HEARING AID COMPATIBILITY RF EMISSIONS TEST REPORT

FCC ID	:	**MSQI005D**
Equipment	:	**ASUS Phone(Mobile Phone)**
Brand Name	:	**ASUS**
Model Name	:	**ASUS_I005D** **ASUS_I005DC**
M-Rating	:	**M3**
Applicant	:	**ASUSTeK COMPUTER INC.** **1F., No. 15, Lide Rd., Beitou Dist., Taipei City 112, Taiwan**
Manufacturer 1	:	**Guangdong Enok Communication Co., Ltd.** **No. 137, 139, Lixiang Road., Songmushan Village, Dalang Town, Dongguan City, Guangdong Province, China**
Manufacturer 2	:	**PT. SAT NUSAPERSADA TBK** **JALAN PELITA VI. NO. 99, BATAM, 29443,INDONESIA**
Standard	:	**FCC 47 CFR §20.19** **ANSI C63.19-2011**

The product was received on Dec. 30, 2020 and testing was started from Jan. 20, 2021 and completed on Jan. 22, 2021. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample provide by manufacturer and the test data has been evaluated in accordance with the test procedures given in ANSI 63.19-2011 / 47 CFR Part 20.19 and has been pass the FCC requirement.

Cona Huang

Approved by: Cona Huang / Deputy Manager

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
HA082114A	Rev. 01	Initial issue of report	Feb. 09, 2021

1. General Information

Product Feature & Specification	
Applicant Name	ASUSTeK COMPUTER INC.
Equipment Name	ASUS Phone(Mobile Phone)
Brand Name	ASUS
Model Name	ASUS_I005D ASUS_I005DC
FCC ID	MSQI005D
EUT Stage	Identical Prototype
Frequency Band	GSM850: 824.2 MHz ~ 848.8 MHz GSM1900: 1850.2 MHz ~ 1909.8 MHz WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band IV: 1710 MHz ~ 1755 MHz WCDMA Band V: 824 MHz ~ 849 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 17: 704 MHz ~ 716 MHz LTE Band 25: 1850 MHz ~ 1915 MHz LTE Band 26: 814 MHz ~ 849 MHz LTE Band 30: 2305 MHz ~ 2315 MHz LTE Band 38: 2570 MHz ~ 2620 MHz LTE Band 41: 2496 MHz ~ 2690 MHz LTE Band 42: 3550 MHz ~ 3600 MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66: 1710 MHz ~ 1780 MHz LTE Band 71: 663 MHz ~ 698 MHz 5G NR n2: 1850 MHz ~ 1910 MHz 5G NR n5: 824 MHz ~ 849 MHz 5G NR n7: 2500 MHz ~ 2570 MHz 5G NR n12: 699 MHz ~ 716 MHz 5G NR n25: 1850 MHz ~ 1915 MHz 5G NR n38: 2570 MHz ~ 2620 MHz 5G NR n41: 2496 MHz ~ 2690 MHz 5G NR n66: 1710 MHz ~ 1780 MHz 5G NR n71: 663 MHz ~ 698 MHz 5G NR n77: 3700 MHz ~ 3980 MHz 5G NR n78: 3700 MHz ~ 3800 MHz WLAN 2.4GHz Band: 2400 MHz ~ 2483.5 MHz WLAN U-NII 1: 5150 MHz ~ 5250 MHz WLAN U-NII 2: 5250 MHz ~ 5350 MHz WLAN U-NII 3: 5470 MHz ~ 5725 MHz WLAN U-NII 4: 5725 MHz ~ 5825 MHz WLAN U-NII 5: 5925 MHz ~ 6425 MHz WLAN U-NII 6: 6425 MHz ~ 6525 MHz WLAN U-NII 7: 6525 MHz ~ 6875 MHz WLAN U-NII 8: 6875 MHz ~ 7125 MHz Bluetooth: 2400 MHz ~ 2483.5 MHz NFC: 13.56 MHz
Mode	GSM/GPRS/EGPRS RMC/AMR 12.2Kbps HSDPA HSUPA DC-HSDPA LTE: QPSK, 16QAM, 64QAM 5G NR: DFT-s-OFDM/CP-OFDM, Pi/2 BPSK/QPSK/16QAM/64QAM/256QAM WLAN: 802.11a/b/g/n/ac/ax HT20/HT40/VHT20/VHT40/VHT80/VHT160/HE20/HE40/HE80/HE160 Bluetooth BR/EDR/LE NFC: ASK

Reviewed by: Jason Wang
Report Producer: Daisy Peng

2. Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test.

Testing Laboratory	
Test Site	SPORTON INTERNATIONAL INC.
Test Site Location	No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No.: **SAR04-HY**

3. Applied Standards

- FCC CFR47 Part 20.19
- ANSI C63.19-2011
- FCC KDB 285076 D01 HAC Guidance v05r01
- FCC KDB 285076 D03 HAC FAQ v01r01

4. RF Audio Interference Level

FCC wireless hearing aid compatibility rules ensure that consumers with hearing loss are able to access wireless communications services through a wide selection of handsets without experiencing disabling radio frequency (RF) interference or other technical obstacles.
To define and measure the hearing aid compatibility of handsets, in CFR47 part 20.19 ANSI C63.19 is referenced. A handset is considered hearing aid-compatible for acoustic coupling if it meets a rating of at least M3 under ANSI C63.19, and A handset is considered hearing aid compatible for inductive coupling if it meets a rating of at least T3. According to ANSI C63.19 2011 version, for acoustic coupling, the RF electric field emissions of wireless communication devices should be measured and rated according to the emission level as below.

