 %	R	√3	1	1	±2.7 %	±2.7 %
Scaling with PMR calibration	±10.0 %	R	√3	1	1	±5.8 %	±5.8 %
System Detection Limit	±1.0 %	R	√3	1	1	±0.6 %	±0.6 %
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %
Response Time	±0.8 %	R	√3	1	1	±0.5 %	±0.5 %
Integration Time	±2.6 %	R	√3	1	1	±1.5 %	±1.5 %
RF Ambient Conditions	±3.0 %	R	√3	1	1	±1.7 %	±1.7 %
RF Reflections	±12.0 %	R	√3	1	1	±6.9 %	±6.9 %
Probe Positioner	±1.2 %	R	√3	1	0.67	±0.7 %	±0.5 %
Probe Positioning	±4.7 %	R	√3	1	0.67	±2.7 %	±1.8 %
Extrap. and Interpolation	±1.0 %	R	√3	1	1	±0.6 %	±0.6 %
Test Sample Related							
Device Positioning Vertical	±4.7 %	R	√3	1	0.67	±2.7 %	±1.8 %
Device Positioning Lateral	±1.0 %	R	√3	1	1	±0.6 %	±0.6 %
Device Holder and Phantom	±2.4 %	R	√3	1	1	±1.4 %	±1.4 %
Power Drift	±5.0 %	R	√3	1	1	±2.9 %	±2.9 %
Phantom and Setup Related							
Phantom Thickness	±2.4 %	R	√3	1	0.67	±1.4 %	±0.9 %
Combined Std. Uncertainty						±16.3 %	±12.3 %
Expanded Std. Uncertainty on Power						±32.6 %	±24.6 %
Expanded Std. Uncertainty on Field						±16.3 %	±12.3 %

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20. System Validation from Original Equipment Supplier

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



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

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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 **SGS-TW (Auden)**

Certificate No: **CD835V3-1052_Mar16**

CALIBRATION CERTIFICATE			
Object	CD835V3 - SN: 1052		
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air		
Calibration date:	March 17, 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 ± 3)°C and humidity < 70%.			
Calibration Equipment used (M&PE critical for calibration)			
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 10 dB Attenuator	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02130)	Mar-16
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: Sep-16
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Sep-16
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16
RF generator R&S SMT-06	SN: 832283011	27-Aug-12 (in house check Oct-15)	In house check: Oct-16
Calibrated by:	Name: Jelton Kastrati	Function: Laboratory Technician	Signature:
Approved by:	Name: Kalja Pokovic	Function: Technical Manager	Signature:
			Issued: March 21, 2016
This calibration certificate shall not be reproduced except in full without written approval of this laboratory.			

Certificate No: CD835V3-1052_Mar16

Page 1 of 5

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Accreditation No.: **SCS 0108**

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 eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 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%.

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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	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz \pm 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	110.2 V/m = 40.85 dBV/m
Maximum measured above low end	100 mW input power	106.8 V/m = 40.57 dBV/m
Averaged maximum above arm	100 mW input power	108.5 V/m \pm 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	15.9 dB	43.2 Ω - 13.5 j Ω
835 MHz	26.6 dB	49.6 Ω + 4.6 j Ω
900 MHz	16.4 dB	57.2 Ω - 14.7 j Ω
950 MHz	20.4 dB	45.6 Ω + 8.1 j Ω
960 MHz	15.6 dB	52.2 Ω + 17.0 j Ω

