RF Emission

HAC

TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Mobile Phone

ISSUED TO
vivo Mobile Communication Co., Ltd.

#283, BBK Road, Wusha, Chang'An, DongGuan City, China

Tested by: Zong Liyao
Zong Liyao
Date Jun. 17. 2020

Approved by:
Wei Yanquan
(Chief Engineer)
Date Jun. 17. 2020

Report No:	BL-SZ2040775-702
EUT Name:	Mobile Phone
Model Name:	vivo 1935
Brand Name:	vivo
FCC ID:	2AUCY-V1935
Test Standard:	FCC 47 CFR Part 20.19 ANSI C63.19: 2011 KDB 285076 D01 HAC Guidance v05r01
M-Rating:	E-Field: M3
Test Conclusion:	Pass
Test Date:	May 28, 2020 ~ May 31, 2020
Date of Issue:	Jun. 17, 2020

Block B, 1st FL,Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong, P. R. China 518055
TEL: +86-755-66850100
Email: qc@baluntek.com
www.baluntek.com

Revision History

Version	Issue Date	Revisions Content
Rev. 01	Jun. 09, 2020	Initial Issue
Rev. 02	Jun. 17, 2020	Update the Test Standards of section 3.1

TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100
Fax Number	+86 755 6182 4271

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A-1. The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196. The laboratory is a testing organization accredited by American Association for Laboratory Accreditation (A2LA) according to ISO/IEC 17025.The accreditation certificate is 4344.01. The laboratory is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L6791.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Test Environment Condition

Ambient Temperature	21℃ to 23℃
Ambient Relative Humidity	45% to 55%
Ambient Pressure	100 KPa to 102 KPa

1.4 Announce

(1) The test report reference to the report template version v1.1.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	vivo Mobile Communication Co., Ltd.
Address	#283, BBK Road, Wusha, Chang'An, DongGuan City, China

2.2 Manufacturer Information

Manufacturer	vivo Mobile Communication Co., Ltd.
Address	#283, BBK Road, Wusha, Chang'An, DongGuan City, China

2.3 Factory Information

Factory	vivo Mobile Communication Co., Ltd.
Address	#283, BBK Road, Wusha, Chang'An, DongGuan City, China

2.4 General Description for Equipment under Test (EUT)

EUT Name	Mobile Phone
Model Name Under Test	vivo 1935
Series Model Name	N/A
Description of Model Name Differentiation	N/A
Hardware Version	MP_0.1
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Ancillary Equipment

Ancillary Equipment 1	Battery	
	Brand Name	vivo
	Model No.	B-M3
	Serial No.	N/A
	Capacitance	4880 mAh
	Rated Voltage	3.87 V
	Limit Charge Voltage	4.2 V
Ancillary Equipment 2	Earphone	
	Model No.	N/A
	Length (Approx.)	1.2 m

2.6 Technical Information

Network and Wireless connectivity	2G Network GSM/GPRS/EDGE 850/1900 MHz 3G Network CDMA 1x Band Class 0 EVDO Rel. 0/Rev. A Band Class 0 WCDMA/HSDPA/HSUPA Band 2/4/5 4G Network FDD LTE Band 2/4/5/7/26 TDD LTE Band 38/41 LTE CA Uplink (UL): 41C Bluetooth 5.0 (BR+EDR+BLE) 2.4G WIFI 802.11b, 802.11g, 802.11n(HT20) 5G WIFI 802.11a, 802.11n(HT20/40) and 802.11ac(VHT20/40/80) Band 1/2/3/4 SRD, GPS, GLONASS, Galileo, BDS, FM receiver
Note : The EUT is a mobile phone, which supports dual SIM card under the same transceiver. Each SIM supports GSM, WCDMA and LTE, and both SIM share the same transmitting electro circuit, NV parameters, so only SIM1 was tested in this report.	

The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	GSM, WCDMA, CDMA, LTE, 2.4G WLAN, 5G WLAN, Bluetooth		
Frequency Range	GSM 850	TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	GSM 1900	TX: 1850 ~ 1910 MHz	RX: 1930 ~ 1990 MHz
	WCDMA Band 2	TX: 1850 ~ 1910 MHz	RX: 1930 ~ 1990 MHz
	WCDMA Band 4	TX: 1710 ~ 1755 MHz	RX: 2110 ~ 2155 MHz
	WCDMA Band 5	TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	CDMA BC0	TX: 824.025 ~ 848.985 MHz	RX: 869.025 ~ 893.985 MHz
	LTE Band 2	TX: 1850 ~ 1910 MHz	RX: 1930 ~ 1990 MHz
	LTE Band 4	TX: 1710 ~ 1755 MHz	RX: 2110 ~ 2155 MHz
	LTE Band 5	TX: 824 ~ 849 MHz	RX: 869 ~ 894 MHz
	LTE Band 7	TX: 2500 ~ 2570 MHz	RX: 2620 ~ 2690 MHz
	LTE Band 26	TX: 814 ~ 849 MHz	RX: 859 ~ 894 MHz
	LTE Band 38	TX: 2570 ~ 2620 MHz	RX: 2570 ~ 2620 MHz
	LTE Band 41	TX: 2496 ~ 2690 MHz	RX: 2496 ~ 2690 MHz
	802.11b/g /n(HT20)	2400 ~ 2483.5 MHz	
	802.11a/ /n(HT20/HT40) /ac(VHT20/VHT40/ VHT80)	5150 ~ 5250 MHz	
		5250 ~ 5350 MHz	
		5470 ~ 5725 MHz	
		5725 ~ 5850 MHz	
	Bluetooth	2400 ~ 2483.5 MHz	
Antenna Type	WWAN: PIFA Antenna; WLAN: PIFA Antenna; Bluetooth: PIFA Antenna		
DTM	Not Support		
Power Reduction	Not Support		
EUT Stage	Portable Device		

2.7 EUT Air Interface description

Air Interface	Band	Type	C63.19 Tested	Simultaneous Transmitter	OTT	Power Reduction
GSM	850	VO	Yes	Bluetooth/WLAN	NA	Not Support
	1900	VO	Yes	Bluetooth/WLAN	NA	Not Support
	GPRS/EDGE	DT	No	Bluetooth/WLAN	Yes	Not Support
WCDMA	Band 2	VO	No	Bluetooth/WLAN	NA	Not Support
	Band 4	VO	No	Bluetooth/WLAN	NA	Not Support
	Band 5	VO	No	Bluetooth/WLAN	NA	Not Support
	HSUPA/HSDPA	VD	No	Bluetooth/WLAN	Yes	Not Support
CDMA	CDMA BC0	VO	Yes	Bluetooth/WLAN	NA	Not Support
	EVDO BC0	DT	No	Bluetooth/WLAN	Yes	Not Support
LTE	Band 2	VD	No	Bluetooth/WLAN	Yes	Not Support
	Band 4	VD	No	Bluetooth/WLAN	Yes	Not Support
	Band 5	VD	No	Bluetooth/WLAN	Yes	Not Support
	Band 7	VD	No	Bluetooth/WLAN	Yes	Not Support
	Band 26	VD	No	Bluetooth/WLAN	Yes	Not Support
	Band 38	VD	Yes	Bluetooth/WLAN	Yes	Not Support
	Band 41	VD	Yes	Bluetooth/WLAN	Yes	Not Support
2.4G WLAN	2412~2462MHz	DT	No	WWAN	Yes	Not Support
5G WLAN	5150~5250 MHz	DT	No	WWAN	Yes	Not Support
	5250~5350 MHz	DT	No	WWAN	Yes	Not Support
	5470~5725 MHz	DT	No	WWAN	Yes	Not Support
	5725~5850 MHz	DT	No	WWAN	Yes	Not Support
Bluetooth	2402~2480 MHz	DT	No	WWAN	NA	Not Support

VO=CMRS Voice Service
DT=Digital Transport
VD=CMRS IP Voice Service and Digital Transport
OTT= OTT VoIP Calling (eg. Volet, Wi-Fi calling and etc.)

Note1: The air interface is exempted from testing by low power exemption that its average antenna input power plus its MIF is ≤17 dBm, and is rated as M4.
Note2: According to ANSI C63.19 2011 -version, for the air interface technology of a device is exempt from testing whose peak antenna input power, averaged over intervals ≤50 μs, is ≤23 dBm. An RF air interface technology that is exempted from testing shall be rated as M4.

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	FCC 47 CFR Part 20.19	Hearing aid-compatible mobile handsets.
2	ANSI C 63.19:2011	American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids
3	KDB 285076 D01 HAC Guidance v05r01	Provides equipment authorization guidance for mobile handsets subject to the requirements of Section 20.19 for hearing aid compatibility

3.2 HAC Test Configuration and Setting

For HAC RF emission testing, the EUT was linked and controlled by wireless communication test set. Communication between the EUT and the wireless communication test set was established by air link. The distance between the EUT and the communicating antenna of the test set is larger than 50 cm and the output power radiated from the wireless communication test set antenna is at least 30 dB smaller than the output power of EUT. The EUT was set from the wireless communication test set to radiate maximum output power during HAC testing.

3.3 Summary of HAC M-Rating

Band	**Measurement Result**		**M-Rating**
GSM 850	E-Field dB (V/m)	41.27	M3
GSM 1900	E-Field dB (V/m)	30.02	M3
CDMA BC0	E-Field dB (V/m)	39.16	M4
LTE B38	E-Field dB (V/m)	27.69	M4
LTE B41(Power Class3)	E-Field dB (V/m)	28.16	M4
LTE B41(Power Class2)	E-Field dB (V/m)	22.47	M4
Note: For other frequency, the air interface is exempted from testing by low power exemption that its average antenna input power plus its MIF is ≤17 dBm, and is rated as M4.			

3.4 ANSI C63.19 HAC RF Categories

3.4.1 RF Emissions

The ANSI Standard presents performance requirements for acceptable interoperability of hearing with wireless communications devices. When these parameters are met, a hearing aid operates acceptably in close proximity to a wireless communications device.

WD RF audio interference level categories:

Category	Limits for E-Field Emission (V/m)	
	<960MHz	>960MHz
M1	50 to 55	40 to 45
M2	45 to 50	35 to 40
M3	40 to 45	30 to 35
M4	<40	<30

3.5 HAC Test Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in ANSI C 63.19:2011.This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Uncertainty Component	Uncertainty Value	Prob. 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	1.17	1.17
Sensor Displacement	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 tp PMR Calibration	9.02	N	1.000	1	1	9.02	9.02
System detection limits	1.30	R	1.732	1	1	0.75	0.75
Readout Electronics	0.25	R	1.732	1	1	0.14	0.14
Response 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
Test sample Related							
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
Combined Std. Uncertainty(k=1)						16.18	13.25
Expanded Uncertainty on Power						32.35	26.50
Expanded Uncertainty on Field						16.18	13.25

4 SATIMO HSC MEASUREMENT SYSTEM

4.1 Definition of Hearing Aid Compatibility (HAC)

On July 10.2003.the Federal Communications Commission (FCC) adopted new rules requiring wireless manufacturers and service providers to provide digital wireless phones that are compatible with hearing aids. The FCC has modified the exemption for wireless phones under the Hearing Aid Compatibility Act of 1998 (HAC Act) in WT Docket 01-309 RM-8658 to extend the benefits of wireless telecommunications to individuals with hearing disabilities. These benefits encompass business, social and emergency communications, which increase the value of the wireless network for everyone. An estimated more than 10% of the population in the United States show signs of hearing impairment and of that fraction, almost 80% use hearing aids. Approximately 500 million people worldwide suffer from hearing loss.

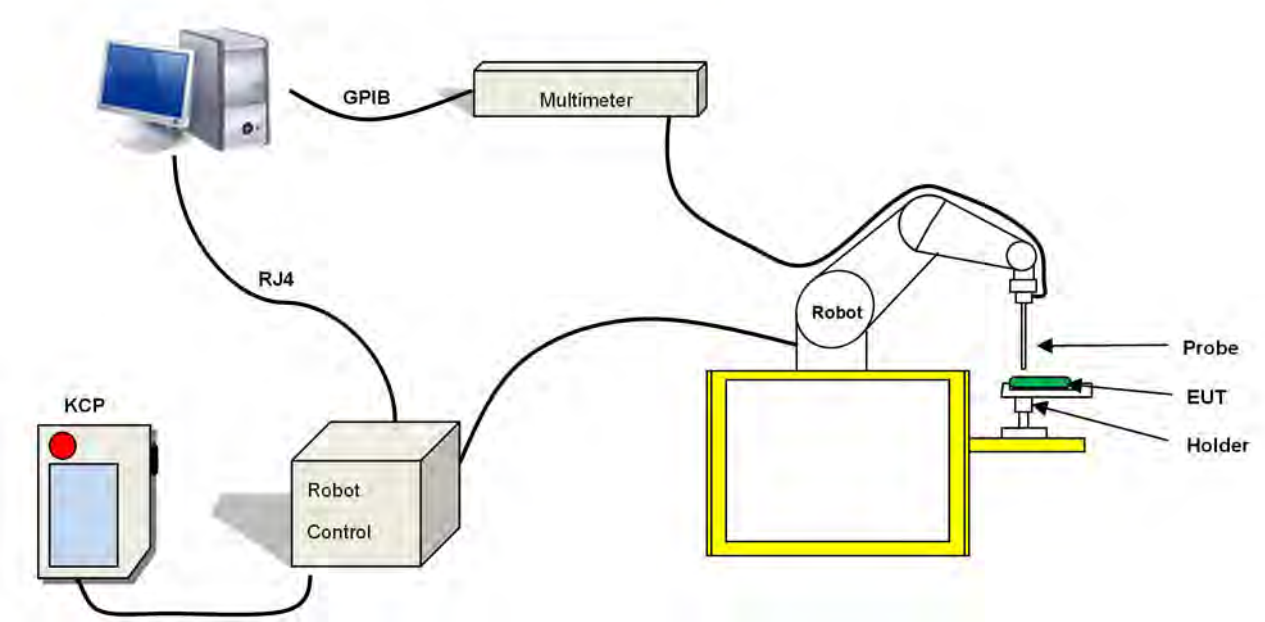
Compatibility Tests involved:

The standard calls for wireless communications devices to be measured for:
- RF Electric-field emissions.
- RF Magnetic- field emissions.
- T-coil mode, magnetic-signal strength in the audio band.
- T-coil mode, magnetic-signal frequency response through the audio band.
- T-coil mode, magnetic-signal and noise articulation index.

The hearing aid must be measured for:
- RF immunity in microphone mode
- RF immunity in T-coil mode

4.2 SATIMO HAC System

SATIMO HAC System Diagram:



4.2.1 Robot

The SATIMO HAC system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA) from KUKA is used. The KUKA robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

4.2.2 HAC E-Field Probe

Serial Number:	SN 24/13 EPH41
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=2.1807 MΩ Dipole 2:R1=2.0612 MΩ Dipole 3:R3=2.1892 MΩ
Connector (HIROSE series SR30)	6 wire male (Hirose SR30series)

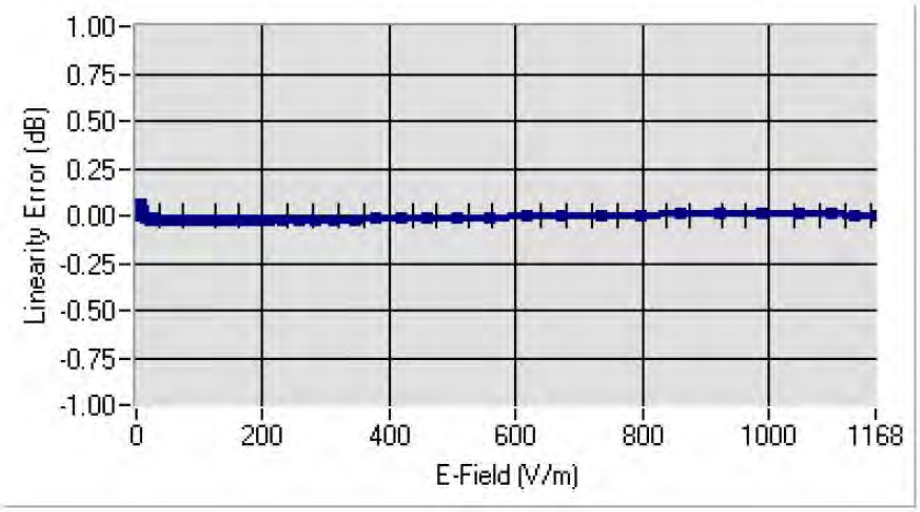
E-Field Probe Calibration Process

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

LINEARITY

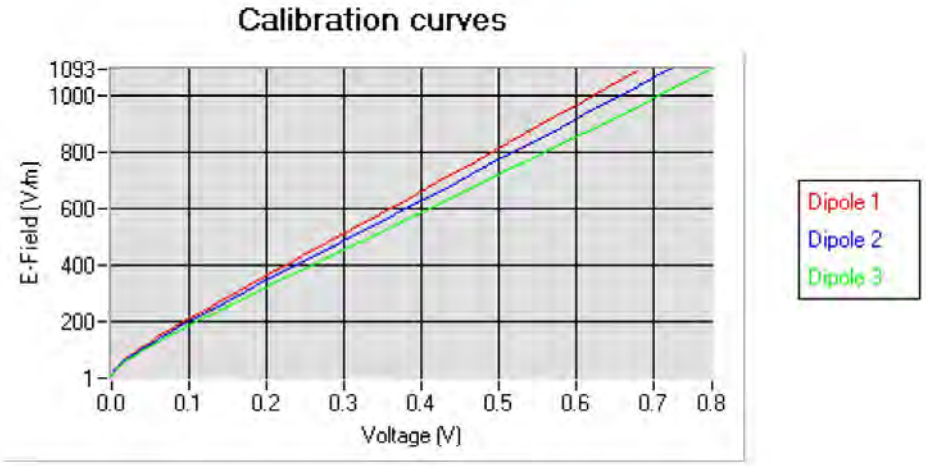
The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 2V/m to 1000V/m).

Linearity: +/- 1.49% (+/- 0.07 dB)



SENSITIVITY

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

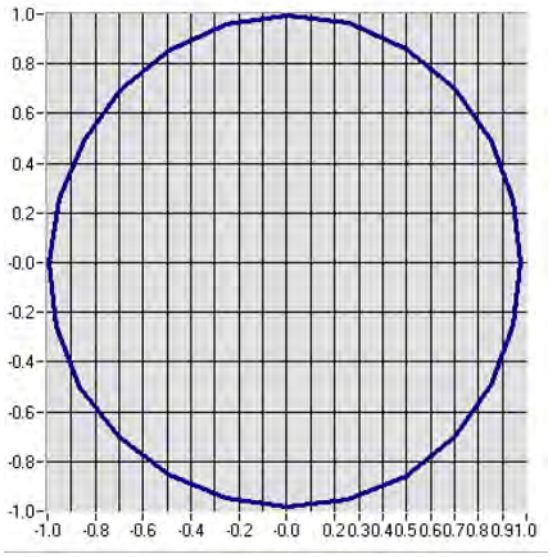


Frequency (GHz)	Normz dipole 1 (μV/(V/m)²)	Normz dipole 2 (μV/(V/m)²)	Normz dipole 3 (μV/(V/m)²)
0.7GHz-2.5GHz	6.54	4.86	5.80
Frequency (GHz)	**DCP dipole 1 (mV)**	**DCP dipole 2 (mV)**	**DCP dipole 3 (mV)**
0.7GHz-2.5GHz	96	96	92

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.