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

Table 5.1 Telephone near-field categories in linear units

5. Air Interface and Operating Mode

Air Interface	Band MHz	Type	C63.19 Tested	Simultaneous Transmitter	Name of Voice Service	Power Reduction
GSM	GSM850	VO	Yes	WLAN, BT	CMRS Voice	No
	GSM1900			WLAN, BT		No
	EDGE850	VD	Yes	WLAN, BT	Google Duo	No
	EDGE1900			WLAN, BT		
WCDMA	Band II	VO	No(1)	WLAN, BT	CMRS Voice	No
	Band IV			WLAN, BT		No
	Band V			WLAN, BT		No
	HSPA	VD	No(1)	WLAN, BT	Google Duo	No
LTE (FDD)	Band 2	VD	No(1)	5G NR, WLAN, BT	VoLTE / Google Duo	No
	Band 4			5G NR, WLAN, BT		No
	Band 5			5G NR, WLAN, BT		No
	Band 7			5G NR, WLAN, BT		No
	Band 12			5G NR, WLAN, BT		No
	Band 13			5G NR, WLAN, BT		No
	Band 17			5G NR, WLAN, BT		No
	Band 25			5G NR, WLAN, BT		No
	Band 26			5G NR, WLAN, BT		No
	Band 30			5G NR, WLAN, BT		No
	Band 66			5G NR, WLAN, BT		No
	Band 71			5G NR, WLAN, BT		No
LTE (TDD)	Band 38	VD	Yes	5G NR, WLAN, BT	VoLTE / Google Duo	No
	Band 41			5G NR, WLAN, BT		No
	Band 42			5G NR, WLAN, BT		No
	Band 48			5G NR, WLAN, BT		No
5G NR	n2	VD	No(1)	LTE, WLAN, BT	Google Duo	No
	n5			LTE, WLAN, BT		No
	n7			LTE, WLAN, BT		No
	n12			LTE, WLAN, BT		No
	n25			LTE, WLAN, BT		No
	n38			LTE, WLAN, BT		No
	n41			LTE, WLAN, BT		No
	n66			LTE, WLAN, BT		No
	n71			LTE, WLAN, BT		No
	n77			LTE, WLAN, BT		No
	n78			LTE, WLAN, BT		No
Wi-Fi	2.4GHz	VD	No(1)	GSM,WCDMA,LTE,5G NR, BT	VoWiFi / Google Duo	No
	U-NII-1			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-2			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-3			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-4			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-5	VD	No(2)	GSM,WCDMA,LTE,5G NR, BT	Google Duo	No
	U-NII-6			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-7			GSM,WCDMA,LTE,5G NR, BT		No
	U-NII-8			GSM,WCDMA,LTE,5G NR, BT		No
BT	2450	DT	No	GSM,WCDMA,LTE,5G NR, BT	NA	No

Type Transport:
VO= Voice only
DT= Digital Transport only (no voice)
VD= CMRS and IP Voice Service over Digital Transport

Remark:
1. The air interface is exempted from testing by low power exemption that its average antenna input power plus its MIF is ≤17 dBm, and is rated as M4.
2. The U-NII-5/6/7/8 are currently outside the scope of ANSI 63.19 and FCC HAC regulations therefore, the U-NII-5/6/7/8 were not evaluated
3. The device have similar frequency in some LTE bands: LTE 38/41, since the supported frequency spans for the smaller LTE bands are completely cover by the larger LTE bands, therefore, only larger LTE bands were required to be tested for hearing-aid compliance.
4. The 5G NR is only applicable for OTT VoIP scenarios, this device does not support VoNR over IMIS.
5. The manufacturer has confirmed the handset as designed is expected to exhibit similar audio intensity levels between an OTT VoIP call placed over a 4G LTE and a 5G NR data connection

6. Measurement System Specification

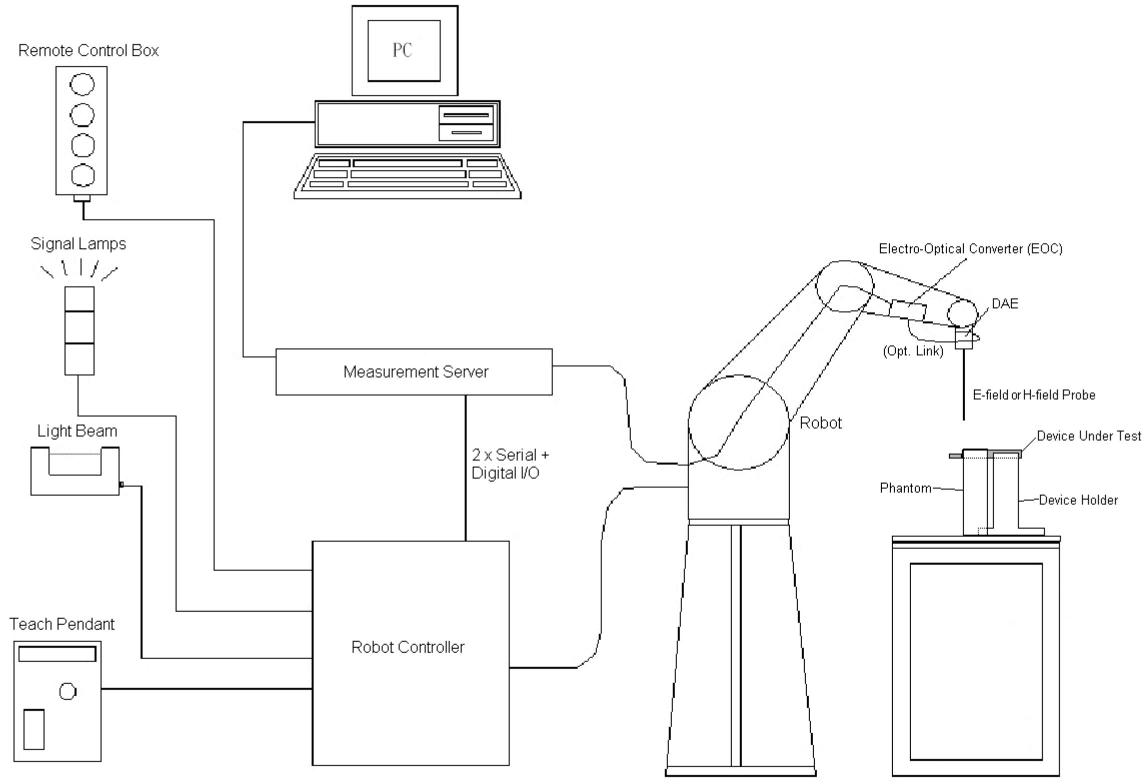

Fig 5.1 System Configurations

6.1 E-Field Probe System

E-Field Probe Specification
<ER3DV6>

Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges	 **Fig 5.2 Photo of E-field Probe**
Calibration	In air from 100 MHz to 3.0 GHz (absolute accuracy ±6.0%, k=2)	
Frequency	100 MHz to 6 GHz; Linearity: ± 2.0 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: 330 mm (Tip: 16 mm) Tip diameter: 8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.5 mm	

