

HAC RF Emission Test Report

Applicant Name:

SAMSUNG Electronics Co., Ltd.
129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677 Rep. of Korea

Date of Issue: 03. 03, 2020**Test Report No.:** HCT-SR-2002-FC006-R1**Test Site:** HCT CO., LTD.

Equipment Type:	Mobile Phone
Application Type	Certification
FCC Rule Part(s):	CFR §20.19 , ANSI C63.19-2011
Model Name:	SM-A315G/DSL
Additional Model Name:	SM-A315G/L
Date of Test:	01/14/2020, 02/20/2020

C63.19-2011
HAC Category

M4 (RF EMISSION CATEGORY)

This wireless portable device has been shown to be hearing-aid compatible under the above rated category, specified in ANSI/IEEE Std. C63.19-2011 and had been tested in accordance with the specified measurement procedures. Hearing-Aid Compatibility is based on the assumption that all production units will be designed electrically identical to the device tested in this report.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By

Yoon Ho Choi
Test Engineer
SAR Team
Certification Division

Reviewed By

Yun Jeang, Heo
Technical Manager
SAR Team
Certification Division

This report only responds to the tested sample and may not be reproduced, except in full, without written approval of the HCT Co., Ltd.

DOCUMENT HISTORY

Rev.	DATE	DESCRIPTION
HCT-SR-2002-FC006	02. 27, 2020	First Approval Report
HCT-SR-2002-FC006-R1	03. 03, 2020	Revised Typo page 6, 22 and Added the LTE 41 RCV Conducted Power table

Table of Contents

1. Test Regulations	4
2. ATTESTATION OF TEST RESULT OF DEVICE UNDER TEST	5
3. DEVICE UNDER TEST DESCRIPTION.....	6
4. HAC MEASUREMENT SET-UP	7
5. SYSTEM SPECIFICATIONS	8
6. HAC RF Emmissions Test Procedure	10
7. System Specifications.....	12
8. SYSTEM VALIDATION	13
9. LTE TDD UPLINK-DOWNLINK CONFIGURATION	15
10. Modulation Interference Factor	16
11. Analysis of RF Air interface Technologies	23
12. TEST PROCEDURE.....	26
13. ANSI/IEEE C63.19 PERFORMANCE CATEGORIES	28
14. MEASUREMENT UNCERTAINTIES	29
15. HAC TEST DATA SUMMARY	30
16. HAC TEST EQUIPMENT Chamber LIST.....	31
17. HAC TEST EQUIPMENT LIST	32
18. CONCLUSION.....	33
Attachment 1. HAC RF Emission Test Plots	34
Attachment 2. System Validation Plots	46
Attachment 3. Probe Calibration Data	50
Attachment 4. Dipole Calibration Data	81

1. Test Regulations

The tests were performed according to the following regulations:

Test Standard	FCC 47 CFR §20.19 ANSI C63.19-2011
Test Method	<ul style="list-style-type: none">• KDB 285076 D01 HAC Guidance v05• KDB 285076 D03 HAC FAQ v01• TCB workshop updates

2. ATTESTATION OF TEST RESULT OF DEVICE UNDER TEST

Test Laboratory	
Company Name:	HCT Co., LTD
Address:	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of Korea
Telephone:	+82 31 645 6300
Fax.:	+82 31 645 6401

Attestation of SAR test result	
Applicant Name:	SAMSUNG Electronics Co., Ltd.
Model Name	SM-A315G/DSL
Additional Model Name	SM-A315G/L
EUT Type:	Mobile Phone
Application Type:	Certification

2.1 Test Methodology

The Tests document in this report were performed in accordance with ANSI C63.19-2011 method of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids, FCC published KDB 285076 D01 HAC Guidance v05, FCC Published KDB285076 D03 HAC FAQ v01 and TCB Workshop updates .

3. DEVICE UNDER TEST DESCRIPTION

3.1 DUT specification

Device Wireless specification overview		
Band & Mode	Operating Mode	Tx Frequency
GSM850	Voice / Data	824.2 MHz ~ 848.8 MHz
GSM1900	Voice / Data	1 850.2 MHz ~ 1 909.8 MHz
WCDMA 850	Voice / Data	826.4 MHz ~ 846.6 MHz
WCDMA 1700	Voice / Data	1 712.4 MHz ~ 1 752.6 MHz
WCDMA 1900	Voice / Data	1 852.4 MHz ~ 1 907.6 MHz
LTE Band 2 (PCS)	Voice / Data	1 850.7 MHz ~ 1 909.3 MHz
LTE Band 4 (AWS)	Voice / Data	1 710.7 MHz ~ 1 754.3 MHz
LTE Band 5 (Cell)	Voice / Data	824.7 MHz ~ 848.3 MHz
LTE Band 12	Voice / Data	699.7 MHz ~ 715.3 MHz
LTE Band 13	Voice / Data	779.5 MHz ~ 784.5 MHz
LTE Band 17	Voice / Data	706.5 MHz ~ 713.5 MHz
LTE TDD Band 41	Voice / Data	2 498.5 MHz ~ 2 687.5 MHz
LTE Band 66 (AWS)	Voice / Data	1 710.7 MHz ~ 1 779.3 MHz
U-NII-1	Voice / Data	5 180 MHz ~ 5 240 MHz
U-NII-2A	Voice / Data	5 260 MHz ~ 5 320 MHz
U-NII-2C	Voice / Data	5 500 MHz ~ 5 720 MHz
U-NII-3	Voice / Data	5 745 MHz ~ 5 825 MHz
2.4 GHz WLAN	Voice / Data	2 412 MHz ~ 2 472 MHz
Bluetooth / LE 5.0	Data	2 402 MHz ~ 2 480 MHz
Device Description		
Device Dimension	Overall (Length x Width): 158.5 mm x 72 mm Overall Diagonal: 168 mm Display Diagonal: 160 mm	
Battery Information	Standard (Li-ion Polymer Battery) Battery Model Name: EB-BA315ABY (Samsung SDI)	
HW version	REV0.1	
SW version	A315G.001	
Device Serial Numbers	Mode	Serial Number
	GSM850, GSM 1900	TA20935M
	LTE TDD Band 41	TAM0399H

4. HAC MEASUREMENT SET-UP

These measurements are performed using the DASY5 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium IV computer, near-field probe, probe alignment sensor. The robot is a six-axis industrial robot performing precise movements.

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the HP Pentium IV 3.0 GHz computer with Windows XP system and HAC Measurement Software DASY5, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

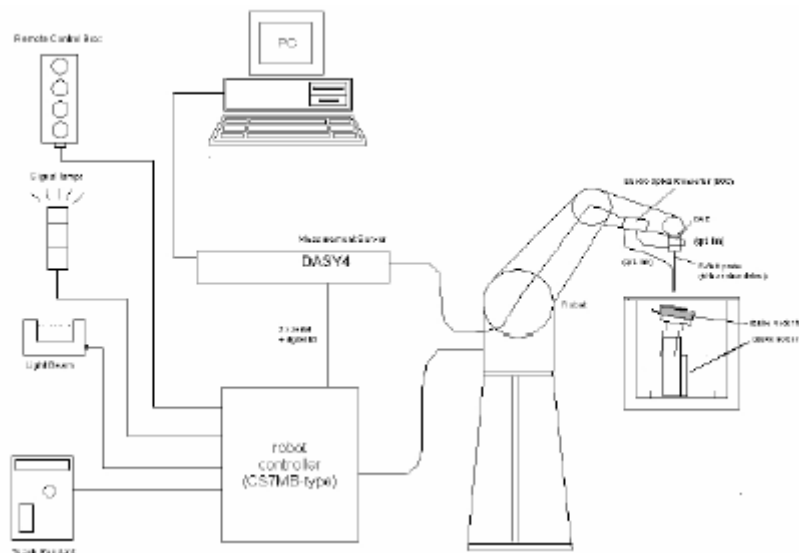


Figure 1. HAC Test Measurement Set-up

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

5. SYSTEM SPECIFICATIONS

5.1 Probe

E-Field Probe Description

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$, $k = 2$)
Frequency	100 MHz to > 6 GHz; Linearity: ± 0.2 dB (100 MHz to 3 GHz)
Directivity	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range	2 V/m to > 1000 V/m (M3 or better device readings fall well below diode compression point)
Linearity	± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.5 mm



[E-Field Probe]

5.2 Phantom & Device Holder



Figure 2. HAC Phantom & Device Holder

The Test Arch phantom should be positioned horizontally on a stable surface. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

The devices can be easily, accurately, and repeatable positioned according to the FCC specifications.

5.3 Robotic System Specifications

Specifications	
POSITIONER:	Stäubli Unimation Corp. Robot Model: TX90 XLspeag
Repeatability:	0.02 mm
No. of axis:	6
Data Acquisition Electronic (DAE) System	
Cell Controller	
Processor:	Core i7
Clock Speed:	3.0 GHz
Operating System:	Windows 7
Data Card:	DASY5 PC-Board
Data Converter	
Features:	Signal Amplifier, multiplexer, A/D converter, and control logic
Software:	DASY5 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock
PC Interface Card	
Function:	24 bit (64 Mhz) DSP for real time processing Link to DAE 16 bit A/D converter for surface detection system serial link to robot direct emergency stop output for robot

6. HAC RF Emissions Test Procedure

The following are step-by-step test procedures.

- a) Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.
- b) Position the WD in its intended test position.
- c) Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
- d) The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 1. If the field alignment method is used, align the probe for maximum field reception.
- e) Record the reading at the output of the measurement system
- f) Scan the entire 50 mm by 50 mm region in equally spaced increments and record the reading at each measurement point. The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
- g) Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.
- h) Identify the maximum reading within the non-excluded sub-grids identified in step g).
- i) Convert the highest field reading within identified in step h) to RF audio interference level, in V/m, by taking the square root of the reading and then dividing it by the measurement system transfer function, established in
5.5.1.1 Convert this result to dB(V/m) by taking the base-10 logarithm and multiplying by 20. Indirect measurement method
Replacing step i), the RF audio interference level in dB (V/m) is obtained by adding the MIF (in dB) to the maximum steady-state rms field-strength reading, in dB (V/m), from step h). Use this result to determine the category rating
- j) Compare this RF audio interference level with the categories in Clause 8 (ANSI C63.19) and record the resulting WD category rating
- k) For the T-Coil mode M-rating assessment, determine whether the chosen perpendicular measurement point is contained in an included sub-grid of the first scan. If so, then a second scan is not necessary. The first scan and resultant category rating may be used for the T-Coil mode M rating.

Otherwise, repeat step a) through step i), with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.



Figure 3. WD reference and plane for RF emission measurements

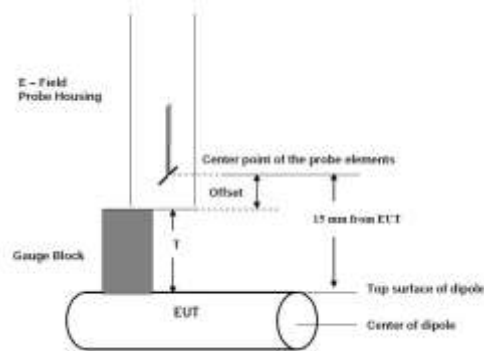


Figure 4. Gauge Block with E-Field Probe

7. System Specifications

E-field measurements are performed using the DASY52 automated dosimetric assessment system. The DASY52 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland.

The DASY52 HAC Extension consists of the following parts:

Test Arch Phantom

The specially designed Test Arch allows high precision positioning of both the device and any of the validation dipoles.

EF3DV3 Isotropic E-Field Probe

Construction:	One dipole parallel, two dipoles normal to probe axis Interleaved sensors Built-in shielding against static charges PEEK enclosure material
Calibration:	In air from 100 MHz to 3.0 GHz(absolute accuracy $\pm 6.0\%$, $k=2$) ISO/IEC 17025 <u>calibration service</u> available.
Frequency:	40 MHz – >6 GHz (can be extended to < 20 MHz); Linearity: ± 0.2 dB (100 MHz – 3 GHz)
Directivity:	± 0.2 dB in air (rotation around probe axis) ± 0.4 dB in air (rotation normal to probe axis)
Dynamic Range:	2 V/m to > 1000 V/m; Linearity: ± 0.2 dB
Dimensions:	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.5 mm Sensor displacement to probe's calibration point: <0.7 mm
Application:	General near-field measurements up to 6 GHz HAC measurements up to 6 GHz Field component measurements Fast automatic scanning in phantoms

8. SYSTEM VALIDATION

The test setup was validated when first configured and verified periodically thereafter to ensure proper function. The procedure provided in this section is a validation procedure using dipole antennas for which the field levels were computed by numeric modeling.

Procedure:

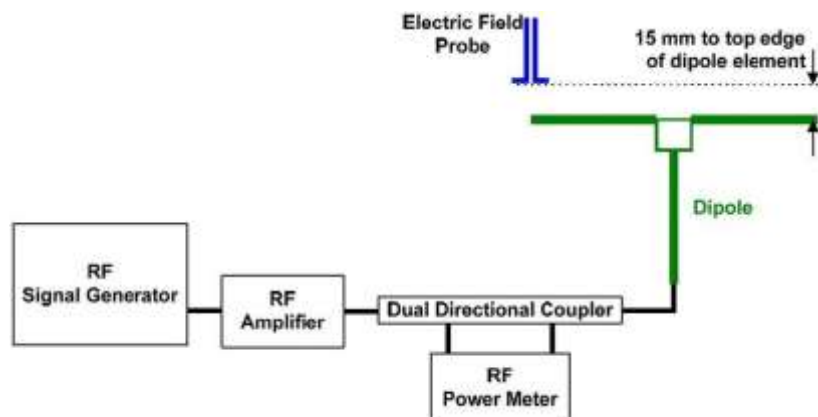
Place a dipole antenna meeting the requirements given in ANSI C63.19 in the normally occupied by the WD.

The dipole antenna serves as a known source for an electrical and magnetic output. Position the E-field probe so that the following occurs:

- The probes and their cables are parallel to the coaxial feed of the dipole antenna.
- The probe cables and the coaxial feed of the dipole antenna approach the measurement area from opposite directions
- The center point of the probe element(s) is 15 mm from the closest surface of the dipole elements.

Scan the length of the dipole with the E-field probe and record the two maximum values found near the dipole ends. Average the two readings and compare the reading to the expected value in the calibration certificate or the expected value in this standard.

Setup diagram



8.1 SYSTEM Validation Result

Mode	Date	Dipole Type_Seria_ Freq.	Input Power	MAX. Measured from		Average max. above arm	Target Value SPEAG	Dev.	Dipole Calib. Date
				Above high end	Above low end				
			[dBm]	[V/m]	[V/m]	[V/m]	[V/m]	[%]	
CW	01/14/2020	CD835V3_SN:1024_(835 MHz)	20	115.08	100.81	107.95	105.4	2.41	02/22/2019
CW	01/14/2020	CD1880V3_SN:1019_(1880 MHz)	20	83.56	80.82	82.19	85.8	-4.21	02/22/2019
CW	02/20/2020	CD2600V3_SN:1019_(2600 MHz)	20	88.51	85.41	86.96	84.2	3.28	09/19/2019

Notes:

- 1) Deviation (%) = $100 * (\text{Measured value} - \text{Target value}) / \text{Target value}$.
ANSI-C63.19 requires values to be within 25 % of their targets. 12 % is deviation and 13 % is measurement uncertainty.
- 2) The maximum E-field was evaluated and compared to the target values provided by SPEAG in the calibration certificate of specific dipoles.
- 3) Please refer to the attachment for detailed measurement data and plot.

9. LTE TDD UPLINK-DOWNLINK CONFIGURATION

9.1 Uplink-Downlink Configuration Investigation

An investigation was performed on each supported power class for LTE TDD to determine the worst case Uplink-Downlink configuration for RFE testing.

Per 3GPP TS 36.211, the total frame length for each TDD radio frame of length $T_f = 307200 \cdot T_s = 10\text{ms}$, where T_s is a number of time units equal to $1/(15000 \times 2048)$ seconds. Additionally, each radio frame consists of 10 subframes, each of length $30720 \cdot T_s = 1 \text{ ms}$, and subframes can be designated as uplink (U), downlink (D), or special subframe (S), depending on the Uplink-Downlink configuration as indicated in Table 4.2-2 of 3GPP TS 36.211. In the transmission duty factor calculation, the special subframe configuration with the shortest UpPTS duration within the special subframe is used and will be applied for measurement. From 3GPP TS 36.211 Table 4.2-1, the shortest UpPTS is $2192 \cdot T_s$ which occurs in the normal cyclic prefix and special subframe configuration 4.

See table below outlining the calculated transmission duty cycles for each Uplink-Downlink configuration:

Uplink-Downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number										Calculated Transmission Duty Cycle [%]
		0	1	2	3	4	5	6	7	8	9	
0	5 ms	D	S	U	U	U	D	S	U	U	U	61.4
1	5 ms	D	S	U	U	D	D	S	U	U	D	41.4
2	5 ms	D	S	U	D	D	D	S	U	D	D	21.4
3	10 ms	D	S	U	U	U	D	D	D	D	D	30.7
4	10 ms	D	S	U	U	D	D	D	D	D	D	20.7
5	10 ms	D	S	U	D	D	D	D	D	D	D	10.7
6	5 ms	D	S	U	U	U	D	S	U	U	D	51.4

Uplink-Downlink Configurations for Type 2 Frame Structures

LTE TDD was evaluated with the following radio configuration: channel 40620, 20MHz BW, 16QAM, 1RB, 0RB offset. All configurations (0-6) are supported. The configuration which resulted in the worst Audio Interference Level was used for full testing. See Table for investigation results. The configuration determined in the investigation below was used to measure the MIF values in 10-4 Table. See Table 9-1 below for result

Table 9-1 LTE TDD Power Class 3 UL-DL Configuration Results

Mode	Channel	UL-DL Config.	Mod.	BW	RB Size	RB offset	Time Avg. Filed [V/m]	Audio Inteference Level [dBV/m]	FCC Limit [dBV/m]	FCC Margin [dB]	MIF	Result	Exclusion Block
LTE TDD/ Band 41	40620	0	16QAM	20	1	0	43.55	29.61	35	5.39	-3.17	M4	none
	40620	1	16QAM	20	1	0	36.02	29.41	35	5.59	-1.72	M4	none
	40620	2	16QAM	20	1	0	8.44	19.73	35	15.27	1.20	M4	none
	40620	3	16QAM	20	1	0	8.46	17.26	35	17.74	-1.29	M4	none
	40620	4	16QAM	20	1	0	8.63	19.13	35	15.87	0.41	M4	none
	40620	5	16QAM	20	1	0	16.01	27.21	35	7.79	3.12	M4	none
	40620	6	16QAM	20	1	0	33.15	27.82	35	7.18	-2.59	M4	none

9.2 Conclusion

Per the investigations above, UL-DL configuration 0 was used for LTE TDD.

10. Modulation Interference Factor

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

10.1 Measuring Modulation Interference Factors

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.

The MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic. any change in modulation characteristic requires determination and application of a new MIF.

The MIF may be determined using a radiated RF field or a conducted RF signal:

- a. 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.
- b. Measure the steady-state RMS level at the output of the fast probe or sensor.
- c. Measure the steady-state average level at the weighting output.
- d. Without changing the square-law detector or weighting system, and using RF illumination or conducted coupling, substitute for the specific modulated signal a 1 kHz, 80% amplitude modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the step d) measurement.
- e. 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.
- f. The MIF for the specific modulation characteristic is provided by the ratio of the step e) measurement to the step b) measurement, expressed in dB ($20 \times \log(\text{step e})/\text{step b}$)).

The following procedure was used to measure the MIF using the SPEAG audio interference Analyzer (AIA), Serial No.:1060:

1. The device was placed into a simulated call using a base station simulator or set to transmit using test software for a given model.
2. The device was then set to continuously transmit at maximum power.
3. Using a coupler if needed, the device output signal was connected to the RF In port of the AIA, which was connected to a desktop computer. Alternatively, a radiated RF signal may be used with the AIA's built-in antenna.
4. The MIF measurement procedure in the DASY software was run, and the resulting MIF value was recorded.
5. Steps 1-4 were repeated for all CMRS air interfaces, frequency bands, and modulations.

The modulation interference factors obtained were applied to readings taken of the actual wireless device in order to obtain an accurate audio interference level reading using the formula:

$$\text{Audio interference Level [dB (V/m)]} = 20 * \log [\text{Raw Field Value (V/m)}] + \text{MIF (dB)}$$

Because the MIF value is output power independent, MIF values for a given mode should be constant across all devices; however, per C63.19-2011 §D.7, MIF values should be measured for each device being evaluated. The voice modes for this device have been investigated in this section of the report.

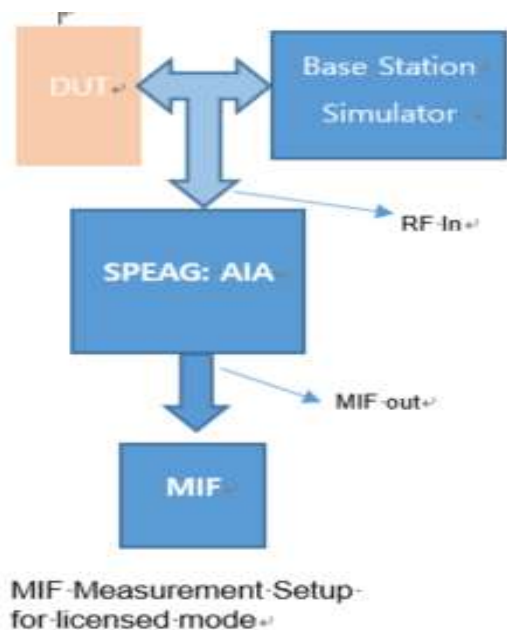


Table 10-1

Mode	GSM850			GSM1900		
	128	190	251	512	661	810
GSM	3.53	3.53	3.53	3.53	3.51	3.46

GSM Modulation Interference Factors

Table 10-2

Mode		WCDMA850			WCDMA1700			WCDMA1900		
		4132	4183	4233	1312	1412	1513	9262	9400	9538
UMTS	12.2kbps RMC	-22.71	-22.59	-22.48	-22.99	-22.64	-23.31	-23.46	-23.35	-22.58
	12.2 kbps AMR	-22.88	-22.83	-22.71	-23.42	-23.20	-23.56	-23.59	-23.38	-23.20

UMTS Modulation Interference Factors

Note :

Measured MIF value maybe lower than sample MIF values provide in ANSI C63.19-2011 Annex D.7 Table D.5 due to manufacturing variations for each device. However per Annex D.7, the sample MIF values of table D.5 are not intended to substitute for measurements of actual devices under test and their respective operating mode.

Table 10-3

LTE Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB offset	MIF [dB]
2	1880	18900	20	16QAM	1	0	-9.98
4	1732.5	20175	20	16QAM	1	0	-10.27
5	836.5	20525	10	16QAM	1	0	-9.94
12	707.5	23095	10	16QAM	1	0	-10.83
13	782	23230	10	16QAM	1	0	-10.55
17	710	23790	10	16QAM	1	0	-9.74
66	1745	132322	20	16QAM	1	0	-10.08
17	710	23790	10	QPSK	1	0	-14.32
17	710	23790	10	64QAM	1	0	-14.22
17	710	23790	10	16QAM	1	24	-10.44
17	710	23790	10	16QAM	1	49	-10.31
17	710	23790	10	16QAM	25	0	-16.1
17	710	23790	10	16QAM	50	0	-16.65
17	710	23790	5	16QAM	1	0	-10.59
17	710	23790	3	16QAM	1	0	-10.42
17	710	23790	1.4	16QAM	1	0	-9.86

LTE FDD Modulation Interference Factors

Table 10-4

LTE Band	Frequency [MHz]	Channel	Bandwidth [MHz]	Modulation	RB Size	RB offset	MIF [dB]
41	2593	40620	20	16QAM	1	0	-3.17
41	2593	40620	20	QPSK	1	0	-3.31
41	2593	40620	20	64QAM	1	0	-3.22
41	2593	40620	20	16QAM	1	50	-3.11
41	2593	40620	20	16QAM	1	99	-3.10
41	2593	40620	20	16QAM	50	49	-3.34
41	2593	40620	20	16QAM	100	0	-3.37
41	2593	40620	15	16QAM	1	74	-3.10
41	2593	40620	10	16QAM	1	49	-3.10
41	2593	40620	5	16QAM	1	24	-3.09
41	2498.5	39675	5	16QAM	1	24	-3.11
41	2545.8	40148	5	16QAM	1	24	-3.09
41	2640.3	41093	5	16QAM	1	24	-3.11
41	2687.5	41565	5	16QAM	1	24	-3.10

LTE TDD Modulation Interference Factors

All FDD LTE bands were found to have substantially similar MIF values given similar RB,BW and modulation configurations.