Isotropy: +/- 1.22% (+/- 0.05 dB)



4.2.3 HAC H-Field Probe

Serial Number:	SN 24/13 EPH49
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=0.289 MΩ Dipole 2:R1=0.287 MΩ Dipole 3:R3=0.281 MΩ
Connector (HIROSE series SR30)	6 wire male (Hirose SR30series)

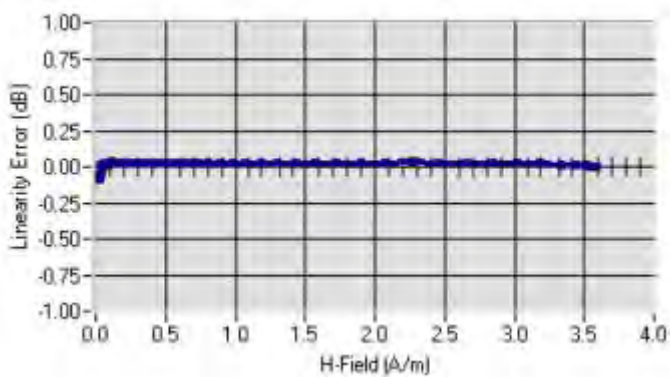
Calibration Method Procedure

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

LINEARITY

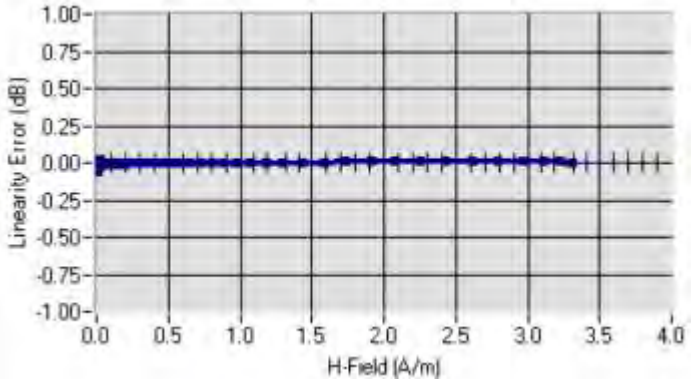
The linearity was determined using a standard dipole with the probe positioned 10 mm above the dipole. The input power of the dipole was adjusted from -15 to 36 dBm using a 1dB step (to cover the range 0.01A/m to 2A/m).

Linearity: +/- 1.83% (+/- 0.08 dB)



Linearity @ 835MHz

Linearity: +/- 1.36% (+/- 0.06 dB)

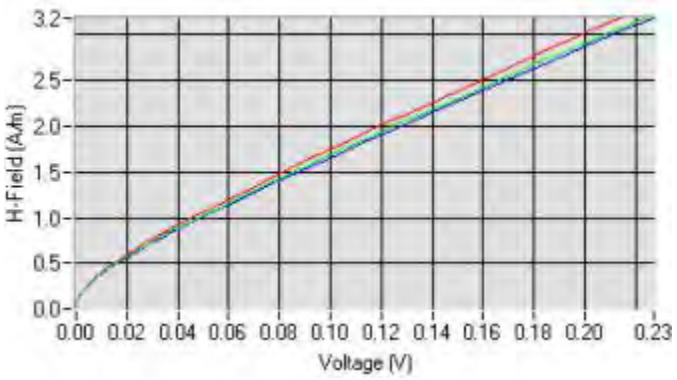


Linearity @ 1900MHz

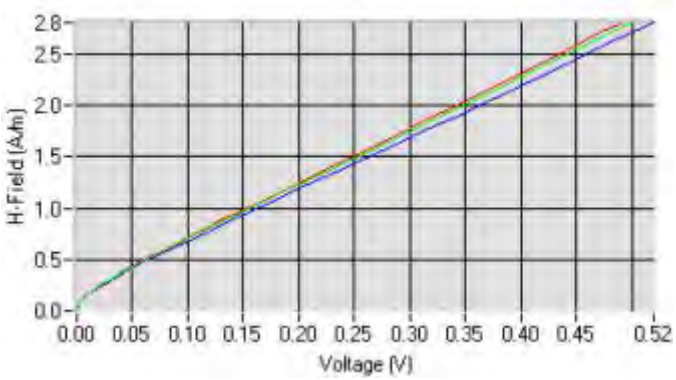
SENSITIVITY

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

Frequency (GHz)	Normz loop 1 (μV/(A/m) ^{2})	Normz loop 2 (μV/(A/m) ^{2})	Normz loop 3 (μV/(A/m) ^{2})
0.7GHz-1.0GHz	0.062	0.072	0.068
1.7GHz-2.5GHz	0.35	0.41	0.37
Frequency (GHz)	**DCP dipole 1 (mV)**	**DCP dipole 2 (mV)**	**DCP dipole 3 (mV)**
0.7GHz-2.5GHz	112	102	106



Calibration Curves @ 835MHz

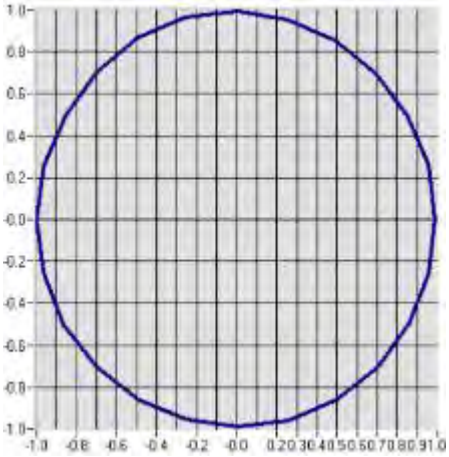


Calibration Curves @ 1900MHz

ISOTROPY

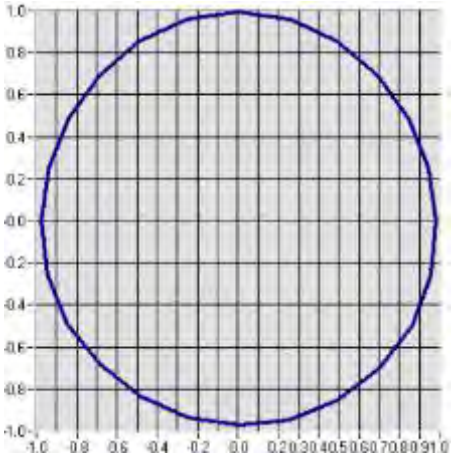
The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole. The probe was rotated along its main axis from 0 - 360 degrees in 15 degree steps.

Isotropy: +/- 1.22% (+/- 0.05 dB)



Isotropy @ 835MHz

Isotropy: +/- 1.22% (+/- 0.05 dB)



Isotropy @ 1900MHz

5 SYSTEM VERIFICATION

5.1 System Check Procedure

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 surfaceof the dipole to the calibration reference point of the sensor, defined by the probe manufacturer is shown in the following diagram:

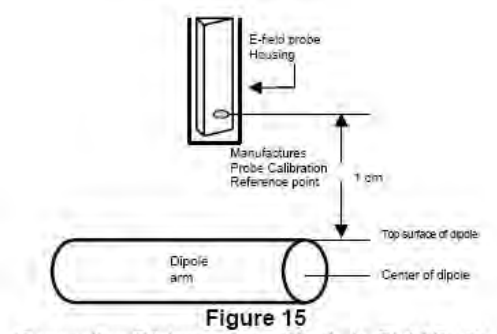


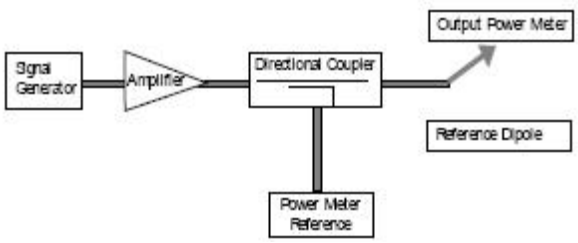
Figure 15
Separation Distance from Dipole to Field Probe

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.

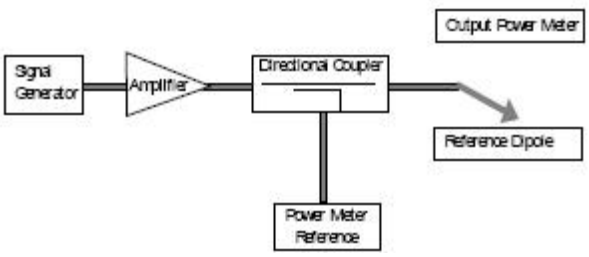
5.2 Validation Procedure

A dipole antenna meeting the requirements given in PC63.19 was placed in the position normally occupied by the WD. The length of the dipole was scanned with both E-field and H-field probes and the maximum values for each were recorde. Using the near-field measurement system, scan the antenna over the radiating dipole and record the greatest field reading observed. 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. RF power was recorded using both an average and a peak power reading meter.

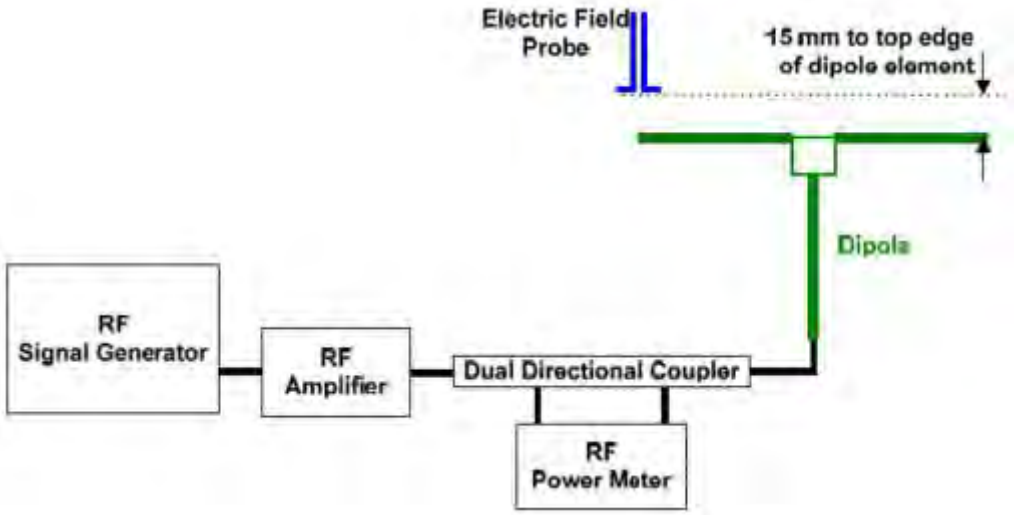
Setup for Desired Output Power to Dipole



Setup to Dipole



5.3 System Validation Setup



Using this setup configuration, the signal generator was adjusted for the desired output power 20dBm (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 System Validation Results

Comparing to the original HAC value provided by SATIMO, the validation data should be within its specification of 10 %.

Frequency	Input Power (dBm)	E-field Result (V/m)	Target Field (V/m)	Tolerance (%)	Date
835 MHz	20.0	214.12	220.4	-2.86	31/5/2020
1900MHz	20.0	155.84	153.4	1.62	28/5/2020
2450MHz	20.0	136.81	134.7	1.57	30/5/2020

6 Modulation Interference Factor (MIF)

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF). For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be developed that relates its interference potential to its steady-state rms signal level or average power level. This factor is a function only of the audio-frequency amplitude modulation characteristics of the signal and is the same for field-strength and conducted power measurements. It is important to emphasize that the MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic. Any change in modulation characteristic requires determination and application of a new MIF.

The MIF may be determined using a radiated RF field, a conducted RF signal, or in a preliminary stage, a mathematical analysis of a modeled RF signal:

a) Verify the slope accuracy and dynamic range capability over the desired operating frequency band of a fast probe or sensor, square-law detector, as specified in D.3, and weighting system as specified in D.4 and D.5. For the probe and instrumentation included in the measurement of MIF, additional calibration and application of calibration factors are not required.
b) Using RF illumination or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range.
c) Measure the steady-state rms level at the output of the fast probe or sensor.
d) Measure the steady-state average level at the weighting output.
e) Without changing the square-law detector or weighting system, and using RF illumination or conducted coupling, substitute for the specific modulated signal a 1kHz, 80% amplitude-modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the step d) measurement.
f) Without changing the carrier level from step e), remove the 1 kHz modulation and again measure the steady-state rms level indicated at the output of the fast probe or sensor.
g) The MIF for the specific modulation characteristic is provided by the ratio of the step f) measurement to the step c) measurement, expressed in dB (20 × log(step f))/step c)).

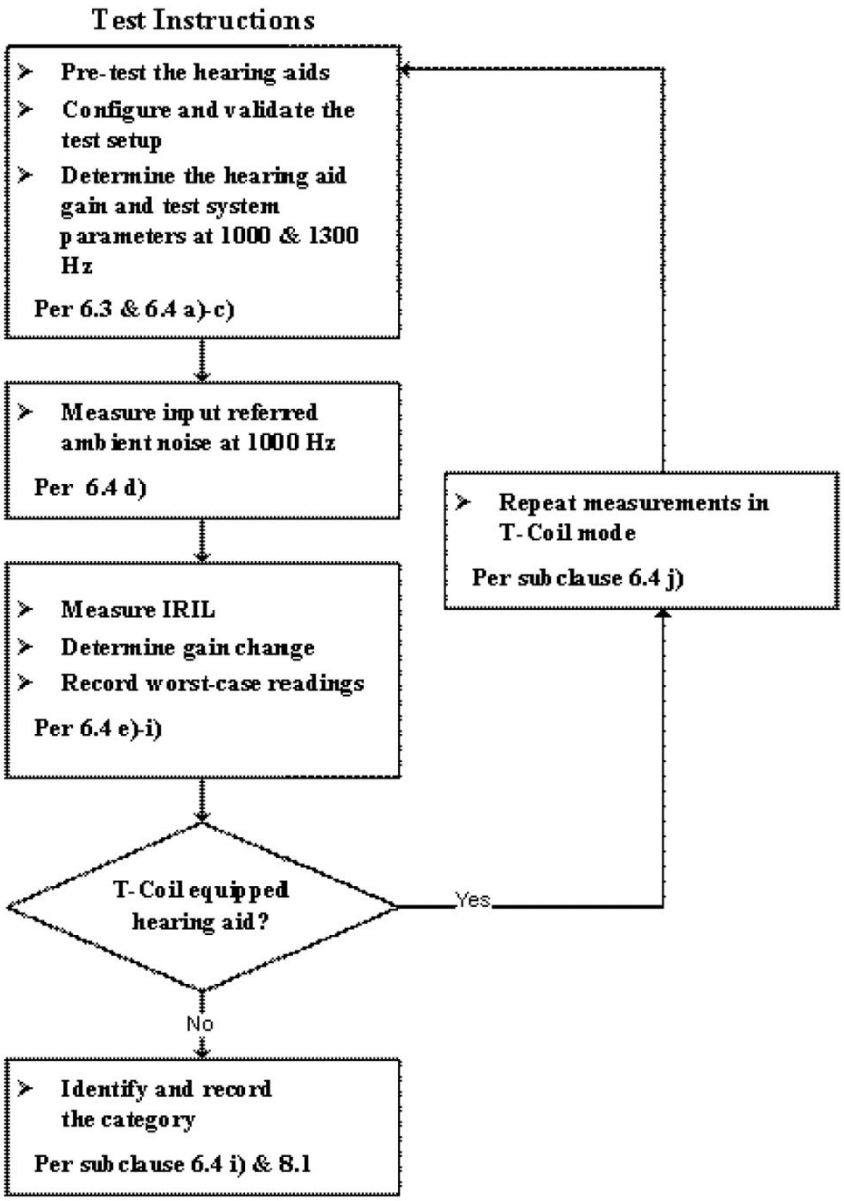
In practice, step e) and step f) need not be repeated for each MIF determination if the relationship between the two measurements has been preestablished for the measurement system over the operating frequency and dynamic ranges.

MIF table

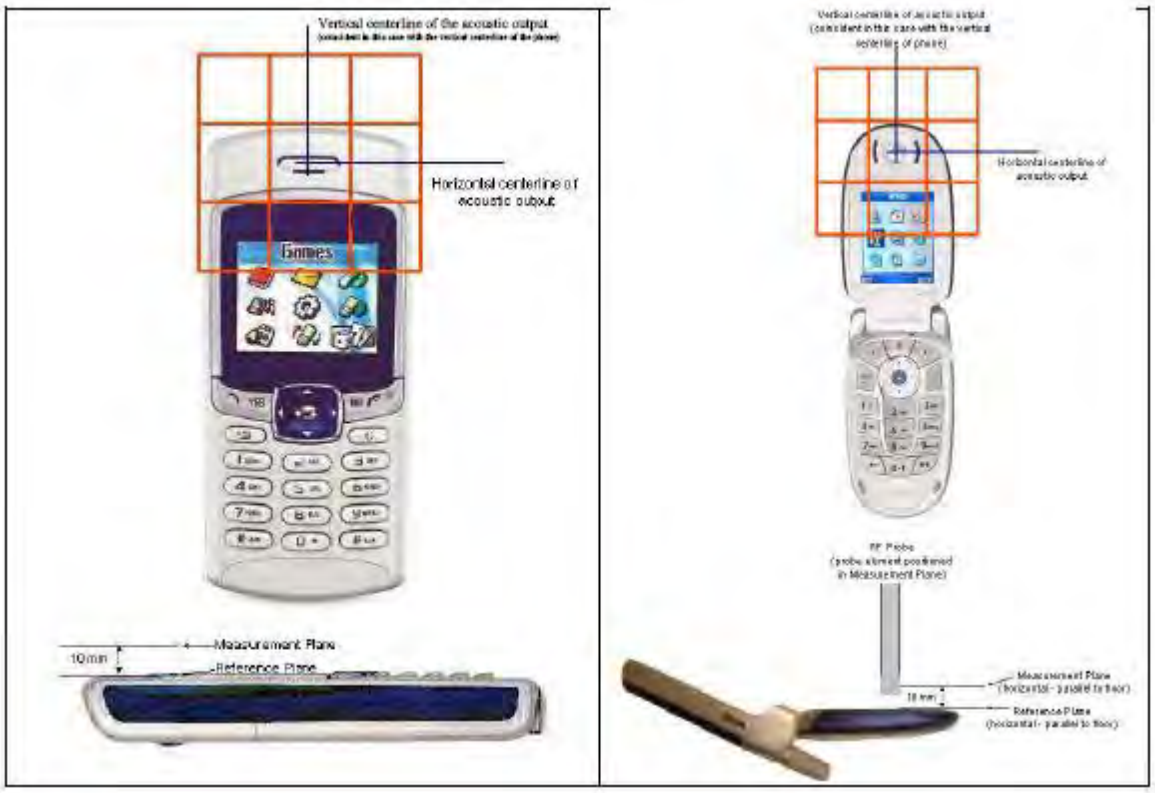
Probe	Signal Type	MIF
E-Field Probe	CW	-99.00
	GSM-FDD (TDMA, GMSK)	3.63
	EDGE-FDD (TDMA, 8PSK, TN 0)	3.75
	UMTS-FDD (WCDMA, AMR)	-25.43
	UMTS-FDD (HSPA+)	-20.39
	CDMA2000 (1xRTT, RC3)	-19.71
	CDMA2000 (1xRTT, RC1 SO3, 1/8th Rate 25 fr.)	3.26
	CDMA2000 (1xEV-DO, Rev. 0)	-17.67
	LTE-FDD(SC-FDMA,1RB,20MHz,16-QAM)	-9.76
	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	-1.62
	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44

7 HAC RF IMMUNITY MEASUREMENT PROCEDURES

7.1 HAC Measurement Process Diagram



7.2 HAC RF Test Setup



Reference and plane for RF emission measurements

7.3 RF Emission Measurement Procedure

The following illustrate a typical RF emissions test scan over a wireless communications device:

a. Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.

b. WD is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.

c. The WD operation for maximum rated RF output power was configured and confirmed with the base station simulator, at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test.

d. The center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The WD audio output was positioned tangent (as physically possible) to the measurement plane.

e. A surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.

f. The measurement system measured the field strength at the reference location.