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

6.2 Data Storage and Evaluation

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

Probe parameters：	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters：	- Frequency	f
	- Crest factor	cf
Media parameters：	- Conductivity	σ
	- Density	ρ

The formula for each channel can be given as：

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

with V_i = compensated signal of channel i, (i = x, y, z)
U_i = input signal of channel i, (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

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

E-field Probes：$\mathbf{E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}}$

with V_i = compensated signal of channel i, (i = x, y, z)
$Norm_i$ = sensor sensitivity of channel i, (i = x, y, z), $\mu V/(V/m)^2$ for E-field Probes
ConvF = sensitivity enhancement in solution
f = carrier frequency [GHz]
E_i = electric field strength of channel i in V/m

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

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

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

7. RF Emissions Test Procedure

Referenced from ANSI C63.19 -2011 section 5.5.1

a. Confirm the proper operation of the field probe, probe measurement system, and other instrumentation and the positioning system.
b. Position the WD in its intended test position.
c. Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
d. The center sub-grid shall be centered on the T-Coil mode perpendicular measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane, refer to illustrated in Figure 8.2. If the field alignment method is used, align the probe for maximum field reception.
e. Record the reading at the output of the measurement system.
f. Scan the entire 50 mm by 50 mm region in equality spaced increments and record the reading at each measurement point, The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
g. Identify the five contiguous sub-grids around the center sub-grid whose maximum reading is the lowest of all available choices. This eliminates the three sub-grids with the maximum readings. Thus, the six areas to be used to determine the WD's highest emissions are identified.
h. Identify the maximum reading within the non-excluded sub-grids identified in step g).
i. Indirect measurement method
j. 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)
k. Compare this RF audio interference level with the categories in ANSI C63.19-2011 clause 8 and record the resulting WD category rating.
l. For the T-Coil perpendicular measurement location is ≥5.0 mm from the center of the acoustic output, then two different 50 mm by 50 mm areas may need to be scanned, the first for the microphone mode assessment and the second for the T-Coil assessment.
m. The second for the T-Coil assessment, with the grid shifted so that it is centered on the perpendicular measurement point. Record the WD category rating.

