HAC RF-Emission Evaluation Report for FCC

Applicant Name	:	**PepperlFuchs SE**
Applicant Address	:	**Lilienthalstrasse 200, 68307 Mannheim, Germany**
Product Name	:	**Phone**
Brand Name	:	**PEPPERL+FUCHS**
Model Number	:	**Smart-Ex 03**
FCC ID	:	**2AXZAS03GR01**
Report Number	:	**USSC236135002**
Compliant Standards	:	**FCC 47 CFR §20.19**
		ANSI C63.19-2011
HAC Category	:	**M3**
Sample Received Date	:	**Apr. 20, 2023**
Date of Testing	:	**Nov. 10 ~ Nov. 20, 2023**
Report Issue Date	:	**Nov. 28, 2023**

*The above equipment has been tested by **Eurofins E&E Wireless Taiwan Co., Ltd.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Device Under Test (DUT) configurations represented herein are true and accurate accounts of the measurements of the sample's characteristics under the conditions specified in this report.*

Note:
1. The test results are valid only for samples provided by customers and under the test conditions described in this report.
2. This report shall not be reproduced except in full, without the written approval of Eurofins E&E Wireless Taiwan Co., Ltd.
3. The relevant information is provided by customers in this test report. According to the correctness, appropriateness or completeness of the information provided by the customer, if there is any doubt or error in the information which affects the validity of the test results, the laboratory does not take the responsibility.

Approved By：

Roy Wu / SAR Technical Director

Testing Laboratory
1330

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Revision History

Rev.	Issue Date	Description	Revised by
00	Nov. 28, 2023	Initial release	Rowan Hsieh

1. Compliance Statement

This device (FCC ID: ***2AXZAS03GR01***) has been tested by ***Eurofins E&E Wireless Taiwan Co., Ltd.*** in accordance with the measurement procedures specified in ANSI C63.19 and FCC KDB procedures, and the results shown in below are capable of demonstrating compliance for Hearing Aid Compatibility (HAC) for minimum criteria of ***M3*** rating specified in *FCC 47 CFR §20.19*.

Equipment Class	*Technology / Band*	*HAC Category (M Rating)*
PCE	GSM850	M4
	GSM1900	M4
	WCDMA Band 2	M4
	WCDMA Band 4	M4
	WCDMA Band 5	M4
	LTE Band 2	M4
	LTE Band 4	M4
	LTE Band 5	M4
	LTE Band 7	M4
	LTE Band 12	M4
	LTE Band 13	M4
	LTE Band 14	M4
	LTE Band 25	M4
	LTE Band 26	M4
	LTE Band 30	M4
	LTE Band 38	M4
	LTE Band 40	M4
	LTE Band 41	M4
	LTE Band 42	M3
	LTE Band 43	M4
	LTE Band 48	M3
	LTE Band 66	M4
	LTE Band 71	M4
	NR n2	M4
	NR n5	M4
	NR n7	M4
	NR n12	M4
	NR n13	M4
	NR n14	M4
	NR n25	M4
	NR n30	M4
	NR n38	M4
	NR n41	M4
	NR n48	M4
	NR n66	M4
	NR n71	M4
	NR n77	M4
	NR n78	M4
DTS	2.4 GHz WLAN	M3
NII	5 GHz WLAN	M4
6CD	6 GHz WLAN	M4

2. Test Regulations

2.1. Reference Standard and Guidance

The Specific Absorption Rate (SAR) testing documented in this report were performed in accordance with following FCC published KDB guidance and standard：

KDB Publication 285076 D01 – HAC Guidance v06r04

KDB Publication 285076 D03 – HAC FAQ v01r06

2.2. HAC Performance Criteria

The FCC uses a technical standard to determine whether a handset is hearing aid-compatible. The HAC technical standard is known as the standard of ***ANSI C63.19-2011***, and devices that meet it will be simply labelled as "hearing aid-compatible." The standard uses an M/T rating system. The ***"M" rating*** is for reducing interference with hearing aids operating in acoustic mode – from ***M1*** to ***M4***, with ***M4*** being the best. The ***"T" rating*** is for their ability to operate with hearing aids that contain a telecoil (a tightly wrapped piece of wire that converts sounds into electromagnetic signals) and operate in inductive coupling mode – from ***T1*** to ***T4***, with ***T4*** being the best. The FCC considers a handset to be hearing aid-compatible if it is rated at least an ***M3*** (for acoustic coupling) and at least a ***T3*** (for inductive coupling).

WD RF Audio Interference Level Categories Specified in ANSI C63.19-2011

Emission Categories	***E-Field Emissions***	
	f < 960 MHz	***f > 960 MHz***
Category M1	**50 ~ 55 dB (V/m)**	**40 ~ 45 dB (V/m)**
Category M2	**45 ~ 50 dB (V/m)**	**35 ~ 40 dB (V/m)**
Category M3	**40 ~ 45 dB (V/m)**	**30 ~ 35 dB (V/m)**
Category M4	**< 40 dB (V/m)**	**< 30 dB (V/m)**

3. Information of Testing Laboratory

Test Facilities

Company Name: Eurofins E&E Wireless Taiwan Co., Ltd.
Address No.: 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan
Website: https://www.atl.com.tw
Telephone: +886-3-271-0188
Fax: +886-3-271-0190
E-mail: infoEETW@eurofins.com

Test Site Location

■ No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan
☐ No. 2, Wuquan 5th Rd. Wugu Dist., New Taipei City, Taiwan

Laboratory Accreditation

Location	TAF	FCC	ISED
No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan	Accreditation No.: 1330	Designation No.: TW0010	Company No.: 7381A CAB ID: TW1330
No. 2, Wuquan 5th Rd. Wugu Dist., New Taipei City, Taiwan	Accreditation No.: 1330	Designation No.: TW0034	Company No.: 28922 CAB ID: TW1330

4. DUT (Device Under Test) Information

4.1. Device Overview

Product Name	Phone
Brand Name	PEPPERL+FUCHS
Model Name	Smart-Ex 03
Variants Description	Smart-Ex 03 is provided to the end user in two variants, one with camera features and the other as a non-camera variant. The camera modules are also populated in the non-camera variant; only SW deactivation and assembling physical camera opening covers, which are not metal, are required. Therefore, the testing was completed on the DUT with the camera features only.
FCC ID	2AXZAS03GR01