8 CONDUCTED RF OUPUT POWER

The measurement conducted power as following:

8.1 GSM

Band	GSM 850			GSM 1900		
Channel	128	190	251	512	661	810
GSM (GMSK, 1-Slot)	33.17	33.12	33.45	30.23	30.25	30.23
GPRS (GMSK, 1-Slot)	33.11	33.27	33.42	30.25	30.20	30.13
GPRS (GMSK, 2-Slot)	30.75	30.84	31.15	28.31	28.31	28.27
GPRS (GMSK, 3-Slot)	28.74	29.08	29.23	26.60	26.57	26.60
GPRS (GMSK, 4-Slot)	27.06	27.20	27.50	25.04	24.98	24.93
EGPRS (8PSK, 1-Slot)	26.90	26.90	27.24	26.93	26.89	26.81
EGPRS (8PSK, 2-Slot)	24.36	24.39	24.64	24.52	24.47	24.39
EGPRS (8PSK, 3-Slot)	23.28	23.18	23.44	23.36	23.39	23.21
EGPRS (8PSK, 4-Slot)	22.01	22.02	22.33	22.32	22.15	22.03

8.2 WCDMA

Band	WCDMA B2			WCDMA B4		
Channel	4133	4175	4232	9263	9400	9537
RMC 12.2Kbps	23.75	**23.76**	23.75	**21.51**	21.35	21.24
HSDPA Subtest-1	22.81	22.76	22.77	21.42	21.33	21.18
HSDPA Subtest-2	22.91	22.79	22.78	20.27	20.25	20.10
HSDPA Subtest-3	22.38	22.28	22.32	19.77	19.74	19.55
HSDPA Subtest-4	22.37	22.29	22.31	19.20	19.18	18.93
HSUPA Subtest-1	22.32	22.28	22.25	21.36	21.29	21.14
HSUPA Subtest-2	20.87	20.74	20.81	20.24	20.23	20.12
HSUPA Subtest-3	21.85	21.73	21.84	19.65	19.56	19.45
HSUPA Subtest-4	20.64	20.59	20.61	19.10	19.05	18.94
HSUPA Subtest-5	22.72	22.70	22.74	18.41	18.37	18.34
Band	**WCDMA B5**			**/**		
Channel	4133	4175	4232	/	/	/
RMC 12.2Kbps	23.75	**23.76**	23.75			
HSDPA Subtest-1	22.81	22.76	22.77			
HSDPA Subtest-2	22.91	22.79	22.78			
HSDPA Subtest-3	22.38	22.28	22.32			
HSDPA Subtest-4	22.37	22.29	22.31			
HSUPA Subtest-1	22.32	22.28	22.25			
HSUPA Subtest-2	20.87	20.74	20.81			
HSUPA Subtest-3	21.85	21.73	21.84			
HSUPA Subtest-4	20.64	20.59	20.61			
HSUPA Subtest-5	22.72	22.70	22.74			

8.3 CDMA

CDMA	BC0		
Channel	1013	384	777
1xRTT RC1 SO55	23.54	23.51	23.50
1xRTT RC3 SO55	**23.55**	23.52	23.42
1xRTT RC3 SO32 (FCH)	23.25	23.21	23.27
1xRTT RC3 SO32 (SCH)	23.27	23.23	23.29
1xEVDO Rel.0 RTAP 153.6kbps	23.17	23.05	23.01
1xEVDO Rel.A RETAP: 4096	23.26	23.13	23.08

8.4 LTE

FDD LTE Band 2							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18700	18900	19100	18700	18900	19100
20 MHz	1 (RB_Pos:0)	24.13	24.17	23.90	23.76	23.54	23.27
	1 (RB_Pos:50)	23.83	23.90	23.84	23.42	23.22	23.11
	1 (RB_Pos:99)	24.12	24.12	23.75	23.80	23.49	23.07
	50 (RB_Pos:0)	22.95	22.98	22.89	22.16	22.08	21.93
	50 (RB_Pos:25)	22.96	22.97	22.84	22.13	22.05	21.89
	50 (RB_Pos:50)	23.09	22.91	22.87	22.16	21.94	21.95
	100 (RB_Pos:0)	23.11	22.97	22.83	22.22	22.03	21.92
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18675	18900	19125	18675	18900	19125
15 MHz	1 (RB_Pos:0)	23.91	24.01	23.91	22.83	23.36	23.17
	1 (RB_Pos:38)	23.84	23.87	23.87	22.76	23.25	23.09
	1 (RB_Pos:74)	23.91	24.00	23.85	22.79	23.38	23.05
	36 (RB_Pos:0)	22.95	22.98	22.85	22.03	22.09	21.92
	36 (RB_Pos:20)	22.94	22.95	22.90	21.99	22.05	21.96
	36 (RB_Pos:39)	22.90	22.90	22.86	21.98	22.06	21.92
	75 (RB_Pos:0)	22.92	22.96	22.84	22.04	22.06	21.92
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18650	18900	19150	18650	18900	19150
10 MHz	1 (RB_Pos:0)	24.10	24.16	23.95	23.04	23.58	22.98
	1 (RB_Pos:25)	23.89	23.92	23.85	22.79	23.30	22.84
	1 (RB_Pos:49)	24.09	24.09	23.83	22.97	23.48	22.75
	25 (RB_Pos:0)	22.93	23.00	22.98	22.03	22.02	22.09
	25 (RB_Pos:12)	22.96	22.97	22.89	22.04	22.05	22.07

	25 (RB_Pos:25)	22.92	22.94	22.89	21.99	21.99	22.03
	50 (RB_Pos:0)	22.94	22.96	22.93	21.96	21.99	22.03
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18625	18900	19175	18625	18900	19175
5 MHz	1 (RB_Pos:0)	23.91	23.95	23.86	23.09	23.48	22.94
	1 (RB_Pos:13)	23.90	24.00	23.92	23.10	23.49	22.93
	1 (RB_Pos:24)	23.81	23.94	23.81	23.05	23.44	22.88
	12 (RB_Pos:0)	22.94	22.95	22.92	22.04	22.12	22.00
	12 (RB_Pos:6)	22.92	22.95	22.90	22.04	22.12	22.01
	12 (RB_Pos:13)	22.91	22.92	22.87	22.00	22.11	21.97
	25 (RB_Pos:0)	22.89	22.91	22.85	22.01	22.02	21.90
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18650	18900	19150	18615	18900	19185
3.0 MHz	1 (RB_Pos:0)	23.85	23.88	23.81	22.73	23.26	22.84
	1 (RB_Pos:8)	23.82	23.87	23.79	22.76	23.26	22.77
	1 (RB_Pos:14)	23.81	23.88	23.85	22.71	23.30	22.73
	8 (RB_Pos:0)	22.90	22.97	22.82	22.07	22.06	21.94
	8 (RB_Pos:3)	22.95	22.96	22.88	22.07	22.05	21.98
	8 (RB_Pos:7)	22.92	22.96	22.85	22.06	22.02	21.93
	15 (RB_Pos:0)	22.91	22.90	22.85	21.96	21.98	21.86
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	18607	18900	19193	18607	18900	19193
1.4 MHz	1 (RB_Pos:0)	23.79	23.79	23.74	22.86	23.17	22.68
	1 (RB_Pos:3)	23.86	23.87	23.81	22.95	23.21	22.77
	1 (RB_Pos:5)	23.78	23.79	23.77	22.89	23.20	22.70
	3 (RB_Pos:0)	23.77	23.76	23.79	22.86	22.96	23.00
	3 (RB_Pos:1)	23.88	23.85	23.86	22.93	23.06	23.09
	3 (RB_Pos:3)	23.77	23.74	23.78	22.90	22.96	23.02
	6 (RB_Pos:0)	22.84	22.88	22.70	22.03	21.79	21.97

FDD LTE Band 4							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20050	20175	20300	20050	20175	20300
20 MHz	1 (RB_Pos:0)	23.80	23.90	23.89	23.31	23.26	23.28
	1 (RB_Pos:50)	23.73	23.82	23.79	23.19	23.15	23.14
	1 (RB_Pos:99)	23.76	23.89	23.76	23.32	23.27	23.17
	50 (RB_Pos:0)	22.86	22.93	22.87	21.90	22.00	21.87
	50 (RB_Pos:25)	22.79	22.86	22.80	21.83	21.98	21.84
	50	22.86	22.85	22.84	21.89	21.88	21.89

	(RB_Pos:50)						
	100 (RB_Pos:0)	22.78	22.87	22.82	21.88	21.96	21.83
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20025	20175	20325	20025	20175	20325
15 MHz	1 (RB_Pos:0)	23.76	23.85	23.87	22.68	23.23	23.23
	1 (RB_Pos:38)	23.61	23.80	23.84	22.52	23.16	23.15
	1 (RB_Pos:74)	23.71	23.82	23.79	22.63	23.23	23.15
	36 (RB_Pos:0)	22.70	22.88	22.80	21.77	22.05	21.86
	36 (RB_Pos:20)	22.77	22.83	22.84	21.85	21.97	21.90
	36 (RB_Pos:39)	22.74	22.81	22.81	21.83	21.94	21.89
	75 (RB_Pos:0)	22.76	22.82	22.79	21.87	21.95	21.80
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20000	20175	20350	20000	20175	20350
10 MHz	1 (RB_Pos:0)	23.70	23.81	23.89	22.63	23.17	22.92
	1 (RB_Pos:25)	23.57	23.80	23.79	22.48	23.16	22.77
	1 (RB_Pos:49)	23.70	23.78	23.77	22.57	23.17	22.77
	25 (RB_Pos:0)	22.72	22.88	22.89	21.77	21.99	22.00
	25 (RB_Pos:12)	22.71	22.87	22.86	21.77	21.95	22.00
	25 (RB_Pos:25)	22.77	22.87	22.83	21.81	21.93	21.91
	50 (RB_Pos:0)	22.72	22.84	22.83	21.79	21.93	21.92
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	19975	20175	20375	19975	20175	20375
5 MHz	1 (RB_Pos:0)	23.63	23.87	23.81	22.87	23.38	22.95
	1 (RB_Pos:13)	23.66	23.89	23.80	22.88	23.39	22.95
	1 (RB_Pos:24)	23.54	23.84	23.74	22.79	23.35	22.91
	12 (RB_Pos:0)	22.65	22.85	22.82	21.78	22.07	21.92
	12 (RB_Pos:6)	22.69	22.85	22.86	21.79	22.06	21.89
	12 (RB_Pos:13)	22.62	22.85	22.82	21.76	22.02	21.86
	25 (RB_Pos:0)	22.61	22.81	22.80	21.71	21.95	21.83
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	19965	20175	20385	19965	20175	20385
3.0 MHz	1 (RB_Pos:0)	23.63	23.82	23.79	22.51	23.19	22.81
	1 (RB_Pos:8)	23.60	23.79	23.75	22.52	23.16	22.74
	1 (RB_Pos:14)	23.55	23.81	23.77	22.48	23.18	22.79
	8 (RB_Pos:0)	22.67	22.87	22.78	21.81	21.94	21.87
	8 (RB_Pos:3)	22.69	22.86	22.79	21.84	21.96	21.89

	8 (RB_Pos:7)	22.65	22.83	22.73	21.74	21.91	21.84
	15 (RB_Pos:0)	22.62	22.82	22.77	21.70	21.92	21.78
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	19957	20175	20393	19957	20175	20393
1.4 MHz	1 (RB_Pos:0)	23.51	23.72	23.67	22.67	23.16	22.67
	1 (RB_Pos:3)	23.58	23.81	23.73	22.68	23.16	22.69
	1 (RB_Pos:5)	23.53	23.71	23.65	22.64	23.13	22.70
	3 (RB_Pos:0)	23.51	23.68	23.62	22.56	22.89	22.82
	3 (RB_Pos:1)	23.52	23.83	23.76	22.61	22.97	22.87
	3 (RB_Pos:3)	23.50	23.71	23.67	22.60	22.88	22.80
	6 (RB_Pos:0)	22.59	22.82	22.71	21.77	21.74	21.92

FDD LTE Band 5							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20450	20525	20600	20450	20525	20600
10 MHz	1 (RB_Pos:0)	23.60	23.47	23.48	22.53	22.85	22.48
	1 (RB_Pos:25)	23.47	23.56	23.51	22.46	22.88	22.58
	1 (RB_Pos:49)	23.58	23.61	23.44	22.47	23.00	22.48
	25 (RB_Pos:0)	22.61	22.62	22.50	21.67	21.72	21.65
	25 (RB_Pos:12)	22.60	22.65	22.60	21.64	21.76	21.73
	25 (RB_Pos:25)	22.67	22.60	22.56	21.75	21.66	21.69
	50 (RB_Pos:0)	22.71	22.63	22.47	21.74	21.70	21.55
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20425	20525	20625	20425	20525	20625
5MHz	1 (RB_Pos:0)	23.61	23.56	23.51	22.82	23.10	22.67
	1 (RB_Pos:13)	23.64	23.62	23.61	22.84	23.15	22.70
	1 (RB_Pos:24)	23.53	23.58	23.50	22.78	23.08	22.66
	12 (RB_Pos:0)	22.66	22.58	22.60	21.77	21.79	21.70
	12 (RB_Pos:6)	22.64	22.63	22.59	21.77	21.81	21.67
	12 (RB_Pos:13)	22.58	22.59	22.54	21.73	21.83	21.67
	25 (RB_Pos:0)	22.62	22.57	22.55	21.71	21.76	21.57
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20415	20525	20635	20415	20525	20635
3.0 MHz	1 (RB_Pos:0)	23.63	23.54	23.54	22.49	22.91	22.60
	1 (RB_Pos:8)	23.58	23.52	23.51	22.51	22.93	22.52
	1 (RB_Pos:14)	23.53	23.52	23.50	22.43	22.93	22.55
	8 (RB_Pos:0)	22.58	22.61	22.52	21.77	21.68	21.61
	8 (RB_Pos:3)	22.65	22.60	22.56	21.82	21.72	21.67

	8 (RB_Pos:7)	22.60	22.59	22.50	21.76	21.68	21.63
	15 (RB_Pos:0)	22.61	22.60	22.58	21.67	21.68	21.55
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20407	20525	20643	20407	20525	20643
1.4MHz	1 (RB_Pos:0)	23.52	23.47	23.40	22.67	22.86	22.42
	1 (RB_Pos:3)	23.62	23.53	23.48	22.72	22.91	22.53
	1 (RB_Pos:5)	23.51	23.49	23.43	22.67	22.83	22.48
	3 (RB_Pos:0)	23.51	23.46	23.44	22.58	22.70	22.58
	3 (RB_Pos:1)	23.58	23.55	23.52	22.65	22.76	22.71
	3 (RB_Pos:3)	23.52	23.49	23.45	22.62	22.66	22.62
	6 (RB_Pos:0)	22.58	22.47	22.46	21.76	21.48	21.70

FDD LTE Band 7							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20850	21100	21350	20850	21100	21350
20MHz	1 (RB_Pos:0)	23.82	23.82	23.80	23.40	23.27	23.22
	1 (RB_Pos:50)	23.87	23.94	24.00	23.40	23.29	23.34
	1 (RB_Pos:99)	23.77	23.87	23.80	23.37	23.29	23.20
	50 (RB_Pos:0)	22.86	22.87	22.90	21.88	21.86	21.88
	50 (RB_Pos:25)	22.86	22.94	22.96	21.89	21.94	21.96
	50 (RB_Pos:50)	22.86	22.93	22.94	21.82	21.93	21.95
	100 (RB_Pos:0)	22.86	22.88	22.93	21.91	21.91	21.95
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20825	21100	21375	20825	21100	21375
15MHz	1 (RB_Pos:0)	23.83	23.79	23.88	22.79	23.27	23.24
	1 (RB_Pos:38)	23.89	23.91	23.96	22.81	23.30	23.28
	1 (RB_Pos:74)	23.80	23.84	23.87	22.75	23.29	23.19
	36 (RB_Pos:0)	22.88	22.87	22.89	21.90	22.01	21.95
	36 (RB_Pos:20)	22.90	22.95	22.96	21.90	22.02	21.95
	36 (RB_Pos:39)	22.85	22.92	22.93	21.88	22.00	21.95
	75 (RB_Pos:0)	22.82	22.90	22.94	21.86	21.99	21.98
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20800	21100	21400	20800	21100	21400
10MHz	1 (RB_Pos:0)	23.90	23.80	23.88	22.84	23.28	22.93
	1 (RB_Pos:25)	23.90	23.88	23.93	22.82	23.22	22.94
	1 (RB_Pos:49)	23.81	23.84	23.83	22.79	23.27	22.88
	25 (RB_Pos:0)	22.93	22.91	22.94	21.93	21.95	22.04

	25 (RB_Pos:12)	22.99	22.95	22.97	21.95	21.98	22.06
	25 (RB_Pos:25)	22.96	22.94	22.95	21.90	21.99	22.03
	50 (RB_Pos:0)	22.89	22.92	22.94	21.87	21.96	21.99
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	20775	21100	21425	20775	21100	21425
5MHz	1 (RB_Pos:0)	23.88	23.89	23.87	23.16	23.45	23.02
	1 (RB_Pos:13)	23.95	23.97	23.98	23.18	23.47	23.06
	1 (RB_Pos:24)	23.84	23.88	23.87	23.15	23.49	23.01
	12 (RB_Pos:0)	22.98	22.88	22.95	22.02	22.06	22.02
	12 (RB_Pos:6)	22.96	22.93	23.02	22.04	22.14	22.05
	12 (RB_Pos:13)	22.95	22.88	22.95	21.97	22.10	22.05
	25 (RB_Pos:0)	22.95	22.89	22.96	21.96	22.01	21.90

FDD LTE Band 26							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26765	26865	26965	26765	26865	26965
15MHz	1 (RB_Pos:0)	23.53	23.57	23.53	22.49	23.00	22.84
	1 (RB_Pos:50)	23.55	23.48	23.54	22.49	22.87	22.89
	1 (RB_Pos:99)	23.40	23.40	23.36	22.34	22.86	22.73
	50 (RB_Pos:0)	22.62	22.52	22.47	21.72	21.70	21.49
	50 (RB_Pos:25)	22.60	22.51	22.45	21.68	21.64	21.52
	50 (RB_Pos:50)	22.48	22.48	22.46	21.57	21.54	21.52
	100 (RB_Pos:0)	22.55	22.48	22.39	21.65	21.61	21.49
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26740	26865	26990	26740	26865	26990
10MHz	1 (RB_Pos:0)	23.51	23.54	23.53	22.50	22.93	22.62
	1 (RB_Pos:38)	23.55	23.48	23.48	22.48	22.83	22.57
	1 (RB_Pos:74)	23.49	23.48	23.37	22.39	22.86	22.39
	36 (RB_Pos:0)	22.67	22.57	22.58	21.75	21.61	21.66
	36 (RB_Pos:20)	22.62	22.53	22.55	21.71	21.62	21.68
	36 (RB_Pos:39)	22.57	22.49	22.48	21.60	21.57	21.65
	75 (RB_Pos:0)	22.60	22.52	22.51	21.62	21.59	21.58
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26715	26865	27015	26715	26865	27015

5MHz	1 (RB_Pos:0)	23.55	23.54	23.48	22.75	23.03	22.60
	1 (RB_Pos:25)	23.55	23.55	23.48	22.75	23.07	22.64
	1 (RB_Pos:49)	23.53	23.50	23.42	22.78	22.92	22.54
	25 (RB_Pos:0)	22.58	22.51	22.54	21.71	21.72	21.62
	25 (RB_Pos:12)	22.57	22.50	22.53	21.67	21.73	21.62
	25 (RB_Pos:25)	22.61	22.48	22.52	21.75	21.70	21.56
	50 (RB_Pos:0)	22.67	22.51	22.49	21.70	21.62	21.49
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26705	26865	27025	26705	26865	27025
3MHz	1 (RB_Pos:0)	23.54	23.49	23.45	22.43	22.89	22.48
	1 (RB_Pos:13)	23.49	23.47	23.43	22.44	22.84	22.43
	1 (RB_Pos:24)	23.48	23.46	23.41	22.38	22.85	22.43
	12 (RB_Pos:0)	22.54	22.53	22.45	21.72	21.62	21.56
	12 (RB_Pos:6)	22.59	22.52	22.48	21.72	21.64	21.57
	12 (RB_Pos:13)	22.53	22.51	22.40	21.69	21.59	21.55
	25 (RB_Pos:0)	22.55	22.48	22.47	21.64	21.58	21.47
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26697	26865	27033	26697	26865	27033
1.4MHz	1 (RB_Pos:0)	23.43	23.36	23.34	22.61	22.80	22.40
	1 (RB_Pos:13)	23.50	23.46	23.41	22.63	22.83	22.41
	1 (RB_Pos:24)	23.45	23.43	23.35	22.59	22.79	22.36
	12 (RB_Pos:0)	23.40	23.36	23.35	22.45	22.57	22.50
	12 (RB_Pos:6)	23.48	23.44	23.39	22.53	22.61	22.59
	12 (RB_Pos:13)	23.40	23.37	23.34	22.51	22.54	22.48
	25 (RB_Pos:0)	22.48	22.44	22.39	21.68	21.40	21.64

