HAC RF EMISSION TEST REPORT

Report No.:	SET2017-05260
Product:	4G Smart Phone
Model No.:	L500U
Brand Name:	N/A
Applicant:	Hyundai Corporation
Address:	25, Yulgok-ro 2-Gil, Jongno-gu, Seoul, South Korea
Test Date	April 20th, 2017
Issued Date	April 20th, 2017
Issued by:	CCIC-SET
Lab Location:	Electronic Testing Building, Shahe Road，Xili, Nanshan District, Shenzhen, 518055, P. R. China
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Test Report

Product................................ :	4G Smart Phone
Model No. ……………………..:	L500U
Brand Name…………………..:	N/A
FCC ID…………………....:	RQQHLT-FSL500C
Applicant……………………..:	Hyundai Corporation
Applicant Address…………..:	25, Yulgok-ro 2-Gil, Jongno-gu, Seoul, South Korea
Manufacturer………………..:	Guizhou Fortuneship Technology Co., Ltd
Manufacturer Address……..:	(No. 4 Plant, High-tech Industrial Park, Xinpu Economic Development Zone) Jingkai Road, Xinpu Jingkai District, Xinpu New District, Zunyi City, Guizhou Province, P. R. China
Test Standards………………:	ANSI C63.19-2011 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids
RF Emission Rating………:	M3
Test Result……………………:	Pass
Tested by ……………………..:	Zhou Gao yu , Test Engineer
Reviewed by…………………..:	Chris You, Senior Engineer
Approved by…………………..:	Zhuqi, Department Manager

Contents

1. GENERAL CONDITIONS

1.1 This report only refers to the item that has undergone the test.

1.2 This report standalone does not constitute or imply by its own an approval of the product by the certification Bodies or competent Authorities.

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1.5 CNAS-Lab Code: L1659

CCIC Southern Electronic Product Testing (Shenzhen) Co., Ltd. CCIC is a third party testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L1659. A 12.8*6.8*6.4 (m) fully anechoic chamber was used for the radiated spurious emissions test.

2. ADMINISTRTIVE DATE

2.1. Identification of the Responsible Testing Laboratory

Company Name:	CCIC-SET
Department:	EMC & RF Department
Address:	Electronic Testing Building, Shahe Road, Nanshan District, ShenZhen, P. R. China
Telephone:	+86-755-26629676
Fax:	+86-755-26627238
Responsible Test Lab Managers:	Mr. Wu Li'an

2.2. Identification of the Responsible Testing Location(s)

Company Name:	CCIC-SET
Address:	Electronic Testing Building, Shahe Road, Nanshan District, Shenzhen, P. R. China

2.3. Organization Item

CCIC-SET Report No.:	SET2017-05260
CCIC-SET Project Leader:	Mr. Li Sixiong
CCIC-SET Responsible for accreditation scope:	Mr. Wu Li'an
Start of Testing:	2017-04-20
End of Testing:	2017-04-20

2.4. Identification of Applicant

Company Name:	Hyundai Corporation
Address:	25, Yulgok-ro 2-Gil, Jongno-gu, Seoul, South Korea
Manufacturer Name:	Guizhou Fortuneship Technology Co., Ltd
Address:	(No. 4 Plant, High-tech Industrial Park, Xinpu Economic Development Zone) Jingkai Road, Xinpu Jingkai District, Xinpu New District, Zunyi City, Guizhou Province, P. R. China

Notes: This data is based on the information by the applicant.

3. EQUIPMENT UNDER TEST(EUT)

3.1. Identification of the Equipment under Test

Sample Name: 4G Smart Phone

Type Name: L500U

Brand Name: /

General description:	Support Band	GSM850MHz/1900MHz WCDMA 850MHz/ 1700MHz/1900MHz LTE Band 2/4/5/7/12/17 Bluetooth 2.4GHz/ WIFI 2.4GHz
	Test Band	GSM 850MHz/ GSM 1900MHz WCDMA 850MHz/ 1700MHz/1900MHz
	Development Stage	Identical Prototype
	Accessories	Power Supply
	Antenna type	PIFA Antenna
	Operation mode	GSM/WCDMA
	Modulation mode	GMSK, 8PSK, QPSK, 16QAM

NOTE:

a. The EUT is a model of /operating in GSM 850 / 1900, WCDMA 850 /1700/1900 MHz LTE band2/4/5/7/12/17, 2.4 GHz WIFI, BT.

b. Please refer to Appendix C for the photographs of the EUT. For a more detailed features description about the EUT, please refer to User's Manual.

3.2 Summary of test results

3.2.1 Test Standards

No.	Identity	Document Title
1	FCC 47 CFR Part 20.19	Hearing aid-compatible mobile handsets.
2	ANCI C63.19:2011	American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids
3	285076 D01 HAC Guidance v04r01	EQUIPMENT AUTHORIZATION GUIDANCE FOR HEARING AID COMPATIBILITY

3.2.2Summary Of HAC Rating

Summary of M-Rating

Band	E-field Db(V/m)	M-Rating
GSM850	42.23	M3
GSM1900	34.60	M3
WCDMA850	33.34	M4
WDCMA1700	27.52	M4
WCDMA1900	27.92	M4

4. HEARING AID COMPATIBILITY

4.1 Introduction

The purpose of the Hearing Aid Compatibility extension is to enable measurements of the near electric and magnetic fields generated by wireless communication devices in the region controlled for use by a hearing aid in accordance with ANSI-C63.19-2011 FCC has granted a request for waiver of the HAC rules in section 20.19 for dual band GSM handsets. The waiver has specific conditions, as stated in the order (FCC 05-166) and expires 1 August 2007.

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 and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.
b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.
c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

a) RF E-Field emissions
c) T-coil mode, magnetic signal strength in the audio band
d) T-coil mode, magnetic signal and noise articulation index
e) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

a) RF immunity in microphone mode
b) RF immunity in T-coil mode

4.2 Description of Test System

4.2.1 COMOHAC E-FIELD PROBE

Serial Number:	SN 02/12 EPH34
Frequency:	0.7GHz – 2.5GHz
Probe length:	330mm
Length of one dipole:	3.3mm
Maximum external diameter:	8mm
Probe extremity diameter:	5mm
Distance between dipoles/probe extremity:	3mm
Resistance of the three dipole (at the connector):	Dipole 1:R1=1.201 MΩ Dipole 2:R1=1.193 MΩ Dipole 3:R3=0.994 MΩ

4.2.2 System Hardware

The HAC positioning ruler is used to position the phone properly with the regard to the position of the probe during a measurement. The positioning system is made of a dedicated frame that can be fixed on the table. The tip of the probe is positioned on a reference point located on the top of the positioning ruler. The distance between this reference point and the cross located on the ruler being known, the speaker of the phone is positioned on this cross in order to make sure both probe and phone are positioned properly.

During the measurement, the HAC ruler has to be removed so that it does not interfere with the measurement.

Position device

5. OPERATIONAL CONDITIONS DURING TEST

5.1 Schematic Test Configuration

During SAR test, EUT was operating in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The EUT should use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link was used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point should be lower than the output power level of the handset by at least 35dB

Air-interface	Band (MHz)	Type	C63.19-2011 Tested	Simultaneous Transmissions	Reduced power	OTT
GSM	850	VO	Yes	WIFI and BT	N/A	N/A
	1900	VO	Yes	WIFI and BT	N/A	N/A
	GPRS/EDGE	DT	N/A	WIFI and BT	N/A	YES
WCDMA	850	VO	Yes	WIFI and BT	N/A	N/A
	1700	VO	Yes	WIFI and BT	N/A	N/A
	1900	VO	Yes	WIFI and BT	N/A	N/A
	HSDPA	DT	N/A	WIFI and BT	N/A	YES
LTE	2/4/5/7/12/17	VD	N/A	WIFI and BT	N/A	YES
WIFI	2450	VD	N/A	GSM or WCDMA or LTE	N/A	YES
BT	2450	DT	N/A	GSM or WCDMA or LTE	N/A	N/A
VO=CMRS Voice Service DT – Digital Transport VD=CMRS IP Voice Service and Digital Transport						

Note: 1. No associated T-coil measurement has been made in accordance with guidance issued by KDB285076 D02 T-Coil for CMRS IP

5.2 HAC Measurement System

The HAC measurement system being used is the COMO HAC system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an 2D scan at a fixed depth within a 50mm*50mm area. When the maximum HAC point has been found, the system will then carry out a 3D scan centered at that point to determine volume averaged HAC level.

5.3 HAC RF Emissions Test Procedure

The following are step-by-step test procedures.

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

b) Position the WD in its intended test position.

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

time during normal operation, may be excluded from consideration.