3.2 Antenna Design and Handling

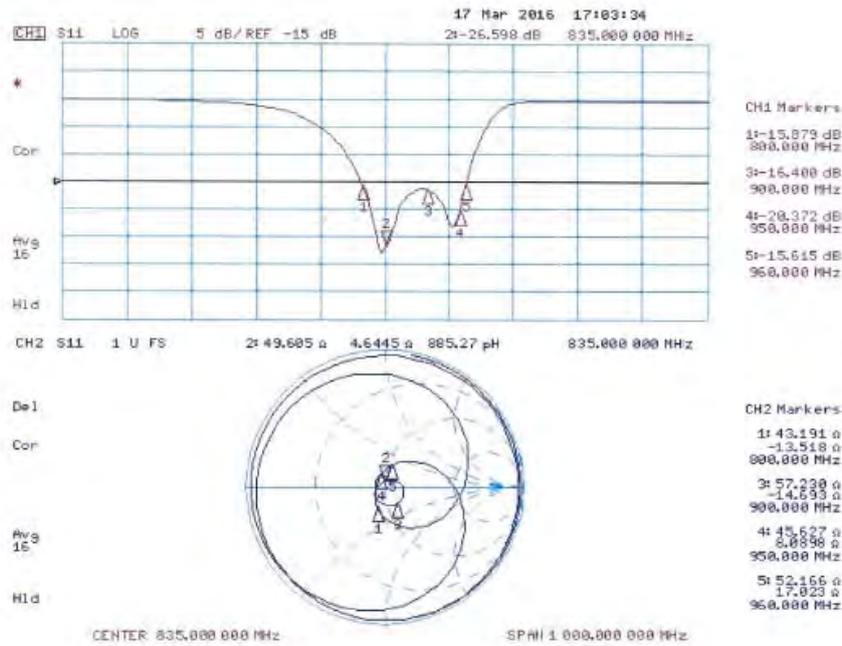
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

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



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DASY5 E-field Result

Date: 17.03.2016

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1052

Communication System: UID 0 - CW ; Frequency: 835 MHz
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 1000$ kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

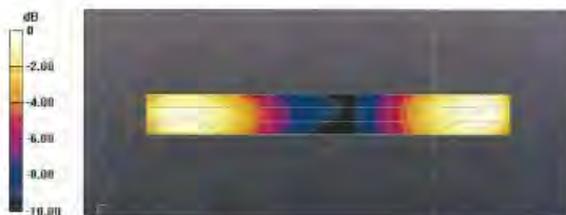
- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2015;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=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 = 113.4 V/m; Power Drift = -0.04 dB
Applied MIF = 0.00 dB
RF audio interference level = 40.85 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1 M3	Grid 2 M3	Grid 3 M3
40.5 dBV/m	40.57 dBV/m	40.35 dBV/m
Grid 4 M4	Grid 5 M4	Grid 6 M4
35.73 dBV/m	35.8 dBV/m	35.6 dBV/m
Grid 7 M3	Grid 8 M3	Grid 9 M3
40.58 dBV/m	40.85 dBV/m	40.78 dBV/m



0 dB = 110.2 V/m = 40.84 dBV/m

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Accreditation No.: **SCS 0108**

Client **SGS-TW (Auden)**

Certificate No: **CD1880V3-1044_Mar16**

CALIBRATION CERTIFICATE			
Object	CD1880V3 - SN: 1044		
Calibration procedure(s)	QA CAL-20.v6 Calibration procedure for dipoles in air		
Calibration date:	March 17, 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 ± 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	GBS7480704	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	US37292783	07-Oct-15 (No. 217-02222)	Oct-16
Power sensor HP 8481A	MY41092317	07-Oct-15 (No. 217-02223)	Oct-16
Reference 10 dB Attenuator	SN: 5047.2 / 06327	01-Apr-15 (No. 217-02130)	Mar-16
Probe ER3DV6	SN: 2336	31-Dec-15 (No. ER3-2336_Dec15)	Dec-16
Probe HSDV6	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-05 (in house check Sep-14)	In house check: Sep-16
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Sep-14)	In house check: Sep-16
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Sep-14)	In house check: Sep-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16
RF generator R&S SMT-05	SN: 832283/011	27-Aug-12 (in house check Oct-15)	In house check: Oct-16
Calibrated by:	Name Jeton Kastrioti	Function Laboratory Technician	Signature
Approved by:	Name Kajsa Pokovic	Function Technical Manager	Signature
			Issued: March 21, 2016
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

Certificate No: CD1880V3-1044_Mar16

Page 1 of 5

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Accreditation No.: SCS 0108

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 eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 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%.