	Tx Frequency (MHz)	Operating Mode
Supported Wireless Technologies	***GSM*** 850 : 824.2 ~ 848.8 1900 : 1850.2 ~ 1909.8	Voice : GMSK GPRS : GMSK EDGE : 8PSK
	WCDMA Band 2 : 1852.4 ~ 1907.6 Band 4 : 1712.4 ~ 1752.6 Band 5 : 826.4 ~ 846.6	UMTS Rel. 99 (Voice / Data) HSDPA (Rel. 5) HSUPA (Rel. 6) HSPA+ (Rel. 7) DC-HSDPA (Rel. 8)
	LTE Band 2 : 1850.7 ~ 1909.3 Band 4 : 1710.7 ~ 1754.3 Band 5 : 824.7 ~ 848.3 Band 7 : 2502.5 ~ 2567.5 Band 12 : 699.7 ~ 715.3 Band 13 : 779.5 ~ 784.5 Band 14 : 790.5 ~ 795.5 Band 25 : 1850.7 ~ 1914.3 Band 26 : 814.7 ~ 848.3 Band 30 : 2307.5 ~ 2312.5 Band 38 : 2572.5 ~ 2617.5 Band 40 : 2302.5 ~ 2397.5 Band 41 : 2498.5 ~ 2687.5 Band 42 : 3552.5 ~ 3597.5 Band 43 : 3600 ~ 3800 Band 48 : 3552.5 ~ 3697.5 Band 66 : 1710.7 ~ 1779.3 Band 71 : 665.5 ~ 695.5	QPSK, 16QAM, 64QAM, 256QAM
	5G NR FR1 n2 : 1852.5 ~ 1907.5 n5 : 826.5 ~ 846.5 n7 : 2502.5 ~ 2567.5 n12 : 701.5 ~ 713.5 n13 : 777 ~ 787 n14 : 790.5 ~ 795.5 n25 : 1852.5 ~ 1912.5 n26 : 816.5 ~ 846.5 n30 : 2307.5 ~ 2312.5 n38 : 2575 ~ 2615 n41 : 2501.01 ~ 2685, 2506.02 ~ 2679.99 n48 : 3555 ~ 3694.98 n66 : 1712.5 ~ 1777.5 n71 : 665.5 ~ 695.5 n77 : 3455.01 ~ 3645, 3705 ~ 3975 n78 : 3455.01 ~ 3544.98, 3705 ~ 3795	***DFT-s-OFDM：*** π/2 BPSK, QPSK, 16QAM, 64QAM, 256QAM ***CP-OFDM：*** QPSK, 16QAM, 64QAM, 256QAM
	WLAN 2.4G : 2412 ~ 2472 5G : 5180 ~ 5240, 5260 ~ 5320, 5500 ~ 5720, 5745 ~ 5825, 5845 ~ 5885 6G : 5935 ~ 6415, 6435 ~ 6515, 6535 ~ 6875, 6895 ~ 7115	2.4G : 802.11b/g/n/ac/ax 5G : 802.11a/n/ac/ax 6G : 802.11a/ax
	Bluetooth 2402 ~ 2480	BR, EDR, LE,

Note:

The above DUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

4.2. Air Interfaces and Operating Mode

Air Interface	Bands	Transport Type	HAC Tested	Simultaneous But Not Tested	Name of Voice Service	Power Reduction
GSM	850	VO	YES	Yes: Wi-Fi or BT	CMRS Voice	No
	1900					No
	EGPRS	VD	YES	Yes: Wi-Fi or BT	N/A	No
WCDMA	2	VO	No(1)	Yes: Wi-Fi or BT	CMRS Voice	No
	4					No
	5					No
	HSPA	VD	No(1)	Yes: Wi-Fi or BT	N/A	No
FDD-LTE	2	VD	No(1)	Yes: NR, Wi-Fi or BT	VoLTE	No
	4					No
	5					No
	7					No
	12					No
	13					No
	14					No
	25					No
	26					No
	30					No
	66					No
	71					No
TDD-LTE	38	VD	YES	Yes: NR, Wi-Fi or BT	VoLTE	No
	40					No
	41					No
	42					No
	43					No
	48					No
5G NR	n2	VD	No(1)	Yes: LTE, Wi-Fi or BT	VoNR	No
	n5					No
	n7					No
	n12					No
	n13					No
	n14					No
	n25					No
	n30					No
	n38					No
	n41					No
	n48					No
	n66					No
	n71					No
	n77					No
	n78					No
Wi-Fi	2.4G	VD	YES	Yes: WWAN, Wi-Fi 5G/6G	VoWiFi	No
	5.2G (UNII-1)			Yes: WWAN, Wi-Fi 2.4G, BT		No
	5.3G (UNII-2A)					No
	5.6G (UNII-2C)					No
	5.8G (UNII-3)					No
	5.9G (UNII-4)					No
	UNII-5	VD	No(1)	Yes: WWAN, Wi-Fi 2.4G, BT	VoWiFi	No
	UNII-6		No(3)			No
	UNII-7					No
	UNII-8					No
Bluetooth	2.4G	DT	No	Yes: WWAN, Wi-Fi 5G/6G	N/A	No

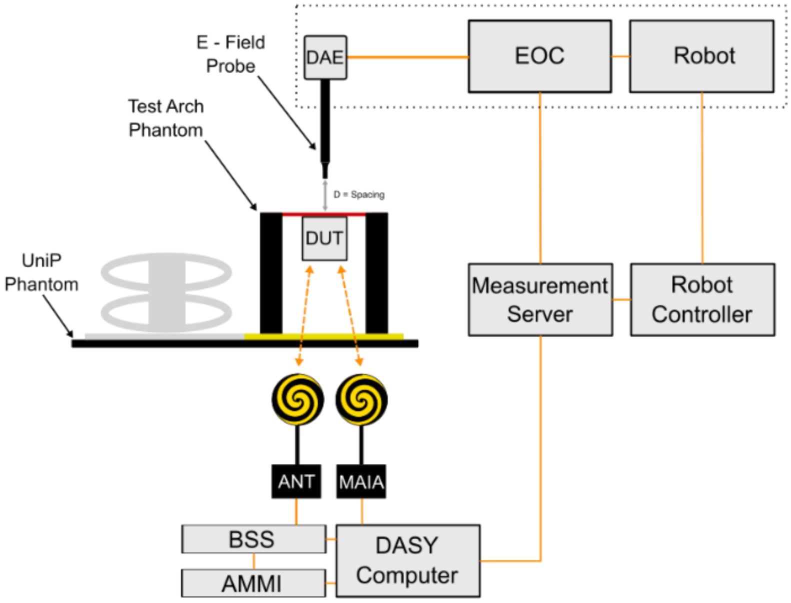
Transport Type:	***Notes:***
VO = Legacy Cellular Voice Service DT = Digital Transport Only (No Voice) VD = CMRS / IP Voice Service over Digital Transport	1. It applies the low power exemption per ANSI C63.19-2011. 2. Wi-Fi UNII 5 was evaluated for operations which are entirely below 6 GHz. Operations partially or entirely > 6 GHz were not evaluated due to equipment limitations and being outside of the current scope of ANSI C63.19 and FCC HAC regulations. 3. Wi-Fi UNII 5 through 8 were not evaluated due to equipment limitations and being outside of the current scope of ANSI C63.19 and FCC HAC regulations. 4. NR FR2 bands are currently outside the scope of ANSI C63.19 and FCC HAC regulations therefore they were not evaluated.

5. Measurement System Description

5.1. Measurement Setup

The SPEAG DASY5 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY5 software defined. The DASY5 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the Control PC.

SPEAG DASY5 HAC Measurement System Setup



The DASY5 system for HAC measurements consists of:

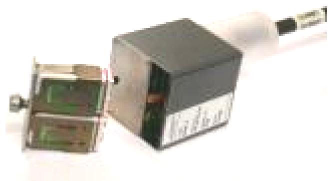
- 6-axis robotic arm (Stäubli TX90XL) for positioning the probe.
- Measurement Server for handling all time-critical tasks, such as measurement data acquisition and supervision of safety features.
- EOC (Electrical to Optical Converter) for converting the optical signal from the DAE to electrical before being transmitted to the measurement server.
- LB (Light-Beam unit) for probe alignment (measurement of the exact probe length and eccentricity).
- HAC probe (EF3D probes) for measuring the E-field distribution on the HAC phantom. The audio interference distribution can be derived from the E-field measurement.
- HAC test arch phantom that can be used for easy positioning of the device under test for radiofrequency emission testing.
- DAE (Data Acquisition Electronics) for reading the probe voltages and transmitting it to the DASY5 control PC.
- Device Holder for positioning the DUT beneath the phantom.
- Control PC for running the HAC software to define/execute the measurements.
- System validation kits for system check / validation purposes.

