



# HEARING AID COMPATIBILITY RF EMISSIONS TEST REPORT

FCC ID : A4RGUL82  
Equipment : Phone  
Model Name : GUL82  
Applicant : Google LLC  
: 1600 Amphitheatre Parkway,  
Mountain View, CA, 94043 USA  
Standard : FCC 47 CFR §20.19  
ANSI C63.19-2019

The product was received on Nov. 28, 2024 and testing was started from Feb. 18, 2025 and completed on Feb. 18, 2025. 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 C63.19-2019 / 47 CFR Part 20.19 and has been pass the FCC requirement.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Laboratory, the test report shall not be reproduced except in full.

Approved by: Cona Huang / Deputy Manager



**Sporton International Inc. Wensan Laboratory**

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## History of this test report

| Report No. | Version | Description             | Issued Date   |
|------------|---------|-------------------------|---------------|
| HA4N0918A  | Rev. 01 | Initial issue of report | Mar. 27, 2025 |
| HA4N0918A  | Rev. 02 | Update section 11       | Apr. 24, 2025 |
| HA4N0918A  | Rev. 03 | Update section 11       | May 06, 2025  |
| HA4N0918A  | Rev. 04 | Update section 11       | May 09, 2025  |
| HA4N0918A  | Rev. 05 | Update section 11       | May 12, 2025  |
|            |         |                         |               |
|            |         |                         |               |



## 1. General Information

| Product Feature & Specification |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Applicant Name                  | Google LLC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Equipment Name                  | Phone                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Model Name                      | GUL82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| FCC ID                          | A4RGUL82                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| SN                              | 4B191FDCQ000LF                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Frequency Band                  | GSM850: 824.2 MHz ~ 848.8 MHz<br>GSM1900: 1850.2 MHz ~ 1909.8 MHz<br>WCDMA Band II: 1850 MHz ~ 1910 MHz<br>WCDMA Band IV: 1710 MHz ~ 1755 MHz<br>WCDMA Band V: 824 MHz ~ 849 MHz<br>LTE Band 2: 1850 MHz ~ 1910 MHz<br>LTE Band 4: 1710 MHz ~ 1755 MHz<br>LTE Band 5: 824 MHz ~ 849 MHz<br>LTE Band 7: 2500 MHz ~ 2570 MHz<br>LTE Band 12: 699 MHz ~ 716 MHz<br>LTE Band 13: 777 MHz ~ 787 MHz<br>LTE Band 14: 788 MHz ~ 798 MHz<br>LTE Band 17: 704 MHz ~ 716 MHz<br>LTE Band 25: 1850 MHz ~ 1915 MHz<br>LTE Band 26: 814 MHz ~ 849 MHz<br>LTE Band 30: 2305 MHz ~ 2315 MHz<br>LTE Band 38: 2570 MHz ~ 2620 MHz<br>LTE Band 41: 2496 MHz ~ 2690 MHz<br>LTE Band 48: 3550 MHz ~ 3700 MHz<br>LTE Band 66: 1710 MHz ~ 1780 MHz<br>LTE Band 71: 663 MHz ~ 698 MHz<br>5G NR n2 : 1850 MHz ~ 1910 MHz<br>5G NR n5 : 824 MHz ~ 849 MHz<br>5G NR n7 : 2500 MHz ~ 2570 MHz<br>5G NR n12 : 699 MHz ~ 716 MHz<br>5G NR n14 : 788 MHz ~ 798 MHz<br>5G NR n25 : 1850 MHz ~ 1915 MHz<br>5G NR n26 : 814 MHz ~ 849 MHz<br>5G NR n30 : 2305 MHz ~ 2315 MHz<br>5G NR n38 : 2570 MHz ~ 2620 MHz<br>5G NR n41 : 2496 MHz ~ 2690 MHz<br>5G NR n48 : 3550 MHz ~ 3700 MHz<br>5G NR n66 : 1710 MHz ~ 1780 MHz<br>5G NR n70 : 1695 MHz ~ 1710 MHz<br>5G NR n71 : 663 MHz ~ 698 MHz<br>5G NR n77: 3700 MHz ~ 3980 MHz, 3450MHz ~ 3550MHz<br>5G NR n78: 3700 MHz ~ 3800 MHz, 3450MHz ~ 3550MHz<br>5G NR n258 : 24.25 GHz~24.45 GHz, 24.75GHz ~25.25GHz<br>5G NR n260 : 37 GHz~40 GHz<br>5G NR n261 : 27.5 GHz~28.35 GHz<br>NTN NB IoT B23: 2000 MHz ~2020 MHz<br>NTN NB IoT B255: 1626.5 MHz ~ 1660.5 MHz<br>WLAN 2.4 GHz Band: 2400 MHz ~ 2483.5 MHz<br>WLAN 5.2 GHz Band: 5150 MHz ~ 5250 MHz<br>WLAN 5.3 GHz Band: 5250 MHz ~ 5350 MHz<br>WLAN 5.6 GHz Band: 5470 MHz ~ 5725 MHz<br>WLAN 5.8 GHz Band: 5725 MHz ~ 5850 MHz<br>WLAN 5.9 GHz Band: 5850 MHz ~ 5895 MHz<br>WLAN 6E: 5925 MHz ~ 6425 MHz, 6425 MHz~6525 MHz, 6525 MHz~6875 MHz, 6875 MHz~7125 MHz<br>Bluetooth: 2400 MHz ~ 2483.5 MHz<br>NFC: 13.56 MHz<br>WPC: 110 kHz ~ 148.5 kHz(Rx)<br>UWB: 6489.6 MHz, 7987.2 MHz<br>Thread: 2405 MHz ~ 2480 MHz |
| Mode                            | GSM/GPRS/EGPRS<br>UMTS: RMC/AMR 12.2Kbps, HSDPA, HSUPA<br>LTE: QPSK, 16QAM, 64QAM, 256QAM<br>NTN: BPSK, QPSK<br>5G NR: DFT-s-OFDM/CP-OFDM, Pi/2 BPSK/QPSK/16QAM/64QAM/256QAM<br>WLAN: 802.11a/b/g/n/ac/ax/be<br>HT20/HT40/VHT20/VHT40/VHT80/VHT160/HE20/HE40/HE80/HE160/EHT20/EHT40/EHT80/EHT160<br>Bluetooth BR/EDR/LE/CS<br>NFC: ASK<br>WPC: ASK<br>UWB: BPM-BPSK/HPSK<br>Thread: QPSK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

Reviewed by: Jason WangReport Producer: Carlie Tsai



## **2. Testing Location**

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3786) and the FCC designation No. TW3786 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.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan<br>TEL: +886-3-327-0838<br>FAX: +886-3-327-0855 |
| Test Site No.      | Sporton Site No.:<br><b>SAR015-HY</b>                                                                                                |

## **3. Applied Standards**

- FCC CFR47 Part 20.19
- ANSI C63.19-2019
- FCC KDB 285076 D01 HAC Guidance v06r04
- FCC KDB 285076 D03 HAC FAQ v01r07

