Hearing Aid Compatibility (HAC) TEST REPORT

<For RF-Emission Measurement>

Applicant Name	SHARP CORPORATION
Address of Applicant	22-22, Nagaike-cho, Abeno-ku, CS & Env. Promotion Div. Quality Compliance Dept. Osaka 545-8522, Japan
EUT Name	Smart Phone
Brand Name	SHARP
Model No.	HR00204
FCC ID	APYHRO00204
Date of receive	May. 27, 2014
Date of Test(s)	Jun. 26, 2014
Date of Issue	Jul. 03, 2014

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.

This report may only be reproduced and distributed in full. If the product in this report is used in any configuration other than that detailed in the report, the manufacturer must ensure the new system complies with all relevant standards. Any mention of SGS Taiwan Electronics & Communication Laboratory or testing done by SGS Taiwan Electronics & Communication Laboratory in connection with distribution or use of the product described in this report must be approved by SGS Taiwan Electronics & Communication Laboratory in writing.

Signed on behalf of SGS

Engineer	**Sr. Engineer**
Sam Kuo	John Yeh
Sam Kuo	**John Yeh**
Date: Jul. 03, 2014	**Date: Jul. 03, 2014**

Revision Version

Report Number	Revision	Description	Issue Date
ES/2014/50016	00	Initial Version	Jul. 03, 2014

This test report contains a reference to the previous version test report that it replaces.

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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 indication 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
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Telephone	+886-2-2299-3279
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Website	http://www.tw.sgs.com/

3. Details of Applicant

Applicant Name	SHARP CORPORATION
Applicant Address	22-22, Nagaike-cho, Abeno-ku, CS & Env. Promotion Div. Quality Compliance Dept. Osaka 545-8522, Japan

4. Description of EUT

EUT Name	Smart Phone
Brand Name	SHARP
Model No.	HR00204
FCC ID	APYHRO00204
MEID	99000527001210
Mode of Operation	☒CDMA ☒CDMA EVDO Rev.0/ Rev. A ☒LTE ☒WLAN802.11 b/g/n (20M) ☒Bluetooth

Duty Cycle	CDMA	1		
	CDMA EVDO Rev.0/ Rev. A	1		
	LTE	1		
	WLAN 802.11 b/g/n(20M)	1		
	Bluetooth	1		
TX Frequency Range (MHz)	CDMA (BC0)	824.7	—	848.31
	CDMA (BC1)	1851.25	—	1908.75
	CDMA (BC10)	817.9	—	823.1
	LTE FDD Band 25	1850	—	1915
	LTE FDD Band 26	814	—	849
	LTE FDD Band 41	2496	—	2690
	WLAN 802.11 b/g/n(20M)	2412	—	2462
	Bluetooth	2402	—	2480
Channel Number (ARFCN)	CDMA (BC0)	1013	—	777
	CDMA (BC1)	25	—	1175
	CDMA (BC10)	476	—	684
	LTE FDD Band 25	26140	—	26590
	LTE FDD Band 26	26740	—	26990
	LTE FDD Band 41	39750	—	41490
	WLAN 802.11 b/g/n(20M)	1	—	11
	Bluetooth	0	—	78

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5. Air Interfaces and Bands

Air- Interface	Band (MHZ)	Type Transport	C63.19 tested	Simultaneous Transmitter but not tested	Voice Over Digital Transport OTT capability
CDMA	CDMA(BC0)	VO	Yes	Yes, WiFi or Bluetooth	No
	CDM (BC1)				No
	CDMA(BC10)				No
CDMA EVDO Rev.0/ Rev. A	CDMA(BC0)	DT	NA	Yes, WiFi or Bluetooth	Yes
	CDM (BC1)				Yes
	CDMA(BC10)				Yes
LTE	Band 25	DT	NA	Yes, WiFi or Bluetooth	Yes
	Band 26				Yes
	Band 41				Yes
WiFi	2450	DT	NA	Yes, CDMA/LTE	Yes
Bluetooth	2450	DT	NA	Yes, CDMA/LTE	No
VO= CMRS Voice Service DT= Digital Transport					

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

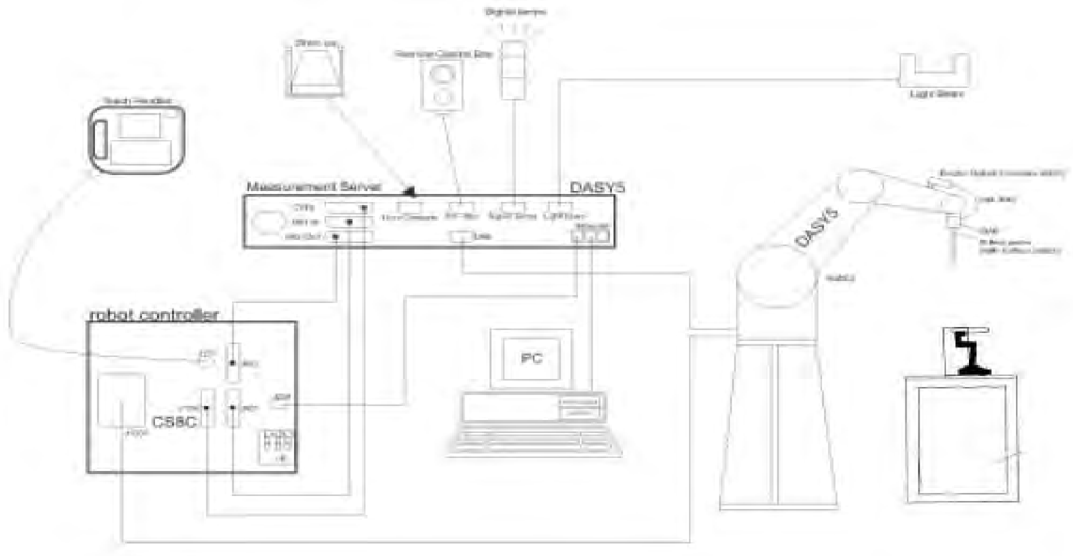

Fig.1 The SPEAG Robotic Diagram

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.
- A computer operating Windows 7.
- DASY5 software.

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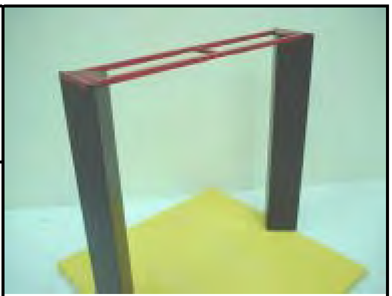
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The Test Arch phantom.
- The device holder for handheld mobile phones.
- Validation dipole kits allowing to validate the proper functioning of the system.

7.2 E Field Probe

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material	 ER3DV6 E-Field Probe
Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy ±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.	 Test Arch
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 <+/- 0.5 dB	 Phone Holder

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8. Test Procedure

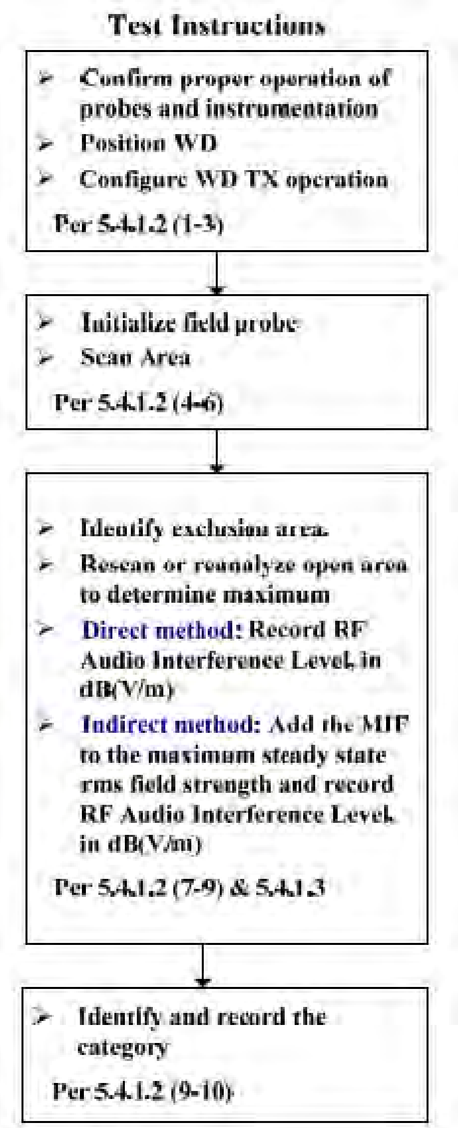

Fig.2 RF emission flow chart

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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 v04 item 10)a, handsets 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 separately.