Table 10-5

LTE Band 41 _ 5 MHz Bandwidth _ Receiver ON

Band width	Modulation	RB Size	RB Offset	Max. Average Power [dBm]					MPR Allowed Per GPP [dB]	MPR [dB]
				39675 Ch. 2498.5 MHz	40148 Ch. 2545.8 MHz	40620 Ch. 2593.0 MHz	41093 Ch. 2640.3 MHz	41565 Ch. 2687.5 MHz		
5 MHz	QPSK	1	0	20.28	20.62	20.42	20.39	20.37	0	0
		1	12	20.50	20.83	20.63	20.53	20.55	0	0
		1	24	20.27	20.61	20.44	20.28	20.38	0	0
		12	0	20.34	20.66	20.51	20.45	20.46	0-1	0
		12	6	20.45	20.81	20.60	20.52	20.52	0-1	0
		12	11	20.48	20.82	20.61	20.50	20.50	0-1	0
		25	0	20.39	20.73	20.53	20.44	20.45	0-1	0
	16QAM	1	0	20.41	20.71	20.56	20.51	20.47	0-1	0
		1	12	20.61	20.91	20.71	20.62	20.63	0-1	0
		1	24	20.40	20.69	20.54	20.39	20.45	0-1	0
		12	0	20.31	20.62	20.44	20.39	20.39	0-2	0
		12	6	20.40	20.73	20.56	20.47	20.49	0-2	0
		12	11	20.44	20.76	20.55	20.45	20.43	0-2	0
		25	0	20.43	20.75	20.58	20.47	20.46	0-2	0
	64QAM	1	0	19.97	20.28	20.13	20.08	20.08	0-2	0
		1	12	20.20	20.51	20.30	20.22	20.23	0-2	0
		1	24	20.00	20.31	20.12	19.97	20.03	0-2	0
		12	0	19.34	19.72	19.50	19.45	19.48	0-3	1
		12	6	19.44	19.81	19.60	19.51	19.51	0-3	1
		12	11	19.46	19.81	19.62	19.48	19.49	0-3	1
		25	0	19.39	19.76	19.57	19.49	19.47	0-3	1

LTE Band 41 _ 10 MHz Bandwidth _ Receiver ON

Band width	Modulation	RB Size	RB Offset	Max. Average Power [dBm]					MPR Allowed Per 3GPP [dB]	MPR [dB]
				39700 Ch. 2501MHz	40160 Ch. 2547MHz	40620 Ch. 2593MHz	41080 Ch. 2639MHz	41540 Ch. 2685MHz		
10 MHz	QPSK	1	0	20.34	20.70	20.59	20.55	20.43	0	0
		1	24	20.49	20.83	20.66	20.56	20.58	0	0
		1	49	20.41	20.68	20.55	20.34	20.43	0	0
		25	0	20.39	20.70	20.60	20.50	20.48	0-1	0
		25	12	20.42	20.79	20.64	20.51	20.46	0-1	0
		25	24	20.46	20.81	20.64	20.49	20.45	0-1	0
		50	0	20.40	20.73	20.61	20.50	20.47	0-1	0
	16QAM	1	0	20.48	20.82	20.69	20.68	20.53	0-1	0
		1	24	20.60	20.95	20.77	20.66	20.60	0-1	0
		1	49	20.52	20.79	20.66	20.44	20.56	0-1	0
		25	0	20.45	20.71	20.60	20.53	20.50	0-2	0
		25	12	20.49	20.79	20.68	20.53	20.44	0-2	0
		25	24	20.48	20.79	20.64	20.49	20.45	0-2	0
		50	0	20.43	20.75	20.63	20.51	20.48	0-2	0
	64QAM	1	0	20.07	20.41	20.28	20.29	20.15	0-2	0
		1	24	20.19	20.52	20.34	20.27	20.18	0-2	0
		1	49	20.10	20.35	20.23	20.05	20.16	0-2	0
		25	0	19.44	19.81	19.63	19.57	19.53	0-3	1
		25	12	19.48	19.81	19.61	19.58	19.51	0-3	1
		25	24	19.53	19.83	19.67	19.53	19.45	0-3	1
		50	0	19.41	19.74	19.61	19.50	19.44	0-3	1

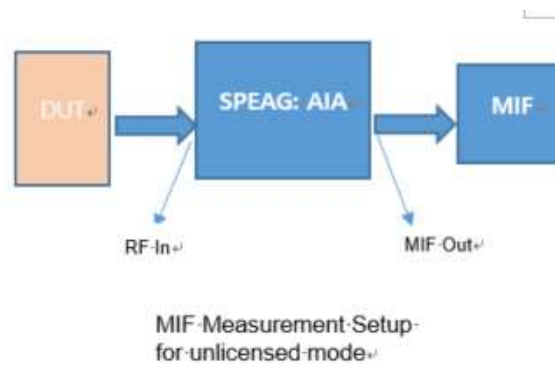
LTE Band 41 _ 15 MHz Bandwidth _ Receiver ON

Band width	Modulation	RB Size	RB Offset	Max. Average Power [dBm]					MPR Allowed Per 3GPP [dB]	MPR [dB]
				39725 Ch.	40173 Ch.	40620 Ch.	41068 Ch.	41515 Ch.		
				2503.5MHz	2548.3MHz	2593.0MHz	2637.8MHz	2682.5MHz		
15 MHz	QPSK	1	0	20.33	20.69	20.53	20.53	20.30	0	0
		1	36	20.52	20.83	20.65	20.57	20.42	0	0
		1	74	20.37	20.59	20.44	20.26	20.30	0	0
		36	0	20.41	20.74	20.61	20.55	20.44	0-1	0
		36	18	20.46	20.83	20.60	20.55	20.47	0-1	0
		36	39	20.52	20.75	20.61	20.47	20.40	0-1	0
		75	0	20.41	20.67	20.54	20.44	20.35	0-1	0
	16QAM	1	0	20.38	20.77	20.63	20.65	20.42	0-1	0
		1	36	20.61	20.89	20.76	20.74	20.60	0-1	0
		1	74	20.53	20.70	20.58	20.36	20.46	0-1	0
		36	0	20.37	20.70	20.56	20.49	20.37	0-2	0
		36	18	20.46	20.69	20.54	20.46	20.44	0-2	0
		36	39	20.39	20.70	20.54	20.40	20.32	0-2	0
		75	0	20.44	20.67	20.52	20.44	20.38	0-2	0
	64QAM	1	0	20.02	20.37	20.25	20.25	20.00	0-2	0
		1	36	20.21	20.52	20.32	20.35	20.21	0-2	0
		1	74	20.11	20.27	20.14	19.95	20.05	0-2	0
		36	0	19.32	19.71	19.50	19.52	19.39	0-3	1
		36	18	19.43	19.71	19.55	19.46	19.46	0-3	1
		36	39	19.47	19.68	19.59	19.41	19.36	0-3	1
		75	0	19.42	19.67	19.55	19.44	19.36	0-3	1

LTE Band 41 _ 20 MHz Bandwidth _ Receiver ON

Band width	Modulation	RB Size	RB Offset	Max. Average Power [dBm]					MPR Allowed Per 3GPP [dB]	MPR [dB]
				39750 Ch.	40185 Ch.	40620 Ch.	41055 Ch.	41490 Ch.		
				2506.0MHz	2549.5MHz	2593.0MHz	2636.5MHz	2680.0MHz		
20 MHz	QPSK	1	0	20.28	20.63	20.47	20.46	20.20	0	0
		1	49	20.59	20.87	20.70	20.65	20.53	0	0
		1	99	20.39	20.51	20.41	20.11	20.28	0	0
		50	0	20.39	20.61	20.45	20.51	20.33	0-1	0
		50	25	20.43	20.67	20.53	20.47	20.39	0-1	0
		50	49	20.49	20.61	20.53	20.36	20.29	0-1	0
		100	0	20.45	20.69	20.57	20.46	20.31	0-1	0
	16QAM	1	0	20.39	20.72	20.60	20.66	20.31	0-1	0
		1	49	20.69	20.94	20.78	20.75	20.62	0-1	0
		1	99	20.50	20.60	20.51	20.25	20.37	0-1	0
		50	0	20.42	20.58	20.54	20.55	20.36	0-2	0
		50	25	20.47	20.66	20.60	20.50	20.42	0-2	0
		50	49	20.55	20.63	20.56	20.39	20.31	0-2	0
		100	0	20.48	20.71	20.58	20.50	20.32	0-2	0
	64QAM	1	0	19.98	20.30	20.19	20.30	19.91	0-2	0
		1	49	20.28	20.54	20.37	20.34	20.22	0-2	0
		1	99	20.09	20.20	20.08	19.82	19.99	0-2	0
		50	0	19.39	19.70	19.54	19.50	19.33	0-3	1
		50	25	19.48	19.70	19.58	19.48	19.38	0-3	1
		50	49	19.47	19.65	19.59	19.33	19.27	0-3	1
		100	0	19.45	19.67	19.57	19.47	19.30	0-3	1

Table 10-6



Mode	802.11b MIF Measurements [dB]			
	Data Rate [Mbps]			
	1	2	5.5	11
802.11b	-13.66	-12.96	-10.37	-9.83

2.4GHz WLAN 802.11b Modulation Interference Factors

Mode	802.11g MIF Measurements [dB]							
	Data Rate [Mbps]							
	6	9	12	18	24	36	48	54
802.11g	-10.69	-9.96	-9.46	-8.86	-8.47	-8.59	-9.05	-9.27

2.4GHz WLAN 802.11g Modulation Interference Factors

Mode	802.11n MIF Measurements [dB]							
	Data Rate [Mbps]							
	6.5	13	19.5	26	39	52	58.5	65
802.11n	-10.59	-9.39	-8.82	-8.56	-8.66	-9.07	-9.3	-9.52

2.4GHz WLAN 802.11n Modulation Interference Factors

Mode	802.11a MIF Measurements [dB]							
	Data Rate [Mbps]							
	6	9	12	18	24	36	48	54
802.11a	-10.7	-9.98	-9.47	-8.88	-8.47	-8.61	-9.05	-9.29

5GHz WLAN 802.11a Modulation Interference Factors

Mode	802.11n MIF Measurements [dB]							
	Data Rate [Mbps]							
	6.5	13	19.5	26	39	52	58.5	65
802.11n	-10.7	-9.46	-8.9	-8.63	-8.72	-9.13	-9.34	-9.58

5GHz WLAN 802.11n Modulation Interference Factors

Mode	802.11ac MIF Measurements [dB]									
	Data Rate [Mbps]									
	6.5	13	19.5	26	39	52	58.5	65	78	
802.11ac	-10.73	-9.5	-8.9	-8.63	-8.69	-9.04	-9.28	-9.51	-9.83	

5GHz WLAN 802.11ac Modulation Interference Factors

Mode	802.11n40 MIF Measurements [dB]								
	Data Rate [Mbps]								
	13.5	27	40.5	54	81	108	121.5	135	
802.11n	-8.95	-8.15	-8.34	-8.87	-9.81	-10.01	-10.23	-10.25	

5GHz WLAN 802.11n40 Modulation Interference Factors

Mode	802.11ac40 MIF Measurements [dB]									
	Data Rate [Mbps]									
	13.5	27	40.5	54	81	108	121.5	135	180	
802.11ac	-9	-8.12	-8.35	-8.82	-9.73	-9.84	-9.92	-9.98	-10.01	

5GHz WLAN 802.11ac40 Modulation Interference Factors

Mode	802.11ac80 MIF Measurements [dB]										
	Data Rate [Mbps]										
	29.3	58.5	87.8	117	175.5	234	263.3	292.5	351	390	
802.11ac	-8.33	-9.13	-10	-10.05	-10.23	-10.54	-10.48	-10.37	-10.42	-10.39	

5GHz WLAN 802.11ac80 Modulation Interference Factors

11. Analysis of RF Air interface Technologies

An analysis was performed, following the guidance of 4.3 and 4.4 of the ANSI standard, of the RF air interface technologies being evaluated. The factors that will affect the RF interference Potential were evaluated, and the worst case operating modes were identified and used in the evaluation. A WD's interference potential is a function both of the WD's average near-field field strength and of the signal's audio-frequency amplitude modulation characteristics. Per 4.4, RF air interface technologies that have low power have been found to produce sufficiently low RF interference potential, so it is possible to exempt them from the product testing specified in Clause 5 of the ANSI standard. An RF air interface technology of a device is exempt from testing When its average antenna input power plus its MIF is $\leq 17\text{dBm}$ for all of its operating modes.

The worst case MIF plus the worst case average antenna input power for all modes are investigated below to determine the testing requirements for this device.

11.1 Air Interfaces and Operating Mode

Air-Interface	Band (MHz)	Type	HAC Tested	Simultaneous Transmissions Note: Not to be tested	Name of Voice service	Power Reduction
GSM	850	VO	Yes	Yes: BT, WLAN	CMRS Voice	N/A
	1900					
	GPRS /EDGE	DT	N/A	Yes: BT, WLAN	google Duo	N/A
WCDMA	850	VO	No ¹	Yes: BT, WLAN	CMRS Voice	N/A
	1700					
	1900					
	HSPA	DT	N/A	Yes: BT, WLAN	google Duo	N/A
LTE (FDD)	700 (B12)	VD	No ¹	Yes: BT, WLAN	VOLTE,google Duo	N/A
	700 (B17)					
	780 (B13)					
	850 (B5)					
	1700 (B4)					
	1700 (B66)					
	1900 (B2)					
LTE (TDD)	2600 (B41)	VD	Yes	Yes: BT, WLAN	VOLTE,google Duo	Yes
WLAN	2450	VD	No ¹	Yes: GSM, WCDMA, or LTE	VoWIFI google Duo	Yes
	5200(UNII 1)					
	5300(UNII 2A)					
	5500(UNII 2C)					
	5800(UNII 3)					
BT	2450	DT	N/A	Yes: GSM, WCDMA, or LTE	N/A	N/A
Type Transport VO = CMRS Voice Service DT = Digital Transport VD = CMRS IP Voice Service and Digital Transport				Note 1. Evaluated for MIF and low power exemption.		

11.2 Individual Mode Evaluations

Air Interface	Maximum Average Power [dBm]	Worst case MIF [dBm]	Total (Power + MIF) [dBm]	C63.19 Testing Required
GSM850	34.0	3.53	37.53	Yes
GSM1900	30.5	3.53	34.03	Yes
UMTS Band 2	24.5	-22.48	2.02	No
UMTS Band 4	24.5	-22.64	1.86	No
UMTS Band 5	25.0	-22.58	2.42	No
LTE Band 2	24.5	-9.98	14.52	No
LTE Band 4	24.5	-10.27	14.23	No
LTE Band 5	25.0	-9.94	15.06	No
LTE Band 12	25.0	-10.83	14.17	No
LTE Band 13	25.0	-10.55	14.45	No
LTE Band 17	25.0	-9.74	15.26	No
LTE Band 41	21.5	-3.09	18.41	Yes
LTE Band 66	24.5	-10.08	14.42	No
802.11b(2.4GHz)	19.0	-9.83	9.17	No
802.11g(2.4GHz)	17.0	-8.47	8.53	No
802.11n (2.4GHz)	17.0	-8.56	8.44	No
802.11a(5GHz) _20 MHz	17.0	-8.47	8.53	No
802.11n (5GHz) _20 MHz	16.0	-8.63	7.37	No
802.11ac(5GHz) _20 MHz	16.0	-8.63	7.37	No
802.11n (5GHz) _40 MHz	15.0	-8.15	6.85	No
802.11ac(5GHz) _40 MHz	15.0	-8.12	6.88	No
802.11ac(5GHz) _80 MHz	14.0	-8.33	5.67	No

Max. Average Power + MIF calculations for Low Power Exemptions

Note(s):

1. WLAN, LTE Band 41 mode was applied RCV-On Back-off during the Voice call mode.
2. Max tune-up limit.

11.3 Low-Power Exemption Conclusions

Per ANSI C63.19-2011, RF Emissions testing for this device is required only for GSM, and LTE TDD voice modes. All other applicable air interfaces are exempt.

12. TEST PROCEDURE

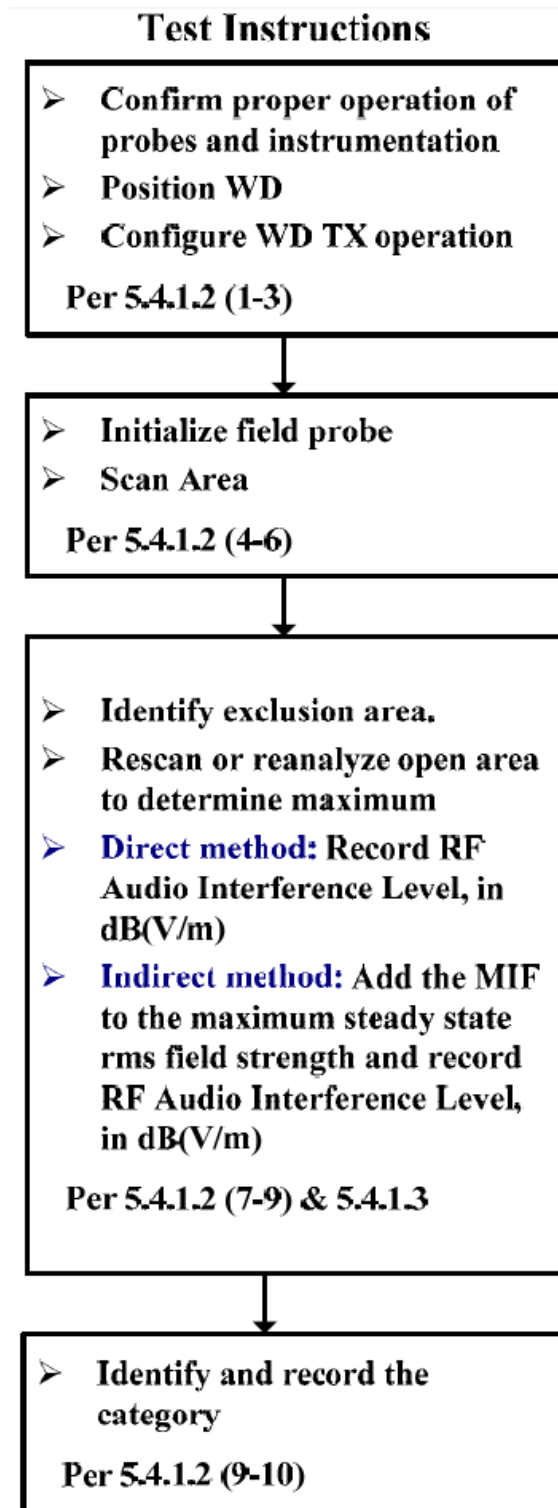


Figure 6. WD near-field emission automated test flowchart

The evaluation was performed with the following procedure:

1. Confirm proper operation of the field probe, probe measurement system and other instrumentation and the positioning system.
2. Position the WD in its intended test position. The measurement should be performed at a distance 1.5 cm from the probe elements so the gauge block can simplify this positioning.
3. Configure the WD normal operation for maximum rated RF output power, at the desired channel and other operating parameters, as intended for the test.
4. The center sub-grid shall be centered on the center of the WD output (acoustic or T-Coil output), as appropriate.
5. A Surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.
6. Locate the field probe at reference location and measure the field strength.
7. Scan the entire 5 cm by 5 cm region at 5 mm increments and record the reading at each measurement point.
8. Identify the maximum field reading within the non-excluded sub-grids identified in Step 7.
9. Move the probe to the location of maximum scan measurement and then 360° rotating the probe to align it for the maximum reading at that position.
10. Locate the field probe at the reference location and measure the field strength for drift evaluation. If conducted power deviations of more than 5 % occurred, the tests were repeated.
11. Convert the maximum field strength reading identified in Step 8 to V/m or A/m, as appropriate. For probes which require a probe modulation factor, this conversion shall be done using the appropriate probe modulation.
12. Repeat Step 1 through Step 11 for both the E-field measurements.

13. ANSI/IEEE C63.19 PERFORMANCE CATEGORIES

The EUT must meet the following M3 or M4 category:

Emission Categories	E-field emissions dB [V/m]	
	< 960 MHz	> 960 MHz
Category M1	50 to 55	40 to 45
Category M2	45 to 50	35 to 40
Category M3	40 to 45	30 to 35
Category M4	< 40	< 30

Telephone near-field categories in linear units

14. MEASUREMENT UNCERTAINTIES

Error Description	Uncertainty value [±%]	Probe Dist.	Div.	(Ci) E	(Ci) H	Std. Unc. E [±%]
Measurement System						
Probe Calibration	5.1	N	1	1	1	5.1
Axial Isotropy	4.7	R	$\sqrt{3}$	1	1	2.7
Sensor Displacement	16.5	R	$\sqrt{3}$	1	0.145	9.5
Boundary Effects	2.4	R	$\sqrt{3}$	1	1	1.4
Phantom Boundary Effect	7.2	R	$\sqrt{3}$	1	0	4.1
Linearity	4.7	R	$\sqrt{3}$	1	1	2.7
Scaling with PMR calibration	10.0	R	$\sqrt{3}$	1	1	5.8
System Detection Limit	1.0	R	$\sqrt{3}$	1	1	0.6
Readout Electronics	0.3	N	1	1	1	0.3
Response Time	0.8	R	$\sqrt{3}$	1	1	0.5
Integration Time	2.6	R	$\sqrt{3}$	1	1	1.5
RF Ambient Conditions	3.0	R	$\sqrt{3}$	1	1	1.7
RF Reflections	12	R	$\sqrt{3}$	1	1	6.9
Probe Positioner	1.2	R	$\sqrt{3}$	1	0.67	0.7
Probe Positioning	4.7	R	$\sqrt{3}$	1	0.67	2.7
Extrap. and Interpolation	1.0	R	$\sqrt{3}$	1	1	0.6
Test Sample Related						
Device Positioning Vertical	4.7	R	$\sqrt{3}$	1	0.67	2.7
Device Positioning Lateral	1.0	R	$\sqrt{3}$	1	1	0.6
Device Holder and Phantom	2.4	R	$\sqrt{3}$	1	1	1.4
Power Drift	5.0	R	$\sqrt{3}$	1	1	2.9
Phantom and Setup Related						
Phantom Thickness	2.4	R	$\sqrt{3}$	1	0.67	1.4
Combined Std. Uncertainty	(k=1)					16.3
Expanded Std. Uncertainty on Power	(Coverage Factor for 95%, k =2)					32.6
Expanded Std. Uncertainty on Field	(Coverage Factor for 95%)					16.3

15. HAC TEST DATA SUMMARY

E-Field Measurement Result (GSM850/GSM1900)

Mode	Channel	Conducted Power	Time Avg. Filed	Audio Inteferece Level	FCC Limit	FCC Margin	MIF	Result	Exclusion Block	Plot No.
		[dBm]	[V/m]	[dBV/m]	[dBV/m]	[dB]				
GSM 850	128	33.34	38.28	35.19	45	9.81	3.53	M4	none	1
	190	33.49	35.48	34.53	45	10.47	3.53	M4	none	2
	251	33.49	37.33	34.97	45	10.03	3.53	M4	none	3
GSM 1900	512	29.84	19.48	29.32	35	5.68	3.53	M4	none	4
	661	29.66	19.95	29.51	35	5.49	3.51	M4	none	5
	810	29.97	18.56	28.83	35	6.17	3.46	M4	none	6

E-Field Measurement Result (LTE TDD)

Mode	Channel	Modulation	BW	RB Size	RB offset	Time Avg. Filed	Audio Inteferece Level	FCC Limit	FCC Margin	MIF	Result	Exclusion Block	Plot No.
						[V/m]	[dBV/m]	[dBV/m]	[dB]				
LTE Band 41	39675	16QAM	5	1	24	24.27	24.59	35	10.41	-3.11	M4	none	7
	40148	16QAM	5	1	24	29.85	26.41	35	8.59	-3.09	M4	none	8
	40620	16QAM	5	1	24	35.44	27.90	35	7.1	-3.09	M4	none	9
	41093	16QAM	5	1	24	28.25	25.91	35	9.09	-3.11	M4	none	10
	41565	16QAM	5	1	24	24.43	24.66	35	10.34	-3.10	M4	none	11

16. HAC TEST EQUIPMENT Chamber LIST

The test sites and measurement facilities used to collect data are located at

SAR 1 Room(HAC)

17. HAC TEST EQUIPMENT LIST

Manufacturer	Type / Model	S/N	Calib. Date	Calib.Interval	Calib.Due
SPEAG	HAC Phantom	-	N/A	N/A	N/A
HP	SAR System Control PC	-	N/A	N/A	N/A
Staubli	TX90 XLSpeag	F11/5K3RA1/A/01	N/A	N/A	N/A
Staubli	CS8Cspeag-TX90	F11/5K3RA1/C/01	N/A	N/A	N/A
Staubli	Teach Pendant (Joystick)	S-1203 0309	N/A	N/A	N/A
SPEAG	DAE4	1417	01/25/2019	Annual	01/25/2020
SPEAG	E-Field Probe EF3DV3	4034	02/22/2019	Annual	02/22/2020
SPEAG	DAE4	868	09/04/2019	Annual	09/04/2020
SPEAG	E-Field Probe EF3DV3	4067	01/21/2020	Annual	01/21/2021
SPEAG	Dipole CD835V3	1024	02/22/2019	Annual	02/22/2020
SPEAG	Dipole CD1880V3	1019	02/22/2019	Annual	02/22/2020
SPEAG	Dipole CD2600V3	1019	09/19/2019	Annual	09/19/2020
SPEAG	Audio Interference Analyzer	1060	N/A	CBT*	N/A
Agilent	Power Meter E4419B	MY41291386	10/07/2019	Annual	10/07/2020
Agilent	Power Sensor 8481A	SG1091286	10/07/2019	Annual	10/07/2020
Agilent	Power Sensor 8481A	MY41090873	10/07/2019	Annual	10/07/2020
Agilent	Power Meter N1911A	MY45101406	09/10/2019	Annual	09/10/2020
Agilent	Power Sensor N1921A	MY55220026	09/06/2019	Annual	09/06/2020
Agilent	Signal Generator N5182A	MY47070230	05/08/2019	Annual	05/08/2020
Agilent	11636B/Power Divider	58698	02/28/2019	Annual	03/06/2020
TESTO	175-H1/Thermometer	40331949309	01/29/2019	Annual	01/29/2020
TESTO	175-H1/Thermometer	40331949309	01/29/2020	Annual	01/29/2021
EMPOWER	RF Power Amplifier / 2001-BBS3Q7EBK	1041D/C0508	07/03/2019	Annual	07/03/2020
MICRO LAB	LP Filter / LA-15N	10453	10/07/2019	Annual	10/07/2020
MICRO LAB	LP Filter / LA-30N	-	10/07/2019	Annual	10/07/2020
Apitech	Attenuator (3dB) 18B-03	1	06/04/2019	Annual	06/04/2020
Agilent	Attenuator (20dB) 33340C	13311	05/08/2019	Annual	05/08/2020
H.P	Attenuator (10dB) 8493C	07560	07/02/2019	Annual	07/02/2020
Agilent	Directional Bridge	3140A03878	06/12/2019	Annual	06/12/2020
Anritsu	Radio Communication Tester MT8821C	6201502997	08/09/2019	Annual	08/09/2020
Agilent	WIRELESS COMMUNICATION E5515C	MY48361100	10/07/2019	Annual	10/07/2020
Agilent	MXA Signal Analyzer N9020A	MY50510407	10/29/2019	Annual	10/29/2020

*Note: CBT (calibrated Before Testing).Prior to testing, AIA Perform self calibration procedures.

18. CONCLUSION

The HAC measurement indicates that the EUT complies with the HAC limits of the ANSI-C63.19-2011. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise Laboratory measures were taken to assure repeatability of the tests.