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

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

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

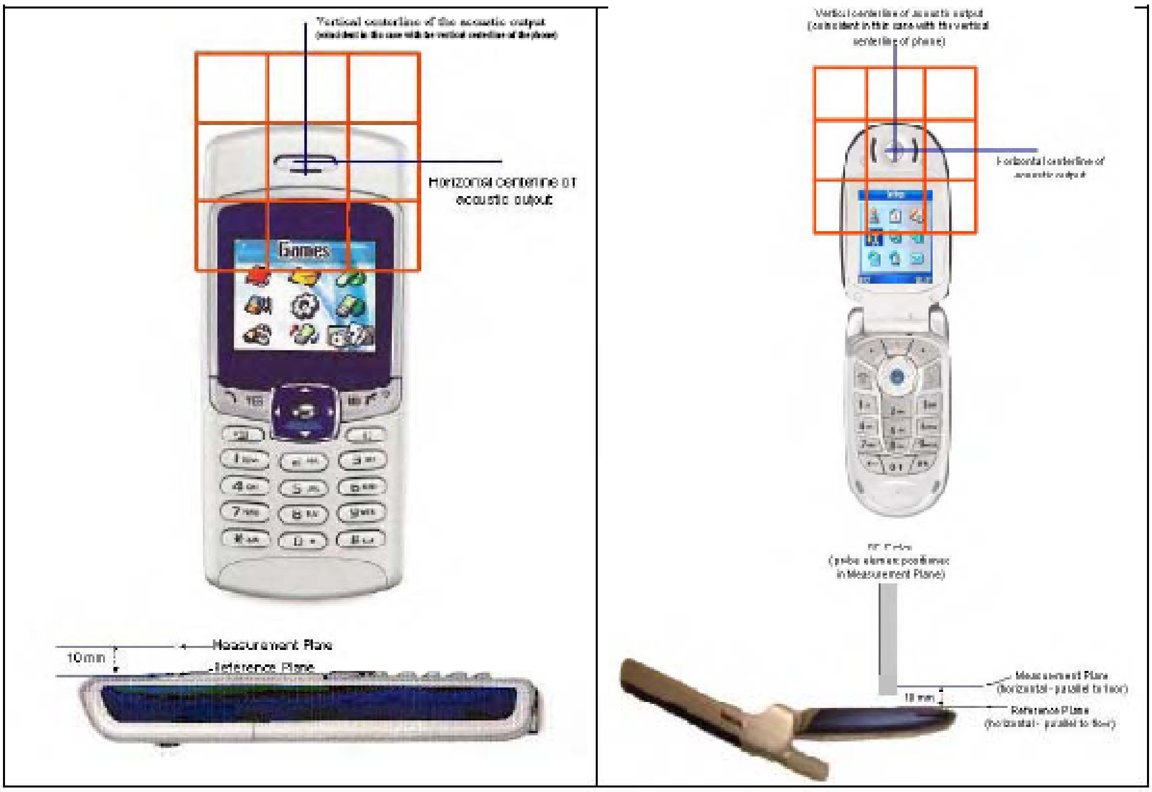
g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.

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

i) Convert the highest field reading within identified in step h) to RF audio interference level, in V/m, by taking the square root of the reading and then dividing it by the measurement system transfer function, established in 5.5.1.1 Convert this result to dB(V/m) by taking the base-10 logarithm and multiplying by 20. Indirect measurement method Replacing step i), the RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB (V/m), from step h). Use this result to determine thecategory rating

j) Compare this RF audio interference level with the categories in Clause 8 (ANSI C63.19-2011) and record the resulting WD category rating

k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating. Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating



WD reference and plane for RF emission measurements

5.4 Equipments and results of validation testing

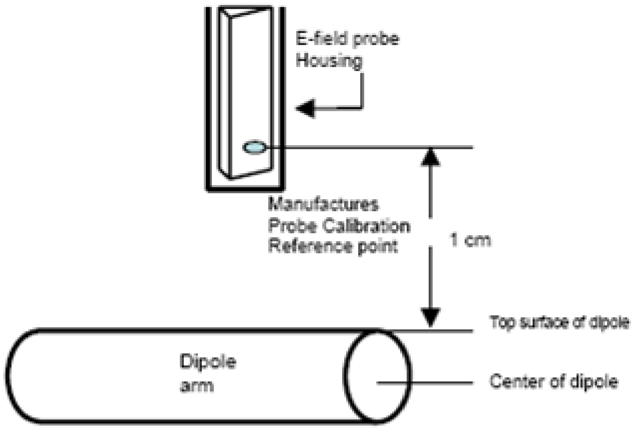
5.4.1 System Check Parameters

The input signal was an unmodulated continuous wave. The following points were taken into consideration in performing this check:

• Average Input Power P = 100mW RMS (20dBm RMS) after adjustment for return loss

• The test fixture must meet the 2 wavelength separation criterion

• The proper measurement of the 1 cm probe to dipole separation, which is measured from top surface of the dipole to the calibration reference point of the sensor, defined by the probe manufacturer is shown in the following diagram:



Separation Distance from Dipole to Field Probe

RF power was recorded using both an average reading meter and a peak reading meter. Readings of the probe are provided by the measurement system.

To assure proper operation of the near-field measurement probe the input power to the dipole shall be commensurate with the full rated output power of the wireless device (e.g. - for a cellular phone wireless device the average peak antenna input power will be on the order of 100mW (i.e. - 20dBm) RMS after adjustment for any mismatch.

5.4.2 Validation Procedure

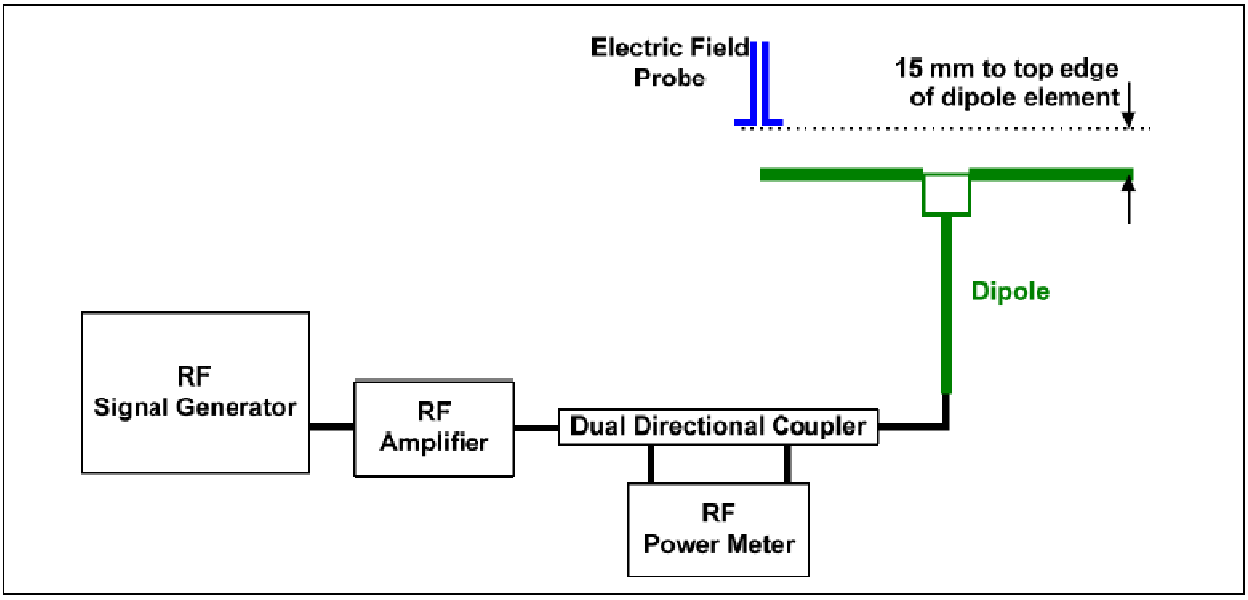
A dipole antenna meeting the requirements given in ANSI C63.19 Section D.11 was placed in the position normally occupied by the WD. The dipole antenna serves as a know source for ant electrical output. Position the E-field probe so that

1. The center point of the probe element is 15mm from the closest surface of dipole elements

2. The length of the dipole was scanned with E-field and the maximum values for each were recorded.
3. Using the near-field measurement system, scan the antenna over the radiating dipole and record the greatest field reading observed.
4. The equipment Setup was as below diagram

Due to the nature of E-fields about free-space dipoles, the two E-field peaks measured over the dipole are averaged to compensate for non-paralellity of the setup see manufacturer method on dipole calibration certificates, field strength measurements shall be made only when the probe is stationary.

Setup diagram



Using this setup configuration, the signal generator was adjusted for the desired output power (100mW) at a specified frequency. The reference power from the coupled port of the directional coupler is recorded. Next, the output cable is connected to the reference dipole.

5.4.3 Test System Validation

Validation Results (20dBm forward input power), System checks the specific test data please see Annex C.

Frequency	Input Power (dBm)	E-field Result (V/m)	Target Field (V/m)	Deviation (%)
835 MHz	20.0	219.08	214.26	2.24
1900MHz	20.0	149.01	147.33	1.14
Note: The tolerance limit of System validation ±25%				

Note: Target value was referring to the measured value in the calibration certificate of reference dipole.

5.4.4. Modulation Interference Factor (MIF)

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF) which replaces the need for the Articulation Weighting Factor (AWF) during the evaluation and is applicable to any modulation scheme.

The Modulation Interference factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF Audio Interference level (in dBV/m). This level considers the audible amplitude modulation components in the RF E-field. CW fields without amplitude modulation are assumed to not interfere with the hearing aid electronics. Modulations without time slots and low fluctuations at low frequencies have low MIF values, TDMA modulations with narrow transmission and repetition rates of few 100 Hz have high MIF values and give similar classifications as ANSI C63-2007.