FDD LTE Band 38							
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	37850	38000	38150	37850	38000	38150
20MHz	1 (RB_Pos:0)	23.91	24.09	24.11	23.33	23.26	23.48
	1 (RB_Pos:50)	23.95	24.10	24.08	23.40	23.30	23.51
	1 (RB_Pos:99)	24.00	23.96	23.96	23.40	23.17	23.32
	50 (RB_Pos:0)	22.90	23.07	23.07	21.95	22.14	22.11
	50 (RB_Pos:25)	22.96	23.14	23.06	21.97	22.16	22.13
	50 (RB_Pos:50)	23.00	23.02	22.93	22.09	22.10	22.06
	100 (RB_Pos:0)	23.03	23.07	23.01	22.06	22.14	22.06

Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	37825	38000	38175	37825	38000	38175
15MHz	1 (RB_Pos:0)	23.87	24.10	24.10	23.33	23.26	23.48
	1 (RB_Pos:38)	23.95	24.13	24.09	23.40	23.30	23.51
	1 (RB_Pos:74)	23.80	24.02	23.95	23.40	23.17	23.32
	36 (RB_Pos:0)	22.88	23.09	22.99	21.95	22.14	22.11
	36 (RB_Pos:20)	22.93	23.13	23.00	21.97	22.16	22.13
	36 (RB_Pos:39)	22.90	23.04	22.95	22.09	22.10	22.06
	75 (RB_Pos:0)	22.92	23.10	22.96	22.06	22.14	22.06
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	37800	38000	38200	37800	38000	38200
10MHz	1 (RB_Pos:0)	23.85	24.11	24.00	23.10	23.51	23.35
	1 (RB_Pos:25)	23.88	24.07	24.04	23.19	23.52	23.36
	1 (RB_Pos:49)	23.87	24.03	23.92	23.15	23.47	23.31
	25 (RB_Pos:0)	22.92	23.09	22.99	21.96	22.15	22.08
	25 (RB_Pos:12)	22.97	23.13	23.03	22.01	22.16	22.05
	25 (RB_Pos:25)	22.94	23.09	22.93	21.95	22.12	22.02
	50 (RB_Pos:0)	22.89	23.07	22.95	21.92	22.12	22.05
Bandwidth (MHz)	RB Set	Power (dBm)					
		QPSK			16QAM		
	Channel	26705	26865	27025	26705	26865	27025
5MHz	1 (RB_Pos:0)	23.91	24.10	23.95	23.12	23.40	23.34
	1 (RB_Pos:13)	24.00	24.17	24.05	23.39	23.48	23.43
	1 (RB_Pos:24)	23.91	24.07	23.94	23.34	23.33	23.32
	12 (RB_Pos:0)	22.92	23.09	22.95	22.04	22.15	22.06
	12 (RB_Pos:6)	23.00	23.13	22.98	22.07	22.16	22.11
	12 (RB_Pos:13)	22.97	23.13	22.95	22.05	22.19	22.08
	25 (RB_Pos:0)	22.96	23.11	22.93	21.95	22.14	21.98

TDD LTE Band 41										
Bandwidth (MHz)	RB Set	Power (dBm)								
		QPSK					16QAM			
	Channel	39750	40185	40620	41055	41490	39750	40185	40620	41055	41490
20MHz	1 (RB_Pos:0)	24.06	24.25	24.78	24.78	25.67	24.17	24.37	24.69	24.99	25.66
	1 (RB_Pos:50)	24.16	24.17	24.47	24.36	24.61	24.15	24.17	24.72	24.42	24.76
	1 (RB_Pos:99)	24.11	24.13	24.28	24.55	24.32	24.13	24.34	24.45	24.60	24.53
	50 (RB_Pos:0)	24.01	24.27	24.05	24.47	24.21	24.16	24.21	24.27	24.52	24.40
	50 (RB_Pos:25)	24.17	24.17	24.06	24.42	24.23	24.15	24.28	24.14	24.60	24.42
	50 (RB_Pos:50)	24.15	24.10	24.09	24.37	24.45	24.20	24.07	24.17	24.36	24.52
	100 (RB_Pos:0)	24.16	24.10	24.02	24.31	24.08	24.17	24.08	24.13	24.50	24.15
Bandwidth (MHz)	RB Set	Power (dBm)								
		QPSK					16QAM			
	Channel	39725	40160	40620	41080	41515	39725	40160	40620	41080	41515
15MHz	1 (RB_Pos:0)	24.27	24.43	24.53	24.68	25.61	24.29	24.49	24.88	25.00	25.70
	1 (RB_Pos:50)	24.07	24.04	24.54	24.42	24.65	24.26	24.21	24.66	24.50	24.70
	1 (RB_Pos:99)	24.06	24.18	24.16	24.58	24.36	24.25	24.25	24.35	24.74	24.55
	50 (RB_Pos:0)	24.03	24.23	24.05	24.49	24.28	24.21	24.36	24.21	24.39	24.48
	50 (RB_Pos:25)	24.02	24.31	24.09	24.31	24.28	24.17	24.46	24.10	24.56	24.40
	50 (RB_Pos:50)	24.19	24.19	24.15	24.32	24.39	24.15	24.16	24.03	24.55	24.58
	100 (RB_Pos:0)	24.17	24.07	24.11	24.23	24.10	24.10	24.29	24.17	24.32	24.29
Bandwidth (MHz)	RB Set	Power (dBm)								
		QPSK					16QAM			
	Channel	39700	40135	40620	41105	41540	39700	40135	40620	41105	41540
10MHz	1 (RB_Pos:0)	24.05	24.31	24.57	24.67	25.68	24.24	24.37	24.67	24.77	25.73
	1 (RB_Pos:50)	24.13	24.07	24.60	24.52	24.68	24.24	24.29	24.53	24.46	24.80
	1 (RB_Pos:99)	24.18	24.27	24.21	24.49	24.40	24.1	24.3	24.2	24.76	24.50

							5	4	9		
	50 (RB_Pos:0)	24.29	24.09	24.19	24.29	24.30	24.26	24.31	24.08	24.52	24.40
	50 (RB_Pos:25)	24.31	24.21	24.14	24.42	24.42	24.15	24.26	24.24	24.43	24.40
	50 (RB_Pos:50)	24.06	24.11	24.01	24.32	24.55	24.04	24.25	24.19	24.31	24.50
	100 (RB_Pos:0)	24.56	24.20	24.13	24.43	24.07	24.15	24.23	24.34	24.39	24.23
Bandwidth (MHz)	RB Set	Power (dBm)									
		QPSK					16QAM				
	Channel	39725	40160	40620	41080	41515	39725	40160	40620	41080	41515
5MHz	1 (RB_Pos:0)	24.23	24.27	24.39	24.68	25.55	24.23	24.47	24.79	25.00	25.69
	1 (RB_Pos:50)	24.19	24.13	24.28	24.09	24.49	24.21	24.22	24.61	24.52	24.79
	1 (RB_Pos:99)	24.03	24.04	24.15	24.44	24.28	24.12	24.29	24.30	24.60	24.55
	50 (RB_Pos:0)	24.11	24.15	24.09	24.20	24.11	24.21	24.21	24.10	24.47	24.47
	50 (RB_Pos:25)	24.12	24.11	24.25	24.23	24.25	24.04	24.37	24.26	24.38	24.39
	50 (RB_Pos:50)	24.28	24.10	24.23	24.09	24.34	24.20	24.17	24.28	24.38	24.53
	100 (RB_Pos:0)	24.25	24.13	24.25	24.09	24.12	24.18	24.30	24.10	24.34	24.16

TDD LTE Band 41											
Bandwidth (MHz)	RB Set	Power (dBm)									
		QPSK					16QAM				
	Channel	39750	40185	40620	41055	41490	39750	40185	40620	41055	41490
20MHz	1 (RB_Pos:0)	25.88	26.06	26.05	26.05	26.45	25.14	25.32	25.32	25.33	26.12
	1 (RB_Pos:50)	25.96	26.08	26.13	26.17	26.02	25.18	25.22	25.31	25.34	25.27
	1 (RB_Pos:99)	26.01	25.99	25.95	25.92	26.05	25.28	25.22	25.21	25.11	25.36
	50 (RB_Pos:0)	24.86	25.13	25.13	25.06	24.78	23.78	24.25	24.21	24.11	23.96
	50 (RB_Pos:25)	24.83	25.08	25.14	25.09	24.89	23.83	24.20	24.23	24.13	24.06
	50 (RB_Pos:50)	24.95	24.99	24.98	24.89	24.88	23.88	24.00	24.14	24.10	24.06
	100 (RB_Pos:0)	24.96	25.11	25.06	25.07	24.75	23.93	24.20	24.21	24.20	23.99

Bandwidth (MHz)	RB Set	Power (dBm)									
		QPSK					16QAM				
	Channel	39725	40160	40620	41080	41515	39725	40160	40620	41080	41515
15MHz	1 (RB_Pos:0)	25.88	25.96	26.09	25.91	25.74	25.21	25.20	25.57	25.17	24.96
	1 (RB_Pos:50)	25.95	26.16	26.14	26.01	26.05	25.21	25.31	25.59	25.29	25.23
	1 (RB_Pos:99)	25.88	26.00	26.00	25.85	25.91	24.87	25.06	25.57	25.16	25.10
	50 (RB_Pos:0)	24.84	25.06	25.08	25.04	24.75	23.88	24.10	24.18	24.16	23.97
	50 (RB_Pos:25)	24.86	25.04	25.14	24.99	25.00	23.92	24.12	24.20	24.15	24.13
	50 (RB_Pos:50)	24.78	24.87	25.05	24.87	24.97	23.89	24.16	24.13	24.03	24.06
	100 (RB_Pos:0)	24.79	24.92	25.08	24.99	24.87	23.84	24.10	24.20	24.26	23.98
Bandwidth (MHz)	RB Set	Power (dBm)									
		QPSK					16QAM				
	Channel	39700	40135	40620	41105	41540	39700	40135	40620	41105	41540
10MHz	1 (RB_Pos:0)	25.88	25.94	26.09	26.03	26.45	25.17	25.19	25.48	25.20	25.88
	1 (RB_Pos:50)	25.86	26.09	26.06	26.08	25.99	25.16	25.25	25.51	25.32	25.48
	1 (RB_Pos:99)	25.89	25.91	26.06	25.83	26.48	25.19	25.17	25.45	25.15	25.93
	50 (RB_Pos:0)	24.86	25.01	25.13	25.05	25.19	23.85	24.17	24.18	24.23	24.29
	50 (RB_Pos:25)	24.86	25.12	25.13	25.03	25.09	23.86	24.18	24.19	24.13	24.09
	50 (RB_Pos:50)	24.86	24.95	25.04	24.85	25.17	23.85	24.02	24.18	24.12	24.31
	100 (RB_Pos:0)	24.82	24.98	25.08	25.04	25.13	23.84	24.25	24.17	24.15	24.35
Bandwidth (MHz)	RB Set	Power (dBm)									
		QPSK					16QAM				
	Channel	39725	40160	40620	41080	41515	39725	40160	40620	41080	41515
5MHz	1 (RB_Pos:0)	25.91	25.92	26.12	26.07	26.00	25.16	25.27	25.52	25.22	25.47
	1 (RB_Pos:50)	26.03	26.03	26.11	25.98	26.03	25.26	25.27	25.52	25.32	25.45
	1 (RB_Pos:99)	25.89	25.95	26.08	25.85	25.98	25.15	25.10	25.40	25.09	25.38
	50 (RB_Pos:0)	24.85	25.02	25.15	25.13	24.92	23.7	24.0	24.1	24.17	24.19

							5	9	2		
	50 (RB_Pos:25)	24.89	25.10	25.12	25.11	24.98	23.78	24.13	24.20	24.09	24.19
	50 (RB_Pos:50)	24.88	24.93	25.11	24.98	25.00	23.93	24.17	24.16	24.17	24.16
	100 (RB_Pos:0)	24.87	25.11	25.06	25.07	24.98	23.86	24.09	24.19	24.17	24.13

8.5 WIFI

2.4G WIFI

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)
2.4 (2.4~2.4835)	802.11b	1	2412	18.30
		6	2437	18.79
		11	2462	18.62
	802.11g	1	2412	16.89
		6	2437	17.21
		11	2462	17.13
	802.11n(HT20)	1	2412	16.27
		6	2437	16.55
		11	2462	16.54

5G WIFI

Band (GHz)	Mode	Channel	Freq. (MHz)	Conducted Power (dBm)
5.2 (5.15~5.25)	802.11a	36	5180	16.51
		44	5220	16.53
		48	5240	16.52
	802.11n(HT20)	36	5180	16.44
		44	5220	16.43
		48	5240	16.57
	802.11n(HT40)	38	5190	16.75
		46	5230	16.72
	802.11ac(VHT20)	36	5180	16.43
		44	5220	16.41
		48	5240	16.42
	802.11ac(VHT40)	38	5190	16.71
		46	5230	16.70
	802.11ac(VHT80)	42	5210	16.39
5.3 (5.25~5.35)	802.11a	52	5260	16.54
		60	5300	16.42
		64	5320	16.32
	802.11n(HT20)	52	5260	16.42
		60	5300	16.31
		64	5320	16.26
	802.11n(HT40)	54	5270	16.61
		62	5310	16.41
	802.11ac(VHT20)	52	5260	16.41
		60	5300	16.32
		64	5320	16.23
	802.11ac(VHT40)	54	5270	16.65

		62	5310	16.44
	802.11ac(VHT80)	58	5290	16.05
5.6 (5.47~5.725)	802.11a	100	5500	16.65
		116	5580	16.70
		140	5700	16.41
	802.11n(HT20)	100	5500	16.53
		116	5580	16.58
		140	5700	16.31
	802.11n(HT40)	102	5510	16.61
		118	5590	16.50
		134	5670	16.26
	802.11ac(VHT20)	100	5500	16.53
		116	5580	16.58
		140	5700	16.32
	802.11ac(VHT40)	102	5510	16.61
		118	5590	16.45
		134	5670	16.25
	802.11ac(VHT80)	106	5530	16.16
		122	5610	16.02
5.8 (5.725~5.850)	802.11a	149	5745	16.27
		157	5785	16.27
		165	5825	16.37
	802.11n(HT20)	149	5745	16.17
		157	5785	16.19
		165	5825	16.30
	802.11n(HT40)	151	5755	16.10
		159	5795	16.30
	802.11ac(VHT20)	149	5745	16.21
		157	5785	16.18
		165	5825	16.30
	802.11ac(VHT40)	151	5755	16.11
		159	5795	16.25
	802.11ac(VHT80)	155	5775	15.71

8.6 Bluetooth

Mode	GFSK			π/4-DQPSK		
Channel	0	39	78	0	39	78
Frequency (MHz)	2402	2441	2480	2402	2441	2480
Conducted Power (dBm)	10.38	10.09	9.83	9.83	9.52	9.43
Mode	8-DPSK			/		
Channel	0	39	78	/	/	/
Frequency (MHz)	2402	2441	2480	/	/	/
Conducted Power (dBm)	9.97	9.75	9.66	/	/	/
Mode	BLE (1Mbps)			BLE (2Mbps)		
Channel	0	19	39	0	19	39
Frequency (MHz)	2402	2440	2480	2402	2440	2480
Conducted Power (dBm)	4.47	4.53	5.80	4.61	4.54	5.75

9 LOW-POWER EXEMPTION

9.1 Tune-up Power

Mode	Tune-up Power(dBm)	
	UAT	DAT
GSM/GPRS 850	33.50	33.50
EGPRS 850	27.50	27.50
GSM/GPRS 1900	/	30.50
EGPRS 1900	/	27.00
WCDMA Band2	24.00	24.00
WCDMA Band4	24.00	24.00
WCDMA Band5	25.00	25.00
HSPA	24.00	24.00
CDMA BC0	25.00	25.00
1XEvDo	25.00	25.00
LTE Band2	24.50	24.50
LTE Band4	24.50	24.50
LTE Band5	25.00	25.00
LTE Band7	24.00	24.00
LTE Band26	25.00	25.00
LTE Band38(Power Class 3)	24.50	24.50
LTE Band41(Power Class 3)	26.00	26.00
LTE Band41(Power Class 2)	26.50	26.50
Note：For GSM 1900 band this product only support DAT(Down Antenna).		

Mode	Tune-up Power(dBm)
2.4G WLAN 802.11b	19.00
2.4G WLAN 802.11g	18.00
2.4G WLAN 802.11n20	18.00
5G WLAN 802.11a	17.00
5G WLAN 802.11n20	17.00
5G WLAN 802.11n40	17.00
5G WLAN 802.11ac20	17.00
5G WLAN 802.11ac40	17.00
5G WLAN 802.11ac80	16.50
Note：According to ANSI C63.19 2011, for 2.4GHz or 5GHz WLAN RF emissions testing exemption shall be applied to an RF air interface technology in a device whose peak antenna input power, averaged over intervals ≤50 μs20, is ≤23 dBm.	

9.2 RF Emissions Lower Power Exemption

Mode	Antenna	Tune-up Limit power(dBm)	MIF Values (dB)	Power + MIF (dB)	C63.19 Test Required?
GSM 850	UAT	3.63	37.13	3.63	**Yes**
	DAT	3.63	37.13	3.63	**Yes**
EGPRS 850	UAT	3.75	31.25	3.75	Yes[2]
	DAT	3.75	31.25	3.75	Yes[2]
GSM 1900	DAT	3.63	34.13	3.63	**Yes**
EGPRS 1900	DAT	3.75	30.75	3.75	Yes[2]
WCDMA Band2	UAT	-25.43	-1.43	-25.43	No
	DAT	-25.43	-1.43	-25.43	No
WCDMA Band4	UAT	-25.43	-1.43	-25.43	No
	DAT	-25.43	-1.43	-25.43	No
WCDMA Band5	UAT	-25.43	-0.43	-25.43	No
	DAT	-25.43	-0.43	-25.43	No
HSPA	UAT	-20.39	3.61	-20.39	No
	DAT	-20.39	3.61	-20.39	No
CDMA BC0 Full Frame Rate	UAT	-19.71	5.29	-19.71	No
	DAT	-19.71	5.29	-19.71	No
CDMA BC0 1/8th Frame Rate	UAT	3.26	28.26	3.26	**Yes**
	DAT	3.26	28.26	3.26	**Yes**
1XEvDo	UAT	-17.67	7.33	-17.67	No
	DAT	-17.67	7.33	-17.67	No
LTE Band2	UAT	-9.76	14.74	-9.76	No
	DAT	-9.76	14.74	-9.76	No
LTE Band4	UAT	-9.76	14.74	-9.76	No
	DAT	-9.76	14.74	-9.76	No
LTE Band5	UAT	-9.76	15.24	-9.76	No
	DAT	-9.76	15.24	-9.76	No
LTE Band7	UAT	-9.76	14.24	-9.76	No
	DAT	-9.76	14.24	-9.76	No
LTE Band26	UAT	-9.76	15.24	-9.76	No
	DAT	-9.76	15.24	-9.76	No
LTE Band38(Power Class 3)	UAT	-1.62	22.88	-1.62	**Yes**
	DAT	-1.62	22.88	-1.62	**Yes**
LTE Band41(Power Class 3)	UAT	-1.62	24.38	-1.62	**Yes**
	DAT	-1.62	24.38	-1.62	**Yes**
LTE Band41(Power Class 2)	UAT	-1.62	24.88	-1.62	**Yes**
	DAT	-1.62	24.88	-1.62	**Yes**

Note1：According to ANSI C63.19 2011-version, for the 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.

Note2：EGPRS data modes is not necessary due the GSM Voice mode is the worst case.

Note3：HAC RF rating is M4 for the air interface which meets the low power exemption.

