



# Hearing Aid Compatibility (HAC) RF Emissions Test Report

APPLICANT : TCL Communication Ltd.  
EQUIPMENT : Mobile Phone  
BRAND NAME : ALCATEL ONETOUCH  
MODEL NAME : 8050E  
MARKETING NAME : PIXI 4 6" 3G Android  
FCC ID : 2ACCJB036  
STANDARD : FCC 47 CFR §20.19  
ANSI C63.19-2011

We, SPORTON INTERNATIONAL (SHENZHEN) INC., would like to declare that the tested sample has been evaluated in accordance with the procedures and had been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL (SHENZHEN) INC., the test report shall not be reproduced except in full.

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**Revision History**

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
HA5N0302	Rev. 01	Initial issue of report	Jan. 05, 2016



**1. Attestation of Test Results**

<b>Applicant Name</b>	TCL Communication Ltd.
<b>Equipment Name</b>	Mobile Phone
<b>Brand Name</b>	ALCATEL ONETOUCH
<b>Model Name</b>	8050E
<b>Marketing Name</b>	PIXI 4 6" 3G Android
<b>FCC ID</b>	2ACCJB036
<b>IMEI Code</b>	SIM1: 014574000100618 SIM2: 014574000100626
<b>HW Version</b>	V04
<b>SW Version</b>	1A1D
<b>EUT Stage</b>	Production Unit
<b>HAC Rating</b>	M4
<b>Date Tested</b>	2015/12/08
<b>Test Result</b>	Pass

This device is compliance with HAC limits specified in guidelines FCC 47 CFR §20.19 and ANSI Standard ANSI C63.19.



**2. Administration Data**

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL (SHENZHEN) INC.
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Applicant	
Company Name	TCL Communication Ltd.
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Manufacturer	
Company Name	TCL Communication Ltd.
Address	5F, C-Tower, No. 232, Liang Jing Road, ZhangJiang High-Tech Park, Pudong Area, Shanghai, 201203, P.R.China



### 3. Equipment Under Test Information

#### 3.1 General Information

Product Feature & Specification	
Frequency Band	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1852.4 MHz ~ 1907.6 MHz WCDMA Band V: 826.4 MHz ~ 846.6 MHz WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	<ul style="list-style-type: none"><li>• GSM/GPRS/EGPRS(Downlink Only)</li><li>• AMR / RMC 12.2Kbps</li><li>• HSDPA</li><li>• HSUPA</li><li>• HSPA+ (16QAM uplink is not supported)</li><li>• 802.11b/g/n HT20/HT40</li><li>• Bluetooth v3.0+EDR, Bluetooth v4.1 LE</li></ul>
<b>Remark:</b> 1. This device supports GRPS / EGPRS mode up to multi-slot class 12 and EGPRS downlink only. 2. When hotspot mode is enabled, power reduction will be activated at WCDMA Band II.	



3.2 Air Interface and Operating Mode

Air Interface	Band MHz	Type	C63.19 Tested	Simultaneous Transmitter	OTT	Power Reduction
GSM	850	VO	Yes	WLAN, BT	NA	No
	1900			WLAN, BT	NA	No
	GPRS	DT	No	WLAN, BT	Yes	No
WCDMA	Band V	VO	No <sup>(1)</sup>	WLAN, BT	NA	No
	Band II			WLAN, BT	NA	Yes
	HSPA	DT	No	WLAN, BT	Yes	No
WLAN	2450	VD	No <sup>(2)</sup>	GSM, WCDMA	Yes	No
BT	2450	DT	No	GSM, WCDMA	NA	No

VO=CMRS Voice Service  
DT=Digital Transport  
VD=CMRS IP Voice Service and Digital Transport

Remark:

- WCDMA is exempted from testing by low power exemption that its average antenna input power plus its MIF is ≤17 dBm, and is rated as M4
- For 2.4GHz WLAN RF emissions testing exemption shall be applied to an RF air interface technology in a device whose Peak antenna input power, averaged over intervals ≤50 μs, is ≤23 dBm.

3.3 Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19 2011-version
- FCC KDB 285076 D01 HAC Guidance v04
- FCC KDB 285076 D02 T Coil testing for CMRS IP v01r01



#### 4. HAC RF Emission

FCC wireless hearing aid compatibility rules ensure that consumers with hearing loss are able to access wireless communications services through a wide selection of handsets without experiencing disabling radio frequency (RF) interference or other technical obstacles.

To define and measure the hearing aid compatibility of handsets, in CFR47 part 20.19 ANSI C63.19 is referenced. A handset is considered hearing aid-compatible for acoustic coupling if it meets a rating of at least M3 under ANSI C63.19, and A handset is considered hearing aid compatible for inductive coupling if it meets a rating of at least T3.

According to ANSI C63.19 2011 version, for acoustic coupling, the RF electric field emissions of wireless communication devices should be measured and rated according to the emission level as below.

Emission Categories	E-field emissions	
	<960Mhz	>960Mhz
M1	50 to 55 dB (V/m)	40 to 45 dB (V/m)
M2	45 to 50 dB (V/m)	35 to 40 dB (V/m)
M3	40 to 45 dB (V/m)	30 to 35 dB (V/m)
M4	<40 dB (V/m)	<30 dB (V/m)

Table 4.1 Telephone near-field categories in linear units



### 5. Measurement System Specification

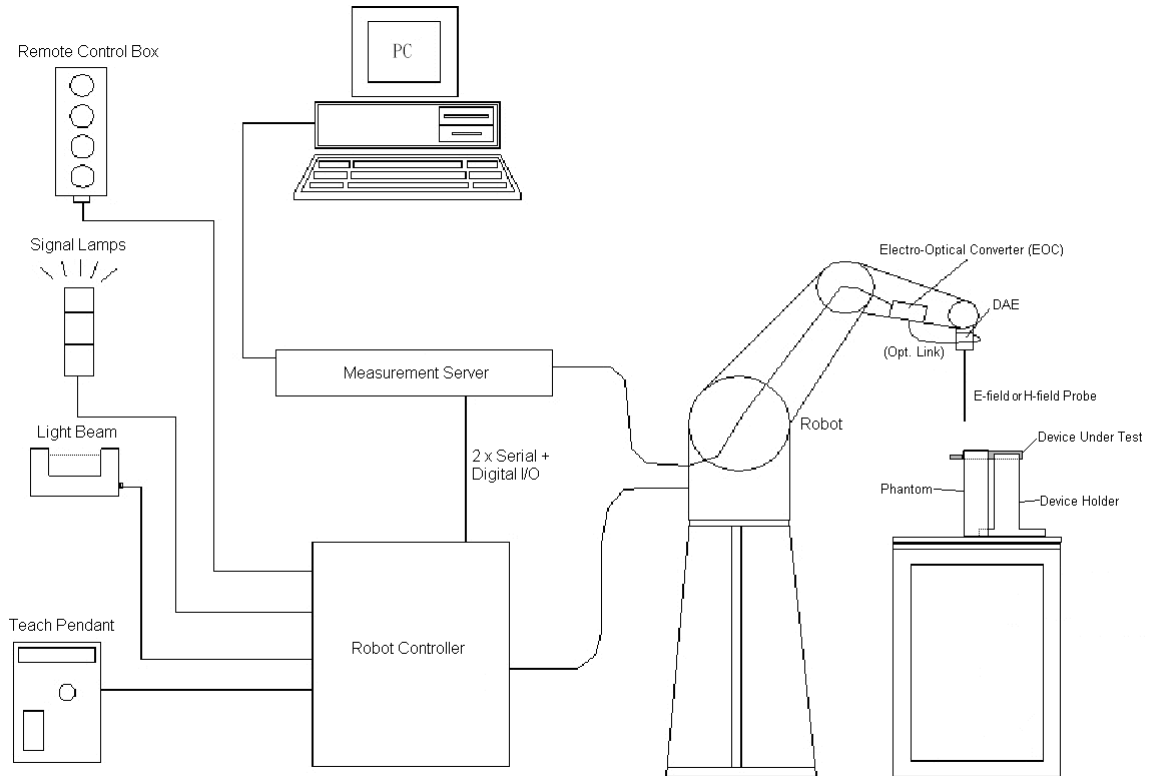


Fig 5.1 SPEAG DASY5 System Configurations

#### 5.1 Test Arch Phantom

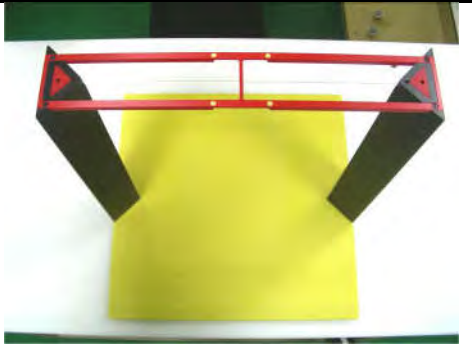
<p><b>Construction :</b></p>	<p>Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.</p>	
<p><b>Dimensions :</b></p>	<p>370x 370 x 370 mm</p>	