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

MIF values were not tested by a probe or as specified in the standards but are based on analysis provided by MVG for all the air interfaces (GSM, WCDMA, CDMA). The data included in this report are for the worst case operating modes.

Transmission protocol	Modulation interference factor
GSM; full-rate version 2; speech codec/handset low	+3.5dB
WCDMA; speech; speech codec low; AMR 12.2 kb/s	-20.0dB
CDMA; speech; SO3; RC3; full frame rate: 8kEVRC	-19.0dB
CDMA; speech; SO3; RC1;1/8th frame rate; 8kEVRC	+3.3dB

A PMR calibrated probe is linearized for the selected waveform over the full dynamic range within the uncertainty

specified in its calibration certificate. E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. OPENHAC is therefore using the \indirect" measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by PMR calibration in order to not overestimate the field reading. The 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. OPENHAC uses well-defined signals for PMR calibration. The MIF of these signals has been determined by simulation and is automatically applied. The MIF measurement uncertainty is estimated as follows, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10

kHz:

0.2 dB for MIF -7 to +5 dB, 0.5 dB for MIF -13 to +11 dB

1 dB for MIF > -20

6. CHARACTERISTICS OF THE TEST

6.1 Applicable Limit Regulations

Table 1 Telephone near-field categories in linear units (<960MHz)

Category	E-field emissions	
	< 960 MHz	> 960 MHz
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)

6.2 Applicable Measurement Standards

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

FCC 47CFR § 20.19 American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids

It specifies the measurement method for demonstration of compliance with the HAC limits for such equipments.

7 LABORATORY ENVIRONMENT

Table 4: The Ambient Conditions during HAC Test

Temperature	Min. = 20 ℃, Max. = 25 ℃
Relative humidity	Min. = 30%, Max. = 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.

7. TEST RESULTS

7.1 Summary of conducted Power Measurement Results

The power level results were listed in the following two tables:

Table 5: Conducted RF Power of GSM850

Band	GSM 850			GSM 1900		
Channel	128	190	251	512	661	810
Frequency	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM	32.64	32.68	32.59	29.26	28.75	28.20

Table 6: Conducted RF Power of WCDMA

Band	WCDMA 850			WCDMA1900		
TX Channel	4132	4182	4233	9262	9400	9538
Frequency	826.4	836.6	846.6	1852.4	1880.0	1907.6
ARM	22.62	22.59	22.69	22.69	22.82	22.65
Band	WCDMA 1700					
TX Channel	1312	1412	1513			
Frequency	1712.4	1732	1752.6			
ARM	22.54	22.71	22.56			

7.2 Summary of Measurement Results

Table 7: RF Emission Values of the EUT

Temperature: 23.0~23.5°C, humidity: 62~64%.				
Band	Channel	Frequency (MHz)	Test Results E-field dB(V/m)	Category
GSM850	Low	824.2	42.23	M3
GSM850	Mid	836.4	41.98	M3
GSM850	High	848.8	40.93	M3
GSM1900	Low	1850.2	34.60	M3
GSM1900	Mid	1880.0	34.55	M3
GSM1900	High	1909.8	33.65	M3
WCDMA850	Low	826.4	33.17	M4
WCDMA850	Mid	836.6	33.34	M4
WCDMA850	High	846.6	33.21	M4
WCDMA1700	Low	1712.4	27.17	M4
WCDMA1700	Mid	1732	27.27	M4
WCDMA1700	High	1752.6	27.52	M4
WCDMA1900	Low	1852.4	27.89	M4
WCDMA1900	Mid	1880.0	27.92	M4
WCDMA1900	High	1907.6	27.43	M4

8. MEASUREMENT UNCERTAINTY

Table 9: Measurement Uncertainty of RF Emission Test

Uncertainty Component	Uncertainty value	Probe Dist.	Div	(Ci) E	(Ci) H	Std. Unc.(+-%)	
						E	H
Measurement System							
Probe calibration	6.00	N	1.000	1	1	6.00	6.00
Axial Isotropy	2.02	R	1.732	1	1	1.17	1.17
Sensor Displacemant	14.30	R	1.732	1	0.217	8.26	1.79
Boundary effect	2.50	R	1.732	1	1	0.87	0.87
Phantom Boundary effect	6.89	R	1.732	1	0	3.52	0.00
Linearity	2.58	R	1.732	1	1	1.49	1.49
Scaling to PMR Calibration	9.02	N	1.000	1	1	9.02	9.02
System Detection Limit	1.30	R	1.732	1	1	0.75	0.75
Readout Electronics	0.25	R	1.732	1	1	0.14	0.14
Reponse Time	1.23	R	1.732	1	1	0.71	0.71
Integration Time	2.15	R	1.732	1	1	1.24	1.24
RF Ambient Conditions	2.03	R	1.732	1	1	1.17	1.17
RF Reflections	9.09	R	1.732	1	1	5.25	5.25
Probe positioner	0.63	N	1.000	1	0.71	0.63	0.45
Probe positioning	3.12	N	1.000	1	0.71	3.12	2.22
Extrapolation and Interpolation	1.18	R	1.732	1	1	0.68	0.68
Uncertainties of the EUT							
Test sample positioning Vertical	2.73	R	1.732	1	0.71	1.58	1.12
Test sample positioning Lateral	1.19	R	1.732	1	1	0.69	0.69
Device Holder and Phantom	2.20	N	1.000	1	1	2.20	2.20
Power Drift	4.08	R	1.732	1	1	2.36	2.36
Phantom and Setup Related							
Phantom Thickness	2.00	N	1.000	1	0.6	2.00	1.20
Conbined Std. Uncertainty(k=1)						16.18	13.25
Expanded Uncertainty on Power						32.35	26.50
Expanded Uncertainty on Field						16.18	13.25

Note:

N-Nomal

R-Rectangular

Div.- Divisor used to obataion standard uncertanty

Table 10: Measurement Uncertainty of T-Coil Test

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	– Probe Calibration	B	6	N	3	1	3.5	∞
2	– Axial isotropy	B	4.7	R	1.732	0.5	4.3	∞
3	—Hemispherical Isotropy	B	9.4	R	1.732	0.5	4.3	∞
4	– Boundary Effect	B	11.0	R	1.732	1	6.4	∞
5	– Linearity	B	4.7	R	1.732	1	2.7	∞
6	– System Detection Limits	B	1.0	R	1.732	1	0.6	∞
7	– Probe Coil Sensitivity	B	0.49	R	1.732	1	0.28	∞
8	– Response Time	B	0.00	R	1.732	1	0.00	∞
9	– Integration Time	B	0.00	R	1.732	1	0.00	∞
10	– RF Ambient Conditions	B	3.0	R	1.732	1	1.73	∞
11	– Probe Position Mechanical tolerance	B	0.4	R	1.732	1	0.2	∞
12	– Probe Position with respect to Phantom Shell	B	2.9	R	1.732	1	1.7	∞
	Uncertainties of the DUT							
13	– Position of the DUT	A	4.8	N	3	1	4.8	5
14	– Holder of the DUT	A	7.1	N	3	1	7.1	5
15	– Repeatability of the WD	B	5.0	R	1.732	1	2.9	∞
	Acoustic noise							
16	– Acoustic noise	B	1.0	R	1.732	1	0.6	∞
21	– Cable loss	B	0.46	N	1.732	1	0.46	∞
Combined Standard Uncertainty				RSS			17.26	42.33
Expanded uncertainty (Confidence interval of 95 %)				K=2			34.52	

9. MAIN TEST INSTRUMENTS

No	EQUIPMENT	TYPE	Series No.	Cal. Date	Due Date
1	E-Field Probe	SCE	SN 02/12 EPH34	2016/12/16	2017/12/15
2	Dipole	SIDB835	SN 18/12 DHA37	2016/12/16	2017/12/15
3	Dipole	SIDB1900	SN 18/12 DHB42	2016/12/16	2017/12/15
4	Vector Network Analyzer	ZVB8	1145.1010.08	2016/06/13	2017/06/12
5	Amplifier	Nucletudes	143060	2017/04/04	2018/04/03
6	Power Meter	NRVS	1020.1809.02	2016/06/13	2017/06/12
7	Multimeter	Keithley - 2000	4014020	2017/04/04	2018/04/03
8	Power Sensor	NRV-Z4	100069	2016/06/10	2017/06/09
9	Wireless Communication Test Set	CMU200	A0304212	2016/06/10	2017/06/09

