HAC TEST REPORT

Test Report No. : 10636726H-L-R1

Applicant	:	**Panasonic Mobile Communications Development of Europe Ltd**
Type of Equipment	:	**Digital Camera**
Model No.	:	**DMC-CM1**
FCC ID	:	**UCE314062A**
Test regulation	:	**FCC47 CFR 20.19** **ANSI C63.19 : 2011**
Test Result	:	**Complied**
HAC T Category	:	**M4**

1. This test report shall not be reproduced in full or partial, without the written approval of UL Japan, Inc.
2. The results in this report apply only to the sample tested.
3. This sample tested is in compliance with the limits of the above regulation.
4. The test results in this report are traceable to the national or international standards.
5. This test report covers HAC technical requirements. It does not cover administrative issues such as Manual or non-HAC test related Requirements. (if applicable)
6. This report is a revised version of 10636726H-L. 10636726H-L is replaced with this report.

Date of test: February 8, 2015

Representative test engineer:

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REVISION HISTORY

Original Test Report No.: 10636726H-L

Revision	Test report No.	Date	Page revised	Contents
- (Original)	10636726H-L	February 20, 2015	-	-
1	10636726H-L-R1	March 5, 2015	P.4	Correction of rating

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1. Photograph of test setup 58

SECTION 1: Customer information

Company Name	:	Panasonic Mobile Communications Development of Europe Ltd
Address	:	Willoughby Road, Bracknell Berkshire RG12 8FP, UK
Telephone Number	:	+44 (0) 1344 706774
Facsimile Number	:	+44 (0) 1344 706796
Contact Person	:	Andrew James

SECTION 2: Equipment under test (E.U.T.)

2.1 Identification of E.U.T.

Type of Equipment	:	Digital Camera
Model No.	:	DMC-CM1
Serial No.	:	004401221416395
Rating	:	AC120V/60Hz (AC Adaptor) DC3.8V (Battery)
Option Battery	:	None
Body-worn Accessary	:	Typical Earphone
Receipt Date of Sample	:	January 7, 2015
Country of Mass-production	:	China
Condition of EUT	:	Production prototype (Not for Sale: This sample is equivalent to mass-produced items.)
Modification of EUT	:	No Modification by the test lab

2.2 Product description

General Specification

Power Supply (radio part input) :
Cellular PA: 3.0V-4.2V (Depend on Battery voltage)
Cellular other RF part: 1.3V, 1.8V, 2.05V, 2.7V (Regulated voltage)
WLAN 5GHz Front-end module: 3.0V-4.2V (Depend on Battery voltage)
WLAN/BT other RF part: 1.3V, 1.8V, 3.0V (Regulated voltage)

Clock frequency(ies) in the system : 2.26GHz (Max)
See below table for other clock frequencies

Frequency	Device
32.768kHz	MSM8974AB
32.768kHz (X'tal)	BUYD2206
27.0MHz	TC358764AXBG, XO2-256-64UCBGA, BUYD2206
48.0MHz (X'tal)	WCN3680
24.0MHz	MSM8974AB, Sub Camera
19.2MHz	WTR1625L, MSM8974AB
19.2MHz (X'tal)	PM8941
9.6MHz	WCD9320
72MHz	Main Camera
27.12MHz	NFC IC

Hardware / Software version : Rev. PR / QRCT Version 3.0.32.0

Radio Specification

	IEEE802.11b	**IEEE802.11g/n (20 M band)**	**IEEE802.11a/n/ac (20 M band)**	**IEEE802.11n/ac (40 M band)**	**IEEE802.11ac (80 M band)**
Frequency of operation	2412-2462MHz	2412-2462MHz	5180-5240MHz 5260-5320MHz 5500-5700MHz 5745-5825MHz	5190-5230MHz 5270-5310MHz 5510-5670MHz 5755-5795MHz	5210MHz 5290MHz 5530-5610MHz 5775MHz
Type of modulation	DSSS (CCK, DQPSK, DBPSK)	OFDM-CCK (64QAM, 16QAM, QPSK, BPSK)	OFDM (64QAM, 16QAM, QPSK, BPSK)		OFDM (64QAM, 16QAM, QPSK, BPSK, 256QAM)
Channel spacing	5MHz		20MHz	40MHz	80MHz
Antenna type	Monopole				
Antenna Connector type	Spring type				
Antenna Gain	2.4GHz: -5.40dBi W52: -3.0dBi, W53: -3.5dBi, W56: -1.5dBi, W58: -1.8dBi				

	Bluetooth Ver.4.0 with EDR function	**GSM**	**W-CDMA**	**LTE**
Frequency of operation	2402-2480MHz	[Up Link] GSM850: 824 – 849MHz PCS: 1850 – 1910MHz [Down Link] GSM850: 869 – 894MHz PCS: 1930 – 1990MHz	[Up Link] Band II: 1850 – 1910MHz Band IV: 1710 – 1755MHz Band V: 824 – 849MHz [Down Link] Band II: 1930 – 1990MHz Band IV: 2110 – 2155MHz Band V: 869 – 894MHz	[Up Link] Band II: 1850 – 1910MHz Band IV: 1710 – 1755MHz Band V: 824 – 849MHz Band VII: 2500 – 2570MHz Band X VII: 704 – 716MHz [Down Link] Band II: 1930 – 1990MHz Band IV: 2110 – 2155MHz Band V: 869 – 894MHz Band VII: 2620 – 2690MHz Band X VII: 734 – 746MHz
Type of modulation	BT: FHSS (GFSK, π/4-DQPSK, 8-DPSK) LE: GFSK	GMSK , 8PSK	QPSK	QPSK, 16QAM
Channel spacing	BT: 1MHz, LE: 2MHz	200kHz	200kHz	100kHz
Antenna type	Monopole	Monopole	Main: Monopole Sub: Monopole	
Antenna Connector type	Spring type	Spring type	Main: Spring type Sub: Spring type	
Antenna Gain	-5.40dBi	GSM850: -0.9dBi PCS: 0.5dBi	Band II: 0.5dBi Band IV: 0.6dBi Band V: -0.9dBi	Band II: 0.5dBi Band IV: 0.6dBi Band V: -0.9dBi Band VII: -0.2dBi Band X VII: -1.5dBi

	NFC	**GPS/GLONASS**
Frequency of operation	13.56MHz	GPS: 1575.42MHz GLONASS: 1597.55-1605.89MHz
Type of modulation	ASK	GPS: BPSK GLONASS: BPSK
Channel spacing	-	GLONASS: 0.5625MHz
Antenna type	Loop	Monopole
Antenna Connector type	Spring type	Spring type
Antenna Gain	N/A	-2.9dBi

SECTION 3 : Test standard information

3.1 Requirements for compliance testing

The requirements for compliance is used as reference specific hearing aid compatibility rules for a Federal Communications Commission (FCC)
The standard for compatibility of digital wireless phones with hearing aids is set forth in American National Standard Institute (ANSI) standard C63.19.
ANSI C63.19 contains two sets of standards: one for reduced radio frequency (RF) interference to enable acoustic coupling with hearing aids that do not operate in telecoil mode, and a separate standard to enable inductive coupling with hearing aids operating in telecoil mode. A digital wireless handset is considered hearing aid compatible for acoustic coupling if it meets a "U3" or "M3" rating under the ANSI standard. A digital wireless handset is considered hearing aid compatible for inductive coupling if it meets a "U3T" or "T3" rating under the ANSI standard.

The "M" rating indicates the amount of reduction of RF interference between telephones and hearing aids in acoustic coupling mode, while the "T" rating represents inductive coupling with hearing aids that are operating in telecoil mode.

The tests documented in this report were performed in accordance with ANSI C63.19-2011 Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, FCC published KDB 285076 D01 HAC Guidance v04 and TCB workshop updates.

Reference
[1]SPEAG uncertainty document (AN 15-7/AN19-17) for DASY 5 System from SPEAG (Schmid & Partner Engineering AG).

3.2 Procedure and result

No.	Item	Test Specification & Procedure	Limit	Result
1	HAC RF Emissions	FCC47 CFR 20.19 , ANSI C63.19, and published KDB procedures for HAC	ANSI C63.19	Complied M4
Note: UL Japan Inc. 's HAC Work Procedures 13-EM-W0435				

3.3 M Category limit

All digital transmission modes in all frequency bands contained in a HAC phone must meet M3 or M4 levels.

Emission categories	<960 MHz	
	E-field emissions	
Category M1	50 to 55	dB (V/m)
Category M2	45 to 50	dB (V/m)
Category M3	40 to 45	dB (V/m)
Category M4	<40	dB (V/m)

Emission categories	>960 MHz	
	E-field emissions	
Category M1	40 to 45	dB (V/m)
Category M2	35 to 40	dB (V/m)
Category M3	30 to 35	dB (V/m)
Category M4	<30	dB (V/m)

3.4 Test Location

*Shielded room for SAR/HAC testings
UL Japan, Inc. Ise EMC Lab.
4383-326 Asama-cho, Ise-shi, Mie-ken 516-0021 JAPAN
Telephone : +81 596 24 8999 Facsimile : +81 596 24 8124

SECTION 4 : Modulation Interference Factor (MIF)

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF) which replaces the need for the Articulation Weighting Factor (AWF) during the evaluation and is applicable to any modulation scheme.
The Modulation Interference factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF Audio Interference level (in dBV/m). This level considers the audible amplitude modulation components in the RF E-field. CW fields without amplitude modulation are assumed to not interfere with the hearing aid electronics. Modulations without time slots and low fluctuations at low frequencies have low MIF values, TDMA modulations with narrow transmission and repetition rates of few 100 Hz have high MIF values and give similar classifications as ANSI C63-2007.

Definitions

ER3D, E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the “indirect" measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by probe modulation response (PMR) calibration in order to not overestimate the field reading.
The evaluation method or the MIF is defined in ANSI C63.19-2011 section D.7. An RMS demodulated RF signal is fed to a spectral filter (similar to an A weighting filter) and forwarded to a temporal filter acting as a quasi-peak detector. The averaged output of these filtering is called to a 1 kHz 80% AM signal as reference. MIF measurement requires additional instrumentation and is not well suited for evaluation by the end user with reasonable uncertainty. It may alternatively be determined through analysis and simulation, because it is constraint and characteristic for a communication signal. DASY52 uses well defined signals for PMR calibration. The MIF of these signals has been determined by simulation and is automatically applied.