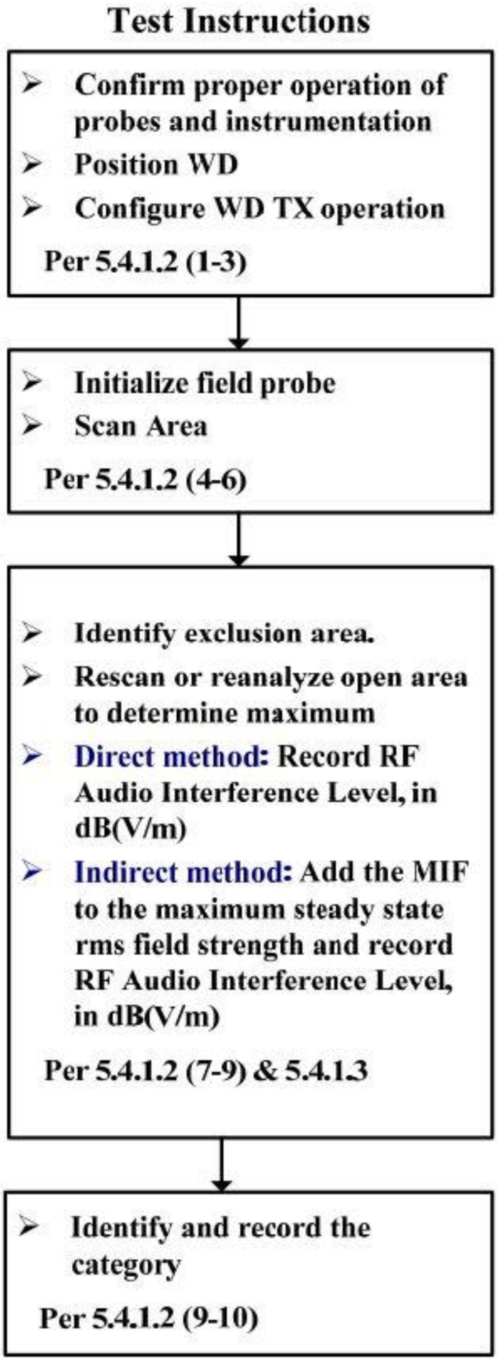

Figure 8.1 RF Emissions Flow Chart

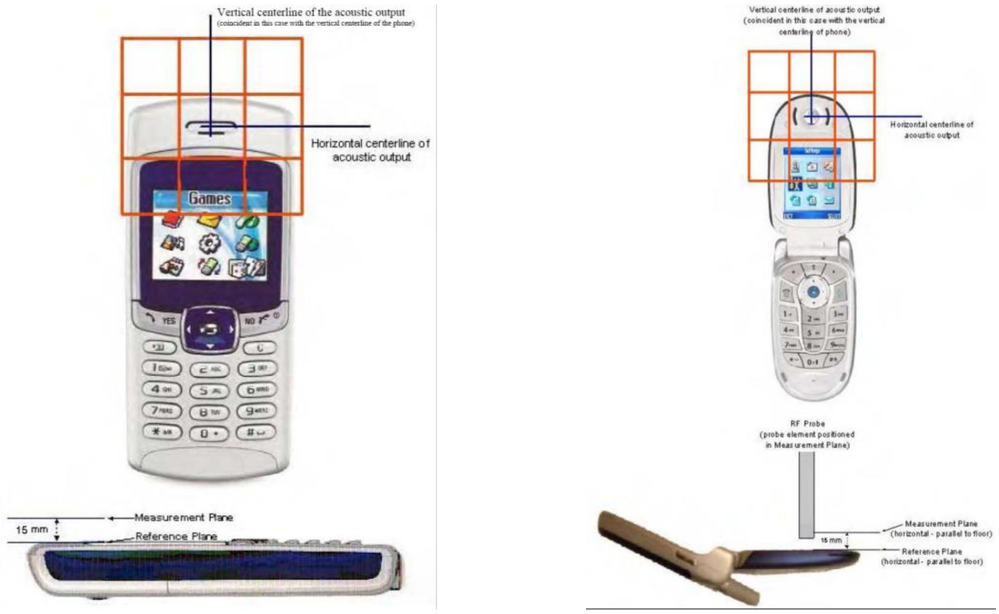

Fig 8.2 EUT reference and plane for HAC RF emission measurements

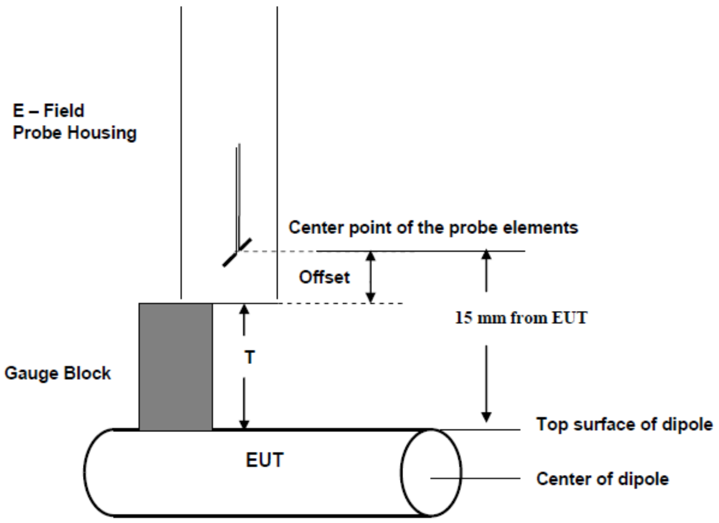

Fig. 8.3 Gauge block with E-field probe

8. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	835MHz Calibration Dipole(2)	CD835V3	1045	Sep. 19, 2018	Sep. 16, 2021
SPEAG	1880MHz Calibration Dipole(2)	CD1880V3	1038	Sep. 19, 2018	Sep. 16, 2021
SPEAG	2450MHz Calibration Dipole(2)	CD2450V3	1186	Jan. 30, 2019	Jan. 28, 2021
SPEAG	2600Mhz Calibration Dipole(2)	CD2600V3	1010	Mar. 14, 2019	Mar. 12, 2021
SPEAG	3500Mhz Calibration Dipole(2)	CD3500V3	1009	Feb. 18, 2019	Feb. 16, 2021
SPEAG	5500Mhz Calibration Dipole(2)	CD5500V3	1009	Jan. 30, 2019	Jan. 28, 2021
SPEAG	Data Acquisition Electronics	DAE4	854	May. 26, 2020	May. 25, 2021
SPEAG	Isotropic E-Field Probe	EF3DV3	4062	Dec. 18, 2020	Dec. 17, 2021
Testo	Hygro meter	608-H1	45196600	Nov. 10, 2020	Nov. 09, 2021
R&S	Base Station	CMU200	117591	Nov. 09, 2020	Nov. 08, 2021
R&S	Wideband Radio Communication Tester	CMW500	169351	Aug. 28, 2020	Aug. 27, 2021
SPEAG	Test Arch Phantom	N/A	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
R&S	Signal Generator	SAM100A	101091	Jul. 20, 2020	Jul. 19, 2021
Anritsu	Power Meter	ML2495A	1419002	Aug. 19, 2020	Aug. 18, 2021
Anritsu	Power Sensor	MA2411B	1911176	Aug. 18, 2020	Aug. 17, 2021
ATM	Dual Directional Coupler	C122H-10	P610410z-02	NCR	NCR
Warison	Directional Coupler	WCOU-10-50S-10	WR889BMC4B1	NCR	NCR
Woken	Attenuator	WK0602-XX	N/A	NCR	NCR
Anritsu	Spectrum Analyzer	MS2830A	6201396378	Jun. 30, 2020	Jun. 29, 2021
Mini-Circuits	Power Amplifier	ZVE-8G+	6418	Oct. 21, 2020	Oct. 20, 2021

Note:
1. NCR: “No-Calibration Required”
2. The dipole calibration interval can be extended to 3 years with justification according to KDB 865664 D01. The dipoles are also not physically damaged, or repaired during the interval. The justification data in appendix C can be found which the return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration for each dipole.

9. Measurement System Validation

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the test Arch and a corresponding distance holder.
The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal HAC measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

<Test Setup>

1. In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator.
2. The center point of the probe element(s) is 15mm from the closest surface of the dipole elements.
3. The calibrated dipole must be placed beneath the arch phantom. The equipment setup is shown below:
4. The output power on dipole port must be calibrated to 20dBm (100mW) before dipole is connected.