At the present time the ANSI C63.19 standard 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.

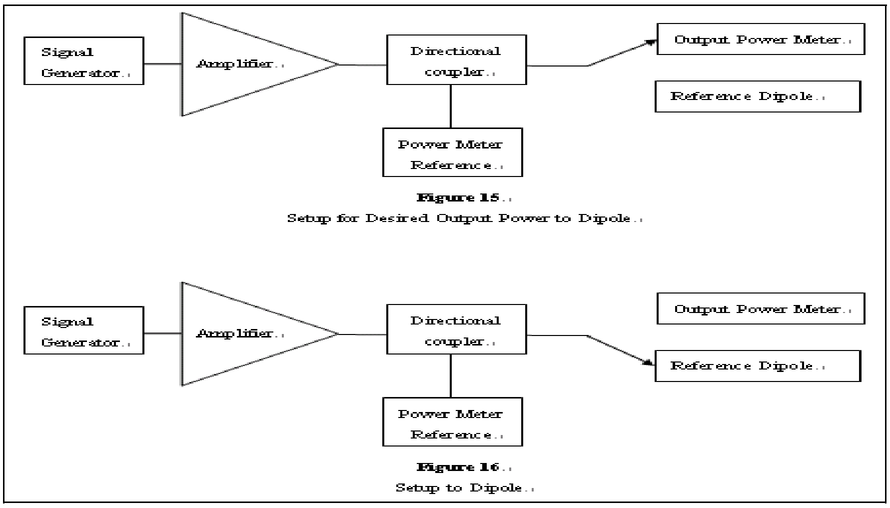

Fig.3 System verification

For E-Field Scan

Mode	Frequency (MHz)	Input Power(dBm)	Measured Value(V/m)	Target Value(V/m)	Measured Date
CW	835	20	111.3	111.7	Jun. 26, 2014
CW	1880	20	89.36	92.96	Jun. 26, 2014

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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 × log(step f))/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 Verision	Communication sysytem	MIF(dB)
10081	CAB (16.01.2014)	CDMA(SO3; RC3; full frame rate)	-19.71
10295	AAB (16.01.2014)	CDMA(SO3; RC1; 1/8 th frame rate)	3.26

11. Measured conducted output power

Band	Channel	Average power(dBm)
CDMA 1xRTT cellular(BC0) SO3;RC3	1013	23.18
	384	23.23
	777	23.16
CDMA 1xRTT cellular(BC0) SO3;RC1	1013	23.21
	384	23.24
	777	23.13
CDMA 1xRTT PCS(BC1) SO3;RC3	25	23.72
	600	23.52
	1175	23.53
CDMA 1xRTT PCS(BC1) SO3;RC1	25	23.75
	600	23.57
	1175	23.58
CDMA 1xRTT BC10 SO3;RC3	476	23.58
	560	23.53
	684	23.45
CDMA 1xRTT BC10 SO3;RC1	476	23.64
	560	23.61
	684	23.55

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12. Justification of held to ear modes tested

I. Analysis of RF air interface technologies

a. LTE, WiFi and other 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 average power(dB)	MIF(dB)	Power+MIF (dB)	ANSI C63.19 2011 test required
CDMA 1xRTT SO3;RC3	23.72	-19.71	4.01	No
CDMA 1xRTT SO3;RC1	23.13	3.26	26.39	Yes

\# We used the predetermined MIF to evaluate the low power exemption.
\# Based on ANSI. C63.19 2011, RF emission testing for CDMA 1xRTT SO3;RC3 is exempted.
\# Based on ANSI. C63.19 2011, CDMA 1xRTT SO3;RC3 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.29,2013	Nov.28,2014
Schmid & Partner Engineering AG	835/1880 MHz System Validation Dipole	CD835V3 CD1880V3	1052 1044	Mar.25,2014 Mar.25,2014	Mar.24,2015 Mar.24,2015
Schmid & Partner Engineering AG	Data acquisition Electronics	DAE4	547	Mar.26,2014	Mar.25,2015
Schmid & Partner Engineering AG	Software	DASY52 52.8.8	N/A	Calibration not required	Calibration not required
Agilent	Dielectric Probe Kit	85070D	US01440168	Calibration not required	Calibration not required
Agilent	Dual-directional coupler	778D	50313	Aug.28.2013	Aug.27.2014
Agilent	RF Signal Generator	N5181A	MY50141235	Dec.24,2013	Dec.23,2016
R&S	Radio Communication Test	CMU200	122498	Jul.17,2013	Jul.16,2014
Schmid & Partner Engineering AG	Test Arch SD HAC	P01	1047	Calibration not required	Calibration not required
Agilent	Power Meter	E4417A	MY51410006	Oct.25,2013	Oct.24,2015

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
CDMA (BC0)	1013	3.26	23.21	0.13	28.35	M4	124
	384	3.26	23.24	0.04	28.42	M4	123
	777	3.26	23.13	-0.00	28.36	M4	236
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**
CDMA (BC1)	25	3.26	23.75	-0.00	27.36	M4	789
	600	3.26	23.57	-0.11	26.08	M4	789
	1175	3.26	23.58	-0.08	24.97	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**
CDMA (BC10)	476	3.26	23.64	-0.04	28.81	M4	123
	560	3.26	23.61	-0.01	28.87	M4	123
	684	3.26	23.55	0.01	28.91	M4	123

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16. Measurement Data

Date: 2014/6/26

HAC-E_CDMA(BC0)_CH1013

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 824.7 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 20.67 V/m; Power Drift = 0.13 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.35 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.46 dBV/m**	Grid 2 **M4** **29.09 dBV/m**	Grid 3 **M4** **28.82 dBV/m**
Grid 4 **M4** **27.36 dBV/m**	Grid 5 **M4** **28.35 dBV/m**	Grid 6 **M4** **28.26 dBV/m**
Grid 7 **M4** **26.13 dBV/m**	Grid 8 **M4** **27.28 dBV/m**	Grid 9 **M4** **27.25 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

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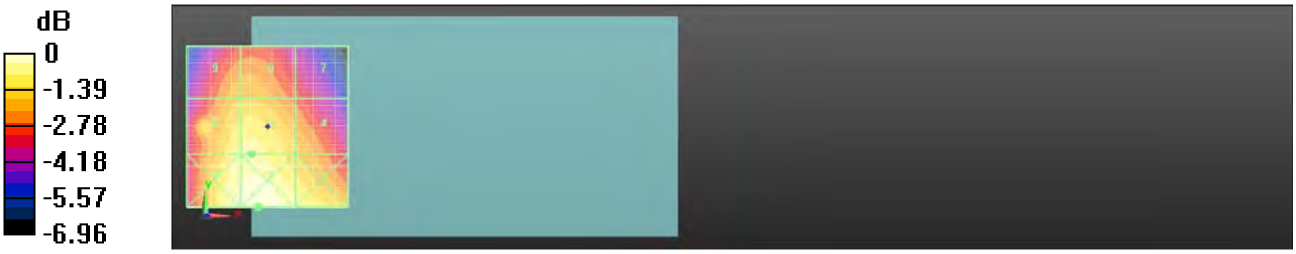
Cursor:
Total = 29.09 dBV/m
E Category: M4
Location: -3, -25, 8.7 mm



0 dB = 28.48 V/m = 29.09 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC0)_CH384

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 836.52 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 21.40 V/m; Power Drift = 0.04 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.42 dBV/m