10. ANNEX A TEST SETUP

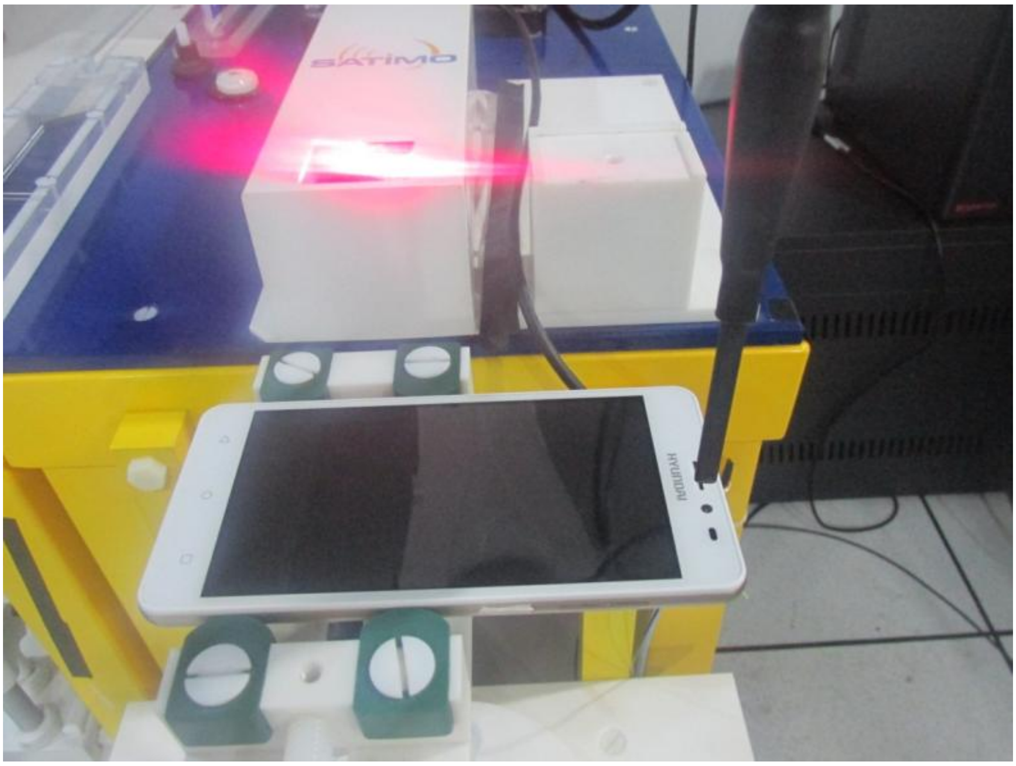


Fig.1 Testing Photo

11. ANNEX B EUT PHOTOS

12. ANNEX C SYSTEM CHECK

System Performance Check (E, 835MHz)

Date of measurement: 04/20/2017

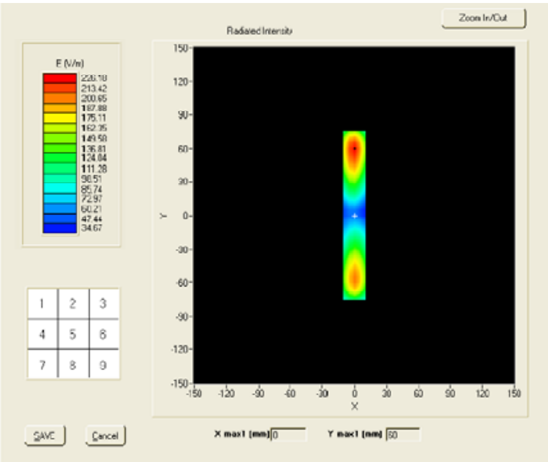
Mobile Phone IMEI number: --

A. Experimental conditions.

Band	CUSTOM (CW835)
Channel	MID
Signal	Duty Cycle: 1
Input power	20dBm

B. HAC Measurement Results

Frequency (MHz): 835.000000

SURFACE HAC


Probe Modulation Factor= 1.00

Maximum value of total field = 214.26 V/m

E in V/m

System Performance Check (E, 1900MHz)

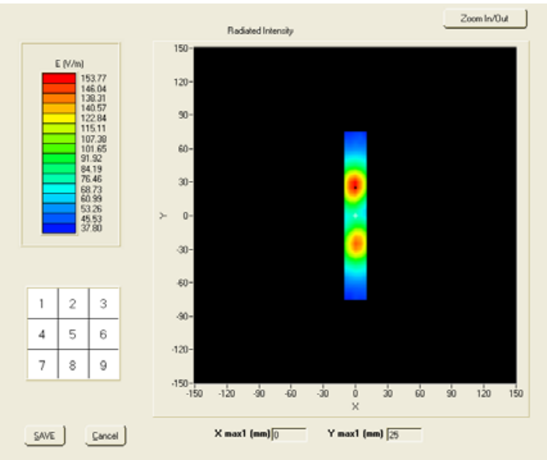
Date of measurement: 04/20/2017
Mobile Phone IMEI number: --

A. Experimental conditions.

Band	CUSTOM (CW1900)
Channel	Middle
Signal	Duty Cycle: 1
Input Power	20dBm

B. HAC Measurement Results

Frequency (MHz): 1900.000000

SURFACE HAC


Probe Modulation Factor= 1.00
Maximum value of total field = 147.33V/m;
E in V/m

13. ANNEX D TEST PLOTS

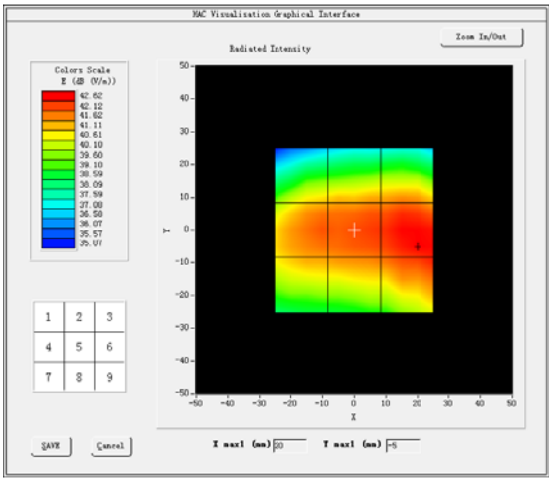
Test Results (GSM850, E-Field, Low Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Low
Signal	GSM
SURFACE HAC	



Maximum value of total field = 42.23 dB (V/m)

Hearing Aid Near-Field Category: M3

Grid 1: 40.86	Grid 2: 41.25	Grid 3: 41.48
Grid 4: 41.97	**Grid 5: 42.23**	**Grid 6: 42.68**
Grid 7: 41.46	**Grid 8: 41.82**	**Grid 9: 42.47**

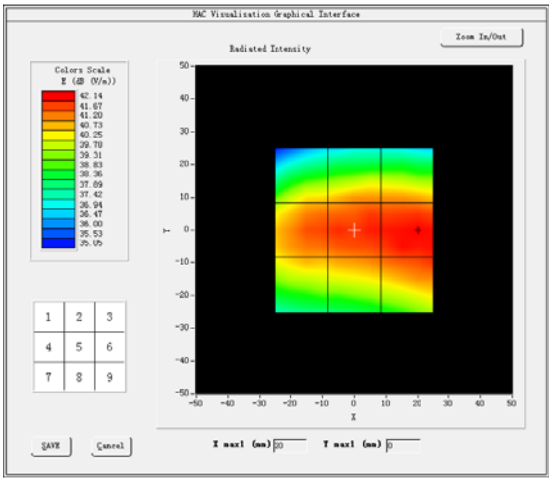
Test Results (GSM850, E-Field, Mid Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Mid
Signal	GSM
SURFACE HAC	



Maximum value of total field = 41.98 dB (V/m)

Hearing Aid Near-Field Category: M3

Grid 1: 40.51	Grid 2: 41.03	Grid 3: 41.00
Grid 4: 41.72	**Grid 5: 41.98**	**Grid 6: 42.15**
Grid 7: 40.97	**Grid 8: 41.47**	**Grid 9: 41.90**

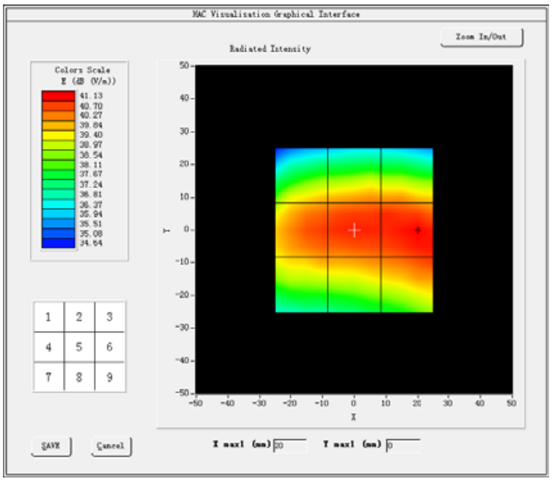
Test Results (GSM850, E-Field, High Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	High
Signal	GSM
SURFACE HAC	



Maximum value of total field = 40.93 dB (V/m)

Hearing Aid Near-Field Category: M3

Grid 1: 39.81	Grid 2: 40.11	Grid 3: 40.08
Grid 4: 40.77	**Grid 5: 40.93**	**Grid 6: 41.14**
Grid 7: 40.18	**Grid 8: 40.40**	**Grid 9: 40.85**

