



# HAC RF Test Report

For

**Applicant Name:** Xwireless LLC  
**Address:** 11565 Old Georgetown Road, Rockville, MD, USA  
**EUT Name:** Mobile Phone  
**Brand Name:** Vortex  
**Model Number:** HD60L

## Issued By

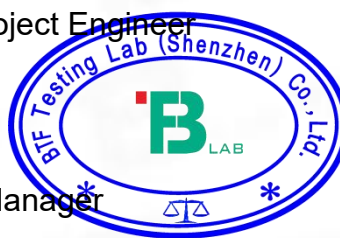
**Company Name:** BTF Testing Lab (Shenzhen) Co., Ltd.  
**Address:** F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park,  
Tantou Community, Songgang Street, Bao'an District, Shenzhen,  
China

**Report Number:** BTF230810R00401  
**Test Standards:** ANSI C63.19-2011 FCC 47 CFR §20.19 KDB 285076 D01v06  
KDB 285076 D02v04 KDB 285076 D03v01r05  
**FCC ID:** 2ADLJ-HD60L

**Test Conclusion:** Pass  
**Test Date:** 2023-07-07  
**Date of Issue:** 2023-08-11

**Prepared By:**   
Monica Zhou / Project Engineer  
**Date:** 2023-08-11

**Approved By:**   
Ryan.CJ / EMC Manager  
**Date:** 2023-08-11



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| Revision History |                                                                              |                   |
|------------------|------------------------------------------------------------------------------|-------------------|
| Version          | Issue Date                                                                   | Revisions Content |
| R_V0             | 2023-08-11                                                                   | Original          |
|                  |                                                                              |                   |
| Note:            | Once the revision has been made, then previous versions reports are invalid. |                   |

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## 1. Introduction

### 1.1 Identification of Testing Laboratory

|               |                                                                                                                                     |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Company Name: | BTF Testing Lab (Shenzhen) Co., Ltd.                                                                                                |
| Address:      | F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China |
| Phone Number: | +86-0755-23146130                                                                                                                   |
| Fax Number:   | +86-0755-23146130                                                                                                                   |

### 1.2 Identification of the Responsible Testing Location

|                         |                                                                                                                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Location:          | BTF Testing Lab (Shenzhen) Co., Ltd.                                                                                                                                                                               |
| Address:                | F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China                                                                                |
| Description:            | All measurement facilities used to collect the measurement data are located at F101, 201 and 301, Building 1, Block 2, Tantou Industrial Park, Tantou Community, Songgang Street, Bao'an District, Shenzhen, China |
| FCC Registration Number | 518915                                                                                                                                                                                                             |
| Designation Number      | CN1330                                                                                                                                                                                                             |

### 1.3 Laboratory Condition

|                            |                    |
|----------------------------|--------------------|
| Ambient Temperature:       | 21°C to 25°C       |
| Ambient Relative Humidity: | 48% to 59%         |
| Ambient Pressure:          | 100 kPa to 102 kPa |

### 1.4 Announcement

- (1) The test report reference to the report template version v0.
- (2) The test report is invalid if not marked with the signatures of the persons responsible for preparing, reviewing and approving the test report.
- (3) The test report is invalid if there is any evidence and/or falsification.
- (4) This document may not be altered or revised in any way unless done so by BTF and all revisions are duly noted in the revisions section.
- (5) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.
- (6) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

## 2. Product Information

### 2.1 Application Information

|               |                                               |
|---------------|-----------------------------------------------|
| Company Name: | Xwireless LLC                                 |
| Address:      | 11565 Old Georgetown Road, Rockville, MD, USA |

### 2.2 Manufacturer Information

|               |                                               |
|---------------|-----------------------------------------------|
| Company Name: | Xwireless LLC                                 |
| Address:      | 11565 Old Georgetown Road, Rockville, MD, USA |

### 2.3 Factory Information

|               |                                                                                                        |
|---------------|--------------------------------------------------------------------------------------------------------|
| Company Name: | ZTECH COMMUNICATION(SZ) CO LTD                                                                         |
| Address:      | FL 7 BLOCK D BAO'AN ZHIGU INNOVATION PARK YIN'TIAN ROAD NO.4<br>XI'XIANG STR' BAO'AN DISTRICT SZ CHINA |