5.1.1 E-Field Probes

Model	EF3DV3
Construction	One dipole parallel, two dipoles normal to probe axis Built-in shielding against static charges
Frequency	40 MHz to 6 GHz Linearity: ± 0.2 dB
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

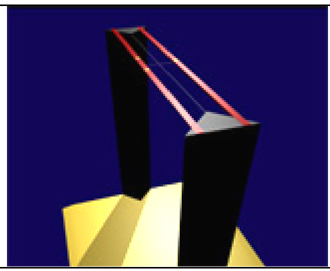
5.1.2 Data Acquisition Electronics (DAE)

Model	DAE3, DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5μV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm



5.1.3 Phantoms

Model	Test Arch
Construction	Enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot.
Dimensions	Length : 370 mm Width : 370 mm Height : 370 mm



5.1.4 Device Holder

Model	Mounting Device
Construction	The Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to ANSI C63.19.
Material	Polyoxymethylene (POM)

5.1.5 Power Source

Model	Powersource1
Signal Type	Continuous Wave
Operating Frequencies	600 MHz to 5850 MHz
Output Power	-5.0 dBm to +17.0 dBm
Power Supply	5V DC, via USB jack
Power Consumption	<3 W
Applications	System performance check and validation with a CW signal.

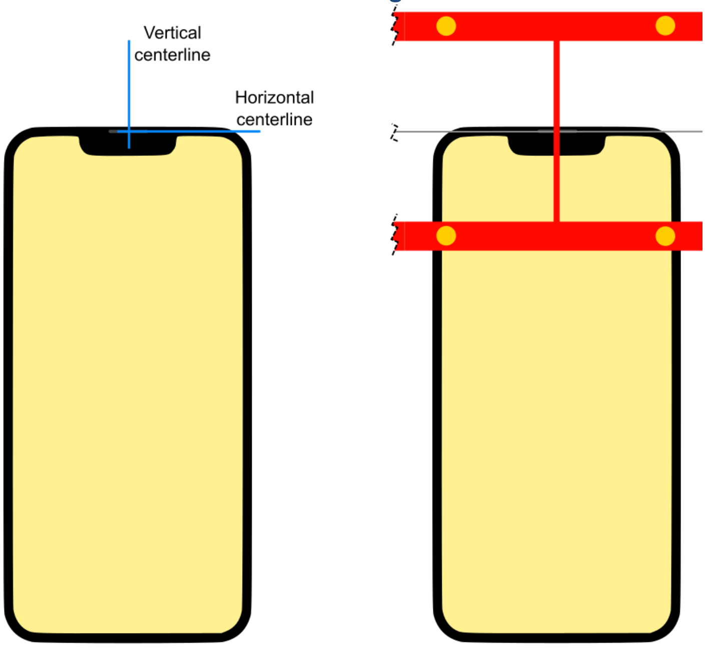
5.1.6 System Validation Dipoles

Model	CD-Serial	
Construction	Free space antenna Hearing Aid susceptibility measurements according to ANSI C63.19. Validation of Hearing Aid RF setup for wireless device emission measurements according to ANSI C63.19	
Frequency	CD700V3 : 698 ~ 806 MHz CD835V3 : 800 ~ 960 MHz CD1880V3 : 1710 ~ 2000 MHz CD2450V3 : 2250 ~ 2650 MHz CD2600V3 : 2450 ~ 2750 MHz CD3500V3 : 3300 ~ 3950 MHz CD5500V3 : 5000 ~ 5900 MHz	
Return Loss	CD700V3 : > 13 dB (750 MHz > 20 dB) CD835V3 : > 13 dB (835 MHz > 25 dB) CD1880V3 : > 13 dB (1880 MHz > 20 dB) CD2450V3 : > 13 dB (2450 MHz > 25 dB) CD2600V3 : > 13 dB (2600 MHz > 20 dB) CD3500V3 : > 13 dB (3500 MHz > 20 dB) CD5500V3 : > 13 dB (5500 MHz > 20 dB)	
Power Capability	> 40 W continuous	

5.2. HAC RF Emissions Measurements Reference and Plane

The DUT is mounted in the device holder in a similar manner as for dosimetric measurements. The earpiece of the DUT should correspond to the center point of the Test Arch (see below Figure). The DUT is moved vertically towards the frame of the Test Arch by using the adjustable DUT holder. The DUT is moved upwards towards the underside of the Test Arch until it touches the frame. Large corrections in the X, Y direction can be achieved by sliding the device holder along the surface while minor adjustments are available on the device holder itself.

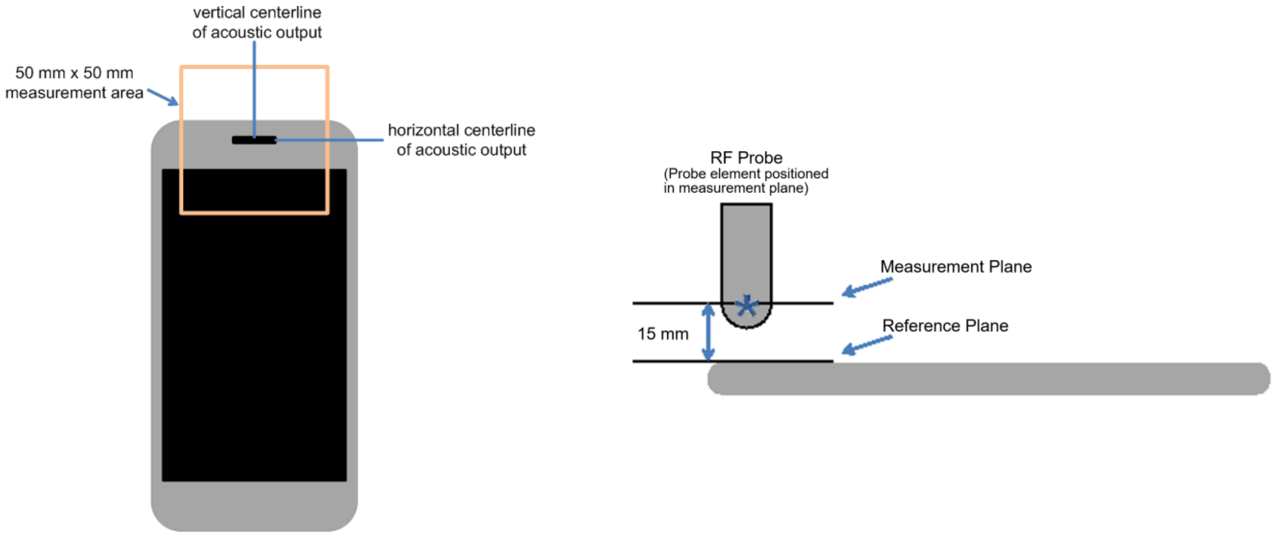
Device Under Test Positioning under the Test Arch