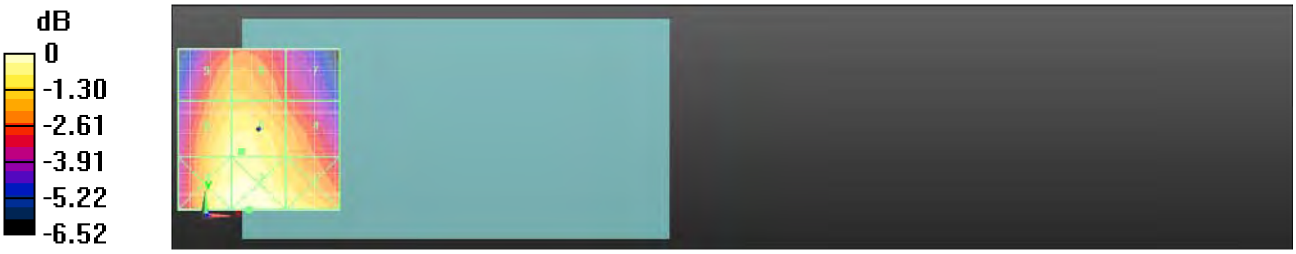
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.53 dBV/m**	Grid 2 **M4** **29.06 dBV/m**	Grid 3 **M4** **28.85 dBV/m**
Grid 4 **M4** **27.48 dBV/m**	Grid 5 **M4** **28.42 dBV/m**	Grid 6 **M4** **28.37 dBV/m**
Grid 7 **M4** **26.33 dBV/m**	Grid 8 **M4** **27.53 dBV/m**	Grid 9 **M4** **27.52 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 = 29.06 dBV/m
E Category: M4
Location: -3, -25, 8.7 mm



0 dB = 28.40 V/m = 29.07 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC0)_CH777

Communication System: UID 10295 - AAB, CDMA2000, RC1, SO3, 1/8th Rate 25 fr.;
Frequency: 848.31 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 21.33 V/m; Power Drift = -0.00 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.36 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.18 dBV/m**	Grid 2 **M4** **28.84 dBV/m**	Grid 3 **M4** **28.61 dBV/m**
Grid 4 **M4** **27.3 dBV/m**	Grid 5 **M4** **28.36 dBV/m**	Grid 6 **M4** **28.32 dBV/m**
Grid 7 **M4** **26.39 dBV/m**	Grid 8 **M4** **27.71 dBV/m**	Grid 9 **M4** **27.69 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

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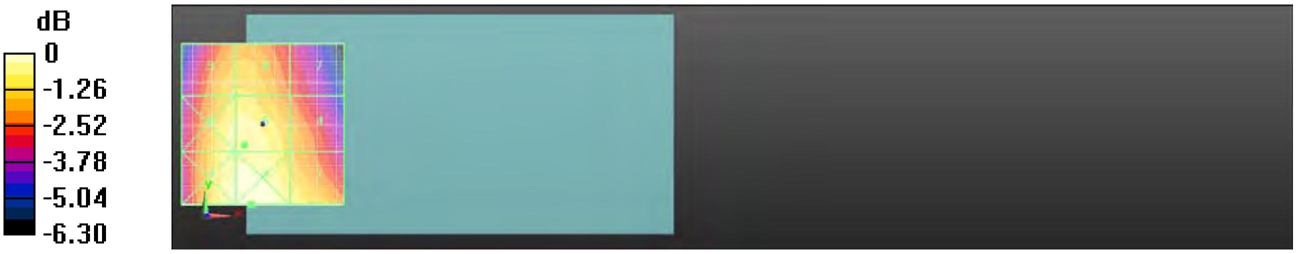
Cursor:
Total = 28.84 dBV/m
E Category: M4
Location: -3.5, -25, 8.7 mm



0 dB = 27.67 V/m = 28.84 dBV/m

Date: 2014/6/26

HAC-E_CDMA(BC1)_CH25

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 1851.25 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 8.832 V/m; Power Drift = -0.00 dB
Applied MIF = 3.26 dB
RF audio interference level = 27.36 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **23.05 dBV/m**	Grid 2 **M4** **26.38 dBV/m**	Grid 3 **M4** **27.36 dBV/m**
Grid 4 **M4** **21.15 dBV/m**	Grid 5 **M4** **23.89 dBV/m**	Grid 6 **M4** **24.88 dBV/m**
Grid 7 **M4** **25.91 dBV/m**	Grid 8 **M4** **27.72 dBV/m**	Grid 9 **M4** **26.1 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

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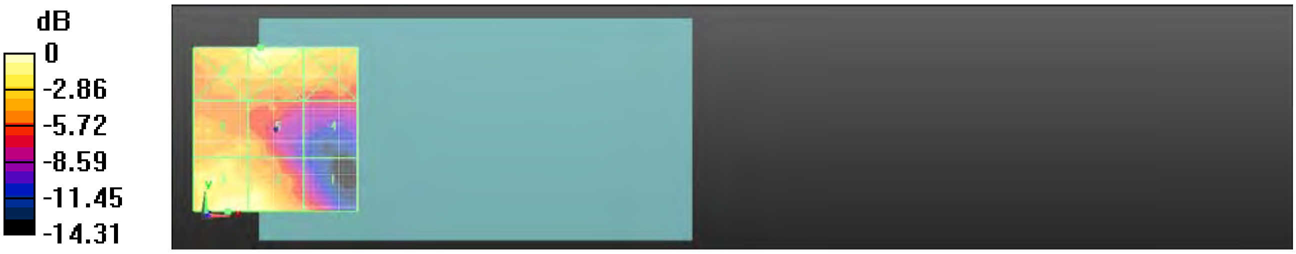
Cursor:
Total = 27.72 dBV/m
E Category: M4
Location: -4.5, 25, 8.7 mm



0 dB = 24.33 V/m = 27.72 dBV/m

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Date: 2014/6/26

HAC-E_CDMA(BC1)_CH600

Communication System: UID 10295 - AAB, CDMA2000, RC1, SO3, 1/8th Rate 25 fr.;
Frequency: 1880 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 6.531 V/m; Power Drift = -0.11 dB
Applied MIF = 3.26 dB
RF audio interference level = 26.08 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **21.25 dBV/m**	Grid 2 **M4** **26.08 dBV/m**	Grid 3 **M4** **25.71 dBV/m**
Grid 4 **M4** **20.68 dBV/m**	Grid 5 **M4** **22.03 dBV/m**	Grid 6 **M4** **23.53 dBV/m**
Grid 7 **M4** **25.58 dBV/m**	Grid 8 **M4** **26.09 dBV/m**	Grid 9 **M4** **26.16 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

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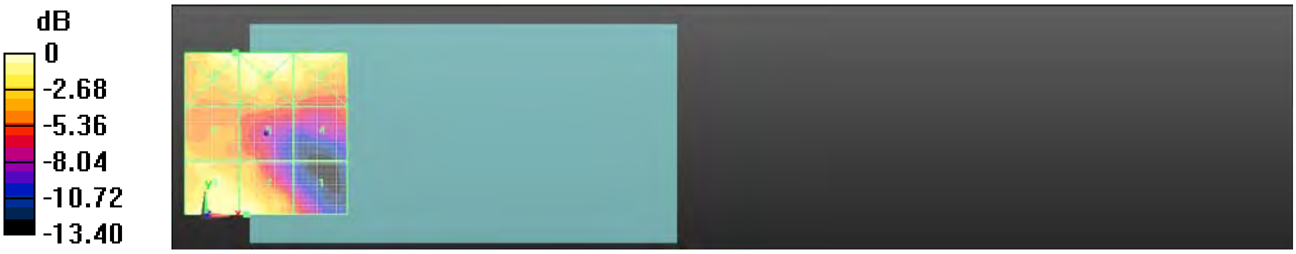
Cursor:
Total = 26.16 dBV/m
E Category: M4
Location: -9.5, 25, 8.7 mm



0 dB = 20.32 V/m = 26.16 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC1)_CH1175

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 1902.75 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 6.020 V/m; Power Drift = -0.08 dB
Applied MIF = 3.26 dB
RF audio interference level = 24.97 dBV/m