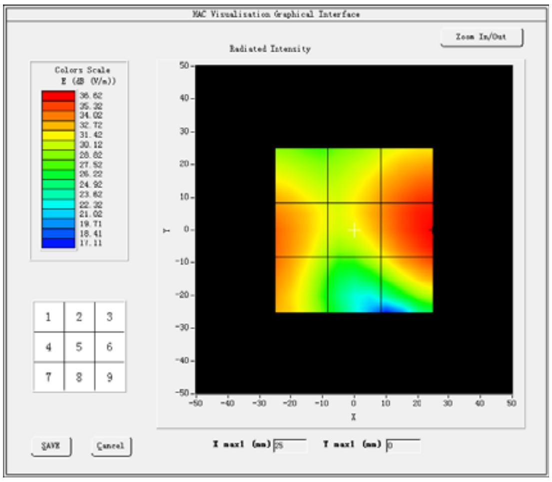
Test Results (GSM1900, E, Low Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Low
Signal	GSM
SURFACE HAC	



Maximum value of total field = 34.60 dB (V/m)

Hearing Aid Near-Field Category: M3

Grid 1: 32.87	Grid 2: 33.46	**Grid 3: 35.64**
Grid 4: 34.60	Grid 5: 33.79	**Grid 6: 36.62**
Grid 7: 34.46	Grid 8: 31.45	**Grid 9: 35.56**

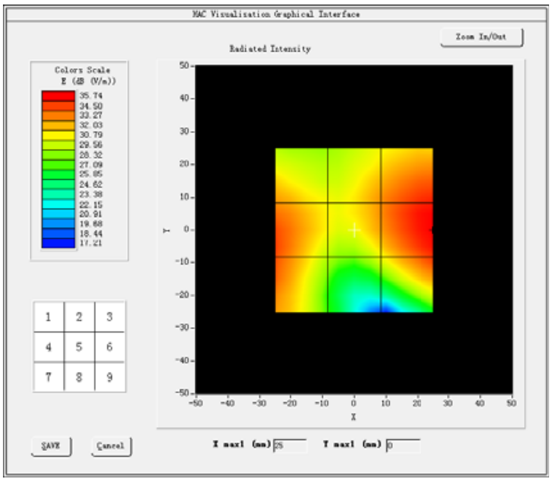
Test Results (GSM1900, E, Middle Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Middle
Signal	GSM
SURFACE HAC	



Maximum value of total field = 34.55 dB (V/m)

Hearing Aid Near-Field Category: M3

Grid 1: 32.54	Grid 2: 33.01	**Grid 3: 34.96**
Grid 4: 34.55	Grid 5: 33.15	**Grid 6: 35.78**
Grid 7: 34.31	Grid 8: 30.83	**Grid 9: 34.84**

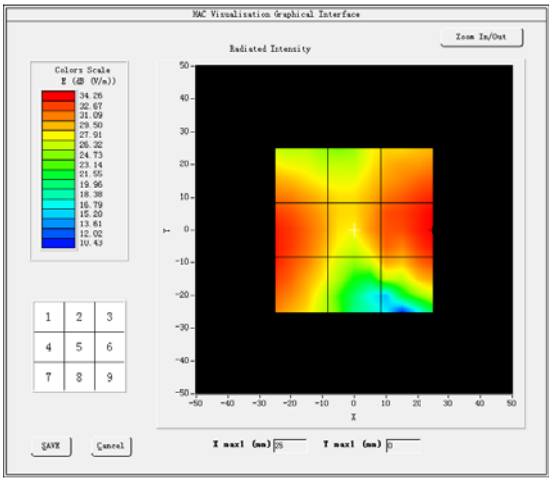
Test Results (GSM1900, E, High Channel)

Date of measurement: 04/20/2017
Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	High
Signal	GSM

SURFACE HAC



Maximum value of total field = 33.65 dB (V/m)
Hearing Aid Near-Field Category: M3

Grid 1: 31.43	Grid 2: 31.03	**Grid 3: 33.37**
Grid 4: 33.65	Grid 5: 32.12	**Grid 6: 34.34**
Grid 7: 33.58	Grid 8: 30.51	**Grid 9: 33.09**

Test Results (WCDMA850, E, Low Channel)

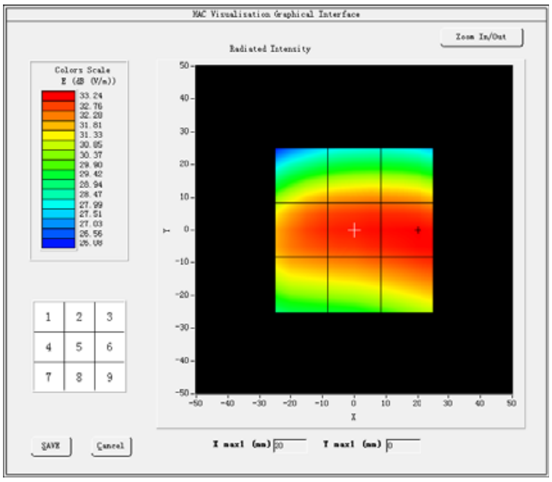
Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Low
Signal	WCDMA

SURFACE HAC



Maximum value of total field = 33.17 dB (V/m)

Hearing Aid Near-Field Category: M4

Grid 1: 31.94	Grid 2: 32.17	Grid 3: 32.15
Grid 4: 32.98	**Grid 5: 33.17**	**Grid 6: 33.27**
Grid 7: 32.43	**Grid 8: 32.74**	**Grid 9: 33.06**

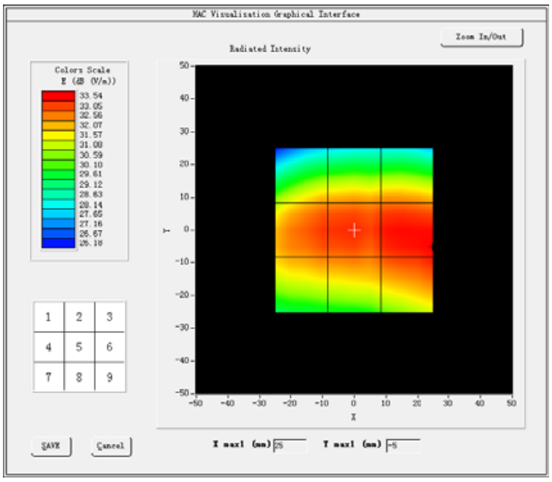
Test Results (WCDMA850, E, Middle Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	Middle
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 33.34 dB (V/m)

Hearing Aid Near-Field Category: M4

Grid 1: 32.07	Grid 2: 32.28	Grid 3: 32.36
Grid 4: 33.15	**Grid 5: 33.34**	**Grid 6: 33.55**
Grid 7: 32.65	**Grid 8: 32.92**	**Grid 9: 33.41**

Test Results (WCDMA850, E, High Channel)

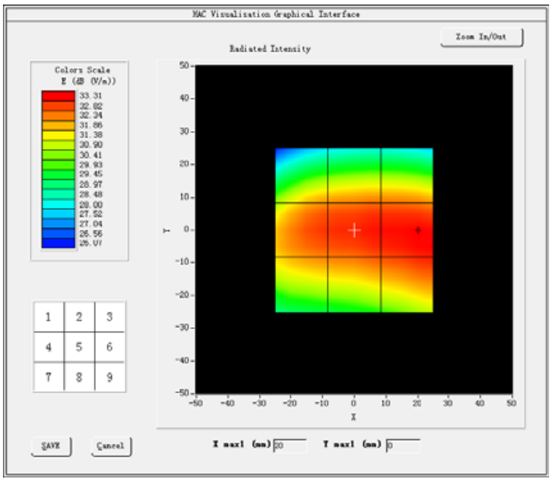
Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA850
Channel	High
Signal	WCDMA

SURFACE HAC



Maximum value of total field = 33.21 dB (V/m)

Hearing Aid Near-Field Category: M4

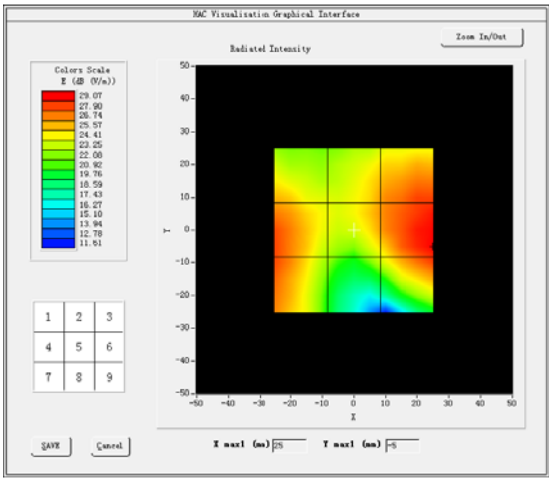
Grid 1: 31.93	Grid 2: 32.19	Grid 3: 32.17
Grid 4: 32.94	**Grid 5: 33.21**	**Grid 6: 33.34**
Grid 7: 32.39	**Grid 8: 32.77**	**Grid 9: 33.14**

Test Results (WCDMA1900, E, Low Channel)

Date of measurement: 04/20/2017
Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Low
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 27.89 dB (V/m)
Hearing Aid Near-Field Category: M4

Grid 1: 25.65	Grid 2: 26.26	**Grid 3: 27.90**
Grid 4: 27.89	Grid 5: 26.44	**Grid 6: 29.12**
Grid 7: 27.86	Grid 8: 24.20	**Grid 9: 28.49**