Attachment 1. HAC RF Emission Test Plots

Plot No.1

GSM850 E-Field 128ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 850 (0); Frequency: 824.2 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

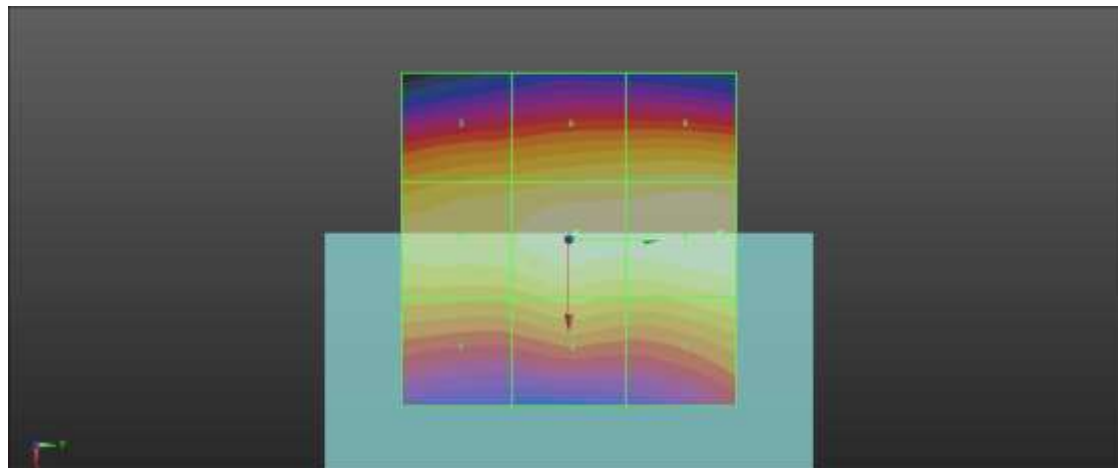
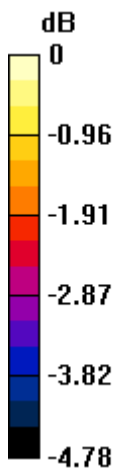
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 50.99 V/m; Power Drift = 0.01 dB
 Applied MIF = 3.53 dB
 RF audio interference level = 35.19 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 34.08 dBV/m	Grid 2 M4 34.85 dBV/m	Grid 3 M4 34.41 dBV/m
Grid 4 M4 34.4 dBV/m	Grid 5 M4 35.07 dBV/m	Grid 6 M4 34.66 dBV/m
Grid 7 M4 34.6 dBV/m	Grid 8 M4 35.19 dBV/m	Grid 9 M4 34.74 dBV/m

Cursor:

Total = 35.19 dBV/m
 E Category: M4
 Location: -1, 22.5, 7.7 mm



0 dB = 57.45 V/m = 35.19 dBV/m

Plot No.2

GSM850 E-Field 190ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 850 (0); Frequency: 836.6 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

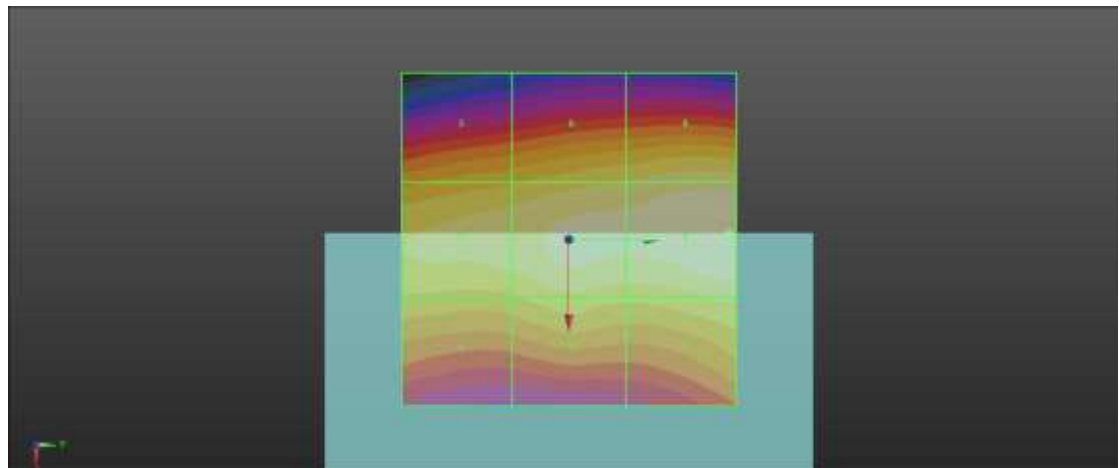
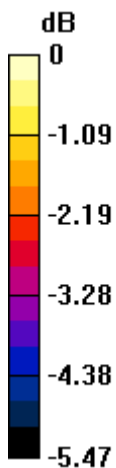
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 46.47 V/m; Power Drift = 0.02 dB
 Applied MIF = 3.53 dB
 RF audio interference level = 34.53 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 33.42 dBV/m	Grid 2 M4 34.01 dBV/m	Grid 3 M4 33.41 dBV/m
Grid 4 M4 33.77 dBV/m	Grid 5 M4 34.3 dBV/m	Grid 6 M4 33.84 dBV/m
Grid 7 M4 33.92 dBV/m	Grid 8 M4 34.53 dBV/m	Grid 9 M4 34.08 dBV/m

Cursor:

Total = 34.53 dBV/m
 E Category: M4
 Location: -1, 24, 7.7 mm



0 dB = 53.29 V/m = 34.53 dBV/m

Plot No.3

GSM850 E-Field 251ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 850 (0); Frequency: 848.8 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

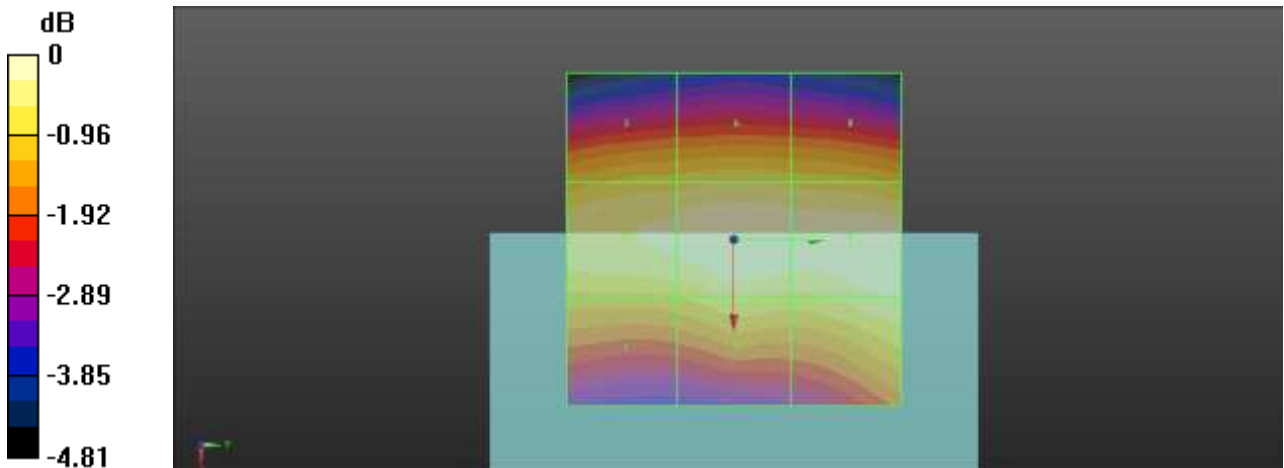
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 51.06 V/m; Power Drift = -0.05 dB
 Applied MIF = 3.53 dB
 RF audio interference level = 34.97 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 34.04 dBV/m	Grid 2 M4 34.75 dBV/m	Grid 3 M4 34.21 dBV/m
Grid 4 M4 34.42 dBV/m	Grid 5 M4 34.97 dBV/m	Grid 6 M4 34.35 dBV/m
Grid 7 M4 34.69 dBV/m	Grid 8 M4 34.95 dBV/m	Grid 9 M4 34.25 dBV/m

Cursor:

Total = 34.97 dBV/m
 E Category: M4
 Location: 0, 1, 7.7 mm



0 dB = 56.07 V/m = 34.97 dBV/m

Plot No.4

GSM1900 E-Field 512ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 1900 (0); Frequency: 1850.2 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

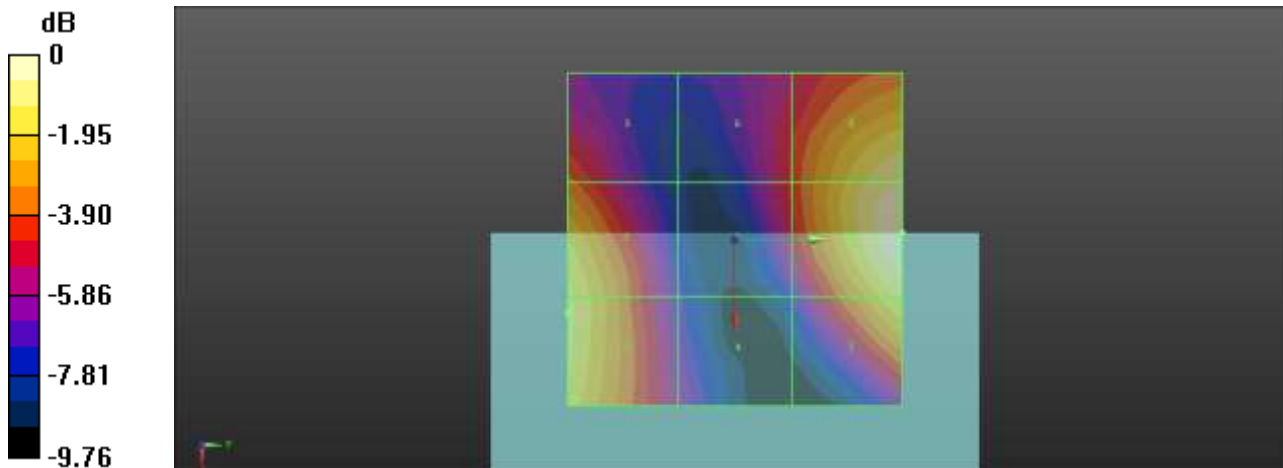
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 7.841 V/m; Power Drift = 0.14 dB
 Applied MIF = 3.53 dB
 RF audio interference level = 29.32 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 28.29 dBV/m	Grid 2 M4 28.21 dBV/m	Grid 3 M4 25.7 dBV/m
Grid 4 M4 23.45 dBV/m	Grid 5 M4 24.95 dBV/m	Grid 6 M4 24.94 dBV/m
Grid 7 M4 28.18 dBV/m	Grid 8 M4 29.32 dBV/m	Grid 9 M4 28.83 dBV/m

Cursor:

Total = 29.32 dBV/m
 E Category: M4
 Location: -1, 25, 7.7 mm



0 dB = 29.25 V/m = 29.32 dBV/m

Plot No.5

GSM1900 E-Field 661ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 1900 (0); Frequency: 1880 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

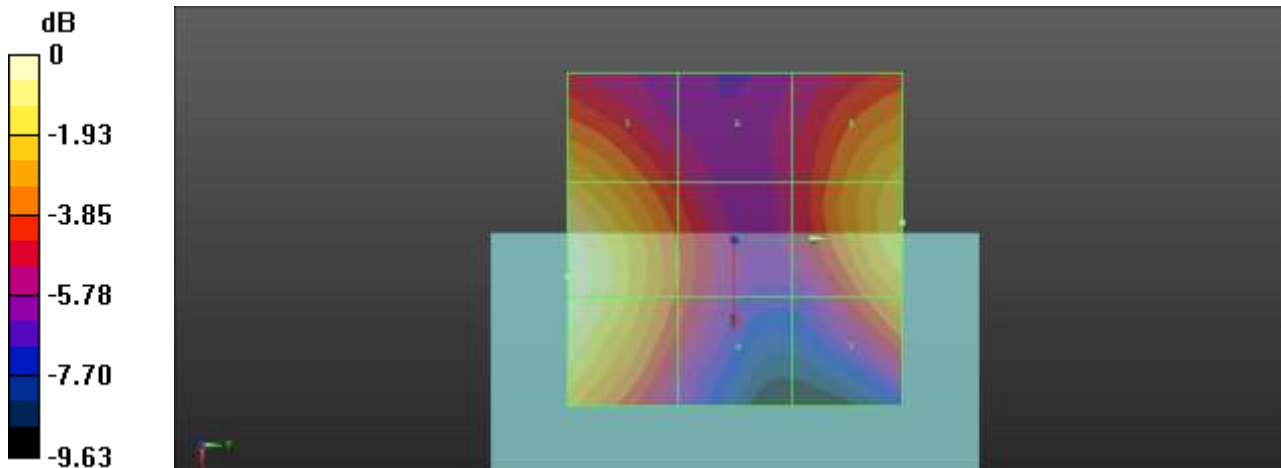
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 12.74 V/m; Power Drift = -0.08 dB
 Applied MIF = 3.51 dB
 RF audio interference level = 29.51 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 29.37 dBV/m	Grid 2 M4 29.51 dBV/m	Grid 3 M4 27.75 dBV/m
Grid 4 M4 25.52 dBV/m	Grid 5 M4 25.76 dBV/m	Grid 6 M4 24.72 dBV/m
Grid 7 M4 27.03 dBV/m	Grid 8 M4 28.23 dBV/m	Grid 9 M4 27.93 dBV/m

Cursor:

Total = 29.51 dBV/m
 E Category: M4
 Location: 5.5, -25, 7.7 mm



0 dB = 29.88 V/m = 29.51 dBV/m

Plot No.6

GSM1900 E-Field 810ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, GSM 1900 (0); Frequency: 1909.8 MHz;Duty Cycle: 1:8.30042
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

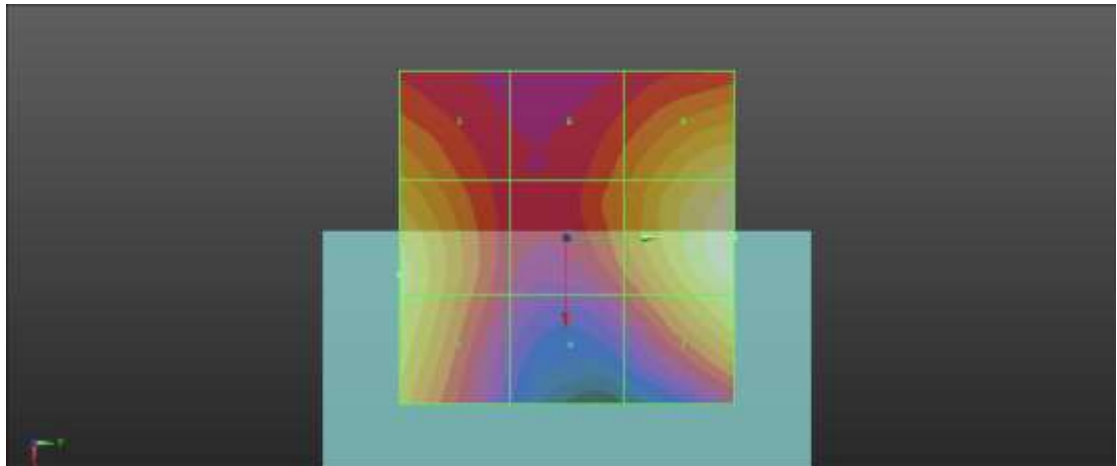
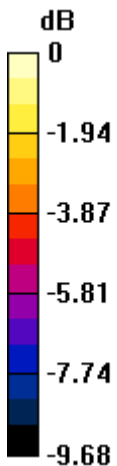
**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 13.23 V/m; Power Drift = 0.03 dB
 Applied MIF = 3.46 dB
 RF audio interference level = 28.83 dBV/m
Emission category: M4**

MIF scaled E-field

Grid 1 M4 27.74 dBV/m	Grid 2 M4 27.87 dBV/m	Grid 3 M4 26.46 dBV/m
Grid 4 M4 24.23 dBV/m	Grid 5 M4 25.63 dBV/m	Grid 6 M4 25.43 dBV/m
Grid 7 M4 28.1 dBV/m	Grid 8 M4 28.83 dBV/m	Grid 9 M4 28.08 dBV/m

Cursor:

Total = 28.83 dBV/m
 E Category: M4
 Location: 0, 25, 7.7 mm



0 dB = 27.63 V/m = 28.83 dBV/m

Plot No. 7

LTE Band 41 5MHz 16QAM 1RB 24offset 39675ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, LTE Band 41 FCC (0); Frequency: 2498.5 MHz;Duty Cycle: 1:1.58016
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

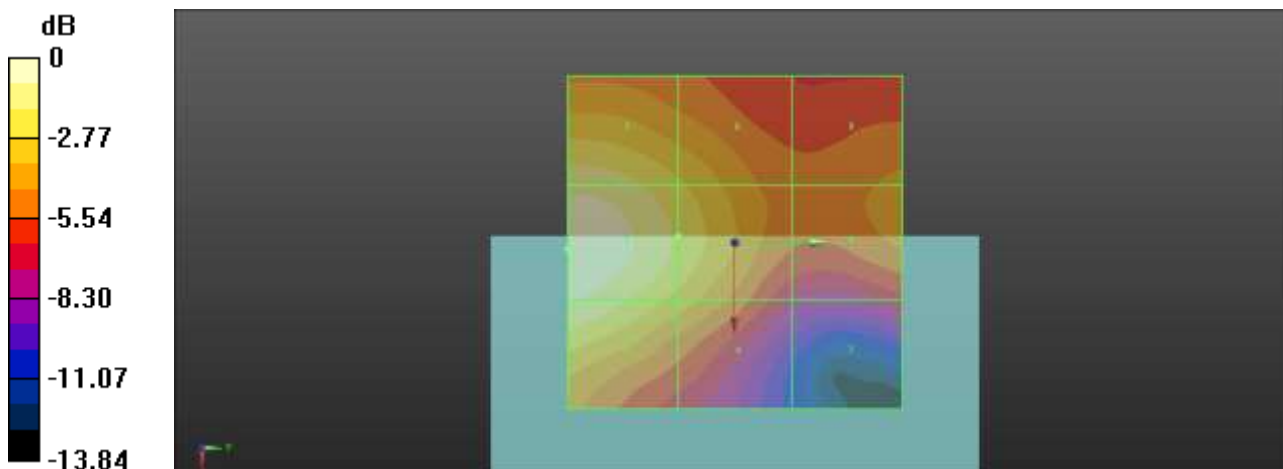
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 21.87 V/m; Power Drift = 0.04 dB
 Applied MIF = -3.11 dB
 RF audio interference level = 24.59 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 M4 23.84 dBV/m	Grid 2 M4 24.59 dBV/m	Grid 3 M4 23.41 dBV/m
Grid 4 M4 21.47 dBV/m	Grid 5 M4 22.6 dBV/m	Grid 6 M4 22 dBV/m
Grid 7 M4 17.99 dBV/m	Grid 8 M4 20.43 dBV/m	Grid 9 M4 20.22 dBV/m

Cursor:

Total = 24.59 dBV/m
 E Category: M4
 Location: 1, -25, 7.7 mm



0 dB = 16.96 V/m = 24.59 dBV/m

Plot No. 8

LTE Band 41 5MHz 16QAM 1RB 24offset 40148ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, LTE Band 41 FCC (0); Frequency: 2545.8 MHz;Duty Cycle: 1:1.58016
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

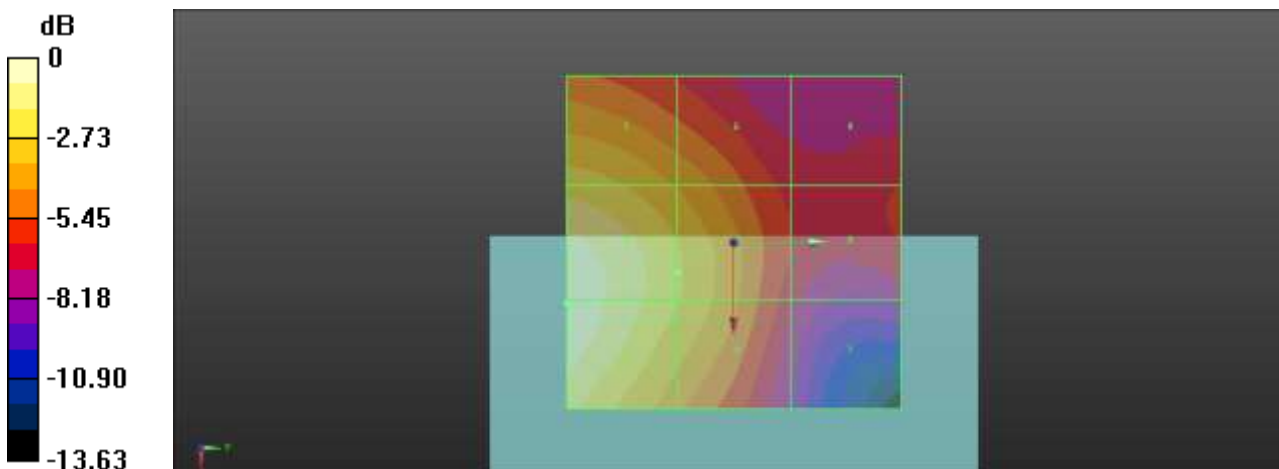
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 23.59 V/m; Power Drift = -0.14 dB
 Applied MIF = -3.09 dB
 RF audio interference level = 26.41 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 M4 26.41 dBV/m	Grid 2 M4 26.41 dBV/m	Grid 3 M4 24.28 dBV/m
Grid 4 M4 23.74 dBV/m	Grid 5 M4 23.85 dBV/m	Grid 6 M4 22.73 dBV/m
Grid 7 M4 19.46 dBV/m	Grid 8 M4 20.26 dBV/m	Grid 9 M4 20.12 dBV/m

Cursor:

Total = 26.41 dBV/m
 E Category: M4
 Location: 9, -25, 7.7 mm



0 dB = 20.92 V/m = 26.41 dBV/m

Plot No. 9

LTE Band 41 5MHz 16QAM 1RB 24offset 40620ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, LTE Band 41 (0); Frequency: 2593 MHz;Duty Cycle: 1:1.58016
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

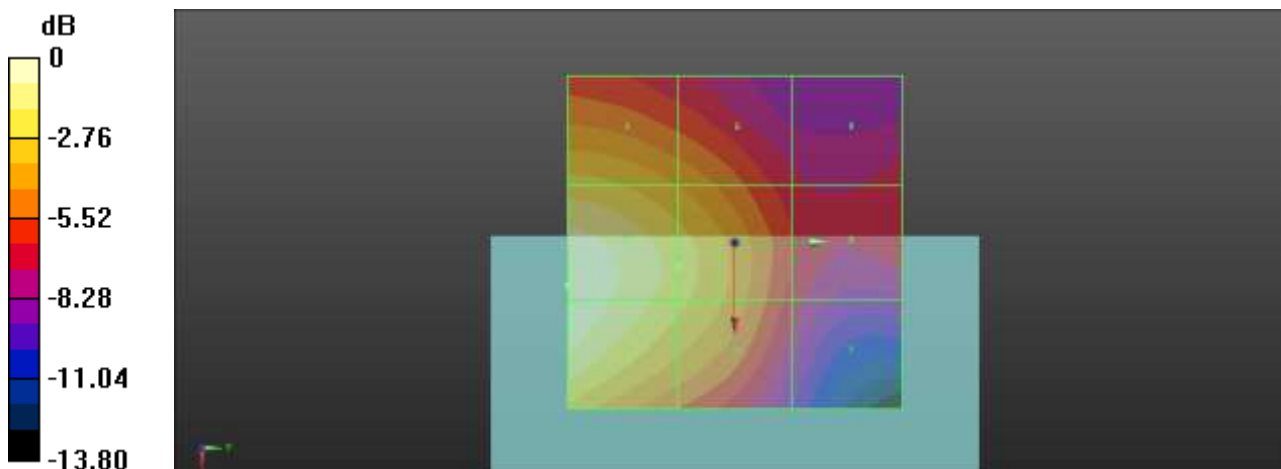
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 30.58 V/m; Power Drift = -0.01 dB
 Applied MIF = -3.09 dB
 RF audio interference level = 27.90 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 M4 27.86 dBV/m	Grid 2 M4 27.9 dBV/m	Grid 3 M4 25.59 dBV/m
Grid 4 M4 25.42 dBV/m	Grid 5 M4 25.66 dBV/m	Grid 6 M4 24.21 dBV/m
Grid 7 M4 21.08 dBV/m	Grid 8 M4 21.55 dBV/m	Grid 9 M4 21.03 dBV/m

Cursor:

Total = 27.90 dBV/m
 E Category: M4
 Location: 6.5, -25, 7.7 mm



0 dB = 24.82 V/m = 27.90 dBV/m

Plot No. 10

LTE Band 41 5MHz 16QAM 1RB 24offset 41093ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, LTE Band 41 FCC (0); Frequency: 2640.3 MHz;Duty Cycle: 1:1.58016
Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

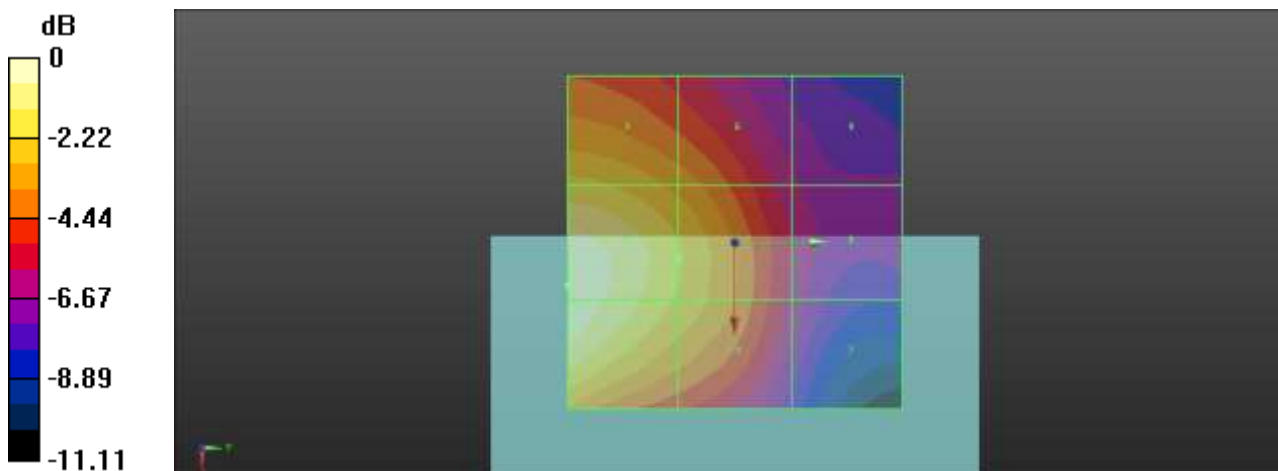
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
dx=0.5000 mm, dy=0.5000 mm
Device Reference Point: 0, 0, -6.3 mm
Reference Value = 24.32 V/m; Power Drift = -0.07 dB
Applied MIF = -3.11 dB
RF audio interference level = 25.91 dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 M4 25.86 dBV/m	Grid 2 M4 25.91 dBV/m	Grid 3 M4 23.96 dBV/m
Grid 4 M4 23.58 dBV/m	Grid 5 M4 23.8 dBV/m	Grid 6 M4 22.72 dBV/m
Grid 7 M4 19.75 dBV/m	Grid 8 M4 19.96 dBV/m	Grid 9 M4 19.48 dBV/m