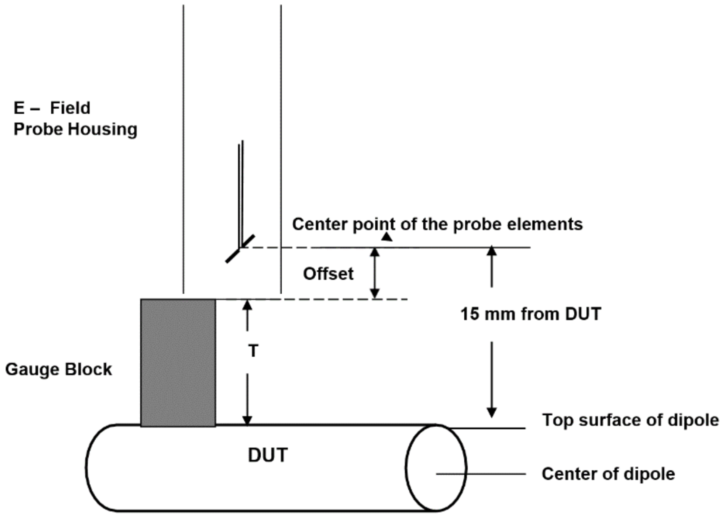
Below Figure illustrates the references and reference plane that was used in the RF emissions measurement.

- The measurement area is 50.0 mm by 50.0 mm.
- The measurement area is centered on the audio frequency output transducer of the DUT (speaker or T-Coil signal).
- The measurement area is in a reference plane, which is defined as the planar area tangent to the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the WD handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 15.0 mm in front of, the reference plane.

DUT Measurement and Reference Planes



Gauge Block for Setting Measurement Distance to Probe



5.3. HAC RF Emissions Test Procedure

The RF emissions test procedure for wireless communications device is as below.

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

[2] Position the DUT in its intended test position.

[3] Set the DUT 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.

[4] 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, illustrated in section 5.2. If the field alignment method is used, align the probe for maximum field reception.

[5] Record the reading at the output of the measurement system.

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

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

[8] Identify the maximum reading within the non-excluded sub-grids identified in step 7.

[9] Indirect Measurement Method: 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 8. Use this result to determine the category rating.

[10] Compare this RF audio interference level with the categories in section 2.2 and record the resulting DUT category rating.

[11] 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 can. 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 1 through step 9, with the grid shifted so that it is centered on the perpendicular measurement point. Record the DUT category rating.

WD Near-Field Emission Test Flowchart

- Confirm proper operation of probes and instrumentation
- Position WD
- Configure WD Tx operation

Per ANSI C63.19-2011 Section 5.5.1.2 (1-3)

↓

- Initialize field probe
- Scan area

Per ANSI C63.19-2011 Section 5.5.1.2 (4-6)

↓

- Identify exclusion area
- Rescan or reanalyze open area to determine maximum
- Indirect Method: Add the MIF to the maximum steady state RMS field strength and record RF Audio Interference Level in dBV/m

Per ANSI C63.19-2011 Section 5.5.1.2 (7-9)

↓

- Identify and record the category

Per ANSI C63.19-2011 Section 5.5.1.2 (9-10)

5.4. Modulation Interference Factor (MIF)

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

The Modulation Interference Factor (MIF, in dB) is added to the measured average E-field (in dBV/m) and converts it to the RF audio interference potential (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 slots and repetition rates of few 100 Hz have high MIF values and give similar classification as ANSI C63.19-2007.

The EF3D E-field probe have a bandwidth <10 kHz and can therefore not evaluate the RF envelope in the full audio band. DASY5 is therefore using the “indirect" measurement method according to ANSI C63.19-2011 which is the primary method. This near field probe read the averaged E-field. Especially for the new high peak-to-average (PAR) signal types, the probes shall be linearized by probe modulation response (PMR) calibration in order to not overestimate the field reading.

The evaluation method 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. It may alternatively be determined through analysis and simulation, because it is constant and characteristic for a communication signal. DASY5 uses well-defined signals for PMR calibration. The MIF of these signals has been determined numerically. It allows a precise scaling and is therefore automatically applied.

The MIF measurement uncertainty is estimated as follows, for modulation frequencies from slotted waveforms with fundamental frequency and at least 2 harmonics within 10 kHz.

MIF	MIF Measurement Uncertainty
-7 to +5 dB	0.2 dB
-13 to +11 dB	0.5 dB
> -20 dB	1.0 dB

The MIF values were evaluated by SPEAG (DASY's manufacturer), and the worst MIF values for each wireless technology listed in below table were used to determine the Low-power Exemption. The detailed parameters for E-field probe can be found in the probe calibration report in the appendix.

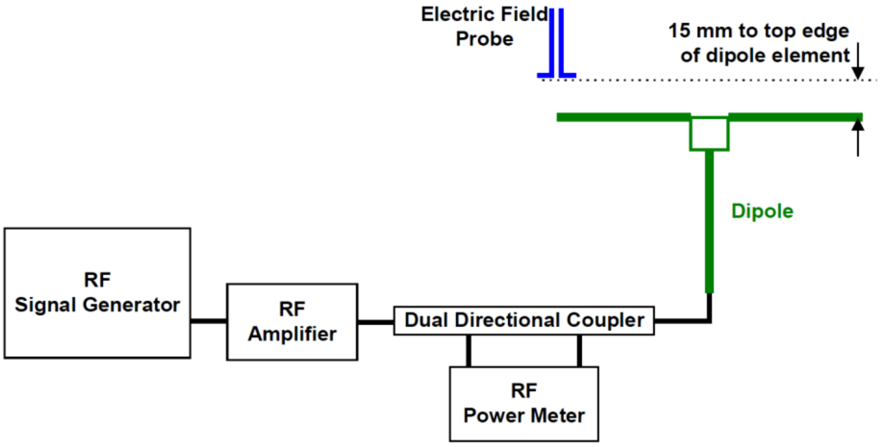
UID	Reversion	Communication System Name	MIF (dB)
10021	DAC	GSM-FDD (TDMA, GMSK)	3.63
10025	DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	3.75
10460	AAB	UMTS-FDD (WCDMA, AMR)	-25.43
10225	CAC	UMTS-FDD (HSPA+)	-20.39
10170	CAF	LTE-FDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-9.76
10173	CAH	LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)	-1.44
10769	AAD	5G NR (CP-OFDM, 1 RB, 15 MHz, QPSK, 15 kHz)	-12.08
10797	AAF	5G NR (CP-OFDM, 1 RB, 40 MHz, QPSK, 30 kHz)	-14.32
10933	AAC	5G NR (DFT-s-OFDM, 1 RB, 30 MHz, QPSK, 15 kHz)	-15.06
10897	AAE	5G NR (DFT-s-OFDM, 1 RB, 5 MHz, QPSK, 30 kHz)	-16.67
10061	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	-2.02
10077	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	0.12
10427	AAC	IEEE 802.11n (HT Greenfield, 150 Mbps, 64-QAM)	-13.44
10069	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	-3.15
10616	AAC	IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle)	-5.57
10671	AAC	IEEE 802.11ax (20MHz, MCS0, 90pc duty cycle)	-5.58

6. System Verification

6.1. HAC Test System Verification

The system check verifies that the system operates within its specifications. It is performed before every E-field measurement. The system check uses normal measurements in the center section of the arch phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

System Verification Setup



The validation dipole is placed beneath the center of arch phantom. The power meter measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power, 100 mW (20 dBm) at the dipole connector and the RF power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at RF power meter.