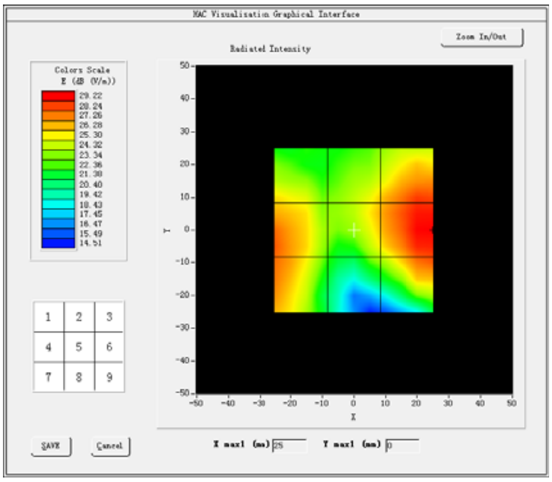
Test Results (WCDMA1900, E, Middle Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	Middle
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 27.92 dB (V/m)

Hearing Aid Near-Field Category: M4

Grid 1: 25.71	Grid 2: 26.13	**Grid 3: 28.35**
Grid 4: 27.92	Grid 5: 26.59	**Grid 6: 29.32**
Grid 7: 27.71	Grid 8: 24.52	**Grid 9: 28.26**

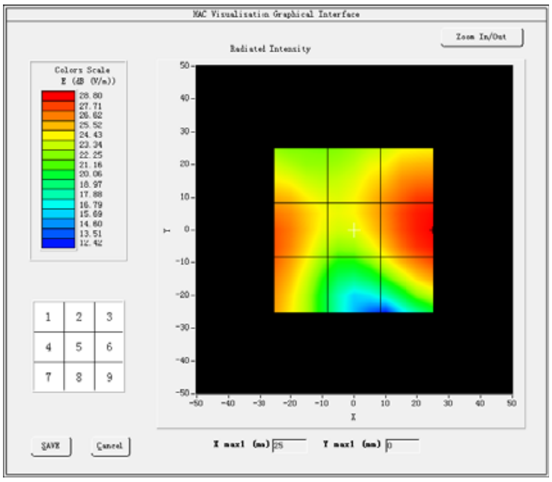
Test Results (WCDMA1900, E, High Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1900
Channel	High
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 27.43 dB (V/m)

Hearing Aid Near-Field Category: M4

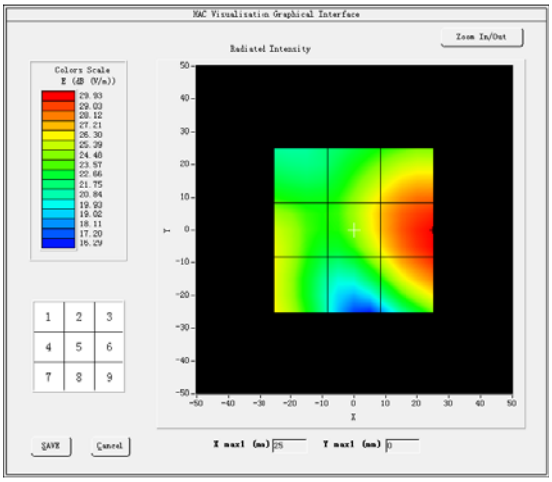
Grid 1: 25.73	Grid 2: 25.99	**Grid 3: 27.94**
Grid 4: 27.43	Grid 5: 26.19	**Grid 6: 28.81**
Grid 7: 27.25	Grid 8: 24.23	**Grid 9: 27.96**

Test Results (WCDMA1700, E, Low Channel)

Date of measurement: 04/20/2017
Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1700
Channel	Low
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 27.17 dB (V/m)
Hearing Aid Near-Field Category: M4

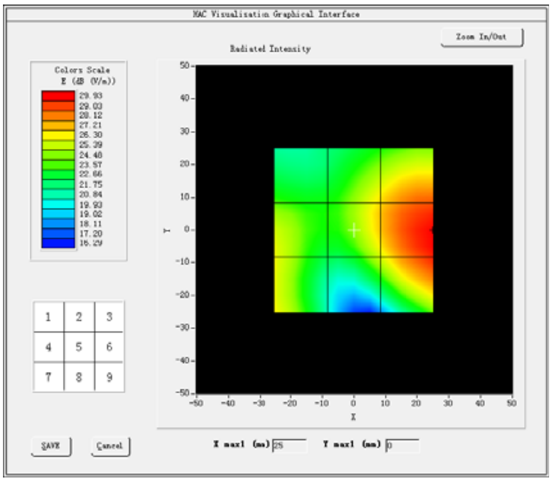
Grid 1: 23.60	Grid 2: 26.41	**Grid 3: 28.20**
Grid 4: 25.91	**Grid 5: 27.17**	**Grid 6: 29.81**
Grid 7: 26.08	Grid 8: 25.90	**Grid 9: 29.21**

Test Results (WCDMA1700, E, Middle Channel)

Date of measurement: 04/20/2017

Mobile Phone IMEI number: --

A. Experimental conditions.

<table>
<tr><td>Grid size (mm x mm)</td><td>50.0, 50.0</td></tr>
<tr><td>Step (mm)</td><td>5</td></tr>
<tr><td>Band</td><td>WCDMA1700</td></tr>
<tr><td>Channel</td><td>Middle</td></tr>
<tr><td>Signal</td><td>WCDMA</td></tr>
<tr><td colspan="2">SURFACE HAC</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td colspan="2">Maximum value of total field = 27.27 dB (V/m)
Hearing Aid Near-Field Category: M4</td></tr>
</table>

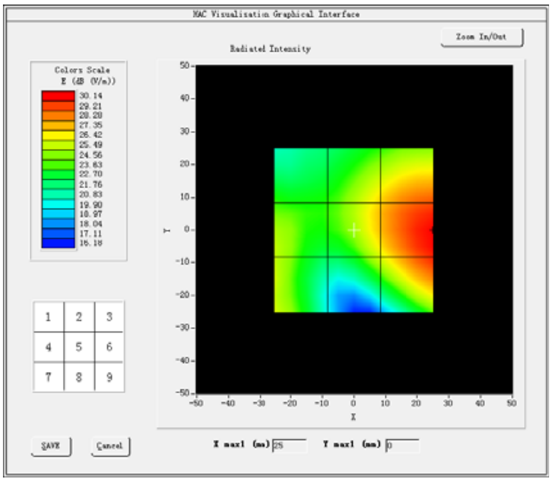
Grid 1: 23.62	Grid 2: 26.64	**Grid 3: 28.39**
Grid 4: 25.95	**Grid 5: 27.27**	**Grid 6: 29.98**
Grid 7: 26.19	Grid 8: 25.96	**Grid 9: 29.56**

Test Results (WCDMA1700, E, High Channel)

Date of measurement: 04/20/2017
Mobile Phone IMEI number: --

A. Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	WCDMA1700
Channel	High
Signal	WCDMA
SURFACE HAC	



Maximum value of total field = 27.52 dB (V/m)
Hearing Aid Near-Field Category: M4

Grid 1: 23.65	Grid 2: 26.92	**Grid 3: 28.64**
Grid 4: 25.42	**Grid 5: 27.52**	**Grid 6: 30.18**
Grid 7: 25.66	Grid 8: 26.15	**Grid 9: 29.72**

14. ANNEX E CALIBRATION REPORTS

COMOHAC E-Field Probe Calibration Report

Ref : ACR.351.1.16.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO.,LTD
BUILDING 28/ 29, EAST OF SHIGU, XILI INDUSTRIAL ZONE XILI ROAD, NANSHAN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOHAC E-FIELD PROBE

SERIAL NO.: SN 02/12 EPH34

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED

Calibration Date: 12/16/16

Summary:

This document presents the method and results from an accredited COMOHAC E-Field Probe calibration performed in MVG USA using the CALIBAIR test bench, for use with a MVG COMOHAC system only. All calibration results are traceable to national metrology institutions.

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	12/16/2016	
Checked by :	Jérôme LUC	Product Manager	12/16/2016	
Approved by :	Kim RUTKOWSKI	Quality Manager	12/16/2016	

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
A	12/16/2016	Initial release

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC E FIELD PROBE
Manufacturer	MVG
Model	SCE
Serial Number	SN 02/12 EPH34
Product Condition (new / used)	Used
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=1.201 MΩ Dipole 2: R2=1.193 MΩ Dipole 3: R3=0.994 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

MVG's COMOHAC E field Probes are built in accordance to the ANSI C63.19 and IEEE 1309 standards.

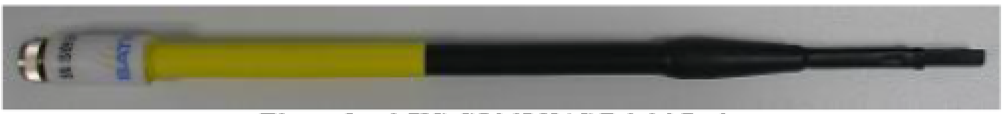


Figure 1 – *MVG COMOHAC E field Probe*

Probe Length	330 mm
Length of Individual Dipoles	3.3 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	3 mm

3 MEASUREMENT METHOD

All methods used to perform the measurements and calibrations comply with the ANSI C63.19 and IEEE 1309 standards.