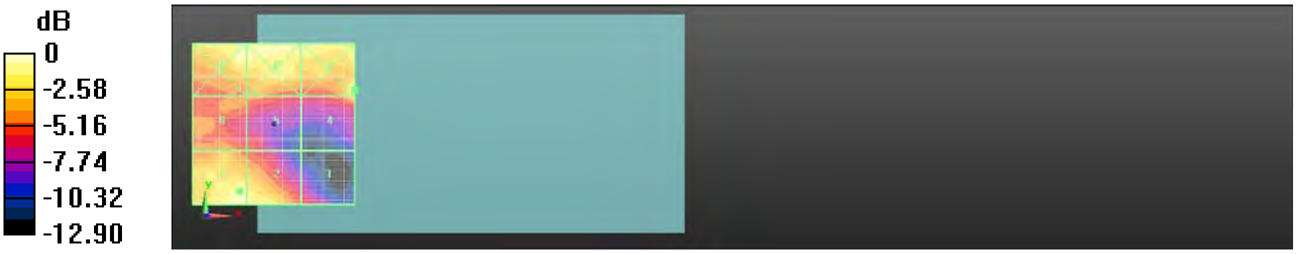
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **20.72 dBV/m**	Grid 2 **M4** **24.67 dBV/m**	Grid 3 **M4** **24.97 dBV/m**
Grid 4 **M4** **24.41 dBV/m**	Grid 5 **M4** **21.58 dBV/m**	Grid 6 **M4** **22.35 dBV/m**
Grid 7 **M4** **26.16 dBV/m**	Grid 8 **M4** **25.69 dBV/m**	Grid 9 **M4** **25.01 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 = 26.16 dBV/m
E Category: M4
Location: 25, 10.5, 8.7 mm



0 dB = 20.33 V/m = 26.16 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC10)_CH476

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 817.9 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 22.61 V/m; Power Drift = -0.04 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.81 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.9 dBV/m**	Grid 2 **M4** **29.42 dBV/m**	Grid 3 **M4** **29.24 dBV/m**
Grid 4 **M4** **27.92 dBV/m**	Grid 5 **M4** **28.81 dBV/m**	Grid 6 **M4** **28.74 dBV/m**
Grid 7 **M4** **26.72 dBV/m**	Grid 8 **M4** **27.91 dBV/m**	Grid 9 **M4** **27.86 dBV/m**

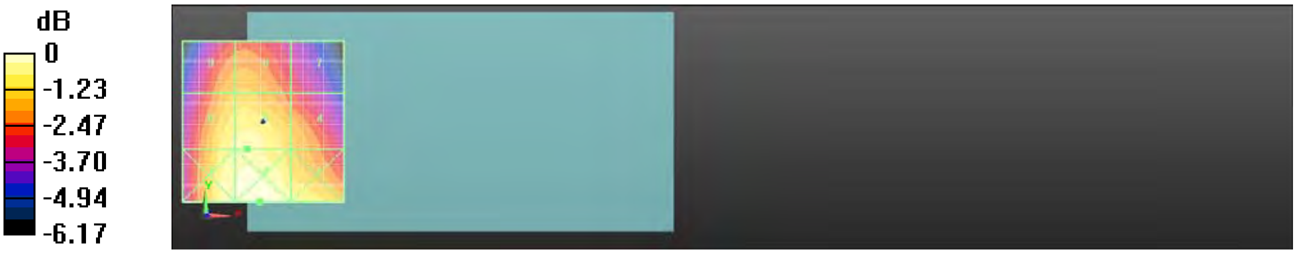
Category	Limits for E-Field Emissions < 960MHz	Limits for E-Field Emissions > 960MHz
M1	50 dBV/m - 55 dB V/m	40 dBV/m - 45 dB V/m
M2	45 dBV/m - 50 dB V/m	35 dBV/m - 40 dB V/m
M3	40 dBV/m - 45 dB V/m	30 dBV/m - 35 dB V/m
M4	<40 dBV/m	<30 dBV/m

Cursor:

Total = 29.42 dBV/m

E Category: M4

Location: -1, -25, 8.7 mm



0 dB = 29.59 V/m = 29.42 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC10)_CH560

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 820 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 22.69 V/m; Power Drift = -0.01 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.87 dBV/m

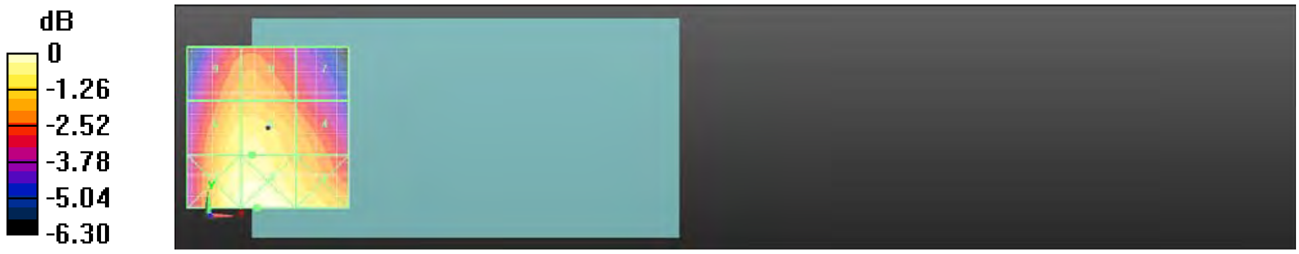
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **29.04 dBV/m**	Grid 2 **M4** **29.49 dBV/m**	Grid 3 **M4** **29.34 dBV/m**
Grid 4 **M4** **27.9 dBV/m**	Grid 5 **M4** **28.87 dBV/m**	Grid 6 **M4** **28.72 dBV/m**
Grid 7 **M4** **26.83 dBV/m**	Grid 8 **M4** **27.9 dBV/m**	Grid 9 **M4** **27.84 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 = 29.49 dBV/m
E Category: M4
Location: -3.5, -25, 8.7 mm



0 dB = 29.81 V/m = 29.49 dBV/m

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Date: 2014/6/26

HAC-E_CDMA (BC10)_CH684

Communication System: CDMA2000, RC1, SO3, 1/8th Rate 25 fr.; Frequency: 823.1 MHz
Medium parameters used: $\sigma = 0$ S/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; ;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

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 = 22.89 V/m; Power Drift = 0.01 dB
Applied MIF = 3.26 dB
RF audio interference level = 28.91 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.99 dBV/m**	Grid 2 **M4** **29.58 dBV/m**	Grid 3 **M4** **29.31 dBV/m**
Grid 4 **M4** **28.06 dBV/m**	Grid 5 **M4** **28.91 dBV/m**	Grid 6 **M4** **28.82 dBV/m**
Grid 7 **M4** **26.82 dBV/m**	Grid 8 **M4** **27.98 dBV/m**	Grid 9 **M4** **27.97 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

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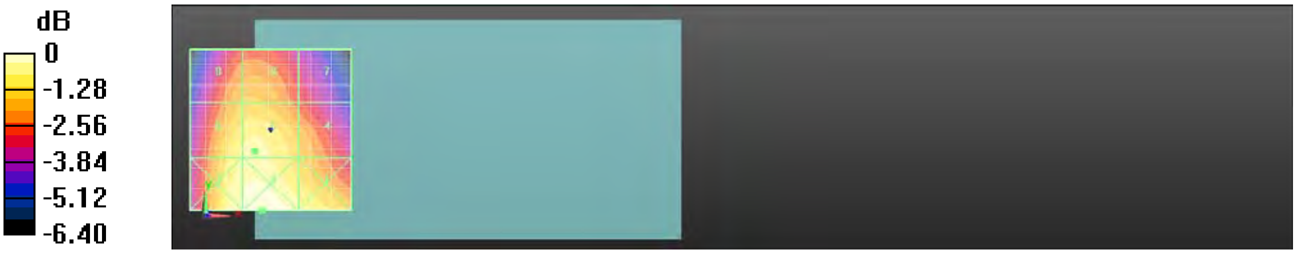
Cursor:
Total = 29.58 dBV/m
E Category: M4
Location: -2.5, -25, 8.7 mm



