HAC RF TESTREPORT

No. I18Z60479-SEM04

For

TCL Communication Ltd.

LTE/UMTS/GSM mobile phone

Model Name: A502DL

With

Hardware Version: PIO

Software Version: vGP1

FCC ID: 2ACCJH086

Results Summary: M Category = M4

Issued Date: 2018-5-16

TESTING
NVLAP LAB CODE 600118-0

Note:

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Test Laboratory:

CTTL, Telecommunication Technology Labs, CAICT

No. 51, Xueyuan Road, Haidian District, Beijing, P. R. China 100191.

Tel:+86(0)10-62304633-2512, Fax:+86(0)10-62304633-2504

REPORT HISTORY

Report Number	Revision	Issue Date	Description
I18Z60479-SEM04	Rev.0	2018-5-16	Initial creation of test report

TABLE OF CONTENT

1 Test Laboratory

1.1 Testing Location

CompanyName:	CTTL(Shouxiang)
Address:	No. 51 Shouxiang Science Building, Xueyuan Road, Haidian District, Beijing, P. R. China100191

1.2 Testing Environment

Temperature:	18°C~25°C,
Relative humidity:	30%~ 70%
Ground system resistance:	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

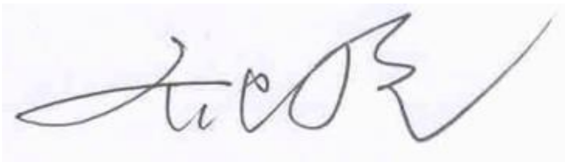
1.3 Project Data

Project Leader:	Qi Dianyuan
Test Engineer:	Lin Hao
Testing Start Date:	May 7, 2018
Testing End Date:	May 7, 2018

1.4 Signature

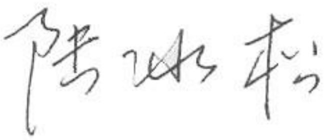
Lin Xiaojun

(Prepared this test report)



Qi Dianyuan

(Reviewed this test report)



Lu Bingsong

Deputy Director of the laboratory

(Approved this test report)

2 Client Information

2.1 Applicant Information

Company Name	TCL Communication Ltd.
Company Address	7/F, Block F4, TCL Communication Technology Building, TCL International E City, Zhong Shan Yuan Road, Nanshan District, Shenzhen, Guangdong, P.R. China 518052
Post Code	518052
Contact Person	Zhizhou Gong
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Company URL	www.alcatel-mobile.com

2.2 Manufacturer Information

Company Name	TCL Communication Ltd.
Company Address	7/F, Block F4, TCL Communication Technology Building, TCL International E City, Zhong Shan Yuan Road, Nanshan District, Shenzhen, Guangdong, P.R. China 518052
Post Code	518052
Contact Person	Zhizhou Gong
Tel	0086-755-36611722
Mobile	0086-18217635320
Fax	0086-755-36612000 ext: 81722
E-Mail	zhizhou.gong@tcl.com
Company URL	www.alcatel-mobile.com

3 Equipment Under Test (EUT) and Ancillary Equipment (AE)

3.1 About EUT

Description:	LTE/UMTS/GSM mobile phone
Model name:	A502DL
Operating mode(s):	GSM 850/900/1800/1900 WCDMA850/900/1700/1900/2100 LTE B2/4/5/12/13/66/71, BT, WLAN

3.2 Internal Identification of EUT used during the test

EUT ID*	IMEI	HW Version	SW Version
EUT1	015145000208559	PIO	vGP1
EUT2	015145000208443	PIO	vGP1

*EUT ID: is used to identify the test sample in the lab internally.

3.3 Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
AE1	Battery	TLp038C1	CAC2400038C1	BYD

*AE ID: is used to identify the test sample in the lab internally.

3.4 Air Interfaces / Bands Indicating Operating Modes

Air-interface	**Band(MHz)**	**Type**	**C63.19/tested**	**Simultaneous Transmissions**	**OTT**
GSM	850	VO	Yes	BT, WLAN	NA
	1900				
GPRS/EDGE	850	DT	NA		
	1900				
WCDMA (UMTS)	850	VO	Yes	BT, WLAN	NA
	1700				
	1900				
	HSPA	DT	NA		
LTE	Band 2/4/5/12/13/66/71	V/D	Yes	BT, WLAN	NA
BT	2450	DT	NA	GSM, WCDMA, LTE	NA
WLAN	2450	V/D	Yes	GSM, WCDMA, LTE	NA

VO: Voice CMRS/PSTN Service Only V/D: Voice CMRS/PSTN and Data Service DT: Digital Transport

* HAC Rating was not based on concurrent voice and data modes, Non current mode was found to represent worst case rating for both M and T rating

4 CONDUCTED OUTPUT POWER MEASUREMENT

4.1 Summary

During the process of testing, the EUT was controlled via Agilent Digital Radio Communication tester (E5515C) to ensure the maximum power transmission and proper modulation. This result contains conducted output power for the EUT. In all cases, the measured output power should be greater and within 5% than EMI measurement.

4.2 Conducted Power

Band	Conducted Power (dBm)		
GSM 850MHz	Channel 251(848.8MHz)	Channel 190(836.6MHz)	Channel 128(824.2MHz)
	31.54	31.58	31.53
GSM 1900MHz	Conducted Power(dBm)		
	Channel 810(1909.8MHz)	Channel 661(1880MHz)	Channel 512(1850.2MHz)
	29.44	29.51	29.77
WCDMA 850MHz	Conducted Power (dBm)		
	Channel 4233(846.6MHz)	Channel 4182(836.4MHz)	Channel 4132(826.4MHz)
	23.44	23.47	23.45
WCDMA 1700MHz	Conducted Power (dBm)		
	Channel 1513 (1752.6MHz)	Channel 1412 (1732.4MHz)	Channel 1312 (1712.4MHz)
	23.88	23.94	23.91
WCDMA 1900MHz	Conducted Power (dBm)		
	Channel 9538(1907.6MHz)	Channel 9400(1880MHz)	Channel 9262(1852.4MHz)
	23.41	23.40	23.37
LTE Band2 QPSK	Conducted Power (dBm)		
	Channel 19100(1900MHz)	Channel18900(1880MHz)	Channel 18700(1860MHz)
	23.44	23.02	23.00
LTE Band5 QPSK	Conducted Power (dBm)		
	Channel 20600(844MHz)	Channel 20525(836.5MHz)	Channel20450(829MHz)
	23.47	23.37	23.45
LTE Band12 QPSK	Conducted Power (dBm)		
	Channel 23130(711MHz)	Channel 23095(707.5MHz)	Channel23060(704MHz)
	23.48	23.38	23.50
LTE Band13 QPSK	Conducted Power (dBm)		
	Channel 23230(782MHz)		
	22.92		
LTE Band66 QPSK	Conducted Power (dBm)		
	Channel 132572(1770MHz)	Channel 132322(1745MHz)	Channel 132072(1720MHz)
	22.91	23.23	23.01
LTE Band71 QPSK	Conducted Power (dBm)		
	Channel 133372(688MHz)	Channel 133297(680.5MHz)	Channel 133222(673MHz)
	22.93	23.00	23.17

LTE Band2 16-QAM	Conducted Power (dBm)		
	Channel 19100(1900MHz)	Channel18900(1880MHz)	Channel 18700(1860MHz)
	22.47	22.38	22.28
LTE Band5 16-QAM	Conducted Power (dBm)		
	Channel 20600(844MHz)	Channel 20525(836.5MHz)	Channel20450(829MHz)
	22.70	22.37	22.27
LTE Band12 16-QAM	Conducted Power (dBm)		
	Channel 23130(711MHz)	Channel 23095(707.5MHz)	Channel23060(704MHz)
	22.22	22.69	22.40
LTE Band13 16-QAM	Conducted Power (dBm)		
	Channel 23230(782MHz)		
	21.83		
LTE Band66 16-QAM	Conducted Power (dBm)		
	Channel 132572(1770MHz)	Channel 132322(1745MHz)	Channel 132072(1720MHz)
	22.15	22.71	22.39
LTE Band71 16-QAM	Conducted Power (dBm)		
	Channel 133372(688MHz)	Channel 133297(680.5MHz)	Channel 133222(673MHz)
	22.13	22.39	22.30
2.4GHz 802.11b 5.5M	Conducted Power (dBm)		
	Channel 11 (2462MHz)	Channel 6 (2437MHz)	Channel 1 (2412MHz)
	20.18	19.96	20.15

5 Reference Documents

5.1 Reference Documents for testing

The following document listed in this section is referred for testing.