After system check testing, the E-field result will be compared with the reference target value derived from validation dipole certificate report, and the deviation of system check should be within its specification of 25 %.

The measuring results for system check are shown as below.

Frequency (MHz)	Input Power (dBm)	E-Field 1 (V/m)	E-Field Low end (V/m)	Average E-Field (V/m)	Normailzed Average E-Field (dB V/m)	Normailzed Average E-Field (V/m)	Target Value (V/m)	Delta (±25 %)	Test Date
835	17	81.41	77.83	79.62	41.02	112.47	110.1	2.15	Nov. 20, 2023
1880	17	62.18	60.99	61.585	38.79	86.99	86.2	0.92	Nov. 20, 2023
2450	17	64.15	64.15	64.15	39.14	90.61	85.5	5.98	Nov. 20, 2023
2600	17	64.5	62.86	63.68	39.08	89.95	85.8	4.84	Nov. 20, 2023
3500	17	63.4	62.88	63.14	39.01	89.19	83.5	6.81	Nov. 20, 2023

Note:

1. For E-Field, the deviation is [(E-Field 1 + E-Field 2) / 2 – Target Value] / Target Value x 100%
2. The result indicates the system check can meet the variation criterion and the plots can be referred to Appendix A of this report.

7. Evaluation for Low-Power Exemption

7.1. Maximum Antenna Input Power

Radio Mode	Band	Max. Antenna Input Power (dBm)							
		Ant 0	Ant 1	Ant 2	Ant 3	Ant 4	Ant 5	Ant 6	Ant 7
GSM / GPRS	850	33	33	-	-	-	-	-	-
EDGE	850	27	27						
GSM / GPRS	1900	30	30	30	30	-	-	-	-
EDGE	190	23	23	23	23				
UMTS / HSPA	Band II	24	24	24	24	-	-	-	-
UMTS / HSPA	Band IV	24	24	24	24	-	-	-	-
UMTS / HSPA	Band V	24	24	-	-	-	-	-	-
LTE	Band 2	24	24	24	24	-	-	-	-
LTE	Band 4	24	24	24	24	-	-	-	-
LTE	Band 5	24	24	-	-	-	-	-	-
LTE	Band 7	24	24	24	24	-	-	-	-
LTE	Band 12	24	24	-	-	-	-	-	-
LTE	Band 13	24	24	-	-	-	-	-	-
LTE	Band 14	24	24	-	-	-	-	-	-
LTE	Band 25	24	24	24	24	-	-	-	-
LTE	Band 26	24	24	-	-	-	-	-	-
LTE	Band 30	24	24	24	24	-	-	-	-
LTE	Band 66	24	24	24	24	-	-	-	-
LTE	Band 71	24	24	-	-	-	-	-	-
LTE	Band 38	24	24	24	24	-	-	-	-
LTE	Band 40	24	24	24	24	-	-	-	-
LTE	Band 41	24	24	24	24	-	-	-	-
LTE	Band 42	-	-	-	-	24	24	24	24
LTE	Band 43	-	-	-	-	24	24	24	24
LTE	Band 48	-	-	-	-	24	24	24	24
5G FR1	n2	24	24	24	24	-	-	-	-
5G FR1	n5	24	24	-	-	-	-	-	-
5G FR1	n7	24	24	24	24	-	-	-	-
5G FR1	n12	24	24	-	-	-	-	-	-
5G FR1	n13	24	24	-	-	-	-	-	-
5G FR1	n14	25	25	-	-	-	-	-	-
5G FR1	n25	24	24	24	24	-	-	-	-
5G FR1	n30	24	24	24	24	-	-	-	-
5G FR1	n66	24	24	24	24	-	-	-	-
5G FR1	n71	24	24	-	-	-	-	-	-
5G FR1	n38	24	24	24	24	-	-	-	-
5G FR1	n41	24	24	24	24	-	-	-	-
5G FR1	n48	-	-	-	-	24	24	24	24
5G FR1	n77	-	-	-	-	24	24	24	24
5G FR1	n78	-	-	-	-	25	25	25	25

Radio Mode		Max. Antenna Input Power (dBm)		
		Ant 0	Ant 1	Ant 1+2
2.4GHz WLAN	802.11b	17	17	20
	802.11g	17	17	20
	802.11n HT20	17	17	20
	802.11n HT40	17	17	20
	802.11ac VHT20	17	17	20
	802.11ac VHT40	17	17	20
	802.11ax HE20	17	17	20
	802.11ax HE40	17	17	20
5GHz WLAN	802.11a	17	17	20
	802.11n-HT20	17	17	20
	802.11n-HT40	17	17	20
	802.11ac-VHT20	17	17	20
	802.11ac-VHT40	17	17	20
	802.11ac-VHT80	17	17	20
	802.11ac-VHT160	17	17	20
	802.11ax-HE20	17	17	20
	802.11ax-HE40	17	17	20
	802.11ax-HE80	17	17	20
	802.11ax-HE160	17	17	20
6GHz WLAN	802.11a	11.5	11.5	14.5
	802.11ax-HE20	11.5	11.5	14.5
	802.11ax-HE40	11.5	11.5	14.5
	802.11ax-HE80	11.5	11.5	14.5
	802.11ax-HE160	11.5	11.5	14.5

7.2. Analysis of Individual RF Air Interface Technology

According to ANSI C63.19-2011 section 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. An RF air interface technology of a device is exempt from testing when its average antenna input power plus its worst-case MIF is ***≤ 17 dBm*** for any of its operating modes. If a device supports multiple RF air interfaces, each RF air interface shall be evaluated individually. An RF air interface technology that is exempted from testing by above method could be rated as M4.

The low power exemption for this device is analyzed in below.

Air Interface		Max. Tune-up Power (dBm)	Worst Case MIF (dB)	Power + MIF (dB)	C63.19 Testing Required
GSM	GSM850	33	3.63	36.63	***YES***
	EDGE850	27	3.75	30.75	*Yes*(1)
	GSM1900	30	3.63	33.63	***YES***
	EDGE1900	23	3.75	26.75	*Yes*(1)
WCDMA	AMR	24	-25.43	-1.43	No
	HSPA	24	-20.39	3.61	No
FDD-LTE		24	-9.76	14.24	No
TDD-LTE		24	-1.44	22.56	***YES***
FDD-5G NR		25	-12.08	12.92	No
TDD-5G NR		25	-12.08	12.92	No

Note:

1. The EDGE data modes were considered but not tested because GSM voice mode was found to be the worst-case modes for the GSM air interface.
2. The TDD-LTE 16QAM / 64QAM data modes were considered but not tested because QPSK mode was worst case for the TDD-LTE air interface.
3. LTE UL-CA data modes were considered but not tested as LTE standalone data modes were found to be the worst-case modes for the LTE air interface.