MIF values were not tested by a probe or as specified in the standards but are based on analysis provided by SPEAG for the following User Identifiers and air interfaces.

UID	Communication System Name	MIF (dB)
10021-DAA	GSM-FDD (TDMA, GMSK)	3.63
10011-CAA	UMTS-FDD (WCDMA)	-27.23
10295-AAA	CDMA2000 (1xRTT, RC1, SO3, 1/8th Rate 25 fr.)	3.26
10170-CAB	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-9.76
10182-CAB	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	-9.76
10176-CAB	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	-9.76
10173-CAB	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44

A PMR calibrated probe is linearized for the selected waveform over the full dynamic range within the uncertainty specified in its calibration certificate. ER3D, EF3D and EU2D E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the indirect" measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by PMR calibration in order to not overestimate the field reading.
The MIF measurement uncertainty is estimated as follows, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz:

- *0.2 dB for MIF -7 to +5 dB,*
- *0.5 dB for MIF -13 to +11 dB*
- *1 dB for MIF > -20 dB*

SECTION 5 : Average antenna input power

WWAN Maximum tune-up tolerance limit

・GSM

		1slots (dBm) Burst	2slots(dBm) Burst	1slots (dBm) Frame	2slots (dBm) Frame
GSM850	GSM	34.0		24.98	
	GPRS	34.0	32.0	24.98	25.98
	EGPRS	28.7	26.5	19.67	20.48
PCS	GSM	31.0		21.98	
	GPRS	31.0	28.8	21.98	22.78
	EGPRS	27.5	25.3	18.47	19.28

・WCDMA

		Normal Mode(dBm)	Hot Spot Mode(dBm)	Power Reduction(dB) *
		RMC/HSDPA/HSUPA	RMC/HSDPA/HSUPA	
WCDMA	B2	24.0	21.5	-2.5
	B4	24.0	21.5	-2.5
	B5	24.0		

・LTE

		Normal Mode(dBm)	Hot Spot Mode(dBm)	Power Reduction(dB)*
LTE	B2	24.0	21.5	-2.5
	B4	24.0	21.5	-2.5
	B5	24.0		
	B7	24.0	19.0	-5.0
	B17	24.0		

Note(s):

* When WLAN tethering function(Hotspot mode) is activated, WWAN transmit power is reduced. This function is adapted to WCDMA Band 2, 4 and LTE Band 2, 4, 7.

SECTION 6 : Evaluation for Low-power Exemption

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.

Air-Interface	Average Antenna Input Power (dBm)*1	MIF (dB)	Input Power plus its MIF (dBm)	HAC Tested
GSM850	34.00	3.63	37.63	Yes
PCS1900	31.00	3.63	34.63	Yes
WCDMA Band II	24.00	-27.23	-3.23	No
WCDMA Band IV	24.00	-27.23	-3.23	No
WCDMA Band V	24.00	-27.23	-3.23	No
LTE Band 2 *2	24.00	-9.76	14.24	No
LTE Band 4 *2	24.00	-9.76	14.24	No
LTE Band 5 *2	24.00	-9.76	14.24	No
LTE Band 7 *2	24.00	-9.76	14.24	No
LTE Band 17 *2	24.00	-9.76	14.24	No

Note(s):
*1 Max tune-up limit. Refer to section 5.

*2 No associated T-Coil measurement has been made in accordance with KDB285076D02 T-Coil testing for CMRS IP.

Conclusions
RF Emission testing for this device is required only for GSM voice modes. All other applicable air-interfaces are exempt.

SECTION 7 : Operation of E.U.T. during testing

7.1 Operating modes for HAC testing

7.1.1 Setting of EUT

<GSM850 >
Tx frequency band : 824.0MHz – 849.00MHz
Channel : 128ch(824.2MHz)/Low ch, 190ch(836.6MHz)/ Mid ch, 251ch(848.6MHz)/ High ch
Modulation : GSM (GMSK)
Power setting : Power class 5

<PCS1900 >
Frequency band : 1850.0MHz – 1910.0MHz
Channel : 512ch(1850.2MHz)/Low ch, 661ch(1880.0MHz)/ Mid ch, 810ch(1909.8MHz)/High ch
Modulation : GSM (GMSK)
Power setting : Power class 0

Note(s):
A communication link was set up with the Universal Radio communication Tester from Rohde & Schwarz(M/N: CMU200, SN: 106223).

SECTION 8 : Test surrounding

8.1 Measurement uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[1]and is given in the following Table.

Error Description	Uncertainty value ± %	Probability distribution	divisor	(ci)	Standard Uncertainty
Measurement System					
Probe calibration	±5.1	Normal	1	1	±5.1
Axial isotropy of the probe	±4.7	Rectangular	√3	1	±2.7
Sensor Displacement	±16.5	Rectangular	√3	1	±9.5
Boundary effects	±2.4	Rectangular	√3	1	±1.4
Probe linearity	±4.7	Rectangular	√3	1	±2.7
Scaling to Peak Envelope Power	±2.0	Rectangular	√3	1	±1.2
System Detection limit	±1.0	Rectangular	√3	1	±0.6
Readout electronics	±0.3	Normal	1	1	±0.3
Response time	±0.8	Rectangular	√3	1	±0.5
Integration time	±2.6	Rectangular	√3	1	±1.5
RF ambient Noise	±3.0	Rectangular	√3	1	±1.7
RF ambient Reflections	±12.0	Rectangular	√3	1	±6.9
Probe Positioner	±1.2	Rectangular	√3	1	±0.7
Probe positioning	±4.7	Rectangular	√3	1	±2.7
Extrap.and Interpolation	±1.0	Rectangular	√3	1	±0.6
Test Sample Related					
Device positioning Vertical	±4.7	Rectangular	√3	1	±2.7
Device positioning Lateral	±1.0	Rectangular	√3	1	±0.6
Device holder and Phantom	±2.4	Rectangular	√3	1	±1.4
Power drift	±5.0	Rectangular	√3	1	±2.9
Phantom and Setup					
Phantom Thickness	±2.4	Rectangular	√3	1	±1.4
Combined Standard Uncertainty					±14.7
Expanded Std. Uncertainty on Power(k=2)					**±29.4**
Expanded Std. Uncertainty on Filed(k=1)					**±14.7**

Note(s):
[1] SPEAG documents Application Notes 24.6.1 HAC Uncertainty Budget According to ANSI C63.19.

SECTION 9 : Measurement results

Ambient temperature (deg.c) : **24.0** Relative Humidity (%) : **42**
Atmospheric Pressure : **1008hPa** Date : **February 8, 2015**

Mode	Channel	RF audio interference level [dBV/m]	M-Rating Category*1
GSM850	824.2MHz(128ch)	39.38 *2	**M4**
GSM850	836.6MHz(190ch)	36.51	**M4**
GSM850	848.6MHz(251ch)	36.40	**M4**
PCS1900	1850.2MHz(512ch)	28.32	**M4**
PCS1900	1880MHz(661ch)	28.11	**M4**
PCS1900	1909.8MHz(810ch)	28.76	**M4**
WCDMA	Refer to section 6 Evaluation for Low-power Exemption. RF Emission testing for this device is required only for GSM voice modes. All other applicable air-interfaces are exempt from testing in accordance with C63.19-2011 Clause 4.4 and are rated M4.		**M4**
LTE	RF Emission testing for this device is required only for GSM voice modes. No Associated T-Coil measurement has been made in accordance with 285076 D02 T-Coil testing for CMRS IP.		**M4**

Note(s):
*1 See Appendix 1 for measurement data plots.
*2: According to the last paragraph of section 4, the MIF measurement uncertainty is estimated to be 0.2 dB for MIF -7 to + 5 dB. The maximum E-field result of 39.38 dB V/m plus measurement uncertainty of 0.2 dB is 39.58 dB V/m, which is still within M4 rating.

SECTION 10 Test instruments

Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MPB-04	Isotropic E-Field Probe	Schmid&Partner Engineering AG	ER3DV6	2427	HAC	2014/03/13 * 12
MDAE-01	Data Acquisition Electronics	Schmid&Partner Engineering AG	DAE4	509	HAC	2014/07/28 * 12
MPH-01	Teat Arch Phantom	Schmid&Partner Engineering AG	Teat Arch Phantom		HAC	Pre Check
MBM-12	Barometer	Sunoh	SBR121	873	HAC	2015/02/04 * 36
MOS-29	Thermo-Hygrometer	Custom	CTH-201	2901	HAC	2015/01/13 * 12
MDA-16	Dipole Antenna	Schmid&Partner Engineering AG	CD835V3	1087	HAC	2012/12/06 * 36
MDA-17	Dipole Antenna	Schmid&Partner Engineering AG	CD1880V3	1088	HAC	2012/12/06 * 36
MPF-02	2mm Oval Flat Phantom	Schmid&Partner Engineering AG	QDOVA001BB	1045	HAC	2014/05/30 * 12
MDH-02	Device Holder(HAC)	Schmid&Partner Engineering AG	Mounting device for transmitter	-	HAC	Pre Check
MOS-26	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q29	HAC	2014/05/20 * 12
COTS-MSAR-03	Dasy5	Schmid&Partner Engineering AG	DASY5	-	HAC	-
MRBT-02	SAR robot	Schmid&Partner Engineering AG	TX60 Lspeag	F10/5E3LA1/A/01	HAC	2014/05/09 * 12
MPM-15	Power Meter	Agilent	N1914A	MY53060017	HAC	2014/06/20 * 12
MPSE-20	Power sensor	Agilent	N8482H	MY53050001	HAC	2014/06/20 * 12
MPSE-21	Power sensor	Agilent	N8482H	MY52460010	HAC	2014/07/02 * 12
MHDC-21	Dual Directional Coupler	Agilent	778D	MY52180243	HAC(0.1-2GHz)	Pre Check
MRFA-24	Pre Amplifier	R&K	R&K CGA020M602-2633R	B30550	HAC	2014/06/19 * 12
MSG-13	Signal Generator	Rohde & Schwarz	SMA 100A	103764	HAC	2014/06/19 * 12
MAT-78	Attenuator	Telegrartner	J01156A0011	0042294119	HAC	Pre Check

The expiration date of the calibration is the end of the expired month.
All equipment is calibrated with valid calibrations. Each measurement data is traceable to the national or international standards.