Fig 5.8 Photo of Arch Phantom

**5.2 E-Field Probe System**

**E-Field Probe Specification**

**<ER3DV6>**

<b>Construction</b>	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
<b>Calibration</b>	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$ , $k=2$ )
<b>Frequency</b>	100 MHz to 6 GHz; Linearity: $\pm 2.0$ dB (100 MHz to 3 GHz)
<b>Directivity</b>	$\pm 0.2$ dB in air (rotation around probe axis) $\pm 0.4$ dB in air (rotation normal to probe axis)
<b>Dynamic Range</b>	2 V/m to 1000 V/m (M3 or better device readings fall well below diode compression point)
<b>Linearity</b>	$\pm 0.2$ dB
<b>Dimensions</b>	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm



**Fig 5.2 Photo of E-field Probe**

**Probe Tip Description:**

HAC field measurements take place in the close near field with high gradients. Increasing the measuring distance from the source will generally decrease the measured field values (in case of the validation dipole approx. 10% per mm).

**5.3 System Hardware**

**DAE**

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

**Robot**

The SPEAG DASY system uses the high precision robots (DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used.

**5.4 Data Storage and Evaluation**

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, and device frequency and modulation data) in measurement files.

<b>Probe parameters :</b>	- Sensitivity	Norm <sub>i</sub> , a <sub>i0</sub> , a <sub>i1</sub> , a <sub>i2</sub>
	- Conversion factor	ConvF <sub>i</sub>
	- Diode compression point	dcp <sub>i</sub>
<b>Device parameters :</b>	- Frequency	f
	- Crest factor	cf
<b>Media parameters :</b>	- Conductivity	σ
	- Density	ρ

The formula for each channel can be given as :

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

- with V<sub>i</sub> = compensated signal of channel i, (i = x, y, z)
- U<sub>i</sub> = input signal of channel i, (i = x, y, z)
- cf = crest factor of exciting field (DASY parameter)
- dcp<sub>i</sub> = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated :

$$\text{E-field Probes : } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

- with V<sub>i</sub> = compensated signal of channel i, (i = x, y, z)
- Norm<sub>i</sub> = sensor sensitivity of channel i, (i = x, y, z), μV/(V/m)<sup>2</sup> for E-field Probes
- ConvF = sensitivity enhancement in solution
- f = carrier frequency [GHz]
- E<sub>i</sub> = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermitian magnitude) :

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.



5.5 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Dipole	CD835V3	1184	Apr. 22, 2015	Apr. 21, 2016
SPEAG	Dipole	CD1880V3	1170	Apr. 22, 2015	Apr. 21, 2016
SPEAG	Data Acquisition Electronics	DAE4	1490	Sep. 14, 2015	Sep. 13, 2016
SPEAG	Prober	ER3DV6	2528	Mar. 24, 2015	Mar. 23, 2016
SPEAG	Test Arch Phantom	Par phantom	1105	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	Base Station	E5515C	MY50267224	Aug. 07, 2015	Aug. 06, 2016
AR	Amplifier	5S1G4	333096	NCR	NCR
Anritsu	Power Sensor	MA2411B	1207253	Jan. 28, 2015	Jan. 27, 2016
Anritsu	Power Meter	ML2495A	1218010	Jan. 28, 2015	Jan. 27, 2016
Anritsu	Power Sensor	MA2411B	917070	Jan. 23, 2015	Jan. 22, 2016
Anritsu	Power Meter	ML2495A	1005002	Jan. 23, 2015	Jan. 22, 2016
Agilent	Dual Directional Coupler	778D	50422	NA	NA
MCL	Attenuation1	BW-S10W5	N/A	NA	NA
Weinschel	Attenuation2	3M-20	N/A	NA	NA
Zhongjilianhe	Attenuation3	MVE2214-03	N/A	NA	NA
R&S	Spectrum Analyzer	FSP7	101634	Aug. 07, 2015	Aug. 06, 2016

Table 5.1 Test Equipment List

Note: NCR: "No-Calibration Required"

## 6. Measurement System Validation

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the test Arch and a corresponding distance holder.

### 6.1 Purpose of System Performance Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal HAC measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

### 6.2 System Setup

1. In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator.
2. The center point of the probe element(s) is 15mm from the closest surface of the dipole elements.
3. The calibrated dipole must be placed beneath the arch phantom. The equipment setup is shown below:

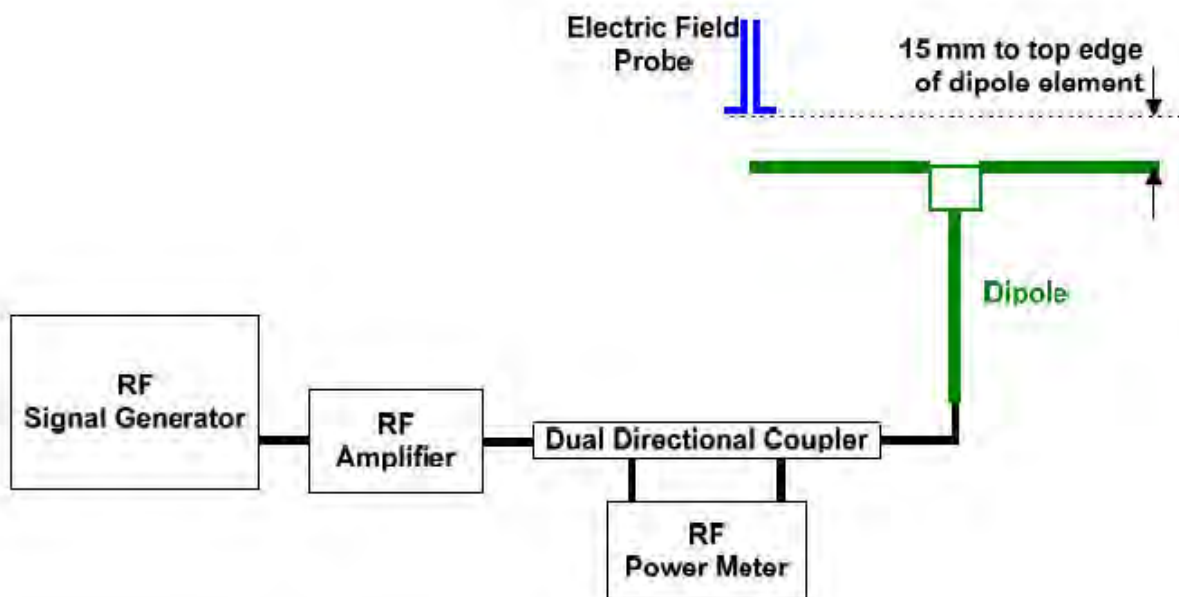
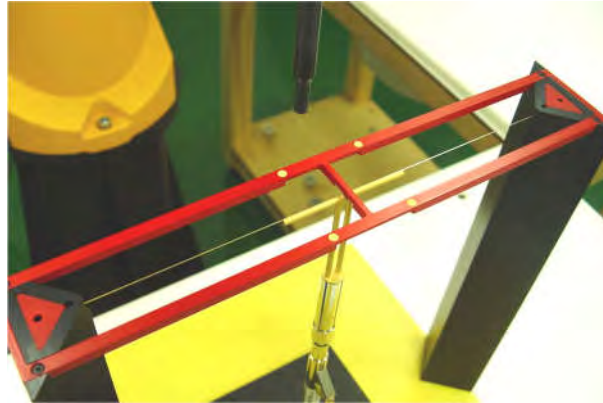


Fig. 6.1 System Validation Setup

The output power on dipole port must be calibrated to 20dBm (100mW) before dipole is connected.



**Fig 7.2 Dipole Setup**

**6.3 Verification Results**

Comparing to the original E-field value provided by SPEAG, the verification data should be within its specification of 25 %. Table 6.1 shows the target value and measured value. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to appendix A of this report.