### 2.4 General Description of Equipment under Test (EUT)

|                       |                     |
|-----------------------|---------------------|
| EUT Name              | Mobile Phone        |
| Under Test Model Name | HD60L               |
| Sample No.            | BTFSN230625E001-2/4 |

### 2.5 Equipment under Test Ancillary Equipment

|                       |                      |         |
|-----------------------|----------------------|---------|
| Ancillary Equipment 1 | Rechargeable Battery |         |
|                       | Capacity             | 2800mAh |
|                       | Rated Voltage        | 3.8V    |

### 2.6 Technical Information

|                                   |                                                                                                                                                                                                                                                                               |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Network and Wireless connectivity | 2G Network GSM/GPRS 850/1900<br>3G Network WCDMA/HSDPA/HSUPA Band 2/4/5<br>4G Network FDD LTE Band 2/4/5/12/13/25/66/71 TDD LTE Band 41<br>2.4G WIFI 802.11b, 802.11g, 802.11n(HT20/HT40)<br>5G WIFI 802.11a, 802.11n(HT20/HT40), 802.11ac(VHT20/VHT40/VHT80)<br>BT (EDR+BLE) |
|-----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 2.7 Air Interfaces / Bands Indicating Operating Modes

| Air Interface | Band       | Type | Simultaneous Transmitter | Name of Service |
|---------------|------------|------|--------------------------|-----------------|
| GSM           | 850        | VO   | WLAN & BT                | CMRS Voice      |
|               | 1900       | VO   | WLAN & BT                | CMRS Voice      |
|               | GPRS/EGPRS | DT   | N/A                      | N/A             |
| WCDMA         | Band II    | VO   | WLAN & BT                | CMRS Voice      |
|               | Band IV    | VO   | WLAN & BT                | CMRS Voice      |
|               | Band V     | VO   | WLAN & BT                | CMRS Voice      |
|               | HSPA       | DT   | N/A                      | N/A             |
| LTE           | Band 2     | VD   | WLAN & BT                | VoLTE           |
|               | Band 4     | VD   | WLAN & BT                | VoLTE           |
|               | Band 5     | VD   | WLAN & BT                | VoLTE           |
|               | Band 12    | VD   | WLAN & BT                | VoLTE           |
|               | Band 13    | VD   | WLAN & BT                | VoLTE           |
|               | Band 25    | VD   | WLAN & BT                | VoLTE           |
|               | Band 41    | VD   | WLAN & BT                | VoLTE           |
|               | Band 66    | VD   | WLAN & BT                | VoLTE           |
|               | Band 71    | VD   | WLAN & BT                | VoLTE           |
| WLAN          | 2.4g & 5g  | DT   | WWAN                     | N/A             |
| BT            | 2450       | DT   | WWAN                     | N/A             |

NA: Not Applicable  
VO: Voice Only  
VD: CMRS and IP Voice Service over Digital Transport  
DT: Digital Transport Only

\* HAC Rating was not based on concurrent voice and data modes; Noncurrent mode was found to represent worst case rating for both M and T rating.  
Note1: The air interface is exempted from testing by low power exemption that its average antenna input power plus its MIF is  $\leq 17$  dBm, and is rated as M4.  
Note2: According to ANSI C63.19 2011-version, for the air interface technology of a device is exempt from testing whose peak antenna input power, averaged over intervals  $\leq 50$   $\mu$ s, is  $\leq 23$  dBm. An RF air interface technology that is exempted from testing shall be rated as M4.

## 3. Summary of Test Results

### 3.1 Test Standards

| No. | Identity             | Document Title                                                                                                                                 |
|-----|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | ANSI C63.19-2011     | American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids                 |
| 2   | FCC 47 CFR §20.19    | Hearing Aid Compatible Mobile Headsets                                                                                                         |
| 3   | KDB 285076 D01v06    | Equipment Authorization Guidance for Hearing Aid Compatibility                                                                                 |
| 4   | KDB 285076 D02v04    | Guidance for performing T-Coil tests for air interfaces supporting voice over IP (e.g., LTE and WiFi) to support CMRS based telephone services |
| 5   | KDB 285076 D03v01r05 | Hearing aid compatibility frequently asked questions                                                                                           |