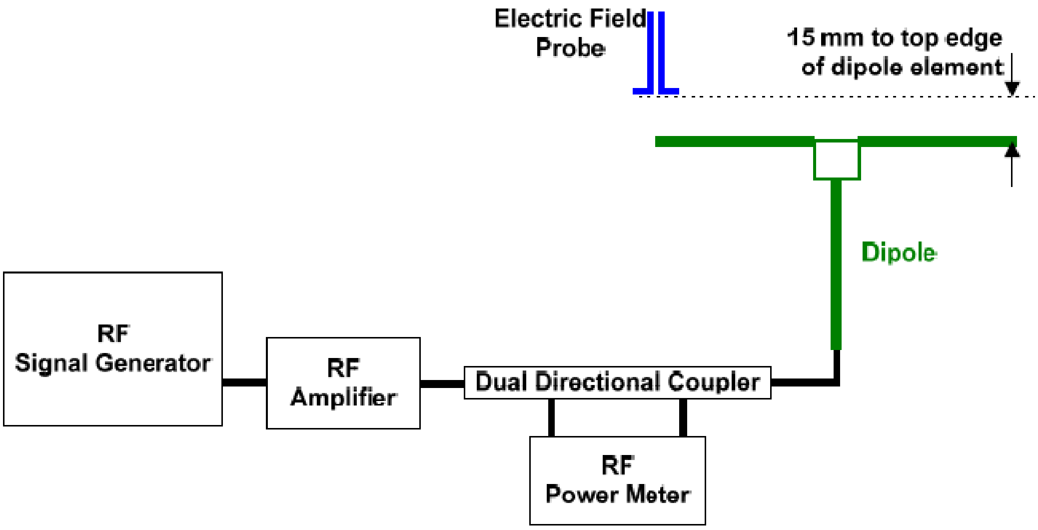

Fig. 7.1 Setup Diagram

<Validation Results>

Comparing to the original E-field value provided by SPEAG, the verification data should be within its specification of 25 %. Table 6.1 shows the target value and measured value. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to appendix A of this report.
Deviation = ((Average E-field Value) - (Target value)) / (Target value) * 100%

Frequency (MHz)	Input Power (dBm)	Target Value (V/m)	E-Field above high end (V/m)	E-Field above low end (V/m)	Average Value (V/m)	Deviation (%)	Date
835	20	108.8	111.9	113.4	112.65	3.54	Jan 20, 2021
1880	20	89.5	86.54	89.85	88.195	-1.46	Jan 20, 2021
2450	20	84.1	79.87	80.96	80.415	-4.38	Jan 21, 2021
2600	20	84.5	81.77	83	82.385	-2.50	Jan 20, 2021
3500	20	84.6	85.23	85.11	85.17	0.67	Jan 21, 2021
5500	20	99.8	91.84	94.28	93.06	-6.75	Jan 22, 2021

10. Modulation Interference Factor

The HAC Standard ANSI C63.19-2011 defines a new scaling using the Modulation Interference Factor (MIF).
For any specific fixed and repeatable modulated signal, a modulation interference factor (MIF, expressed in dB) may be developed that relates its interference potential to its steady-state rms signal level or average power level. This factor is a function only of the audio-frequency amplitude modulation characteristics of the signal and is the same for field-strength and conducted power measurements. It is important to emphasize that the MIF is valid only for a specific repeatable audio-frequency amplitude modulation characteristic. Any change in modulation characteristic requires determination and application of a new MIF
The Modulation Interference factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF Audio Interference level (in dBV/m). This level considers the audible amplitude modulation components in the RF E-field. CW fields without amplitude modulation are assumed to not interfere with the hearing aid electronics. Modulations without time slots and low fluctuations at low frequencies have low MIF values, TDMA modulations with narrow transmission and repetition rates of few 100 Hz have high MIF values and give similar classifications as ANSI C63.19-2011.
ER3D, EF3D and EU2D E-field probes have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY52 is therefore using the indirect measurement method according to ANSI C63.19-2011 which is the primary method. These near field probes read the averaged E-field measurement. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by PMR calibration in order to not overestimate the field reading. Probe Modulation Response (PMR) calibration linearizes the probe response over its dynamic range for specific modulations which are characterized by their UID and result in an uncertainty specified in the probe calibration certificate. The MIF is characteristic for a given waveform envelope and can be used as a constant conversion factor if the probe has been PMR calibrated.
The evaluation method for the MIF is defined in ANSI C63.19-2011 section D.7. An RMS demodulated RF signal is fed to a spectral filter (similar to an A weighting filter) and forwarded to a temporal filter acting as a quasi-peak detector. The averaged output of these filtering is scaled to a 1 kHz 80% AM signal as reference. MIF measurement requires additional instrumentation and is not well suited for evaluation by the end user with reasonable uncertainty. It may alliteratively be determined through analysis and simulation, because it is constant and characteristic for a communication signal. DASY52 uses well-defined signals for PMR calibration. The MIF of these signals has been determined by simulation and it is automatically applied.
The MIF measurement uncertainty is estimated as follows, declared by HAC equipment provider SPEAG, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz:
1. 0.2 dB for MIF: -7 to +5 dB
2. 0.5 dB for MIF: -13 to +11 dB
3. 1 dB for MIF: > -20 dB

MIF values applied in this test report were provided by the HAC equipment provider of SPEAG, and the worst values for all air interface are listed below to be determine the Low-power Exemption.

UID	Communication System Name	MIF(dB)
10021	GSM-FDD(TDMA,GMSK)	3.63
10025	EDGE-FDD (TDMA, 8PSK, TN 0)	3.75
10460	UMTS-FDD(WCDMA, AMR)	-25.43
10225	UMTS-FDD (HSPA+)	-20.39
10170	LTE-FDD(SC-FDMA,1RB,20MHz,16-QAM)	-9.76
10173	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44
10769	5G NR (CP-OFDM, 1 RB, 15 MHz, QPSK, 15 kHz)	-12.08
10061	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	-2.02
10077	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	0.12
10427	IEEE 802.11n (HT Greeneld, 150 Mbps, 64-QAM)	-13.44
10069	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	-3.15
10616	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	-5.57
10671	IEEE 802.11ax (20MHz, MCS0, 90pc duty cycle)	-5.58