Cursor:

Total = 25.91 dBV/m
E Category: M4
Location: 6.5, -25, 7.7 mm



0 dB = 19.75 V/m = 25.91 dBV/m

Plot No. 11

LTE Band 41 5MHz 16QAM 1RB 24offset 41565ch

DUT: SM-A315G/DSL;Type: Bar

Communication System: UID 0, LTE Band 41 FCC (0); Frequency: 2687.5 MHz;Duty Cycle: 1:1.58016
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

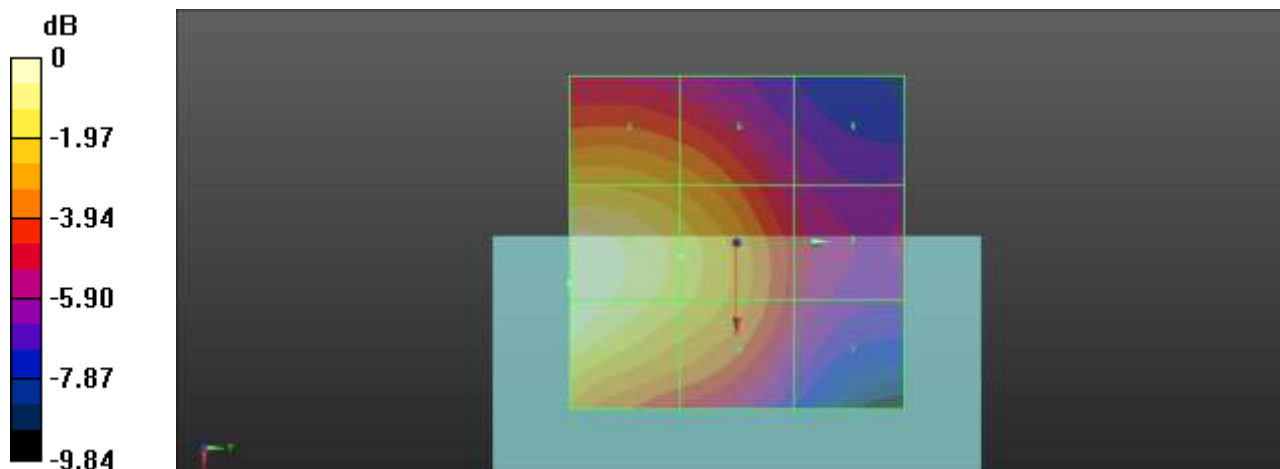
Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (101x101x1): Interpolated grid:
 dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 23.20 V/m; Power Drift = -0.12 dB
 Applied MIF = -3.10 dB
 RF audio interference level = **24.66** dBV/m
Emission category: M4

MIF scaled E-field

Grid 1 M4 24.6 dBV/m	Grid 2 M4 24.66 dBV/m	Grid 3 M4 22.71 dBV/m
Grid 4 M4 22.88 dBV/m	Grid 5 M4 23.16 dBV/m	Grid 6 M4 21.93 dBV/m
Grid 7 M4 19.61 dBV/m	Grid 8 M4 19.89 dBV/m	Grid 9 M4 19.06 dBV/m

Cursor:

Total = 24.66 dBV/m
 E Category: M4
 Location: 6, -25, 7.7 mm



0 dB = 17.09 V/m = 24.65 dBV/m

Attachment 2. System Validation Plots

DUT: HAC Dipole 835 MHz; Type: CD835V3

Communication System: UID 0, CW (0); Frequency: 835 MHz; Duty Cycle: 1:1
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (41x381x1): Interpolated grid:

dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 62.77 V/m; Power Drift = -0.00 dB
 Applied MIF = 0.00 dB
 RF audio interference level = 41.22 dBV/m

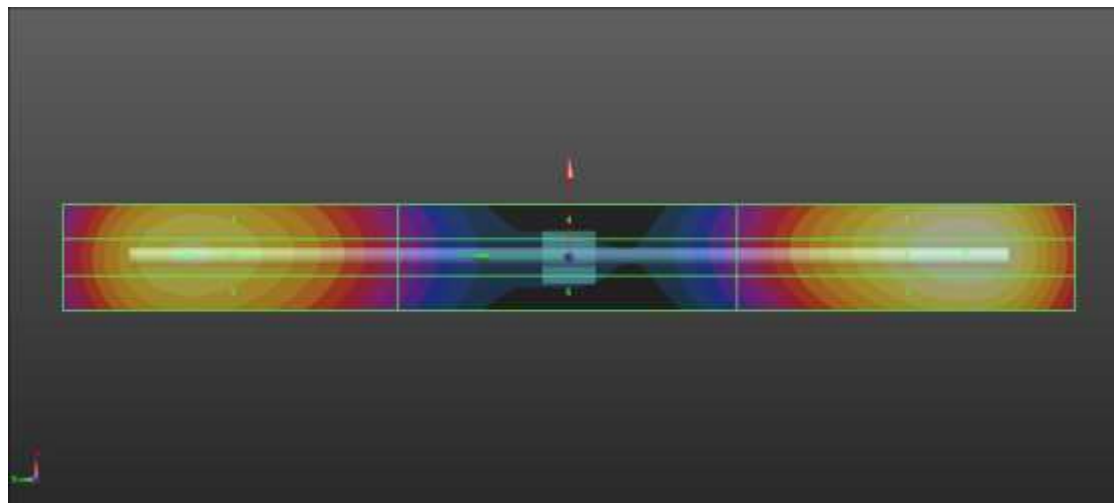
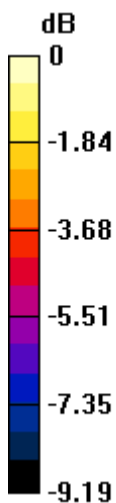
Emission category: M3

MIF scaled E-field

Grid 1 M3 41.14 dBV/m	Grid 2 M3 41.22 dBV/m	Grid 3 M3 40.91 dBV/m
Grid 4 M4 35.79 dBV/m	Grid 5 M4 35.87 dBV/m	Grid 6 M4 35.66 dBV/m
Grid 7 M4 39.98 dBV/m	Grid 8 M3 40.07 dBV/m	Grid 9 M4 39.87 dBV/m

Cursor:

Total = 41.22 dBV/m
 E Category: M3
 Location: 1, -74.5, 9.7 mm



0 dB = 115.1 V/m = 41.22 dBV/m

DUT: HAC Dipole 1880 MHz; Type: CD1880V3

Communication System: UID 0, CW (0); Frequency: 1880 MHz;Duty Cycle: 1:1
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2019-02-22;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 2019-01-25
- Phantom: HAC Test Arch with AMCC
- Measurement SW: DASY52, Version 52.8 (8);

**Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D:
 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (41x181x1): Interpolated grid:**

dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 66.62 V/m; Power Drift = -0.01 dB
 Applied MIF = 0.00 dB
 RF audio interference level = 38.44 dBV/m

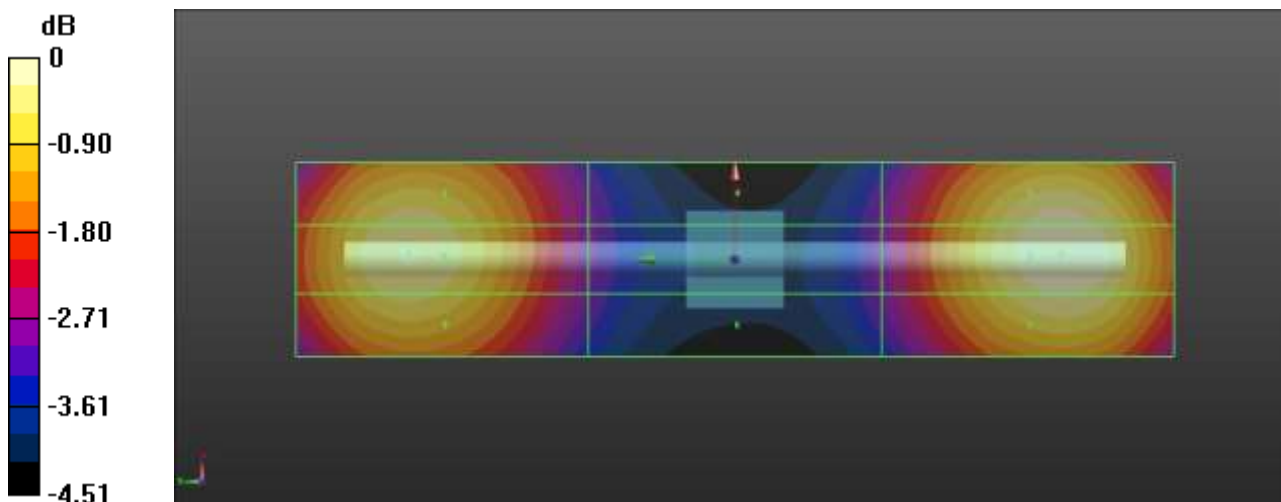
Emission category: M2

MIF scaled E-field

Grid 1 M2 38.33 dBV/m	Grid 2 M2 38.44 dBV/m	Grid 3 M2 38.21 dBV/m
Grid 4 M2 35.57 dBV/m	Grid 5 M2 35.58 dBV/m	Grid 6 M2 35.5 dBV/m
Grid 7 M2 38.03 dBV/m	Grid 8 M2 38.15 dBV/m	Grid 9 M2 37.94 dBV/m

Cursor:

Total = 38.44 dBV/m
 E Category: M2
 Location: 0.5, -33.5, 9.7 mm



0 dB = 83.52 V/m = 38.44 dBV/m

DUT: HAC Dipole 2600 MHz; Type: CD2600V3

Communication System: UID 0, CW (0); Frequency: 2600 MHz;Duty Cycle: 1:1
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Emission Section

DASY Configuration:

- Probe: EF3DV3 - SN4067; ConvF(1, 1, 1); Calibrated: 2020-01-21;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn868; Calibrated: 2019-09-04
- Phantom: HAC Test Arch with AMCC
- easurement SW: DASY52, Version 52.8 (8);

Device E-Field measurement (E-field scan for ANSI C63.19-2007 & -2011 compliance)/E Scan - ER3D: 15 mm from Probe Center to the Device/Hearing Aid Compatibility Test (41x181x1): Interpolated grid:

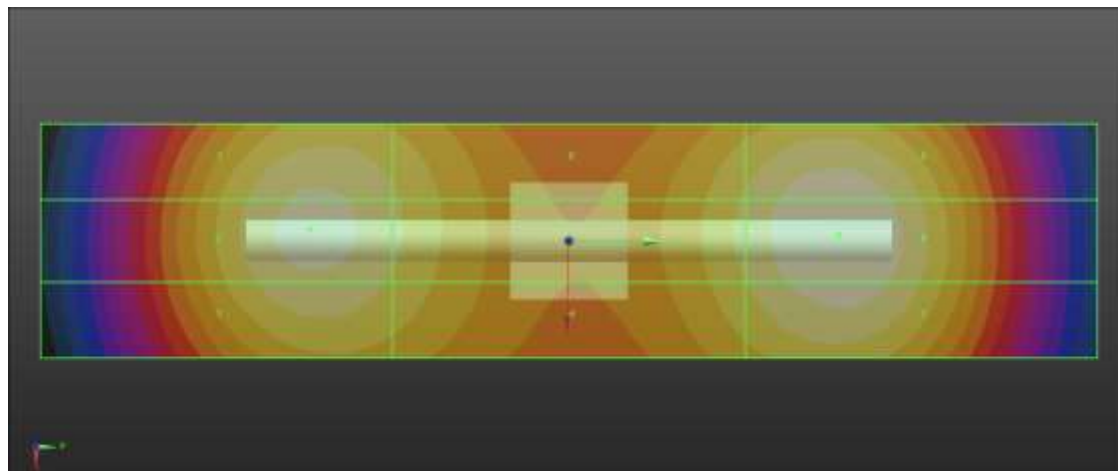
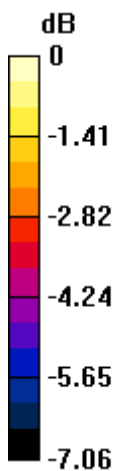
dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 78.14 V/m; Power Drift = -0.04 dB
 Applied MIF = 0.00 dB
 RF audio interference level = 38.94 dBV/m
Emission category: M2

MIF scaled E-field

Grid 1 M2 38.38 dBV/m	Grid 2 M2 38.63 dBV/m	Grid 3 M2 38.55 dBV/m
Grid 4 M2 37.99 dBV/m	Grid 5 M2 38.15 dBV/m	Grid 6 M2 38.08 dBV/m
Grid 7 M2 38.74 dBV/m	Grid 8 M2 38.94 dBV/m	Grid 9 M2 38.81 dBV/m

Cursor:

Total = 38.94 dBV/m
 E Category: M2
 Location: -0.5, 23, 9.7 mm



0 dB = 88.51 V/m = 38.94 dBV/m

Attachment 3. Probe Calibration Data

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



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

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

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **EF3-4067_Jan20**

CALIBRATION CERTIFICATE

Object: **EF3DV3- SN:4067**

Calibration procedure(s): **QA CAL-02.v9, QA CAL-25.v7**
Calibration procedure for E-field probes optimized for close near field evaluations in air



Calibration date: **January 21, 2020**

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

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

Calibration Equipment used (MATE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104776	03-Apr-19 (No. 217-02892/02893)	Apr-20
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-19 (No. 217-02894)	Apr-20
DAE4	SN: 789	27-Dec-19 (No. DAE4-799_Dec19)	Dec-20
Reference Probe ER3DV6	SN: 2328	05-Oct-19 (No. ER3-2328_Oct19)	Oct-20
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-18)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-18)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

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

Issued: January 21, 2020

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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



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

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

Accreditation No.: **SCS 0108**

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
E _n	incident E-field orientation normal to probe axis
E _p	incident E-field orientation parallel to probe axis
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASYS system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- b) CTIA Test Plan for Hearing Aid Compatibility, Rev 3.1.1, May 2017

Methods Applied and Interpretation of Parameters:

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

EF3DV3 – SN:4067

January 21, 2020

DASY/EASY - Parameters of Probe: EF3DV3 - SN:4067

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$)	0.82	1.04	1.12	$\pm 10.1\%$
DCP (mV) ^b	96.5	98.0	97.8	

Calibration results for Frequency Response (30 MHz – 6 GHz)

Frequency MHz	Target E-Field V/m	Measured E-field (En) V/m	Deviation E-normal in %	Measured E-field (Ep) V/m	Deviation E-normal in %	Unc (k=2) %
30	77.3	77.2	-0.2%	77.4	0.1%	$\pm 5.1\%$
100	77.3	78.3	1.3%	77.7	0.5%	$\pm 5.1\%$
450	77.1	78.1	1.3%	77.6	0.6%	$\pm 5.1\%$
600	77.1	77.8	0.9%	77.3	0.2%	$\pm 5.1\%$
750	77.2	77.7	0.7%	77.2	0.1%	$\pm 5.1\%$
1800	143.3	139.4	-2.7%	139.7	-2.5%	$\pm 5.1\%$
2000	135.2	131.6	-2.6%	131.8	-2.5%	$\pm 5.1\%$
2200	127.7	123.6	-3.2%	124.9	-2.2%	$\pm 5.1\%$
2500	124.9	122.0	-2.4%	123.2	-1.4%	$\pm 5.1\%$
3000	79.5	75.8	-4.7%	76.9	-3.3%	$\pm 5.1\%$
3500	256.1	247.8	-3.3%	245.7	-4.1%	$\pm 5.1\%$
3700	250.9	240.2	-4.2%	238.3	-5.0%	$\pm 5.1\%$
5200	49.1	49.6	1.0%	49.9	1.6%	$\pm 5.1\%$
5500	49.6	49.3	-0.6%	48.3	-2.6%	$\pm 5.1\%$
5800	48.9	48.7	-0.5%	49.6	1.4%	$\pm 5.1\%$

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

^a Numerical linearization parameter: uncertainty not required.

^b Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EF3DV3 – SN:4067

January 21, 2020

DASY/EASY - Parameters of Probe: EF3DV3 - SN:4067

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB μ V	C	D dB	VR mV	Max dev.	Max Unc [§] (k=2)
0	CW	X	0.00	0.00	1.00	0.00	177.6	± 3.3 %	± 4.7 %
		Y	0.00	0.00	1.00		152.8		
		Z	0.00	0.00	1.00		163.5		
10352- AAA	Pulse Waveform (200Hz, 10%)	X	2.18	64.04	8.60	10.00	60.0	± 3.3 %	± 9.6 %
		Y	15.00	87.86	20.30		60.0		
		Z	6.00	74.00	13.00		60.0		
10353- AAA	Pulse Waveform (200Hz, 20%)	X	1.25	62.48	6.86	6.99	80.0	± 1.2 %	± 9.6 %
		Y	15.00	89.21	19.61		80.0		
		Z	1.58	64.33	8.01		80.0		
10354- AAA	Pulse Waveform (200Hz, 40%)	X	0.58	60.83	5.06	3.98	95.0	± 0.8 %	± 9.6 %
		Y	15.00	91.48	19.15		95.0		
		Z	0.80	62.99	6.47		95.0		
10355- AAA	Pulse Waveform (200Hz, 60%)	X	0.34	60.37	3.95	2.22	120.0	± 0.8 %	± 9.6 %
		Y	15.00	93.61	18.77		120.0		
		Z	0.29	60.17	4.52		120.0		
10387- AAA	QPSK Waveform, 1 MHz	X	0.41	60.00	4.86	0.00	150.0	± 2.9 %	± 9.6 %
		Y	0.74	62.51	8.98		150.0		
		Z	0.39	60.00	4.53		150.0		
10388- AAA	QPSK Waveform, 10 MHz	X	2.22	69.47	16.53	0.00	150.0	± 1.1 %	± 9.6 %
		Y	2.45	69.80	16.62		150.0		
		Z	2.12	69.01	16.41		150.0		
10396- AAA	64-QAM Waveform, 100 kHz	X	2.15	67.85	17.89	3.01	150.0	± 1.4 %	± 9.6 %
		Y	3.07	72.14	19.83		150.0		
		Z	1.87	65.32	16.58		150.0		
10399- AAA	64-QAM Waveform, 40 MHz	X	3.42	67.33	16.01	0.00	150.0	± 1.8 %	± 9.6 %
		Y	3.44	66.91	15.76		150.0		
		Z	3.31	66.94	15.84		150.0		
10414- AAA	WLAN CCDF, 64-QAM, 40MHz	X	4.68	66.05	15.87	0.00	150.0	± 3.4 %	± 9.6 %
		Y	4.75	65.40	15.50		150.0		
		Z	4.52	65.68	15.66		150.0		

Note: For details on UID parameters see Appendix

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

[§] Numerical linearization parameter: uncertainty not required.

[§] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EF3DV3 – SN:4067

January 21, 2020

DASY/EASY - Parameters of Probe: EF3DV3 - SN:4067

Sensor Frequency Model Parameters

	Sensor X	Sensor Y	Sensor Z
Frequency Corr. (LF)	0.03	-0.01	5.32
Frequency Corr. (HF)	2.82	2.82	2.82

Sensor Model Parameters

	C1 fF	C2 fF	α V ⁻¹	T1 ms.V ⁻²	T2 ms.V ⁻¹	T3 ms	T4 V ⁻²	T5 V ⁻¹	T6
X	31.6	210.04	37.15	7.16	0.00	4.98	0.31	0.12	1.00
Y	47.3	311.71	36.52	11.88	0.52	5.07	0.68	0.28	1.01
Z	28.9	189.77	36.39	6.76	0.00	4.98	0.00	0.14	1.00

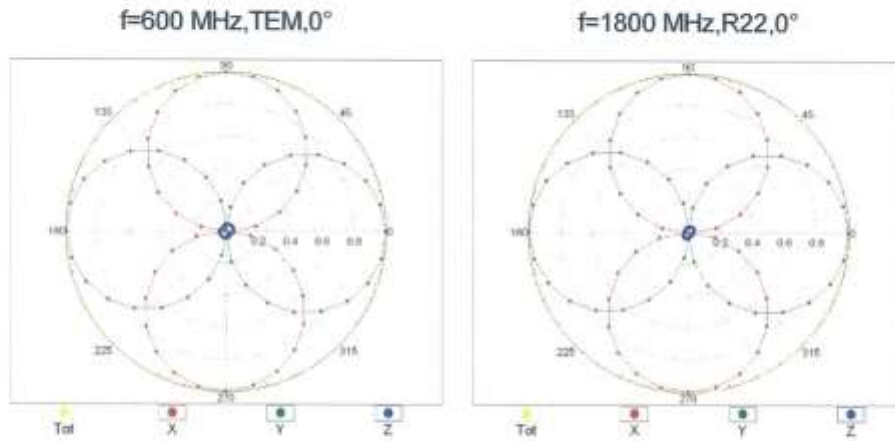
Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	82.8
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	12 mm
Tip Length	25 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm
Probe Tip to Sensor Z Calibration Point	1.5 mm

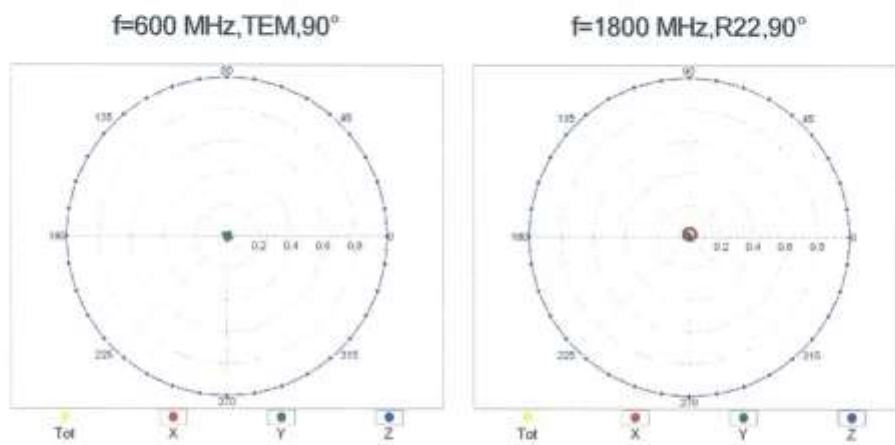
EF3DV3 – SN:4067

January 21, 2020

Receiving Pattern (ϕ), $\theta = 0^\circ$



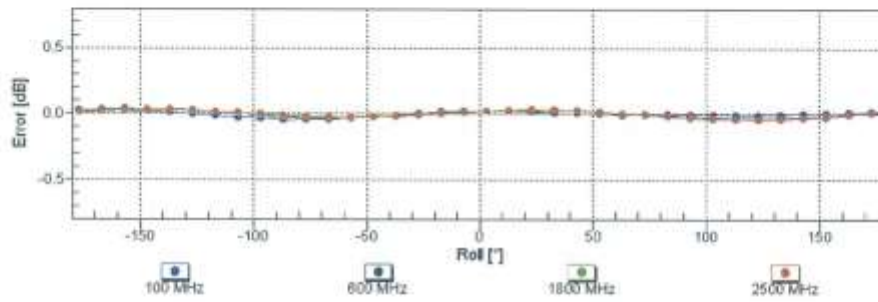
Receiving Pattern (ϕ), $\theta = 90^\circ$



EF3DV3 – SN:4067

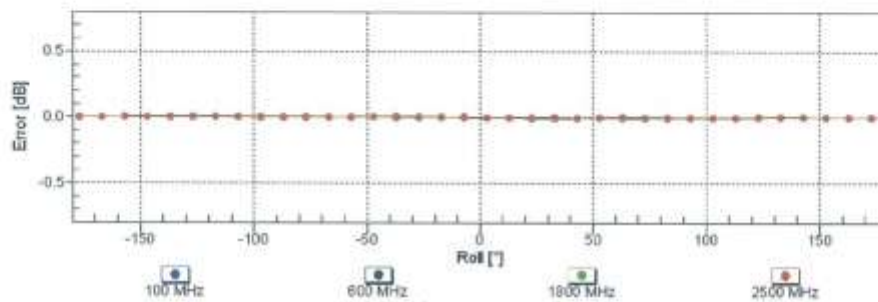
January 21, 2020

Receiving Pattern (ϕ), $\vartheta = 0^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

Receiving Pattern (ϕ), $\vartheta = 90^\circ$

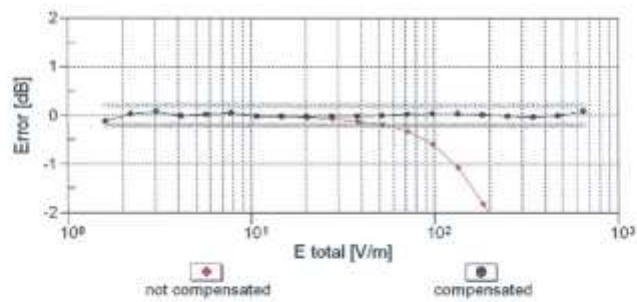
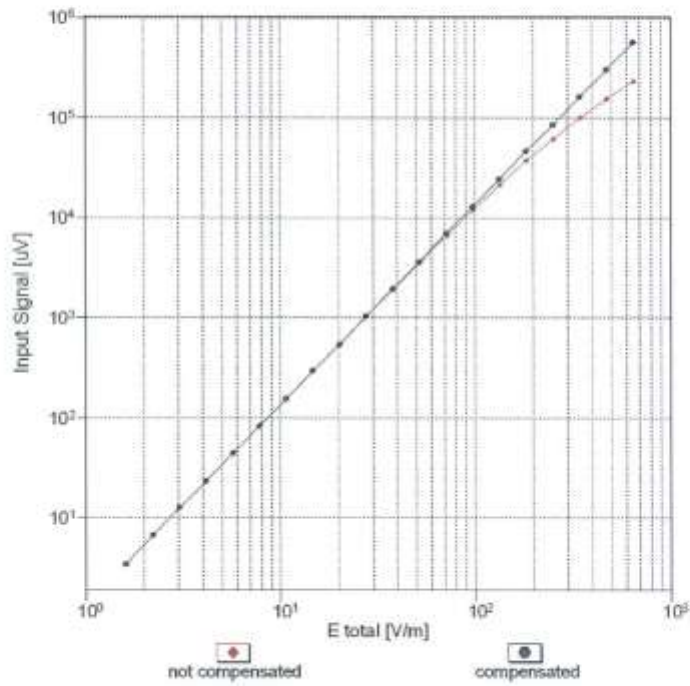