3.1 LINEARITY

The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 2V/m to 1000A/m).

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using the waveguide method outlined in the fore mentioned standards.

3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps.

3.4 PROBE MODULATION RESPONSE

The modulation factor was determined by illuminating the probe with a reference wave from a standard dipole 10 mm away, applying first a CW signal and then a modulated signal (both at same power level). The modulation factor is the ratio, in linear units, of the CW to modulated signal reading.

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEEE 1528 and IEC/CEI 62209 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	**Uncertainty value (%)**	**Probability Distribution**	**Divisor**	**ci**	**Standard Uncertainty (%)**
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					4.509%
Expanded uncertainty 95 % confidence level k = 2					9.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Lab Temperature	21 °C

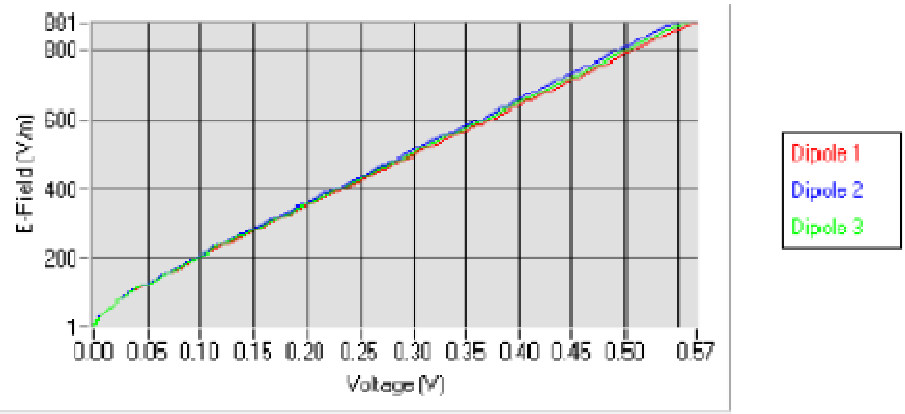
Lab Humidity	45 %

5.1 SENSITIVITY IN AIR

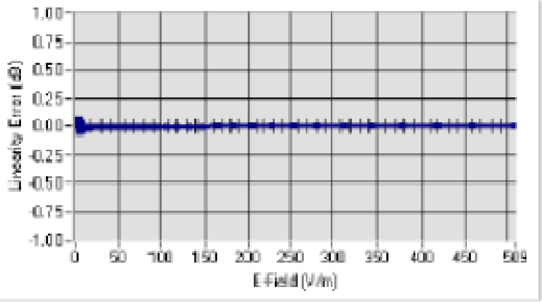
Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
4.98	5.00	5.06

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
97	90	92

Calibration curves

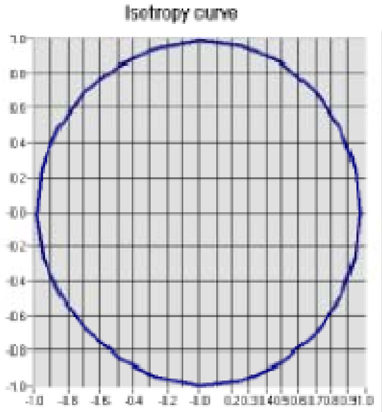


5.2 LINEARITY



Linearity:I+/-1.23% (+/-0.05dB)

5.3 ISOTROPY



Isotropy:I+/-1.71% (+/-0.07dB)

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
HAC positioning ruler	MVG	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Reference Probe	MVG	EPH28 SN 08/11	10/2016	10/2017
Reference Probe	MVG	HPH38 SN31/10	10/2016	10/2017
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	150798832	10/2015	10/2017

HAC Reference Dipole Calibration Report

Ref : ACR.351.4.16.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO.,LTD

BUILDING 28/ 29, EAST OF SHIGU, XILI INDUSTRIAL ZONE XILI ROAD, NANSHAN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOHAC E-FIELD PROBE

SERIAL NO.: SN 18/12 DHA37

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration Date: 12/16/16

Summary:

This document presents the method and results from an accredited HAC reference dipole calibration performed in MVG USA using the COMOHAC test bench. All calibration results are traceable to national metrology institutions.

HAC REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.351.4.16.SATU.A

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	12/16/2016	
Checked by :	Jérôme LUC	Product Manager	12/16/2016	
Approved by :	Kim RUTKOWSKI	Quality Manager	12/16/2016	

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	*Date*	*Modifications*
A	12/16/2016	Initial release

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the ANSI C63.19 standard for reference dipoles used for HAC measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC 800-950 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SIDB835
Serial Number	SN 18/12 DHA37
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOHAC Validation Dipoles are built in accordance to the ANSI C63.19 standard. The product is designed for use with the COMOHAC system only.

Figure 1 – *MVG COMOHAC Validation Dipole*

4 MEASUREMENT METHOD

The ANSI C63.19 standard outlines the requirements for reference dipoles to be used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standard.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for HAC system validation measurements and checks must have a return loss of -10 dB or better. The return loss measurement shall be performed in free space.

4.2 REFERENCE DIPOLE CALIBRATION

The IEEE ANSI C63-19 standard states that the dipole used for validation measurements and checks must be scanned with the E and H field probe, with the dipole 10 mm below the probe. The E and H field strength plots are compared to the simulation results obtained by MVG.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Gain
400-6000MHz	0.1 dB

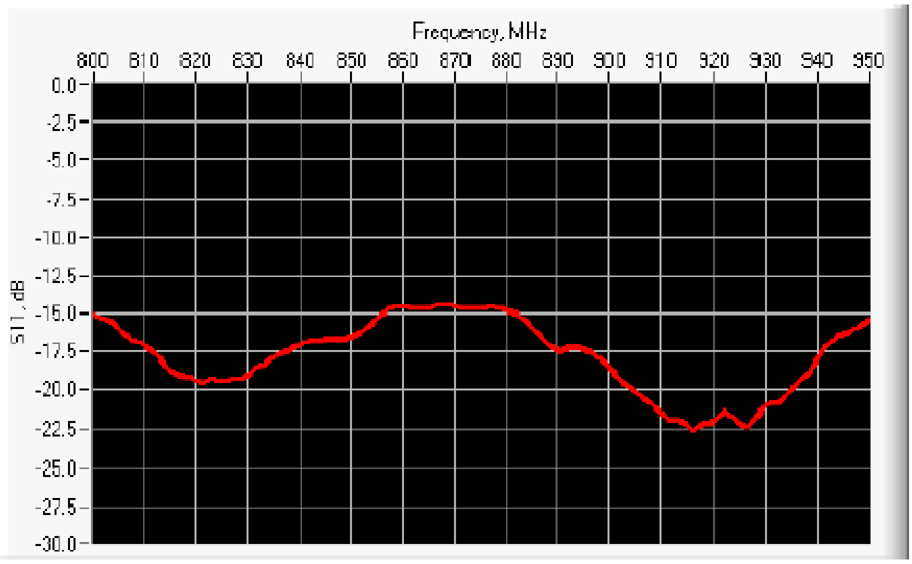
5.2 VALIDATION MEASUREMENT

The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	**Uncertainty value (%)**	**Probability Distribution**	**Divisor**	**Uncertainty (dB)**	**Standard Uncertainty (%)**
RF reflections	0.1	R	$\sqrt{3}$	0.06	
Field probe conv. Factor	0.4	R	$\sqrt{3}$	0.23	
Field probe anisotropy	0.25	R	$\sqrt{3}$	0.14	
Positioning accuracy	0.2	R	$\sqrt{3}$	0.12	
Probe cable placement	0.1	R	$\sqrt{3}$	0.06	
System repeatability	0.2	R	$\sqrt{3}$	0.12	
EUT repeatability	0.4	N	1	0.40	
Combined standard uncertainty				0.52	
Expanded uncertainty 95 % confidence level k = 2				1.00	13.0

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
800-950 MHz	-14.43	-10

6.2 VALIDATION MEASUREMENT

The IEEE ANSI C63.19 standard states that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss requirements. The system validations measurement results are then compared to MVG's simulated results.