#### 4. Air Interfaces

| Air Interface | Band MHz | Type | C63.19 Tested       | Simultaneous Transmitter | Name of Voice Service | Power State for HAC Compliance |
|---------------|----------|------|---------------------|--------------------------|-----------------------|--------------------------------|
| GSM           | GSM850   | VO   | No <sup>(1)</sup>   | WLAN, BT, Thread         | CMRS Voice            | Head                           |
|               | GSM1900  |      |                     |                          | Google Meet           |                                |
|               | EDGE850  | VD   |                     |                          |                       |                                |
|               | EDGE1900 |      |                     |                          |                       |                                |
| UMTS          | Band 2   | VO   | No <sup>(1)</sup>   | WLAN, BT, Thread         | CMRS Voice            | Pmax                           |
|               | Band 4   |      |                     |                          |                       |                                |
|               | Band 5   |      |                     |                          |                       |                                |
|               | HSPA     | VD   |                     |                          |                       |                                |
| LTE           | Band 2   | VD   | No <sup>(1)</sup>   | 5G NR, WLAN, BT, Thread  | VoLTE / Google Meet   | Pmax                           |
|               | Band 4   |      |                     |                          |                       |                                |
|               | Band 5   |      |                     |                          |                       |                                |
|               | Band 7   |      |                     |                          |                       |                                |
|               | Band 12  |      |                     |                          |                       |                                |
|               | Band 13  |      |                     |                          |                       |                                |
|               | Band 14  |      |                     |                          |                       |                                |
|               | Band 17  |      |                     |                          |                       |                                |
|               | Band 25  |      |                     |                          |                       |                                |
|               | Band 26  |      |                     |                          |                       |                                |
|               | Band 30  |      |                     |                          |                       |                                |
|               | Band 38  |      |                     |                          |                       |                                |
|               | Band 41  |      |                     |                          |                       |                                |
|               | Band 48  |      |                     |                          |                       |                                |
|               | Band 66  |      |                     |                          |                       |                                |
|               | Band 71  |      |                     |                          |                       |                                |
| 5G NR         | n2       | VD   | No <sup>(1,2)</sup> | LTE, WLAN, BT, Thread    | VoNR / Google Meet    | Pmax                           |
|               | n5       |      |                     |                          |                       |                                |
|               | n7       |      |                     |                          |                       |                                |
|               | n12      |      |                     |                          |                       |                                |
|               | n14      |      |                     |                          |                       |                                |
|               | n25      |      |                     |                          |                       |                                |
|               | n26      |      |                     |                          |                       |                                |
|               | n30      |      |                     |                          |                       |                                |
|               | n38      |      |                     |                          |                       |                                |
|               | n41      |      |                     |                          |                       |                                |
|               | n48      |      |                     |                          |                       |                                |
|               | n66      |      |                     |                          |                       |                                |
|               | n70      |      |                     |                          |                       |                                |
|               | n71      |      |                     |                          |                       |                                |
|               | n77      |      |                     |                          |                       |                                |
|               | n78      |      |                     |                          |                       |                                |
|               | n258     | VD   |                     |                          | Google Meet           | NA                             |
|               | n260     |      |                     |                          |                       |                                |
|               | n261     |      |                     |                          |                       |                                |

|             |             |    |                      |                                               |                            |      |
|-------------|-------------|----|----------------------|-----------------------------------------------|----------------------------|------|
| Wi-Fi       | 2450        | VD | Yes <sup>(1,2)</sup> | GSM, WCDMA, LTE, 5G NR, 5G/6GHz WLAN          | VoWiFi<br>/<br>Google Meet | Pmax |
|             | 5200        |    |                      | GSM, WCDMA, LTE, 5G NR, 2.4G WLAN, BT, Thread |                            |      |
|             | 5300        |    |                      |                                               |                            |      |
|             | 5500        |    |                      |                                               |                            |      |
|             | 5800 / 5900 |    |                      |                                               |                            |      |
|             | U-NII 5     | VD |                      | GSM, WCDMA, LTE, 5G NR, 2.4G WLAN, BT, Thread | VoWiFi<br>/<br>Google Meet | Pmax |
|             | U-NII 6     |    |                      |                                               |                            |      |
|             | U-NII 7     |    |                      |                                               |                            |      |
|             | U-NII 8     |    |                      |                                               |                            |      |
| NTN         | B23         | DT | No                   | NA                                            | NA                         | NA   |
|             | B255        |    |                      |                                               |                            |      |
| BT / Thread | 2450        | DT | No                   | GSM, WCDMA, LTE, 5G NR, 5G/6GHz WLAN          | NA                         | NA   |
| UWB         | 6500/8000   | DT | No                   | WWAN, WLAN, BT, Thread, NFC                   | NA                         | NA   |
| NFC         | 13.56       | DT | No                   | WWAN, WLAN, BT, Thread, UWB                   | NA                         | NA   |

**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 max power plus MIF is complies with ANSI C63.19-2019 Table 4.1 RF<sub>AiPL</sub>.
2. The FR2 and WiFi 6E are currently outside the scope of ANSI C63.19 and FCC HAC regulations therefore they were not evaluated.
3. The UNII-5 was evaluated for operations which are entirely below 6 GHz, above 6 GHz were not evaluated due outside of the current scope of ANSI C63.19 and FCC HAC regulations.
4. Because features of Google Meet allow the option of voice-only communications, Meet has been tested for HAC/T-Coil compatibility to ensure the best user experience.
5. The product UMTS/LTE/NR/WiFi support TAS feature, therefore UMTS/LTE/NR/WiFi HAC were tested at Pmax level. The GSM set to highest device transmit power in a held to the ear mode.
6. Pmax is the maximum output power for the handset for the indicated air interface.
7. Head refers to the handset's maximum RF power possible for all user conditions during held-to-ear scenarios.

## 5. WD Emission Requirements

The WD's conducted power must be at or below either the stated RFAIPL (Table 4.1 ) or the stated peak power level (Table 4.2), or the average near-field emissions over the measurement area must be at or below the stated RFAIL (Table 4.3), or the stated peak field strength (Table 4.4). The WD may demonstrate compliance by meeting any of these four requirements, but it must do so in each of its operating bands at its established worst-case normal speech-mode operating condition.

| Table 4.1 - Wireless device RF audio interference power level |                          |
|---------------------------------------------------------------|--------------------------|
| Frequency range (MHz)                                         | RF <sub>AIPL</sub> (dBm) |
| < 960                                                         | 29                       |
| 960 - 2000                                                    | 26                       |
| > 2000                                                        | 25                       |