Frequency (MHz)	Input Power (dBm)	Target Value (V/m)	E-Field above high end (V/m)	E-Field above low end (V/m)	Average Value (V/m)	Deviation (%)	Date
835	20	106.5	113.2	115.3	114.25	7.28	Dec. 08, 2015
1880	20	88.7	94.8	97.12	95.96	8.18	Dec. 08, 2015

**Table 6.1 Test Results of System Validation**

**Note: Deviation = ((Average E-field Value) - (Target value)) / (Target value) \* 100%**



## 7. RF Emissions Test Procedure

Referenced from ANSI C63.19 -2011 section 5.5.1

- a) Confirm the 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 8.2. 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 equality 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) *Indirect measurement method*  
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)
- j) Compare this RF audio interference level with the categories in ANSI C63.19-2011 clause 8 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.

### Test Instructions

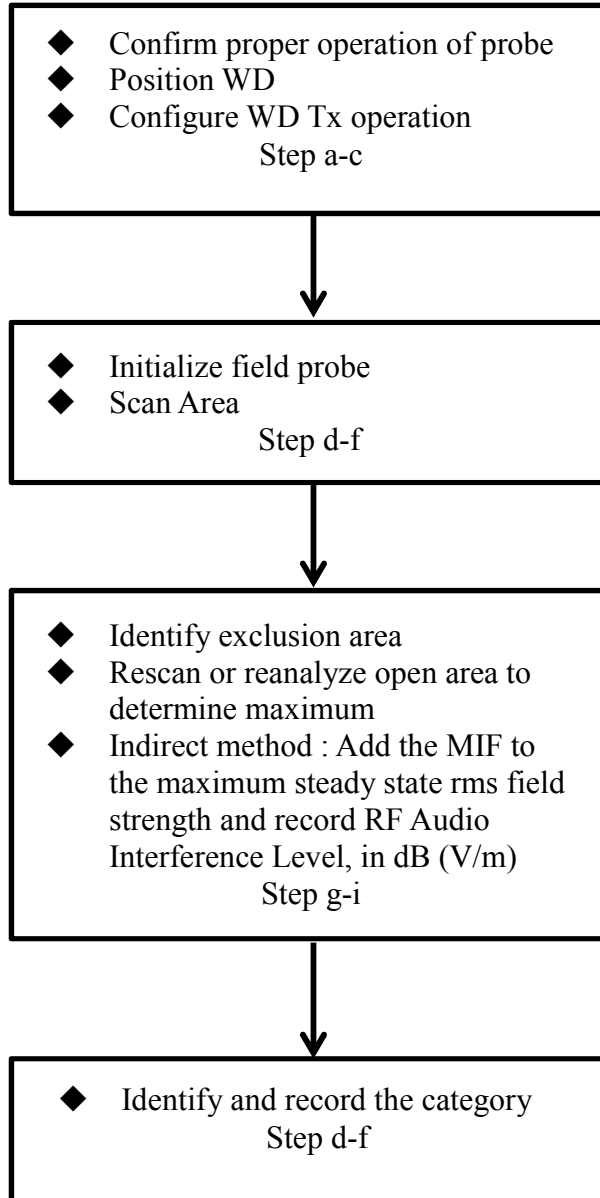


Fig 8.1 Flow Chart of HAC RF Emission





Fig 8.2 EUT reference and plane for HAC RF emission measurements

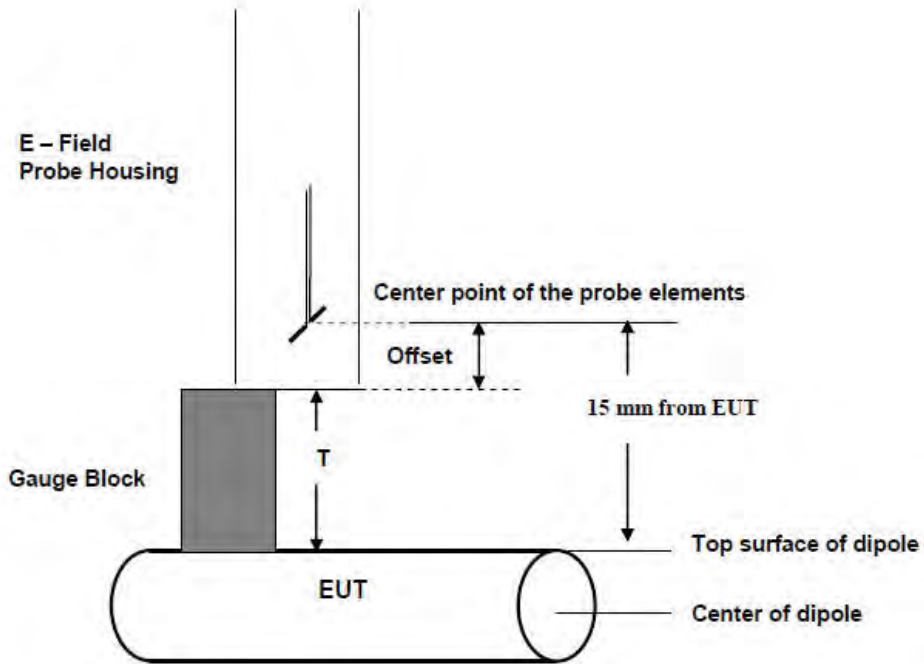


Fig. 8.3 Gauge block with E-field probe



## 8. Modulation Interference Factor

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF).

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 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 C63.19-2007.

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. Probe Modulation Response (PMR) calibration linearizes the probe response over its dynamic range for specific modulations which are characterized by their UID and result in an uncertainty specified in the probe calibration certificate. The MIF is characteristic for a given waveform envelope and can be used as a constant conversion factor if the probe has been PMR calibrated.

The evaluation method for 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 scaled 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 constant 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 it is automatically applied.



MIF values applied in this test report were provided by the HAC equipment provider, SPEAG, and the values are listed below

UID	Communication System Name	MIF(dB)
10021	GSM-FDD(TDMA,GMSK)	3.63
10011	UMTS-FDD(WCDMA)	-27.23

The MIF measurement uncertainty is estimated as follows, declared by HAC equipment provider SPEAG, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz:

- i) 0.2 dB for MIF: -7 to +5 dB,
- ii) 0.5 dB for MIF: -13 to +11 dB
- iii) 1 dB for MIF: > -20 dB



### 9. Low-power Exemption

<Max Tune-up Limit>

(Full Power)

Mode		Average Power (dBm)
GSM	850	33.50
	1900	30.50
WCDMA	Band V	24.00
	Band II	24.00
2.4GHz WLAN		17.00

(Hotspot Reduced Power)

Mode		Average Power (dBm)
WCDMA	Band II	21.00

<Low Power Exemption>

Air Interface	Max Average Antenna Input Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 test required
GSM850	33.50	3.63	37.13	Yes
GSM1900	30.50	3.63	34.13	Yes
WCDMA Band V	24.00	-27.23	-3.23	No
WCDMA Band II	24.00	-27.23	-3.23	No

Air Interface	Max Average Antenna Input Power (dBm)	C63.19 test required
2.4GHz WLAN	17.00	No

**General Note:**

1. According to ANSI C63.19 2011-version, for WWAN RF air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is  $\leq 17$  dBm for any of its operating modes.
2. For WWAN operation the worst case MIF plus the worst case average antenna input power for all modes are investigated to determine the testing requirements for this device.
3. According to ANSI C63.19 2011, for WLAN RF emissions testing exemption shall be applied to an RF air interface technology in a device whose Peak antenna input power, averaged over intervals  $\leq 50 \mu s$ , is  $\leq 23$  dBm.
4. HAC RF rating is M4 for the air interface which meets the low power exemption.