11. Low-power Exemption

<WWAN Max Tune-up Limit>

Frequency Band		Average Power (dBm)	
		WWAN LAT	WWAN UAT
GSM	GSM850	34.50	32.00
	EDGE850	27.50	27.50
	GSM1900	31.50	
	EDGE1900	25.50	
WCDMA	Band II	25.50	
	Band IV	25.50	
	Band V	25.50	25.50
	HSPA	24.50	24.50
FDD LTE	Band 7	25.50	
	Band 12/17	25.50	25.50
	Band 13	25.50	25.50
	Band 25/2	25.50	
	Band 26/5	25.50	25.00
	Band 30	25.50	
	Band 66/4	25.50	
	Band 71	25.50	25.50
TDD LTE	Band 41/38	25.50	
	Band 42/48	22.00	22.00
5G NR FDD	n5	24.50	24.50
	n7	24.50	
	n12	24.50	24.50
	n25/2	24.50	
	n66	24.50	
	n71	24.50	24.50
5G NR TDD	n41/38	24.50	21.50
	n77/78	22.00	22.00

WWAN LAT

Air Interface	Max Average Antenna Input Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 test required
GSM850	34.50	3.63	38.13	Yes
EDGE850	27.50	3.75	31.25	No(1)
GSM1900	31.50	3.63	35.13	Yes
EDGE1900	25.50	3.75	29.25	No(1)
WCDMA	25.50	-25.43	0.07	No
WCDMA - HSPA	24.50	-20.39	4.11	No
LTE - FDD	25.50	-9.76	15.74	No
LTE – TDD	25.50	-1.44	24.06	Yes
5G FR1 - FDD	24.50	-12.08	12.42	No
5G NR - TDD	24.50	-12.08	12.42	No

General Note:

1. EDGE data modes is not necessary due the GSM Voice mode is the worst case.
2. According to ANSI C63.19 2011-version, for the air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17 dBm for any of its operating modes.
3. HAC RF rating is M4 for the air interface which meets the low power exemption.

WWAN UAT

Air Interface	Max Average Antenna Input Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 test required
GSM850	32.00	3.63	35.63	Yes
EDGE850	27.50	3.75	31.25	No(1)
WCDMA	25.50	-25.43	0.07	No
WCDMA - HSPA	24.50	-20.39	4.11	No
LTE - FDD	25.50	-9.76	15.74	No
LTE – TDD	22.00	-1.44	20.56	Yes
5G FR1 - FDD	24.50	-12.08	12.42	No
5G NR - TDD	22.00	-12.08	9.92	No

General Note:

1. EDGE data modes is not necessary due the GSM Voice mode is the worst case.
2. According to ANSI C63.19 2011-version, for the air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17 dBm for any of its operating modes.
3. HAC RF rating is M4 for the air interface which meets the low power exemption.

<WLAN Max Tune-up Limit>

WLAN		
Frequency Band		Average Power (dBm)
WLAN 2.4GHz	802.11b	22.00
	802.11g	22.00
	802.11n-HT20	22.00
	802.11n-HT40	22.00
	802.11ac-VHT20	22.00
	802.11ac-VHT40	22.00
	802.11ax-HE20	22.00
	802.11ax-HE40	22.00
WLAN 5GHz	802.11a	21.50
	802.11n-HT20	21.50
	802.11n-HT40	21.50
	802.11ac-VHT20	21.50
	802.11ac-VHT40	21.50
	802.11ac-VHT80	21.50
	802.11ac-VHT160	21.00
	802.11ax-HE20	21.50
	802.11ax-HE40	21.50
	802.11ax-HE80	21.50
	802.11ax-HE160	20.50
WLAN 6E	802.11a	4.50
	802.11n-HT20	4.50
	802.11n-HT40	7.50
	802.11ac-VHT20	4.50
	802.11ac-VHT40	7.50
	802.11ac-VHT80	11.00
	802.11ac-VHT160	14.50
	802.11ax-HE20	4.50
	802.11ax-HE40	7.50
	802.11ax-HE80	11.00
	802.11ax-HE160	14.50

WLAN

Air Interface		Max Average Antenna Input Power (dBm)	Worst Case MIF (dB)	Power + MIF(dB)	C63.19 test required
WLAN 2.4GHz	802.11b	22.00	-2.02	19.98	No(1)
	802.11g	22.00	0.12	22.12	Yes
	802.11n-HT20	22.00	-13.44	8.56	No
	802.11n-HT40	22.00	-13.44	8.56	No
	802.11ac-VHT20	22.00	-5.57	16.43	No
	802.11ac-VHT40	22.00	-5.57	16.43	No
	802.11ax-HE20	22.00	-5.58	16.42	No
	802.11ax-HE40	22.00	-5.58	16.42	No
WLAN 5GHz	802.11a	21.50	-3.15	18.35	Yes
	802.11n-HT20	21.50	-13.44	8.06	No
	802.11n-HT40	21.50	-13.44	8.06	No
	802.11ac-VHT20	21.50	-5.57	15.93	No
	802.11ac-VHT40	21.50	-5.57	15.93	No
	802.11ac-VHT80	21.50	-5.57	15.93	No
	802.11ac-VHT160	21.00	-5.57	15.43	No
	802.11ax-HE20	21.50	-5.58	15.92	No
	802.11ax-HE40	21.50	-5.58	15.92	No
	802.11ax-HE80	21.50	-5.58	15.92	No
	802.11ax-HE160	20.50	-5.58	14.92	No
WLAN 6E	802.11a	4.50	-3.15	1.35	No
	802.11n-HT20	4.50	-13.44	-8.94	No
	802.11n-HT40	7.50	-13.44	-5.94	No
	802.11ac-VHT20	4.50	-5.57	-1.07	No
	802.11ac-VHT40	7.50	-5.57	1.93	No
	802.11ac-VHT80	11.00	-5.57	5.43	No
	802.11ac-VHT160	14.50	-5.57	8.93	No
	802.11ax-HE20	4.50	-5.58	-1.08	No
	802.11ax-HE40	7.50	-5.58	1.92	No
	802.11ax-HE80	11.00	-5.58	5.42	No
	802.11ax-HE160	14.50	-5.58	8.92	No

General Note:

1. 802.11b mode is not necessary due the 802.11g mode is the worst case.
2. According to ANSI C63.19 2011-version, for the air interface technology of a device is exempt from testing when its average antenna input power plus its MIF is ≤17 dBm for any of its operating modes.
3. HAC RF rating is M4 for the air interface which meets the low power exemption.