10 HAC RF Emission Test Results

10.1 E-Filled Emission Test Results

Band	Mode	Antenna	Ch.	Freq.	Peak E-Field	M-Rating	Meas. No.
GSM 850	Voice	UAT	128	824.20	38.26	M4	1#
			190	836.60	40.17	M3	2#
			251	848.80	41.27	M3	3#
GSM 850	Voice	DAT	128	824.20	31.42	M4	4#
			190	836.60	32.36	M4	5#
			251	848.80	34.29	M4	6#
GSM 1900	Voice	DAT	512	1850.20	30.02	M3	7#
			661	1880.00	29.87	M4	8#
			810	1909.80	29.68	M4	9#
CDMA BC0	1xRTT, RC1 SO3	UAT	1013	824.70	36.54	M4	10#
			384	836.52	38.08	M4	11#
			777	848.31	39.16	M4	12#
CDMA BC0	1xRTT, RC1 SO3	DAT	1013	824.70	27.93	M4	13#
			384	836.52	28.67	M4	14#
			777	848.31	30.29	M4	15#
LTE Band 38	QPSK	UAT	37850	2580.00	27.69	M4	16#
			38000	2595.00	27.62	M4	17#
			38150	2610.00	27.51	M4	18#
LTE Band 38	QPSK	DAT	37850	2580.00	21.01	M4	19#
			38000	2595.00	20.69	M4	20#
			38150	2610.00	20.77	M4	21#
LTE Band 41 (power class3)	QPSK	UAT	39750	2506.00	27.48	M4	22#
			40185	2549.50	27.98	M4	23#
			40620	2593.00	27.38	M4	24#
			41055	2636.50	27.26	M4	25#
			41490	2680.00	26.95	M4	26#
LTE Band 41 (power class3)	QPSK	DAT	39750	2506.00	26.63	M4	27#
			40185	2549.50	28.16	M4	28#
			40620	2593.00	27.48	M4	29#
			41055	2636.50	27.32	M4	30#
			41490	2680.00	26.57	M4	31#
LTE Band 41 (power class2)	QPSK	UAT	39750	2506.00	20.67	M4	32#
			40185	2549.50	22.47	M4	33#
			40620	2593.00	20.50	M4	34#
			41055	2636.50	20.68	M4	35#
			41490	2680.00	14.07	M4	36#
LTE Band 41 (power class2)	QPSK	DAT	39750	2506.00	20.15	M4	37#
			40185	2549.50	20.39	M4	38#
			40620	2593.00	20.79	M4	39#
			41055	2636.50	20.72	M4	40#
			41490	2680.00	16.73	M4	41#

11 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
800-950MHz Dipole	SATIMO	SIDB835	SN 18/12 DHA41	2019/11/16	2020/11/15
1700-2000MHz Dipole	SATIMO	SIDB1900	SN 18/12 DHB46	2019/11/16	2020/11/15
2100-2600MHZ Dipole	SATIMO	SIDB2450	SN 18/12 DHB48	2019/11/16	2020/11/15
E-Field Probe	SATIMO	SCE	SN 24/13 EPH41	2019/11/16	2020/11/15
Antenna	SATIMO	ANTA3	SN 17/13 ZNTA45	N/A	N/A
MultiMeter	Keithley	MultiMeter 2000	4024022	2019/06/17	2020/06/16
Signal Generator	R&S	SMBV100A	260592	2019/06/13	2020/06/12
Power Meter	Agilent	NRVD-B2	7250BJ-0112/2011	2019/10/30	2020/10/29
Power Sensor	Agilent	NRV-Z4	100381	2019/10/30	2020/10/29
Power Sensor	Agilent	NRV-Z2	100211	2019/10/30	2020/10/29
Power Amplifier	SATIMO	8960-E5515C	MY50260493	2019/06/13	2020/06/13
Wireless Communication Test Set	Agilent	CMW 500	138884	2019/06/13	2020/06/13
Directional coupler	AA-MCS	AAMCS-UDC	000272	N/A	N/A

ANNEX A HAC TEST RESULT OF SYSTEM VERIFICAION

E-Field System Check Data(835MHz)

Experimental conditions.

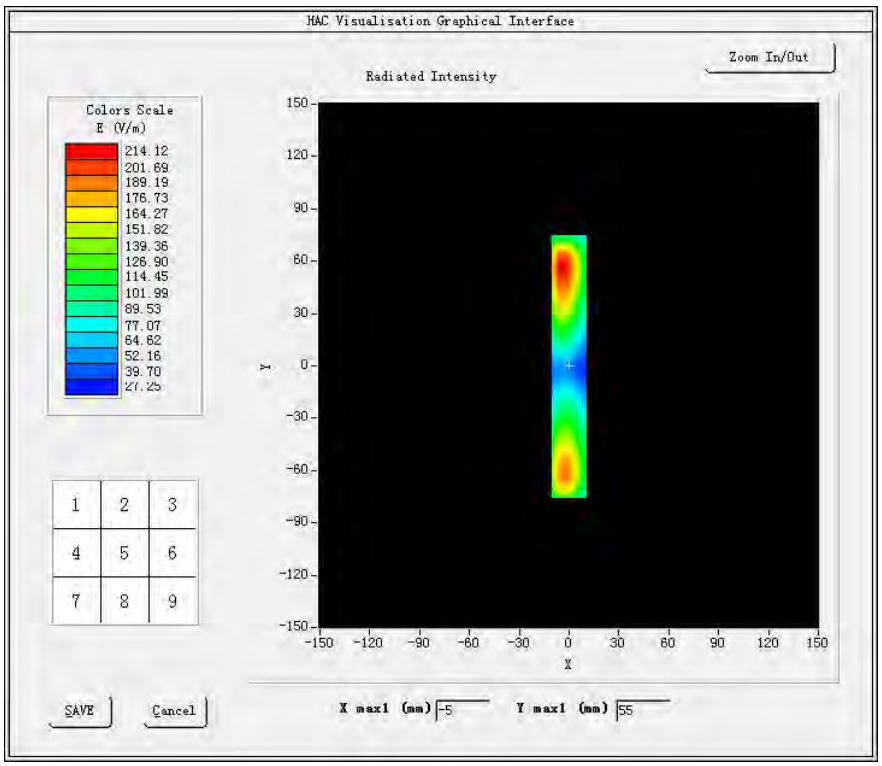
Grid size (mm x mm)	20.0, 150.0
Step (mm)	5
Band	835MHz
Channel	
Signal	CW
Date of measurement	31/5/2020

HAC Measurement Results

Frequency (MHz): 835.000000

Maximum value of total field = 214.12 V/m

SURFACE E-Field



E-Filed System Check Data (1900MHz)

Experimental conditions

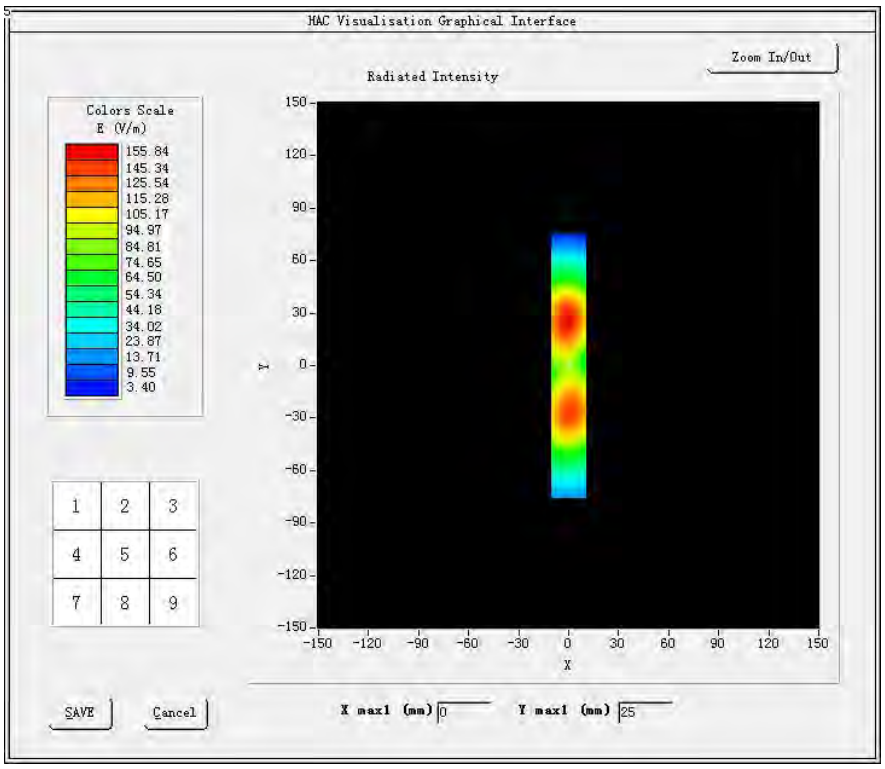
Grid size (mm x mm)	20.0, 150.0
Step (mm)	5
Band	1900 MHz
Channel	
Signal	CW
Date of measurement	28/5/2020

HAC Measurement Results

Frequency (MHz): 1900.000000

Maximum value of total field = 155.84V/m

SURFACE HAC



E-Filed System Check Data (2450MHz)

Experimental conditions

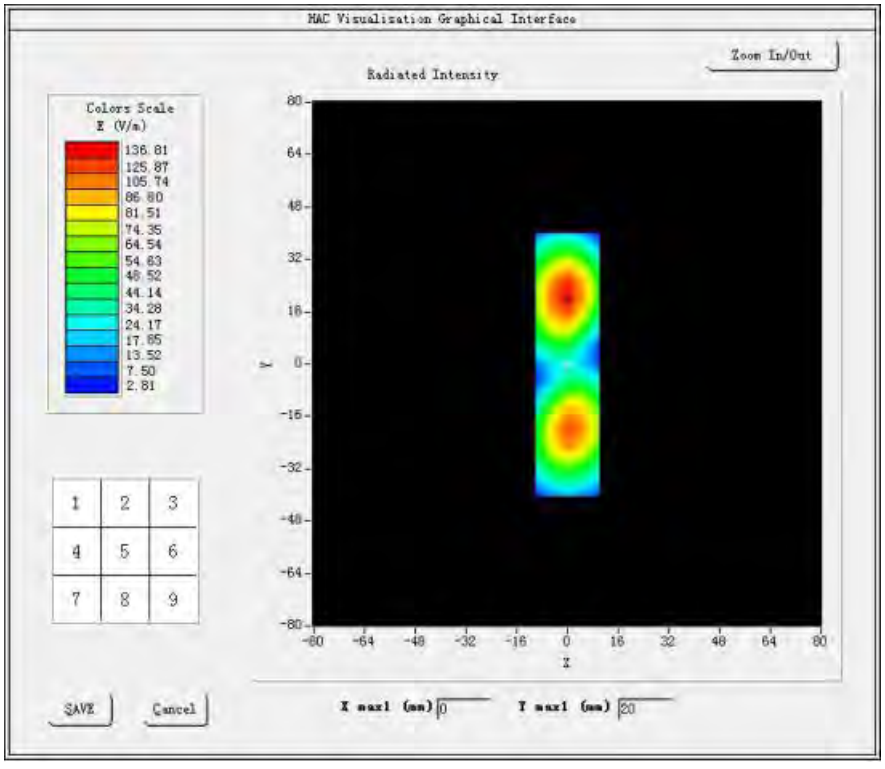
Grid size (mm x mm)	20.0, 150.0
Step (mm)	5
Band	2450 MHz
Channel	
Signal	CW
Date of measurement	30/5/2020

HAC Measurement Results

Frequency (MHz): 2450.000000

Maximum value of total field = 136.81V/m

SURFACE HAC



ANNEX B HAC RF MEASUREMENT RESULT

MEASUREMENT 1

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Low
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

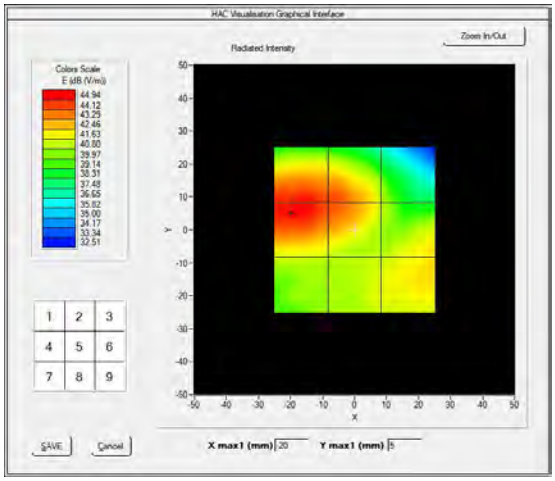
Lower Band (Channel 128):

Frequency (MHz): 824.200000

Maximum value of total field = 38.26 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 38.83	**Grid 2: 38.21**	Grid 3: 34.28
Grid 4: 39.25	**Grid 5: 38.26**	Grid 6: 36.23
Grid 7: 35.30	Grid 8: 35.58	Grid 9: 36.27

MEASUREMENT 2

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Middle
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

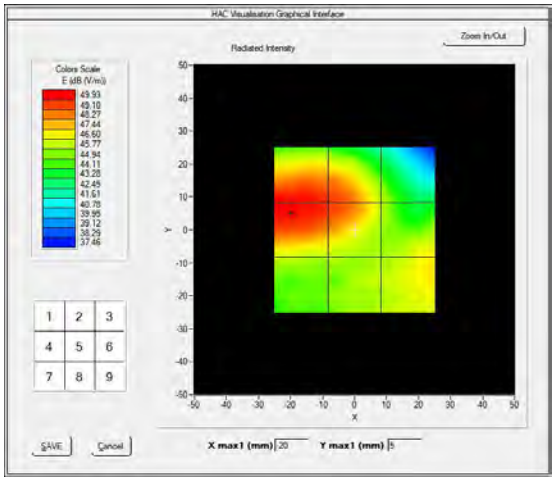
Middle Band (Channel 190):

Frequency (MHz): 836.600000

Maximum value of total field = 40.17 dB (V/m)

Hearing Aid Near-Field Category: M3

SURFACE HAC



E in dB (V/m)

Grid 1: 40.68	Grid 2: 40.03	Grid 3: 36.05
Grid 4: 40.94	Grid 5: 40.17	Grid 6: 37.54
Grid 7: 36.84	Grid 8: 36.76	Grid 9: 37.79

MEASUREMENT 3

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	High
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

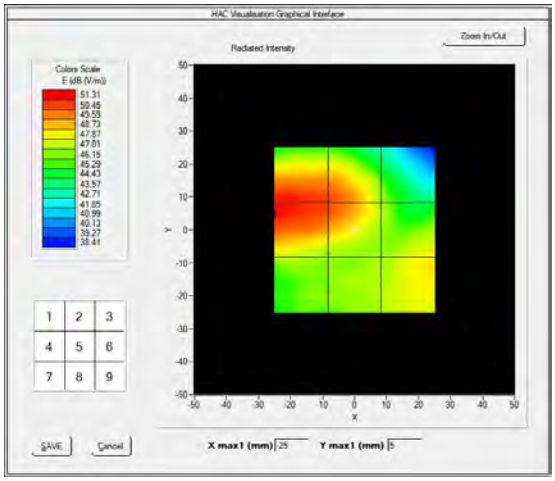
Higher Band (Channel 251):

Frequency (MHz): 848.800000

Maximum value of total field = 41.27 dB (V/m)

Hearing Aid Near-Field Category: M3

SURFACE HAC



E in dB (V/m)

Grid 1: 41.91	Grid 2: 41.23	Grid 3: 36.87
Grid 4: 42.25	Grid 5: 41.27	Grid 6: 38.68
Grid 7: 37.89	Grid 8: 37.91	Grid 9: 39.12

MEASUREMENT 4

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Low
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

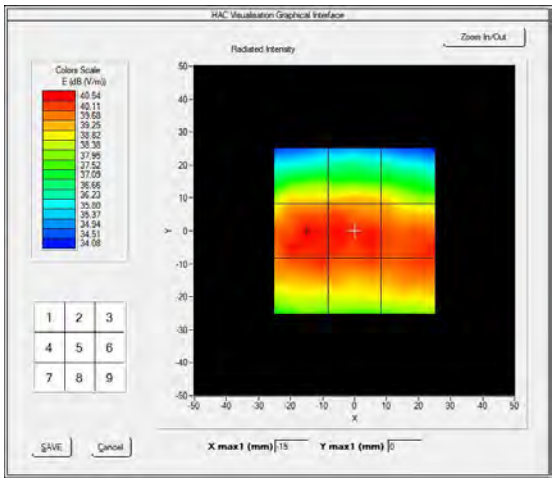
Lower Band (Channel 128):

Frequency (MHz): 824.200000

Maximum value of total field = 31.42 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 29.91	Grid 2: 30.10	Grid 3: 29.86
Grid 4: 31.47	Grid 5: 31.42	Grid 6: 31.33
Grid 7: 31.20	Grid 8: 31.17	Grid 9: 31.17

MEASUREMENT 5

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	Middle
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

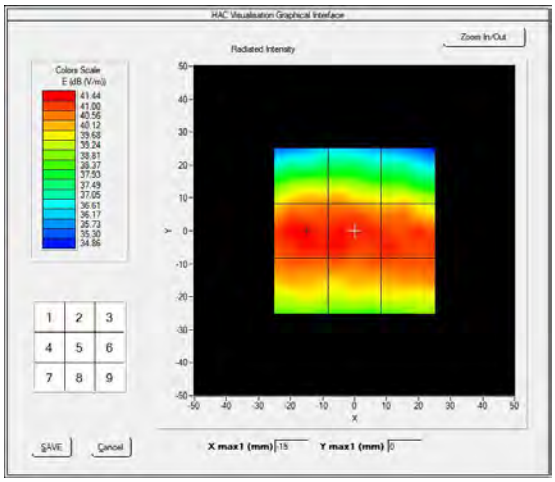
Middle Band (Channel 190):

Frequency (MHz): 836.600000

Maximum value of total field = 32.36 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 31.12	Grid 2: 31.22	Grid 3: 30.62
Grid 4: 32.44	Grid 5: 32.36	Grid 6: 32.23
Grid 7: 31.97	Grid 8: 32.02	Grid 9: 31.99

MEASUREMENT 6

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM850
Channel	High
Signal	GSM
Date of measurement	05/31/2020

HAC Measurement Results

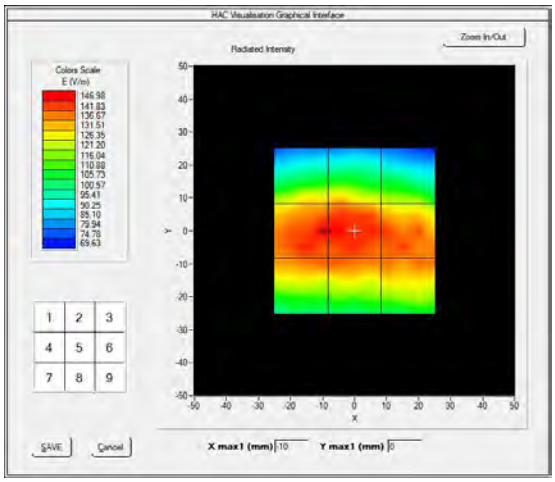
Higher Band (Channel 251):

Frequency (MHz): 848.800000

Maximum value of total field = 34.29 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 33.06	Grid 2: 33.25	Grid 3: 32.38
Grid 4: 34.29	Grid 5: 34.29	Grid 6: 34.03
Grid 7: 33.89	Grid 8: 33.88	Grid 9: 33.78

MEASUREMENT 7

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Low
Signal	GSM
Date of measurement	05/28/2020

HAC Measurement Results

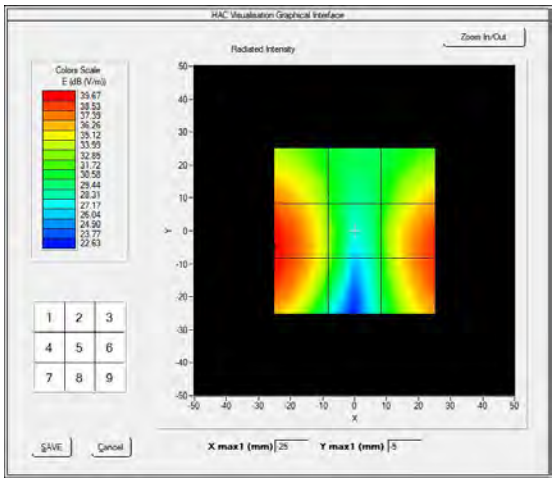
Lower Band (Channel 512):