**10. Conducted RF Output Power (Unit: dBm)**

**SIM 1:**  
(Full Power)

Air Interface	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
Average Antenna Input Power(dBm)	32.55	32.59	32.56	29.95	29.98	29.99

Air Interface	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
Frequency (MHz)	826.4	836.4	846.6	1852.4	1880.0	1907.6
Average Antenna Input Power(dBm)	23.10	23.01	23.12	23.55	23.45	23.50

(Reduced Power)

Air Interface	WCDMA Band II		
Channel	9262	9400	9538
Frequency (MHz)	1852.4	1880.0	1907.6
Average Antenna Input Power(dBm)	20.72	20.60	20.65

**SIM 2:**  
(Full Power)

Air Interface	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
Average Antenna Input Power(dBm)	32.53	32.56	32.54	29.90	29.94	29.97

Air Interface	WCDMA Band V			WCDMA Band II		
Channel	4132	4182	4233	9262	9400	9538
Frequency (MHz)	826.4	836.4	846.6	1852.4	1880.0	1907.6
Average Antenna Input Power(dBm)	23.07	23.01	23.10	23.52	23.40	23.51

(Reduced Power)

Air Interface	WCDMA Band II		
Channel	9262	9400	9538
Frequency (MHz)	1852.4	1880.0	1907.6
Average Antenna Input Power(dBm)	20.71	20.56	20.61

**11. HAC RF Emission Test Results**

Plot No.	Air Interface	Operating Mode	Channel	Average Antenna Input Power (dBm)	MIF	RF audio interference level dB(V/m)	Margin to FCC M3 limit (dB)	Battery	M-Rating
01	GSM850	GSM Voice	128	32.55	3.63	35.21	9.79	1	M4
02	GSM850	GSM Voice	189	32.59	3.63	35.73	9.27	1	M4
03	GSM850	GSM Voice	251	32.56	3.63	36.16	8.84	1	M4
04	GSM850	GSM Voice	251	32.56	3.63	35.69	9.31	2	M4
05	GSM1900	GSM Voice	512	29.95	3.63	26.07	8.93	1	M4
06	GSM1900	GSM Voice	661	29.98	3.63	26.05	8.95	1	M4
07	GSM1900	GSM Voice	810	29.99	3.63	25.67	9.33	1	M4
08	GSM1900	GSM Voice	512	29.95	3.63	27.00	8.00	2	M4

**Remark:**

1. The HAC measurement system applies MIF value onto the measured RMS E-field, which is indirect method in ANSI C63.19 2011 version, and reports the RF audio interference level.
2. The uncertainty is 0.2dB of MIF ranges from -7dB to +5dB. GSM850 band with rating M4, GSM1900 band with rating M4 would not be affected considering the MIF uncertainty.
3. There is special HAC mode software on this EUT.

Test Engineer : Luke Lu.



## **12. Uncertainty Assessment**

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual “root-sum-squares” (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 12.1.



Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (E)	Standard Uncertainty (E)
<b>Measurement System</b>					
Probe Calibration	5.1	Normal	1	1	± 5.1 %
Axial Isotropy	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 %
Phantom Boundary Effects	7.2	Rectangular	√3	1	± 4.1 %
Linearity	4.7	Rectangular	√3	1	± 2.7 %
Scaling with PMF Calibration	10.0	Rectangular	√3	1	± 5.77 %
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 Conditions	3.0	Rectangular	√3	1	± 1.7 %
RF 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 %
<b>Test Sample Related</b>					
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 %
<b>Phantom and Setup Related</b>					
Phantom Thickness	2.4	Rectangular	√3	1	± 1.4 %
<b>Combined Standard Uncertainty</b>					± 16.30 %
<b>Coverage Factor for 95 %</b>					K = 2
<b>Expanded Std. Uncertainty on Power</b>					± 32.6 %
<b>Expanded Std. Uncertainty on Field</b>					± 16.3 %

**Table 12.1 Uncertainty Budget of HAC free field assessment**

**Remark:**

Worst-Case uncertainty budget for HAC free field assessment according to ANSIC63.19 [1], [2]. The budget is valid for the frequency range 700 MHz - 3 GHz and represents a worst case analysis.





### **13. References**

- [1] ANSI C63.19-2011, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", 27 May 2011
- [2] SPEAG DASY System Handbook



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## **Appendix A. Plots of System Performance Check**

The plots are shown as follows.

**HAC\_E\_Dipole\_835\_151208**

**DUT: HAC-Dipole 835 MHz**

Communication System: UID 0, CW; Frequency: 835 MHz;Duty Cycle: 1:1

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

**Ambient Temperature:** 23.5 °C

DASY5 Configuration:

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8);SEMCAD X Version 14.6.10 (7331)

**E Scan - measurement distance from the probe sensor center to CD835 =15mm/Hearing Aid Compatibility Test at 15mm distance (41x361x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm  
 Device Reference Point: 0, 0, -6.3 mm  
 Reference Value = 113.3 V/m; Power Drift = -0.01 dB  
 E-field emissions = 114.9 V/m  
 Average value of Total=(113.2+115.3)/2=114.25 V/m

MIF scaled E-field

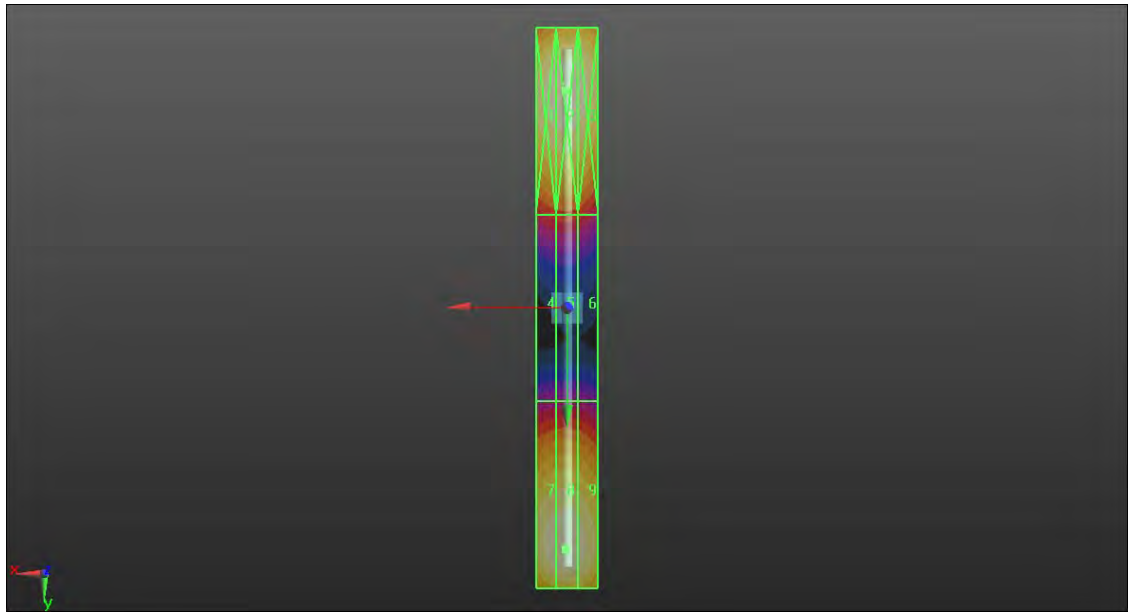
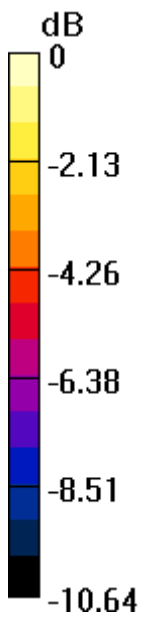
<b>Grid 1 M4</b> <b>114.1 V/m</b>	<b>Grid 2 M4</b> <b>113.2 V/m</b>	<b>Grid 3 M4</b> <b>113.2 V/m</b>
<b>Grid 4 M4</b> <b>68.58 V/m</b>	<b>Grid 5 M4</b> <b>69.53 V/m</b>	<b>Grid 6 M4</b> <b>67.73 V/m</b>
<b>Grid 7 M4</b> <b>113.3 V/m</b>	<b>Grid 8 M4</b> <b>115.3 V/m</b>	<b>Grid 9 M4</b> <b>112.3 V/m</b>

**Cursor:**

Total = 113.2 V/m

E Category: M4

Location: 0.5, -69.5, 9.7 mm



0 dB = 115.9 V/m = 41.28 dBV/m

**HAC\_E\_Dipole\_1880\_151208**

**DUT: HAC Dipole 1880 MHz**

Communication System: UID 0, CW; Frequency: 1880 MHz;Duty Cycle: 1:1

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

**Ambient Temperature:** 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8);SEMCAD X Version 14.6.10 (7331)

**E Scan - measurement distance from the probe sensor center to CD1880 =15mm/Hearing Aid Compatibility Test at 15mm distance (41x181x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm  
 Device Reference Point: 0, 0, -6.3 mm  
 Reference Value = 166.9 V/m; Power Drift = 0.00 dB  
 E-field emissions = 97.62 V/m  
 Average value of Total=(94.8+97.12)/2=95.96 V/m