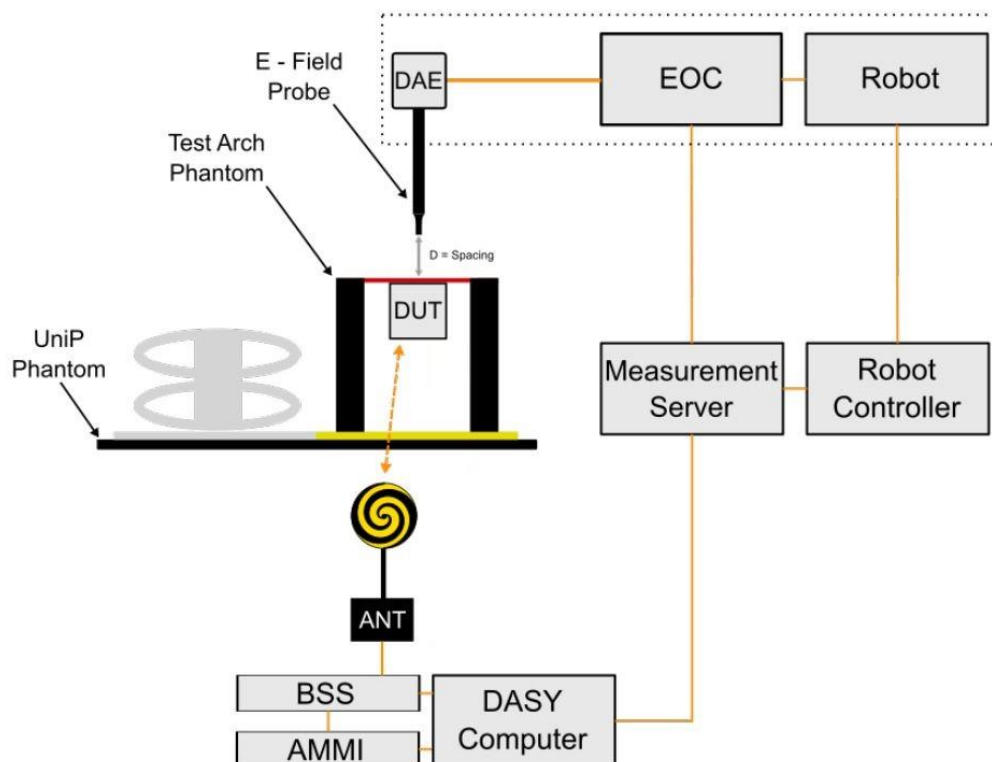
| Table 4.2 - Wireless device RF peak power level |                                |
|-------------------------------------------------|--------------------------------|
| Frequency range (MHz)                           | RF <sub>Peak Power</sub> (dBm) |
| < 960                                           | 35                             |
| 960 - 2000                                      | 32                             |
| > 2000                                          | 31                             |

| Table 4.3 - Wireless device RF audio interference level |                             |
|---------------------------------------------------------|-----------------------------|
| Frequency range (MHz)                                   | RF <sub>AIL</sub> [dB(V/m)] |
| < 960                                                   | 39                          |
| 960 - 2000                                              | 36                          |
| > 2000                                                  | 35                          |

| Table 4.4 - Wireless device RF peak near-field level |                              |
|------------------------------------------------------|------------------------------|
| Frequency range (MHz)                                | RF <sub>Peak</sub> [dB(V/m)] |
| < 960                                                | 45                           |
| 960 - 2000                                           | 42                           |
| > 2000                                               | 41                           |

## 6. System Description and Operation

### <System Components>



#### **Remark:**

A typical al DASY system for HAC measurements consists of

- 6-axis robotic arm (Staubli TX2-60L/ TX2-90XL) for positioning the probe
- Mounting Platform for keeping the phantoms at a field location relative to the robot
- 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 Data Acquisition Electronics (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)
- Test Arch for Device Under Test (DUT) testing
- DAE that reads the probe voltages and transmits them to the DASY PC. It is also used to detect probe touch and collision signals
- Device Holder for positioning the DUT beneath the phantom
- ANT (wideband Antenna) for broadcasting the downlink signals emitted by base station simulators (BSS) to the WD
- Operator PC for running the DASY software to define/execute the measurements.

The following components are needed for RFail measurements only:

- Modulation Interference Factor (MIF)
- Isotropic E-field, free-space probe (e.g., EF3DVx)
- Radiofrequency (RF) emission calibration dipoles for system check / validation purposes.

**<EF3DV3 E-Field Probe Specification>**

|                      |                                                                                                                                                                                             |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Construction</b>  | One dipole parallel, two dipoles normal to probe axis<br>Interleaved sensors<br>Built-in shielding against static charges<br>PEEK enclosure material                                        |
| <b>Calibration</b>   | In air from 30 MHz to 6.0 GHz<br>(absolute accuracy $\pm 5.1\%$ , $k=2$ )                                                                                                                   |
| <b>Frequency</b>     | 30 MHz – 6 GHz<br>Linearity: $\pm 0.2$ dB (100 MHz – 3 GHz)                                                                                                                                 |
| <b>Directivity</b>   | $\pm 0.2$ dB in air (rotation around probe axis)<br>$\pm 0.4$ dB in air (rotation normal to probe axis)                                                                                     |
| <b>Dynamic Range</b> | 2 – >1000 V/m                                                                                                                                                                               |
| <b>Linearity</b>     | $\pm 0.2$ dB                                                                                                                                                                                |
| <b>Dimensions</b>    | Overall length: 337 mm (tip: 20 mm)<br>Tip diameter: 3.9 mm (body: 12 mm)<br>Distance from probe tip to dipole centers: 1.5 mm<br>Sensor displacement to probe's calibration point: <0.7 mm |

**Voltage to E-field Conversion**

The measured voltage is first linearized to a quantity proportional to the square of the E-field using the (a, b, c, d) set of parameters specific to the communication system and sensor :

$$V_{\text{comp}i} = U_i + U_i^2 \cdot \frac{10^{\frac{d}{10}}}{\text{dcp}_i}$$

where  $V_{\text{comp}i}$  = compensated signal of channel i ( $\mu\text{V}$ ) ( $i = x, y, z$ )  
 $U_i$  = input signal of channel i ( $\mu\text{V}$ ) ( $i = x, y, z$ )  
 $d$  = PMR factor d (dB) (Probe parameter)  
 $\text{dcp}_i$  = diode compression point of channel i ( $\mu\text{V}$ ) (Probe parameter,  $i = x, y, z$ )

$$V_{\text{comp}i \text{ dB}\sqrt{\mu\text{V}}} = 10 + \log_{10} (V_{\text{comp}i})$$

$$\text{corr}_i = a_i \cdot e - \left( \frac{V_{\text{comp}i \text{ dB}\sqrt{\mu\text{V}}} - b_i}{c_i} \right)^2$$

where  $\text{corr}_i$  = correction factor of channel i (dB) ( $i = x, y, z$ )  
 $V_{\text{comp}i \text{ dB}\sqrt{\mu\text{V}}}$  = compensated voltage of channel i ( $\text{dB}\sqrt{\mu\text{V}}$ ) ( $i = x, y, z$ )  
 $a_i$  = PMR factor a of channel i (dB) (Probe parameter,  $i = x, y, z$ )  
 $b_i$  = PMR factor b of channel i ( $\text{dB}\sqrt{\mu\text{V}}$ ) (Probe parameter,  $i = x, y, z$ )  
 $c_i$  = PMR factor c of channel i (Probe parameter,  $i = x, y, z$ )

The voltage  $V_{i \text{ dB}\sqrt{\mu\text{V}}}$  is the linearized voltage in  $\text{dB}\sqrt{\mu\text{V}}$  :

$$V_{i \text{ dB}\sqrt{\mu\text{V}}} = V_{\text{comp}i \text{ dB}\sqrt{\mu\text{V}}} - \text{corr}_i$$

where  $V_{i \text{ dB}\sqrt{\mu\text{V}}}$  = linearized voltage of channel i ( $\text{dB}\sqrt{\mu\text{V}}$ ) ( $i = x, y, z$ )  
 $V_{\text{comp}i \text{ dB}\sqrt{\mu\text{V}}}$  = compensated voltage of channel i ( $\text{dB}\sqrt{\mu\text{V}}$ ) ( $i = x, y, z$ )  
 $\text{Corr}_i$  = correction factor of channel i (dB) ( $i = x, y, z$ )