Reference	Title	Version
ANSI C63.19-2011	American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids	2011 Edition
FCC 47 CFR §20.19	Hearing Aid Compatible Mobile Headsets	2015 Edition
KDB 285076 D01	Equipment Authorization Guidance for Hearing Aid Compatibility	v04

6 OPERATIONAL CONDITIONS DURING TEST

6.1 HAC MEASUREMENT SET-UP

These measurements are performed using the DASY5 NEO automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Stäubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor. The robot is a six-axis industrial robot performing precise movements. A cell controller system contains the power supply, robot controller, teach pendant (Joystick),and remote control, is used to drive the robot motors. The PC consists of the HP Intel Core21.86 GHz computer with Windows XP system and HAC Measurement Software DASY5 NEO, A/D interface card, monitor, mouse, and keyboard. The Stäubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE)circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

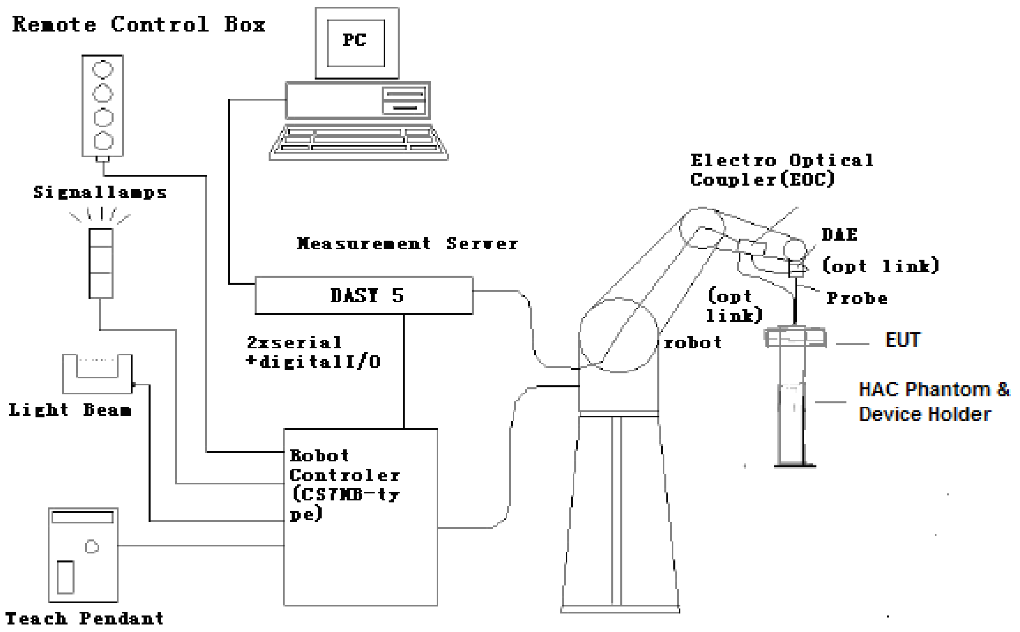
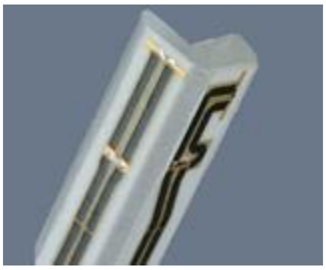


Fig. 1 HAC Test Measurement Set-up

The DAE4 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. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

6.2 Probe Specification

E-Field Probe Description



[ER3DV6]

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges PEEK enclosure material
Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy ±6.0%, k=2)
Frequency	40 MHz to > 6 GHz (can be extended to < 20 MHz) Linearity: ± 0.2 dB (100 MHz to 3 GHz)
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range	2 V/m to > 1000 V/m; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm
Application	General near-field measurements up to 6 GHz Field component measurements Fast automatic scanning in phantoms

6.3Test Arch Phantom &Phone Positioner

The Test Arch phantom should be positioned horizontally on a stable surface. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. It enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot (Dimensions: 370 x 370 x 370 mm).

The Phone Positioner supports accurate and reliable positioning of any phone with effect on near field <±0.5 dB.

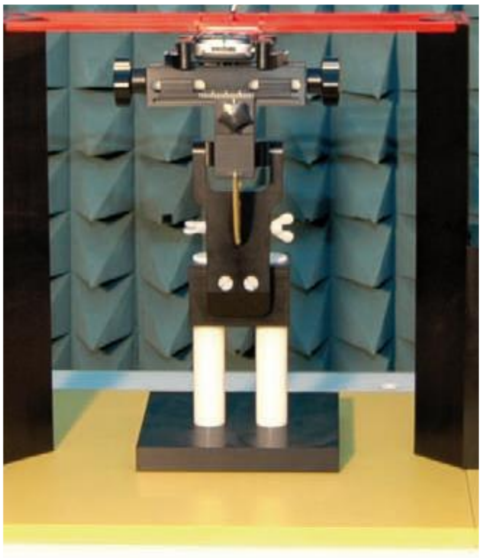


Fig. 2 HAC Phantom & Device Holder

6.4Robotic System Specifications

Specifications

Positioner: Stäubli Unimation Corp. Robot Model: RX160L
Repeatability: ±0.02 mm
No. of Axis: 6

Data Acquisition Electronic (DAE) System

Cell Controller
Processor: Intel Core2
Clock Speed: 1.86GHz
Operating System: Windows XP
Data Converter
Features: Signal Amplifier, multiplexer, A/D converter, and control logic
Software: DASY5 software
Connecting Lines: Optical downlink for data and status info.
Optical uplink for commands and clock

7 EUT ARRANGEMENT

7.1 WD RF Emission Measurements Reference and Plane

Figure 4 illustrates the references and reference plane that shall be used in the WD emissions measurement.

・ The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.

・ The grid is centered on the audio frequency output transducer of the WD (speaker or T-coil).

・ The grid is located by reference to a reference plane. This reference plane is the planar area that contains the highest point in the area of the WD that normally rests against the user’s ear

•The measurement plane is located parallel to the reference plane and 15 mm from it, out from the phone. The grid is located in the measurement plane.

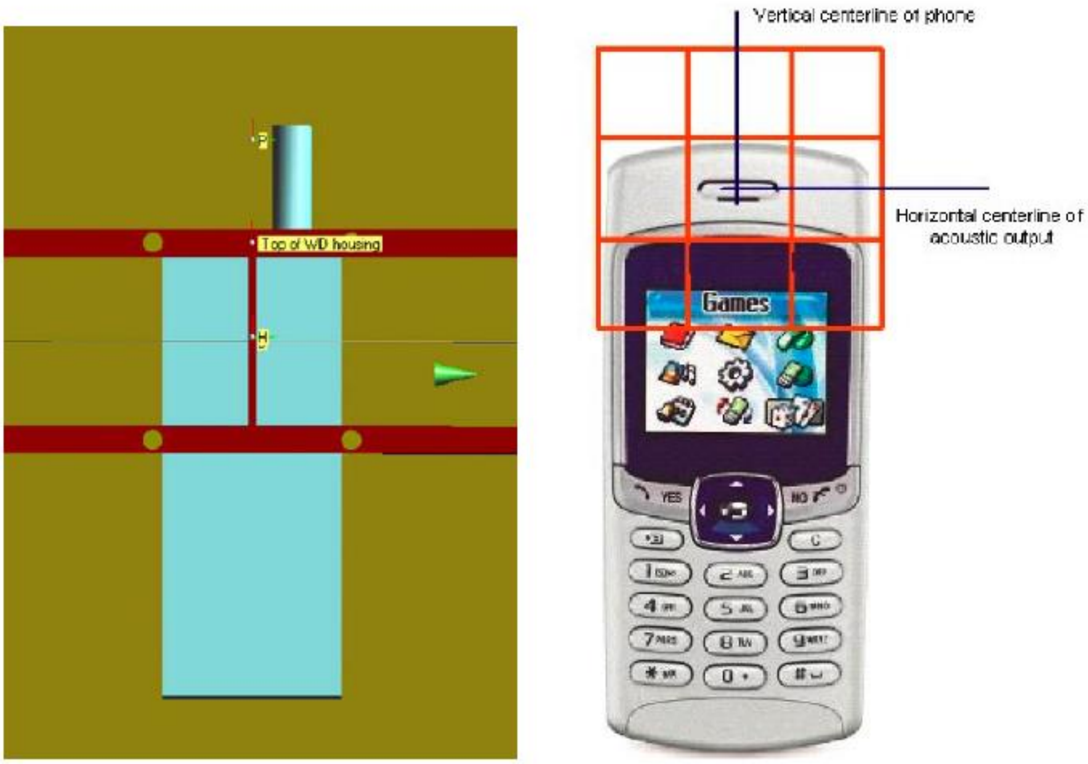


Fig. 3 WD reference and plane for RF emission measurements

8 SYSTEM VALIDATION

8.1 Validation Procedure

Place a dipole antenna meeting the requirements given in ANSI C63.19 in the position normally occupied by the WD. The dipole antenna serves as a known source for an electrical output. Position the E-field probes so that:

•The probes and their cables are parallel to the coaxial feed of the dipole antenna

•The probe cables and the coaxial feed of the dipole antenna approach the measurement area from opposite directions

• The center point of the probe element(s) are 15 mm from the closest surface of the dipole elements.