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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	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1880 MHz \pm 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	89.3 V/m = 39.01 dBV/m
Maximum measured above low end	100 mW input power	86.3 V/m = 38.72 dBV/m
Averaged maximum above arm	100 mW input power	87.8 V/m \pm 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	23.7 dB	49.0 Ω + 6.4 j Ω
1880 MHz	20.2 dB	51.0 Ω + 9.8 j Ω
1900 MHz	20.3 dB	54.2 Ω + 9.1 j Ω
1950 MHz	28.1 dB	54.1 Ω + 0.5 j Ω
2000 MHz	21.4 dB	42.3 Ω + 1.6 j Ω

3.2 Antenna Design and Handling

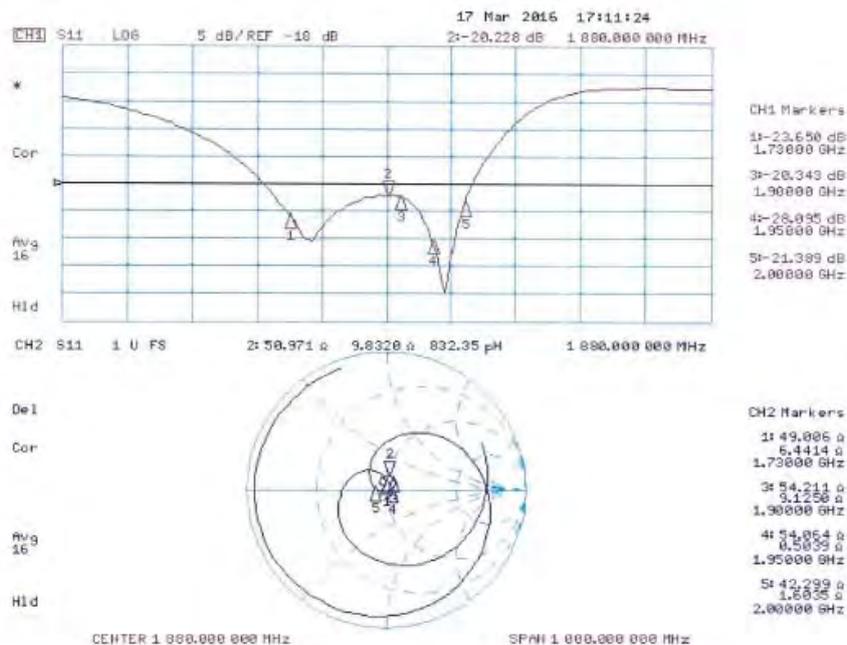
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

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



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DASY5 E-field Result

Date: 17.03.2016

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1044

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:

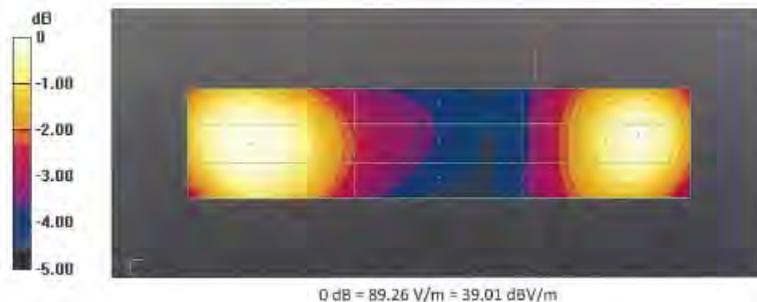
- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 31.12.2015;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 04.09.2015
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=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 = 147.6 V/m; Power Drift = 0.00 dB
Applied MIF = 0.00 dB
RF audio interference level = 39.01 dBV/m
Emission category: M2

MIF scaled E-field

Grid 1 M2 38.89 dBV/m	Grid 2 M2 39.01 dBV/m	Grid 3 M2 38.88 dBV/m
Grid 4 M2 36.59 dBV/m	Grid 5 M2 36.66 dBV/m	Grid 6 M2 36.53 dBV/m
Grid 7 M2 38.52 dBV/m	Grid 8 M2 38.72 dBV/m	Grid 9 M2 38.65 dBV/m



End of 1st part of report

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