12. Conducted RF Output Power (Unit: dBm)

<UAT>

Average Antenna Input Power(dBm)			
Band	GSM850		
Channel	128	189	251
Frequency (MHz)	824.2	836.4	848.8
GSM (GMSK, 1 Tx slot)	30.79	30.99	30.92

<LAT>

Average Antenna Input Power(dBm)						
Band	GSM850			GSM1900		
Channel	128	189	251	512	661	810
Frequency (MHz)	824.2	836.4	848.8	1850.2	1880.0	1909.8
GSM (GMSK, 1 Tx slot)	33.03	33.16	32.83	29.90	30.45	30.30

<LTE Band 41 LAT>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low Middle Ch. / Freq.	Power Middle Ch. / Freq.	Power High Middle Ch. / Freq.	Power High Ch. / Freq.
Channel				39750	40185	40620	41055	41490
Frequency (MHz)				2506	2549.5	2593	2636.5	2680
20	QPSK	1	0	24.10	24.04	24.10	24.10	24.00

<LTE Band 48 UAT>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low Middle Ch. / Freq.	Power High Middle Ch. / Freq.	Power High Ch. / Freq.
Channel				55340	55830	56150	56640
Frequency (MHz)				3560	3609	3641	3690
20	QPSK	1	0	20.84	20.97	20.92	20.86

<LTE Band 48 LAT>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Low Middle Ch. / Freq.	Power High Middle Ch. / Freq.	Power High Ch. / Freq.
Channel				55340	55830	56150	56640
Frequency (MHz)				3560	3609	3641	3690
20	QPSK	1	0	20.84	20.97	20.92	20.86

<WLAN 2.4GHz>

2.4GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)
	802.11g 6Mbps	1	2412	24.18
		6	2437	22.77
		11	2462	23.37

<WLAN 5GHz>

5.2GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)
	802.11a 6Mbps	36	5180	21.12
		40	5200	21.02
		44	5220	21.31
		48	5240	21.47
5.3GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)
	802.11a 6Mbps	52	5260	21.32
		56	5280	21.27
		60	5300	21.17
		64	5320	21.37
5.5GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)
	802.11a 6Mbps	100	5500	21.21
		116	5580	21.17
		132	5660	20.75
		140	5700	21.21
5.8GHz WLAN	Mode	Channel	Frequency (MHz)	Average power (dBm)
	802.11a 6Mbps	149	5745	22.66
		157	5785	22.61
		165	5825	22.71

13. HAC RF Emission Test Results

Plot No.	Air Interface	Modulation / Mode	Channel	DUT Status	Aero Active Cooler	Transmit Ant.	Average Antenna Input Power (dBm)	MIF	E-Field (dBV/m)	Margin to FCC M3 limit (dB)	E-Field M Rating
1	GSM850	Voice	128	UAT	-	ANT 2	30.79	3.63	37.10	7.90	M4
2	GSM850	Voice	189	UAT	-	ANT 2	30.99	3.63	37.66	7.34	M4
3	GSM850	Voice	251	UAT	-	ANT 2	30.92	3.63	37.68	7.32	M4
4	GSM850	Voice	128	LAT	-	ANT 0	33.03	3.63	28.12	16.88	M4
5	GSM850	Voice	189	LAT	-	ANT 0	33.16	3.63	30.14	14.86	M4
6	GSM850	Voice	251	LAT	-	ANT 0	32.83	3.63	30.90	14.10	M4
7	GSM1900	Voice	512	LAT	-	ANT 1	29.9	3.63	25.63	9.37	M4
8	GSM1900	Voice	661	LAT	-	ANT 1	30.45	3.63	25.44	9.56	M4
9	GSM1900	Voice	810	LAT	-	ANT 1	30.3	3.63	24.00	11.00	M4
10	LTE Band 41	20M_QPSK_1_0	39750	LAT	-	ANT 1	24.1	-1.44	20.35	14.65	M4
11	LTE Band 41	20M_QPSK_1_0	40185	LAT	-	ANT 1	24.04	-1.44	20.36	14.64	M4
12	LTE Band 41	20M_QPSK_1_0	40620	LAT	-	ANT 1	24.1	-1.44	18.37	16.63	M4
13	LTE Band 41	20M_QPSK_1_0	41550	LAT	-	ANT 1	24.1	-1.44	19.34	15.66	M4
14	LTE Band 41	20M_QPSK_1_0	41490	LAT	-	ANT 1	24	-1.44	15.55	19.45	M4
15	LTE Band 48	20M_QPSK_1_0	55340	UAT	-	ANT 9	20.84	-1.44	26.22	8.78	M4
16	LTE Band 48	20M_QPSK_1_0	55830	UAT	-	ANT 9	20.97	-1.44	25.69	9.31	M4
17	LTE Band 48	20M_QPSK_1_0	56150	UAT	-	ANT 9	20.92	-1.44	25.28	9.72	M4
18	LTE Band 48	20M_QPSK_1_0	56640	UAT	-	ANT 9	20.86	-1.44	25.66	9.34	M4
19	LTE Band 48	20M_QPSK_1_0	55340	LAT	-	ANT 11	20.84	-1.44	13.67	21.33	M4
20	LTE Band 48	20M_QPSK_1_0	55830	LAT	-	ANT 11	20.97	-1.44	13.82	21.18	M4
21	LTE Band 48	20M_QPSK_1_0	56150	LAT	-	ANT 11	20.92	-1.44	14.21	20.79	M4
22	LTE Band 48	20M_QPSK_1_0	56640	LAT	-	ANT 11	20.86	-1.44	15.55	19.45	M4
23	WLAN2.4GHz	802.11g 6Mbps	1	-	-	Ant 4+5	24.18	0.12	27.72	7.28	M4
24	WLAN2.4GHz	802.11g 6Mbps	6	-	-	Ant 4+5	22.77	0.12	32.89	2.11	M3
25	WLAN2.4GHz	802.11g 6Mbps	11	-	-	Ant 4+5	23.37	0.12	27.64	7.36	M4
41	WLAN2.4GHz	802.11g 6Mbps	6	-	v	Ant 4+5	22.77	0.12	31.51	3.49	M3
26	WLAN5GHz	802.11a 6Mbps	36	-	-	Ant 4+5	21.12	-3.15	24.15	10.85	M4
27	WLAN5GHz	802.11a 6Mbps	40	-	-	Ant 4+5	21.02	-3.15	24.40	10.60	M4
28	WLAN5GHz	802.11a 6Mbps	44	-	-	Ant 4+5	21.31	-3.15	24.23	10.77	M4
29	WLAN5GHz	802.11a 6Mbps	48	-	-	Ant 4+5	21.47	-3.15	24.54	10.46	M4
30	WLAN5GHz	802.11a 6Mbps	52	-	-	Ant 4+5	21.32	-3.15	24.34	10.66	M4
31	WLAN5GHz	802.11a 6Mbps	56	-	-	Ant 4+5	21.27	-3.15	24.65	10.35	M4
32	WLAN5GHz	802.11a 6Mbps	60	-	-	Ant 4+5	21.17	-3.15	24.63	10.37	M4
33	WLAN5GHz	802.11a 6Mbps	64	-	-	Ant 4+5	21.37	-3.15	25.00	10.00	M4
34	WLAN5GHz	802.11a 6Mbps	100	-	-	Ant 4+5	21.21	-3.15	24.80	10.20	M4
35	WLAN5GHz	802.11a 6Mbps	116	-	-	Ant 4+5	21.17	-3.15	23.83	11.17	M4
36	WLAN5GHz	802.11a 6Mbps	132	-	-	Ant 4+5	20.75	-3.15	22.38	12.62	M4
37	WLAN5GHz	802.11a 6Mbps	140	-	-	Ant 4+5	21.21	-3.15	22.39	12.61	M4
38	WLAN5GHz	802.11a 6Mbps	149	-	-	Ant 4+5	22.66	-3.15	23.19	11.81	M4
39	WLAN5GHz	802.11a 6Mbps	157	-	-	Ant 4+5	22.61	-3.15	22.42	12.58	M4
40	WLAN5GHz	802.11a 6Mbps	165	-	-	Ant 4+5	22.71	-3.15	22.23	12.77	M4