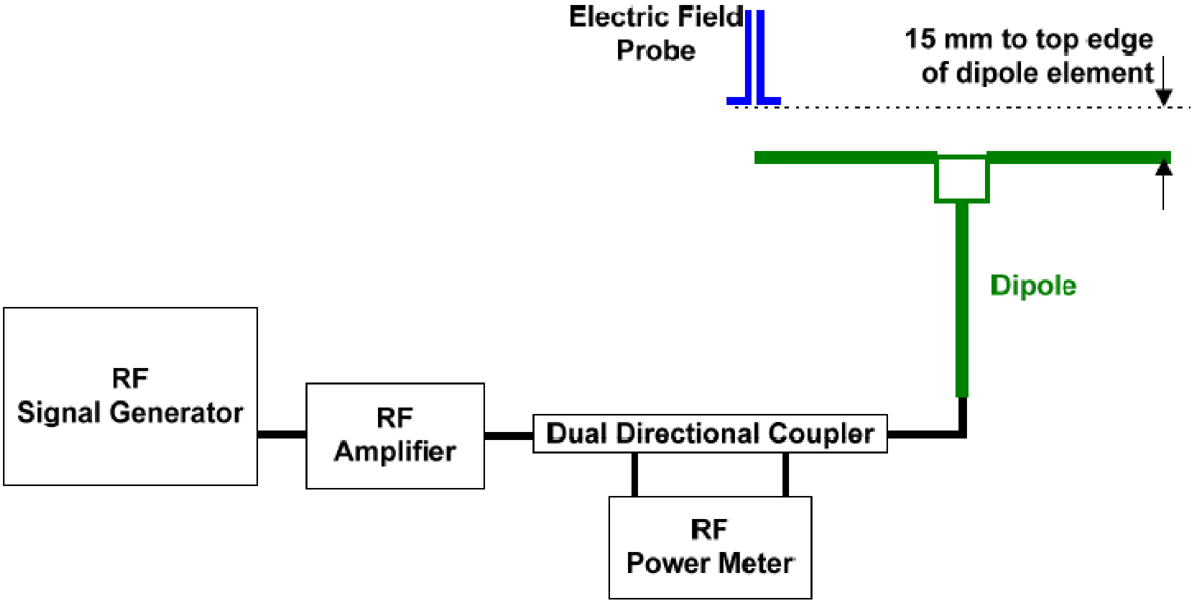


Fig. 4 Dipole Validation Setup

8.2 Validation Result

E-Field Scan						
Mode	**Frequency (MHz)**	**Input Power (mW)**	**Measured[1] Value(dBV/m)**	**Target[2] Value(dBV/m)**	**Deviation[3] (%)**	**Limit[4] (%)**
CW	835	100	40.48	40.67	-2.16	±25
CW	1880	100	39.40	39.24	1.86	±25
CW	2450	100	39.12	39.28	-1.83	±25

Notes:

1. Please refer to the attachment for detailed measurement data and plot.

2. Target value is provided by SPEAD in the calibration certificate of specific dipoles.

3. Deviation (%) = 100 * (Measured value minus Target value) divided by Target value.

4. ANSI C63.19 requires values within ± 25% are acceptable, of which 12% is deviation and 13% is measurement uncertainty. Values independently validated for the dipole actually used in the measurements should be used, when available.

9 Evaluation of MIF

9.1 Introduction

The MIF (Modulation Interference Factor) is used to classify E-field emission to determine Hearing Aid Compatibility (HAC). It scales the power-averaged signal to the RF audio interference level and is characteristic to a modulation scheme. The HAC standard preferred "indirect" measurement method is based on average field measurement with separate scaling by the MIF. With an Audio Interference Analyzer (AIA) designed by SPEAG specifically for the MIF measurement, these values have been verified by practical measurements on an RF signal modulated with each of the waveforms. The resulting deviations from the simulated values are within the requirements of the HAC standard.

The AIA (Audio Interference Analyzer) is an USB powered electronic sensor to evaluate signals in the frequency range 698MHz - 6 GHz. It contains RMS detector and audio frequency circuits for sampling of the RF envelope.

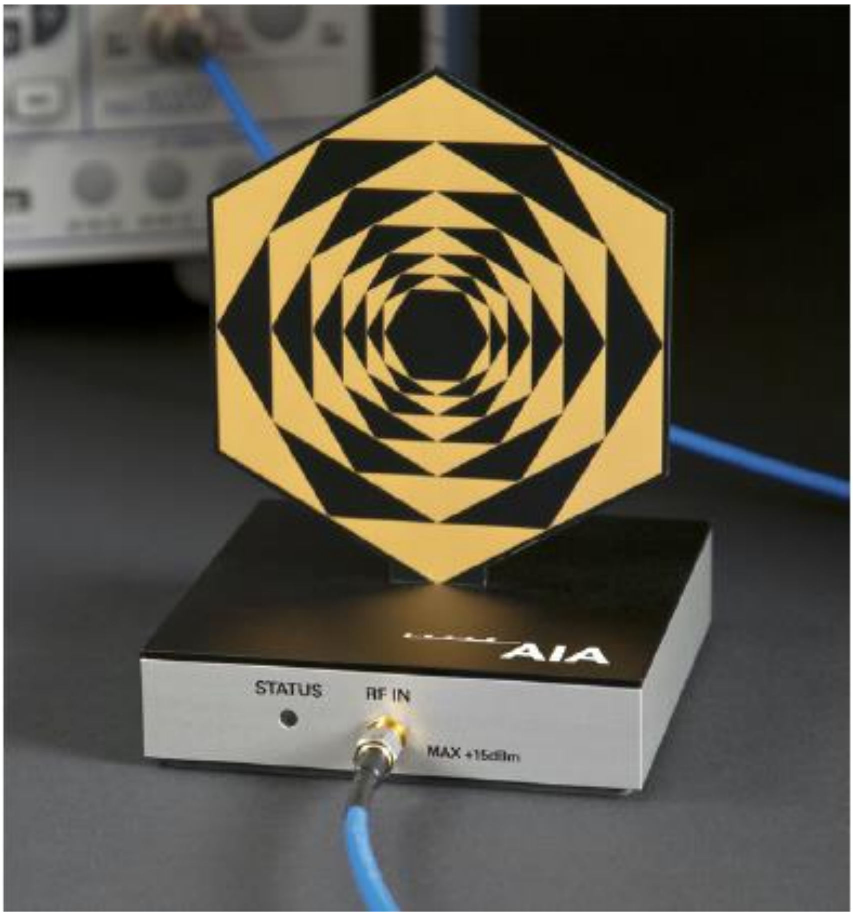


Fig. 5 AIA Front View

9.2 MIF measurement with the AIA

The MIF is measured with the AIA as follows:

1. Connect the AIA via USB to the DASY5 PC and verify the configuration settings.
2. Couple the RF signal to be evaluated to an AIA via cable or antenna.
3. Generate a MIF measurement job for the unknown signal and select the measurement port and timing settings.
4. Document the results via the post processor in a report.

9.3 Test equipment for the MIF measurement

No.	Name	Type	Serial Number	Manufacturer
01	Signal Generator	E4438C	MY49071430	Agilent
02	AIA	SE UMS 170 CB	1029	SPEAG
03	BTS	E5515C	MY50263375	Agilent

9.4 Test signal validation

The signal generator (E4438C) is used to generate a 1GHz signal with different modulation in the below table based on the ANSI C63.19-2011. The measured MIF with AIA are compared with the target values given in ANSI C63.19-2011 table D.3, D.4 and D5.