MIF scaled E-field

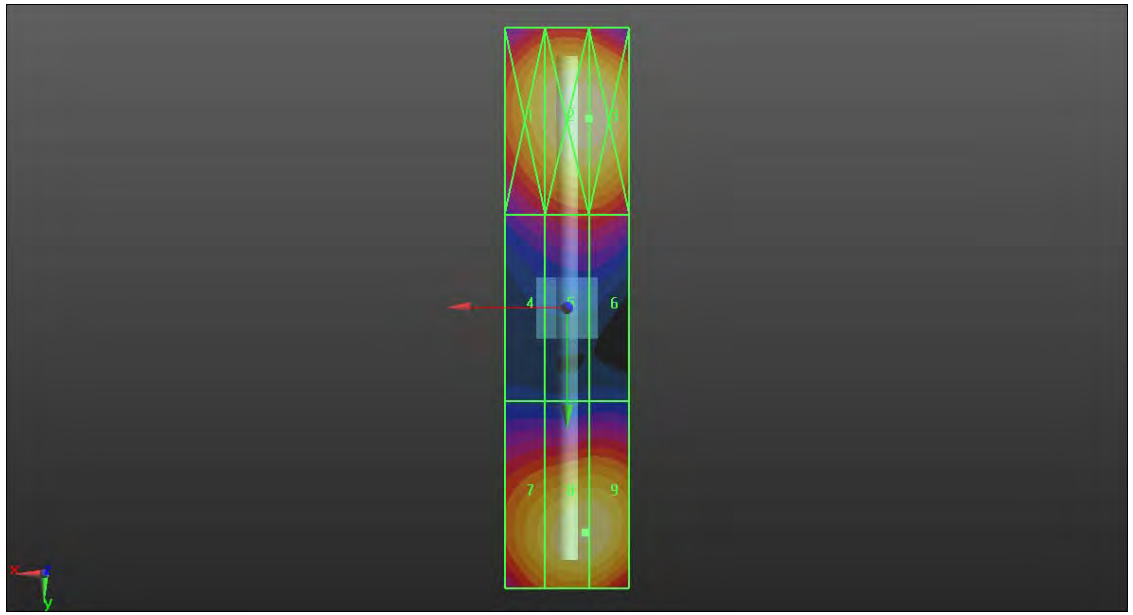
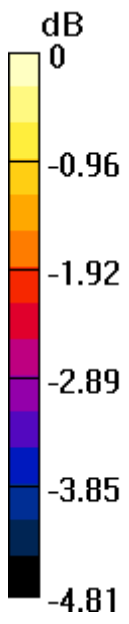
<b>Grid 1 M3</b> <b>95.33 V/m</b>	<b>Grid 2 M3</b> <b>94.8 V/m</b>	<b>Grid 3 M3</b> <b>101.0 V/m</b>
<b>Grid 4 M3</b> <b>75.46 V/m</b>	<b>Grid 5 M3</b> <b>79.64 V/m</b>	<b>Grid 6 M3</b> <b>79.64 V/m</b>
<b>Grid 7 M3</b> <b>92.57 V/m</b>	<b>Grid 8 M3</b> <b>97.12 V/m</b>	<b>Grid 9 M3</b> <b>97.55 V/m</b>

**Cursor:**

Total = 101.0 V/m

E Category: M3

Location: -3.5, -30.5, 9.7 mm



0 dB = 101.0 V/m = 40.09 dBV/m



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## **Appendix B. Plots of RF Emission Measurement**

The plots are shown as follows.

**01\_HAC RF\_GSM850\_GSM Voice\_Ch128**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 824.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch128/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 = 42.63 V/m; Power Drift = -0.09 dB

Applied MIF = 3.63 dB

RF audio interference level = 35.21 dBV/m

**Emission category: M4**

MIF scaled E-field

<b>Grid 1 M4</b> <b>32.63 dBV/m</b>	<b>Grid 2 M4</b> <b>34.02 dBV/m</b>	<b>Grid 3 M4</b> <b>34.02 dBV/m</b>
<b>Grid 4 M4</b> <b>33.89 dBV/m</b>	<b>Grid 5 M4</b> <b>35.21 dBV/m</b>	<b>Grid 6 M4</b> <b>35.2 dBV/m</b>
<b>Grid 7 M4</b> <b>34.87 dBV/m</b>	<b>Grid 8 M4</b> <b>35.91 dBV/m</b>	<b>Grid 9 M4</b> <b>35.86 dBV/m</b>

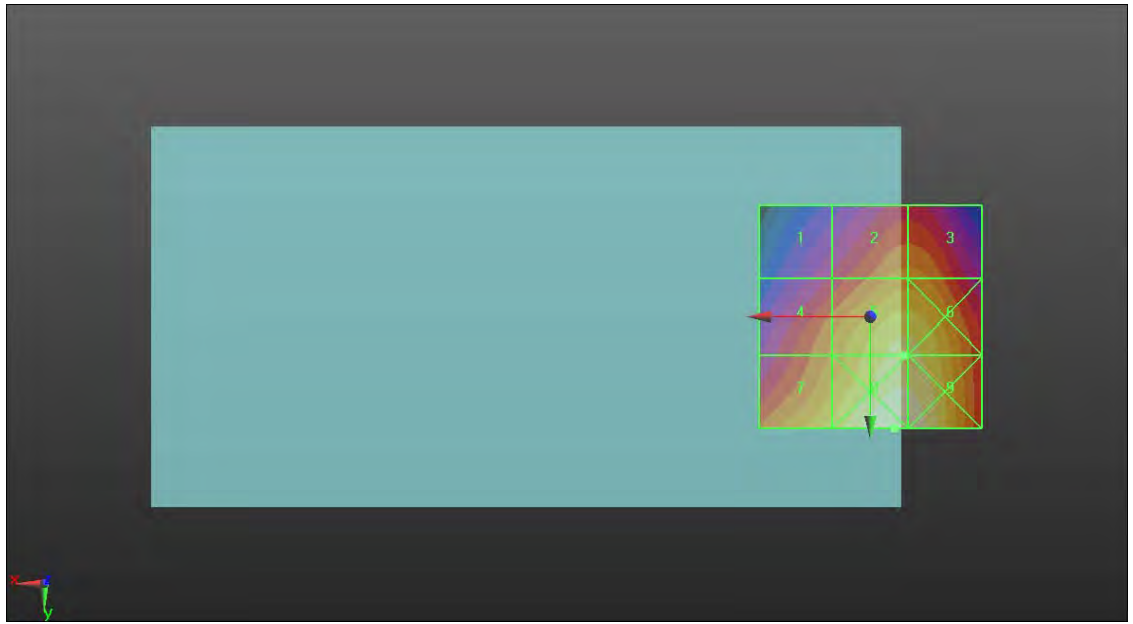
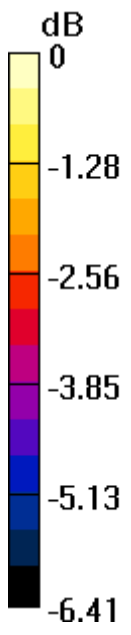
**Cursor:**

Total = 35.91 dBV/m

E Category: M4

Location: -5.5, 25, 8.7 mm





0 dB = 62.46 V/m = 35.91 dBV/m

**02\_HAC RF\_GSM850\_GSM Voice\_Ch189**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 836.4 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch189/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 = 44.80 V/m; Power Drift = -0.04 dB