As for some calibrations performed after the tested dates, those test equipment have been controlled by means of an unbroken chains of calibrations.

APPENDIX 1 : HAC Measurement data

1. HAC RF Emissions Test Procedure

The following are step-by-step test procedures.
a) Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.

b) Position the WD in its intended test position.

c) Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.

d) The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 1. If the field alignment method is used, align the probe for maximum field reception.

e) Record the reading at the output of the measurement system

f) Scan the entire 50 mm by 50 mm region in equally spaced increments and record the reading at each measurement point. The distance between measurement points shall be sufficient to assure the identification of the maximum reading.

g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.

h) Identify the maximum reading within the non-excluded sub-grids identified in step g).

i) Convert the highest field reading within identified in step h) to RF audio interference level, in V/m, by taking the square root of the reading and then dividing it by the measurement system transfer function, established in 5.5.1.1 Convert this result to dB(V/m) by taking the base-10 logarithm and multiplying by 20.

Indirect measurement method
Replacing step i), the RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB(V/m), from step h). Use this result to determine the category rating
j) Compare this RF audio interference level with the categories in Clause 8 (ANSI C63.19-2011) and record the resulting WD category rating

k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating.

Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.

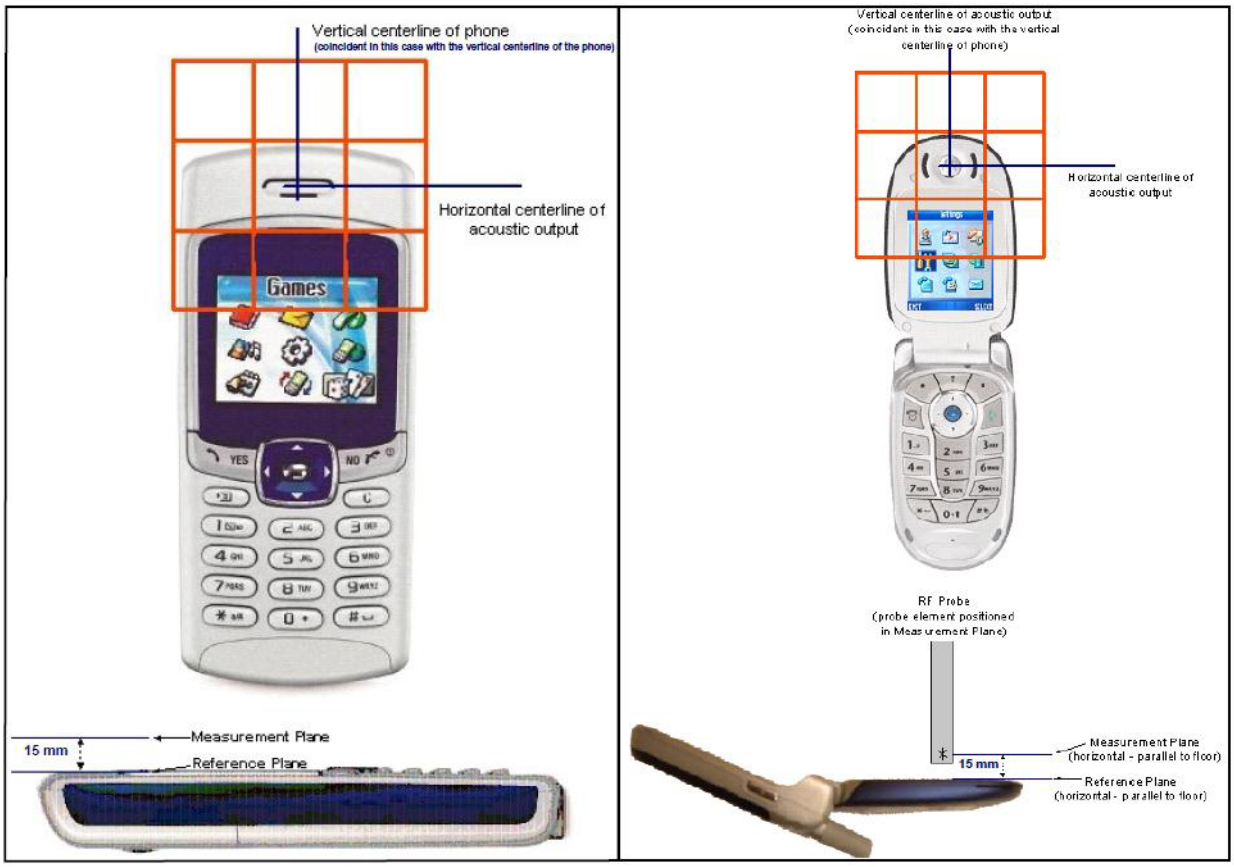
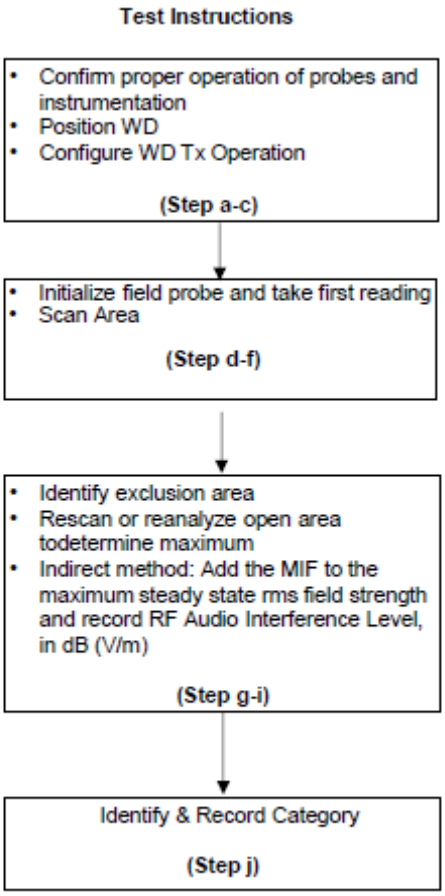


Figure 1: WD reference and plane for RF emission measurements

Test flowchart Per ANSI-PC63.19 2011



2. E-Filed measurement data (EGSM900/ DCS1800)

HAC M rate GSM850 GSM 824.2MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: GSM 850 (824.0 - 849.0 MHz); Frequency: 824.2 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

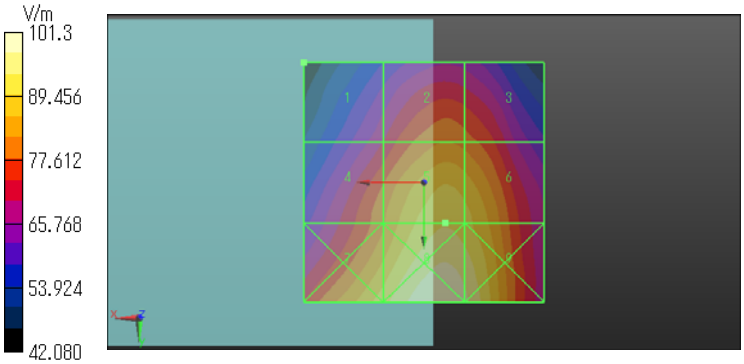
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device 2 2 2 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 75.75 V/m; Power Drift = -0.13 dB
Applied MIF = 3.63 dB
RF audio interference level = 39.38 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **36.88 dBV/m**	Grid 2 **M4** **38.23 dBV/m**	Grid 3 **M4** **38.05 dBV/m**
Grid 4 **M4** **38.19 dBV/m**	Grid 5 **M4** **39.38 dBV/m**	Grid 6 **M4** **39.19 dBV/m**
Grid 7 **M4** **39.28 dBV/m**	Grid 8 **M3** **40.11 dBV/m**	Grid 9 **M4** **39.86 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 32.48 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



HAC M rate GSM850 GSM 836.6MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: GSM 850 (824.0 - 849.0 MHz); Frequency: 836.6 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

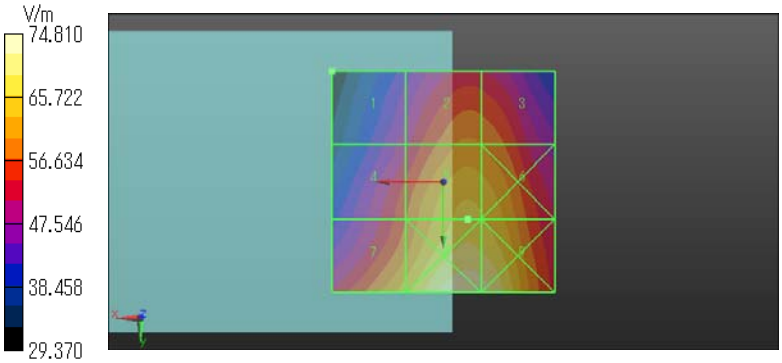
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device 2 2 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 54.20 V/m; Power Drift = -0.12 dB
Applied MIF = 3.63 dB
RF audio interference level = 36.51 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **33.94 dBV/m**	Grid 2 **M4** **35.62 dBV/m**	Grid 3 **M4** **35.53 dBV/m**
Grid 4 **M4** **35.06 dBV/m**	Grid 5 **M4** **36.51 dBV/m**	Grid 6 **M4** **36.42 dBV/m**
Grid 7 **M4** **36.24 dBV/m**	Grid 8 **M4** **37.48 dBV/m**	Grid 9 **M4** **37.35 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 29.36 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



HAC M rate GSM850 GSM 848.6MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: GSM 850 (824.0 - 849.0 MHz); Frequency: 848.6 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

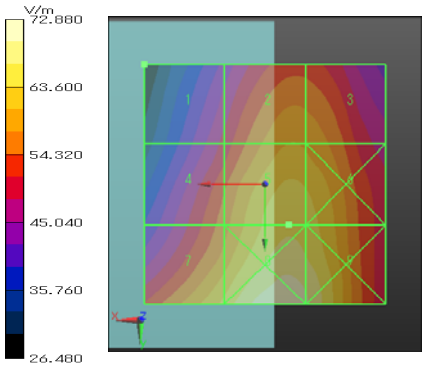
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device 2 2 2 2 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 51.62 V/m; Power Drift = -0.03 dB
Applied MIF = 3.63 dB
RF audio interference level = 36.40 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **33.87 dBV/m**	Grid 2 **M4** **35.66 dBV/m**	Grid 3 **M4** **35.57 dBV/m**
Grid 4 **M4** **35 dBV/m**	Grid 5 **M4** **36.4 dBV/m**	Grid 6 **M4** **36.29 dBV/m**
Grid 7 **M4** **36.21 dBV/m**	Grid 8 **M4** **37.25 dBV/m**	Grid 9 **M4** **36.96 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 28.46 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