0 dB = 30.14 V/m = 29.58 dBV/m

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17. System Verification

Date: 2014/6/26

Dipole CD835_SN:1052

Communication System: CW; Frequency: 835 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:

- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole E-Field measurement: Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 124.8 V/m; Power Drift = 0.05 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 111.3 V/m

Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M4** **101.2 V/m**	Grid 2 **M4** **111.1 V/m**	Grid 3 **M4** **111.3 V/m**
Grid 4 **M4** **67.91 V/m**	Grid 5 **M4** **67.91 V/m**	Grid 6 **M4** **63.67 V/m**
Grid 7 **M4** **120.0 V/m**	Grid 8 **M4** **118.5 V/m**	Grid 9 **M4** **104.5 V/m**

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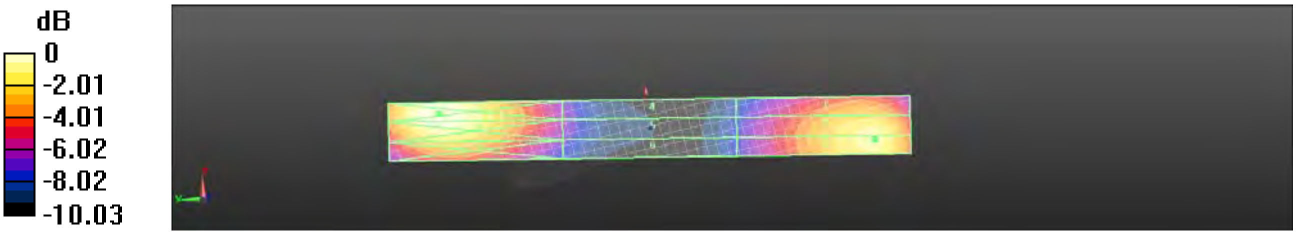
Cursor:
Total = 120.0 V/m
E Category: M4
Location: 6, 72.5, 9.7 mm



0 dB = 120.0 V/m = 41.58 dBV/m

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Date: 2014/6/26

Dipole CD1880_SN:1044
Communication System: CW; Frequency: 1880 MHz
Medium parameters used: σ = 0 S/m, ε_r = 1; ρ = 1000 kg/m^3
Phantom section: RF Section

DASY5 Configuration:
- Probe: ER3DV6 - SN2306; ConvF(1, 1, 1); Calibrated: 2013/11/29;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn547; Calibrated: 2014/3/26
- Phantom: HAC Test Arch; Type:
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Dipole E-Field measurement : Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 157.2 V/m; Power Drift = 0.00 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 89.36 V/m
Near-field category: M3 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M3** **85.96 V/m**	Grid 2 **M3** **89.36 V/m**	Grid 3 **M3** **89.20 V/m**
Grid 4 **M3** **76.45 V/m**	Grid 5 **M3** **76.45 V/m**	Grid 6 **M3** **72.24 V/m**
Grid 7 **M3** **102.1 V/m**	Grid 8 **M3** **102.1 V/m**	Grid 9 **M3** **92.77 V/m**

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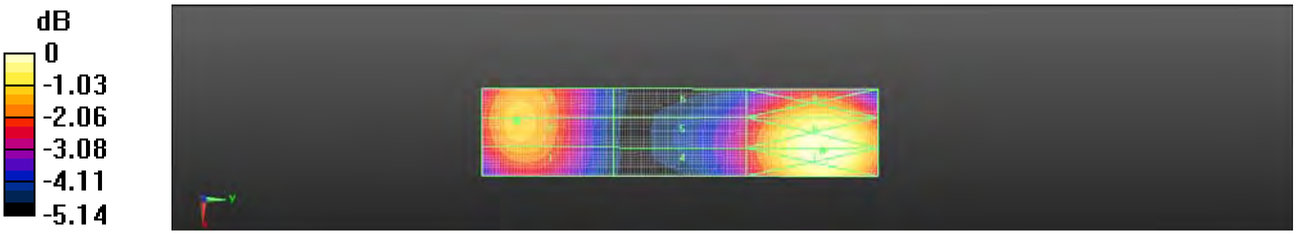
Cursor:
Total = 102.1 V/m
E Category: M3
Location: 4, 32.5, 9.7 mm



0 dB = 102.1 V/m = 40.18 dBV/m

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18. DAE & Probe Calibration Certificate

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Accreditation No.: SCS 108

Client SGS - TW (Auden)

Certificate No: DAE4-547_Mar14

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 547

Calibration procedure(s): QA CAL-06.v26
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: March 26, 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
Keithley Multimeter Type 2001	SN: 0810278	01-Oct-13 (No:13976)	Oct-14
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-14 (in house check)	In house check: Jan-15
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-14 (in house check)	In house check: Jan-15

	Name	Function	Signature
Calibrated by:	Eric Hainfeld	Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: March 26, 2014

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Certificate No: DAE4-547_Mar14 Page 1 of 5

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Accreditation No.: SCS 108

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	404.032 ± 0.02% (k=2)	404.058 ± 0.02% (k=2)	404.202 ± 0.02% (k=2)
Low Range	3.95713 ± 1.50% (k=2)	3.96202 ± 1.50% (k=2)	3.97561 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	158.0 ° ± 1 °

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Appendix

1. DC Voltage Linearity

High Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	199995.43	-0.60	-0.00
Channel X	+ Input	20004.43	4.15	0.02
Channel X	- Input	-19997.69	3.25	-0.02
Channel Y	+ Input	199994.87	-1.15	-0.00
Channel Y	+ Input	19998.43	-1.93	-0.01
Channel Y	- Input	-20001.87	-0.85	0.00
Channel Z	+ Input	199997.48	1.41	0.00
Channel Z	+ Input	20001.10	0.79	0.00
Channel Z	- Input	-20003.63	-2.53	0.01

Low Range		Reading (µV)	Difference (µV)	Error (%)
Channel X	+ Input	2000.64	0.17	0.01
Channel X	+ Input	201.77	0.85	0.42
Channel X	- Input	-199.11	-0.24	0.12
Channel Y	+ Input	2000.97	0.62	0.03
Channel Y	+ Input	200.19	-0.69	-0.34
Channel Y	- Input	-199.95	-0.97	0.49
Channel Z	+ Input	2000.53	0.21	0.01
Channel Z	+ Input	200.38	-0.40	-0.20
Channel Z	- Input	-199.62	-0.59	0.29

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	19.65	17.65
	- 200	-14.62	-15.78
Channel Y	200	-6.89	-7.43
	- 200	3.98	4.06
Channel Z	200	20.93	20.98
	- 200	-22.42	-22.42

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	-	2.53	-2.12
Channel Y	200	9.67	-	3.63
Channel Z	200	5.84	6.75	-

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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	16141	15478
Channel Y	16453	16523
Channel Z	15984	17120

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	2.01	0.79	3.52	0.47
Channel Y	-0.51	-1.15	0.66	0.34
Channel Z	-0.87	-1.96	0.11	0.45

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

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	-8	-9

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Accreditation No.: **SCS 108**

Client **SGS-TW (Auden)**

Certificate No: **ER3-2306_Nov13**

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 29, 2013

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-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El Naouq	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: November 29, 2013

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Certificate No: ER3-2306_Nov13   Page 1 of 10

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Accreditation No.: **SCS 108**

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).