Air Interface		***Max. Tune-up Power (dBm)***	***Worst Case MIF (dB)***	***Power + MIF (dB)***	***C63.19 Testing Required***
2.4GHz WLAN	802.11b	20	-2.02	17.98	***YES***
	802.11g	20	0.12	20.12	***YES***
	802.11n HT20	20	-13.44	6.56	No
	802.11n HT40	20	-13.44	6.56	No
	802.11ac VHT20	20	-5.57	14.43	No
	802.11ac VHT40	20	-5.57	14.43	No
	802.11ax HE20	20	-5.58	14.42	No
	802.11ax HE40	20	-5.58	14.42	No
5GHz WLAN	802.11a	19	-3.15	15.85	No
	802.11n-HT20	19	-13.44	5.56	No
	802.11n-HT40	19	-13.44	5.56	No
	802.11ac-VHT20	19	-5.57	13.43	No
	802.11ac-VHT40	19	-5.57	13.43	No
	802.11ac-VHT80	19	-5.57	13.43	No
	802.11ac-VHT160	19	-5.57	13.43	No
	802.11ax-HE20	19	-5.58	13.42	No
	802.11ax-HE40	19	-5.58	13.42	No
	802.11ax-HE80	19	-5.58	13.42	No
	802.11ax-HE160	19	-5.58	13.42	No
6GHz WLAN	802.11a	14.5	-3.15	-1.35	No
	802.11ax-HE20	14.5	-5.58	8.92	No
	802.11ax-HE40	14.5	-5.58	8.92	No
	802.11ax-HE80	14.5	-5.58	8.92	No
	802.11ax-HE160	14.5	-5.58	8.92	No
	802.11be-EHT20	14.5	-28.73	-14.23	No
	802.11be-EHT40	14.5	-28.73	-14.23	No
	802.11be-EHT80	14.5	-28.73	-14.23	No
	802.11be-EHT160	14.5	-28.73	-14.23	No

Note:

1. The 802.11b modes were considered but not tested because 802.11g mode was worst case for the WLAN 2.4G air interface.

8. HAC RF Emission Measurement

8.1. Measured Conducted Power Results

Band	GSM850 Ant 0			GSM1900 Ant 0		
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)	32.12	32.08	32.15	29.26	29.37	29.21

Band	GSM850 Ant 1			GSM1900 Ant 1		
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)	32.15	32.00	32.38	29.51	29.92	29.85

Band	GSM1900 Ant 2		
Channel	512	661	810
Frequency (MHz)	1850.2	1880.0	1909.8
GSM (GMSK, 1 Tx Slot)	29.26	29.37	29.21

Band	GSM1900 Ant 3		
Channel	512	661	810
Frequency (MHz)	1850.2	1880.0	1909.8
GSM (GMSK, 1 Tx Slot)	20.89	20.91	20.81

Band	LTE Band 38 Ant 0					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		37850	38000	38150
		Frequency (MHz)		2580	2595	2610
20M	QPSK	1	0	23.24	23.28	23.25

Band	LTE Band 38 Ant 1					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		37850	38000	38150
		Frequency (MHz)		2580	2595	2610
20M	QPSK	1	0	23.26	23.32	23.26

Band	LTE Band 38 Ant 2					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		37850	38000	38150
		Frequency (MHz)		2580	2595	2610
20M	QPSK	1	0	23.15	23.21	22.92

Band	LTE Band 38 Ant 3					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		37850	38000	38150
		Frequency (MHz)		2580	2595	2610
20M	QPSK	1	0	23.74	23.80	23.77

Band	LTE Band 40 Ant 0					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		38750	39150	39550
		Frequency (MHz)		2310	2350	2390
20M	QPSK	1	0	23.27	23.23	23.18

Band	LTE Band 40 Ant 1					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		38750	39150	39550
		Frequency (MHz)		2310	2350	2390
20M	QPSK	1	0	23.38	23.37	23.31

Band	LTE Band 40 Ant 2					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		38750	39150	39550
		Frequency (MHz)		2310	2350	2390
20M	QPSK	1	0	23.26	23.17	23.24

Band	LTE Band 40 Ant3					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		38750	39150	39550
		Frequency (MHz)		2310	2350	2390
20M	QPSK	1	0	23.27	23.24	23.23

Band	LTE Band 41 Ant 0							
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High-Mid	High
		Channel		39750	40185	40620	41055	41490
		Frequency (MHz)		2506	2549.5	2593	2636.5	2680
20M	QPSK	1	0	23.25	23.27	23.28	23.25	23.26

Band	LTE Band 41 Ant 1							
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High-Mid	High
		Channel		39750	40185	40620	41055	41490
		Frequency (MHz)		2506	2549.5	2593	2636.5	2680
20M	QPSK	1	0	23.35	23.24	23.49	23.33	23.29

Band	LTE Band 41 Ant 2							
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High-Mid	High
		Channel		39750	40185	40620	41055	41490
		Frequency (MHz)		2506	2549.5	2593	2636.5	2680
20M	QPSK	1	0	23.24	23.28	23.30	23.24	23.01

Band	LTE Band 41 Ant 3							
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High-Mid	High
		Channel		39750	40185	40620	41055	41490
		Frequency (MHz)		2506	2549.5	2593	2636.5	2680
20M	QPSK	1	0	23.91	23.80	23.93	23.81	23.92

Band	LTE Band 42 Ant 4						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High
		Channel		42190	42623	43057	43490
		Frequency (MHz)		3460	3503.3	3546.7	3590
20M	QPSK	1	0	22.45	22.83	22.87	22.81

Band	LTE Band 42 Ant 5						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High
		Channel		42190	42623	43057	43490
		Frequency (MHz)		3460	3503.3	3546.7	3590
20M	QPSK	1	0	23.60	23.61	23.77	23.53

Band	LTE Band 42 Ant 6						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High
		Channel		42190	42623	43057	43490
		Frequency (MHz)		3460	3503.3	3546.7	3590
20M	QPSK	1	0	23.36	23.56	23.55	23.49

Band	LTE Band 42 Ant 7						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	Mid	High
		Channel		42190	42623	43057	43490
		Frequency (MHz)		3460	3503.3	3546.7	3590
20M	QPSK	1	0	23.34	23.21	23.51	23.43

Band	LTE Band 43 Ant 4					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		44190	44340	44490
		Frequency (MHz)		3660	3675	3690
20M	QPSK	1	0	22.85	22.89	22.84

Band	LTE Band 43 Ant 5					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		44190	44340	44490
		Frequency (MHz)		3660	3675	3690
20M	QPSK	1	0	23.71	23.78	23.73

Band	LTE Band 43 Ant 6					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		44190	44340	44490
		Frequency (MHz)		3660	3675	3690
20M	QPSK	1	0	22.99	23.19	23.05

Band	LTE Band 43 Ant 7					
BW	Modulation	RB Size	RB Offset	Low	Mid	High
		Channel		44190	44340	44490
		Frequency (MHz)		3660	3675	3690
20M	QPSK	1	0	23.44	23.75	23.50

Band	LTE Band 48 Ant 4						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	High-Mid	High
		Channel		55340	55780	56210	56640
		Frequency (MHz)		3560	3603	3647	3690
20M	QPSK	1	0	22.58	22.87	22.91	22.88

Band	LTE Band 48 Ant 5						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	High-Mid	High
		Channel		55340	55780	56210	56640
		Frequency (MHz)		3560	3603	3647	3690
20M	QPSK	1	0	22.95	23.18	23.07	23.00