Frequency (MHz): 1850.200000

Maximum value of total field = 30.02 dB (V/m)

Hearing Aid Near-Field Category: M3

SURFACE HAC



E in dB (V/m)

Grid 1: 28.00	Grid 2: 22.52	Grid 3: 27.34
Grid 4: 30.67	Grid 5: 23.51	Grid 6: 30.02
Grid 7: 30.65	Grid 8: 23.25	Grid 9: 29.81

MEASUREMENT 8

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	Middle
Signal	GSM
Date of measurement	05/28/2020

HAC Measurement Results

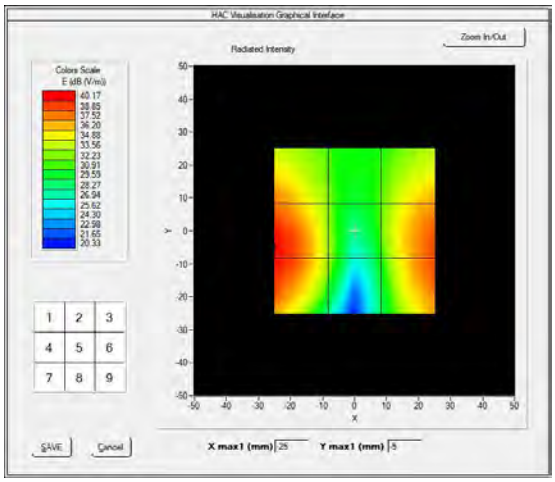
Middle Band (Channel 661):

Frequency (MHz): 1880.000000

Maximum value of total field = 29.87 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 28.54	Grid 2: 22.90	Grid 3: 27.44
Grid 4: 31.16	Grid 5: 23.20	Grid 6: 29.87
Grid 7: 30.99	Grid 8: 23.03	Grid 9: 29.73

MEASUREMENT 9

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	GSM1900
Channel	High
Signal	GSM
Date of measurement	05/28/2020

HAC Measurement Results

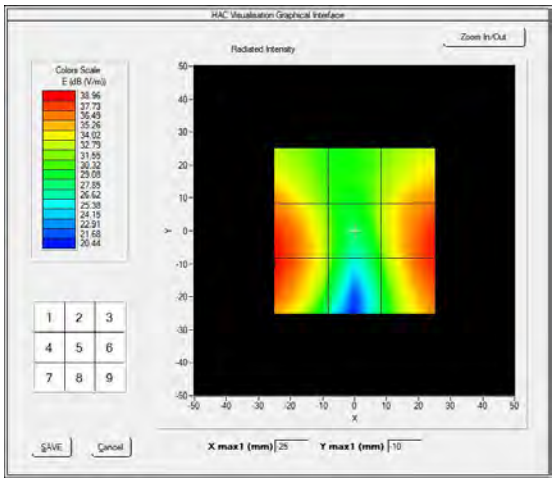
Higher Band (Channel 810):

Frequency (MHz): 1909.800000

Maximum value of total field = 29.68 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.00	Grid 2: 23.35	Grid 3: 27.26
Grid 4: 29.92	Grid 5: 23.80	Grid 6: 29.68
Grid 7: 29.99	Grid 8: 22.37	Grid 9: 29.44

MEASUREMENT 10

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Low
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

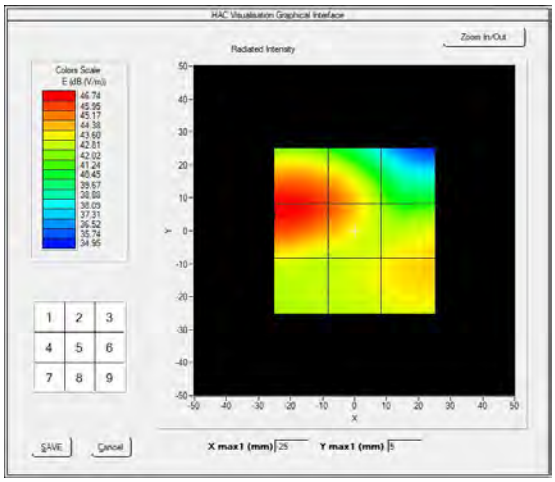
Lower Band (Channel 1013):

Frequency (MHz): 824.700000

Maximum value of total field = 36.54 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 37.53	Grid 2: 36.45	Grid 3: 32.43
Grid 4: 37.76	Grid 5: 36.54	Grid 6: 34.95
Grid 7: 34.32	Grid 8: 34.49	Grid 9: 35.08

MEASUREMENT 11

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Middle
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

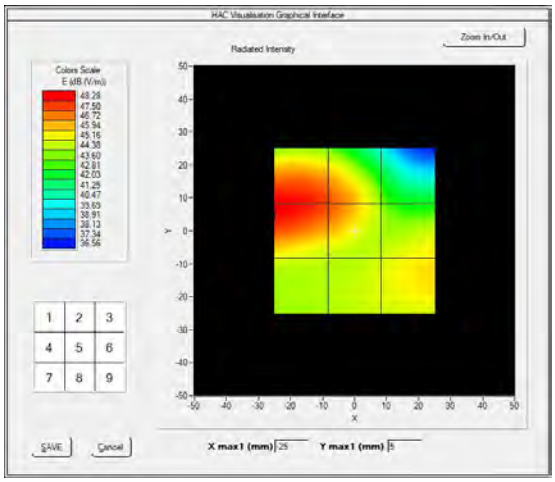
Middle Band (Channel 384):

Frequency (MHz): 836.520000

Maximum value of total field = 38.08 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 39.13	Grid 2: 38.03	Grid 3: 33.96
Grid 4: 39.31	Grid 5: 38.08	Grid 6: 36.29
Grid 7: 35.74	Grid 8: 35.72	Grid 9: 36.40

MEASUREMENT 12

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	High
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

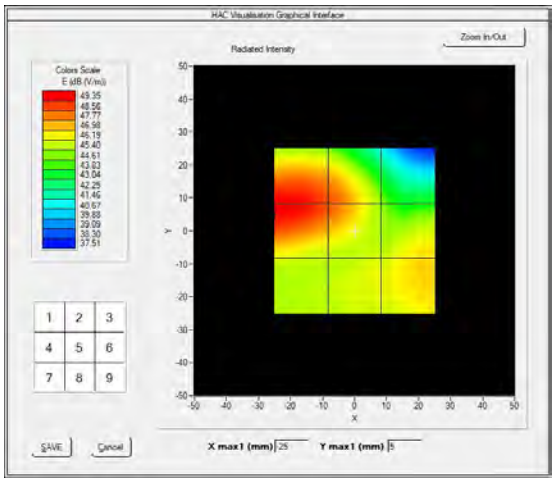
Higher Band (Channel 777):

Frequency (MHz): 848.310000

Maximum value of total field = 39.16 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 40.21	Grid 2: 39.13	Grid 3: 35.08
Grid 4: 40.39	Grid 5: 39.16	Grid 6: 37.50
Grid 7: 36.66	Grid 8: 36.86	Grid 9: 37.65

MEASUREMENT 13

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Low
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

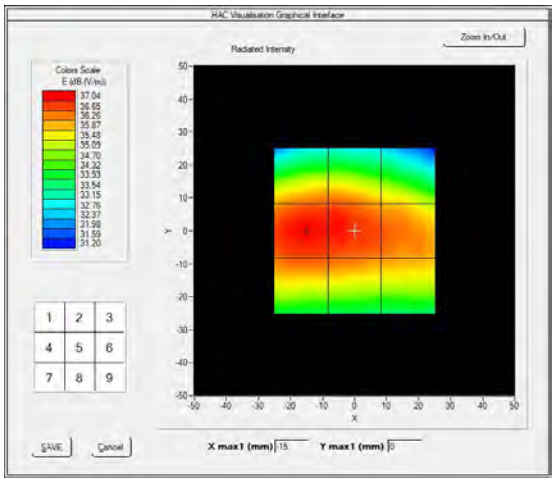
Lower Band (Channel 1013):

Frequency (MHz): 824.700000

Maximum value of total field = 27.93 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.19	Grid 2: 27.19	Grid 3: 26.43
Grid 4: 27.97	Grid 5: 27.93	Grid 6: 27.41
Grid 7: 27.51	Grid 8: 27.41	Grid 9: 27.08

MEASUREMENT 14

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	Middle
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

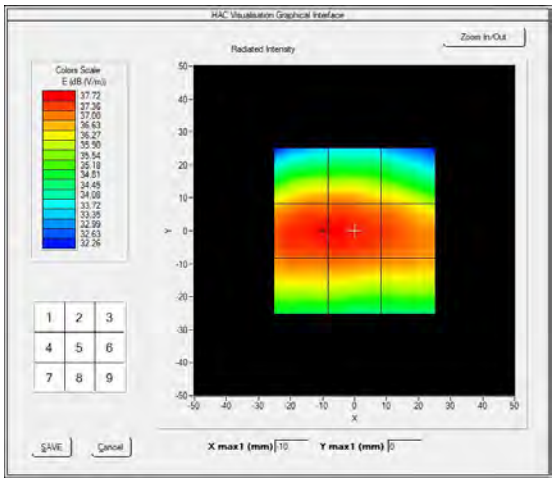
Middle Band (Channel 384):

Frequency (MHz): 836.520000

Maximum value of total field = 28.67 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.74	Grid 2: 27.82	Grid 3: 27.30
Grid 4: 28.67	Grid 5: 28.67	Grid 6: 28.33
Grid 7: 28.15	Grid 8: 28.19	Grid 9: 27.95

MEASUREMENT 15

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	BC0_US_Cellular
Channel	High
Signal	CDMA
Date of measurement	05/31/2020

HAC Measurement Results

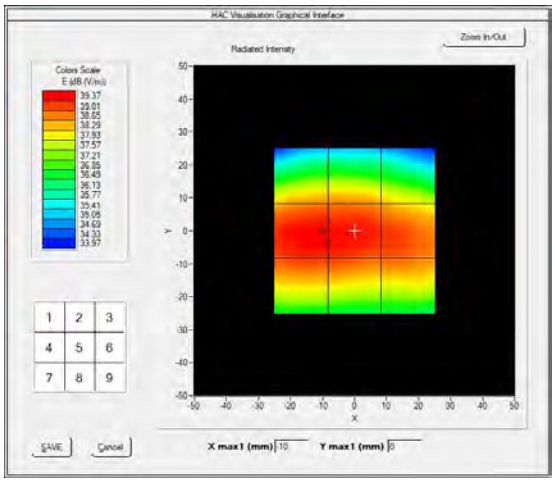
Higher Band (Channel 777):

Frequency (MHz): 848.310000

Maximum value of total field = 30.29 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 29.32	Grid 2: 29.35	Grid 3: 28.97
Grid 4: 30.35	Grid 5: 30.29	Grid 6: 30.04
Grid 7: 30.07	Grid 8: 30.02	Grid 9: 29.79

MEASUREMENT 16

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

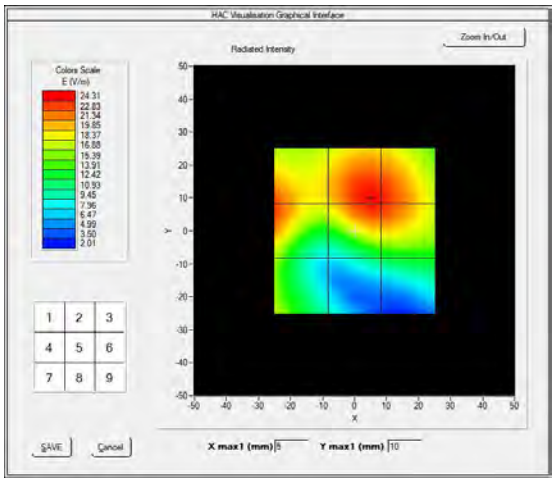
Lower Band (Channel 37850):

Frequency (MHz): 2580.000000

Maximum value of total field = 27.69 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 26.97	Grid 2: 27.72	Grid 3: 27.37
Grid 4: 27.26	Grid 5: 27.69	Grid 6: 27.36
Grid 7: 24.38	Grid 8: 21.58	Grid 9: 22.47

MEASUREMENT 17

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

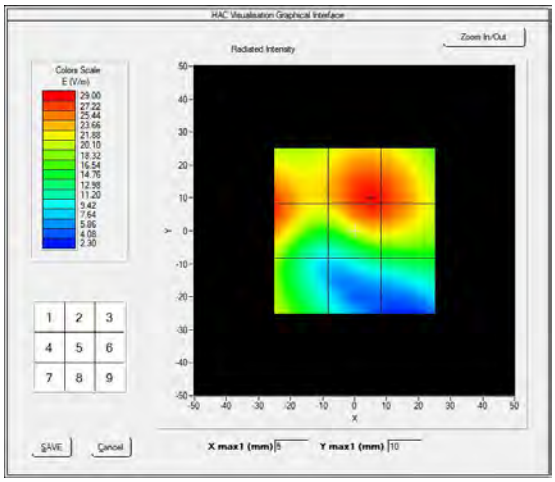
Middle Band (Channel 38000):

Frequency (MHz): 2595.000000

Maximum value of total field = 27.62 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.06	Grid 2: 27.65	Grid 3: 27.29
Grid 4: 27.29	Grid 5: 27.62	Grid 6: 27.28
Grid 7: 24.58	Grid 8: 21.35	Grid 9: 22.24

MEASUREMENT 18

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

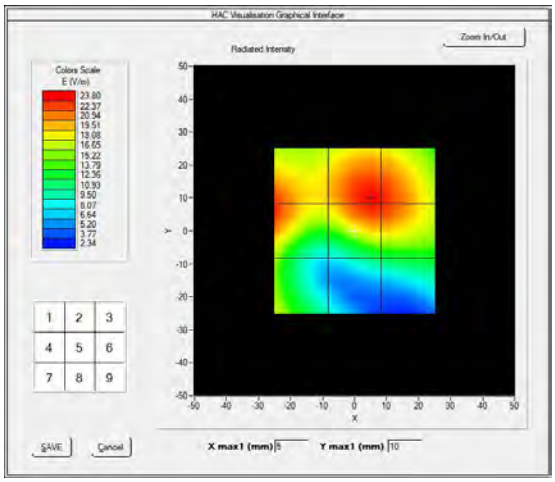
Higher Band (Channel 38150):

Frequency (MHz): 2610.000000

Maximum value of total field = 27.51 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.02	Grid 2: 27.53	Grid 3: 27.21
Grid 4: 27.24	Grid 5: 27.51	Grid 6: 27.20
Grid 7: 24.47	Grid 8: 21.49	Grid 9: 22.24

MEASUREMENT 19

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

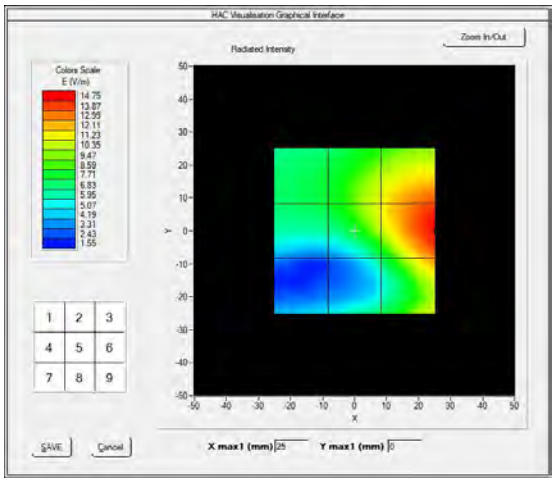
Lower Band (Channel 37850):

Frequency (MHz): 2580.000000

Maximum value of total field = 21.01 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 17.86	Grid 2: 20.91	Grid 3: 22.53
Grid 4: 17.79	Grid 5: 21.01	Grid 6: 23.38
Grid 7: 13.45	Grid 8: 17.42	Grid 9: 22.30

MEASUREMENT 20

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

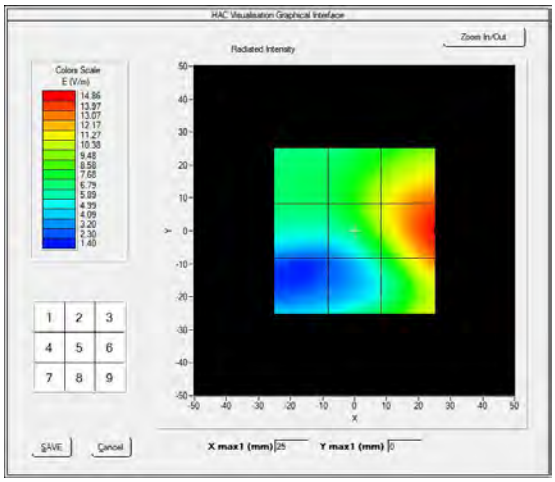
Middle Band (Channel 38000):

Frequency (MHz): 2595.000000

Maximum value of total field = 20.69 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 17.33	Grid 2: 20.53	Grid 3: 22.43
Grid 4: 17.23	Grid 5: 20.69	Grid 6: 23.44
Grid 7: 13.47	Grid 8: 17.53	Grid 9: 22.51

MEASUREMENT 21

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 38
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

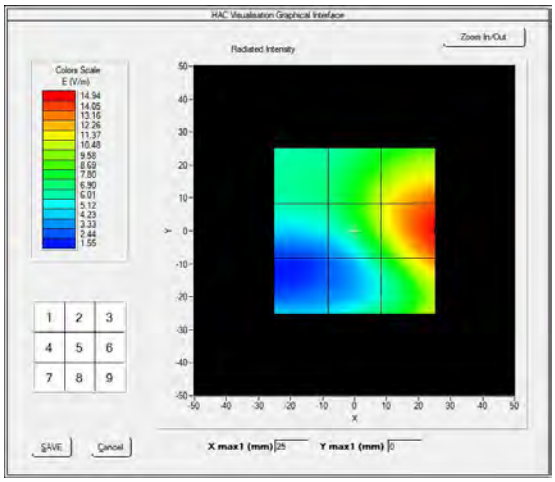
Higher Band (Channel 38150):

Frequency (MHz): 2610.000000

Maximum value of total field = 20.77 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 16.66	Grid 2: 20.52	Grid 3: 22.52
Grid 4: 16.47	Grid 5: 20.77	Grid 6: 23.49
Grid 7: 13.26	Grid 8: 17.78	Grid 9: 22.49

MEASUREMENT 22

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

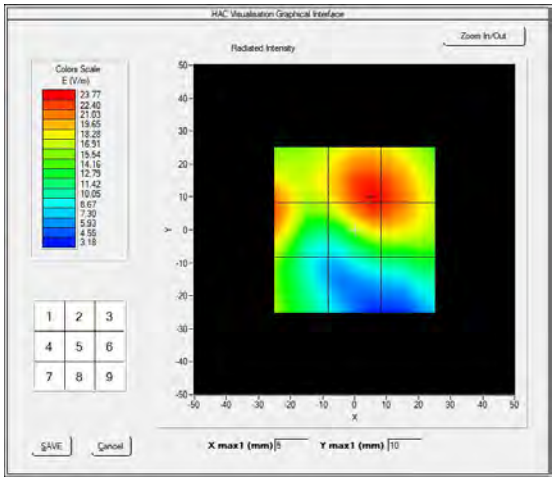
Lower Band (Channel 39750):

Frequency (MHz): 2506.000000

Maximum value of total field = 27.48 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 26.49	Grid 2: 27.53	Grid 3: 27.26
Grid 4: 26.84	Grid 5: 27.48	Grid 6: 27.23
Grid 7: 24.26	Grid 8: 21.69	Grid 9: 22.80