Applied MIF = 3.63 dB

RF audio interference level = 35.73 dBV/m

**Emission category: M4**

MIF scaled E-field

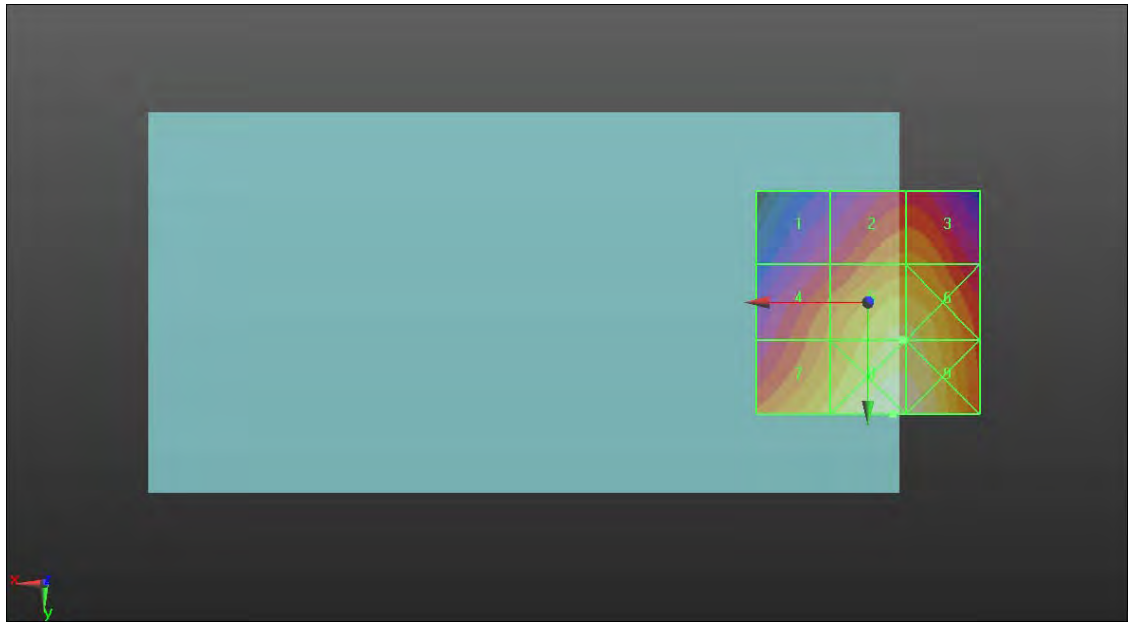
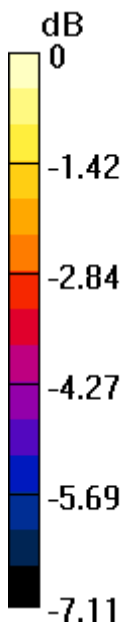
<b>Grid 1 M4</b> <b>32.89 dBV/m</b>	<b>Grid 2 M4</b> <b>34.39 dBV/m</b>	<b>Grid 3 M4</b> <b>34.39 dBV/m</b>
<b>Grid 4 M4</b> <b>34.3 dBV/m</b>	<b>Grid 5 M4</b> <b>35.73 dBV/m</b>	<b>Grid 6 M4</b> <b>35.72 dBV/m</b>
<b>Grid 7 M4</b> <b>35.37 dBV/m</b>	<b>Grid 8 M4</b> <b>36.5 dBV/m</b>	<b>Grid 9 M4</b> <b>36.43 dBV/m</b>

**Cursor:**

Total = 36.50 dBV/m

E Category: M4

Location: -5.5, 25, 8.7 mm



0 dB = 66.80 V/m = 36.50 dBV/m

**03\_HAC RF\_GSM850\_GSM Voice\_Ch251**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 848.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch251/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 = 46.25 V/m; Power Drift = -0.15 dB

Applied MIF = 3.63 dB

RF audio interference level = 36.16 dBV/m

**Emission category: M4**

MIF scaled E-field

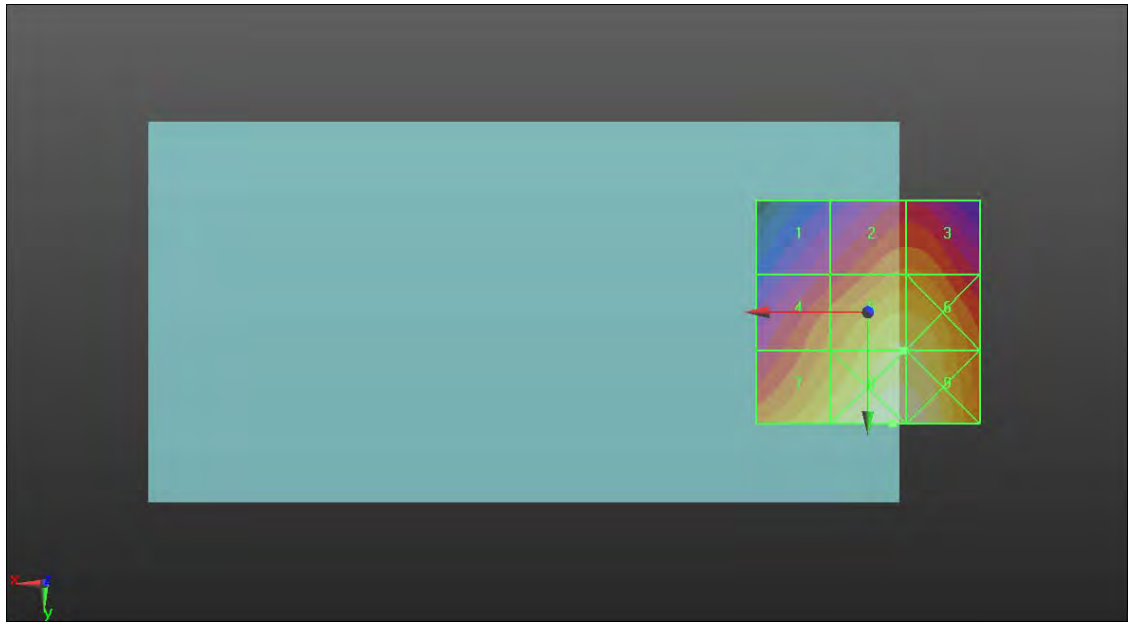
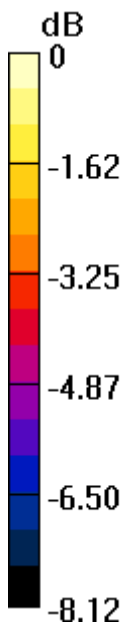
<b>Grid 1 M4</b> <b>32.97 dBV/m</b>	<b>Grid 2 M4</b> <b>34.56 dBV/m</b>	<b>Grid 3 M4</b> <b>34.56 dBV/m</b>
<b>Grid 4 M4</b> <b>34.68 dBV/m</b>	<b>Grid 5 M4</b> <b>36.16 dBV/m</b>	<b>Grid 6 M4</b> <b>36.16 dBV/m</b>
<b>Grid 7 M4</b> <b>36 dBV/m</b>	<b>Grid 8 M4</b> <b>37.12 dBV/m</b>	<b>Grid 9 M4</b> <b>37.06 dBV/m</b>

**Cursor:**

Total = 37.12 dBV/m

E Category: M4

Location: -5.5, 25, 8.7 mm



0 dB = 71.75 V/m = 37.12 dBV/m

**04\_HAC RF\_GSM850\_GSM Voice\_Ch251**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 848.8 MHz; Duty Cycle: 1:8.3

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

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch251/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 = 44.08 V/m; Power Drift = 0.03 dB

Applied MIF = 3.63 dB

RF audio interference level = 35.69 dBV/m

**Emission category: M4**

MIF scaled E-field

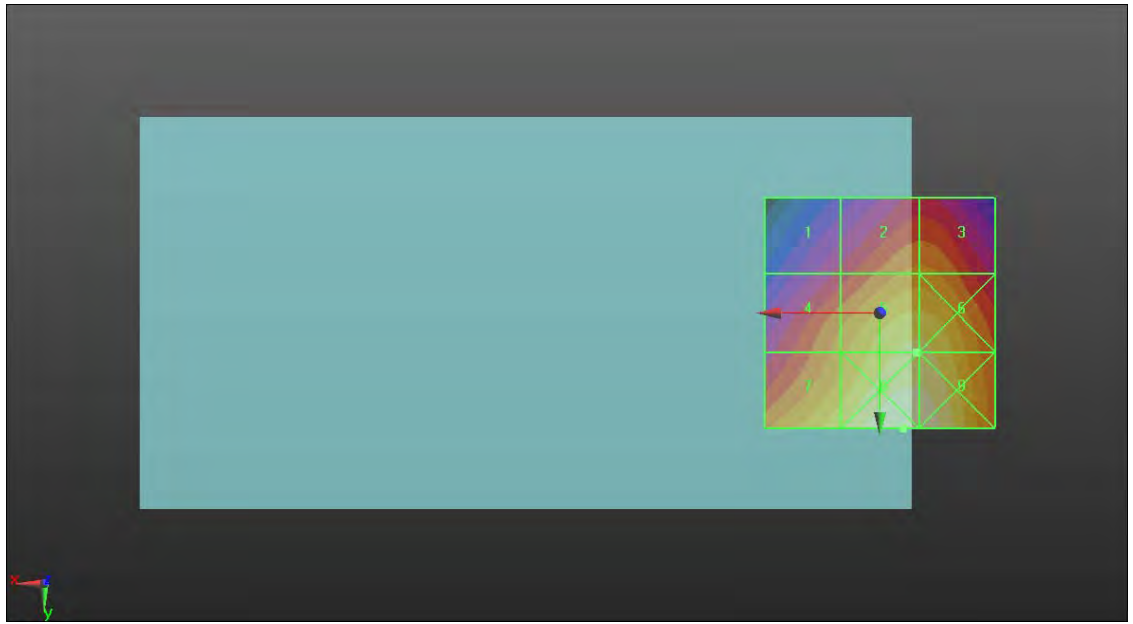
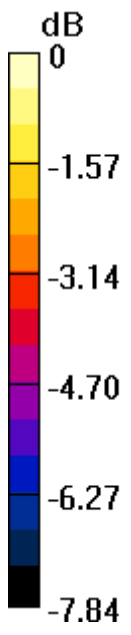
<b>Grid 1 M4</b> <b>32.63 dBV/m</b>	<b>Grid 2 M4</b> <b>34.18 dBV/m</b>	<b>Grid 3 M4</b> <b>34.18 dBV/m</b>
<b>Grid 4 M4</b> <b>34.28 dBV/m</b>	<b>Grid 5 M4</b> <b>35.69 dBV/m</b>	<b>Grid 6 M4</b> <b>35.69 dBV/m</b>
<b>Grid 7 M4</b> <b>35.52 dBV/m</b>	<b>Grid 8 M4</b> <b>36.59 dBV/m</b>	<b>Grid 9 M4</b> <b>36.55 dBV/m</b>