Pulse modulation	Target MIF	Measured MIF	Deviation
0.5ms pulse, 1000Hz repetition rate	-0.9 dB	-0.9 dB	0 dB
1ms pulse, 100Hz repetition rate	+3.9 dB	+3.7 dB	0.2 dB
0.1ms pulse, 100Hz repetition rate	+10.1 dB	+10.0 dB	0.1 dB
10ms pulse, 10Hz repetition rate	+1.6 dB	+1.7 dB	0.1 dB
Sine-wave modulation	**Target MIF**	**Measured MIF**	**Deviation**
1 kHz, 80% AM	-1.2 dB	-1.3 dB	0.1 dB
1 kHz, 10% AM	-9.1 dB	-9.0 dB	0.1 dB
1 kHz, 1% AM	-19.1 dB	-18.9 dB	0.2 dB
100 Hz, 10% AM	-16.1 dB	-16.0 dB	0.1 dB
10 kHz, 10% AM	-21.5 dB	-21.6 dB	0.1 dB
Transmission protocol	**Target MIF**	**Measured MIF**	**Deviation**
GSM; full-rate version 2; speech codec/handset low	+3.5 dB	+3.47 dB	0.03 dB
WCDMA; speech; speech codec low; AMR 12.2 kb/s	-20.0 dB	-19.8 dB	0.2 dB
CDMA; speech; SO3; RC3; full frame rate; 8kEVRC	-19.0 dB	-19.1 dB	0.1 dB
CDMA; speech; SO3; RC1; 1/8th frame rate; 8kEVRC	+3.3 dB	+3.44 dB	0.14 dB

9.5 DUT MIF results

Typical MIF levels in ANSI C63.19-2011	
Transmission protocol	Modulation interference factor
GSM; full-rate version 2; speech codec/handset low	+3.5 dB
WCDMA; speech; speech codec low; AMR 12.2 kb/s	-20.0 dB
LTE-FDD (SC-FDMA, 1RB, 20MHz, QPSK)	-15.63 dB
LTE-FDD (SC-FDMA, 1RB, 20MHz, 16QAM)	-9.76 dB

Measured MIF levels		
Band	Channel	Modulation interference factor (dB)
GSM 850	251	3.43
	190	3.47
	128	3.46
GSM 1900	810	3.51
	661	3.52
	512	3.51
WCDMA 850	4233	-22.18
	4182	-22.49
	4132	-22.33
WCDMA 1700	1513	-23.62
	1412	-23.15
	1312	-22.96
WCDMA 1900	9538	-23.47
	9400	-22.73
	9262	-23.08
LTE Band2 QPSK	19100	-13.58
	18900	-13.61
	18700	-14.63
LTE Band5 QPSK	20600	-14.61
	20525	-14.45
	20450	-14.65
LTE Band12 QPSK	23130	-14.43
	23095	-14.92
	23060	-14.42
LTE Band13 QPSK	23230	-13.3
LTE Band66 QPSK	132572	-14.38
	132322	-14.33
	132072	-14.37
LTE Band71 QPSK	133372	-14.47
	133297	-14,41
	133222	-13.79

LTE Band2 16QAM	19100	-11.58
	18900	-10.75
	18700	-9.95
LTE Band5 16QAM	20600	-10.15
	20525	-10.98
	20450	-9.78
LTE Band12 16QAM	23130	-11.05
	23095	-9.76
	23060	-10.25
LTE Band13 16QAM	23230	-10.61
LTE Band66 16QAM	132572	-10.79
	132322	-10.59
	132072	-10.52
LTE Band71 QPSK	133372	-9.88
	133297	-9.91
	133222	-10.65
2.4GHz 802.11b 5.5M	11	-7.45
	6	-7.24
	1	-8.04

10 Evaluation for low-power exemption

10.1 Product testing threshold

There are two methods for exempting an RF air interface technology from testing. The first method requires evaluation of the MIF for the worst-case operating mode. 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. The second method does not require determination of the MIF. The 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 μs20, is ≤23 dBm. An RF air interface technology that is exempted from testing by either method shall be rated as M4.
The first method is used to be exempt from testing for the RF air interface technology in this report.

10.2 Conducted power

Band	Average power (dBm)	MIF (dB)	Sum (dBm)
GSM 850	31.58	3.47	35.05
GSM 1900	29.77	3.52	33.29
WCDMA 850	23.47	-22.18	1.29
WCDMA 1700	23.94	-22.96	0.98
WCDMA 1900	23.41	-22.73	0.68
LTE B2	22.47	-9.95	12.52
LTE B5	22.70	-9.78	12.92
LTE B12	22.69	-9.76	12.93
LTE B13	21.83	-10.61	11.22
LTE B66	22.71	-10.52	12.19
LTE B71	22.39	-9.88	12.51
WiFi-2.4G	20.18	-7.24	12.94

10.3 Conclusion

According to the above table, the sums of average power and MIF for UMTS, LTE and WiFi are less than 17dBm. So it is only measured for GSM bands. The UMTS, LTE and WiFi are exempt from testing and rated as M4.

11 RF TEST PROCEDUERES

The evaluation was performed with the following procedure:

1) Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.

2) Position the WD in its intended test position. The gauge block can simplify this positioning.

3) Configure the WD normal operation for maximum rated RF output power, at the desired channel and other operating parameters (e.g., test mode), as intended for the test.

4) The center sub-grid shall centered on the center of the T-Coil mode axial measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the50 mm by 50 mm grid, which is contained in the measurement plane. If the field alignment method is used, align the probe for maximum field reception.

5) Record the reading.

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

7) 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.

8) Identify the maximum field reading within the non-excluded sub-grids identified in Step 7)

9) Evaluate the MIF and add to the maximum steady-state rms field-strength reading to obtain the RF audio interference level..

10) Compare this RF audio interference level with the categories and record the resulting WD category rating.

12 Measurement Results (E-Field)

Frequency		Measured Value(dBV/m)	Power Drift (dB)	Category
MHz	Channel			
GSM 850				
848.8	251	34.37	-0.07	**M4** (see Fig B.1)
836.6	190	34.72	0.09	**M4** (see Fig B.2)
824.2	128	35.84	-0.01	**M4** (see Fig B.3)
GSM 1900				
1909.8	810	28.41	-0.08	**M4** (see Fig B.4)
1880	661	27.21	-0.06	**M4** (see Fig B.5)
1850.2	512	27.68	0.03	**M4** (see Fig B.6)

13 ANSIC 63.19-2011 LIMITS

WD RF audio interference level categories in logarithmic units

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

14 MEASUREMENT UNCERTAINTY

No.	Error source	Type	Uncertainty Value(%)	Prob. Dist.	k	c_iE	Standard Uncertainty (%) $u_i^{'}$ (%)E	Degree of freedom V_{eff} or v_i
Measurement System								
1	Probe Calibration	B	5.	N	1	1	5.1	∞
2	Axial Isotropy	B	4.7	R	$\sqrt{3}$	1	2.7	∞
3	Sensor Displacement	B	16.5	R	$\sqrt{3}$	1	9.5	∞
4	Boundary Effects	B	2.4	R	$\sqrt{3}$	1	1.4	∞
5	Linearity	B	4.7	R	$\sqrt{3}$	1	2.7	∞
6	Scaling to Peak Envelope Power	B	2.0	R	$\sqrt{3}$	1	1.2	∞
7	System Detection Limit	B	1.0	R	$\sqrt{3}$	1	0.6	∞
8	Readout Electronics	B	0.3	N	1	1	0.3	∞
9	Response Time	B	0.8	R	$\sqrt{3}$	1	0.5	∞
10	Integration Time	B	2.6	R	$\sqrt{3}$	1	1.5	∞
11	RF Ambient Conditions	B	3.0	R	$\sqrt{3}$	1	1.7	∞
12	RF Reflections	B	12.0	R	$\sqrt{3}$	1	6.9	∞
13	Probe Positioner	B	1.2	R	$\sqrt{3}$	1	0.7	∞
14	Probe Positioning	A	4.7	R	$\sqrt{3}$	1	2.7	∞
15	Extra. And Interpolation	B	1.0	R	$\sqrt{3}$	1	0.6	∞
Test Sample Related								
16	Device Positioning Vertical	B	4.7	R	$\sqrt{3}$	1	2.7	∞
17	Device Positioning Lateral	B	1.0	R	$\sqrt{3}$	1	0.6	∞
18	Device Holder and Phantom	B	2.4	R	$\sqrt{3}$	1	1.4	∞
19	Power Drift	B	5.0	R	$\sqrt{3}$	1	2.9	∞

20	AIA measurement	B	12	R	$\sqrt{3}$	1	6.9	∞
Phantom and Setup related								
21	Phantom Thickness	B	2.4	R	$\sqrt{3}$	1	1.4	∞
Combined standard uncertainty(%)							16.2	
Expanded uncertainty (confidence interval of 95 %)		$u_e = 2u_c$		N	k=2		32.4	