MEASUREMENT 23

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

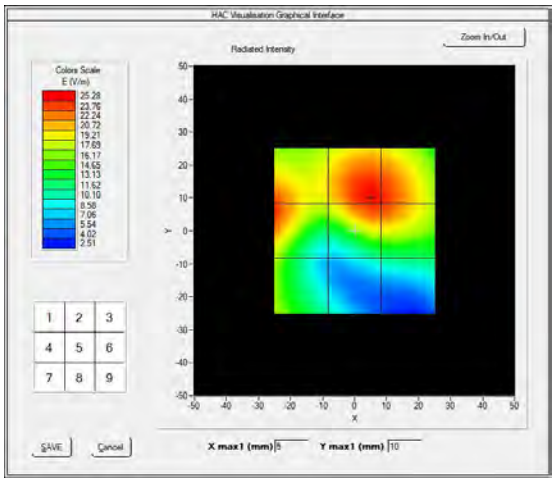
Lower Band (Channel 40185):

Frequency (MHz): 2549.500000

Maximum value of total field = 27.98 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.34	Grid 2: 28.08	Grid 3: 27.69
Grid 4: 27.71	Grid 5: 27.98	Grid 6: 27.65
Grid 7: 24.79	Grid 8: 20.86	Grid 9: 21.59

MEASUREMENT 24

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

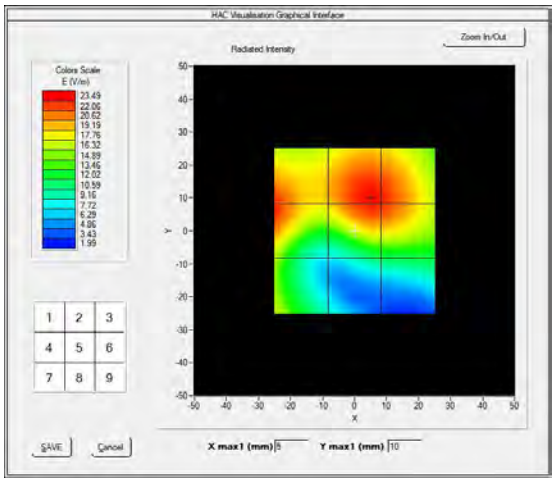
Middle Band (Channel 40620):

Frequency (MHz): 2593.000000

Maximum value of total field = 27.38 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 26.92	Grid 2: 27.42	Grid 3: 27.02
Grid 4: 27.15	Grid 5: 27.38	Grid 6: 27.00
Grid 7: 24.21	Grid 8: 20.99	Grid 9: 21.56

MEASUREMENT 25

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

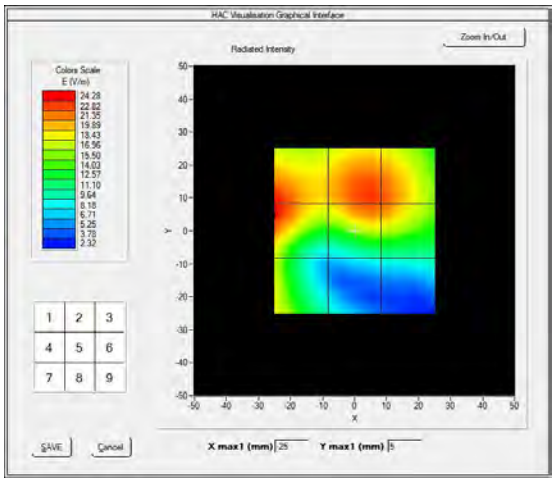
Higher Band (Channel 41055):

Frequency (MHz): 2636.500000

Maximum value of total field = 27.26 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.56	Grid 2: 27.35	Grid 3: 26.89
Grid 4: 27.77	Grid 5: 27.26	Grid 6: 26.82
Grid 7: 25.15	Grid 8: 19.32	Grid 9: 20.03

MEASUREMENT 26

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

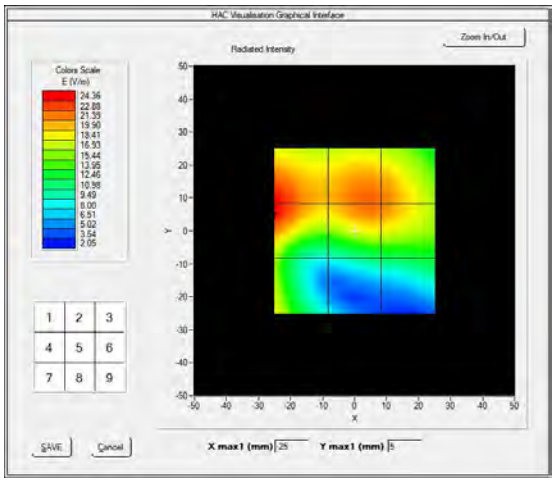
Higher Band (Channel 41490):

Frequency (MHz): 2680.000000

Maximum value of total field = 26.95 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.72	Grid 2: 26.95	Grid 3: 26.54
Grid 4: 27.84	Grid 5: 26.95	Grid 6: 26.55
Grid 7: 25.12	Grid 8: 21.24	Grid 9: 22.16

MEASUREMENT 27

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

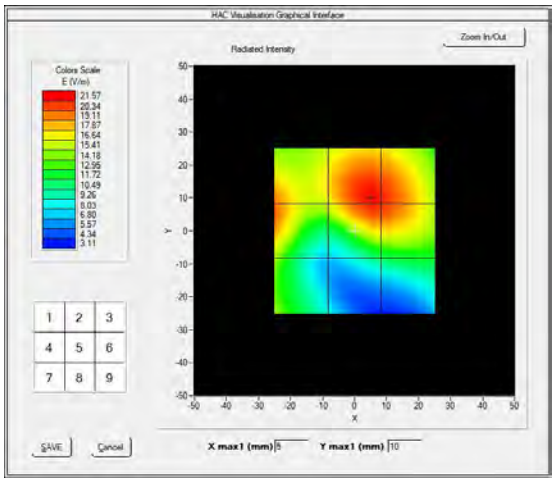
Lower Band (Channel 39750):

Frequency (MHz): 2506.000000

Maximum value of total field = 26.63 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 25.60	Grid 2: 26.68	Grid 3: 26.30
Grid 4: 25.94	Grid 5: 26.63	Grid 6: 26.29
Grid 7: 23.39	Grid 8: 20.91	Grid 9: 21.69

MEASUREMENT 28

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

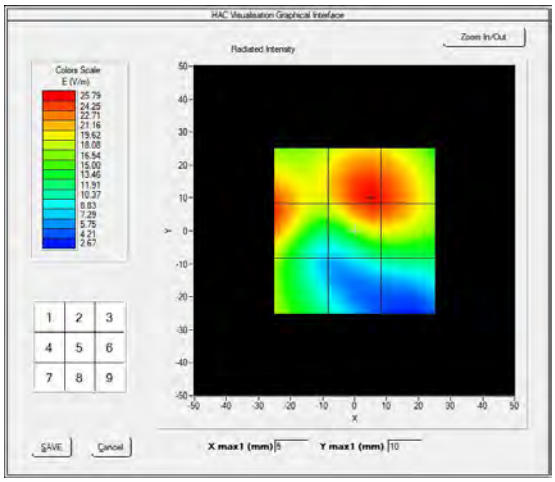
Lower Band (Channel 40185):

Frequency (MHz): 2549.500000

Maximum value of total field = 28.16 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.50	Grid 2: 28.25	Grid 3: 27.88
Grid 4: 27.88	Grid 5: 28.16	Grid 6: 27.84
Grid 7: 24.98	Grid 8: 21.14	Grid 9: 21.92

MEASUREMENT 29

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

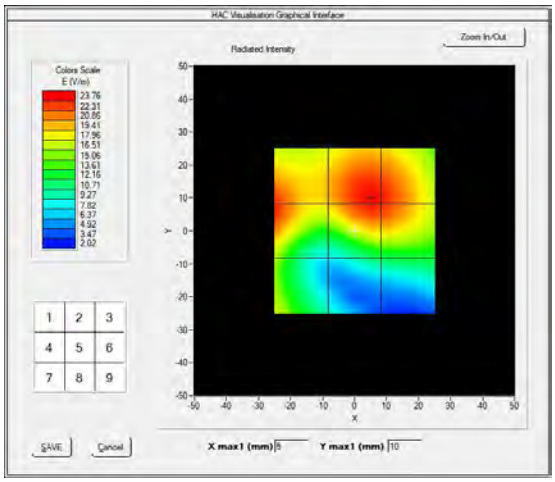
Middle Band (Channel 40620):

Frequency (MHz): 2593.000000

Maximum value of total field = 27.48 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.03	Grid 2: 27.52	Grid 3: 27.16
Grid 4: 27.25	Grid 5: 27.48	Grid 6: 27.15
Grid 7: 24.47	Grid 8: 21.29	Grid 9: 21.80

MEASUREMENT 30

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

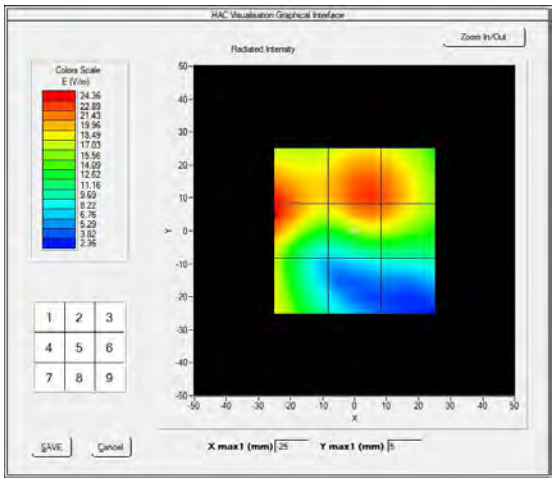
Higher Band (Channel 41055):

Frequency (MHz): 2636.500000

Maximum value of total field = 27.32 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.54	Grid 2: 27.40	Grid 3: 26.95
Grid 4: 27.78	Grid 5: 27.32	Grid 6: 26.88
Grid 7: 25.22	Grid 8: 19.46	Grid 9: 20.19

MEASUREMENT 31

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

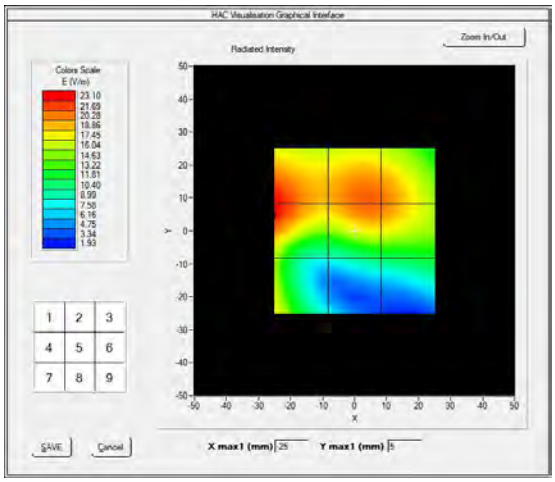
Higher Band (Channel 41490):

Frequency (MHz): 2680.000000

Maximum value of total field = 26.57 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 27.22	Grid 2: 26.57	Grid 3: 26.13
Grid 4: 27.36	Grid 5: 26.57	Grid 6: 26.14
Grid 7: 24.75	Grid 8: 20.82	Grid 9: 21.78

MEASUREMENT 32

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

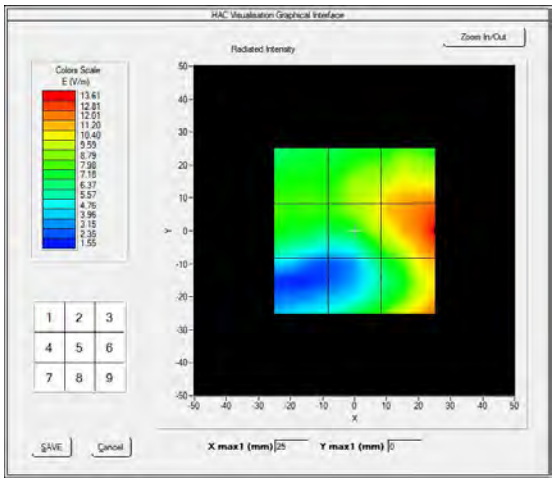
Lower Band (Channel 39750):

Frequency (MHz): 2506.000000

Maximum value of total field = 20.67 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 18.47	Grid 2: 20.40	Grid 3: 21.35
Grid 4: 18.48	Grid 5: 20.67	Grid 6: 22.68
Grid 7: 14.25	Grid 8: 18.37	Grid 9: 21.71

MEASUREMENT 33

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

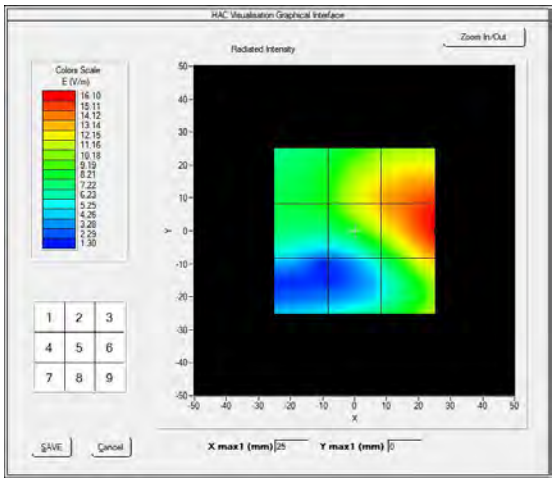
Lower Band (Channel 40185):

Frequency (MHz): 2549.500000

Maximum value of total field = 22.47 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 19.24	Grid 2: 22.45	Grid 3: 23.60
Grid 4: 19.19	Grid 5: 22.47	Grid 6: 24.21
Grid 7: 14.07	Grid 8: 17.51	Grid 9: 22.67

MEASUREMENT 34

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

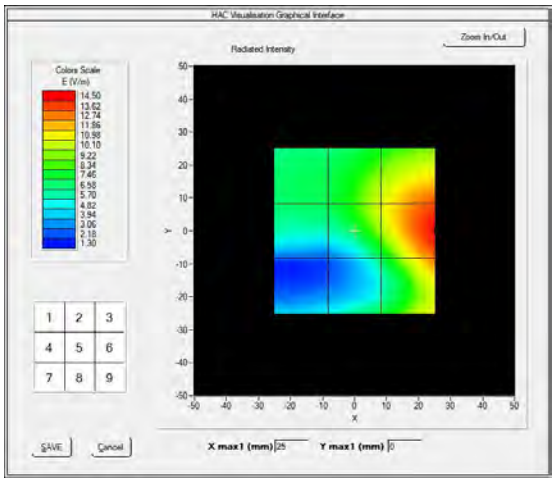
Middle Band (Channel 40620):

Frequency (MHz): 2593.000000

Maximum value of total field = 20.50 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 17.19	Grid 2: 20.36	Grid 3: 22.28
Grid 4: 17.08	Grid 5: 20.50	Grid 6: 23.23
Grid 7: 13.49	Grid 8: 17.41	Grid 9: 22.27

MEASUREMENT 35

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

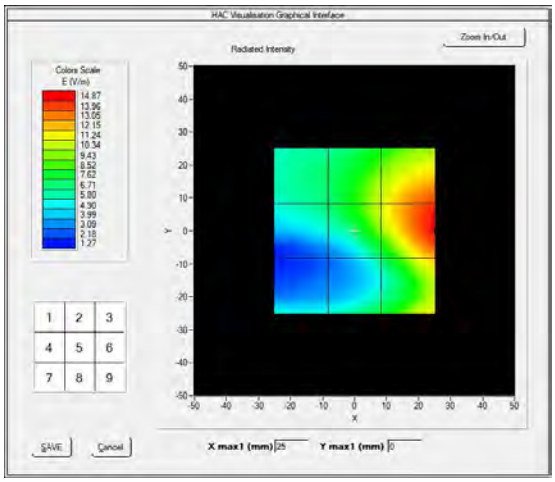
Higher Band (Channel 41055):

Frequency (MHz): 2636.500000

Maximum value of total field = 20.68 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 16.76	Grid 2: 20.58	Grid 3: 22.75
Grid 4: 16.57	Grid 5: 20.68	Grid 6: 23.49
Grid 7: 14.35	Grid 8: 17.78	Grid 9: 21.94

MEASUREMENT 36

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

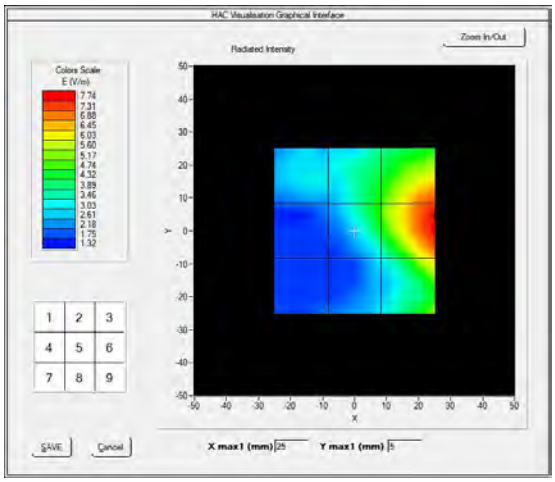
Higher Band (Channel 41490):

Frequency (MHz): 2680.000000

Maximum value of total field = 14.07 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 9.50	Grid 2: 13.72	Grid 3: 16.97
Grid 4: 7.14	Grid 5: 14.07	Grid 6: 17.85
Grid 7: 5.84	Grid 8: 9.78	Grid 9: 16.30

MEASUREMENT 37

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

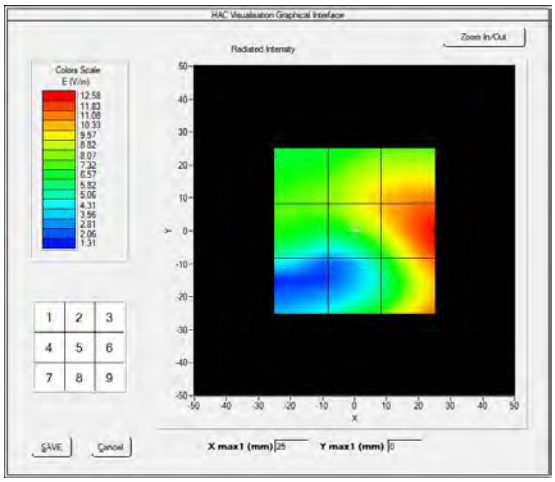
Lower Band (Channel 39750):

Frequency (MHz): 2506.000000

Maximum value of total field = 20.15 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 18.19	Grid 2: 20.09	Grid 3: 20.84
Grid 4: 18.18	Grid 5: 20.15	Grid 6: 22.00
Grid 7: 14.21	Grid 8: 17.84	Grid 9: 21.31

MEASUREMENT 38

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Low
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

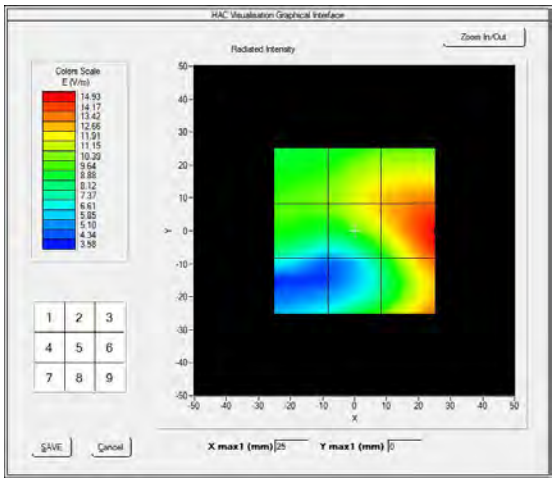
Lower Band (Channel 40185):

Frequency (MHz): 2549.500000

Maximum value of total field = 20.08 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 18.14	Grid 2: 20.04	Grid 3: 20.79
Grid 4: 18.15	Grid 5: 20.08	Grid 6: 21.88
Grid 7: 14.19	Grid 8: 17.81	Grid 9: 21.25

MEASUREMENT 39

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	Middle
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

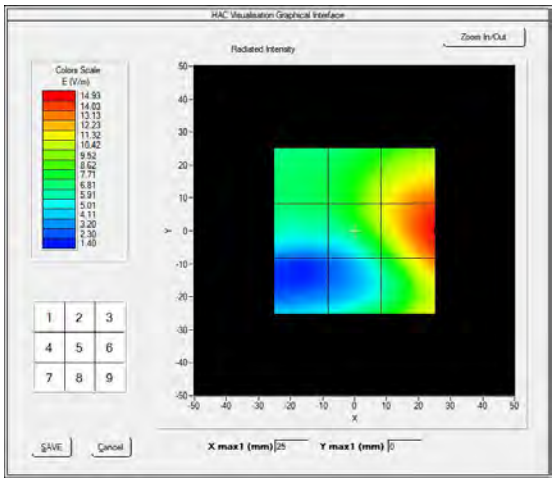
Middle Band (Channel 40620):

Frequency (MHz): 2593.000000

Maximum value of total field = 20.39 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 17.51	Grid 2: 20.65	Grid 3: 22.52
Grid 4: 17.42	Grid 5: 20.39	Grid 6: 23.48
Grid 7: 13.84	Grid 8: 17.72	Grid 9: 22.59

MEASUREMENT 40

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

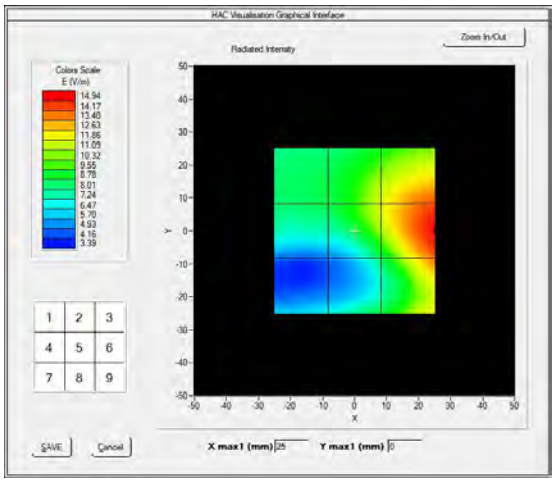
Higher Band (Channel 41055):

Frequency (MHz): 2636.500000

Maximum value of total field = 20.72 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 17.48	Grid 2: 20.59	Grid 3: 22.53
Grid 4: 17.38	Grid 5: 20.72	Grid 6: 23.31
Grid 7: 13.91	Grid 8: 17.81	Grid 9: 22.42

MEASUREMENT 41

Experimental conditions.