**Cursor:**

Total = 36.59 dBV/m

E Category: M4

Location: -5, 25, 8.7 mm



0 dB = 67.53 V/m = 36.59 dBV/m

**05\_HAC RF\_GSM1900\_GSM Voice\_Ch512**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 1850.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch512/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 = 10.78 V/m; Power Drift = 0.17 dB

Applied MIF = 3.63 dB

RF audio interference level = 26.07 dBV/m

**Emission category: M4**

MIF scaled E-field

<b>Grid 1 M4</b> <b>28.06 dBV/m</b>	<b>Grid 2 M4</b> <b>29.06 dBV/m</b>	<b>Grid 3 M4</b> <b>29 dBV/m</b>
<b>Grid 4 M4</b> <b>26.05 dBV/m</b>	<b>Grid 5 M4</b> <b>25.2 dBV/m</b>	<b>Grid 6 M4</b> <b>25.2 dBV/m</b>
<b>Grid 7 M4</b> <b>25.32 dBV/m</b>	<b>Grid 8 M4</b> <b>26.05 dBV/m</b>	<b>Grid 9 M4</b> <b>26.07 dBV/m</b>

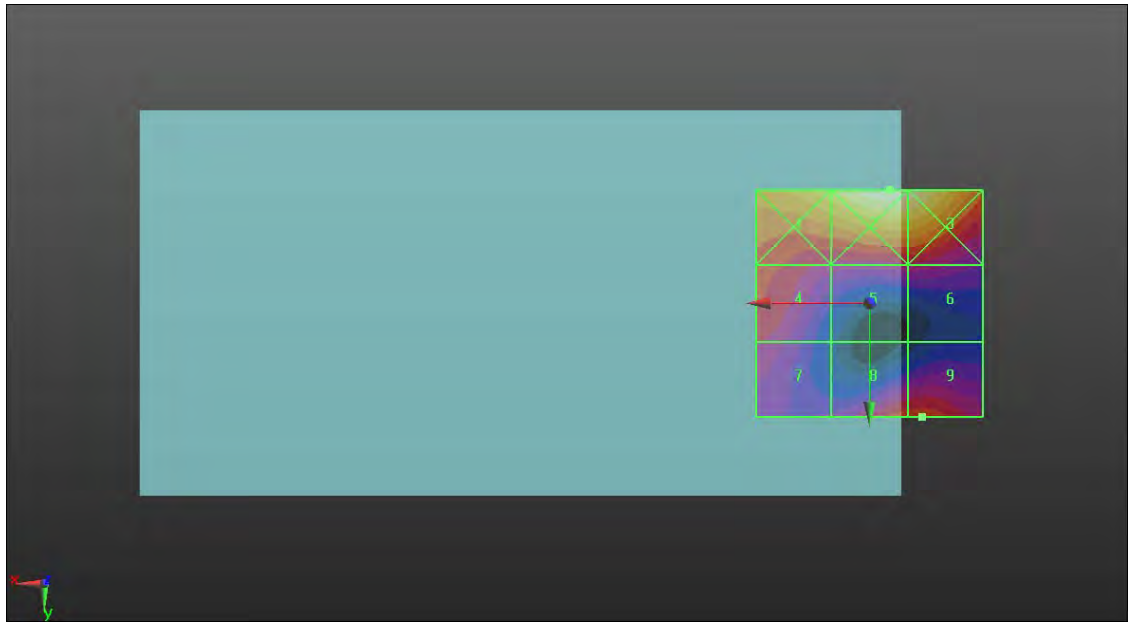
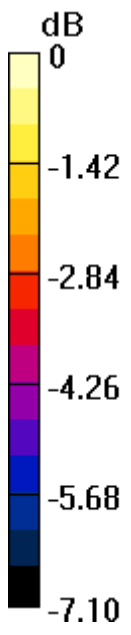
**Cursor:**

Total = 29.06 dBV/m

E Category: M4

Location: -4.5, -25, 8.7 mm





0 dB = 28.38 V/m = 29.06 dBV/m

**06\_HAC RF\_GSM1900\_GSM Voice\_Ch661**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 1880 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch661/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 = 10.57 V/m; Power Drift = 0.05 dB

Applied MIF = 3.63 dB

RF audio interference level = 26.05 dBV/m

**Emission category: M4**

MIF scaled E-field

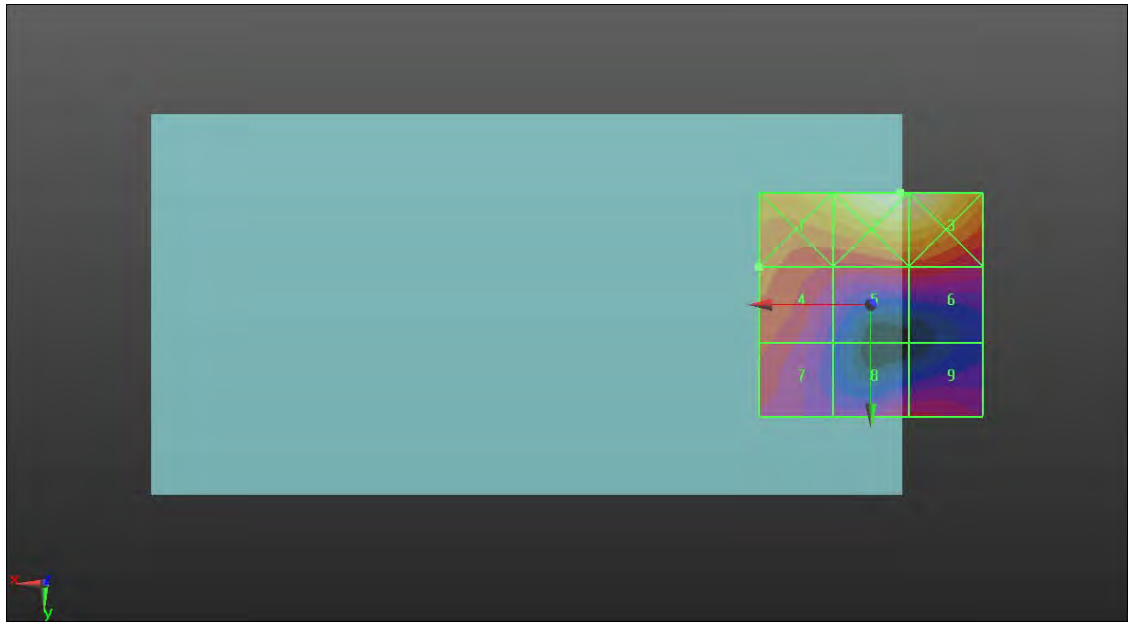
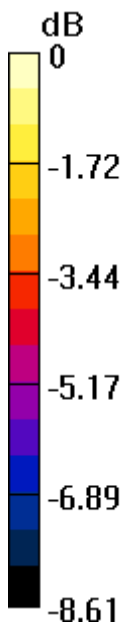
<b>Grid 1 M4</b> <b>27.83 dBV/m</b>	<b>Grid 2 M4</b> <b>29.23 dBV/m</b>	<b>Grid 3 M4</b> <b>29.18 dBV/m</b>
<b>Grid 4 M4</b> <b>26.05 dBV/m</b>	<b>Grid 5 M4</b> <b>25.42 dBV/m</b>	<b>Grid 6 M4</b> <b>25.42 dBV/m</b>
<b>Grid 7 M4</b> <b>25.42 dBV/m</b>	<b>Grid 8 M4</b> <b>24.83 dBV/m</b>	<b>Grid 9 M4</b> <b>24.87 dBV/m</b>