Finally, the linearized voltage is converted in  $\mu V$  :

$$V_i = 10^{\frac{V_{i\text{dB}\sqrt{\mu V}}}{10}}$$

where  $V_i$  = linearized voltage of channel  $i$  ( $\mu V$ ) ( $i = x, y, z$ )  
 $V_{i\text{dB}\sqrt{\mu V}}$  = linearized voltage of channel  $i$  ( $\text{dB}\sqrt{\mu V}$ ) ( $i = x, y, z$ )

The E-field data for each channel are calculated using the linearized voltage :

$$\text{E-field Probes : } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

where  $V_i$  = compensated signal of channel  $i$ , ( $i = x, y, z$ )  
 $\text{Norm}_i$  = sensor sensitivity ( $\mu V/(V/m)^2$ ) of channel  $i$  ( $i = x, y, z$ )  
 $\text{ConvF}$  = sensitivity enhancement in solution  
 $E_i$  = electric field strength of channel  $i$  in  $V/m$

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

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

### **Averaged E-field Calculation**

The averaged E-field is defined by

$$E_{\text{avg}} = \frac{1}{n} \cdot \sum_{i=1}^n E_i$$

where  $n$  = the number of measurement grid point  
 $E_i$  = the E-field measured at point  $i$

### **RFail Calculation**

The RFail is finally computed with

$$RFail[\text{dB}(V/m)] = 20 \cdot \log_{10}(E_{\text{avg}}) + MIF$$

where  $RFail$  = the Radio Frequency Audio Interference Level in  $\text{dB}(V/m)$   
 $E_{\text{avg}}$  = the averaged E-field in  $(V/m)$  calculated  
 $MIF$  = the Modulation Interference Factor in  $\text{dB}$ .

## 7. RF Emissions Test Procedure

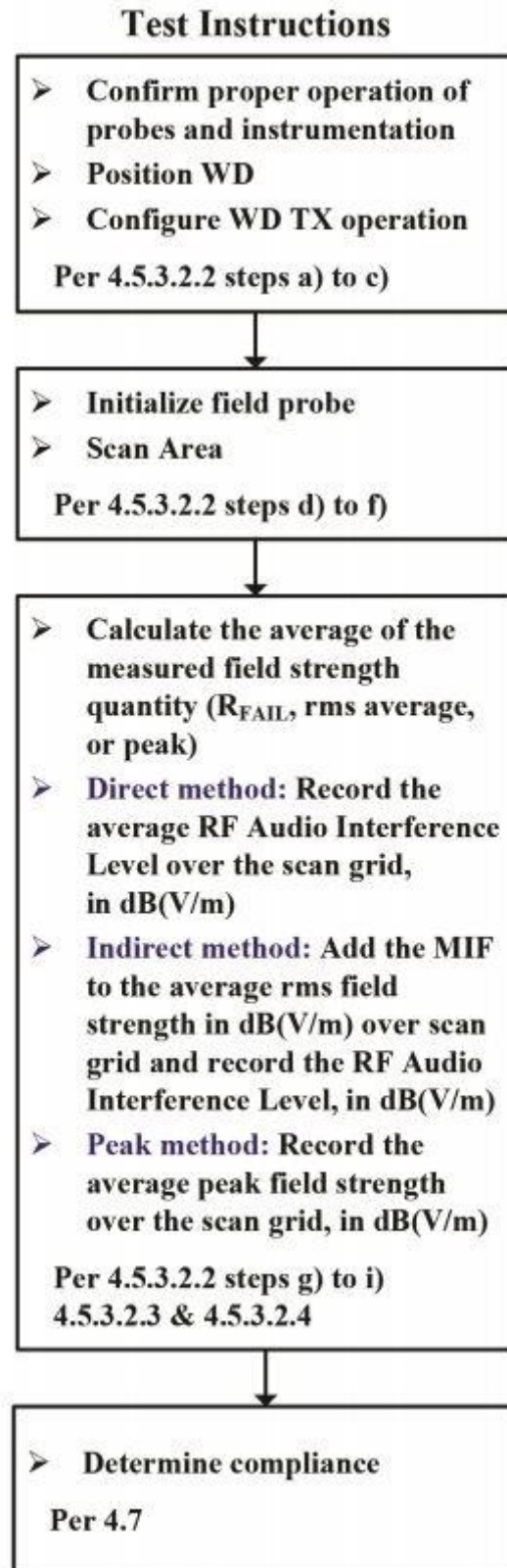
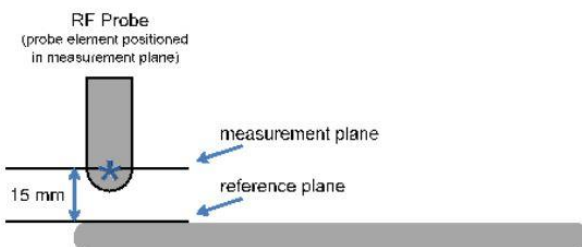
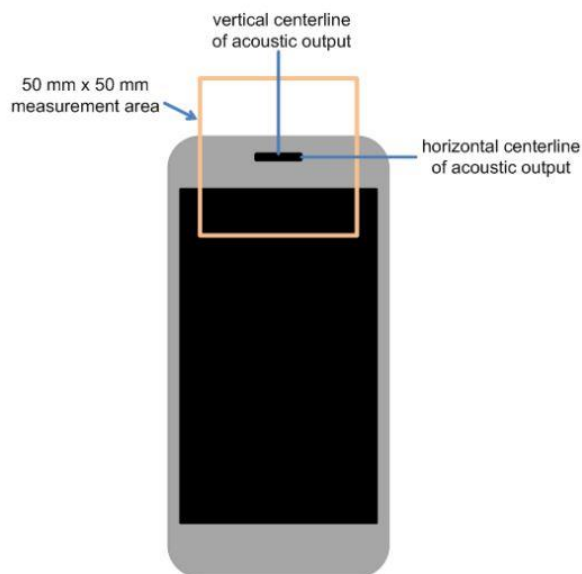
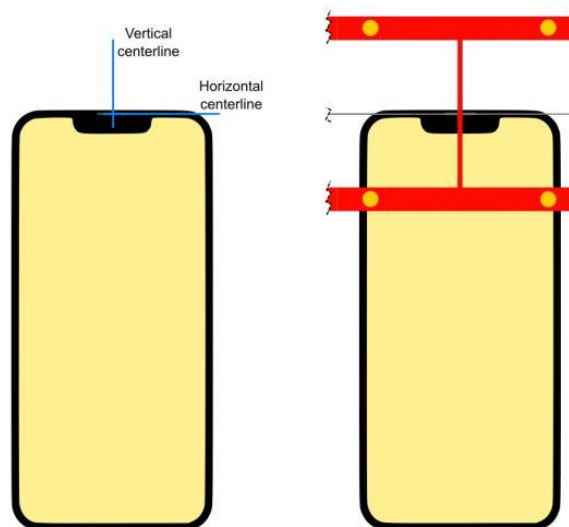