Band	LTE Band 48 Ant 6						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	High-Mid	High
		Channel		55340	55780	56210	56640
		Frequency (MHz)		3560	3603	3647	3690
20M	QPSK	1	0	23.25	23.29	22.96	23.24

Band	LTE Band 48 Ant 7						
BW	Modulation	RB Size	RB Offset	Low	Low-Mid	High-Mid	High
		Channel		55340	55780	56210	56640
		Frequency (MHz)		3560	3603	3647	3690
20M	QPSK	1	0	23.01	23.22	23.06	23.20

Mode	Channel	Frequency (MHz)	Average Power (Ant-0)	Average Power (Ant-1)	Average Power (Ant-0 + Ant-1)
802.11b	1	2412	19.84	19.85	21.17
	6	2437	19.75	19.8	22.71
	11	2462	19.61	19.79	21.56

8.2. HAC RF Emission Test Results

Plot No.	Band	Modulation	Channel	Audio Interference Level (dB V/m)	FCC Limit (dB V/m)	FCC Margin (dB)	Margin to FCC M3 limit (dB)	Antenna
01	GSM850	GSM Voice	128	33.27	45	-11.73	M4	Ant 0
02	GSM850	GSM Voice	189	32.82	45	-12.18	M4	Ant 0
03	GSM850	GSM Voice	251	32.56	45	-12.44	M4	Ant 0
04	GSM850	GSM Voice	128	29.05	45	-15.95	M4	Ant 1
05	GSM850	GSM Voice	189	27.9	45	-17.1	M4	Ant 1
06	GSM850	GSM Voice	251	27.48	45	-17.52	M4	Ant 1
07	GSM1900	GSM Voice	512	27.92	35	-7.08	M4	Ant 0
08	GSM1900	GSM Voice	661	28.49	35	-6.51	M4	Ant 0
09	GSM1900	GSM Voice	810	27.85	35	-7.15	M4	Ant 0
10	GSM1900	GSM Voice	512	22.6	35	-12.4	M4	Ant 1
11	GSM1900	GSM Voice	661	23.02	35	-11.98	M4	Ant 1
12	GSM1900	GSM Voice	810	23.01	35	-11.99	M4	Ant 1
13	GSM1900	GSM Voice	512	29.69	35	-5.31	M4	Ant 2
14	GSM1900	GSM Voice	661	29.2	35	-5.8	M4	Ant 2
15	GSM1900	GSM Voice	810	28.03	35	-6.97	M4	Ant 2
16	GSM1900	GSM Voice	512	26	35	-9	M4	Ant 3
17	GSM1900	GSM Voice	661	27.28	35	-7.72	M4	Ant 3
18	GSM1900	GSM Voice	810	27.61	35	-7.39	M4	Ant 3
19	LTE B38	QPSK	37850	15.85	35	-19.15	M4	Ant 0
20	LTE B38	QPSK	38000	16.71	35	-18.29	M4	Ant 0
21	LTE B38	QPSK	38150	16.59	35	-18.41	M4	Ant 0
22	LTE B38	QPSK	37850	16.58	35	-18.42	M4	Ant 1
23	LTE B38	QPSK	38000	16.6	35	-18.4	M4	Ant 1
24	LTE B38	QPSK	38150	16.72	35	-18.28	M4	Ant 1
25	LTE B38	QPSK	37850	17.78	35	-17.22	M4	Ant 2
26	LTE B38	QPSK	38000	17.95	35	-17.05	M4	Ant 2
27	LTE B38	QPSK	38150	18	35	-17	M4	Ant 2
28	LTE B38	QPSK	37850	22.06	35	-12.94	M4	Ant 3
29	LTE B38	QPSK	38000	23.06	35	-11.94	M4	Ant 3
30	LTE B38	QPSK	38150	23	35	-12	M4	Ant 3
31	LTE B40	QPSK	38750	18.99	35	-16.01	M4	Ant 0
32	LTE B40	QPSK	39150	18.37	35	-16.63	M4	Ant 0
33	LTE B40	QPSK	39549	17.12	35	-17.88	M4	Ant 0
34	LTE B40	QPSK	38750	20.2	35	-14.8	M4	Ant 1
35	LTE B40	QPSK	39150	18.76	35	-16.24	M4	Ant 1
36	LTE B40	QPSK	39549	18.13	35	-16.87	M4	Ant 1
37	LTE B40	QPSK	38750	22.26	35	-12.74	M4	Ant 2
38	LTE B40	QPSK	39150	22.65	35	-12.35	M4	Ant 2
39	LTE B40	QPSK	39549	21.99	35	-13.01	M4	Ant 2
40	LTE B40	QPSK	38750	24.22	35	-10.78	M4	Ant 3
41	LTE B40	QPSK	39150	22.55	35	-12.45	M4	Ant 3
42	LTE B40	QPSK	39549	20.61	35	-14.39	M4	Ant 3

Plot No.	Band	Modulation	Channel	Audio Interference Level (dB V/m)	FCC Limit (dB V/m)	FCC Margin (dB)	Margin to FCC M3 limit (dB)	Antenna
43	LTE B41	QPSK	39750	18.06	35	-16.94	M4	Ant 0
44	LTE B41	QPSK	40185	17.78	35	-17.22	M4	Ant 0
45	LTE B41	QPSK	40620	17.96	35	-17.04	M4	Ant 0
46	LTE B41	QPSK	41055	17.75	35	-17.25	M4	Ant 0
47	LTE B41	QPSK	41490	18.01	35	-16.99	M4	Ant 0
48	LTE B41	QPSK	39750	17.72	35	-17.28	M4	Ant 1
49	LTE B41	QPSK	40185	17.4	35	-17.6	M4	Ant 1
50	LTE B41	QPSK	40620	17.15	35	-17.85	M4	Ant 1
51	LTE B41	QPSK	41055	17.16	35	-17.84	M4	Ant 1
52	LTE B41	QPSK	41490	17.81	35	-17.19	M4	Ant 1
53	LTE B41	QPSK	39750	17.58	35	-17.42	M4	Ant 2
54	LTE B41	QPSK	40185	17.53	35	-17.47	M4	Ant 2
55	LTE B41	QPSK	40620	17.71	35	-17.29	M4	Ant 2
56	LTE B41	QPSK	41055	17.93	35	-17.07	M4	Ant 2
57	LTE B41	QPSK	41490	18.87	35	-16.13	M4	Ant 2
58	LTE B41	QPSK	39750	19.79	35	-15.21	M4	Ant 3
59	LTE B41	QPSK	40185	20.46	35	-14.54	M4	Ant 3
60	LTE B41	QPSK	40620	20.54	35	-14.46	M4	Ant 3
61	LTE B41	QPSK	41055	21.24	35	-13.76	M4	Ant 3
62	LTE B41	QPSK	41490	21.51	35	-13.49	M4	Ant 3
63	LTE B42	QPSK	42190	30.38	35	-4.62	M3	Ant 4
64	LTE B42	QPSK	42623	30.95	35	-4.05	M3	Ant 4
65	LTE B42	QPSK	43057	30.62	35	-4.38	M3	Ant 4
66	LTE B42	QPSK	43490	30.12	35	-4.88	M3	Ant 4
67	LTE B42	QPSK	42190	23.88	35	-11.12	M4	Ant 5
68	LTE B42	QPSK	42623	26.03	35	-8.97	M4	Ant 5
69	LTE B42	QPSK	43057	26.93	35	-8.07	M4	Ant 5
70	LTE B42	QPSK	43490	27.58	35	-7.42	M4	Ant 5
71	LTE B42	QPSK	42190	21.11	35	-13.89	M4	Ant 6
72	LTE B42	QPSK	42623	21.15	35	-13.85	M4	Ant 6
73	LTE B42	QPSK	43057	20.15	35	-14.85	M4	Ant 6
74	LTE B42	QPSK	43490	19.71	35	-15.29	M4	Ant 6
75	LTE B42	QPSK	42190	23.03	35	-11.97	M4	Ant 7
76	LTE B42	QPSK	42623	22.17	35	-12.83	M4	Ant 7
77	LTE B42	QPSK	43057	21.56	35	-13.44	M4	Ant 7
78	LTE B42	QPSK	43490	21.03	35	-13.97	M4	Ant 7
79	LTE B43	QPSK	44190	29.7	35	-5.3	M4	Ant 4
80	LTE B43	QPSK	44340	29.24	35	-5.76	M4	Ant 4
81	LTE B43	QPSK	44490	29.15	35	-5.85	M4	Ant 4
82	LTE B43	QPSK	44190	28.21	35	-6.79	M4	Ant 5
83	LTE B43	QPSK	44340	27.99	35	-7.01	M4	Ant 5
84	LTE B43	QPSK	44490	27.61	35	-7.39	M4	Ant 5
85	LTE B43	QPSK	44190	19.06	35	-15.94	M4	Ant 6
86	LTE B43	QPSK	44340	19.33	35	-15.67	M4	Ant 6
87	LTE B43	QPSK	44490	19.41	35	-15.59	M4	Ant 6