15 MAIN TEST INSTRUMENTS

Table 1: List of Main Instruments

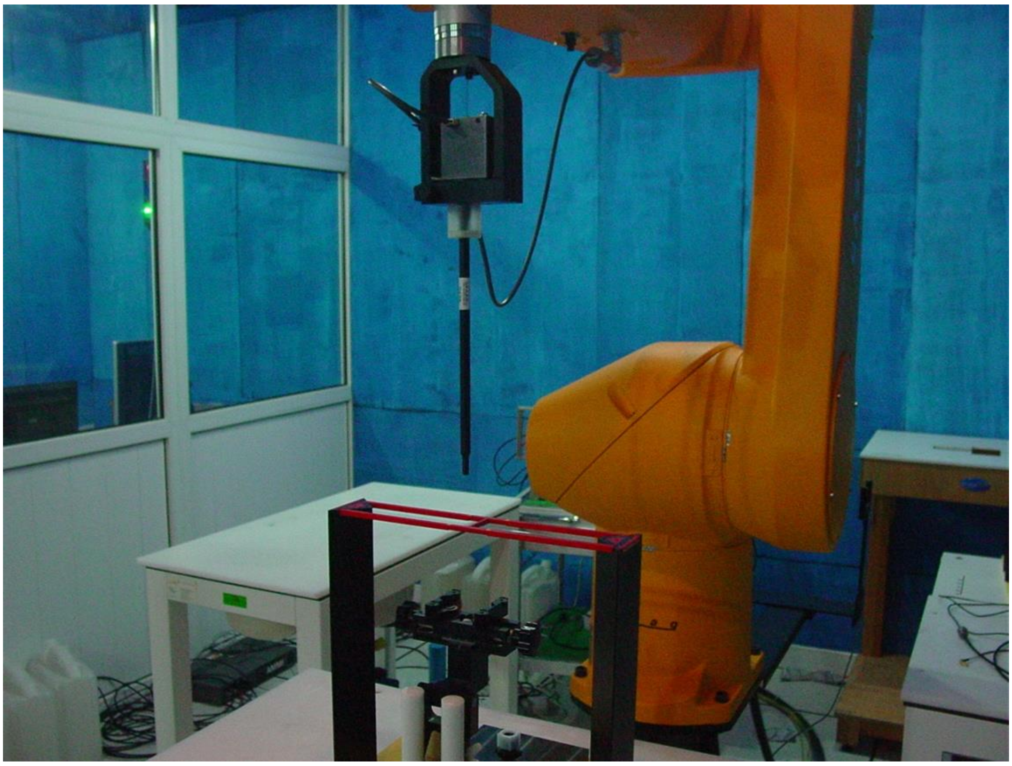
No.	Name	Type	Serial Number	Calibration Date	Valid Period
01	Signal Generator	E4438C	MY49071430	January 2, 2018	One Year
02	Power meter	NRVD	102083	November 01, 2017	One year
03	Power sensor	NRV-Z5	100542		
04	Amplifier	60S1G4	0331848	No Calibration Requested	
05	AIA	SE UMS 170 CB	1029	No Calibration Requested	
06	E-Field Probe	ER3DV6	2272	December 19, 2017	One year
07	DAE	SPEAG DAE4	777	September 8, 2017	One year
08	HAC Dipole	CD835V3	1023	August 23, 2017	One year
09	HAC Dipole	CD1880V3	1018	August 23, 2017	One year
10	HAC Dipole	CD2450V3	1021	August 23, 2017	One year
11	BTS	E5515C	MY50263375	January 23, 2018	One year
12	BTS	CMW 500	164049	September 12, 2017	One year

16 CONCLUSION

The HAC measurement indicates that the EUT complies with the HAC limits of the ANSIC63.19-2011. The total M-rating is **M4.**

END OF REPORT BODY

ANNEX A TEST LAYOUT



Picture A1:HAC RF System Layout

ANNEX B TEST PLOTS

HAC RF E-Field GSM 850 High

Date: 2018-5-7

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C

Communication System: GSM 850; Frequency: 848.8 MHz; Duty Cycle: 1:8.3

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

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 45.13 V/m; Power Drift = -0.07 dB

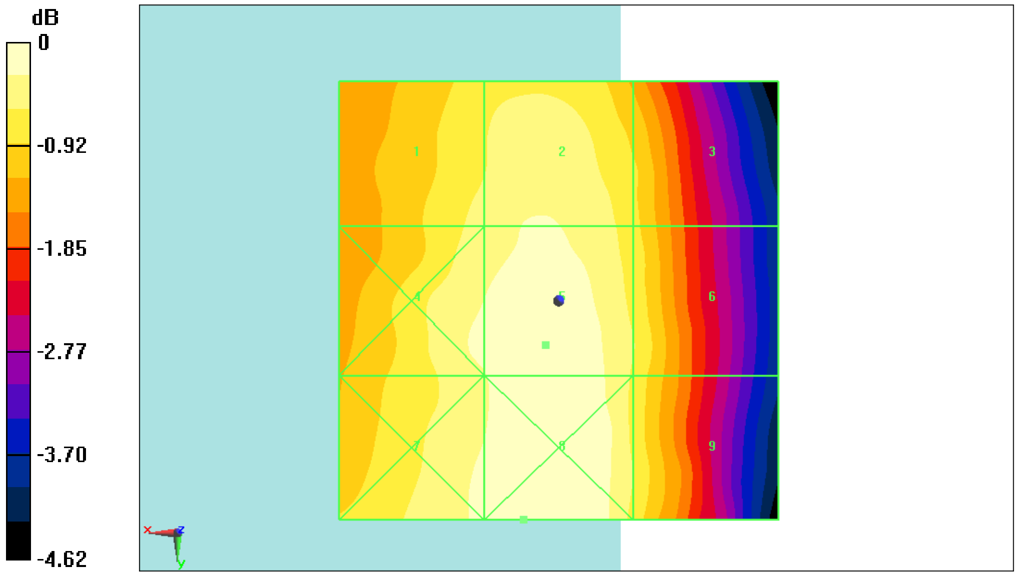
Applied MIF = 3.43 dB

RF audio interference level = 34.37 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **33.93 dBV/m**	Grid 2 **M4** **34.12 dBV/m**	Grid 3 **M4** **33.59 dBV/m**
Grid 4 **M4** **34.18 dBV/m**	Grid 5 **M4** **34.37 dBV/m**	Grid 6 **M4** **33.81 dBV/m**
Grid 7 **M4** **34.19 dBV/m**	Grid 8 **M4** **34.41 dBV/m**	Grid 9 **M4** **33.79 dBV/m**



0 dB = 52.52 V/m = 34.41 dBV/m

Fig B.1 HAC RF E-Field GSM 850 High

HAC RF E-Field GSM 850 Middle

Date: 2018-5-7

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C

Communication System: GSM 850; Frequency: 836.6 MHz; Duty Cycle: 1:8.3

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

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 45.99 V/m; Power Drift = 0.09 dB

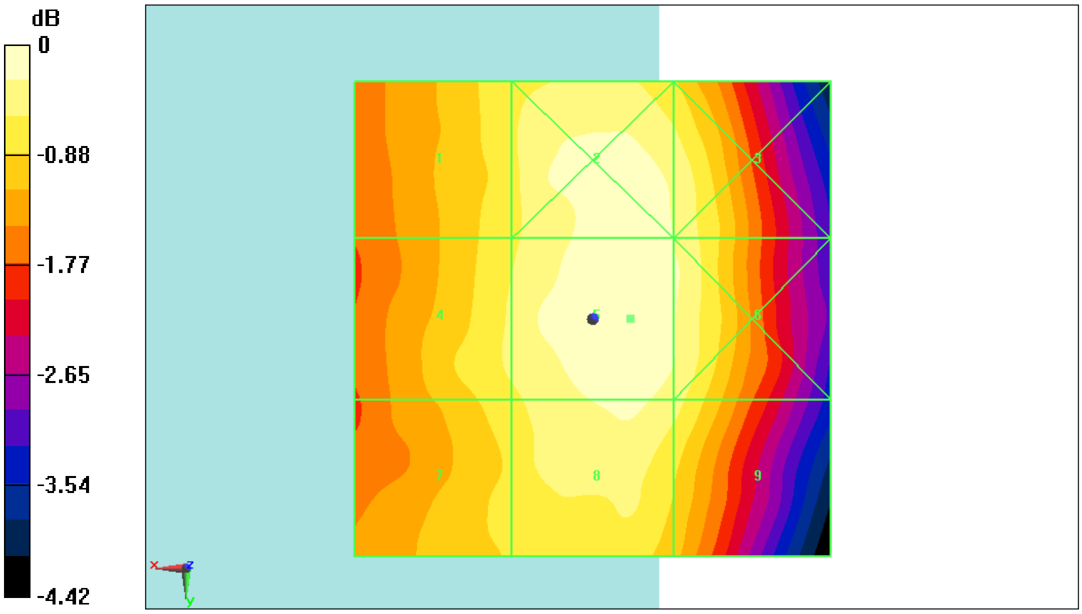
Applied MIF = 3.47 dB

RF audio interference level = 34.72 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **34.09 dBV/m**	Grid 2 **M4** **34.61 dBV/m**	Grid 3 **M4** **34.42 dBV/m**
Grid 4 **M4** **34.2 dBV/m**	Grid 5 **M4** **34.72 dBV/m**	Grid 6 **M4** **34.48 dBV/m**
Grid 7 **M4** **34.06 dBV/m**	Grid 8 **M4** **34.51 dBV/m**	Grid 9 **M4** **34.26 dBV/m**