Figure of WD near-field emission scan flowchart according to ANSI C63.19:2019



**The references and reference plane that shall be used in the WD emissions measurement**



**Device Under Test Positioning under the Test Arch**

### Test procedure: Indirect measurement—preferred

- The measurement procedure using a probe and instrumentation chain with a response of <10 kHz (see ANSI C63.19-2019 section 4.5.1) is identical to the direct measurement method of ANSI C63.19-2019 section 4.5.3.2.2; however, because of the bandwidth limitations, it cannot include the direct use of the spectral and temporal weighting functions. The output of such measurement systems must be readings of steady state rms field strength in dB(V/m).
- The RF audio interference level in dB(V/m) is obtained by adding the Modulation Interference Factor (in decibels) to the average steady state rms field strength reading over the measurement area, in dB(V/m), from Step c). Use this result to determine the WD's compliance per ANSI C63.19-2019 section 4.7.
- Scan the entire 50 mm by 50 mm measurement area in equally spaced step sizes and record the reading at each measurement point. The step size shall meet the specification for step size in ANSI C63.19:2019 section 4.5.3.
- Calculate the average of the measurements taken in Step c)
- Convert the average value found in Step d) to RF audio interference level, in volts per meter, by taking the square root of the reading and then dividing it by the measurement system transfer function, as established in ANSI C63.19:2019 section 4.5.3.2.1 pre-test procedure. Convert the result to dB(V/m) by taking the base-10 logarithm and multiplying it by 20. Expressed as a formula

RF audio interference level in dB(V/M)  $20 * \log(R_{ave}^{1/2} / TF)$

where

$R_{ave}$  is the average reading

- Compare this RF audio interference level to the limits in ANSI C63.19:2019 section 4.7 and record the result
- Per ANSI C63.19-2019 section 4.6, WDs capable of operating multiple transmitters shall be subject to emissions requirements for all such transmitters expected to be operated when the WD is in voice mode operation positioned at a user's ear. Each qualified transmitter is tested individually using the method of Clause 4. Other WD transmitters shall be temporarily disabled or reduced in power level such that their average antenna input power is at least 6 dB lower than the average antenna input power of the transmitter under test. The transmitter under test is set to the fixed and repeatable combination of power and modulation characteristic that is representative of the worst case (highest interference potential) likely to be encountered while the WD is experiencing normal voice mode operation. The limiting measurement for device qualification is the highest RF audio interference potential measured for any of the WD transmitters. If the highest interference measurement is from a transmitter that is not required for normal voice mode operation, a secondary rating may be given that applies when that transmitter is disabled

**8. Test Equipment List**

| Manufacturer  | Name of Equipment                   | Type/Model | Serial Number | Calibration   |               |
|---------------|-------------------------------------|------------|---------------|---------------|---------------|
|               |                                     |            |               | Last Cal.     | Due Date      |
| SPEAG         | 2450MHz Calibration Dipole          | CD2450V3   | 1186          | Jan. 21, 2025 | Jan. 20, 2026 |
| SPEAG         | Data Acquisition Electronics        | DAE4       | 376           | Sep. 16, 2024 | Sep. 15, 2025 |
| SPEAG         | Isotropic E-Field Probe             | EF3DV3     | 4047          | Dec. 03, 2024 | Dec. 02, 2025 |
| Testo         | Hygro meter                         | 608-H1     | 45196600      | Oct. 28, 2024 | Oct. 27, 2025 |
| R&S           | Wideband Radio Communication Tester | CMW500     | 115793        | Dec. 12, 2024 | Dec. 11, 2025 |
| SPEAG         | Test Arch Phantom                   | N/A        | N/A           | NCR           | NCR           |
| SPEAG         | Phone Positioner                    | N/A        | N/A           | NCR           | NCR           |
| Anritsu       | Signal Generator                    | MG3710A    | 6201502524    | Sep. 24, 2024 | Sep. 23, 2025 |
| Anritsu       | Power Meter                         | ML2495A    | 1419002       | Aug. 13, 2024 | Aug. 12, 2025 |
| Anritsu       | Power Sensor                        | MA2411B    | 1911176       | Aug. 13, 2024 | Aug. 12, 2025 |
| ATM           | Dual Directional Coupler            | C122H-10   | P610410z-02   | NCR           | NCR           |
| Woken         | Attenuator                          | WK0602-XX  | N/A           | NCR           | NCR           |
| Anritsu       | Spectrum Analyzer                   | N9010A     | MY53470118    | Aug. 09, 2024 | Aug. 08, 2025 |
| Mini-Circuits | Power Amplifier                     | ZVE-8G+    | D120604       | Oct. 16, 2024 | Oct. 15, 2025 |
| Mini-Circuits | Power Amplifier                     | ZHL-42W+   | 715701915     | May. 17, 2024 | May. 16, 2025 |

**Note:**

1. NCR: "No-Calibration Required"

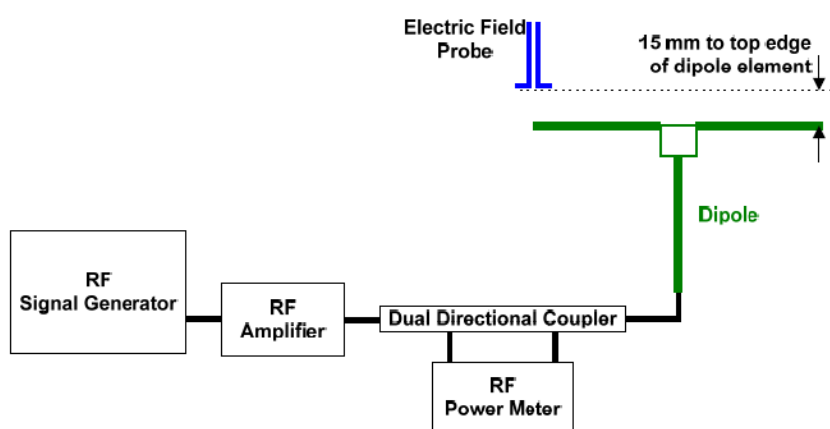
## 9. System Validation

Obtaining accurate measurements and relevant quantities in Module HAC depends on the proper functioning of many components and the correct parameter settings. Faulty results due to drift, failures, or incorrect parameters might not be recognized, as the differences might not be obvious in the measurements.

SPEAG DASY incorporates a system check, also called system verification procedure, to test for the proper functioning of the system based on the tests described in ANSI C63.19-2019: the RF interference potential test setup is verified with RF Emission Calibration Dipoles.

### <Test Setup>

1. Set the RF signal generator for either CW. Set its output power so the peak power applied to the antenna is equal to that recorded for the real or emulated signal using the WD modulation format
2. Average input power  $P = 100 \text{ mW}$  (20 dBm) after adjustment for return loss. An input power that generates field levels similar to those from the WD or other suitable level may also be used
3. The test fixture should meet the two-wavelength separation criterion
4. The probe-to-dipole separation, which is measured from closest surface of the dipole to the center point of the probe sensor element, should be 15 mm



**Figure of Setup Diagram**

### <Validation Procedure>

Place a dipole antenna meeting the requirements given in ANSI C63.19: 2019 D.11 in the position 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:

- a. The probe and its cable are parallel to the coaxial feed of the dipole antenna
- b. The probe cable and the coaxial feed of the dipole antenna approach the measurement area from opposite directions; and
- c. 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 expected value in the calibration certificate or expected value in this standard.

| Frequency (MHz) | Input Power (dBm) | Target Value (V/m) | Measured E-Field (V/m) | Deviation (%) | Date          |
|-----------------|-------------------|--------------------|------------------------|---------------|---------------|
| 2450            | 20                | 87.10              | 89.2                   | 2.41          | Feb. 18, 2025 |



## **10. Modulation Interference Factor**

For any specific fixed and repeatable modulated signal, a Modulation Interference Factor (MIF, expressed in decibels) 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 or 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.