HAC M rate PCS1900 GSM 1850.2MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: PCS 1900 (1850.0 - 1910.0 MHz); Frequency: 1850.2 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

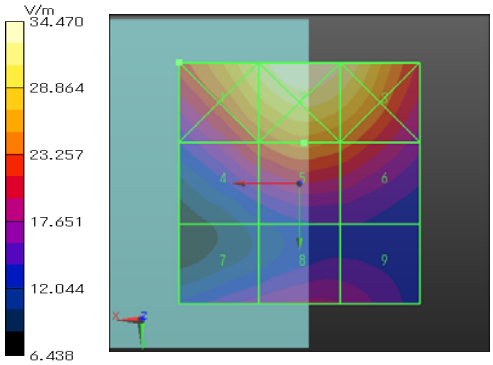
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 15.95 V/m; Power Drift = 0.13 dB
Applied MIF = 3.63 dB
RF audio interference level = 28.32 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **29.99 dBV/m**	Grid 2 **M3** **30.75 dBV/m**	Grid 3 **M3** **30.36 dBV/m**
Grid 4 **M4** **27.29 dBV/m**	Grid 5 **M4** **28.32 dBV/m**	Grid 6 **M4** **27.79 dBV/m**
Grid 7 **M4** **24.65 dBV/m**	Grid 8 **M4** **25.28 dBV/m**	Grid 9 **M4** **25.04 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 26.98 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



HAC M rate PCS1900 GSM 1880MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: PCS 1900 (1850.0 - 1910.0 MHz); Frequency: 1880 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

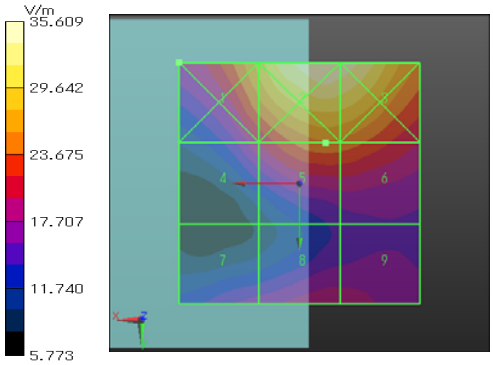
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 14.37 V/m; Power Drift = 0.12 dB
Applied MIF = 3.63 dB
RF audio interference level = 28.11 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **29.09 dBV/m**	Grid 2 **M3** **31.03 dBV/m**	Grid 3 **M3** **30.88 dBV/m**
Grid 4 **M4** **25.87 dBV/m**	Grid 5 **M4** **28.11 dBV/m**	Grid 6 **M4** **28 dBV/m**
Grid 7 **M4** **24.63 dBV/m**	Grid 8 **M4** **25.58 dBV/m**	Grid 9 **M4** **25.54 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 25.01 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



HAC M rate PCS1900 GSM 1909.8MHz E field

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Communication System Band: PCS 1900 (1850.0 - 1910.0 MHz); Frequency: 1909.8 MHz;Duty Cycle: 1:8.6896

Phantom section: TCoil Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY Configuration:

- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

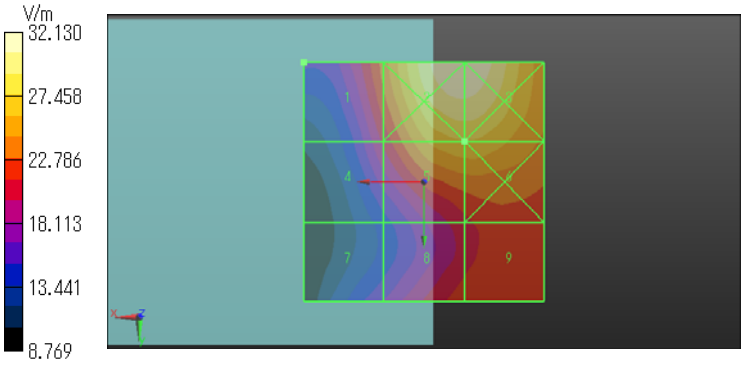
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device 2 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 16.70 V/m; Power Drift = 0.04 dB
Applied MIF = 3.63 dB
RF audio interference level = 28.76 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **27.42 dBV/m**	Grid 2 **M3** **30.14 dBV/m**	Grid 3 **M3** **30.12 dBV/m**
Grid 4 **M4** **26.04 dBV/m**	Grid 5 **M4** **28.76 dBV/m**	Grid 6 **M4** **28.76 dBV/m**
Grid 7 **M4** **24.45 dBV/m**	Grid 8 **M4** **26.9 dBV/m**	Grid 9 **M4** **27.06 dBV/m**

Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:
Total = 23.80 dBV/m
E Category: M4
Location: 25, -25, 8.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



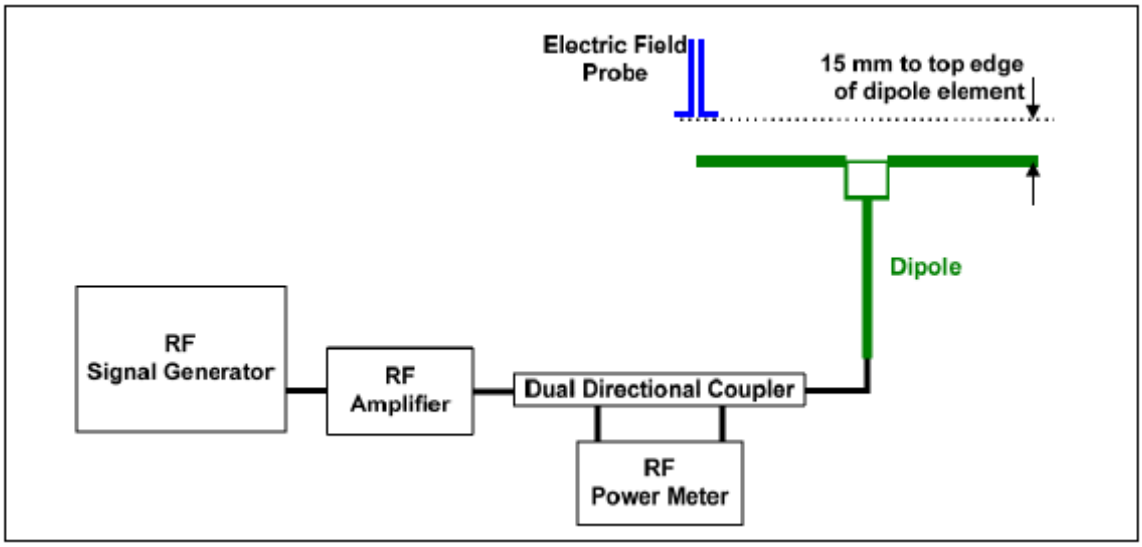
APPENDIX 2 : System Validation

The test setup was validated when first configured and verified periodically thereafter to ensure proper function. The procedure provided in this section is a validation procedure using dipole antennas for which the field levels were computed by numeric modeling.
Procedure
Place a dipole antenna meeting the requirements given in ANSI C63.19-2011 in the normally occupied by the WD. The dipole antenna serves as a known source for an electrical and magnetic output. Position the E-field probe so that the following occurs:

- The probes and their cables are parallel to the coaxial feed of the dipole antenna
- The probe cables and the coaxial feed of the dipole antenna approach the measurement area from opposite directions
- The center point of the probe element(s) is 15 mm from the closest surface of the dipole elements.

Scan the length of the dipole with the E-field probe and record the two maximum values found near the dipole ends. Average the two readings and compare the reading to the expected value in the calibration certificate or the expected value in this standard.

Setup diagram



1. System Validation result

The target values were made into the calibration values of SPEAG. And the validation results of 835MHz (E-Filed) & 1880MHz (E-Filed) checked that it was within +/-10% as compared with the calibration values of SPEAG.
The validation results are in the table below.

Frequency : **835MHz**
Dipole : **CD835V3 SN:1087**
Power : **100mW**

1880MHz SYSTEM PERFORMANCE CHECK				
Date	E-Filed		Deviation	Limit
	Target*1	Measured		[%]
8-Feb	161.4	163.2	1.1	+/-10

Frequency : **1880MHz**
Dipole : **CD1880V3 SN:1088**
Power : **100mW**

1880MHz SYSTEM PERFORMANCE CHECK				
Date	E-Filed		Deviation	Limit
	Target*1	Measured		[%]
8-Feb	133.65	128.85	-3.6	+/-10

Note:
*1: The value to compared to the calibration data is the average of the two maximum in the subgrids 2 and 8.

2. E-Filed System Validation Measurement data

E-Filed 835MHz System Validation / Forward Conducted Power : 100mW

Communication System: UID 0, CW; Communication System Band: ITD835 (835.0 MHz); Frequency: 835 MHz;Duty Cycle: 1:1

Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

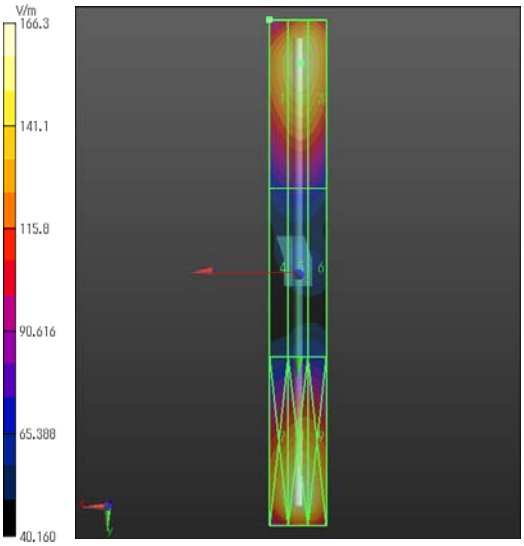
- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - measurement distance from the probe sensor center to CD835 = 10mm & 15mm/Hearing Aid Compatibility Test at 10mm distance (41x361x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 100.4 V/m; Power Drift = 0.01 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 160.0 V/m
Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M4** **150.5 V/m**	Grid 2 **M4** **160.0 V/m**	Grid 3 **M4** **157.6 V/m**
Grid 4 **M4** **75.53 V/m**	Grid 5 **M4** **78.38 V/m**	Grid 6 **M4** **77.11 V/m**
Grid 7 **M4** **155.1 V/m**	Grid 8 **M4** **166.3 V/m**	Grid 9 **M4** **162.5 V/m**