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)

EF3DV3 – SN:4067

January 21, 2020

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

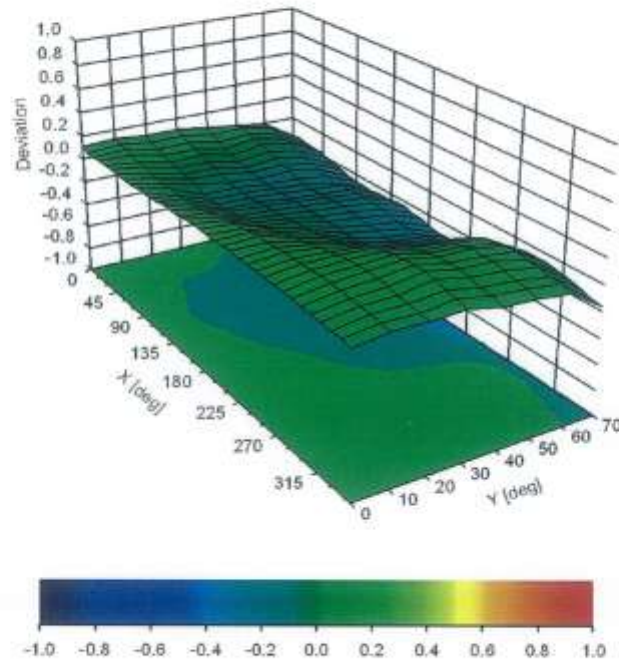


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

EF3DV3 – SN:4067

January 21, 2020

Deviation from Isotropy in Air Error (ϕ , θ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)

EF3DV3 – SN:4067

January 21, 2020

Appendix: Modulation Calibration Parameters

UID	Rev	Communication System Name	Group	PAR (dB)	Unc [±] (k=2)
0		CW	CW	0.00	± 4.7 %
10010	CAA	SAR Validation (Square, 100ms, 10ms)	Test	10.00	± 9.6 %
10011	CAB	UMTS-FDD (WCDMA)	WCDMA	2.91	± 9.6 %
10012	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	WLAN	1.87	± 9.6 %
10013	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	WLAN	9.46	± 9.6 %
10021	DAC	GSM-FDD (TDMA, GMSK)	GSM	9.39	± 9.6 %
10023	DAC	GPRS-FDD (TDMA, GMSK, TN 0)	GSM	9.57	± 9.6 %
10024	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1)	GSM	6.56	± 9.6 %
10025	DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	GSM	12.62	± 9.6 %
10026	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1)	GSM	9.55	± 9.6 %
10027	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	GSM	4.80	± 9.6 %
10028	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	GSM	3.55	± 9.6 %
10029	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	GSM	7.78	± 9.6 %
10030	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH1)	Bluetooth	5.30	± 9.6 %
10031	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH3)	Bluetooth	1.87	± 9.6 %
10032	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	Bluetooth	1.16	± 9.6 %
10033	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1)	Bluetooth	7.74	± 9.6 %
10034	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3)	Bluetooth	4.53	± 9.6 %
10035	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5)	Bluetooth	3.83	± 9.6 %
10036	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH1)	Bluetooth	8.01	± 9.6 %
10037	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH3)	Bluetooth	4.77	± 9.6 %
10038	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH5)	Bluetooth	4.10	± 9.6 %
10039	CAB	CDMA2000 (1xRTT, RC1)	CDMA2000	4.57	± 9.6 %
10042	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate)	AMPS	7.78	± 9.6 %
10044	CAA	IS-91/EIA/TIA-553 FDD (FDMA, FM)	AMPS	0.00	± 9.6 %
10048	CAA	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	DECT	13.80	± 9.6 %
10049	CAA	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	DECT	10.79	± 9.6 %
10056	CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	TD-SCDMA	11.01	± 9.6 %
10058	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	GSM	6.52	± 9.6 %
10059	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)	WLAN	2.12	± 9.6 %
10060	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)	WLAN	2.83	± 9.6 %
10061	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	WLAN	3.60	± 9.6 %
10062	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	WLAN	6.68	± 9.6 %
10063	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)	WLAN	8.63	± 9.6 %
10064	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)	WLAN	9.09	± 9.6 %
10065	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)	WLAN	9.00	± 9.6 %
10066	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)	WLAN	9.38	± 9.6 %
10067	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)	WLAN	10.12	± 9.6 %
10068	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)	WLAN	10.24	± 9.6 %
10069	CAC	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	WLAN	10.56	± 9.6 %
10071	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)	WLAN	9.83	± 9.6 %
10072	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps)	WLAN	9.62	± 9.6 %
10073	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps)	WLAN	9.94	± 9.6 %
10074	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps)	WLAN	10.30	± 9.6 %
10075	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps)	WLAN	10.77	± 9.6 %
10076	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps)	WLAN	10.94	± 9.6 %
10077	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	WLAN	11.00	± 9.6 %
10081	CAB	CDMA2000 (1xRTT, RC3)	CDMA2000	3.97	± 9.6 %
10082	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate)	AMPS	4.77	± 9.6 %
10090	DAC	GPRS-FDD (TDMA, GMSK, TN 0-4)	GSM	6.56	± 9.6 %
10097	CAB	UMTS-FDD (HSDPA)	WCDMA	3.98	± 9.6 %
10098	CAB	UMTS-FDD (HSUPA, Subtest 2)	WCDMA	3.98	± 9.6 %
10099	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-4)	GSM	9.55	± 9.6 %
10100	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	LTE-FDD	5.67	± 9.6 %
10101	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	LTE-FDD	6.42	± 9.6 %
10102	CAE	LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	LTE-FDD	6.60	± 9.6 %
10103	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK)	LTE-TDD	9.29	± 9.6 %
10104	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM)	LTE-TDD	9.97	± 9.6 %
10105	CAG	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM)	LTE-TDD	10.01	± 9.6 %
10108	CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	LTE-FDD	5.80	± 9.6 %

EF3DV3 - SN:4067

January 21, 2020

10109	CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	LTE-FDD	6.43	±9.6%
10110	CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	LTE-FDD	5.75	±9.6%
10111	CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	LTE-FDD	6.44	±9.6%
10112	CAG	LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	LTE-FDD	6.59	±9.6%
10113	CAG	LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	LTE-FDD	6.62	±9.6%
10114	CAC	IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)	WLAN	8.10	±9.6%
10115	CAC	IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM)	WLAN	8.46	±9.6%
10116	CAC	IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM)	WLAN	8.15	±9.6%
10117	CAC	IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK)	WLAN	8.07	±9.6%
10118	CAC	IEEE 802.11n (HT Mixed, 81 Mbps, 16-QAM)	WLAN	8.59	±9.6%
10119	CAC	IEEE 802.11n (HT Mixed, 135 Mbps, 64-QAM)	WLAN	8.13	±9.6%
10140	CAE	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM)	LTE-FDD	6.49	±9.6%
10141	CAE	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM)	LTE-FDD	6.53	±9.6%
10142	CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	LTE-FDD	5.73	±9.6%
10143	CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	LTE-FDD	6.35	±9.6%
10144	CAE	LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)	LTE-FDD	6.65	±9.6%
10145	CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	LTE-FDD	5.76	±9.6%
10146	CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	LTE-FDD	6.41	±9.6%
10147	CAF	LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM)	LTE-FDD	6.72	±9.6%
10149	CAE	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	LTE-FDD	6.42	±9.6%
10150	CAE	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	LTE-FDD	6.60	±9.6%
10151	CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	LTE-TDD	9.28	±9.6%
10152	CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM)	LTE-TDD	9.92	±9.6%
10153	CAG	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM)	LTE-TDD	10.05	±9.6%
10154	CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	LTE-FDD	5.75	±9.6%
10155	CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	LTE-FDD	6.43	±9.6%
10156	CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	LTE-FDD	5.79	±9.6%
10157	CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	LTE-FDD	6.49	±9.6%
10158	CAG	LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	LTE-FDD	6.62	±9.6%
10159	CAG	LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	LTE-FDD	6.56	±9.6%
10160	CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	LTE-FDD	5.82	±9.6%
10161	CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)	LTE-FDD	6.43	±9.6%
10162	CAE	LTE-FDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)	LTE-FDD	6.58	±9.6%
10166	CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	LTE-FDD	5.46	±9.6%
10167	CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	LTE-FDD	6.21	±9.6%
10168	CAF	LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM)	LTE-FDD	6.79	±9.6%
10169	CAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	LTE-FDD	5.73	±9.6%
10170	CAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	LTE-FDD	6.52	±9.6%
10171	AAE	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	LTE-FDD	6.49	±9.6%
10172	CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)	LTE-TDD	9.21	±9.6%
10173	CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	LTE-TDD	9.48	±9.6%
10174	CAG	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)	LTE-TDD	10.25	±9.6%
10175	CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	LTE-FDD	5.72	±9.6%
10176	CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	LTE-FDD	6.52	±9.6%
10177	CAI	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	LTE-FDD	5.73	±9.6%
10178	CAG	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	LTE-FDD	6.52	±9.6%
10179	CAG	LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	LTE-FDD	6.50	±9.6%
10180	CAG	LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	LTE-FDD	6.50	±9.6%
10181	CAE	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	LTE-FDD	5.72	±9.6%
10182	CAE	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	LTE-FDD	6.52	±9.6%
10183	AAD	LTE-FDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)	LTE-FDD	6.50	±9.6%
10184	CAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	LTE-FDD	5.73	±9.6%
10185	CAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	LTE-FDD	6.51	±9.6%
10186	AAE	LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM)	LTE-FDD	6.50	±9.6%
10187	CAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	LTE-FDD	5.73	±9.6%
10188	CAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	LTE-FDD	6.52	±9.6%
10189	AAF	LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM)	LTE-FDD	6.50	±9.6%
10193	CAC	IEEE 802.11n (HT Greenfield, 6.5 Mbps, BPSK)	WLAN	8.09	±9.6%
10194	CAC	IEEE 802.11n (HT Greenfield, 39 Mbps, 16-QAM)	WLAN	8.12	±9.6%
10195	CAC	IEEE 802.11n (HT Greenfield, 65 Mbps, 64-QAM)	WLAN	8.21	±9.6%
10196	CAC	IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK)	WLAN	8.10	±9.6%
10197	CAC	IEEE 802.11n (HT Mixed, 39 Mbps, 16-QAM)	WLAN	8.13	±9.6%
10198	CAC	IEEE 802.11n (HT Mixed, 65 Mbps, 64-QAM)	WLAN	8.27	±9.6%
10219	CAC	IEEE 802.11n (HT Mixed, 7.2 Mbps, BPSK)	WLAN	8.03	±9.6%

EF3DV3 – SN:4067

January 21, 2020

10220	CAC	IEEE 802.11n (HT Mixed, 43.3 Mbps, 16-QAM)	WLAN	8.13	±9.6%
10221	CAC	IEEE 802.11n (HT Mixed, 72.2 Mbps, 64-QAM)	WLAN	8.27	±9.6%
10222	CAC	IEEE 802.11n (HT Mixed, 15 Mbps, BPSK)	WLAN	8.06	±9.6%
10223	CAC	IEEE 802.11n (HT Mixed, 90 Mbps, 16-QAM)	WLAN	8.48	±9.6%
10224	CAC	IEEE 802.11n (HT Mixed, 150 Mbps, 64-QAM)	WLAN	8.08	±9.6%
10225	CAB	UMTS-FDD (HSPA+)	WCDMA	5.97	±9.6%
10226	CAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)	LTE-TDD	9.49	±9.6%
10227	CAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM)	LTE-TDD	10.26	±9.6%
10228	CAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)	LTE-TDD	9.22	±9.6%
10229	CAD	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)	LTE-TDD	9.48	±9.6%
10230	CAD	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM)	LTE-TDD	10.25	±9.6%
10231	CAD	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, QPSK)	LTE-TDD	9.19	±9.6%
10232	CAG	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)	LTE-TDD	9.48	±9.6%
10233	CAG	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)	LTE-TDD	10.25	±9.6%
10234	CAG	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK)	LTE-TDD	9.21	±9.6%
10235	CAG	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)	LTE-TDD	9.48	±9.6%
10236	CAG	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)	LTE-TDD	10.25	±9.6%
10237	CAG	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)	LTE-TDD	9.21	±9.6%
10238	CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM)	LTE-TDD	9.48	±9.6%
10239	CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM)	LTE-TDD	10.25	±9.6%
10240	CAF	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK)	LTE-TDD	9.21	±9.6%
10241	CAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM)	LTE-TDD	9.82	±9.6%
10242	CAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM)	LTE-TDD	9.86	±9.6%
10243	CAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)	LTE-TDD	9.46	±9.6%
10244	CAD	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	LTE-TDD	10.06	±9.6%
10245	CAD	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM)	LTE-TDD	10.06	±9.6%
10246	CAD	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	LTE-TDD	9.30	±9.6%
10247	CAG	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)	LTE-TDD	9.91	±9.6%
10248	CAG	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)	LTE-TDD	10.09	±9.6%
10249	CAG	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, QPSK)	LTE-TDD	9.29	±9.6%
10250	CAG	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)	LTE-TDD	9.81	±9.6%
10251	CAG	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)	LTE-TDD	10.17	±9.6%
10252	CAG	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK)	LTE-TDD	9.24	±9.6%
10253	CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM)	LTE-TDD	9.90	±9.6%
10254	CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM)	LTE-TDD	10.14	±9.6%
10255	CAF	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, QPSK)	LTE-TDD	9.20	±9.6%
10256	CAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)	LTE-TDD	9.96	±9.6%
10257	CAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM)	LTE-TDD	10.08	±9.6%
10258	CAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)	LTE-TDD	9.34	±9.6%
10259	CAD	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)	LTE-TDD	9.98	±9.6%
10260	CAD	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM)	LTE-TDD	9.97	±9.6%
10261	CAD	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, QPSK)	LTE-TDD	9.24	±9.6%
10262	CAG	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)	LTE-TDD	9.83	±9.6%
10263	CAG	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)	LTE-TDD	10.16	±9.6%
10264	CAG	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, QPSK)	LTE-TDD	9.23	±9.6%
10265	CAG	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM)	LTE-TDD	9.92	±9.6%
10266	CAG	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)	LTE-TDD	10.07	±9.6%
10267	CAG	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK)	LTE-TDD	9.30	±9.6%
10268	CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM)	LTE-TDD	10.06	±9.6%
10269	CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM)	LTE-TDD	10.13	±9.6%
10270	CAF	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	LTE-TDD	9.58	±9.6%
10274	CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.10)	WCDMA	4.87	±9.8%
10275	CAB	UMTS-FDD (HSUPA, Subtest 5, 3GPP Rel8.4)	WCDMA	3.98	±9.6%
10277	CAA	PHS (QPSK)	PHS	11.81	±9.6%
10278	CAA	PHS (QPSK, BW 884MHz, Rolloff 0.5)	PHS	11.81	±9.6%
10279	CAA	PHS (QPSK, BW 884MHz, Rolloff 0.38)	PHS	12.18	±9.6%
10290	AAB	CDMA2000, RC1, SC55, Full Rate	CDMA2000	3.91	±9.6%
10291	AAB	CDMA2000, RC3, SC55, Full Rate	CDMA2000	3.46	±9.6%
10292	AAB	CDMA2000, RC3, SC32, Full Rate	CDMA2000	3.39	±9.6%
10293	AAB	CDMA2000, RC3, SC3, Full Rate	CDMA2000	3.50	±9.6%
10295	AAB	CDMA2000, RC1, SC3, 1/8th Rate 25 fr.	CDMA2000	12.49	±9.6%
10297	AAD	LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK)	LTE-FDD	5.81	±9.6%
10298	AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)	LTE-FDD	5.72	±9.6%
10299	AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)	LTE-FDD	6.39	±9.6%

Certificate No: EF3-4067_Jan20

Page 12 of 22

EF3DV3 – SN:4067

January 21, 2020

10300	AAD	LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM)	LTE-FDD	6.60	±9.6 %
10301	AAA	IEEE 802.16e WIMAX (29:18, 5ms, 10MHz, QPSK, PUSC)	WIMAX	12.03	±9.6 %
10302	AAA	IEEE 802.16e WIMAX (29:18, 5ms, 10MHz, QPSK, PUSC, 3 CTRL symbols)	WIMAX	12.57	±9.6 %
10303	AAA	IEEE 802.16e WIMAX (31:15, 5ms, 10MHz, 64QAM, PUSC)	WIMAX	12.52	±9.6 %
10304	AAA	IEEE 802.16e WIMAX (29:18, 5ms, 10MHz, 64QAM, PUSC)	WIMAX	11.86	±9.6 %
10305	AAA	IEEE 802.16e WIMAX (31:15, 10ms, 10MHz, 64QAM, PUSC, 15 symbols)	WIMAX	15.24	±9.6 %
10306	AAA	IEEE 802.16e WIMAX (29:18, 10ms, 10MHz, 64QAM, PUSC, 18 symbols)	WIMAX	14.67	±9.6 %
10307	AAA	IEEE 802.16e WIMAX (29:18, 10ms, 10MHz, QPSK, PUSC, 18 symbols)	WIMAX	14.49	±9.6 %
10308	AAA	IEEE 802.16e WIMAX (29:18, 10ms, 10MHz, 16QAM, PUSC)	WIMAX	14.46	±9.6 %
10309	AAA	IEEE 802.16e WIMAX (29:18, 10ms, 10MHz, 16QAM, AMC 2x3, 18 symbols)	WIMAX	14.58	±9.6 %
10310	AAA	IEEE 802.16e WIMAX (29:18, 10ms, 10MHz, QPSK, AMC 2x3, 18 symbols)	WIMAX	14.57	±9.6 %
10311	AAD	LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK)	LTE-FDD	6.06	±9.6 %
10313	AAA	iDEN 1:3	iDEN	10.51	±9.6 %
10314	AAA	iDEN 1:6	iDEN	13.48	±9.6 %
10315	AAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)	WLAN	1.71	±9.6 %
10316	AAB	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle)	WLAN	8.36	±9.6 %
10317	AAC	IEEE 802.11a WiFi 5 GHz (OFDM, 6 Mbps, 96pc duty cycle)	WLAN	8.36	±9.6 %
10352	AAA	Pulse Waveform (200Hz, 10%)	Generic	10.00	±9.6 %
10353	AAA	Pulse Waveform (200Hz, 20%)	Generic	6.99	±9.6 %
10354	AAA	Pulse Waveform (200Hz, 40%)	Generic	3.98	±9.6 %
10355	AAA	Pulse Waveform (200Hz, 60%)	Generic	2.22	±9.6 %
10356	AAA	Pulse Waveform (200Hz, 80%)	Generic	0.97	±9.6 %
10387	AAA	QPSK Waveform, 1 MHz	Generic	5.10	±9.6 %
10388	AAA	QPSK Waveform, 10 MHz	Generic	5.22	±9.6 %
10396	AAA	64-QAM Waveform, 100 kHz	Generic	6.27	±9.6 %
10399	AAA	64-QAM Waveform, 40 MHz	Generic	6.27	±9.6 %
10400	AAD	IEEE 802.11ac WiFi (20MHz, 64-QAM, 99pc duty cycle)	WLAN	8.37	±9.6 %
10401	AAD	IEEE 802.11ac WiFi (40MHz, 64-QAM, 99pc duty cycle)	WLAN	8.60	±9.6 %
10402	AAD	IEEE 802.11ac WiFi (80MHz, 64-QAM, 99pc duty cycle)	WLAN	8.53	±9.6 %
10403	AAB	CDMA2000 (1xEV-DO, Rev. 0)	CDMA2000	3.76	±9.6 %
10404	AAB	CDMA2000 (1xEV-DO, Rev. A)	CDMA2000	3.77	±9.6 %
10406	AAB	CDMA2000, RC3, SC32, SCH0, Full Rate	CDMA2000	5.22	±9.6 %
10410	AAG	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9, Subframe Conf=4)	LTE-TDD	7.82	±9.6 %
10414	AAA	WLAN CCDF, 64-QAM, 40MHz	Generic	8.54	±9.6 %
10415	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle)	WLAN	1.54	±9.6 %
10416	AAA	IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 99pc duty cycle)	WLAN	8.23	±9.6 %
10417	AAB	IEEE 802.11ah WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle)	WLAN	8.23	±9.6 %
10418	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Long preamble)	WLAN	8.14	±9.6 %
10419	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Short preamble)	WLAN	8.19	±9.6 %
10422	AAB	IEEE 802.11n (HT Greenfield, 7.2 Mbps, BPSK)	WLAN	8.32	±9.6 %
10423	AAB	IEEE 802.11n (HT Greenfield, 43.3 Mbps, 16-QAM)	WLAN	8.47	±9.6 %
10424	AAB	IEEE 802.11n (HT Greenfield, 72.2 Mbps, 64-QAM)	WLAN	8.40	±9.6 %
10425	AAB	IEEE 802.11n (HT Greenfield, 15 Mbps, BPSK)	WLAN	8.41	±9.6 %
10426	AAB	IEEE 802.11n (HT Greenfield, 90 Mbps, 16-QAM)	WLAN	8.45	±9.6 %
10427	AAB	IEEE 802.11n (HT Greenfield, 150 Mbps, 64-QAM)	WLAN	8.41	±9.6 %
10430	AAD	LTE-FDD (OFDMA, 5 MHz, E-TM 3.1)	LTE-FDD	8.28	±9.6 %
10431	AAD	LTE-FDD (OFDMA, 10 MHz, E-TM 3.1)	LTE-FDD	8.38	±9.6 %
10432	AAC	LTE-FDD (OFDMA, 15 MHz, E-TM 3.1)	LTE-FDD	8.34	±9.6 %
10433	AAC	LTE-FDD (OFDMA, 20 MHz, E-TM 3.1)	LTE-FDD	8.34	±9.6 %
10434	AAA	W-CDMA (BS Test Model 1, 64 DPCH)	WCDMA	8.60	±9.6 %
10435	AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	±9.6 %
10447	AAD	LTE-FDD (OFDMA, 5 MHz, E-TM 3.1, Clipping 44%)	LTE-FDD	7.56	±9.6 %
10448	AAD	LTE-FDD (OFDMA, 10 MHz, E-TM 3.1, Clipping 44%)	LTE-FDD	7.53	±9.6 %
10449	AAC	LTE-FDD (OFDMA, 15 MHz, E-TM 3.1, Clipping 44%)	LTE-FDD	7.51	±9.6 %
10450	AAC	LTE-FDD (OFDMA, 20 MHz, E-TM 3.1, Clipping 44%)	LTE-FDD	7.48	±9.6 %

Certificate No: EF3-4067_Jan20

Page 13 of 22

EF3DV3 – SN:4067

January 21, 2020

10451	AAA	W-CDMA (BS Test Model 1, 64 DPCH, Clipping 44%)	WCDMA	7.59	± 9.6 %
10453	AAD	Validation (Square, 10ms, 1ms)	Test	10.00	± 9.6 %
10456	AAB	IEEE 802.11ac WiFi (160MHz, 64-QAM, 99pc duty cycle)	WLAN	8.63	± 9.6 %
10457	AAA	UMTS-FDD (DC-HSDPA)	WCDMA	6.62	± 9.6 %
10458	AAA	CDMA2000 (1xEV-DO, Rev. B, 2 carriers)	CDMA2000	6.55	± 9.6 %
10459	AAA	CDMA2000 (1xEV-DO, Rev. B, 3 carriers)	CDMA2000	8.25	± 9.6 %
10460	AAA	UMTS-FDD (WCDMA, AMR)	WCDMA	2.39	± 9.6 %
10461	AAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	± 9.6 %
10462	AAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.30	± 9.6 %
10463	AAB	LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.56	± 9.6 %
10464	AAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	± 9.6 %
10465	AAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.32	± 9.6 %
10466	AAC	LTE-TDD (SC-FDMA, 1 RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.57	± 9.6 %
10467	AAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	± 9.6 %
10468	AAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.32	± 9.6 %
10469	AAF	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.56	± 9.6 %
10470	AAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	± 9.6 %
10471	AAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.32	± 9.6 %
10472	AAF	LTE-TDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.57	± 9.6 %
10473	AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.82	± 9.6 %
10474	AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.32	± 9.6 %
10475	AAE	LTE-TDD (SC-FDMA, 1 RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.57	± 9.6 %
10477	AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.32	± 9.6 %
10478	AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.57	± 9.6 %
10479	AAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.74	± 9.6 %
10480	AAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.18	± 9.6 %
10481	AAB	LTE-TDD (SC-FDMA, 50% RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.45	± 9.6 %
10482	AAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.71	± 9.6 %
10483	AAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.39	± 9.6 %
10484	AAC	LTE-TDD (SC-FDMA, 50% RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.47	± 9.6 %
10485	AAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.59	± 9.6 %
10486	AAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.38	± 9.6 %
10487	AAF	LTE-TDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.60	± 9.6 %
10488	AAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.70	± 9.6 %
10489	AAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.31	± 9.6 %
10490	AAF	LTE-TDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.54	± 9.6 %
10491	AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, QPSK, UL	LTE-TDD	7.74	± 9.6 %