0 dB = 54.47 V/m = 34.72 dBV/m

Fig B.2 HAC RF E-Field GSM 850 Middle

HAC RF E-Field GSM 850 Low

Date: 2018-5-7

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C

Communication System: GSM 850; Frequency: 824.2 MHz; Duty Cycle: 1:8.3

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

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 3/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 51.49 V/m; Power Drift = -0.01 dB

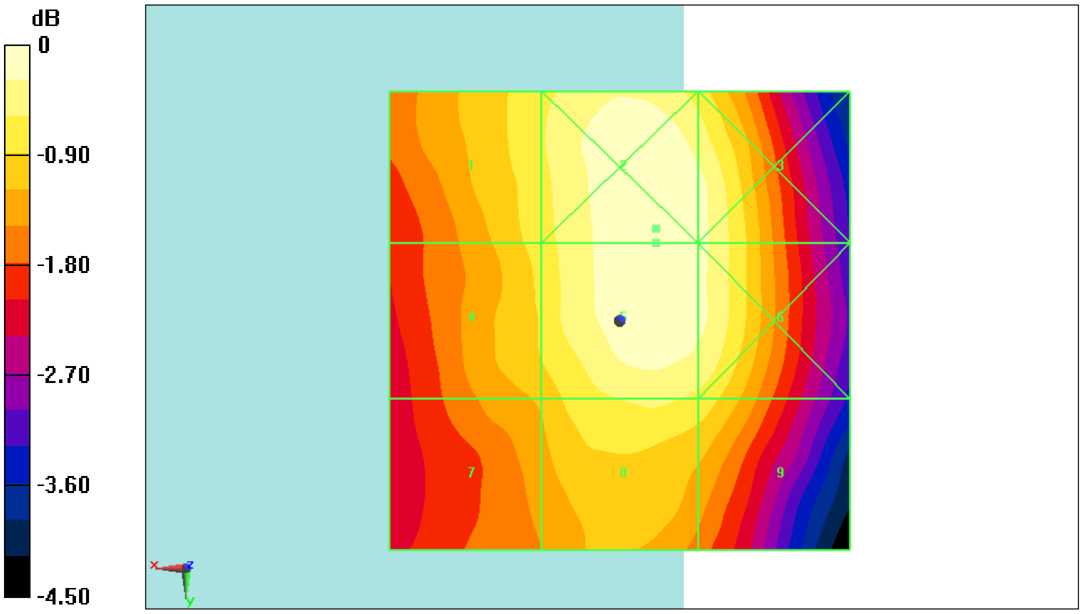
Applied MIF = 3.46 dB

RF audio interference level = 35.84 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **35.22 dBV/m**	Grid 2 **M4** **35.85 dBV/m**	Grid 3 **M4** **35.67 dBV/m**
Grid 4 **M4** **35.11 dBV/m**	Grid 5 **M4** **35.84 dBV/m**	Grid 6 **M4** **35.67 dBV/m**
Grid 7 **M4** **34.74 dBV/m**	Grid 8 **M4** **35.32 dBV/m**	Grid 9 **M4** **35.17 dBV/m**



0 dB = 62.02 V/m = 35.85 dBV/m

Fig B.3 HAC RF E-Field GSM 850 Low

HAC RF E-Field GSM 1900 High

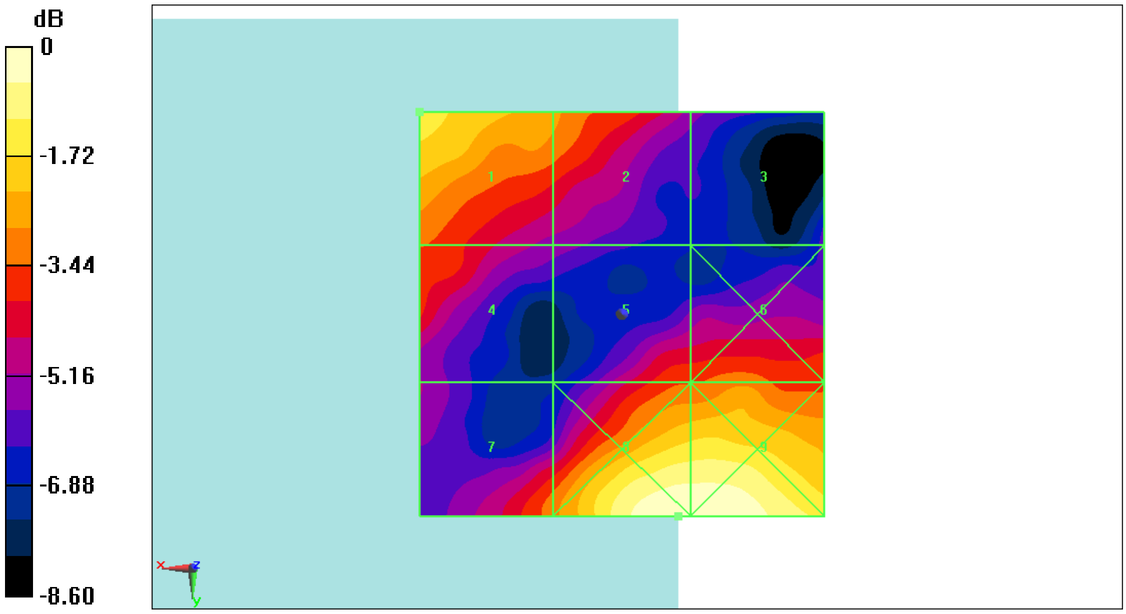
Date: 2018-5-7

Electronics: DAE4 Sn777
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Ambient Temperature: 22.0°C
Communication System: DCS 1900; Frequency: 1909.8 MHz; Duty Cycle: 1:8.3
Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 11.21 V/m; Power Drift = -0.08 dB
Applied MIF = 3.51 dB
RF audio interference level = 28.41 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **28.41 dBV/m**	Grid 2 **M4** **27.23 dBV/m**	Grid 3 **M4** **24.51 dBV/m**
Grid 4 **M4** **26.48 dBV/m**	Grid 5 **M4** **26.4 dBV/m**	Grid 6 **M4** **26.86 dBV/m**
Grid 7 **M4** **26.8 dBV/m**	Grid 8 **M4** **29.85 dBV/m**	Grid 9 **M4** **29.82 dBV/m**



0 dB = 31.09 V/m = 29.85 dBV/m

Fig B.4 HAC RF E-Field GSM 1900 High

HAC RF E-Field GSM 1900 Middle

Date: 2018-5-7

Electronics: DAE4 Sn777

Medium: Air

Medium parameters used: σ = 0 mho/m, ε_r = 1; ρ = 1000 kg/m^3

Ambient Temperature: 22.0°C

Communication System: DCS 1900; Frequency: 1880 MHz; Duty Cycle: 1:8.3

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

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 2/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 11.82 V/m; Power Drift = -0.06 dB