Cursor:
Total = 82.91 V/m
E Category: M4
Location: 10, -90, 4.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



E-Filed 1880MHz System Validation / Forward Conducted Power : 100mW

Dipole 1880MHz; Type: CD1880V3; Serial: 1088

Communication System: UID 0, CW; Communication System Band: CD1880 (1880.0 MHz); Frequency: 1880 MHz;Duty Cycle: 1:1

Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY Configuration:

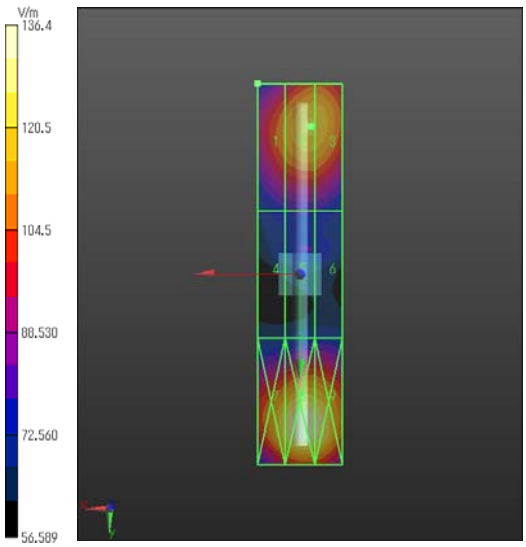
- Probe: ER3DV6 - SN2427; ConvF(1, 1, 1); Calibrated: 2014/03/13;
  - Sensor-Surface: (Fix Surface)
  - Electronics: DAE4 Sn509; Calibrated: 2014/07/28
  - Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
  - DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - measurement distance from the probe sensor center to CD1880 = 10mm & 15mm/Hearing Aid Compatibility Test at 10mm distance (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 147.0 V/m; Power Drift = -0.05 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 121.3 V/m
Near-field category: M2 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M3** **111.5 V/m**	Grid 2 **M2** **121.3 V/m**	Grid 3 **M2** **120.9 V/m**
Grid 4 **M3** **77.41 V/m**	Grid 5 **M3** **79.41 V/m**	Grid 6 **M3** **78.52 V/m**
Grid 7 **M2** **126.2 V/m**	Grid 8 **M2** **136.4 V/m**	Grid 9 **M2** **133.7 V/m**

Cursor:
Total = 71.93 V/m
E Category: M3
Location: 10, -45, 4.7 mm
Date: 2015/02/08
Ambient Temp. : 24.0 degree.C.



3. System check uncertainty

The uncertainty budget has been determined for the DASY5 measurement system according to the SPEAG documents[1]and is given in the following Table.

Error Description	Uncertainty value ± %	Probability distribution	divisor	(ci)	Standard Uncertainty
Measurement System					
Probe calibration	±5.1	Normal	1	1	±5.1
Axial isotropy of the probe	±4.7	Rectangular	√3	1	±2.7
Sensor Displacement	±16.5	Rectangular	√3	1	±9.5
Boundary effects	±2.4	Rectangular	√3	1	±1.4
Probe linearity	±4.7	Rectangular	√3	1	±2.7
Scaling to Peak Envelope Power	±0	Rectangular	√3	1	±0
System Detection limit	±1.0	Rectangular	√3	1	±0.6
Readout electronics	±0.3	Normal	1	1	±0.3
Response time	±0	Rectangular	√3	1	±0
Integration time	±0	Rectangular	√3	1	±0
RF ambient Noise	±3.0	Rectangular	√3	1	±1.7
RF ambient Reflections	±6.0	Rectangular	√3	1	±6.9
Probe Positioner	±1.2	Rectangular	√3	1	±0.7
Probe positioning	±4.7	Rectangular	√3	1	±2.7
Extrap.and Interpolation	±1.0	Rectangular	√3	1	±0.6
Dipole Related					
Distance Dipole-Scanning Plane	±5.2	Rectangular	√3	1	±3.0
Input Power	±4.7	Normal	1	1	±4.7
Combined Standard Uncertainty					±13.7
Expanded Std. Uncertainty on Power(k=2)					**±27.4**
Expanded Std. Uncertainty on Filed(k=1)					**±13.7**

Note: [1] SPEAG documents Application Notes 24.6.1 HAC Uncertainty Budget According to ANSI C63.19.

4. System Validation Dipole (CD835V3,S/N: 1087)

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 108**

Client **UL Japan (PTT)**

Certificate No: **CD835V3-1087_Dec12**

CALIBRATION CERTIFICATE

Object CD835V3 - SN: 1087

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

Calibration date: December 06, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 10 dB Attenuator	SN: 5047.2 (10q)	27-Mar-12 (No. 217-01527)	Apr-13
Probe ER3DV6	SN: 2336	29-Dec-11 (No. ER3-2336_Dec11)	Dec-12
Probe H3DV6	SN: 6065	29-Dec-11 (No. H3-6065_Dec11)	Dec-12
DAE4	SN: 781	29-May-12 (No. DAE4-781_May12)	May-13

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

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: December 11, 2012

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

Certificate No: CD835V3-1087_Dec12 Page 1 of 6

Calibration Laboratory of
Schmid & Partner
Engineering AG
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Accredited by the Swiss Accreditation Service (SAS)
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Accreditation No.: SCS 108

References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the top edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections.
  It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- *E-field distribution:* E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

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	V52.8.3
Extrapolation	Advanced Extrapolation	
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz ± 1 MHz	
Input power drift	< 0.06 dB	

Maximum Field values at 835 MHz

H-field 10 mm above dipole surface	condition	interpolated maximum
Maximum measured	100 mW input power	**0.443 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	161.8 V / m
Maximum measured above low end	100 mW input power	160.9 V / m
Averaged maximum above arm	100 mW input power	**161.4 V / m ± 12.8 % (k=2)**

Appendix

Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	16.0 dB	42.7 Ω - 12.9 jΩ
835 MHz	29.0 dB	50.2 Ω + 3.5 jΩ
900 MHz	16.1 dB	58.8 Ω - 14.8 jΩ
950 MHz	21.5 dB	44.5 Ω + 5.8 jΩ
960 MHz	17.2 dB	50.3 Ω + 13.9 jΩ

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

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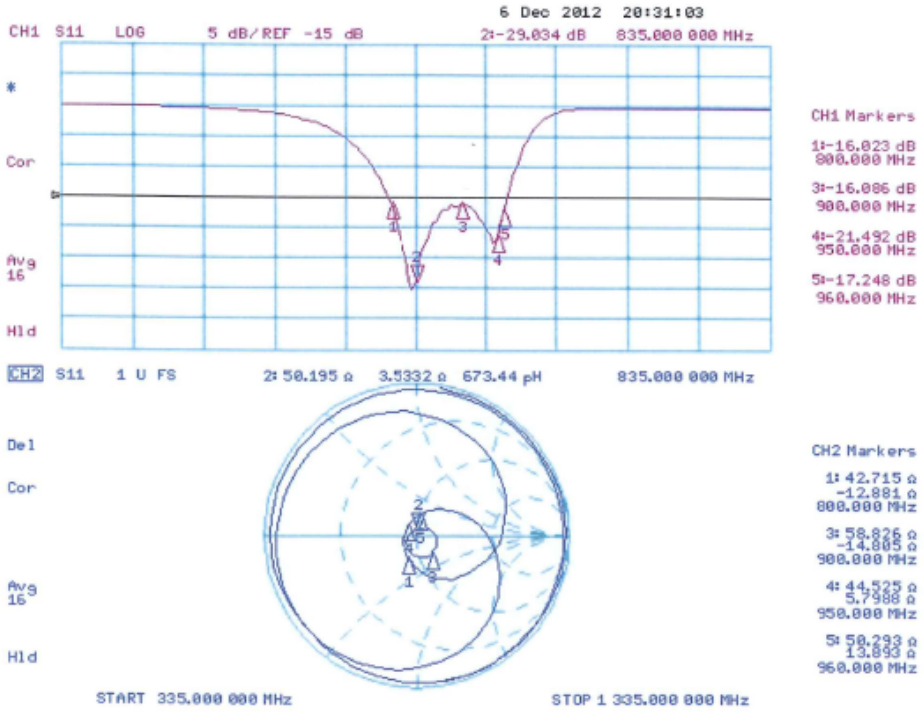
Impedance Measurement Plot



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Facsimile : +81 596 24 8124

DASY5 H-field Result

Date: 06.12.2012

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1087

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

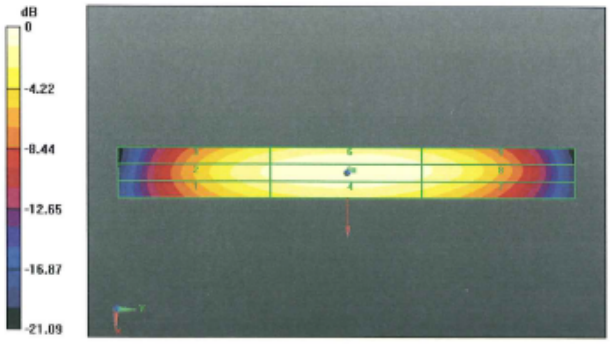
DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2011
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 29.05.2012
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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 = 0.4700 A/m; Power Drift = -0.01 dB
PMR not calibrated. PMF = 1.000 is applied.
H-field emissions = 0.4432 A/m
Near-field category: M4 (AWF 0 dB)

PMF scaled H-field

Grid 1 M4 **0.366 A/m**	Grid 2 M4 **0.393 A/m**	Grid 3 M4 **0.378 A/m**
Grid 4 M4 **0.409 A/m**	Grid 5 M4 **0.443 A/m**	Grid 6 M4 **0.431 A/m**
Grid 7 M4 **0.357 A/m**	Grid 8 M4 **0.393 A/m**	Grid 9 M4 **0.383 A/m**