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Probe ER3DV6

SN:2306

Manufactured: December 17, 2002
Calibrated: November 29, 2013

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

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

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)	1.10	1.12	1.25	± 10.1 %
DCP (mV)[B]	101.2	100.6	103.5	

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	175.8	±2.7 %
		Y	0.0	0.0	1.0		227.8	
		Z	0.0	0.0	1.0		225.3	
10011-CAA	UMTS-FDD (WCDMA)	X	3.17	66.6	18.4	2.91	144.4	±0.5 %
		Y	3.19	66.6	18.3		134.4	
		Z	3.27	67.3	18.6		131.5	
10012-CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	X	2.51	66.4	17.6	1.87	145.8	±0.7 %
		Y	2.45	65.8	17.3		135.7	
		Z	2.77	68.1	18.3		132.6	
10013-CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	X	10.33	69.6	23.0	9.46	133.1	±2.2 %
		Y	10.19	69.1	22.6		122.7	
		Z	10.23	69.4	22.7		120.4	
10021-DAA	GSM-FDD (TDMA, GMSK)	X	4.03	77.8	20.0	9.39	122.5	±1.9 %
		Y	3.15	73.4	17.8		148.7	
		Z	3.93	73.6	17.1		148.2	
10039-CAA	CDMA2000 (1xRTT, RC1)	X	4.40	66.1	18.8	4.57	135.1	±0.7 %
		Y	4.35	65.8	18.6		127.1	
		Z	4.36	66.0	18.6		122.3	
10081-CAA	CDMA2000 (1xRTT, RC3)	X	3.67	65.4	18.2	3.97	133.3	±0.7 %
		Y	3.69	65.4	18.2		125.8	
		Z	3.70	65.8	18.3		120.9	
10114-CAA	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	X	10.24	69.7	22.1	8.10	139.2	±2.7 %
		Y	10.20	69.5	21.9		130.9	
		Z	9.94	68.7	21.3		125.1	
10193-CAA	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	X	9.78	69.3	21.9	8.09	133.5	±2.5 %
		Y	9.72	69.0	21.7		125.1	
		Z	9.45	68.3	21.1		119.0	
10295-AAA	CDMA2000, RC1, SO3, 1/8th Rate 25 fr.	X	6.13	73.3	28.9	12.49	97.0	±1.9 %
		Y	6.05	72.5	28.2		92.8	
		Z	6.86	74.9	28.6		94.3	

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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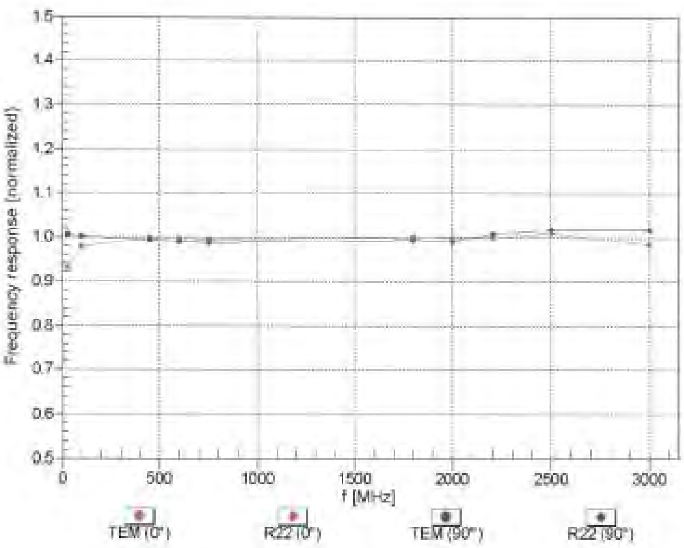
ER3DV6 - SN:2306 November 29, 2013

Frequency Response of E-Field

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



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

Certificate No: ER3-2306_Nov13 Page 5 of 10

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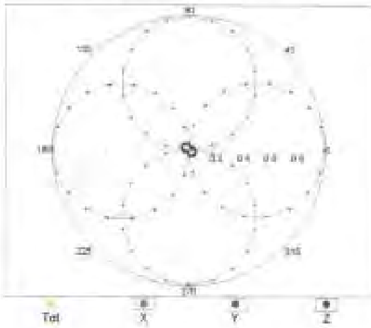
Receiving Pattern (ϕ), $\vartheta = 0°$

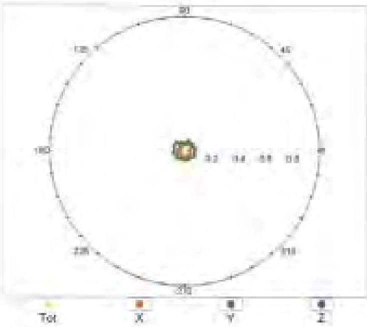
f=600 MHz,TEM,0°

f=2500 MHz,R22,0°

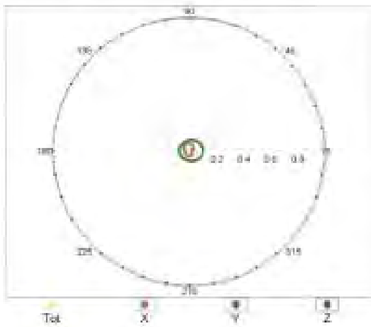


Receiving Pattern (ϕ), $\vartheta = 90°$

f=600 MHz,TEM,90°



f=2500 MHz,R22,90°



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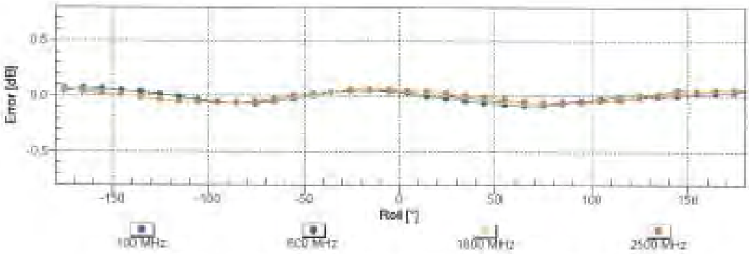
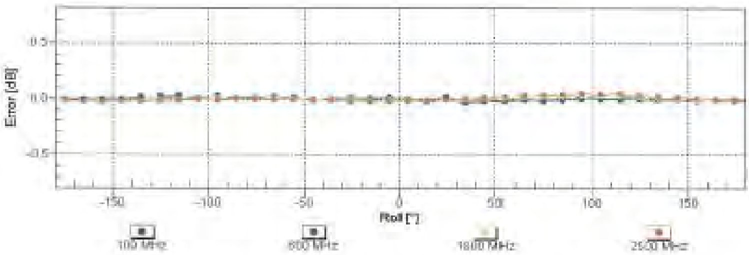
Receiving Pattern (ϕ), ϑ = 0°



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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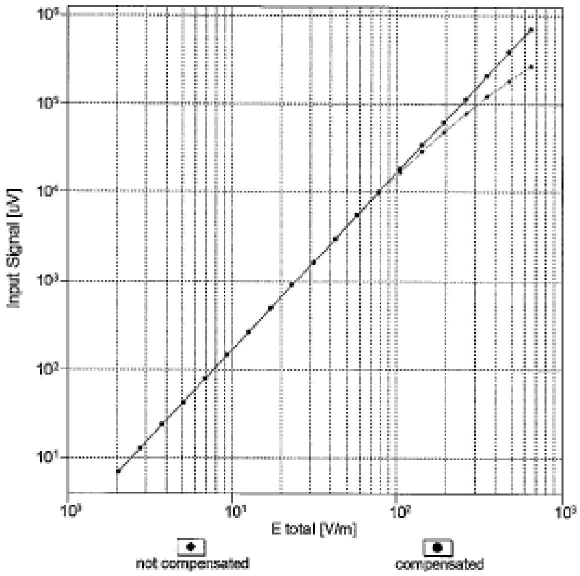
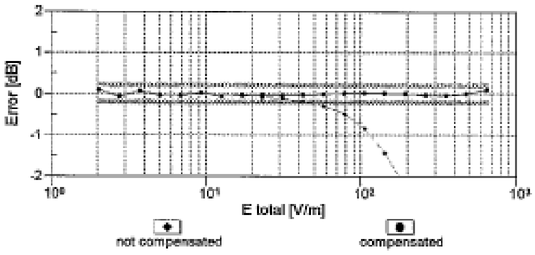
ER3DV6– SN:2306 November 29, 2013