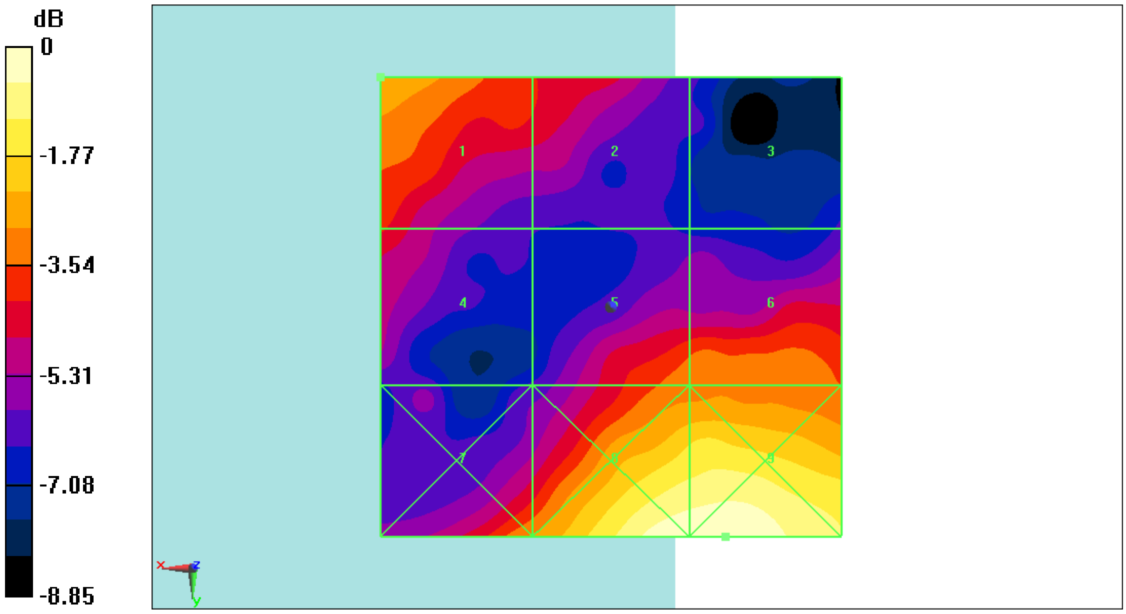
Applied MIF = 3.52 dB

RF audio interference level = 27.21 dBV/m

Emission category: M4

MIF scaled E-field

Grid 1 **M4** **27.21 dBV/m**	Grid 2 **M4** **25.78 dBV/m**	Grid 3 **M4** **23.62 dBV/m**
Grid 4 **M4** **25.85 dBV/m**	Grid 5 **M4** **26.64 dBV/m**	Grid 6 **M4** **26.76 dBV/m**
Grid 7 **M4** **27.01 dBV/m**	Grid 8 **M4** **29.75 dBV/m**	Grid 9 **M4** **29.84 dBV/m**



0 dB = 31.03 V/m = 29.84 dBV/m

Fig B.5 HAC RF E-Field GSM 1900 Middle

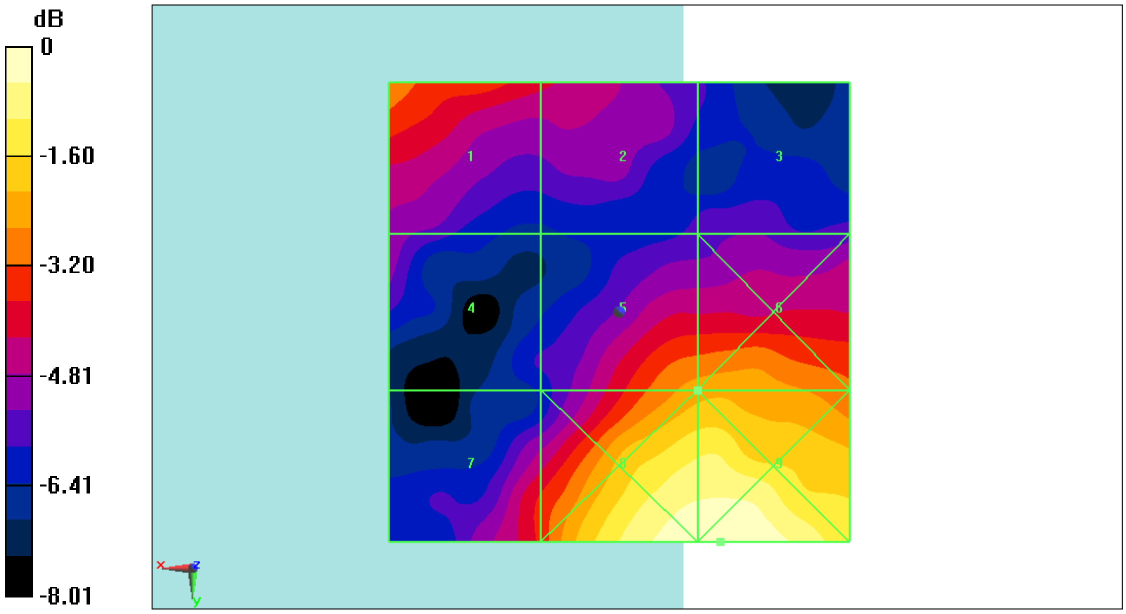
HAC RF E-Field GSM 1900 Low

Date: 2018-5-7
Electronics: DAE4 Sn777
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Ambient Temperature: 22.0°C
Communication System: DCS 1900; Frequency: 1850.2 MHz; Duty Cycle: 1:8.3
Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)

E Scan - ER3DV6 - 2011: 15 mm from Probe Center to the Device 3/Hearing Aid Compatibility Test (101x101x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 12.97 V/m; Power Drift = 0.03 dB
Applied MIF = 3.51 dB
RF audio interference level = 27.68 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 **M4** **27.45 dBV/m**	Grid 2 **M4** **26.01 dBV/m**	Grid 3 **M4** **24.79 dBV/m**
Grid 4 **M4** **25.18 dBV/m**	Grid 5 **M4** **27.68 dBV/m**	Grid 6 **M4** **27.8 dBV/m**
Grid 7 **M4** **26.6 dBV/m**	Grid 8 **M3** **30.02 dBV/m**	Grid 9 **M3** **30.09 dBV/m**



0 dB = 31.94 V/m = 30.09 dBV/m

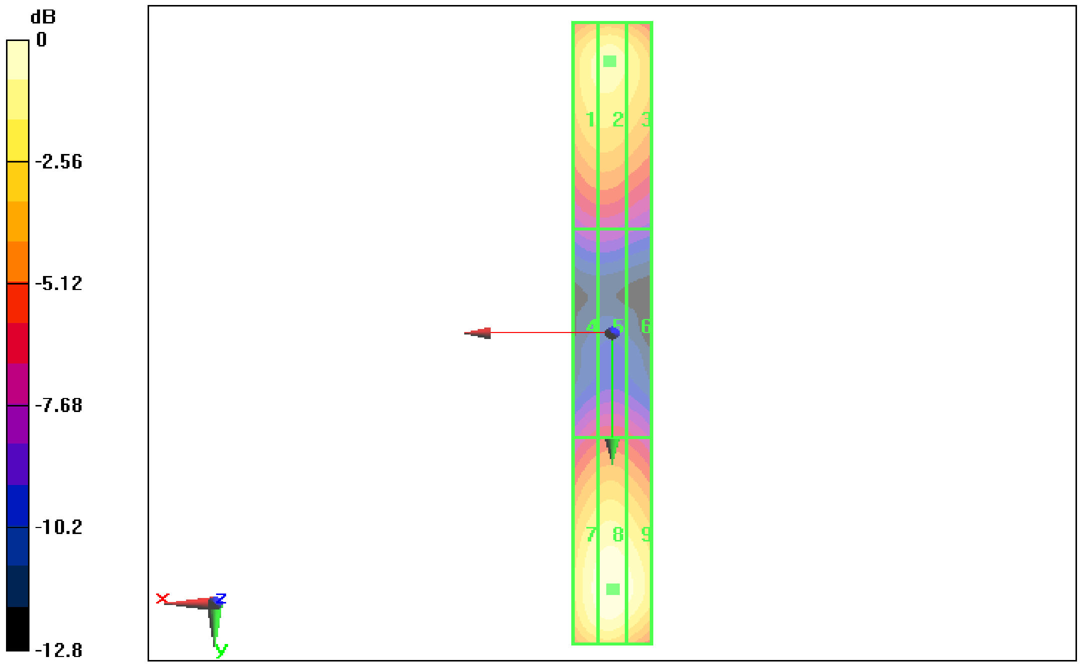
Fig B.6 HAC RF E-Field GSM 1900 Low

ANNEX C SYSTEM VALIDATION RESULT

E SCAN of Dipole 835 MHz
Date: 2018-5-7
Electronics: DAE4 Sn777
Medium: Air
Medium parameters used: σ = 0 mho/m, εr = 1; ρ = 1000 kg/m3
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)
E Scan - measurement distance from the probe sensor center to CD835 Dipole = 15mm/Hearing Aid Compatibility Test (41x361x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 106.3 V/m; Power Drift = -0.03 dB
Applied MIF = 0.00 dB
RF audio interference level = 40.48 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1**M3** **40.34 dBV/m**	Grid 2**M3** **40.47 dBV/m**	Grid 3**M3** **40.28 dBV/m**
Grid 4 **M4** **35.88 dBV/m**	Grid 5 **M4** **35.99 dBV/m**	Grid 6 **M4** **35.83 dBV/m**
Grid 7 **M3** **40.29 dBV/m**	Grid 8 **M3** **40.48 dBV/m**	Grid 9 **M3** **40.41 dBV/m**