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

- a. Verify the slope accuracy and dynamic range capability over the desired operating frequency band of a fast probe or sensor, square-law detector, as specified in ANSI C63.19: 2019 D.3, and weighting system as specified in ANSI C63.19: 2019 D.4 and ANSI C63.19: 2019 D.5. For the probe and instrumentation included in the measurement of MIF, additional calibration and application of calibration factors are not required.
- b. Using RF illumination, or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range
- c. Measure the steady-state rms level at the output of the fast probe or sensor
- d. Measure the steady-state average level at the weighting output
- e. Without changing the square-law detector or weighting system, and using RF illumination, or conducted coupling, substitute for the specific modulated signal a 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
- f. Without changing the carrier level from Step e), remove the 1 kHz modulation and again measure the steady-state rms level indicated at the output of the fast probe or sensor.
- g. The MIF for the specific modulation characteristic is given by the ratio of the Step f) measurement to the Step c) measurement, expressed in decibels ( $20 \cdot \log(\text{step6}/\text{step3})$ )

In practice, Step e) and Step f) need not be repeated for each MIF determination if the relationship between the two measurements has been pre-established for the measurement system over the operating frequency and dynamic ranges. In such cases, only the modulation characteristic being tested needs to be available during WD testing. Since indirect measurement procedure was used for RF audio interference power level evaluation, the 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 determine the Wireless device RF audio interference power level.



| UID   | Communication System Name                                 | MIF(dB) |
|-------|-----------------------------------------------------------|---------|
| 10021 | GSM-FDD(TDMA,GMSK)                                        | 3.63    |
| 10023 | GPRS-FDD (TDMA, GMSK, TN 0)                               | 3.8     |
| 10024 | GPRS-FDD (TDMA, GMSK, TN 0-1)                             | 1.15    |
| 10027 | GPRS-FDD (TDMA, GMSK, TN 0-1-2)                           | -0.67   |
| 10028 | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)                         | -2.05   |
| 10025 | EDGE-FDD (TDMA, 8PSK, TN 0)                               | 3.75    |
| 10026 | EDGE-FDD (TDMA, 8PSK, TN 0-1)                             | 1.23    |
| 10029 | EDGE-FDD (TDMA, 8PSK, TN 0-1-2)                           | -0.52   |
| 10058 | EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)                         | -1.82   |
| 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 100% duty (CP-OFDM, 1 RB, 15 MHz, QPSK, 15 kHz)     | -12.08  |
| 10973 | 5G NR 40% duty ((DFT-s-OFDM, 1 RB, 100 MHz, QPSK, 30 kHz) | -1.64   |
| 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 Greenfield, 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   |
| 11026 | IEEE 802.11be (320MHz, MCS0, 99pc duty cycle)             | -28.73  |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 1 RB, 100MHz,BPSK, 30kHz)     | -0.78   |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 50% RB, 100MHz,BPSK, 30kHz)   | -0.82   |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 1 RB, 100MHz,QPSK, 30kHz)     | -0.96   |
| *NA   | 5G NR 25% PC1.5(CP-OFDM, 1 RB, 100MHz,QPSK, 30kHz)        | -1.56   |
| *NA   | 5G NR 25% PC1.5(CP-OFDM, 50% RB, 100MHz,QPSK, 30kHz)      | -1.72   |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 1 RB, 10MHz,BPSK, 30kHz)      | -0.83   |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 50% RB, 10MHz,BPSK, 30kHz)    | -0.85   |
| *NA   | 5G NR 25% PC1.5(DFT-s-OFDM, 1 RB, 10MHz,QPSK, 30kHz)      | -0.99   |
| *NA   | 5G NR 25% PC1.5(CP-OFDM, 1 RB, 10MHz,QPSK, 30kHz)         | -1.61   |
| *NA   | 5G NR 25% PC1.5(CP-OFDM, 50% RB, 10MHz,QPSK, 30kHz)       | -1.76   |

**Remark:**

Refer to appendix E for RFE UID specifications summary provided by SPEAG

\*Refer to appendix G for MIF measurements conducted by test lab for 5G NR TDD power class 1.5.

## 11. Evaluation of WD RF interference potential

**General Note:**

1. The following table is according to ANSI C63.19:2019 section 4.4 indirect measurement procedure to evaluation max average conducted power from each air interface plus MIF to evaluate whether it complies with ANSI C63.19-2019 Table 4.1  $RF_{AIPL}$ , compliance with table 4.1 means compliance with WD emission requirements.
2. Since the device support TAS feature for UMTS, LTE, FR1 and WiFi thus HAC RF was evaluated at Pmax Average Power level to complies with ANSI C63.19-2019 Table 4.1  $RF_{AIPL}$ .
3. The Head Average Power level for GSM operation was used to complies with ANSI C63.19-2019 Table 4.1  $RF_{AIPL}$ .
4. If there some air interface were not meet ANSI C63.19-2019 table 4.1 requirement, these air interfaces were further evaluation ANSI C63.19-2019 Table 4.3  $RF_{AIL}$  requirement. And the  $RF_{AIL}$  evaluation result refer to section11.1