Plot No.	Band	Modulation	Channel	Audio Interference Level (dB V/m)	FCC Limit (dB V/m)	FCC Margin (dB)	Margin to FCC M3 limit (dB)	Antenna
88	LTE B43	QPSK	44190	20.75	35	-14.25	M4	Ant 7
89	LTE B43	QPSK	44340	20.47	35	-14.53	M4	Ant 7
90	LTE B43	QPSK	44490	20.49	35	-14.51	M4	Ant 7
91	LTE B48	QPSK	55340	30.58	35	-4.42	M3	Ant 4
92	LTE B48	QPSK	55773	29.96	35	-5.04	M4	Ant 4
93	LTE B48	QPSK	56207	29.63	35	-5.37	M4	Ant 4
94	LTE B48	QPSK	56640	28.9	35	-6.1	M4	Ant 4
95	LTE B48	QPSK	55340	27.27	35	-7.73	M4	Ant 5
96	LTE B48	QPSK	55773	27.61	35	-7.39	M4	Ant 5
97	LTE B48	QPSK	56207	27.95	35	-7.05	M4	Ant 5
98	LTE B48	QPSK	56640	27.31	35	-7.69	M4	Ant 5
99	LTE B48	QPSK	55340	20.48	35	-14.52	M4	Ant 6
100	LTE B48	QPSK	55773	19.8	35	-15.2	M4	Ant 6
101	LTE B48	QPSK	56207	19.6	35	-15.4	M4	Ant 6
102	LTE B48	QPSK	56640	19.15	35	-15.85	M4	Ant 6
103	LTE B48	QPSK	55340	21.46	35	-13.54	M4	Ant 7
104	LTE B48	QPSK	55773	21.27	35	-13.73	M4	Ant 7
105	LTE B48	QPSK	56207	20.84	35	-14.16	M4	Ant 7
106	LTE B48	QPSK	56640	20.44	35	-14.56	M4	Ant 7

Plot No.	Air Interface	Channel	Tx Ant.	Ant. Input Power (dBm)	MIF	Audio Interference Level (dBV/m)	Margin to FCC M3 limit (dB)	M-Rating
110	WLAN 2.4 GHz	802.11g	1	32.12	35	-2.88	M3	2
111	WLAN 2.4 GHz	802.11g	6	33.12	35	-1.88	M3	2
112	WLAN 2.4 GHz	802.11g	11	32.27	35	-2.73	M3	2

9. Test Equipment

Manufacturer	Equipment	Model No.	Serial No.	Cal. Date	Cal. Interval
SPEAG	835 MHz System Validation Kit	CD835V3	1017	Oct 17, 2022	3 year
SPEAG	1880 MHz System Validation Kit	CD1880V3	1036	Oct 17, 2022	3 year
SPEAG	2450 MHz System Validation Kit	CD2450V3	1037	Oct 17, 2022	3 year
SPEAG	2600 MHz System Validation Kit	CD2600V3	1031	Aug 05, 2022	3 year
SPEAG	3500 MHz System Validation Kit	CD3500V3	1021	Aug 05, 2022	3 year
SPEAG	Isotropic E-Field Probe	EF3DV3	4087	Aug 17, 2023	1 year
SPEAG	Data Acquisition Electronics	DAE4	541	Mar 22, 2023	1 year
SPEAG	Powersource1	SE UMS 160 CA	4244	May. 16, 2023	1 year
R&S	Wireless Communication Test Set	CMW500	170768	Nov. 30, 2022	1 year
Anritsu	Radio Communication Analyzer	MT8821C	6272459653	Aug. 16, 2023	1 year

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, attenuator, coupler, or filter were connected to a calibrated source to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.

Test Engineer：Gary Chao, Raymond Wu

10. Measurement Uncertainty

The measurement uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Decision Rule:

■ Uncertainty is not included.

□ Uncertainty is included.

Uncertainty Budget for HAC RF Emission

Source of Uncertainty	Uncertainty (± %)	Probability Distribution	Div.	ci (E)	Standard Uncertainty (± %, E)
Measurement System					
Probe Calibration	5.05	N	1	1	5.1
Axial Isotropy	4.7	R	√3	1	2.7
Sensor Displacement	16.5	R	√3	1	9.5
Boundary Effects	2.4	R	√3	1	1.4
Phantom Boundary Effect	7.2	R	√3	1	4.2
Linearity	4.7	R	√3	1	2.7
Scaling with PMR Calibration	10.0	R	√3	1	5.8
System Detection Limit	0.25	R	√3	1	0.1
Readout Electronics	0.3	N	1	1	0.3
Response Time	0.0	R	√3	1	0.0
Integration Time	2.6	R	√3	1	1.5
RF Ambient Conditions	3.0	R	√3	1	1.7
RF Reflections	12.0	R	√3	1	6.9
Probe Positioner	1.2	R	√3	1	0.7
Probe Positioning	4.7	R	√3	1	2.7
Extrap. and Interpolation	2.0	R	√3	1	1.2
Test Sample Related					
Device Positioning Vertical	4.7	R	√3	1	2.7
Device Positioning Lateral	1.0	R	√3	1	0.6
Device Holder and Phantom	2.4	R	√3	1	1.4
Power Drift	5.0	R	√3	1	2.9
Phantom and Setup Related					
Phantom Thickness	2.4	R	√3	1	1.4
Combined Standard Uncertainty				**RSS**	16.3
Expanded Uncertainty on Power					32.6
Expanded Uncertainty on Field					**16.3**

*********************************** End of Report ***********************************