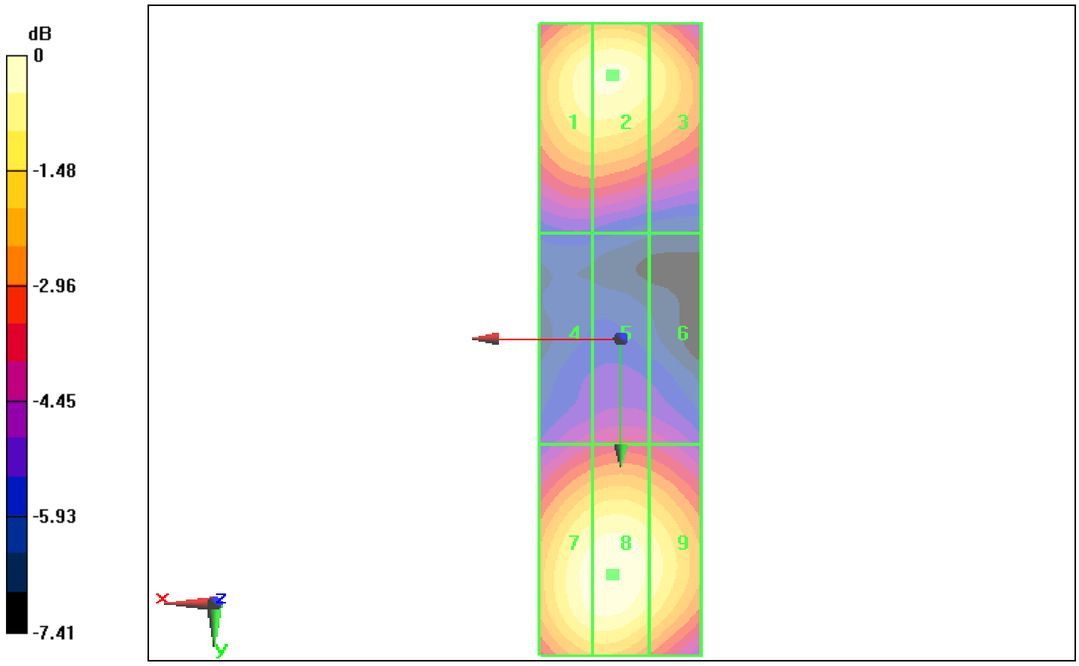


0 dB = 40.48 dBV/m

E SCAN of Dipole 1880 MHz
Date: 2018-5-7
Electronics: DAE4 Sn777
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1
Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)
E Scan - measurement distance from the probe sensor center to CD1880 Dipole = 15mm/Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 154.2 V/m; Power Drift = -0.02 dB
Applied MIF = 0.00 dB
RF audio interference level = 39.40 dBV/m
Emission category: M2

MIF scaled E-field

Grid 1**M2** **39.16 dBV/m**	Grid 2**M2** **39.40 dBV/m**	Grid 3**M2** **39.31 dBV/m**
Grid 4**M2** **37.17 dBV/m**	Grid 5**M2** **37.31 dBV/m**	Grid 6**M2** **37.21 dBV/m**
Grid 7**M2** **38.73 dBV/m**	Grid 8**M2** **39.00 dBV/m**	Grid 9**M2** **38.93 dBV/m**

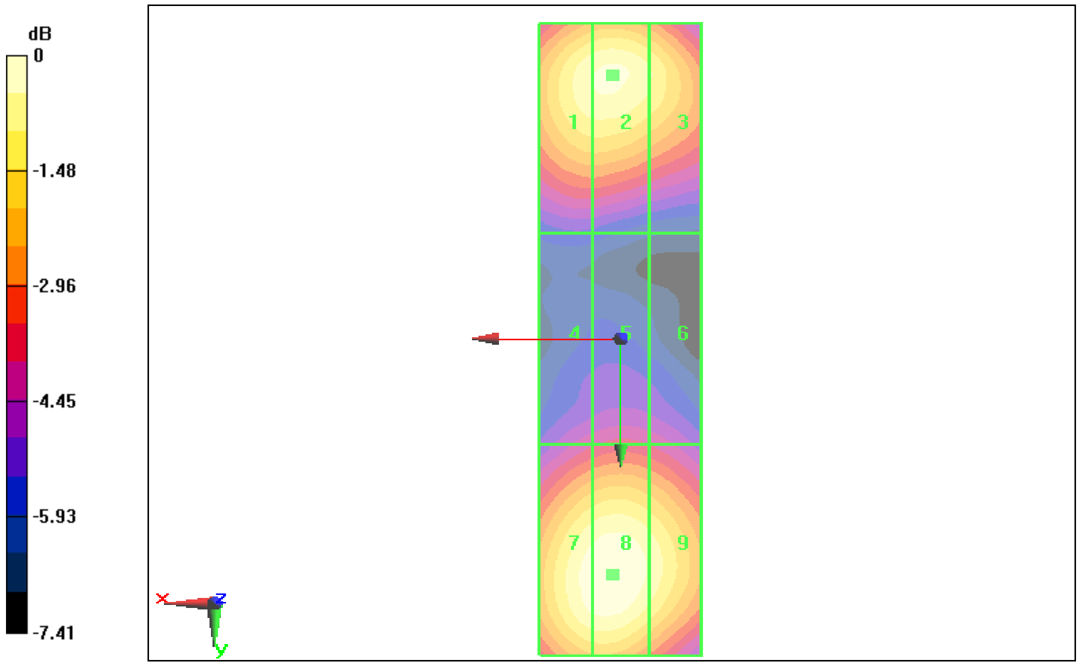


0 dB = 39.40 dBV/m

E SCAN of Dipole 2450 MHz
Date: 2018-5-7
Electronics: DAE4 Sn777
Medium: Air
Medium parameters used: $\sigma = 0$ mho/m, $\varepsilon_r = 1$; $\rho = 1000$ kg/m^3
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Probe: ER3DV6 - SN2272;ConvF(1, 1, 1)
E Scan - measurement distance from the probe sensor center to CD2450 Dipole = 15mm/Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 85.95 V/m; Power Drift = 0.04 dB
Applied MIF = 0.00 dB
RF audio interference level = 39.12 dBV/m
Emission category: M2

MIF scaled E-field

Grid 1**M2** **38.83 dBV/m**	Grid 2**M2** **39.12 dBV/m**	Grid 3**M2** **39.04 dBV/m**
Grid 4**M2** **38.37 dBV/m**	Grid 5**M2** **38.59 dBV/m**	Grid 6**M2** **38.48 dBV/m**
Grid 7**M2** **38.23 dBV/m**	Grid 8**M2** **38.51 dBV/m**	Grid 9**M2** **38.46 dBV/m**



0 dB = 39.12 dBV/m

ANNEX D PROBE CALIBRATION CERTIFICATE

E_Probe ER3DV6

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

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

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

Accreditation No.: **SCS 0108**

Client CTTL (Auden)

Certificate No: ER3-2272_Dec17

CALIBRATION CERTIFICATE

Object	ER3DV6 - SN:2272
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:	December 19, 2017

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ER3DV6	SN: 2328	10-Oct-17 (No. ER3-2328_Oct17)	Oct-18
DAE4	SN: 789	2-Aug-17 (No. DAE4-789_Aug17)	Aug-18
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-17)	In house check: Oct-18

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

Issued: December 20, 2017

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

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 0108

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, Rev 3.0, November 2013

Methods Applied and Interpretation of Parameters:

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

Probe ER3DV6

SN:2272

Manufactured: November 29, 2001
Calibrated: December 19, 2017

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

DASY/EASY - Parameters of Probe: ER3DV6 - SN:2272

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)	1.60	1.67	1.72	± 10.1 %
DCP (mV)[B]	101.0	97.8	100.7	

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	200.2	±3.5 %
		Y	0.0	0.0	1.0		165.8	
		Z	0.0	0.0	1.0		197.0	

Note: For details on UID parameters see Appendix.

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms.V^{-2}$	T2 $ms.V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
X	94.34	448.4	35.94	25.97	1.333	5.10	0.00	0.662	1.014
Y	100.1	483.8	36.93	26.47	1.401	5.10	0.00	0.669	1.019
Z	83.01	396.9	36.42	29.84	3.892	5.10	0.00	0.874	1.016

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.