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





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

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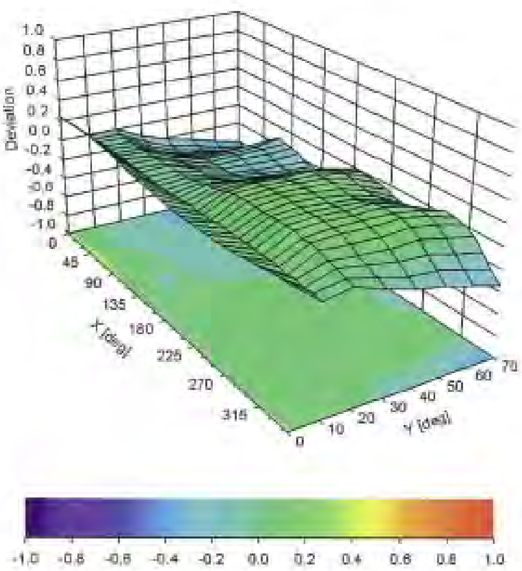
ER3DV6- SN:2306 November 29, 2013

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:2306

Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	-45.5
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	$\sqrt{3}$	1	1	±2.7 %	±2.7 %
Sensor Displacement	±16.5 %	R	$\sqrt{3}$	1	0.145	±9.5 %	±1.4 %
Boundary Effects	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %
Phantom Boundary Effect	±7.2 %	R	$\sqrt{3}$	1	0	±4.1 %	±0.0 %
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %
Scaling with PMR calibration	±10.0 %	R	$\sqrt{3}$	1	1	±5.8 %	±5.8 %
System Detection Limit	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %
RF Ambient Conditions	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %
RF Reflections	±12.0 %	R	$\sqrt{3}$	1	1	±6.9 %	±6.9 %
Probe Positioner	±1.2 %	R	$\sqrt{3}$	1	0.67	±0.7 %	±0.5 %
Probe Positioning	±4.7 %	R	$\sqrt{3}$	1	0.67	±2.7 %	±1.8 %
Extrap. and Interpolation	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Test Sample Related							
Device Positioning Vertical	±4.7 %	R	$\sqrt{3}$	1	0.67	±2.7 %	±1.8 %
Device Positioning Lateral	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %
Device Holder and Phantom	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %
Phantom and Setup Related							
Phantom Thickness	±2.4 %	R	$\sqrt{3}$	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

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

Accreditation No.: **SCS 108**

Client **SGS-TW (Auden)**

Certificate No: **CD835V3-1052_Mar14**

CALIBRATION CERTIFICATE

Object: CD835V3 - SN: 1052

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

Calibration date: March 25, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Power sensor HP E4412A	SN: MY41495277	01-Apr-08 (in house check Oct-13)	In house check: Oct-15
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-13)	In house check: Oct-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-13)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	
Approved by:	Fin Bomholt	Deputy Technical Manager	

Issued: March 26, 2014

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Certificate No: CD835V3-1052_Mar14 Page 1 of 8

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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.

[2] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm (15 mm for [2]) above the top metal edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections.
It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was 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] and [2], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (15 mm for [2]) (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10mm, 15mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz ± 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 835 MHz

H-field 10 mm above dipole surface	condition	**interpolated maximum**
Maximum measured	100 mW input power	**0.469 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	173.2 V / m
Maximum measured above low end	100 mW input power	155.4 V / m
Averaged maximum above arm	100 mW input power	**164.3 V / m ± 12.8 % (k=2)**

E-field 15 mm above dipole surface	condition	**Interpolated maximum**
Maximum measured above high end	100 mW input power	111.7 V / m
Maximum measured above low end	100 mW input power	102.5 V / m
Averaged maximum above arm	100 mW input power	**107.1 V / m ± 12.8 % (k=2)**

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Appendix

Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	16.1 dB	44.4 Ω - 13.9 jΩ
835 MHz	31.1 dB	49.9 Ω + 2.8 jΩ
900 MHz	17.0 dB	56.9 Ω - 13.7 jΩ
950 MHz	19.8 dB	45.7 Ω + 8.9 jΩ
960 MHz	14.9 dB	53.3 Ω + 16.5 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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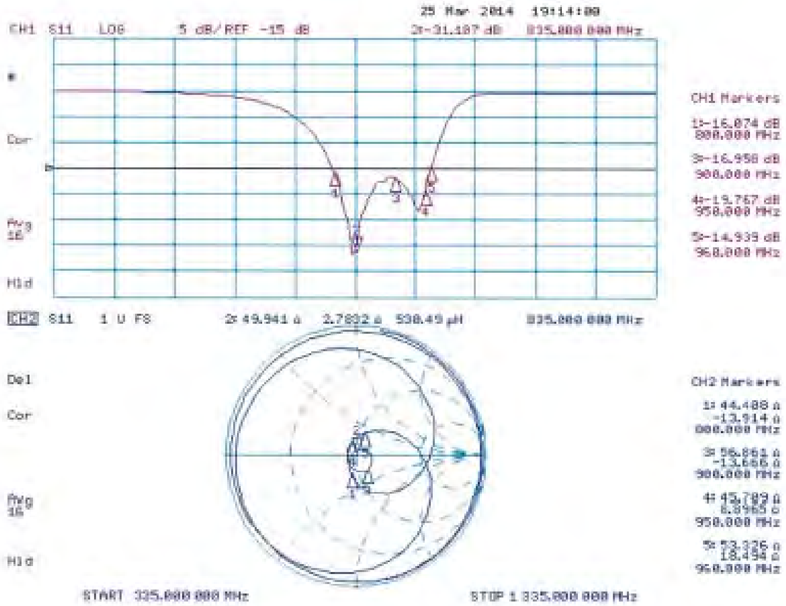
Impedance Measurement Plot



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DASY5 H-field Result

Date: 25.03.2014

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, $\varepsilon_r = 1$; $\rho = 1$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

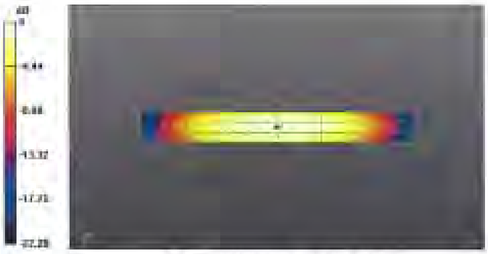
DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 30.12.2013
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 13.09.2013
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole 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 = 0.4970 A/m; Power Drift = 0.00 dB
PMR not calibrated. PMF = 1.000 is applied.
H-field emissions = 0.4688 A/m
Near-field category: M4 (AWF 0 dB)

PMF scaled H-field

Grid 1 **M4** **0.381 A/m**	Grid 2 **M4** **0.407 A/m**	Grid 3 **M4** **0.392 A/m**
Grid 4 **M4** **0.432 A/m**	Grid 5 **M4** **0.469 A/m**	Grid 6 **M4** **0.455 A/m**
Grid 7 **M4** **0.381 A/m**	Grid 8 **M4** **0.421 A/m**	Grid 9 **M4** **0.410 A/m**



0 dB = 0.4688 A/m = -6.58 dBA/m

Certificate No: CD835V3-1052_Mar14 Page 6 of 8

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DASY5 E-field Result

Date: 21.03.2014

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: σ = 0 S/m, $\epsilon_r = 1$; ρ = 1000 kg/m³
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

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

Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=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 = 126.3 V/m; Power Drift = 0.03 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 173.2 V/m
Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M4** **144.2 V/m**	Grid 2 **M4** **155.4 V/m**	Grid 3 **M4** **153.6 V/m**
Grid 4 **M4** **84.83 V/m**	Grid 5 **M4** **91.98 V/m**	Grid 6 **M4** **91.36 V/m**
Grid 7 **M4** **159.7 V/m**	Grid 8 **M4** **173.2 V/m**	Grid 9 **M4** **172.1 V/m**

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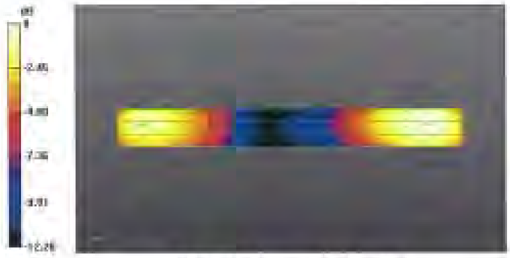
Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=15mm/Hearing Aid Compatibility Test (41x361x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 126.7 V/m; Power Drift = 0.01 dB
PMR not calibrated, PMF = 1.000 is applied.
E-field emissions = 111.7 V/m
Near-field category: M4 (AWF 0 dB)

PMF scaled E-field

Grid 1 M4 **98.07 V/m**	Grid 2 M4 **102.5 V/m**	Grid 3 M4 **102.0 V/m**
Grid 4 M4 **63.14 V/m**	Grid 5 M4 **65.98 V/m**	Grid 6 M4 **65.91 V/m**
Grid 7 M4 **106.8 V/m**	Grid 8 M4 **111.7 V/m**	Grid 9 M4 **111.4 V/m**



0 dB = 173.2 V/m = 44.77 dBV/m

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Accreditation No.: SCS 108

Client SGS-TW (Auden)

Certificate No: CD1880V3-1044_Mar14

CALIBRATION CERTIFICATE

Object: CD1880V3 - SN: 1044

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

Calibration date: March 25, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

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

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

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Fin Bomholt	Deputy Technical Manager	F. Bomholt

Issued: March 26, 2014

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Certificate No: CD1880V3-1044_Mar14 Page 1 of 5

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S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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**

References

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

[2] ANSI-C63.19-2011
American National Standard, Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids.