Grid size (mm x mm)	50.0, 50.0
Step (mm)	5
Band	LTE band 41
Channel	High
Signal	LTE
Date of measurement	05/30/2020

HAC Measurement Results

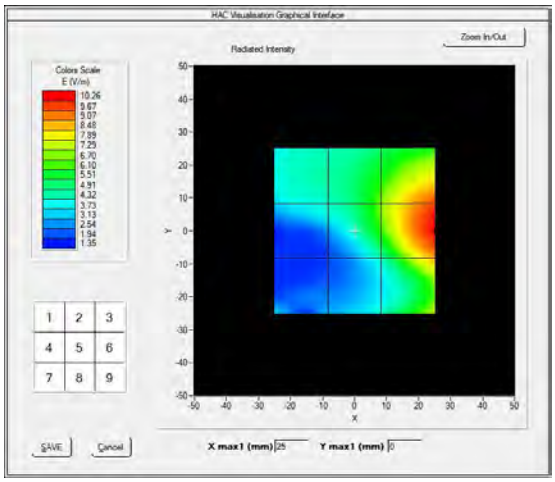
Higher Band (Channel 41490):

Frequency (MHz): 2680.000000

Maximum value of total field = 16.73 dB (V/m)

Hearing Aid Near-Field Category: M4

SURFACE HAC



E in dB (V/m)

Grid 1: 12.91	Grid 2: 16.56	Grid 3: 19.36
Grid 4: 12.29	Grid 5: 16.73	Grid 6: 20.25
Grid 7: 10.43	Grid 8: 12.80	Grid 9: 18.85

ANNEX C EUT EXTERNAL PHOTO

Please refer the document “BL-SZ2040775-AW. PDF”.

ANNEX D TEST SETUP PHOTO

Please refer the document “BL-SZ2040775-AS-2. PDF”.

ANNEX E CALIBRATION FOR PROBE AND DIPOLE

E-Filed Probe EPH41

COMOHAC E-Field Probe Calibration Report

Ref : ACR.71.19.19.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,
NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055
MVG COMOHAC E-FIELD PROBE
SERIAL NO.: SN 24/13 EPH41

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

11/16/2019

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	11/6/2019	
Checked by :	Jérôme LUC	Product Manager	11/6/2019	
Approved by :	Kim RUTKOWSKI	Quality Manager	11/6/2019	

	Customer Name
Distribution :	SHENZHEN BALUN TECHNOLOGY Co.,Ltd.

Issue	Date	Modifications
A	11/6/2019	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 24/13 EPH41
Product Condition (new / used)	Used
Frequency Range of Probe	0.7GHz-2.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=1.139 MΩ Dipole 2: R2=1.139 MΩ Dipole 3: R3=1.104 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

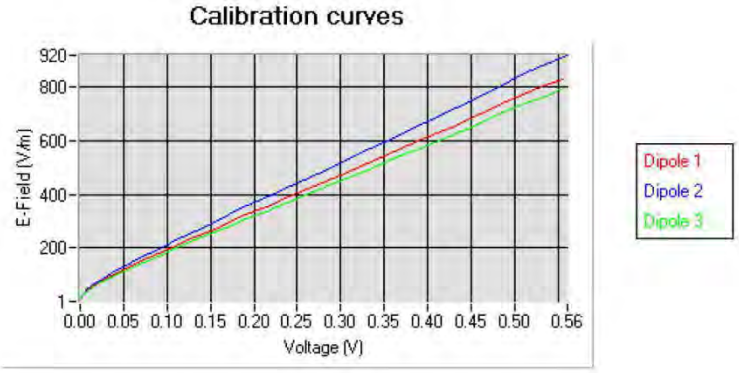
Calibration Parameters	
Lab Temperature	21 °C

Lab Humidity	45 %

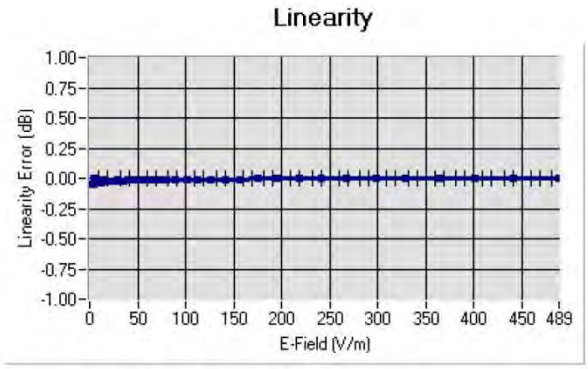
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu V/(V/m)^2$)	Normy dipole 2 ($\mu V/(V/m)^2$)	Normz dipole 3 ($\mu V/(V/m)^2$)
5.19	5.27	5.14

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
95	97	91

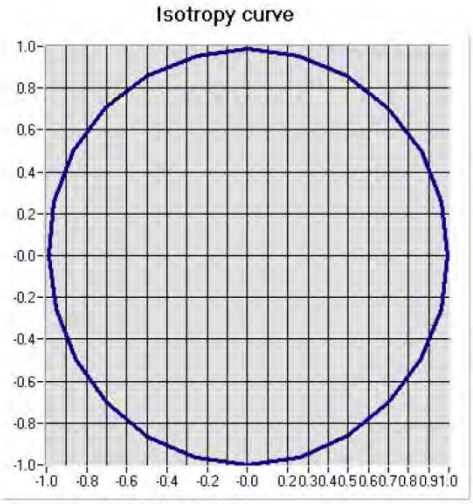


5.2 LINEARITY



Linearity: +/-1.10% (+/-0.05dB)

5.3 ISOTROPY



Isotropy: +/-0.71% (+/-0.03dB)

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	02/2019	02/2022
Reference Probe	MVG	EPH28 SN 08/11	10/2019	10/2020
Reference Probe	MVG	HPH38 SN31/10	10/2019	10/2020
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
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	11/2017	11/2020

HAC Reference Dipole Calibration Report

Ref : ACR.71.20.19.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,
NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

MVG COMOHAC REFERENCE DIPOLE

FREQUENCY: 800-950MHZ
SERIAL NO.: SN 18/12 DHA41

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

11/16/2019

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	11/16/2019	
Checked by :	Jérôme LUC	Product Manager	11/16/2019	
Approved by :	Kim RUTKOWSKI	Quality Manager	11/16/2019	

	Customer Name
Distribution :	SHENZHEN BALUN TECHNOLOGY Co.,Ltd.

Issue	Date	Modifications
A	11/16/2019	Initial release

TABLE OF CONTENTS

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 DHA41
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

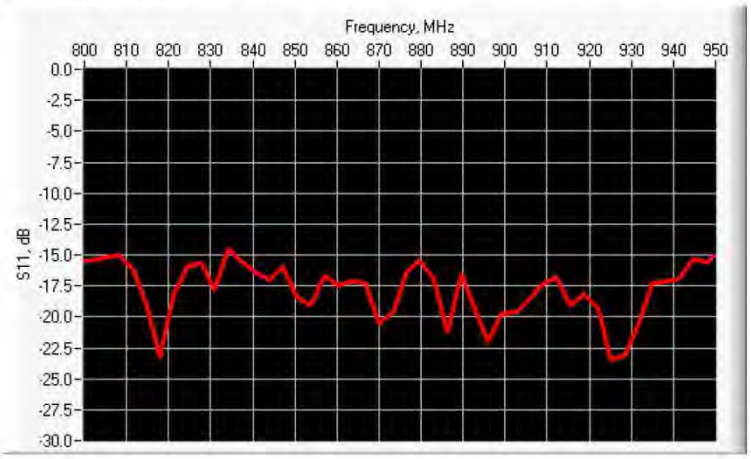
5.2 VALIDATION MEASUREMENT

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	-14.53	-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.

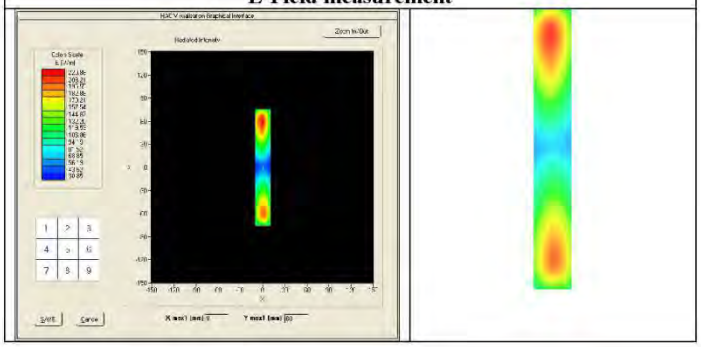
Measurement Condition

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%

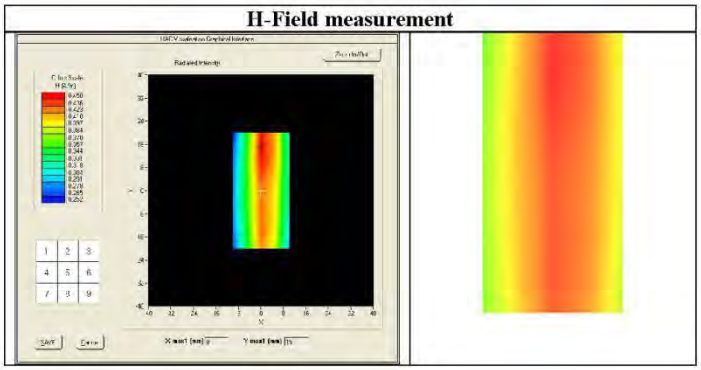
Measurement Result

	Measured	Internal Requirement
E field (V/m)	220.88	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	02/2019	02/2022
Reference Probe	MVG	EPH28 SN 08/11	10/2019	10/2020
Reference Probe	MVG	HPH38 SN31/10	10/2019	10/2020
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
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	11/2017	11/2020

HAC Reference Dipole Calibration Report

Ref : ACR.71.21.19.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,
NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

MVG COMOHAC REFERENCE DIPOLE

FREQUENCY: 1700-2000MHZ
SERIAL NO.: SN 18/12 DHB46

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

11/16/2019

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	11/16/2019	
Checked by :	Jérôme LUC	Product Manager	11/16/2019	
Approved by :	Kim RUTKOWSKI	Quality Manager	11/16/2019	

	Customer Name
Distribution :	SHENZHEN BALUN TECHNOLOGY Co.,Ltd.

Issue	Date	Modifications
A	11/16/2019	Initial release

TABLE OF CONTENTS

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 DHB46
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

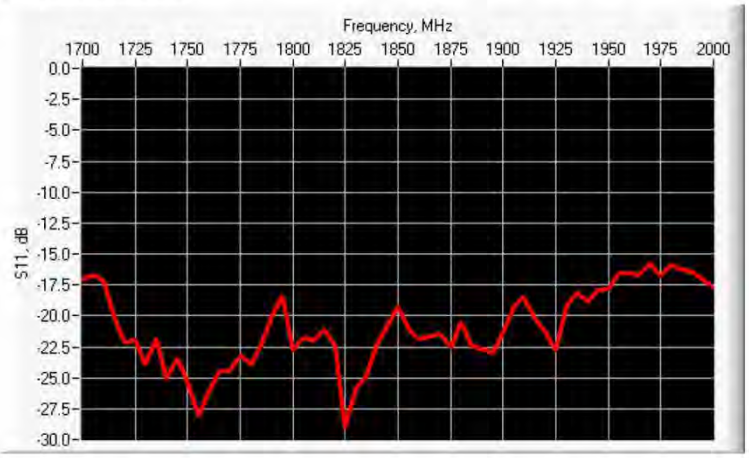
5.2 VALIDATION MEASUREMENT

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)
1700-2000 MHz	-15.78	-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.

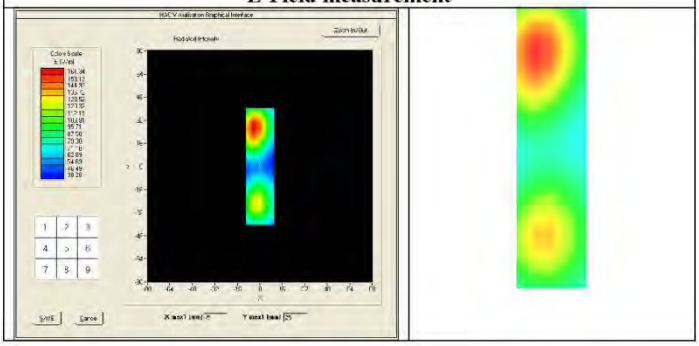
Measurement Condition

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%

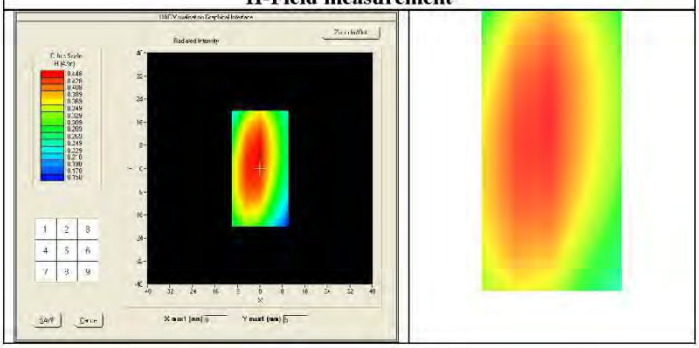
Measurement Result

	Measured	Internal Requirement
E field (V/m)	161.34	153.4
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	02/2019	02/2022
Reference Probe	MVG	EPH28 SN 08/11	10/2019	10/2020
Reference Probe	MVG	HPH38 SN31/10	10/2019	10/2020
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
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	11/2017	11/2020

HAC Reference Dipole Calibration Report

Ref : ACR.71.22.19.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,
NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

MVG COMOHAC REFERENCE DIPOLE

FREQUENCY: 2100-2600MHZ
SERIAL NO.: SN 18/12 DHC48

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

ACCREDITED

11/16/2019

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	11/16/2019	
Checked by :	Jérôme LUC	Product Manager	11/16/2019	
Approved by :	Kim RUTKOWSKI	Quality Manager	11/16/2019	

	Customer Name
Distribution :	SHENZHEN BALUN TECHNOLOGY Co.,Ltd.

Issue	Date	Modifications
A	11/16/2019	Initial release

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 2100-2600 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SIDB2450
Serial Number	SN 18/12 DHC48
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

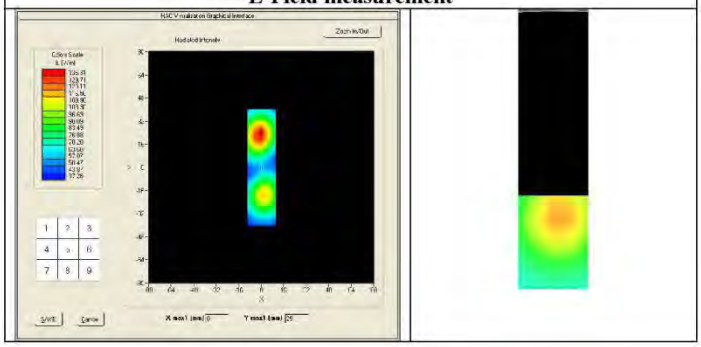
The ANSI C63.19 standard outlines the requirements for reference dipoles to be used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standard.

TABLE OF CONTENTS

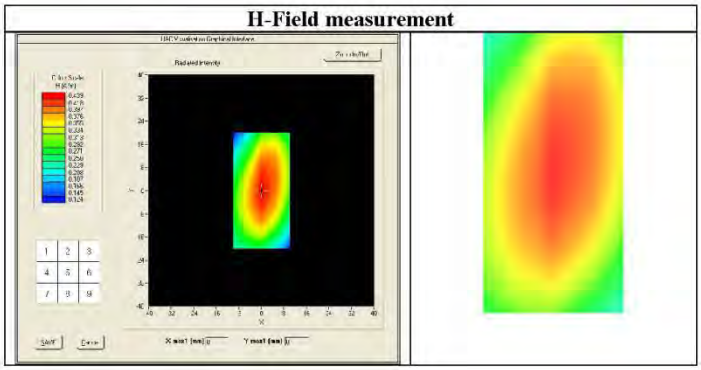
Measurement Result

	Measured	Internal Requirement
E field (V/m)	136.31	134.7
H field (A/m)	0.44	0.439

E-Field measurement

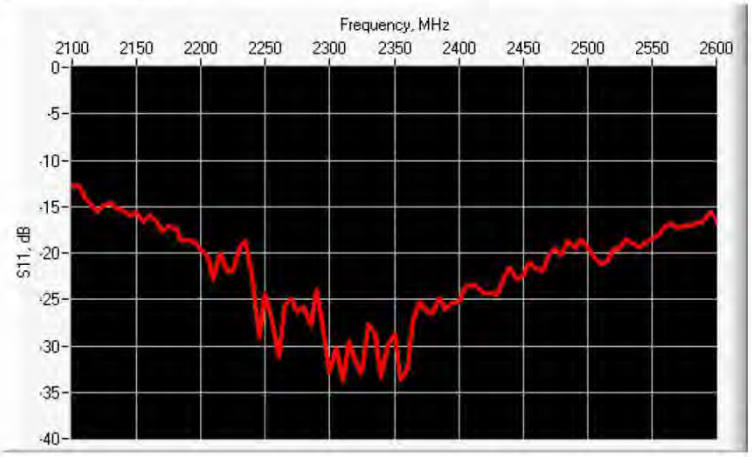


H-Field measurement



6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Worst Case Return Loss (dB)	Requirement (dB)
2100-2600 MHz	-12.80	-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	2450 MHz
Input power	20 dBm
Lab Temperature	21°C
Lab Humidity	45%

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

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	02/2019	02/2022
Reference Probe	MVG	EPH28 SN 08/11	10/2019	10/2020
Reference Probe	MVG	HPH38 SN31/10	10/2019	10/2020
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
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	11/2017	11/2020

--END OF REPORT--