0 dB = 0.4432 A/m = -7.07 dBA/m

DASY5 E-field Result

Date: 06.12.2012

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1087

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

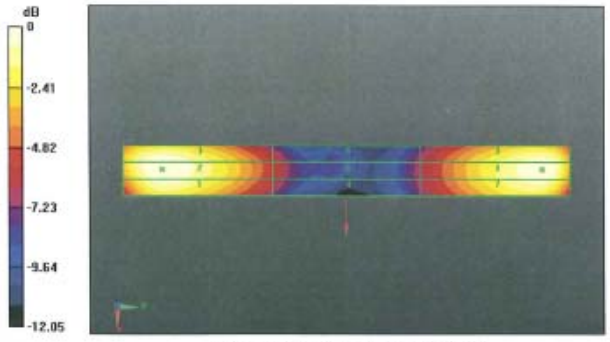
DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2011;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 29.05.2012
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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 = 107.0 V/m; Power Drift = -0.05 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 161.8 V/m
Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 M4 **155.7 V/m**	Grid 2 M4 **161.8 V/m**	Grid 3 M4 **158.8 V/m**
Grid 4 M4 **82.49 V/m**	Grid 5 M4 **85.55 V/m**	Grid 6 M4 **83.97 V/m**
Grid 7 M4 **153.5 V/m**	Grid 8 M4 **160.9 V/m**	Grid 9 M4 **156.8 V/m**



0 dB = 161.8 V/m = 44.18 dBV/m

Certificate No: CD835V3-1087_Dec12 Page 6 of 6

The average of the two maximum in the subgrids 2 and 8 :161.4V/m

CD835V3 Calibration for Impedance and Return-loss

Equipment	Dipole Antenna	Model	CD835V3
Manufacture	Schmid&Partner Engineering AG	Serial	1087
Tested by	Hisayoshi Sato		

1. Test environment

Date	February 7, 2015		
Ambient Temperature	24.0 deg.C	Relative humidity	45%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	SAR	2014/08/21 * 12
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	SAR	2014/08/18 * 12
EST-46	3.5mm ECONOMY CALIBRATION KIT	Agilent	85052D	MY43252869	SAR	2014/08/15 * 12
MOS-30	Thermo-Hygrometer	Custom	CTH-201	3001	SAR	2014/07/06 * 12

3. Test Result

Frequency[MHz]	Return Loss[dB]		Deviation[dB	Limit (±20% of SPEAG value)[dB]	Result
	SPEAG value	UL Japan value			
800	16.0	17.6	1.6	± 3.2	OK
835	29.0	32.1	3.1	± 5.8	OK
900	16.1	15.3	-0.8	± 3.2	OK
950	21.5	19.4	-2.1	± 4.3	OK
960	17.2	19.4	2.2	± 3.4	OK

Frequency	Impeadance (Speag value)		Impeadance(ULJ value)		Deviation(Limit +/-5Ω+/-5jΩ		Result
	Real	imaginary	Real	imaginary	Real	imaginary	
800	42.7	-12.9	42.2	-10.1	0.5	-2.8	OK
835	50.2	3.5	48.3	-0.7	1.9	4.2	OK
900	58.8	-14.8	56.3	-16.1	2.5	1.3	OK
950	44.5	5.8	42.9	6.1	1.6	-0.3	OK
960	50.3	13.9	51.3	12.9	-1.0	1.0	OK

*Tolerance : According to the KDB450824D02

5. System Validation Dipole (CD1880V3,S/N: 1088)

Calibration Laboratory of
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Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 108

Client UL Japan (PTT)

Certificate No: CD1880V3-1088_Dec12

CALIBRATION CERTIFICATE

Object: CD1880V3 - SN: 1088

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

Calibration date: December 06, 2012

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 10 dB Attenuator	SN: 5047.2 (10q)	27-Mar-12 (No. 217-01527)	Apr-13
Probe ER3DV6	SN: 2336	29-Dec-11 (No. ER3-2336_Dec11)	Dec-12
Probe H3DV6	SN: 6065	29-Dec-11 (No. H3-6065_Dec11)	Dec-12
DAE4	SN: 781	29-May-12 (No. DAE4-781_May12)	May-13

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

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	
Approved by:	Fin Bomholt	R&D Director	

Issued: December 7, 2012

Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 108

References

[1] ANSI-C63.19-2007
American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm above the top edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections.
  It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- *E-field distribution:* E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (in z) above the top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, 10mm above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

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	V52.8.3
Extrapolation	Advanced Extrapolation	
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1880 MHz ± 1 MHz	
Input power drift	< 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	**0.461 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	135.2 V / m
Maximum measured above low end	100 mW input power	132.1 V / m
Averaged maximum above arm	100 mW input power	**133.7 V / m ± 12.8 % (k=2)**

Appendix

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	26.1 dB	46.8 Ω + 3.6 jΩ
1880 MHz	17.5 dB	46.7 Ω + 12.5 jΩ
1900 MHz	17.8 dB	50.8 Ω + 13.0 jΩ
1950 MHz	22.4 dB	56.8 Ω + 4.3 jΩ
2000 MHz	27.7 dB	46.0 Ω + 0.1 jΩ

3.2 Antenna Design and Handling

The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.
The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.
Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

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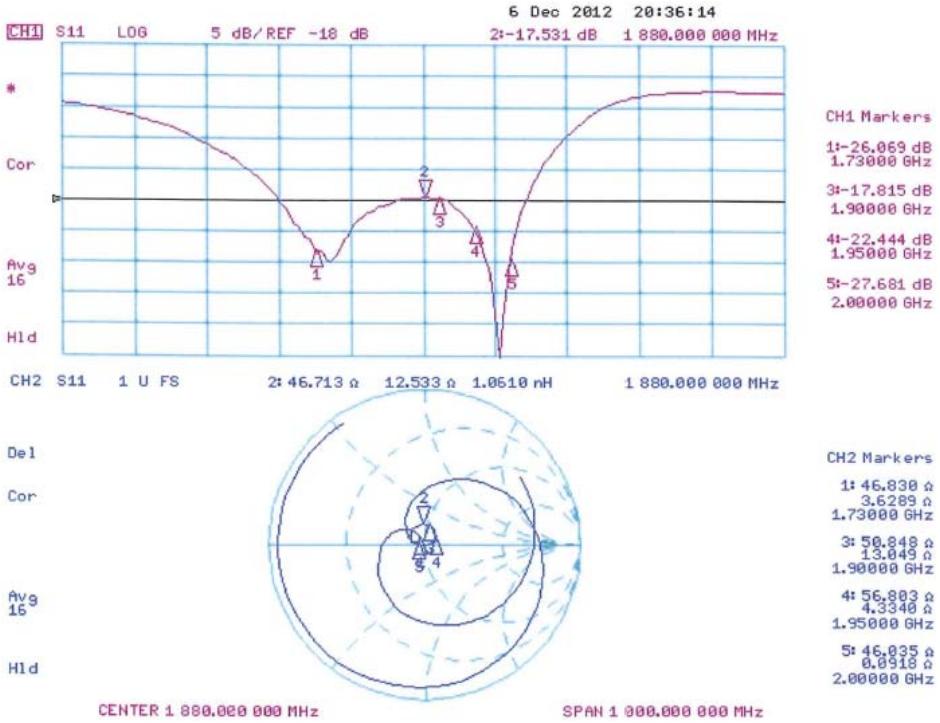
Impedance Measurement Plot



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DASY5 H-field Result

Date: 06.12.2012

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1088

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

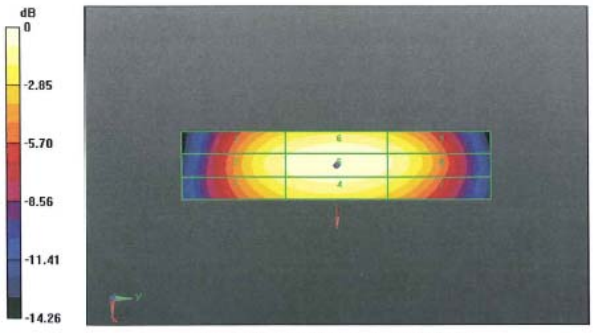
DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 29.12.2011
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 29.05.2012
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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 = 0.4880 A/m; Power Drift = 0.00 dB
PMR not calibrated. PMF = 1.000 is applied.
H-field emissions = 0.4615 A/m
Near-field category: M2 (AWF 0 dB)

PMF scaled H-field

Grid 1 **M2** **0.396 A/m**	Grid 2 **M2** **0.420 A/m**	Grid 3 **M2** **0.406 A/m**
Grid 4 **M2** **0.432 A/m**	Grid 5 **M2** **0.461 A/m**	Grid 6 **M2** **0.448 A/m**
Grid 7 **M2** **0.390 A/m**	Grid 8 **M2** **0.423 A/m**	Grid 9 **M2** **0.413 A/m**



0 dB = 0.4615 A/m = -6.72 dBA/m

DASY5 E-field Result

Date: 06.12.2012

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1088

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

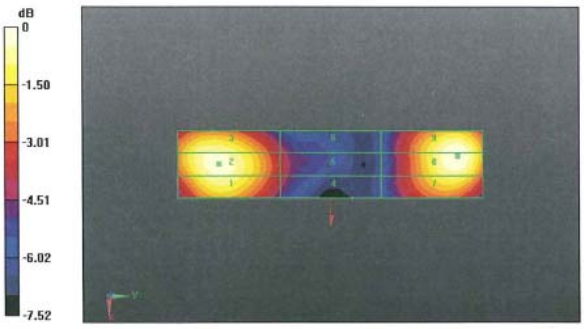
DASY52 Configuration:

- Probe: ER3DV6 - SN2336; ConvF(1, 1, 1); Calibrated: 29.12.2011;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 29.05.2012
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.3(988); SEMCAD X 14.6.7(6848)

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 = 146.5 V/m; Power Drift = 0.00 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 135.2 V/m
Near-field category: M2 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M2** **128.4 V/m**	Grid 2 **M2** **132.1 V/m**	Grid 3 **M2** **128.7 V/m**
Grid 4 **M3** **86.26 V/m**	Grid 5 **M3** **88.47 V/m**	Grid 6 **M3** **85.23 V/m**
Grid 7 **M2** **123.1 V/m**	Grid 8 **M2** **135.2 V/m**	Grid 9 **M2** **134.7 V/m**



0 dB = 135.2 V/m = 42.62 dBV/m

CD1880V3 Calibration for Impedance and Return-loss

Equipment	Dipole Antenna	Model	CD1880V3
Manufacture	Schmid&Partner Engineering AG	Serial	1088
Tested by	Hisayoshi Sato		