Methods Applied and Interpretation of Parameters:

- *Coordinate System:* y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 10 mm (15 mm for [2]) above the top metal edge of the dipole arms.
- *Measurement Conditions:* Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- *Antenna Positioning:* The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections.
It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- *Feed Point Impedance and Return Loss:* These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was 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] and [2], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 10 mm (15 mm for [2]) (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.
- *H-field distribution:* H-field is measured with an isotropic H-field probe with 100mW forward power to the antenna feed point, in the x-y-plane. The scan area and sensor distance is equivalent to the E-field scan. The maximum of the field is available at the center (subgrid 5) above the feed point. The H-field value stated as calibration value represents the maximum of the interpolated H-field, 10mm above the dipole surface at the feed point.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

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Measurement Conditions

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

DASY Version	DASY5	V52.8.7
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	10mm,15mm	
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	**0.474 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	146.9 V / m
Maximum measured above low end	100 mW input power	141.1 V / m
Averaged maximum above arm	100 mW input power	**144.0 V / m ± 12.8 % (k=2)**

E-field 15 mm above dipole surface	condition	**Interpolated maximum**
Maximum measured above high end	100 mW input power	93.0 V / m
Maximum measured above low end	100 mW input power	91.3 V / m
Averaged maximum above arm	100 mW input power	**92.2 V / m ± 12.8 % (k=2)**

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Appendix

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	23.9 dB	49.9 Ω + 6.4 jΩ
1880 MHz	19.4 dB	51.5 Ω + 10.8 jΩ
1900 MHz	19.6 dB	55.1 Ω + 9.8 jΩ
1950 MHz	26.4 dB	55.0 Ω + 0.1 jΩ
2000 MHz	21.7 dB	42.5 Ω + 1.4 jΩ

3.2 Antenna Design and Handling

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

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

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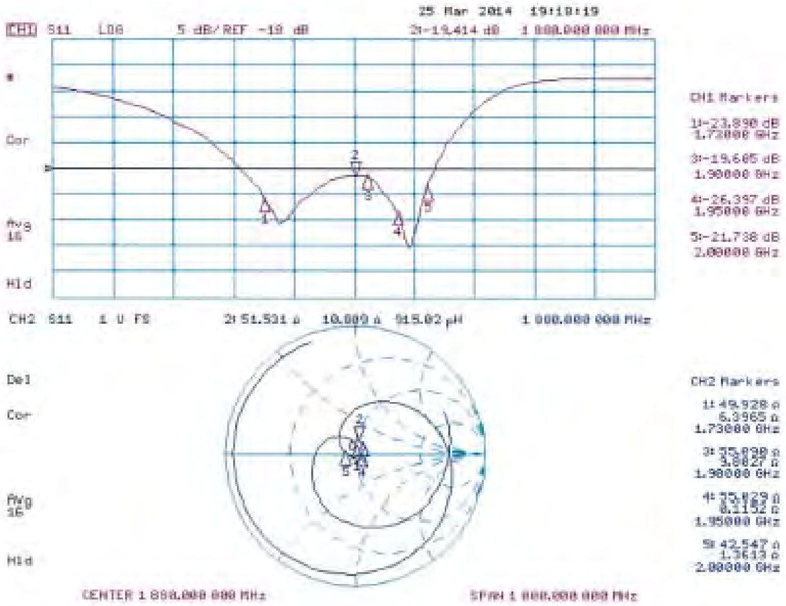
Impedance Measurement Plot



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DASY5 H-field Result

Date: 25.03.2014

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: $\sigma = 0$ S/m, $\varepsilon_r = 1$, $\rho = 1$ kg/m^3
Phantom section: RF Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

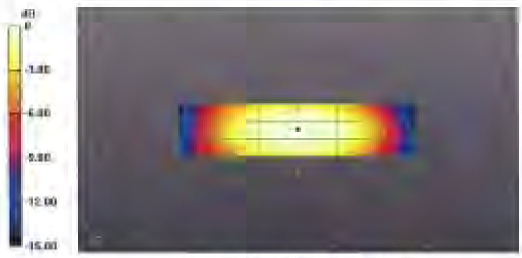
DASY52 Configuration:

- Probe: H3DV6 - SN6065; ; Calibrated: 30.12.2013
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 13.09.2013
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole 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 = 0.5010 A/m; Power Drift = 0.00 dB
PMR not calibrated. PMF = 1.000 is applied.
H-field emissions = 0.4737 A/m
Near-field category: M2 (AWF 0 dB)

PMF scaled H-field

Grid 1 **M2** **0.412 A/m**	Grid 2 **M2** **0.432 A/m**	Grid 3 **M2** **0.412 A/m**
Grid 4 **M2** **0.452 A/m**	Grid 5 **M2** **0.474 A/m**	Grid 6 **M2** **0.450 A/m**
Grid 7 **M2** **0.417 A/m**	Grid 8 **M2** **0.439 A/m**	Grid 9 **M2** **0.413 A/m**



0 dB = 0.4737 A/m = -6.49 dBA/m

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DASY5 E-field Result

Date: 21.03.2014

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: $\sigma = 0$ S/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: 30.12.2013
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 13.09.2013
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=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 = 145.1 V/m; Power Drift = -0.04 dB
PMR not calibrated. PMF = 1.000 is applied.
E-field emissions = 146.9 V/m
Near-field category: M2 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M2** 135.8 V/m	Grid 2 **M2** 146.9 V/m	Grid 3 **M2** 143.3 V/m
Grid 4 **M3** 86.33 V/m	Grid 5 **M3** 93.55 V/m	Grid 6 **M3** 92.92 V/m
Grid 7 **M2** 132.6 V/m	Grid 8 **M2** 141.1 V/m	Grid 9 **M2** 139.1 V/m

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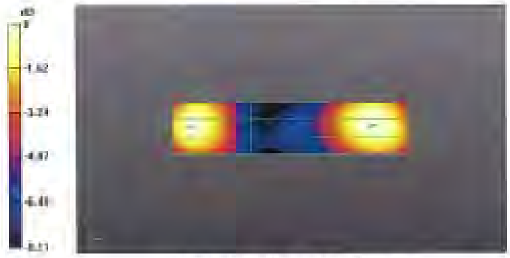
Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 145.0 V/m; Power Drift = 0.04 dB
PMR not calibrated, PMF = 1.000 is applied.
E-field emissions = 92.96 V/m
Near-field category: M3 (AWF 0 dB)

PMF scaled E-field

Grid 1 **M3** **88.13 V/m**	Grid 2 **M3** **91.27 V/m**	Grid 3 **M3** **90.28 V/m**
Grid 4 **M3** **69.22 V/m**	Grid 5 **M3** **71.51 V/m**	Grid 6 **M3** **71.24 V/m**
Grid 7 **M3** **89.64 V/m**	Grid 8 **M3** **92.96 V/m**	Grid 9 **M3** **91.99 V/m**



0 dB = 146.9 V/m = 43.34 dBV/m

End of 1st part of report

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