Certificate No: EF3-4067_Jan20

Page 14 of 22

EF3DV3 – SN:4067

January 21, 2020

		Subframe=2,3,4,7,8,9)			
10492	AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.41	±9.6 %
10493	AAE	LTE-TDD (SC-FDMA, 50% RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.55	±9.6 %
10494	AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.74	±9.6 %
10495	AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.37	±9.6 %
10496	AAF	LTE-TDD (SC-FDMA, 50% RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.54	±9.6 %
10497	AAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.57	±9.6 %
10498	AAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.40	±9.6 %
10499	AAB	LTE-TDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.68	±9.6 %
10500	AAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.67	±9.6 %
10501	AAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.44	±9.6 %
10502	AAC	LTE-TDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.52	±9.6 %
10503	AAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.72	±9.6 %
10504	AAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.31	±9.6 %
10505	AAF	LTE-TDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.54	±9.6 %
10506	AAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.74	±9.6 %
10507	AAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.36	±9.6 %
10508	AAF	LTE-TDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.55	±9.6 %
10509	AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.99	±9.6 %
10510	AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.49	±9.6 %
10511	AAE	LTE-TDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.51	±9.6 %
10512	AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9)	LTE-TDD	7.74	±9.6 %
10513	AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.42	±9.6 %
10514	AAF	LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM, UL Subframe=2,3,4,7,8,9)	LTE-TDD	8.45	±9.6 %
10515	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 99pc duty cycle)	WLAN	1.58	±9.6 %
10516	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps, 99pc duty cycle)	WLAN	1.57	±9.6 %
10517	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 99pc duty cycle)	WLAN	1.58	±9.6 %
10518	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 9 Mbps, 99pc duty cycle)	WLAN	8.23	±9.6 %
10519	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 12 Mbps, 99pc duty cycle)	WLAN	8.39	±9.6 %
10520	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 18 Mbps, 99pc duty cycle)	WLAN	8.12	±9.6 %
10521	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 24 Mbps, 99pc duty cycle)	WLAN	7.97	±9.6 %
10522	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 36 Mbps, 99pc duty cycle)	WLAN	8.45	±9.6 %
10523	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 48 Mbps, 99pc duty cycle)	WLAN	8.08	±9.6 %
10524	AAB	IEEE 802.11a/n WiFi 5 GHz (OFDM, 54 Mbps, 99pc duty cycle)	WLAN	8.27	±9.6 %
10525	AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 99pc duty cycle)	WLAN	8.36	±9.6 %
10526	AAB	IEEE 802.11ac WiFi (20MHz, MCS1, 99pc duty cycle)	WLAN	8.42	±9.6 %
10527	AAB	IEEE 802.11ac WiFi (20MHz, MCS2, 99pc duty cycle)	WLAN	8.21	±9.6 %
10528	AAB	IEEE 802.11ac WiFi (20MHz, MCS3, 99pc duty cycle)	WLAN	8.36	±9.6 %
10529	AAB	IEEE 802.11ac WiFi (20MHz, MCS4, 99pc duty cycle)	WLAN	8.36	±9.6 %
10531	AAB	IEEE 802.11ac WiFi (20MHz, MCS6, 99pc duty cycle)	WLAN	8.43	±9.6 %
10532	AAB	IEEE 802.11ac WiFi (20MHz, MCS7, 99pc duty cycle)	WLAN	8.29	±9.6 %
10533	AAB	IEEE 802.11ac WiFi (20MHz, MCS8, 99pc duty cycle)	WLAN	8.38	±9.6 %

Certificate No: EF3-4067_Jan20

Page 15 of 22

EF3DV3 – SN:4067

January 21, 2020

10534	AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 99pc duty cycle)	WLAN	8.45	±9.6 %
10535	AAB	IEEE 802.11ac WiFi (40MHz, MCS1, 99pc duty cycle)	WLAN	8.45	±9.6 %
10536	AAB	IEEE 802.11ac WiFi (40MHz, MCS2, 99pc duty cycle)	WLAN	8.32	±9.6 %
10537	AAB	IEEE 802.11ac WiFi (40MHz, MCS3, 99pc duty cycle)	WLAN	8.44	±9.6 %
10538	AAB	IEEE 802.11ac WiFi (40MHz, MCS4, 99pc duty cycle)	WLAN	8.54	±9.6 %
10540	AAB	IEEE 802.11ac WiFi (40MHz, MCS6, 99pc duty cycle)	WLAN	8.39	±9.6 %
10541	AAB	IEEE 802.11ac WiFi (40MHz, MCS7, 99pc duty cycle)	WLAN	8.46	±9.6 %
10542	AAB	IEEE 802.11ac WiFi (40MHz, MCS8, 99pc duty cycle)	WLAN	8.65	±9.6 %
10543	AAB	IEEE 802.11ac WiFi (40MHz, MCS9, 99pc duty cycle)	WLAN	8.65	±9.6 %
10544	AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle)	WLAN	8.47	±9.6 %
10545	AAB	IEEE 802.11ac WiFi (80MHz, MCS1, 99pc duty cycle)	WLAN	8.55	±9.6 %
10546	AAB	IEEE 802.11ac WiFi (80MHz, MCS2, 99pc duty cycle)	WLAN	8.35	±9.6 %
10547	AAB	IEEE 802.11ac WiFi (80MHz, MCS3, 99pc duty cycle)	WLAN	8.49	±9.6 %
10548	AAB	IEEE 802.11ac WiFi (80MHz, MCS4, 99pc duty cycle)	WLAN	8.37	±9.6 %
10550	AAB	IEEE 802.11ac WiFi (80MHz, MCS6, 99pc duty cycle)	WLAN	8.38	±9.6 %
10551	AAB	IEEE 802.11ac WiFi (80MHz, MCS7, 99pc duty cycle)	WLAN	8.50	±9.6 %
10552	AAB	IEEE 802.11ac WiFi (80MHz, MCS8, 99pc duty cycle)	WLAN	8.42	±9.6 %
10553	AAB	IEEE 802.11ac WiFi (80MHz, MCS9, 99pc duty cycle)	WLAN	8.45	±9.6 %
10554	AAC	IEEE 802.11ac WiFi (160MHz, MCS0, 99pc duty cycle)	WLAN	8.48	±9.6 %
10555	AAC	IEEE 802.11ac WiFi (160MHz, MCS1, 99pc duty cycle)	WLAN	8.47	±9.6 %
10556	AAC	IEEE 802.11ac WiFi (160MHz, MCS2, 99pc duty cycle)	WLAN	8.50	±9.6 %
10557	AAC	IEEE 802.11ac WiFi (160MHz, MCS3, 99pc duty cycle)	WLAN	8.52	±9.6 %
10558	AAC	IEEE 802.11ac WiFi (160MHz, MCS4, 99pc duty cycle)	WLAN	8.61	±9.6 %
10560	AAC	IEEE 802.11ac WiFi (160MHz, MCS6, 99pc duty cycle)	WLAN	8.73	±9.6 %
10561	AAC	IEEE 802.11ac WiFi (160MHz, MCS7, 99pc duty cycle)	WLAN	8.56	±9.6 %
10562	AAC	IEEE 802.11ac WiFi (160MHz, MCS8, 99pc duty cycle)	WLAN	8.69	±9.6 %
10563	AAC	IEEE 802.11ac WiFi (160MHz, MCS9, 99pc duty cycle)	WLAN	8.77	±9.6 %
10564	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 9 Mbps, 99pc duty cycle)	WLAN	8.25	±9.6 %
10565	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 12 Mbps, 99pc duty cycle)	WLAN	8.45	±9.6 %
10566	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 18 Mbps, 99pc duty cycle)	WLAN	8.13	±9.6 %
10567	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 24 Mbps, 99pc duty cycle)	WLAN	8.00	±9.6 %
10568	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 36 Mbps, 99pc duty cycle)	WLAN	8.37	±9.6 %
10569	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 48 Mbps, 99pc duty cycle)	WLAN	8.10	±9.6 %
10570	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 54 Mbps, 99pc duty cycle)	WLAN	8.30	±9.6 %
10571	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 90pc duty cycle)	WLAN	1.99	±9.6 %
10572	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 90pc duty cycle)	WLAN	1.99	±9.6 %
10573	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps, 90pc duty cycle)	WLAN	1.98	±9.6 %
10574	AAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps, 90pc duty cycle)	WLAN	1.98	±9.6 %
10575	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 90pc duty cycle)	WLAN	8.59	±9.6 %
10576	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 9 Mbps, 90pc duty cycle)	WLAN	8.60	±9.6 %
10577	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 12 Mbps, 90pc duty cycle)	WLAN	8.70	±9.6 %
10578	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 18 Mbps, 90pc duty cycle)	WLAN	8.49	±9.6 %
10579	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 24 Mbps, 90pc duty cycle)	WLAN	8.36	±9.6 %
10580	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 36 Mbps, 90pc duty cycle)	WLAN	8.76	±9.6 %
10581	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 48 Mbps, 90pc duty cycle)	WLAN	8.35	±9.6 %
10582	AAA	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 54 Mbps, 90pc duty cycle)	WLAN	8.67	±9.6 %
10583	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 90pc duty cycle)	WLAN	8.59	±9.6 %
10584	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps, 90pc duty cycle)	WLAN	8.60	±9.6 %
10585	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps, 90pc duty cycle)	WLAN	8.70	±9.6 %
10586	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps, 90pc duty cycle)	WLAN	8.49	±9.6 %

Certificate No: EF3-4067_Jan20

Page 16 of 22

EF3DV3 - SN:4067

January 21, 2020

10567	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps, 90pc duty cycle)	WLAN	8.36	±9.6%
10568	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps, 90pc duty cycle)	WLAN	8.76	±9.6%
10569	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps, 90pc duty cycle)	WLAN	8.35	±9.6%
10590	AAB	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps, 90pc duty cycle)	WLAN	8.67	±9.6%
10591	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS0, 90pc duty cycle)	WLAN	8.63	±9.6%
10592	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS1, 90pc duty cycle)	WLAN	8.79	±9.6%
10593	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS2, 90pc duty cycle)	WLAN	8.64	±9.6%
10594	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS3, 90pc duty cycle)	WLAN	8.74	±9.6%
10595	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS4, 90pc duty cycle)	WLAN	8.74	±9.6%
10596	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS5, 90pc duty cycle)	WLAN	8.71	±9.6%
10597	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS6, 90pc duty cycle)	WLAN	8.72	±9.6%
10598	AAB	IEEE 802.11n (HT Mixed, 20MHz, MCS7, 90pc duty cycle)	WLAN	8.50	±9.6%
10599	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS0, 90pc duty cycle)	WLAN	8.79	±9.6%
10600	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS1, 90pc duty cycle)	WLAN	8.88	±9.6%
10601	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS2, 90pc duty cycle)	WLAN	8.82	±9.6%
10602	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS3, 90pc duty cycle)	WLAN	8.94	±9.6%
10603	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS4, 90pc duty cycle)	WLAN	9.03	±9.6%
10604	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS5, 90pc duty cycle)	WLAN	8.78	±9.6%
10605	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS6, 90pc duty cycle)	WLAN	8.97	±9.6%
10606	AAB	IEEE 802.11n (HT Mixed, 40MHz, MCS7, 90pc duty cycle)	WLAN	8.82	±9.6%
10607	AAB	IEEE 802.11ac WiFi (20MHz, MCS0, 90pc duty cycle)	WLAN	8.64	±9.6%
10608	AAB	IEEE 802.11ac WiFi (20MHz, MCS1, 90pc duty cycle)	WLAN	8.77	±9.6%
10609	AAB	IEEE 802.11ac WiFi (20MHz, MCS2, 90pc duty cycle)	WLAN	8.57	±9.6%
10610	AAB	IEEE 802.11ac WiFi (20MHz, MCS3, 90pc duty cycle)	WLAN	8.78	±9.6%
10611	AAB	IEEE 802.11ac WiFi (20MHz, MCS4, 90pc duty cycle)	WLAN	8.70	±9.6%
10612	AAB	IEEE 802.11ac WiFi (20MHz, MCS5, 90pc duty cycle)	WLAN	8.77	±9.6%
10613	AAB	IEEE 802.11ac WiFi (20MHz, MCS6, 90pc duty cycle)	WLAN	8.94	±9.6%
10614	AAB	IEEE 802.11ac WiFi (20MHz, MCS7, 90pc duty cycle)	WLAN	8.59	±9.6%
10615	AAB	IEEE 802.11ac WiFi (20MHz, MCS8, 90pc duty cycle)	WLAN	8.82	±9.6%
10616	AAB	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	WLAN	8.82	±9.6%
10617	AAB	IEEE 802.11ac WiFi (40MHz, MCS1, 90pc duty cycle)	WLAN	8.81	±9.6%
10618	AAB	IEEE 802.11ac WiFi (40MHz, MCS2, 90pc duty cycle)	WLAN	8.58	±9.6%
10619	AAB	IEEE 802.11ac WiFi (40MHz, MCS3, 90pc duty cycle)	WLAN	8.86	±9.6%
10620	AAB	IEEE 802.11ac WiFi (40MHz, MCS4, 90pc duty cycle)	WLAN	8.87	±9.6%
10621	AAB	IEEE 802.11ac WiFi (40MHz, MCS5, 90pc duty cycle)	WLAN	8.77	±9.6%
10622	AAB	IEEE 802.11ac WiFi (40MHz, MCS6, 90pc duty cycle)	WLAN	8.68	±9.6%
10623	AAB	IEEE 802.11ac WiFi (40MHz, MCS7, 90pc duty cycle)	WLAN	8.82	±9.6%
10624	AAB	IEEE 802.11ac WiFi (40MHz, MCS8, 90pc duty cycle)	WLAN	8.96	±9.6%
10625	AAB	IEEE 802.11ac WiFi (40MHz, MCS9, 90pc duty cycle)	WLAN	8.96	±9.6%
10626	AAB	IEEE 802.11ac WiFi (80MHz, MCS0, 90pc duty cycle)	WLAN	8.83	±9.6%
10627	AAB	IEEE 802.11ac WiFi (80MHz, MCS1, 90pc duty cycle)	WLAN	8.88	±9.6%
10628	AAB	IEEE 802.11ac WiFi (80MHz, MCS2, 90pc duty cycle)	WLAN	8.71	±9.6%
10629	AAB	IEEE 802.11ac WiFi (80MHz, MCS3, 90pc duty cycle)	WLAN	8.85	±9.6%
10630	AAB	IEEE 802.11ac WiFi (80MHz, MCS4, 90pc duty cycle)	WLAN	8.72	±9.6%
10631	AAB	IEEE 802.11ac WiFi (80MHz, MCS5, 90pc duty cycle)	WLAN	8.81	±9.6%
10632	AAB	IEEE 802.11ac WiFi (80MHz, MCS6, 90pc duty cycle)	WLAN	8.74	±9.6%
10633	AAB	IEEE 802.11ac WiFi (80MHz, MCS7, 90pc duty cycle)	WLAN	8.83	±9.6%
10634	AAB	IEEE 802.11ac WiFi (80MHz, MCS8, 90pc duty cycle)	WLAN	8.80	±9.6%
10635	AAB	IEEE 802.11ac WiFi (80MHz, MCS9, 90pc duty cycle)	WLAN	8.81	±9.6%
10636	AAC	IEEE 802.11ac WiFi (160MHz, MCS0, 90pc duty cycle)	WLAN	8.83	±9.6%
10637	AAC	IEEE 802.11ac WiFi (160MHz, MCS1, 90pc duty cycle)	WLAN	8.79	±9.6%
10638	AAC	IEEE 802.11ac WiFi (160MHz, MCS2, 90pc duty cycle)	WLAN	8.86	±9.6%
10639	AAC	IEEE 802.11ac WiFi (160MHz, MCS3, 90pc duty cycle)	WLAN	8.85	±9.6%
10640	AAC	IEEE 802.11ac WiFi (160MHz, MCS4, 90pc duty cycle)	WLAN	8.98	±9.6%
10641	AAC	IEEE 802.11ac WiFi (160MHz, MCS5, 90pc duty cycle)	WLAN	9.06	±9.6%
10642	AAC	IEEE 802.11ac WiFi (160MHz, MCS6, 90pc duty cycle)	WLAN	9.06	±9.6%
10643	AAC	IEEE 802.11ac WiFi (160MHz, MCS7, 90pc duty cycle)	WLAN	8.89	±9.6%
10644	AAC	IEEE 802.11ac WiFi (160MHz, MCS8, 90pc duty cycle)	WLAN	9.05	±9.6%
10645	AAC	IEEE 802.11ac WiFi (160MHz, MCS9, 90pc duty cycle)	WLAN	9.11	±9.6%
10646	AAG	LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK, UL Subframe=2,7)	LTE-TDD	11.96	±9.6%
10647	AAF	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,7)	LTE-TDD	11.96	±9.6%
10648	AAA	CDMA2000 (1x Advanced)	CDMA2000	3.45	±9.6%
10652	AAE	LTE-TDD (OFDMA, 5 MHz, E-TM 3.1, Clipping 44%)	LTE-TDD	6.91	±9.6%
10653	AAE	LTE-TDD (OFDMA, 10 MHz, E-TM 3.1, Clipping 44%)	LTE-TDD	7.42	±9.6%

EF3DV3 – SN:4067

January 21, 2020

10654	AAD	LTE-TDD (OFDMA, 15 MHz, E-TM 3.1, Clipping 44%)	LTE-TDD	6.96	±9.6 %
10655	AAE	LTE-TDD (OFDMA, 20 MHz, E-TM 3.1, Clipping 44%)	LTE-TDD	7.21	±9.6 %
10656	AAA	Pulse Waveform (200Hz, 10%)	Test	10.00	±9.6 %
10659	AAA	Pulse Waveform (200Hz, 20%)	Test	6.99	±9.6 %
10660	AAA	Pulse Waveform (200Hz, 40%)	Test	3.98	±9.6 %
10661	AAA	Pulse Waveform (200Hz, 60%)	Test	2.22	±9.6 %
10662	AAA	Pulse Waveform (200Hz, 80%)	Test	0.97	±9.6 %
10670	AAA	Bluetooth Low Energy	Bluetooth	2.19	±9.6 %
10671	AAA	IEEE 802.11ax (20MHz, MCS0, 90pc duty cycle)	WLAN	9.09	±9.6 %
10672	AAA	IEEE 802.11ax (20MHz, MCS1, 90pc duty cycle)	WLAN	8.57	±9.6 %
10673	AAA	IEEE 802.11ax (20MHz, MCS2, 90pc duty cycle)	WLAN	8.78	±9.6 %
10674	AAA	IEEE 802.11ax (20MHz, MCS3, 90pc duty cycle)	WLAN	8.74	±9.6 %
10675	AAA	IEEE 802.11ax (20MHz, MCS4, 90pc duty cycle)	WLAN	8.90	±9.6 %
10676	AAA	IEEE 802.11ax (20MHz, MCS5, 90pc duty cycle)	WLAN	8.77	±9.6 %
10677	AAA	IEEE 802.11ax (20MHz, MCS6, 90pc duty cycle)	WLAN	8.73	±9.6 %
10678	AAA	IEEE 802.11ax (20MHz, MCS7, 90pc duty cycle)	WLAN	8.78	±9.6 %
10679	AAA	IEEE 802.11ax (20MHz, MCS8, 90pc duty cycle)	WLAN	8.89	±9.6 %
10680	AAA	IEEE 802.11ax (20MHz, MCS9, 90pc duty cycle)	WLAN	8.80	±9.6 %
10681	AAA	IEEE 802.11ax (20MHz, MCS10, 90pc duty cycle)	WLAN	8.82	±9.6 %
10682	AAA	IEEE 802.11ax (20MHz, MCS11, 90pc duty cycle)	WLAN	8.83	±9.6 %
10683	AAA	IEEE 802.11ax (20MHz, MCS0, 99pc duty cycle)	WLAN	8.42	±9.6 %
10684	AAA	IEEE 802.11ax (20MHz, MCS1, 99pc duty cycle)	WLAN	8.26	±9.6 %
10685	AAA	IEEE 802.11ax (20MHz, MCS2, 99pc duty cycle)	WLAN	8.33	±9.6 %
10686	AAA	IEEE 802.11ax (20MHz, MCS3, 99pc duty cycle)	WLAN	8.28	±9.6 %
10687	AAA	IEEE 802.11ax (20MHz, MCS4, 99pc duty cycle)	WLAN	8.45	±9.6 %
10688	AAA	IEEE 802.11ax (20MHz, MCS5, 99pc duty cycle)	WLAN	8.29	±9.6 %
10689	AAA	IEEE 802.11ax (20MHz, MCS6, 99pc duty cycle)	WLAN	8.55	±9.6 %
10690	AAA	IEEE 802.11ax (20MHz, MCS7, 99pc duty cycle)	WLAN	8.29	±9.6 %
10691	AAA	IEEE 802.11ax (20MHz, MCS8, 99pc duty cycle)	WLAN	8.26	±9.6 %
10692	AAA	IEEE 802.11ax (20MHz, MCS9, 99pc duty cycle)	WLAN	8.29	±9.6 %
10693	AAA	IEEE 802.11ax (20MHz, MCS10, 99pc duty cycle)	WLAN	8.25	±9.6 %
10694	AAA	IEEE 802.11ax (20MHz, MCS11, 99pc duty cycle)	WLAN	8.57	±9.6 %
10695	AAA	IEEE 802.11ax (40MHz, MCS0, 90pc duty cycle)	WLAN	8.76	±9.6 %
10696	AAA	IEEE 802.11ax (40MHz, MCS1, 90pc duty cycle)	WLAN	8.91	±9.6 %
10697	AAA	IEEE 802.11ax (40MHz, MCS2, 90pc duty cycle)	WLAN	8.61	±9.6 %
10698	AAA	IEEE 802.11ax (40MHz, MCS3, 90pc duty cycle)	WLAN	8.89	±9.6 %
10699	AAA	IEEE 802.11ax (40MHz, MCS4, 90pc duty cycle)	WLAN	8.82	±9.6 %
10700	AAA	IEEE 802.11ax (40MHz, MCS5, 90pc duty cycle)	WLAN	8.73	±9.6 %
10701	AAA	IEEE 802.11ax (40MHz, MCS6, 90pc duty cycle)	WLAN	8.86	±9.6 %
10702	AAA	IEEE 802.11ax (40MHz, MCS7, 90pc duty cycle)	WLAN	8.70	±9.6 %
10703	AAA	IEEE 802.11ax (40MHz, MCS8, 90pc duty cycle)	WLAN	8.82	±9.6 %
10704	AAA	IEEE 802.11ax (40MHz, MCS9, 90pc duty cycle)	WLAN	8.56	±9.6 %
10705	AAA	IEEE 802.11ax (40MHz, MCS10, 90pc duty cycle)	WLAN	8.89	±9.6 %
10706	AAA	IEEE 802.11ax (40MHz, MCS11, 90pc duty cycle)	WLAN	8.66	±9.6 %
10707	AAA	IEEE 802.11ax (40MHz, MCS0, 99pc duty cycle)	WLAN	8.32	±9.6 %
10708	AAA	IEEE 802.11ax (40MHz, MCS1, 99pc duty cycle)	WLAN	8.55	±9.6 %
10709	AAA	IEEE 802.11ax (40MHz, MCS2, 99pc duty cycle)	WLAN	8.33	±9.6 %
10710	AAA	IEEE 802.11ax (40MHz, MCS3, 99pc duty cycle)	WLAN	8.29	±9.6 %
10711	AAA	IEEE 802.11ax (40MHz, MCS4, 99pc duty cycle)	WLAN	8.39	±9.6 %
10712	AAA	IEEE 802.11ax (40MHz, MCS5, 99pc duty cycle)	WLAN	8.67	±9.6 %
10713	AAA	IEEE 802.11ax (40MHz, MCS6, 99pc duty cycle)	WLAN	8.33	±9.6 %
10714	AAA	IEEE 802.11ax (40MHz, MCS7, 99pc duty cycle)	WLAN	8.26	±9.6 %
10715	AAA	IEEE 802.11ax (40MHz, MCS8, 99pc duty cycle)	WLAN	8.45	±9.6 %
10716	AAA	IEEE 802.11ax (40MHz, MCS9, 99pc duty cycle)	WLAN	8.30	±9.6 %
10717	AAA	IEEE 802.11ax (40MHz, MCS10, 99pc duty cycle)	WLAN	8.48	±9.6 %
10718	AAA	IEEE 802.11ax (40MHz, MCS11, 99pc duty cycle)	WLAN	8.24	±9.6 %
10719	AAA	IEEE 802.11ax (80MHz, MCS0, 90pc duty cycle)	WLAN	8.81	±9.6 %
10720	AAA	IEEE 802.11ax (80MHz, MCS1, 90pc duty cycle)	WLAN	8.87	±9.6 %
10721	AAA	IEEE 802.11ax (80MHz, MCS2, 90pc duty cycle)	WLAN	8.76	±9.6 %
10722	AAA	IEEE 802.11ax (80MHz, MCS3, 90pc duty cycle)	WLAN	8.55	±9.6 %
10723	AAA	IEEE 802.11ax (80MHz, MCS4, 90pc duty cycle)	WLAN	8.70	±9.6 %
10724	AAA	IEEE 802.11ax (80MHz, MCS5, 90pc duty cycle)	WLAN	8.90	±9.6 %
10725	AAA	IEEE 802.11ax (80MHz, MCS6, 90pc duty cycle)	WLAN	8.74	±9.6 %
10726	AAA	IEEE 802.11ax (80MHz, MCS7, 90pc duty cycle)	WLAN	8.72	±9.6 %