1. Test environment

Date	February 6, 2015		
Ambient Temperature	24.0 deg.C	Relative humidity	45%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
MNA-01	Network Analyzer	Agilent/HP	E8358A	US41080381	SAR	2014/08/21 * 12
MNCK-01	Type N Calibration Kit	Agilent	85032F	MY41495257	SAR	2014/08/18 * 12
EST-46	3.5mm ECONOMY CALIBRATION KIT	Agilent	85052D	MY43252869	SAR	2014/08/15 * 12
MOS-30	Thermo-Hygrometer	Custom	CTH-201	3001	SAR	2014/07/06 * 12

3. Test Result

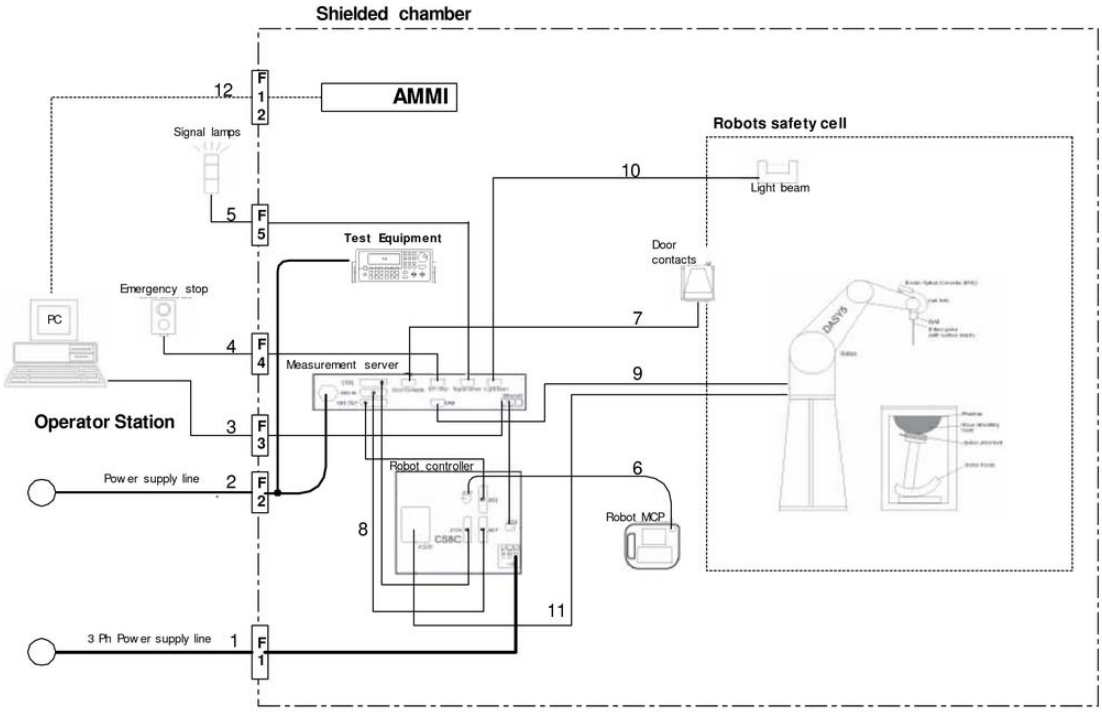
Frequency[MHz]	Return Loss[dB]		Tolerance[dB	Limit (±20% of SPEAG value)[dB]	Decision
	SPEAG value	UL Japan value			
1730	26.1	28.8	2.7	± 5.2	OK
1880	17.5	20.1	2.6	± 3.5	OK
1900	17.8	18.4	0.6	± 3.6	OK
1950	22.4	25.0	2.6	± 4.5	OK
2000	27.7	28.5	0.8	± 5.5	OK

Frequency	Impeadance (Speag value)		Impeadance(ULJ value)		Tolerance(Limit +/-5Ω+/-5j		Decision
	Real	imaginary	Real	imaginary	Real	imaginary	
1730	46.8	3.6	47.2	5.4	-0.4	-1.8	OK
1880	46.7	12.5	48.4	12.9	-1.7	-0.4	OK
1900	50.8	13.0	47.2	15.3	3.6	-2.3	OK
1950	56.8	4.3	55.5	6.2	1.3	-1.9	OK
2000	46.0	0.1	48.2	1.8	-2.2	-1.7	OK

*Tolerance : According to the KDB450824D02

APPENDIX 3 : System specifications

1. Configuration and peripherals



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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
   An arm extension for accommodating the data acquisition electronics (DAE).

2. An isotropic field probe optimized and calibrated for the targeted measurement.

3. A data acquisition electronic (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.

4. 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.

5. 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.

6. The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

7. A computer running WinXP and the DASY5 software.

8. Remote control with teaches pendant and additional circuitry for robot safety such as warning lamps, etc.

9. The phantom, the device holder and other accessories according to the targeted measurement.

2. System components

ER3DV6

<Isotropic E-Field Probe for General Near-Field Measurements>

Construction : One dipole parallel, two dipoles normal to probe axis
Built-in shielding against static charges PEEK enclosure material

Calibration : In air from 100 MHz to 3.0 GHz
(absolute accuracy ±6.0%, k=2)

Frequency : 40 MHz to > 6 GHz (can be extended to < 20 MHz)
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 : Overall length: 330 mm (Tip: 16 mm)
Tip diameter: 8 mm (Body: 12 mm)
Distance from probe tip to dipole centers: 2.5 mm

Application : General near-field measurements up to 6 GHz
Field component measurements
Fast automatic scanning in phantoms

E-Field Probe (**ER3DV6)**

Teat Arch Phantom

: Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
Dimensions : 370 x 370 x 370 mm

Phone Positioner

: Supports accurate and reliable positioning of any phone.
Effect on near field <+/- 0.5 dB

3. Test system specifications

Robot TX60L

Number of Axes	:	6
Nominal Load	:	2 kg
Maximum Load	:	5kg
Reach	:	920mm
Repeatability	:	+/-0.03mm
Control Unit	:	CS8c
Programming Language	:	VAL3
Weight	:	52.2kg
Manuafacture	:	Stäubli Unimation Corp. Robot Model: TX60L

DASY5 Measurement server

Features	:	Intel ULV Celeron 400MHz 128MB chip disk and 128MB RAM 16 Bit A/D converter for surface detection system Vacuum Fluorescent Display Robot Interface Serial link to DAE (with watchdog supervision) Door contact port (Possibility to connect a light curtain) Emergency stop port (to connect the remote control) Signal lamps port Light beam port Three Ethernet connection ports Two USB 2.0 Ports Two serial links Expansion port for future applications
Dimensions (L x W x H)	:	440 x 241 x 89 mm
Manufacture	:	Schimid & Partner Engineering AG

Data Acquisition Electronic (DAE)

Features	:	Signal amplifier, multiplexer, A/D converter and control logic Serial optical link for communication with DASY5 embedded system (fully remote controlled) 2 step probe touch detector for mechanical surface detection and emergency robot stop (not in -R version)
Measurement Range	:	1 µV to > 200 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset voltage	:	< 1 µV (with auto zero)
Input Resistance	:	200 MΩ
Battery Power	:	> 10 h of operation (with two 9 V battery)
Dimension	:	60 x 60 x 68 mm
Manufacture	:	Schimid & Partner Engineering AG

4. Isotropic E-Field Probe E-Field Probe Calibration (ER3DV6 SN 2427)

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

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

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

Accreditation No.: **SCS 108**

Client **UL Japan (PTT)** Certificate No: **ER3-2427_Mar14**

CALIBRATION CERTIFICATE

Object ER3DV6 - SN:2427

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: March 13, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ER3DV6	SN: 2328	10-Oct-13 (No. ER3-2328_Oct13)	Oct-14
DAE4	SN: 789	15-May-13 (No. DAE4-789_May13)	May-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

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

Issued: March 13, 2014

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
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Accredited by the Swiss Accreditation Service (SAS) Accreditation No.: **SCS 108**
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Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
b) CTIA Test Plan for Hearing Aid Compatibility, April 2010.

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 for XY sensors and ϑ = 90 for Z sensor (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart).
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *Spherical isotropy (3D deviation from isotropy)*: in a locally homogeneous field realized using an open waveguide setup.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Probe ER3DV6

SN:2427

Manufactured: July 24, 2007
Calibrated: March 13, 2014

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

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DASY/EASY - Parameters of Probe: ER3DV6 - SN:2427

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)	1.55	1.74	2.05	± 10.1 %
DCP (mV)[B]	99.4	100.0	100.4	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	193.3	±3.8 %
		Y	0.0	0.0	1.0		216.7	
		Z	0.0	0.0	1.0		213.0	
10011-CAB	UMTS-FDD (WCDMA)	X	3.10	65.6	18.1	2.91	113.8	±1.2 %
		Y	3.30	67.3	19.2		130.0	
		Z	3.28	67.0	18.8		126.1	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	20.71	99.3	28.8	9.39	122.1	±1.7 %
		Y	18.18	99.4	28.5		128.5	
		Z	24.31	99.3	29.0		107.5	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.81	65.1	18.3	3.97	110.9	±0.7 %
		Y	3.95	66.4	19.1		127.7	
		Z	3.88	65.8	18.6		123.3	

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%.