**Cursor:**

Total = 29.23 dBV/m

E Category: M4

Location: -6.5, -25, 8.7 mm



0 dB = 28.94 V/m = 29.23 dBV/m

**07\_HAC RF\_GSM1900\_GSM Voice\_Ch810**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 1909.8 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch810/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 = 11.70 V/m; Power Drift = -0.01 dB

Applied MIF = 3.63 dB

RF audio interference level = 25.67 dBV/m

**Emission category: M4**

MIF scaled E-field

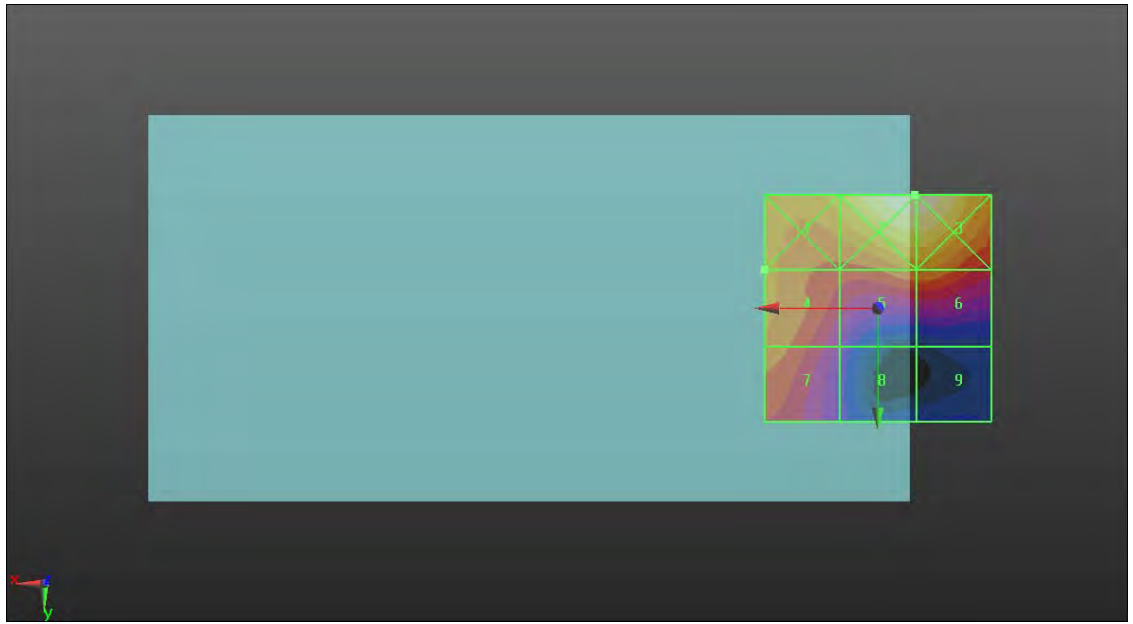
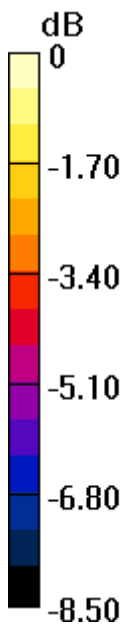
<b>Grid 1 M4</b> <b>26.48 dBV/m</b>	<b>Grid 2 M4</b> <b>28.27 dBV/m</b>	<b>Grid 3 M4</b> <b>28.27 dBV/m</b>
<b>Grid 4 M4</b> <b>25.67 dBV/m</b>	<b>Grid 5 M4</b> <b>25.51 dBV/m</b>	<b>Grid 6 M4</b> <b>25.52 dBV/m</b>
<b>Grid 7 M4</b> <b>25.23 dBV/m</b>	<b>Grid 8 M4</b> <b>22.96 dBV/m</b>	<b>Grid 9 M4</b> <b>21.8 dBV/m</b>

**Cursor:**

Total = 28.27 dBV/m

E Category: M4

Location: -8, -25, 8.7 mm



0 dB = 25.91 V/m = 28.27 dBV/m

**08\_HAC RF\_GSM1900\_GSM Voice\_Ch512**

Communication System: UID 10021 - DAB, GSM-FDD (TDMA, GMSK); Frequency: 1850.2 MHz; Duty Cycle: 1:8.3

Medium: Air Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 0$  kg/m<sup>3</sup>

Ambient Temperature : 23.5 °C

**DASY5 Configuration:**

- Probe: ER3DV6 - SN2528; ConvF(1, 1, 1); Calibrated: 2015.03.24;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1490; Calibrated: 2015.09.14
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA;
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Ch512/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 = 11.23 V/m; Power Drift = -0.01 dB

Applied MIF = 3.63 dB

RF audio interference level = 27.00 dBV/m

**Emission category: M4**

MIF scaled E-field

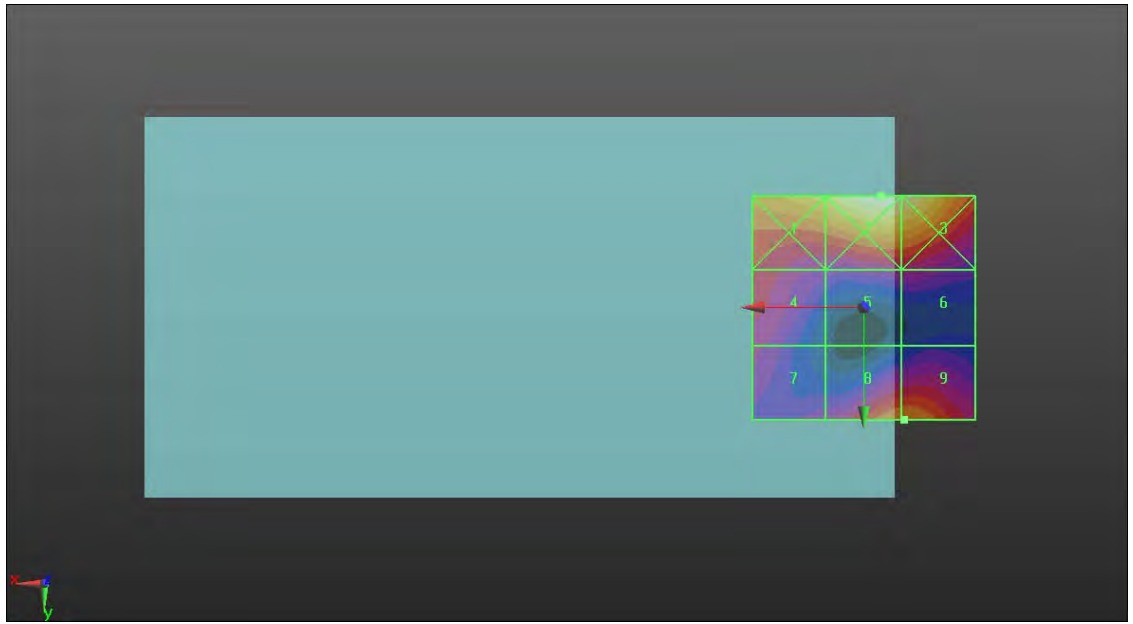
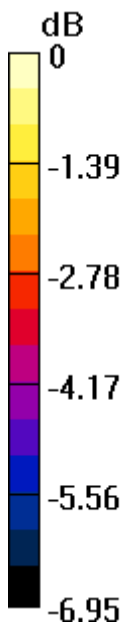
<b>Grid 1 M4</b> <b>28.26 dBV/m</b>	<b>Grid 2 M4</b> <b>29.27 dBV/m</b>	<b>Grid 3 M4</b> <b>29.12 dBV/m</b>
<b>Grid 4 M4</b> <b>26.01 dBV/m</b>	<b>Grid 5 M4</b> <b>25.33 dBV/m</b>	<b>Grid 6 M4</b> <b>25.33 dBV/m</b>
<b>Grid 7 M4</b> <b>25.29 dBV/m</b>	<b>Grid 8 M4</b> <b>27 dBV/m</b>	<b>Grid 9 M4</b> <b>27 dBV/m</b>

**Cursor:**

Total = 29.27 dBV/m

E Category: M4

Location: -4, -25, 8.7 mm



0 dB = 29.06 V/m = 29.27 dBV/m