Certificate No: EF3-4067_Jan20

Page 18 of 22

EF3DV3 - SN:4067

January 21, 2020

10727	AAA	IEEE 802.11ax (80MHz, MCS8, 90pc duty cycle)	WLAN	8.66	±9.6 %
10728	AAA	IEEE 802.11ax (80MHz, MCS9, 90pc duty cycle)	WLAN	8.65	±9.6 %
10729	AAA	IEEE 802.11ax (80MHz, MCS10, 90pc duty cycle)	WLAN	8.64	±9.6 %
10730	AAA	IEEE 802.11ax (80MHz, MCS11, 90pc duty cycle)	WLAN	8.67	±9.6 %
10731	AAA	IEEE 802.11ax (80MHz, MCS0, 99pc duty cycle)	WLAN	8.42	±9.6 %
10732	AAA	IEEE 802.11ax (80MHz, MCS1, 99pc duty cycle)	WLAN	8.46	±9.6 %
10733	AAA	IEEE 802.11ax (80MHz, MCS2, 99pc duty cycle)	WLAN	8.40	±9.6 %
10734	AAA	IEEE 802.11ax (80MHz, MCS3, 99pc duty cycle)	WLAN	8.25	±9.6 %
10735	AAA	IEEE 802.11ax (80MHz, MCS4, 99pc duty cycle)	WLAN	8.33	±9.6 %
10736	AAA	IEEE 802.11ax (80MHz, MCS5, 99pc duty cycle)	WLAN	8.27	±9.6 %
10737	AAA	IEEE 802.11ax (80MHz, MCS6, 99pc duty cycle)	WLAN	8.36	±9.6 %
10738	AAA	IEEE 802.11ax (80MHz, MCS7, 99pc duty cycle)	WLAN	8.42	±9.6 %
10739	AAA	IEEE 802.11ax (80MHz, MCS8, 99pc duty cycle)	WLAN	8.29	±9.6 %
10740	AAA	IEEE 802.11ax (80MHz, MCS9, 99pc duty cycle)	WLAN	8.48	±9.6 %
10741	AAA	IEEE 802.11ax (80MHz, MCS10, 99pc duty cycle)	WLAN	8.40	±9.6 %
10742	AAA	IEEE 802.11ax (80MHz, MCS11, 99pc duty cycle)	WLAN	8.43	±9.6 %
10743	AAA	IEEE 802.11ax (160MHz, MCS0, 90pc duty cycle)	WLAN	8.94	±9.6 %
10744	AAA	IEEE 802.11ax (160MHz, MCS1, 90pc duty cycle)	WLAN	9.16	±9.6 %
10745	AAA	IEEE 802.11ax (160MHz, MCS2, 90pc duty cycle)	WLAN	8.93	±9.6 %
10746	AAA	IEEE 802.11ax (160MHz, MCS3, 90pc duty cycle)	WLAN	9.11	±9.6 %
10747	AAA	IEEE 802.11ax (160MHz, MCS4, 90pc duty cycle)	WLAN	9.04	±9.6 %
10748	AAA	IEEE 802.11ax (160MHz, MCS5, 90pc duty cycle)	WLAN	8.93	±9.6 %
10749	AAA	IEEE 802.11ax (160MHz, MCS6, 90pc duty cycle)	WLAN	8.90	±9.6 %
10750	AAA	IEEE 802.11ax (160MHz, MCS7, 90pc duty cycle)	WLAN	8.79	±9.6 %
10751	AAA	IEEE 802.11ax (160MHz, MCS8, 90pc duty cycle)	WLAN	8.82	±9.6 %
10752	AAA	IEEE 802.11ax (160MHz, MCS9, 90pc duty cycle)	WLAN	8.81	±9.6 %
10753	AAA	IEEE 802.11ax (160MHz, MCS10, 90pc duty cycle)	WLAN	9.00	±9.6 %
10754	AAA	IEEE 802.11ax (160MHz, MCS11, 90pc duty cycle)	WLAN	8.94	±9.6 %
10755	AAA	IEEE 802.11ax (160MHz, MCS0, 99pc duty cycle)	WLAN	8.64	±9.6 %
10756	AAA	IEEE 802.11ax (160MHz, MCS1, 99pc duty cycle)	WLAN	8.77	±9.6 %
10757	AAA	IEEE 802.11ax (160MHz, MCS2, 99pc duty cycle)	WLAN	8.77	±9.6 %
10758	AAA	IEEE 802.11ax (160MHz, MCS3, 99pc duty cycle)	WLAN	8.69	±9.6 %
10759	AAA	IEEE 802.11ax (160MHz, MCS4, 99pc duty cycle)	WLAN	8.58	±9.6 %
10760	AAA	IEEE 802.11ax (160MHz, MCS5, 99pc duty cycle)	WLAN	8.49	±9.6 %
10761	AAA	IEEE 802.11ax (160MHz, MCS6, 99pc duty cycle)	WLAN	8.58	±9.6 %
10762	AAA	IEEE 802.11ax (160MHz, MCS7, 99pc duty cycle)	WLAN	8.49	±9.6 %
10763	AAA	IEEE 802.11ax (160MHz, MCS8, 99pc duty cycle)	WLAN	8.53	±9.6 %
10764	AAA	IEEE 802.11ax (160MHz, MCS9, 99pc duty cycle)	WLAN	8.54	±9.6 %
10765	AAA	IEEE 802.11ax (160MHz, MCS10, 99pc duty cycle)	WLAN	8.54	±9.6 %
10766	AAA	IEEE 802.11ax (160MHz, MCS11, 99pc duty cycle)	WLAN	8.51	±9.6 %
10767	AAB	5G NR (CP-OFDM, 1 RB, 5 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	7.99	±9.6 %
10768	AAB	5G NR (CP-OFDM, 1 RB, 10 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.01	±9.6 %
10769	AAB	5G NR (CP-OFDM, 1 RB, 15 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.01	±9.6 %
10770	AAB	5G NR (CP-OFDM, 1 RB, 20 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.02	±9.6 %
10771	AAB	5G NR (CP-OFDM, 1 RB, 25 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.02	±9.6 %
10772	AAB	5G NR (CP-OFDM, 1 RB, 30 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.23	±9.6 %
10773	AAB	5G NR (CP-OFDM, 1 RB, 40 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.03	±9.6 %
10774	AAB	5G NR (CP-OFDM, 1 RB, 50 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.02	±9.6 %
10776	AAB	5G NR (CP-OFDM, 50% RB, 10 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.30	±9.6 %
10778	AAB	5G NR (CP-OFDM, 50% RB, 20 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.34	±9.6 %
10780	AAB	5G NR (CP-OFDM, 50% RB, 30 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.36	±9.6 %
10781	AAB	5G NR (CP-OFDM, 50% RB, 40 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.38	±9.6 %
10782	AAB	5G NR (CP-OFDM, 50% RB, 50 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.43	±9.6 %

Certificate No: EF3-4067_Jan20

Page 19 of 22

EF3DV3 – SN:4067

January 21, 2020

10783	AAB	5G NR (CP-OFDM, 100% RB, 5 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.31	± 9.6 %
10784	AAB	5G NR (CP-OFDM, 100% RB, 10 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.29	± 9.6 %
10785	AAB	5G NR (CP-OFDM, 100% RB, 15 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.40	± 9.6 %
10786	AAB	5G NR (CP-OFDM, 100% RB, 20 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.35	± 9.6 %
10787	AAB	5G NR (CP-OFDM, 100% RB, 25 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.44	± 9.6 %
10788	AAB	5G NR (CP-OFDM, 100% RB, 30 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.39	± 9.6 %
10789	AAB	5G NR (CP-OFDM, 100% RB, 40 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.37	± 9.6 %
10790	AAB	5G NR (CP-OFDM, 100% RB, 50 MHz, QPSK, 15 kHz)	5G NR FR1 TDD	8.39	± 9.6 %
10791	AAB	5G NR (CP-OFDM, 1 RB, 5 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.83	± 9.6 %
10792	AAB	5G NR (CP-OFDM, 1 RB, 10 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.92	± 9.6 %
10793	AAB	5G NR (CP-OFDM, 1 RB, 15 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.95	± 9.6 %
10794	AAB	5G NR (CP-OFDM, 1 RB, 20 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.82	± 9.6 %
10795	AAB	5G NR (CP-OFDM, 1 RB, 25 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.84	± 9.6 %
10796	AAB	5G NR (CP-OFDM, 1 RB, 30 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.82	± 9.6 %
10797	AAB	5G NR (CP-OFDM, 1 RB, 40 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.01	± 9.6 %
10798	AAB	5G NR (CP-OFDM, 1 RB, 50 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.89	± 9.6 %
10799	AAB	5G NR (CP-OFDM, 1 RB, 60 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.93	± 9.6 %
10801	AAB	5G NR (CP-OFDM, 1 RB, 80 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.89	± 9.6 %
10802	AAB	5G NR (CP-OFDM, 1 RB, 90 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.87	± 9.6 %
10803	AAB	5G NR (CP-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	7.93	± 9.6 %
10805	AAB	5G NR (CP-OFDM, 50% RB, 10 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10806	AAB	5G NR (CP-OFDM, 50% RB, 15 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.37	± 9.6 %
10809	AAB	5G NR (CP-OFDM, 50% RB, 30 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10810	AAB	5G NR (CP-OFDM, 50% RB, 40 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10812	AAB	5G NR (CP-OFDM, 50% RB, 60 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.35	± 9.6 %
10817	AAB	5G NR (CP-OFDM, 100% RB, 5 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.35	± 9.6 %
10818	AAB	5G NR (CP-OFDM, 100% RB, 10 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10819	AAB	5G NR (CP-OFDM, 100% RB, 15 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.33	± 9.6 %
10820	AAB	5G NR (CP-OFDM, 100% RB, 20 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.30	± 9.6 %
10821	AAB	5G NR (CP-OFDM, 100% RB, 25 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10822	AAB	5G NR (CP-OFDM, 100% RB, 30 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10823	AAB	5G NR (CP-OFDM, 100% RB, 40 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.36	± 9.6 %
10824	AAB	5G NR (CP-OFDM, 100% RB, 50 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.39	± 9.6 %

Certificate No: EF3-4067_Jan20

Page 20 of 22

EF3DV3 – SN:4067

January 21, 2020

			TDD		
10825	AAB	5G NR (CP-OFDM, 100% RB, 60 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10827	AAB	5G NR (CP-OFDM, 100% RB, 80 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.42	± 9.6 %
10828	AAB	5G NR (CP-OFDM, 100% RB, 90 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.43	± 9.6 %
10829	AAB	5G NR (CP-OFDM, 100% RB, 100 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	8.40	± 9.6 %
10830	AAB	5G NR (CP-OFDM, 1 RB, 10 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.63	± 9.6 %
10831	AAB	5G NR (CP-OFDM, 1 RB, 15 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.73	± 9.6 %
10832	AAB	5G NR (CP-OFDM, 1 RB, 20 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.74	± 9.6 %
10833	AAB	5G NR (CP-OFDM, 1 RB, 25 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.70	± 9.6 %
10834	AAB	5G NR (CP-OFDM, 1 RB, 30 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.75	± 9.6 %
10835	AAB	5G NR (CP-OFDM, 1 RB, 40 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.70	± 9.6 %
10836	AAB	5G NR (CP-OFDM, 1 RB, 50 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.66	± 9.6 %
10837	AAB	5G NR (CP-OFDM, 1 RB, 60 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.68	± 9.6 %
10839	AAB	5G NR (CP-OFDM, 1 RB, 80 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.70	± 9.6 %
10840	AAB	5G NR (CP-OFDM, 1 RB, 90 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.67	± 9.6 %
10841	AAB	5G NR (CP-OFDM, 1 RB, 100 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	7.71	± 9.6 %
10843	AAB	5G NR (CP-OFDM, 50% RB, 15 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.49	± 9.6 %
10844	AAB	5G NR (CP-OFDM, 50% RB, 20 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10846	AAB	5G NR (CP-OFDM, 50% RB, 30 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10854	AAB	5G NR (CP-OFDM, 100% RB, 10 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10855	AAB	5G NR (CP-OFDM, 100% RB, 15 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.36	± 9.6 %
10856	AAB	5G NR (CP-OFDM, 100% RB, 20 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.37	± 9.6 %
10857	AAB	5G NR (CP-OFDM, 100% RB, 25 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.35	± 9.6 %
10858	AAB	5G NR (CP-OFDM, 100% RB, 30 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.36	± 9.6 %
10859	AAB	5G NR (CP-OFDM, 100% RB, 40 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.34	± 9.6 %
10860	AAB	5G NR (CP-OFDM, 100% RB, 50 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10861	AAB	5G NR (CP-OFDM, 100% RB, 60 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.40	± 9.6 %
10863	AAB	5G NR (CP-OFDM, 100% RB, 80 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10864	AAB	5G NR (CP-OFDM, 100% RB, 90 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.37	± 9.6 %
10865	AAB	5G NR (CP-OFDM, 100% RB, 100 MHz, QPSK, 60 kHz)	5G NR FR1 TDD	8.41	± 9.6 %
10866	AAB	5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	5.68	± 9.6 %
10868	AAB	5G NR (DFT-s-OFDM, 100% RB, 100 MHz, QPSK, 30 kHz)	5G NR FR1 TDD	5.89	± 9.6 %
10869	AAC	5G NR (DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	5.75	± 9.6 %
10870	AAC	5G NR (DFT-s-OFDM, 100% RB, 100 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	5.86	± 9.6 %

Certificate No: EF3-4067_Jan20

Page 21 of 22

EF3DV3 – SN:4067

January 21, 2020

10871	AAC	5G NR (DFT-s-OFDM, 1 RB, 100 MHz, 16QAM, 120 kHz)	TDD 5G NR FR2 TDD	5.75	± 9.6 %
10872	AAC	5G NR (DFT-s-OFDM, 100% RB, 100 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	6.52	± 9.6 %
10873	AAC	5G NR (DFT-s-OFDM, 1 RB, 100 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	6.61	± 9.6 %
10874	AAC	5G NR (DFT-s-OFDM, 100% RB, 100 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	6.65	± 9.6 %
10875	AAC	5G NR (CP-OFDM, 1 RB, 100 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	7.78	± 9.6 %
10876	AAC	5G NR (CP-OFDM, 100% RB, 100 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	8.39	± 9.6 %
10877	AAC	5G NR (CP-OFDM, 1 RB, 100 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	7.95	± 9.6 %
10878	AAC	5G NR (CP-OFDM, 100% RB, 100 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	8.41	± 9.6 %
10879	AAC	5G NR (CP-OFDM, 1 RB, 100 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	8.12	± 9.6 %
10880	AAC	5G NR (CP-OFDM, 100% RB, 100 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	8.38	± 9.6 %
10881	AAC	5G NR (DFT-s-OFDM, 1 RB, 50 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	5.75	± 9.6 %
10882	AAC	5G NR (DFT-s-OFDM, 100% RB, 50 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	5.96	± 9.6 %
10883	AAC	5G NR (DFT-s-OFDM, 1 RB, 50 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	6.57	± 9.6 %
10884	AAC	5G NR (DFT-s-OFDM, 100% RB, 50 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	6.53	± 9.6 %
10885	AAC	5G NR (DFT-s-OFDM, 1 RB, 50 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	6.61	± 9.6 %
10886	AAC	5G NR (DFT-s-OFDM, 100% RB, 50 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	6.65	± 9.6 %
10887	AAC	5G NR (CP-OFDM, 1 RB, 50 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	7.78	± 9.6 %
10888	AAC	5G NR (CP-OFDM, 100% RB, 50 MHz, QPSK, 120 kHz)	5G NR FR2 TDD	8.35	± 9.6 %
10889	AAC	5G NR (CP-OFDM, 1 RB, 50 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	8.02	± 9.6 %
10890	AAC	5G NR (CP-OFDM, 100% RB, 50 MHz, 16QAM, 120 kHz)	5G NR FR2 TDD	8.40	± 9.6 %
10891	AAC	5G NR (CP-OFDM, 1 RB, 50 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	8.13	± 9.6 %
10892	AAC	5G NR (CP-OFDM, 100% RB, 50 MHz, 64QAM, 120 kHz)	5G NR FR2 TDD	8.41	± 9.6 %

⁶ Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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



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

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

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **EF3-4034_Feb19**

CALIBRATION CERTIFICATE

결	판정자	확인자
재	<i>[Signature]</i>	<i>[Signature]</i>
적용/상업	612 17/02/2019	612 17/02/2019
일 자	2019 10.13	2019 10.13

Object **EF3DV3- SN:4034**

Calibration procedure(s) **QA CAL-02.v9, QA CAL-25.v7**
Calibration procedure for E-field probes optimized for close near field evaluations in air

Calibration date: **February 22, 2019**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-18 (No. 217-02682)	Apr-19
DAE4	SN: 789	14-Jan-19 (No. DAE4-789_Jan19)	Jan-20
Reference Probe ER3DV6	SN: 2328	08-Oct-18 (No. ER3-2328_Oct18)	Oct-19
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-20
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-20
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-20
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-20
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19

	Name	Function	Signature
Calibrated by:	Manu Seitz	Laboratory Technician	<i>[Signature]</i>
Approved by:	Katja Pokovic	Technical Manager	<i>[Signature]</i>

Issued: February 23, 2019

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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



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

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

Accreditation No.: **SCS 0108**

Glossary:

NORM _{x,y,z}	sensitivity in free space
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
En	incident E-field orientation normal to probe axis
Ep	incident E-field orientation parallel to probe axis
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- a) IEEE Std 1309-2005, " IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- b) CTIA Test Plan for Hearing Aid Compatibility, Rev 3.1.1, May 2017

Methods Applied and Interpretation of Parameters:

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

EF3DV3 – SN:4034

February 22, 2019

DASY/EASY - Parameters of Probe: EF3DV3 - SN:4034

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$)	0.96	0.78	1.24	$\pm 10.1\%$
DCP (mV) ^b	97.2	100.0	98.0	

Calibration results for Frequency Response (30 MHz – 6 GHz)

Frequency MHz	Target E-Field V/m	Measured E-field (E _n) V/m	Deviation E-normal in %	Measured E-field (E _p) V/m	Deviation E-normal in %	Unc (k=2) %
30	77.3	77.0	-0.4%	77.4	0.1%	$\pm 5.1\%$
100	77.2	78.1	1.2%	77.7	0.6%	$\pm 5.1\%$
450	77.0	78.0	1.3%	77.6	0.7%	$\pm 5.1\%$
600	77.2	77.8	0.8%	77.4	0.3%	$\pm 5.1\%$
750	77.1	77.5	0.4%	77.0	-0.2%	$\pm 5.1\%$
1800	140.3	136.7	-2.6%	136.7	-2.6%	$\pm 5.1\%$
2000	133.0	129.2	-2.9%	129.4	-2.7%	$\pm 5.1\%$
2200	125.0	121.5	-2.8%	122.4	-2.1%	$\pm 5.1\%$
2500	123.7	120.6	-2.5%	121.5	-1.8%	$\pm 5.1\%$
3000	78.9	74.9	-5.1%	76.0	-3.8%	$\pm 5.1\%$
3500	256.8	248.7	-3.1%	246.4	-4.1%	$\pm 5.1\%$
3700	249.7	239.4	-4.1%	238.4	-4.5%	$\pm 5.1\%$
5200	50.8	50.9	0.2%	51.2	0.8%	$\pm 5.1\%$
5500	49.6	49.0	-1.3%	48.8	-1.7%	$\pm 5.1\%$
5800	48.9	49.2	0.6%	49.4	1.0%	$\pm 5.1\%$

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Unc ^c (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.0	$\pm 3.5\%$	$\pm 4.7\%$
		Y	0.0	0.0	1.0		173.5		
		Y	0.0	0.0	1.0		173.8		

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

^a Numerical linearization parameter: uncertainty not required.

^b Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EF3DV3 – SN:4034

February 22, 2019

DASY/EASY - Parameters of Probe: EF3DV3 - SN:4034

Sensor Frequency Model Parameters

	Sensor X	Sensor Y	Sensor Z
Frequency Corr. (LF)	0.23	0.15	6.33
Frequency Corr. (HF)	2.82	2.82	2.82

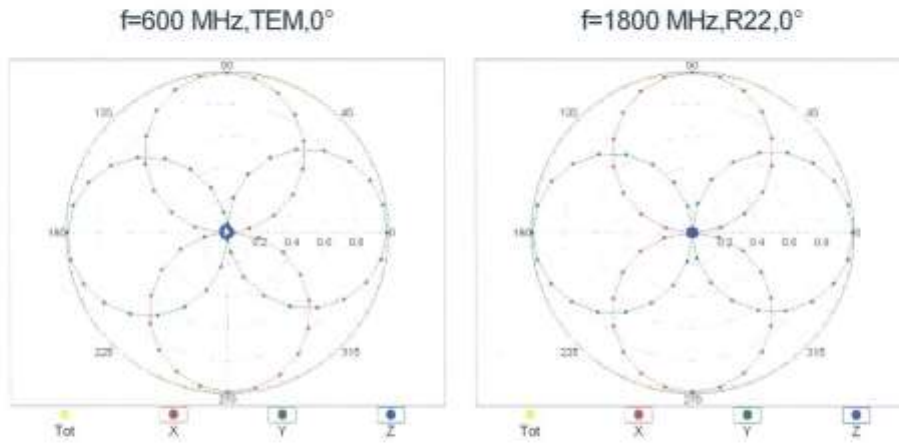
Other Probe Parameters

Sensor Arrangement	Rectangular
Connector Angle (°)	7.3
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	12 mm
Tip Length	25 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	1.5 mm
Probe Tip to Sensor Y Calibration Point	1.5 mm
Probe Tip to Sensor Z Calibration Point	1.5 mm

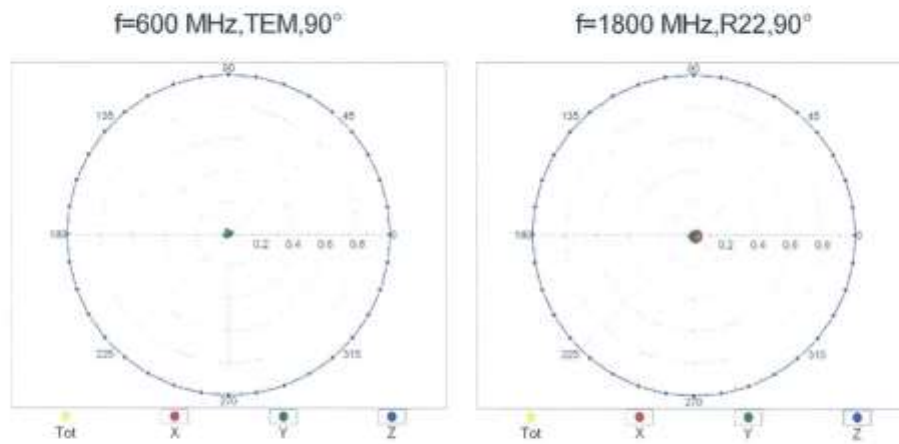
EF3DV3 – SN:4034

February 22, 2019

Receiving Pattern (ϕ), $\vartheta = 0^\circ$



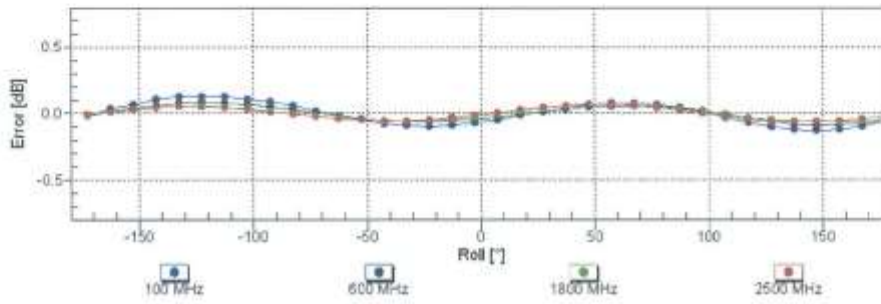
Receiving Pattern (ϕ), $\vartheta = 90^\circ$



EF3DV3 – SN:4034

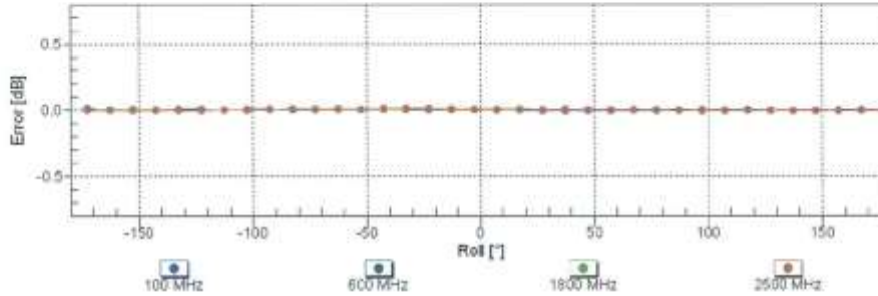
February 22, 2019

Receiving Pattern (ϕ), $\vartheta = 0^\circ$



Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

Receiving Pattern (ϕ), $\vartheta = 90^\circ$

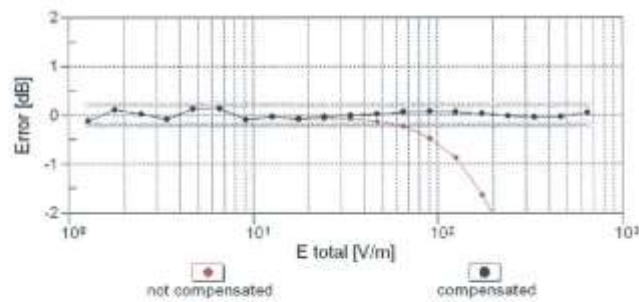
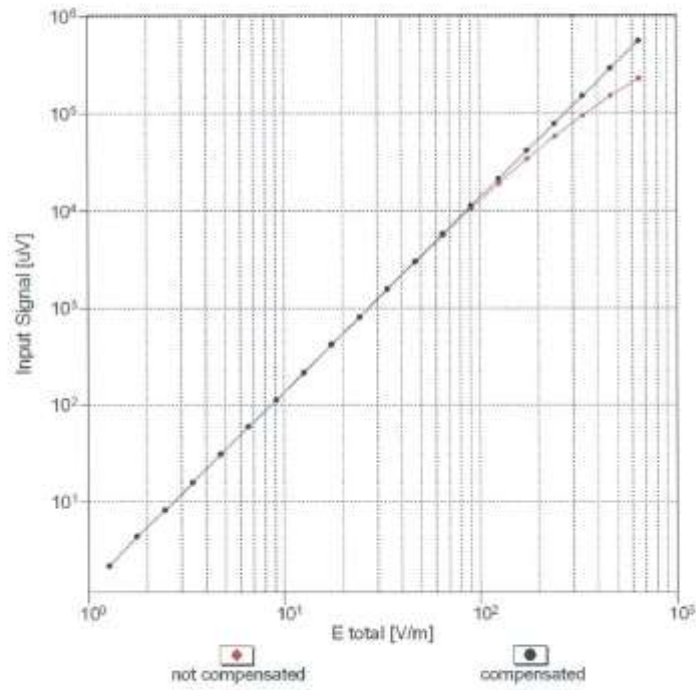