**<WWAN operation>**

| Ant 0                      |                                     |                |                                       |                     |                   |                         |             |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|-------------------|-------------------------|-------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | $RF_{AIPL}$ (dBm) | $RF_{AIPL}$ Limit (dBm) | $RF_{AIPL}$ |
| GSM850                     | 31.50                               | 12.5           | 22.50                                 | 3.63                | 26.13             | 29                      | Pass        |
| GPRS850 - 1TX              | 33.50                               | 12.5           | 24.50                                 | 3.8                 | 28.3              | 29                      | Pass        |
| GPRS850 - 2TX              | 32.50                               | 25             | 26.50                                 | 1.15                | 27.65             | 29                      | Pass        |
| GPRS850 - 3TX              | 31.50                               | 37.5           | 27.24                                 | -0.67               | 26.57             | 29                      | Pass        |
| GPRS850 - 4TX              | 30.50                               | 50             | 27.50                                 | -2.05               | 25.45             | 29                      | Pass        |
| EDGE850 - 1TX              | 27.50                               | 12.5           | 18.50                                 | 3.75                | 22.25             | 29                      | Pass        |
| EDGE850 - 2TX              | 26.50                               | 25             | 20.50                                 | 1.23                | 21.73             | 29                      | Pass        |
| EDGE850 - 3TX              | 25.50                               | 37.5           | 21.24                                 | -0.52               | 20.72             | 29                      | Pass        |
| EDGE850 - 4TX              | 24.50                               | 50             | 21.50                                 | -1.82               | 19.68             | 29                      | Pass        |
| GSM1900                    | 30.20                               | 12.5           | 21.20                                 | 3.63                | 24.83             | 26                      | Pass        |
| GPRS1900 - 1TX             | 30.20                               | 12.5           | 21.20                                 | 3.8                 | 25                | 26                      | Pass        |
| GPRS1900 - 2TX             | 28.70                               | 25             | 22.70                                 | 1.15                | 23.85             | 26                      | Pass        |
| GPRS1900 - 3TX             | 28.20                               | 37.5           | 23.94                                 | -0.67               | 23.27             | 26                      | Pass        |
| GPRS1900 - 4TX             | 27.20                               | 50             | 24.20                                 | -2.05               | 22.15             | 26                      | Pass        |
| EDGE1900 - 1TX             | 26.20                               | 12.5           | 17.20                                 | 3.75                | 20.95             | 26                      | Pass        |
| EDGE1900 - 2TX             | 25.20                               | 25             | 19.20                                 | 1.23                | 20.43             | 26                      | Pass        |
| EDGE1900 - 3TX             | 24.20                               | 37.5           | 19.94                                 | -0.52               | 19.42             | 26                      | Pass        |
| EDGE1900 - 4TX             | 23.20                               | 50             | 20.20                                 | -1.82               | 18.38             | 26                      | Pass        |
| WCDMA                      | 25.00                               | 100            | 25.00                                 | -25.43              | -0.43             | 26                      | Pass        |
| WCDMA - HSPA               | 25.00                               | 100            | 25.00                                 | -20.39              | 4.61              | 26                      | Pass        |
| LTE - FDD                  | 25.00                               | 100            | 25.00                                 | -9.76               | 15.24             | 25                      | Pass        |
| LTE - TDD_PC3/PC2          | 27.10                               | 63.3           | 25.10                                 | -1.44               | 23.66             | 25                      | Pass        |
| 5G FR1 - FDD_PC3           | 25.00                               | 100            | 25.00                                 | -12.08              | 12.92             | 25                      | Pass        |
| 5G NR - TDD_PC2            | 27.10                               | 50             | 24.10                                 | -1.64               | 22.46             | 25                      | Pass        |
| 5G FR1 - TDD_PC1.5 UL MIMO | 27.10                               | 25             | 21.10                                 | -0.78               | 20.32             | 25                      | Pass        |

| Ant 1                      |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| GSM850                     | 31.20                               | 12.5           | 22.20                                 | 3.63                | 25.83                    | 29                             | Pass               |
| GPRS850 - 1TX              | 32.50                               | 12.5           | 23.50                                 | 3.8                 | 27.3                     | 29                             | Pass               |
| GPRS850 - 2TX              | 29.50                               | 25             | 23.50                                 | 1.15                | 24.65                    | 29                             | Pass               |
| GPRS850 - 3TX              | 27.70                               | 37.5           | 23.44                                 | -0.67               | 22.77                    | 29                             | Pass               |
| GPRS850 - 4TX              | 26.50                               | 50             | 23.50                                 | -2.05               | 21.45                    | 29                             | Pass               |
| EDGE850 - 1TX              | 27.20                               | 12.5           | 18.20                                 | 3.75                | 21.95                    | 29                             | Pass               |
| EDGE850 - 2TX              | 26.20                               | 25             | 20.20                                 | 1.23                | 21.43                    | 29                             | Pass               |
| EDGE850 - 3TX              | 25.20                               | 37.5           | 20.94                                 | -0.52               | 20.42                    | 29                             | Pass               |
| EDGE850 - 4TX              | 24.20                               | 50             | 21.20                                 | -1.82               | 19.38                    | 29                             | Pass               |
| WCDMA                      | 24.70                               | 100            | 24.70                                 | -25.43              | -0.73                    | 26                             | Pass               |
| WCDMA - HSPA               | 24.70                               | 100            | 24.70                                 | -20.39              | 4.31                     | 26                             | Pass               |
| LTE - FDD                  | 25.00                               | 100            | 25.00                                 | -9.76               | 15.24                    | 25                             | Pass               |
| 5G FR1 - FDD_PC3           | 25.00                               | 100            | 25.00                                 | -12.08              | 12.92                    | 25                             | Pass               |
| 5G NR - TDD_PC2            | 27.20                               | 50             | 24.20                                 | -1.64               | 22.56                    | 25                             | Pass               |
| 5G FR1 - TDD_PC1.5 UL MIMO | 26.90                               | 25             | 20.90                                 | -0.78               | 20.12                    | 25                             | Pass               |

| Ant 2                      |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| GSM1900                    | 30.50                               | 12.5           | 21.50                                 | 3.63                | 25.13                    | 26                             | Pass               |
| GPRS1900 - 1TX             | 30.50                               | 12.5           | 21.50                                 | 3.8                 | 25.3                     | 26                             | Pass               |
| GPRS1900 - 2TX             | 29.00                               | 25             | 23.00                                 | 1.15                | 24.15                    | 26                             | Pass               |
| GPRS1900 - 3TX             | 28.50                               | 37.5           | 24.24                                 | -0.67               | 23.57                    | 26                             | Pass               |
| GPRS1900 - 4TX             | 27.50                               | 50             | 24.50                                 | -2.05               | 22.45                    | 26                             | Pass               |
| EDGE1900 - 1TX             | 26.50                               | 12.5           | 17.50                                 | 3.75                | 21.25                    | 26                             | Pass               |
| EDGE1900 - 2TX             | 25.50                               | 25             | 19.50                                 | 1.23                | 20.73                    | 26                             | Pass               |
| EDGE1900 - 3TX             | 24.50                               | 37.5           | 20.24                                 | -0.52               | 19.72                    | 26                             | Pass               |
| EDGE1900 - 4TX             | 23.50                               | 50             | 20.50                                 | -1.82               | 18.68                    | 26                             | Pass               |
| WCDMA                      | 25.00                               | 100            | 25.00                                 | -25.43              | -0.43                    | 26                             | Pass               |
| WCDMA - HSPA               | 25.00                               | 100            | 25.00                                 | -20.39              | 4.61                     | 26                             | Pass               |
| LTE - FDD                  | 25.00                               | 100            | 25.00                                 | -9.76               | 15.24                    | 25                             | Pass               |
| LTE - TDD_PC3/PC2          | 26.90                               | 63.3           | 24.90                                 | -1.44               | 23.46                    | 25                             | Pass               |
| 5G FR1 - FDD_PC3           | 25.00                               | 100            | 25.00                                 | -12.08              | 12.92                    | 25                             | Pass               |
| 5G NR - TDD_PC2            | 26.90                               | 50             | 23.90                                 | -1.64               | 22.26                    | 25                             | Pass               |
| 5G FR1 - TDD_PC1.5 UL MIMO | 26.90                               | 25             | 20.90                                 | -0.78               | 20.12                    | 25                             | Pass               |

| Ant 5                      |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| LTE - FDD                  | 24.50                               | 100            | 24.50                                 | -9.76               | 14.74                    | 25                             | Pass               |
| 5G FR1 - FDD_PC3           | 24.50                               | 100            | 25.00                                 | -12.08              | 12.92                    | 25                             | Pass               |
| 5G NR - TDD_PC2            | 27.20                               | 50             | 24.20                                 | -1.64               | 22.56                    | 25                             | Pass               |
| 5G FR1 - TDD_PC1.5 UL MIMO | 26.90                               | 25             | 20.90                                 | -0.78               | 20.12                    | 25                             | Pass               |