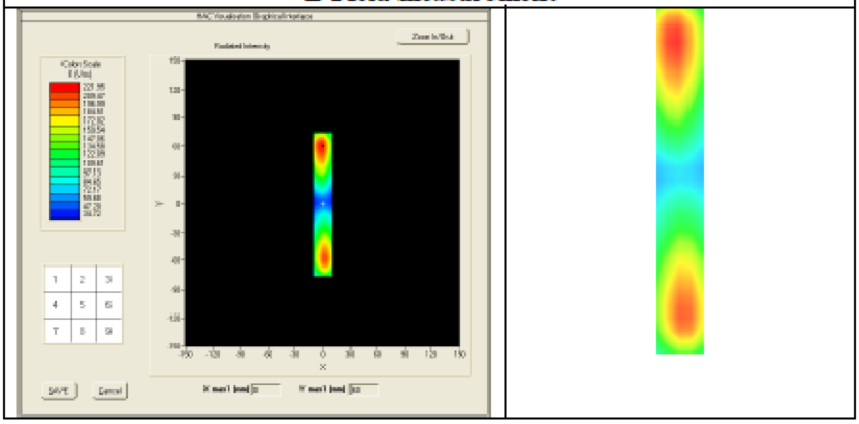
Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 08/11 EPH28
H-Field probe	SN 31/10 HPH38
Distance between dipole and sensor center	10 mm
E-field scan size	X=150mm/Y=20mm
H-field scan size	X=40mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	835 MHz
Input power	20 dBm
Lab Temperature	21°C
Lab Humidity	45%

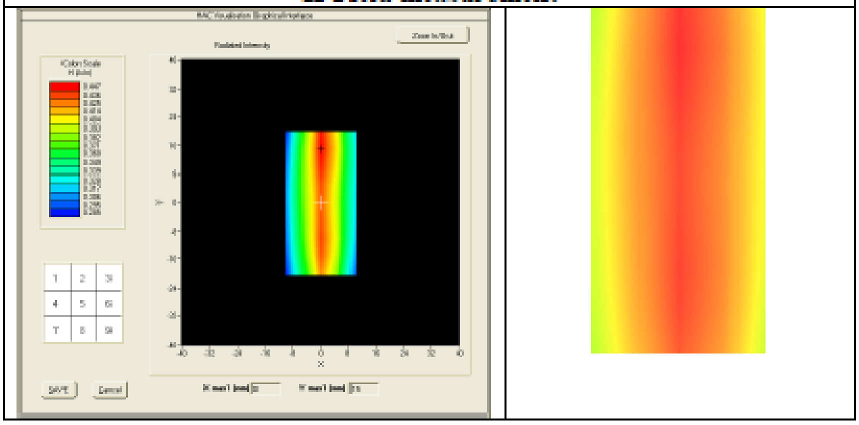
Measurement Result

	Measured	Internal Requirement
E field (V/m)	221.95	220.4
H field (A/m)	0.45	0.445

E-Field measurement



H-Field measurement



7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
HAC positioning ruler	MVG	TABH12 SN 42/09	Validated. No cal required.	Validated. No cal required.
COMOHAC Test Bench	Version 2	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Reference Probe	MVG	EPH28 SN 08/11	10/2016	10/2017
Reference Probe	MVG	HPH38 SN31/10	10/2016	10/2017
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017

HAC Reference Dipole Calibration Report

Ref : ACR.351.5.16.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO.,LTD
BUILDING 28/ 29, EAST OF SHIGU, XILI INDUSTRIAL ZONE XILI ROAD, NANSHAN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOHAC E-FIELD PROBE

SERIAL NO.: SN 18/12 DHB42

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144

Calibration CERT #2246-02

Calibration Date: 12/16/16

Summary:

This document presents the method and results from an accredited HAC reference dipole calibration performed in MVG USA using the COMOHAC test bench. All calibration results are traceable to national metrology institutions.

	Name	*Function*	*Date*	*Signature*
Prepared by :	Jérôme LUC	Product Manager	12/16/2016	
Checked by :	Jérôme LUC	Product Manager	12/16/2016	
Approved by :	Kim RUTKOWSKI	Quality Manager	12/16/2016	Kim Rutkowski

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1 INTRODUCTION

This document contains a summary of the requirements set forth by the ANSI C63.19 standard for reference dipoles used for HAC measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOHAC 1700-2000 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SIDB1900
Serial Number	SN 18/12 DHB42
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOHAC Validation Dipoles are built in accordance to the ANSI C63.19 standard. The product is designed for use with the COMOHAC system only.

Figure 1 – *MVG COMOHAC Validation Dipole*

4 MEASUREMENT METHOD

The ANSI C63.19 standard outlines the requirements for reference dipoles to be used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standard.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for HAC system validation measurements and checks must have a return loss of -10 dB or better. The return loss measurement shall be performed in free space.

4.2 REFERENCE DIPOLE CALIBRATION

The IEEE ANSI C63-19 standard states that the dipole used for validation measurements and checks must be scanned with the E and H field probe, with the dipole 10 mm below the probe. The E and H field strength plots are compared to the simulation results obtained by MVG.

5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Gain
400-6000MHz	0.1 dB

5.2 VALIDATION MEASUREMENT

The guideline outlined in the IEEE ANSI C63.19 standard was followed to generate the measurement uncertainty for validation measurements.

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	**Uncertainty value (%)**	**Probability Distribution**	**Divisor**	**Uncertainty (dB)**	**Standard Uncertainty (%)**
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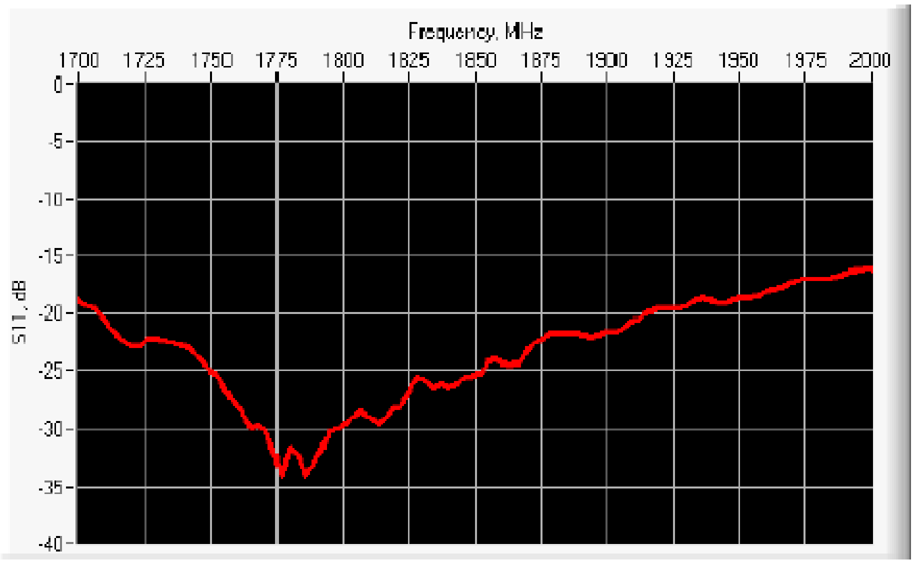
Combined standard uncertainty				0.52	
Expanded uncertainty 95 % confidence level k = 2				1.00	13.0

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
1700-2000 MHz	-16.20	-10

6.2 VALIDATION MEASUREMENT

The IEEE ANSI C63.19 standard states that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss requirements. The system validations measurement results are then compared to MVG's simulated results.

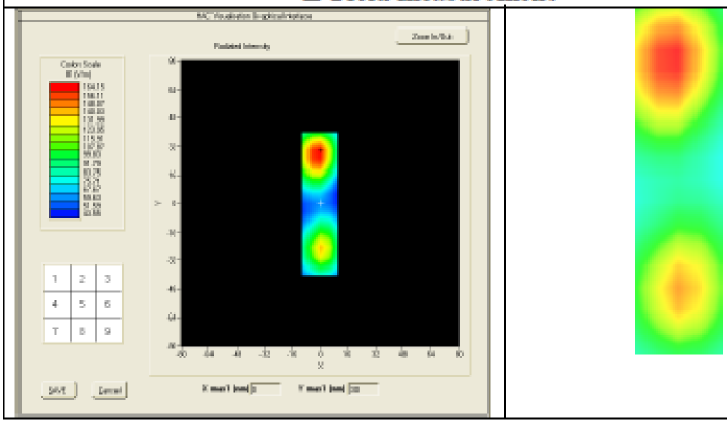
Measurement Condition

Software Version	OpenHAC V2
HAC positioning ruler	SN 42/09 TABH12
E-Field probe	SN 08/11 EPH28
H-Field probe	SN 31/10 HPH38
Distance between dipole and sensor center	10 mm
E-field scan size	X=150mm/Y=20mm
H-field scan size	X=40mm/Y=20mm
Scan resolution	dx=5mm/dy=5mm
Frequency	1900 MHz
Input power	20 dBm
Lab Temperature	21°C
Lab Humidity	45%

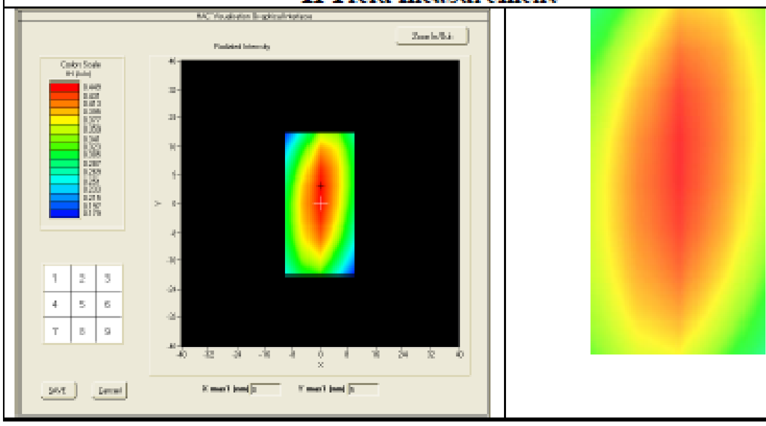
Measurement Result

	Measured	Internal Requirement
E field (V/m)	164.15	153.4
H field (A/m)	0.45	0.445

E-Field measurement



H-Field measurement



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Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017

———End of the Report———