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

EF3DV3 - SN:4034

February 22, 2019

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

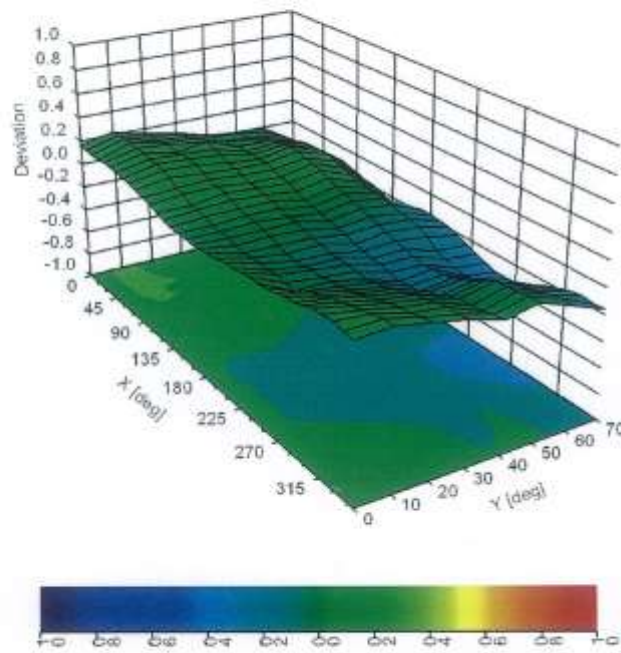


Uncertainty of Linearity Assessment: $\pm 0.6\%$ (k=2)

EF3DV3 – SN:4034

February 22, 2019

Deviation from Isotropy in Air Error (ϕ , θ), $f = 900$ MHz



Uncertainty of Spherical Isotropy Assessment: $\pm 2.6\%$ ($k=2$)

Attachment 4. Dipole Calibration Data

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



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

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

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **CD835V3-1024_Feb19**

CALIBRATION CERTIFICATE

		계	담당자	확인자
Object	CD835V3 - SN: 1024	재	<i>[Signature]</i>	<i>[Signature]</i>
Calibration procedure(s)	QA CAL-20.v7 Calibration Procedure for Validation Sources in air	제출일 2019.03.13	SW 2019.03.13	확인일 2019.03.13
Calibration date:	February 22, 2019			
<p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p>				
Calibration Equipment used (M&TE critical for calibration)				
Primary Standards	ID #	Cal Date (Certificate No.)		Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)		Apr-19
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)		Apr-19
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)		Apr-19
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)		Apr-19
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)		Apr-19
Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)		Jan-20
DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)		Jan-20
Secondary Standards	ID #	Check Date (in house)		Scheduled Check
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)		In house check: Oct-20
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-17)		In house check: Oct-20
Power sensor HP 8482A	SN: US37295597	09-Oct-09 (in house check Oct-17)		In house check: Oct-20
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-17)		In house check: Oct-20
Network Analyzer HP 8358A	SN: US41060477	31-Mar-14 (in house check Oct-18)		In house check: Oct-19
Calibrated by:	Name Claudio Leutler	Function Laboratory Technician	Signature <i>[Signature]</i>	
Approved by:	Name Katja Pokozvic	Function Technical Manager	Signature <i>[Signature]</i>	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.				Issued: February 25, 2019

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



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

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

Accreditation No.: **SCS 0108**

References

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

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASYS Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	835 MHz \pm 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 835 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	105.7 V/m = 40.48 dBV/m
Maximum measured above low end	100 mW input power	105.1 V/m = 40.43 dBV/m
Averaged maximum above arm	100 mW input power	105.4 V/m \pm 12.6 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
800 MHz	22.4 dB	45.7 Ω - 5.9 $j\Omega$
835 MHz	28.2 dB	53.6 Ω + 1.9 $j\Omega$
880 MHz	16.5 dB	62.4 Ω - 11.5 $j\Omega$
900 MHz	17.5 dB	50.1 Ω - 13.5 $j\Omega$
945 MHz	22.8 dB	49.6 Ω + 7.2 $j\Omega$

3.2 Antenna Design and Handling

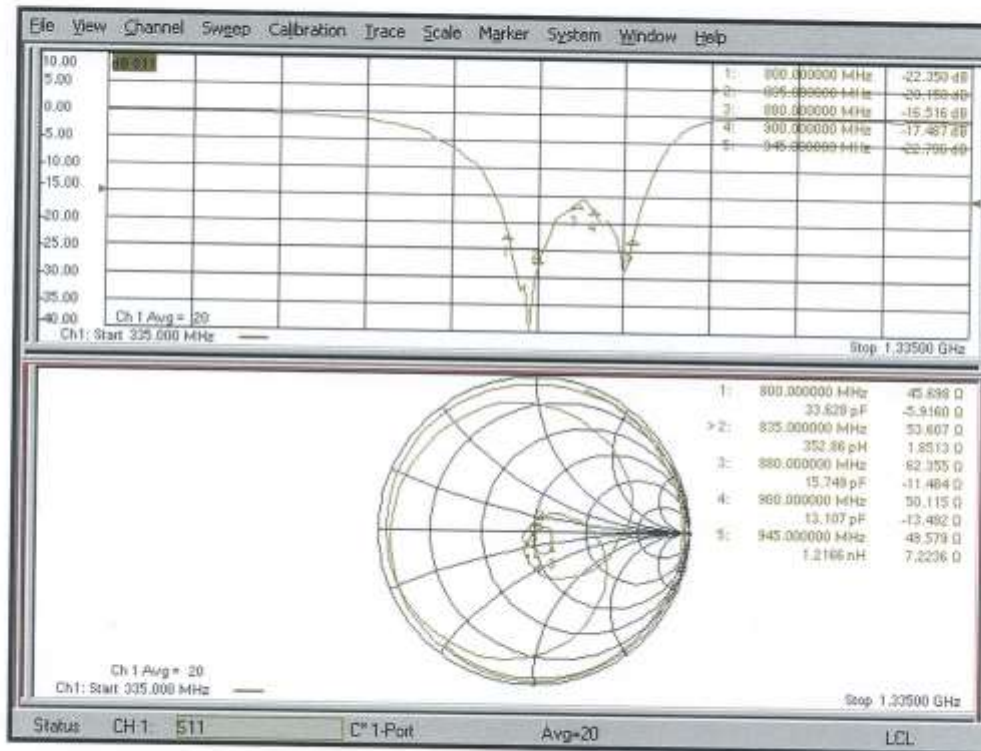
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

Impedance Measurement Plot



DASY5 E-field Result

Date: 22.02.2019

Test Laboratory: SPEAG Lab2

DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1024

Communication System: UID 0 - CW ; Frequency: 835 MHz
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Section
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

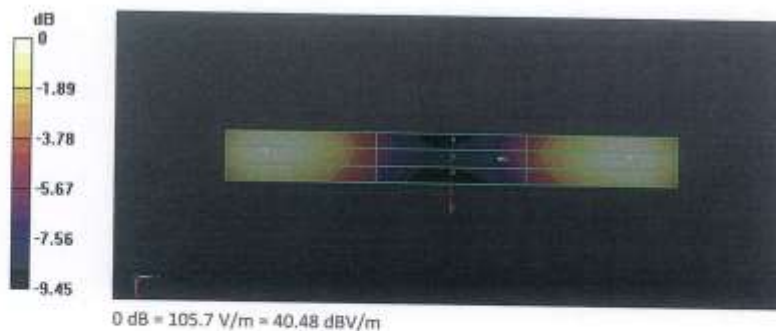
DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 835 MHz; Calibrated: 03.01.2019
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 09.01.2019
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Dipole E-Field measurement @ 835MHz /E-Scan - 835MHz d=15mm/Hearing Aid Compatibility Test (41x361x1):
 Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 126.1 V/m; Power Drift = 0.04 dB
 Applied MIF = 0.00 dB
 RF audio interference level = 40.48 dBV/m
Emission category: M3

MIF scaled E-field

Grid 1 M4 39.86 dBV/m	Grid 2 M3 40.43 dBV/m	Grid 3 M3 40.42 dBV/m
Grid 4 M4 35.32 dBV/m	Grid 5 M4 35.71 dBV/m	Grid 6 M4 35.7 dBV/m
Grid 7 M3 40.12 dBV/m	Grid 8 M3 40.48 dBV/m	Grid 9 M3 40.43 dBV/m



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



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

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

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **CD1880V3-1019_Feb19**

CALIBRATION CERTIFICATE		검	단	화																																																								
		재	명	인																																																								
Object	CD1880V3 - SN: 1019	재	명	인																																																								
Calibration procedure(s)	QA CAL-20.v7 Calibration Procedure for Validation Sources in air	SW	명	인																																																								
Calibration date:	February 22, 2019	2019.03.13	2019.03.13																																																									
<p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter NRP</td> <td>SN: 104778</td> <td>04-Apr-18 (No. 217-02672/02673)</td> <td>Apr-19</td> </tr> <tr> <td>Power sensor NRP-Z91</td> <td>SN: 103244</td> <td>04-Apr-18 (No. 217-02672)</td> <td>Apr-19</td> </tr> <tr> <td>Power sensor NRP-Z91</td> <td>SN: 103245</td> <td>04-Apr-18 (No. 217-02673)</td> <td>Apr-19</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>04-Apr-18 (No. 217-02682)</td> <td>Apr-19</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>04-Apr-18 (No. 217-02683)</td> <td>Apr-19</td> </tr> <tr> <td>Probe EF3DV3</td> <td>SN: 4013</td> <td>03-Jan-19 (No. EF3-4013_Jan19)</td> <td>Jan-20</td> </tr> <tr> <td>DAE4</td> <td>SN: 781</td> <td>09-Jan-19 (No. DAE4-781_Jan19)</td> <td>Jan-20</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>Power meter Agilent 4419B</td> <td>SN: GB42420191</td> <td>09-Oct-09 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>Power sensor HP E4412A</td> <td>SN: US38485102</td> <td>05-Jan-10 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>Power sensor HP B482A</td> <td>SN: US37295597</td> <td>09-Oct-09 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>RF generator R&S SMT-06</td> <td>SN: 832283/011</td> <td>27-Aug-12 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>Network Analyzer HP 8358A</td> <td>SN: US41080477</td> <td>31-Mar-14 (in house check Oct-18)</td> <td>In house check: Oct-19</td> </tr> </tbody> </table>					Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19	Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19	Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19	Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19	Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19	Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)	Jan-20	DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)	In house check: Oct-20	Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-17)	In house check: Oct-20	Power sensor HP B482A	SN: US37295597	09-Oct-09 (in house check Oct-17)	In house check: Oct-20	RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-17)	In house check: Oct-20	Network Analyzer HP 8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration																																																									
Power meter NRP	SN: 104778	04-Apr-18 (No. 217-02672/02673)	Apr-19																																																									
Power sensor NRP-Z91	SN: 103244	04-Apr-18 (No. 217-02672)	Apr-19																																																									
Power sensor NRP-Z91	SN: 103245	04-Apr-18 (No. 217-02673)	Apr-19																																																									
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-18 (No. 217-02682)	Apr-19																																																									
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-18 (No. 217-02683)	Apr-19																																																									
Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)	Jan-20																																																									
DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20																																																									
Secondary Standards	ID #	Check Date (in house)	Scheduled Check																																																									
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)	In house check: Oct-20																																																									
Power sensor HP E4412A	SN: US38485102	05-Jan-10 (in house check Oct-17)	In house check: Oct-20																																																									
Power sensor HP B482A	SN: US37295597	09-Oct-09 (in house check Oct-17)	In house check: Oct-20																																																									
RF generator R&S SMT-06	SN: 832283/011	27-Aug-12 (in house check Oct-17)	In house check: Oct-20																																																									
Network Analyzer HP 8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19																																																									
Calibrated by:	Name: Claudio Leubler Function: Laboratory Technician	Signature:																																																										
Approved by:	Name: Katja Pokovic Function: Technical Manager	Signature:																																																										
<p>This calibration certificate shall not be reproduced except in full without written approval of the laboratory.</p> <p style="text-align: right;">Issued: February 25, 2019</p>																																																												

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



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

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

Accreditation No.: **SCS 0108**

References

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

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	1880 MHz \pm 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 1880 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	86.6 V/m = 38.75 dBV/m
Maximum measured above low end	100 mW input power	84.9 V/m = 38.58 dBV/m
Averaged maximum above arm	100 mW input power	85.8 V/m \pm 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
1730 MHz	31.6 dB	52.6 Ω + 0.8 j Ω
1880 MHz	19.6 dB	56.1 Ω + 9.3 j Ω
1900 MHz	19.0 dB	59.6 Ω + 7.8 j Ω
1950 MHz	22.5 dB	58.0 Ω - 1.3 j Ω
2000 MHz	28.3 dB	51.3 Ω + 3.7 j Ω

3.2 Antenna Design and Handling

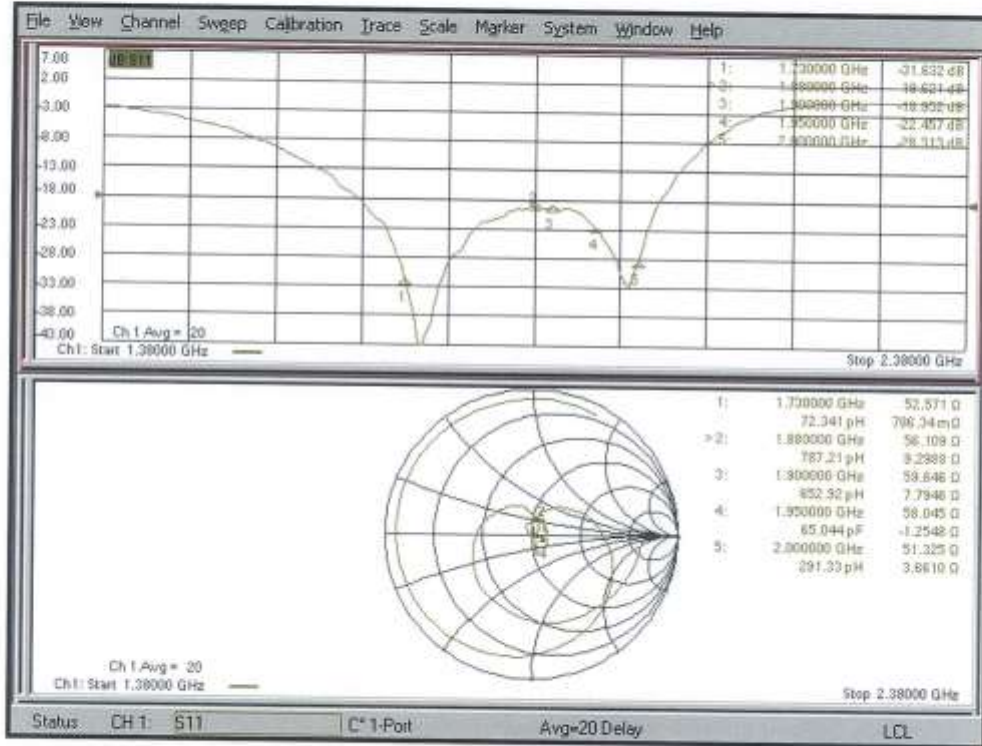
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

Impedance Measurement Plot



DASY5 E-field Result

Date: 22.02.2019

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1019

Communication System: UID 0 - CW ; Frequency: 1880 MHz
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Section
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 1880 MHz; Calibrated: 03.01.2019
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 09.01.2019
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

Dipole E-Field measurement @ 1880MHz /E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 145.5 V/m; Power Drift = -0.00 dB

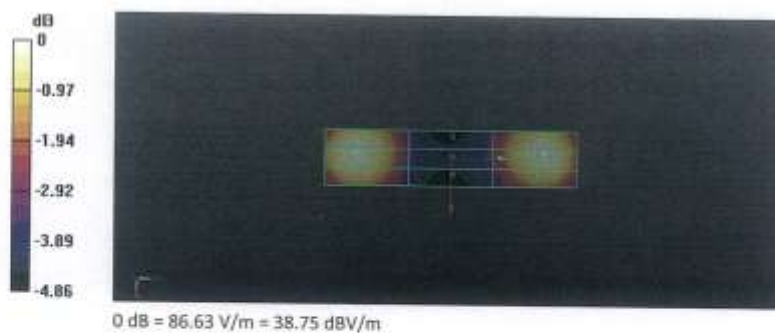
Applied MIF = 0.00 dB

RF audio interference level = 38.75 dBV/m

Emission category: M2

MIF scaled E-field

Grid 1 M2 38.34 dBV/m	Grid 2 M2 38.75 dBV/m	Grid 3 M2 38.72 dBV/m
Grid 4 M2 35.65 dBV/m	Grid 5 M2 35.93 dBV/m	Grid 6 M2 35.92 dBV/m
Grid 7 M2 38.15 dBV/m	Grid 8 M2 38.58 dBV/m	Grid 9 M2 38.55 dBV/m



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



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

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

Accreditation No.: **SCS 0108**

Client: **HCT (Dymstec)**

Certificate No: **CD2600V3-1019_Sep19**

CALIBRATION CERTIFICATE		검	판	다	자	하	인	자																																																								
Object	CD2600V3 - SN: 1019	재	장	의	장	의	장	의																																																								
Calibration procedure(s)	QA CAL-20.v7 Calibration Procedure for Validation Sources in air	제	일/년	SW	12/2018	(G)	12/2018																																																									
Calibration date:	September 19, 2019	일	년	2019	10	19	2019	1/10/19																																																								
<p>This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.</p> <p>All calibrations have been conducted in the closed laboratory facility; environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p> <table border="1"> <thead> <tr> <th>Primary Standards</th> <th>ID #</th> <th>Cal Date (Certificate No.)</th> <th>Scheduled Calibration</th> </tr> </thead> <tbody> <tr> <td>Power meter NRP</td> <td>SN: 104776</td> <td>03-Apr-19 (No. 217-02892/02893)</td> <td>Apr-20</td> </tr> <tr> <td>Power sensor NRP-Z91</td> <td>SN: 103244</td> <td>03-Apr-19 (No. 217-02892)</td> <td>Apr-20</td> </tr> <tr> <td>Power sensor NRP-Z91</td> <td>SN: 103245</td> <td>03-Apr-19 (No. 217-02893)</td> <td>Apr-20</td> </tr> <tr> <td>Reference 20 dB Attenuator</td> <td>SN: 5058 (20k)</td> <td>04-Apr-19 (No. 217-02894)</td> <td>Apr-20</td> </tr> <tr> <td>Type-N mismatch combination</td> <td>SN: 5047.2 / 06327</td> <td>04-Apr-19 (No. 217-02895)</td> <td>Apr-20</td> </tr> <tr> <td>Probe EF3DV3</td> <td>SN: 4013</td> <td>03-Jan-19 (No. EF3-4013_Jan19)</td> <td>Jan-20</td> </tr> <tr> <td>DAE4</td> <td>SN: 781</td> <td>09-Jan-19 (No. DAE4-781_Jan19)</td> <td>Jan-20</td> </tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Secondary Standards</th> <th>ID #</th> <th>Check Date (in house)</th> <th>Scheduled Check</th> </tr> </thead> <tbody> <tr> <td>Power meter Agilent 4419B</td> <td>SN: GB42420191</td> <td>09-Oct-09 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>Power sensor HP E4412A</td> <td>SN: US3B485102</td> <td>05-Jan-10 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>Power sensor HP B482A</td> <td>SN: US37295597</td> <td>09-Oct-09 (in house check Oct-17)</td> <td>In house check: Oct-20</td> </tr> <tr> <td>RF generator R&S SMT-06</td> <td>SN: 837633/005</td> <td>10-Jan-19 (in house check Jan-19)</td> <td>In house check: Oct-22</td> </tr> <tr> <td>Network Analyzer Agilent E8358A</td> <td>SN: US41080477</td> <td>31-Mar-14 (in house check Oct-18)</td> <td>In house check: Oct-19</td> </tr> </tbody> </table>									Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration	Power meter NRP	SN: 104776	03-Apr-19 (No. 217-02892/02893)	Apr-20	Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20	Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20	Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20	Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20	Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)	Jan-20	DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20	Secondary Standards	ID #	Check Date (in house)	Scheduled Check	Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)	In house check: Oct-20	Power sensor HP E4412A	SN: US3B485102	05-Jan-10 (in house check Oct-17)	In house check: Oct-20	Power sensor HP B482A	SN: US37295597	09-Oct-09 (in house check Oct-17)	In house check: Oct-20	RF generator R&S SMT-06	SN: 837633/005	10-Jan-19 (in house check Jan-19)	In house check: Oct-22	Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration																																																													
Power meter NRP	SN: 104776	03-Apr-19 (No. 217-02892/02893)	Apr-20																																																													
Power sensor NRP-Z91	SN: 103244	03-Apr-19 (No. 217-02892)	Apr-20																																																													
Power sensor NRP-Z91	SN: 103245	03-Apr-19 (No. 217-02893)	Apr-20																																																													
Reference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-19 (No. 217-02894)	Apr-20																																																													
Type-N mismatch combination	SN: 5047.2 / 06327	04-Apr-19 (No. 217-02895)	Apr-20																																																													
Probe EF3DV3	SN: 4013	03-Jan-19 (No. EF3-4013_Jan19)	Jan-20																																																													
DAE4	SN: 781	09-Jan-19 (No. DAE4-781_Jan19)	Jan-20																																																													
Secondary Standards	ID #	Check Date (in house)	Scheduled Check																																																													
Power meter Agilent 4419B	SN: GB42420191	09-Oct-09 (in house check Oct-17)	In house check: Oct-20																																																													
Power sensor HP E4412A	SN: US3B485102	05-Jan-10 (in house check Oct-17)	In house check: Oct-20																																																													
Power sensor HP B482A	SN: US37295597	09-Oct-09 (in house check Oct-17)	In house check: Oct-20																																																													
RF generator R&S SMT-06	SN: 837633/005	10-Jan-19 (in house check Jan-19)	In house check: Oct-22																																																													
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-18)	In house check: Oct-19																																																													
Calibrated by:	Name: Leif Klyener Function: Laboratory Technician Signature:																																																															
Approved by:	Name: Katja Pokovic Function: Technical Manager Signature:																																																															
Issued: September 20, 2019																																																																
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.																																																																

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



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

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

Accreditation No.: **SCS 0108**

References

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

Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic E-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.2
Phantom	HAC Test Arch	
Distance Dipole Top - Probe Center	15 mm	
Scan resolution	dx, dy = 5 mm	
Frequency	2600 MHz \pm 1 MHz	
Input power drift	< 0.05 dB	

Maximum Field values at 2600 MHz

E-field 15 mm above dipole surface	condition	Interpolated maximum
Maximum measured above high end	100 mW input power	84.5 V/m = 38.53 dBV/m
Maximum measured above low end	100 mW input power	83.9 V/m = 38.48 dBV/m
Averaged maximum above arm	100 mW input power	84.2 V/m \pm 12.8 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters

Frequency	Return Loss	Impedance
2450 MHz	19.3 dB	43.0 Ω - 7.4 j Ω
2550 MHz	30.5 dB	47.8 Ω + 1.9 j Ω
2600 MHz	33.7 dB	51.2 Ω + 1.7 j Ω
2650 MHz	30.0 dB	53.3 Ω - 0.2 j Ω
2750 MHz	18.3 dB	50.2 Ω - 12.3 j Ω

3.2 Antenna Design and Handling

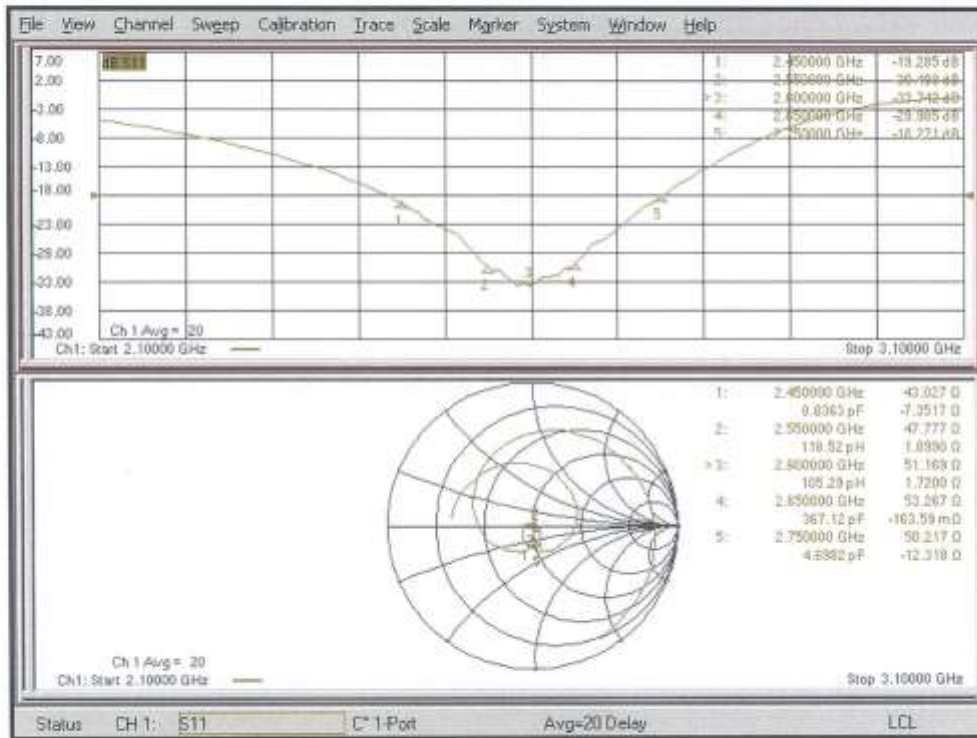
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

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

Impedance Measurement Plot



DASY5 E-field Result

Date: 19.09.2019

Test Laboratory: SPEAG Lab2

DUT: HAC Dipole 2600 MHz; Type: CD2600V3; Serial: CD2600V3 - SN: 1019

Communication System: UID 0 - CW; Frequency: 2600 MHz
 Medium parameters used: $\sigma = 0$ S/m, $\epsilon_r = 1$; $\rho = 0$ kg/m³
 Phantom section: RF Section
 Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1) @ 2600 MHz; Calibrated: 03.01.2019
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 09.01.2019
- Phantom: HAC Test Arch with AMCC; Type: 5D HAC P01 BA; Serial: 1070
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

Dipole E-Field measurement @ 2600MHz/E-Scan - 2600MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm
 Device Reference Point: 0, 0, -6.3 mm
 Reference Value = 62.69 V/m; Power Drift = -0.00 dB
 Applied MIF = 0.00 dB
 RF audio interference level = 38.53 dBV/m
Emission category: M2

MIF scaled E-field

Grid 1 M2 38.17 dBV/m	Grid 2 M2 38.48 dBV/m	Grid 3 M2 38.41 dBV/m
Grid 4 M2 37.74 dBV/m	Grid 5 M2 37.96 dBV/m	Grid 6 M2 37.9 dBV/m
Grid 7 M2 38.29 dBV/m	Grid 8 M2 38.53 dBV/m	Grid 9 M2 38.42 dBV/m