[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY - Parameters of Probe: ER3DV6 - SN:2427

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
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Modulation Calibration Parameters

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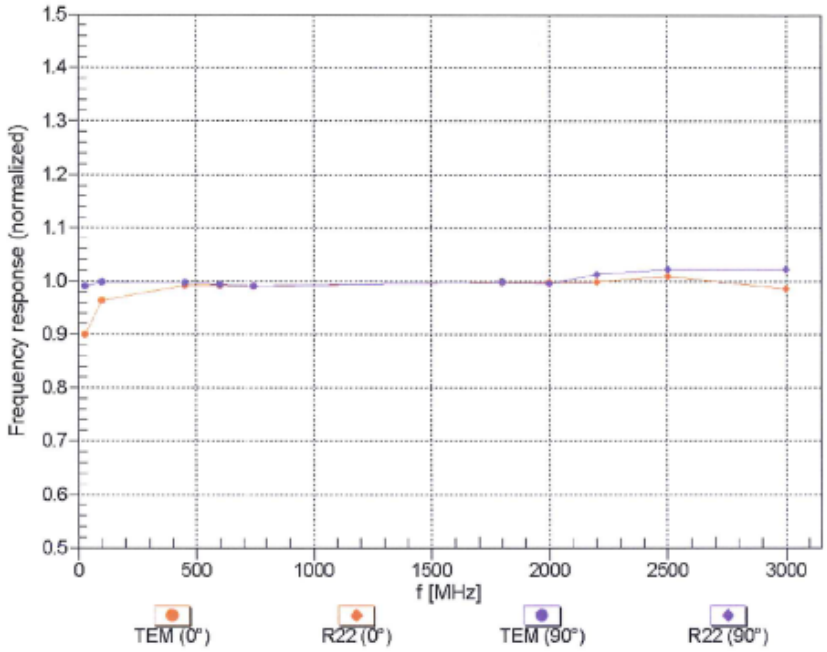
0	CW	X	0.0	0.0	1.0	0.00	193.3	±3.8 %
		Y	0.0	0.0	1.0		216.7	
		Z	0.0	0.0	1.0		213.0	
10011-CAB	UMTS-FDD (WCDMA)	X	3.10	65.6	18.1	2.91	113.8	±1.2 %
		Y	3.30	67.3	19.2		130.0	
		Z	3.28	67.0	18.8		126.1	
10021-DAB	GSM-FDD (TDMA, GMSK)	X	20.71	99.3	28.8	9.39	122.1	±1.7 %
		Y	18.18	99.4	28.5		128.5	
		Z	24.31	99.3	29.0		107.5	
10081-CAB	CDMA2000 (1xRTT, RC3)	X	3.81	65.1	18.3	3.97	110.9	±0.7 %
		Y	3.95	66.4	19.1		127.7	
		Z	3.88	65.8	18.6		123.3	

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%.

[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ER3DV6– SN:2427 March 13, 2014

Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

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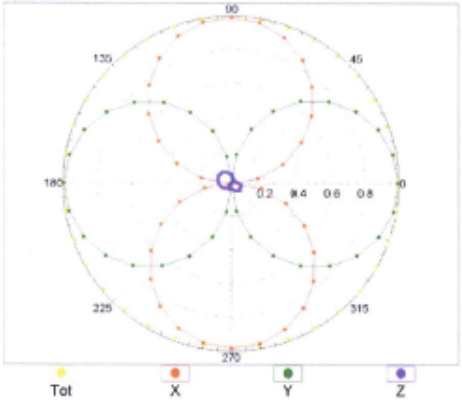
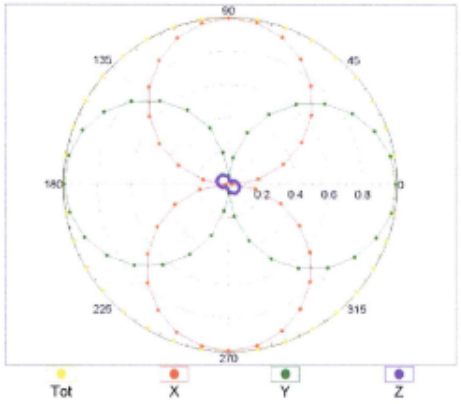
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM,0°

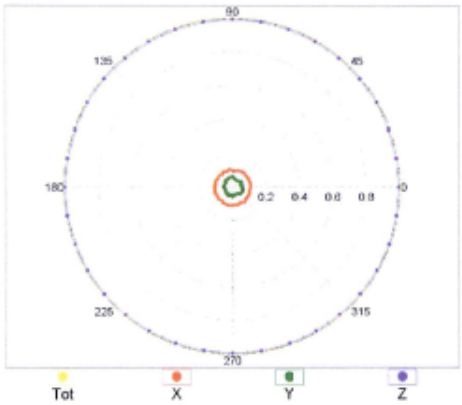


f=2500 MHz,R22,0°

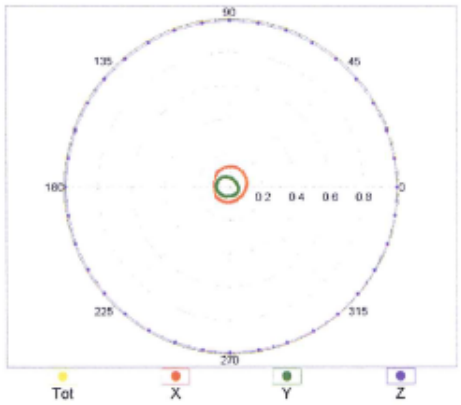


Receiving Pattern (ϕ), ϑ = 90°

f=600 MHz,TEM,90°



f=2500 MHz,R22,90°



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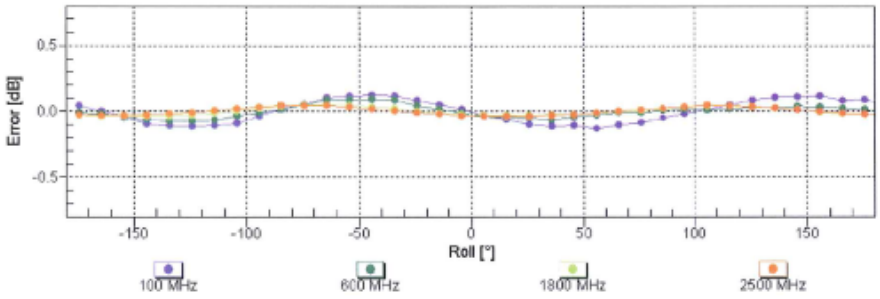
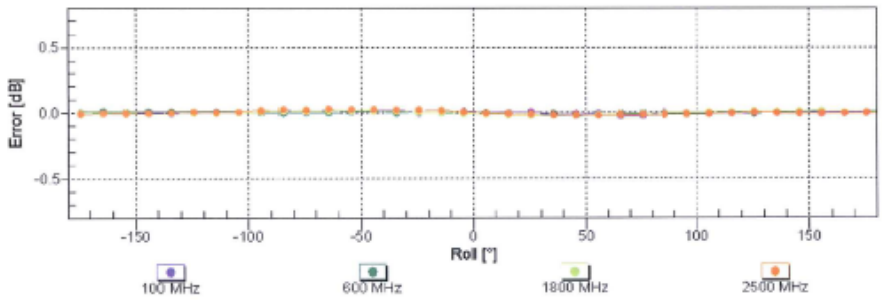
ER3DV6– SN:2427 March 13, 2014

Receiving Pattern (ϕ), ϑ = 0°



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

Receiving Pattern (ϕ), ϑ = 90°



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

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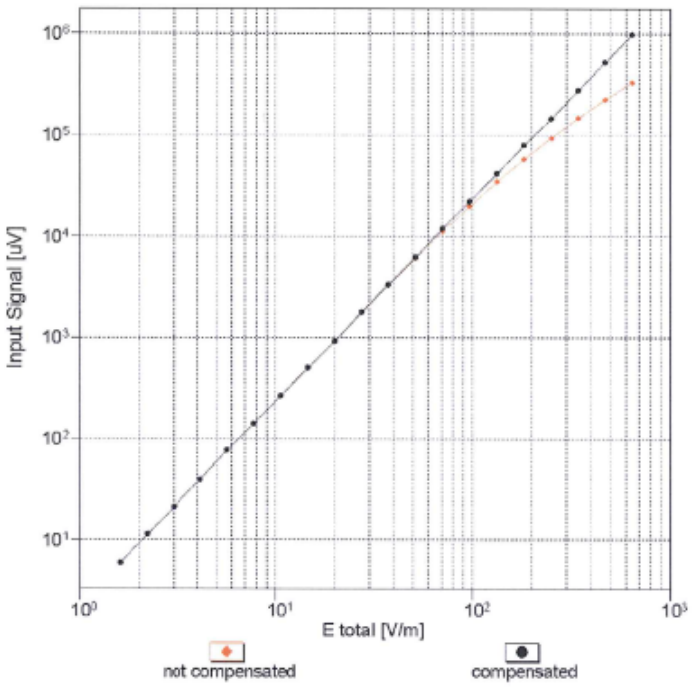
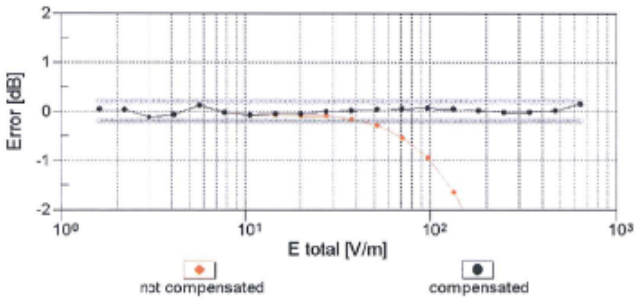
Dynamic Range f(E-field)
(TEM cell , f = 900 MHz)





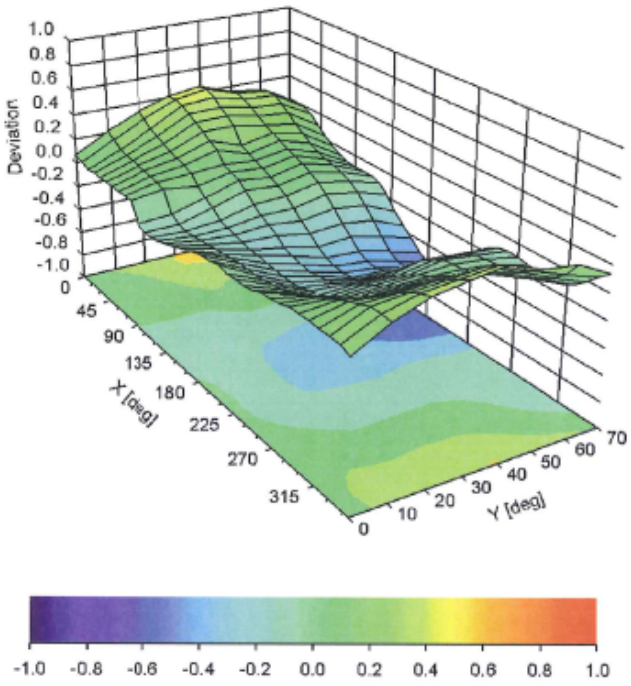
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

ER3DV6– SN:2427

March 13, 2014

Deviation from Isotropy in Air

Error (ϕ, ϑ), f = 900 MHz



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

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DASY/EASY - Parameters of Probe: ER3DV6 - SN:2427

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-24.3
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 Pont	2.5 mm