Remark:

1. The HAC measurement system applies MIF value onto the measured RMS E-field, which is indirect method in ANSI C63.19 2011 version, and reports the RF audio interference level.
2. Phone Condition: Mute on; Backlight off; Max Volume
3. The device support additional accessories of AeroActive cooler, this accessory will attach the device to do spot check worst case to ensure the M-Rating is compliance.

Test Engineer：Bevis Chang and Randy Lin

14. Uncertainty Assessment

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type A evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.
The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances. Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is showed in Table 12.1.
The judgment of conformity in the report is based on the measurement results excluding the measurement uncertainty.

Error Description	Uncertainty Value (±%)	Probability Distribution	Divisor	Ci (E)	Standard Uncertainty (E)
Measurement System					
Probe Calibration	5.1	Normal	1	1	± 5.1 %
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	1	± 2.7 %
Sensor Displacement	16.5	Rectangular	$\sqrt{3}$	1	± 9.5 %
Boundary Effects	2.4	Rectangular	$\sqrt{3}$	1	± 1.4 %
Phantom Boundary Effects	7.2	Rectangular	$\sqrt{3}$	1	± 4.1 %
Linearity	4.7	Rectangular	$\sqrt{3}$	1	± 2.7 %
Scaling with PMR Calibration	10.0	Rectangular	$\sqrt{3}$	1	± 5.77 %
System Detection Limit	1.0	Rectangular	$\sqrt{3}$	1	± 0.6 %
Readout Electronics	0.3	Normal	1	1	± 0.3 %
Response Time	0.8	Rectangular	$\sqrt{3}$	1	± 0.5 %
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	± 1.5 %
RF Ambient Conditions	3.0	Rectangular	$\sqrt{3}$	1	± 1.7 %
RF Reflections	12.0	Rectangular	$\sqrt{3}$	1	± 6.9 %
Probe Positioner	1.2	Rectangular	$\sqrt{3}$	1	± 0.7 %
Probe Positioning	4.7	Rectangular	$\sqrt{3}$	1	± 2.7 %
Extrap. and Interpolation	1.0	Rectangular	$\sqrt{3}$	1	± 0.6 %
Test Sample Related					
Device Positioning Vertical	4.7	Rectangular	$\sqrt{3}$	1	± 2.7 %
Device Positioning Lateral	1.0	Rectangular	$\sqrt{3}$	1	± 0.6 %
Device Holder and Phantom	2.4	Rectangular	$\sqrt{3}$	1	± 1.4 %
Power Drift	5.0	Rectangular	$\sqrt{3}$	1	± 2.9 %
Phantom and Setup Related					
Phantom Thickness	2.4	Rectangular	$\sqrt{3}$	1	± 1.4 %
Combined Standard Uncertainty					± 16.30 %
Coverage Factor for 95 %					K = 2
Expanded Std. Uncertainty on Power					**± 32.6 %**
Expanded Std. Uncertainty on Field					**± 16.3 %**
Declaration of Conformity: The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.					
Comments and Explanations: The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.					

Uncertainty Budget of HAC free field assessment

15. References

[1] ANSI C63.19-2011, “American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids”, 27 May 2011.

[2] FCC KDB 285076 D02v03, “Guidance for performing T-Coil tests for air interfaces supporting voice over IP (e.g., LTE and WiFi) to support CMRS based telephone services”, Sep 2017

[3] FCC KDB 285076 D03v01r01, “Hearing aid compatibility frequently asked questions”, Apr. 2020.

[4] SPEAG DASY System Handbook