| Ant 6                      |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| LTE - TDD_PC3/PC2          | 25.00                               | 63.3           | 21.40                                 | -1.44               | 19.96                    | 25                             | Pass               |
| 5G NR - TDD_PC2            | 27.10                               | 50             | 24.10                                 | -1.64               | 22.46                    | 25                             | Pass               |
| 5G FR1 - TDD_PC1.5 UL MIMO | 26.60                               | 25             | 20.60                                 | -0.78               | 19.82                    | 25                             | Pass               |

| Ant 7                      |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| LTE - TDD_PC3/PC2          | 22.20                               | 63.3           | 18.60                                 | -1.44               | 17.16                    | 25                             | Pass               |
| 5G NR - TDD_PC2            | 26.70                               | 50             | 23.70                                 | -1.64               | 22.06                    | 25                             | Pass               |
| 5G FR1 - TDD_PC1.5 UL MIMO | 26.00                               | 25             | 20.00                                 | -0.78               | 19.22                    | 25                             | Pass               |

| Ant 0+1                    |                                     |                |                                       |                     |                          |                                |                    |
|----------------------------|-------------------------------------|----------------|---------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface              | Max Burst Antenna Input Power (dBm) | Duty Cycle (%) | Max Average Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| 5G FR1 - TDD_PC1.5 UL MIMO | 30.01                               | 25             | 24.01                                 | -0.78               | 23.23                    | 25                             | Pass               |

Note: The above UL MIMO power is a conservative, linear sum of the worst-case max allowed powers among PC1.5 MIMO antennas.

#### <WLAN operation>

##### <SISO 2.4GHz>

| Ant 3         |                                     |                     |                          |                                |                    |
|---------------|-------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface | Max Burst Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| 802.11b       | 22.50                               | -2.02               | 20.48                    | 25                             | Pass               |

| Ant 4         |                                     |                     |                          |                                |                    |
|---------------|-------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface | Max Burst Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| 802.11b       | 22.50                               | -2.02               | 20.48                    | 25                             | Pass               |

##### <MIMO 2.4GHz>

| Ant 3+4        |                                     |                     |                          |                                |                    |
|----------------|-------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface  | Max Burst Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| 802.11b        | 25.50                               | -2.02               | 23.48                    | 25                             | Pass               |
| 802.11g        | 25.00                               | 0.12                | 25.12                    | 25                             | Testing            |
| 802.11n-HT20   | 24.00                               | -13.44              | 10.56                    | 25                             | Pass               |
| 802.11ac-VHT20 | 24.00                               | -5.57               | 18.43                    | 25                             | Pass               |
| 802.11ax-HE20  | 24.00                               | -5.58               | 18.42                    | 25                             | Pass               |
| 802.11be-EHT20 | 24.00                               | -28.73              | -4.73                    | 25                             | Pass               |

**<MIMO 5/6GHz>**

| Ant 3+4         |                                     |                     |                          |                                |                    |
|-----------------|-------------------------------------|---------------------|--------------------------|--------------------------------|--------------------|
| Air Interface   | Max Burst Antenna Input Power (dBm) | Worst Case MIF (dB) | RF <sub>AIPL</sub> (dBm) | RF <sub>AIPL</sub> Limit (dBm) | RF <sub>AIPL</sub> |
| 802.11a         | 24.00                               | -3.15               | 20.85                    | 25                             | Pass               |
| 802.11n-HT20    | 24.00                               | -13.44              | 10.56                    | 25                             | Pass               |
| 802.11n-HT40    | 23.00                               | -13.44              | 9.56                     | 25                             | Pass               |
| 802.11ac-VHT20  | 24.00                               | -5.57               | 18.43                    | 25                             | Pass               |
| 802.11ac-VHT40  | 23.00                               | -5.57               | 17.43                    | 25                             | Pass               |
| 802.11ac-VHT80  | 23.00                               | -5.57               | 17.43                    | 25                             | Pass               |
| 802.11ac-VHT160 | 19.50                               | -5.57               | 13.93                    | 25                             | Pass               |
| 802.11ax-HE20   | 24.00                               | -5.58               | 18.42                    | 25                             | Pass               |
| 802.11ax-HE40   | 23.00                               | -5.58               | 17.42                    | 25                             | Pass               |
| 802.11ax-HE80   | 23.00                               | -5.58               | 17.42                    | 25                             | Pass               |
| 802.11ax-HE160  | 19.50                               | -5.58               | 13.92                    | 25                             | Pass               |
| 802.11be-EHT20  | 24.00                               | -28.73              | -4.73                    | 25                             | Pass               |
| 802.11be-EHT40  | 23.00                               | -28.73              | -5.73                    | 25                             | Pass               |
| 802.11be-EHT80  | 23.00                               | -28.73              | -5.73                    | 25                             | Pass               |
| 802.11be-EHT160 | 19.50                               | -28.73              | -9.23                    | 25                             | Pass               |

**11.1 Evaluation RF<sub>AIL</sub>****General Note:**

1. The HAC measurement system applies MIF value onto the measured RMS E-field, which is indirect method in ANSI C63.19-2019 version, and reports the RF audio interference level.
2. Phone Condition: Mute on; Backlight off; Max Volume

| Plot No. | Air Interface | Radio Configuration | Channel | Transmit Ant. | Average Antenna Input Power (dBm) | MIF  | RF <sub>AIL</sub> (dBV/m) |
|----------|---------------|---------------------|---------|---------------|-----------------------------------|------|---------------------------|
| 1        | WLAN2.4GHz    | 802.11g 6Mbps       | 6       | Ant 3+4       | 24.07                             | 0.12 | 28.04                     |

Test Engineer : Sam Lin

## 12. Uncertainty Assessment

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty 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 below Table..

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) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|--------------------------|------------|--------|--------------------------|
| <b>Measurement System</b>                                                                                                                                                                                                            |                        |                          |            |        |                          |
| 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 %                  |
| <b>Test Sample Related</b>                                                                                                                                                                                                           |                        |                          |            |        |                          |
| 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 %                  |
| <b>Phantom and Setup Related</b>                                                                                                                                                                                                     |                        |                          |            |        |                          |
| Phantom Thickness                                                                                                                                                                                                                    | 2.4                    | Rectangular              | $\sqrt{3}$ | 1      | ± 1.4 %                  |
| <b>Combined Standard Uncertainty</b>                                                                                                                                                                                                 |                        |                          |            |        | ± 16.30 %                |
| <b>Coverage Factor for 95 %</b>                                                                                                                                                                                                      |                        |                          |            |        | K = 2                    |
| <b>Combined Std. Uncertainty</b>                                                                                                                                                                                                     |                        |                          |            |        | ± 16.30 %                |
| <b>Coverage Factor for 95 %</b>                                                                                                                                                                                                      |                        |                          |            |        | K = 2                    |
| <b>Expanded STD Uncertainty</b>                                                                                                                                                                                                      |                        |                          |            |        | ± 32.6 %                 |
| Declaration of Conformity:<br>The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.                                           |                        |                          |            |        |                          |
| Comments and Explanations:<br>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



### **13. References**

- [1] ANSI C63.19:2019, "American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids", Aug. 2019.
- [2] FCC KDB 285076 D01v06r04, "Equipment Authorization Guidance for Hearing Aid Compatibility", Sep. 2023.
- [3] FCC KDB 285076 D03v01r07, "Hearing aid compatibility frequently asked questions", Dec. 2024
- [4] SPEAG DASY System Handbook