## 3.2 ANSI C63.19 HAC RF Categories

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

### WD RF audio Interference level categories in logarithmic units

| Emission categories | <960MHz Limits for E-field emissions | >960MHz Limits for E-field emissions |
|---------------------|--------------------------------------|--------------------------------------|
| M1                  | 50 to 55 dB (V/m)                    | 40 to 45 dB (V/m)                    |
| M2                  | 45 to 50 dB (V/m)                    | 35 to 40 dB (V/m)                    |
| M3                  | 40 to 45 dB (V/m)                    | 30 to 35 dB (V/m)                    |
| M4                  | < 40 dB (V/m)                        | < 30 dB (V/m)                        |

## 3.3 Summary of HAC M-Rating

| Band                     | Channel     | Measurement Result |       | M-Rating |
|--------------------------|-------------|--------------------|-------|----------|
| GSM850                   | Low (128)   | E-Field dB (V/m)   | 31.81 | M4       |
|                          | Middle(190) | E-Field dB (V/m)   | 31.52 | M4       |
|                          | High(251)   | E-Field dB (V/m)   | 32.05 | M4       |
| GSM1900                  | Low (512)   | E-Field dB (V/m)   | 23.35 | M4       |
|                          | Middle(661) | E-Field dB (V/m)   | 24.12 | M4       |
|                          | High(810)   | E-Field dB (V/m)   | 26.02 | M4       |
| HAC Rate Category:<br>M4 |             |                    |       |          |

### 3.4 HAC Test Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in ANSI C6 3.19: 2011. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ .

| UNCERTAINTY EVALUATION FOR RF HAC MEASUREMENT                        |                    |             |            |                  |                 |
|----------------------------------------------------------------------|--------------------|-------------|------------|------------------|-----------------|
| Uncertainty Component                                                | Tol<br>( $\pm$ dB) | Prob. Dist. | Div.       | Uncertainty (dB) | Uncertainty (%) |
| Measurement System                                                   |                    |             |            |                  |                 |
| RF reflections                                                       | 0.1                | R           | $\sqrt{3}$ | 0.06             |                 |
| Field probe conv. Factor                                             | 0.4                | R           | $\sqrt{3}$ | 0.23             |                 |
| Field probe anisotropy                                               | 0.25               | R           | $\sqrt{3}$ | 0.14             |                 |
| Positioning accuracy                                                 | 0.2                | R           | $\sqrt{3}$ | 0.12             |                 |
| Probe cable placement                                                | 0.1                | R           | $\sqrt{3}$ | 0.06             |                 |
| System repeatability                                                 | 0.2                | R           | $\sqrt{3}$ | 0.12             |                 |
| EUT repeatability                                                    | 0.4                | N           | 1          | 0.40             |                 |
| Combined Standard Uncertainty                                        |                    | N           | 1          | 0.52             |                 |
| Expanded Uncertainty<br>(95% CONFIDENCE INTERVAL)                    |                    | N           | $K=2$      | 1.03             | 12.65           |
| REPORTED Expanded uncertainty<br>(confidence level of 95%, $k = 2$ ) |                    | N           | $K=2$      | 1.00             | 13.00           |

## 4. Measurement System

### 4.1 Definition of Hearing Aid Compatibility (HAC)

The purpose of this standard is to establish categories for hearing aids and for WD (wireless communications devices) that can indicate to health care practitioners and hearing aid users which hearing aids are compatible with which WD, and to provide tests that can be used to assess the electromagnetic characteristics of hearing aids and WD and assign them to these categories. The various parameters required, in order to demonstrate compatibility and accessibility are measured. The design of the standard is such that when a hearing aid and WD achieve one of the categories specified, as measured by the methodology of this standard, the indicated performance is realized.

In order to provide for the usability of a hearing aid with a WD, several factors must be coordinated:

- a) Radio frequency (RF) measurements of the near-field electric and magnetic fields emitted by a WD to categorize these emissions for correlation with the RF immunity of a hearing aid.
- b) Magnetic field measurements of a WD emitted via the audio transducer associated with the T-coil mode of the hearing aid, for assessment of hearing aid performance.
- c) Measurements with the hearing aid and a simulation of the categorized WD T-coil emissions to assess the hearing aid RF immunity in the T-coil mode.

The WD radio frequency (RF) and audio band emissions are measured.

Hence, the following are measurements made for the WD:

- a) RF E-Field emissions
- b) T-coil mode, magnetic signal strength in the audio band
- c) T-coil mode, magnetic signal and noise articulation index
- d) T-coil mode, magnetic signal frequency response through the audio band

Corresponding to the WD measurements, the hearing aid is measured for:

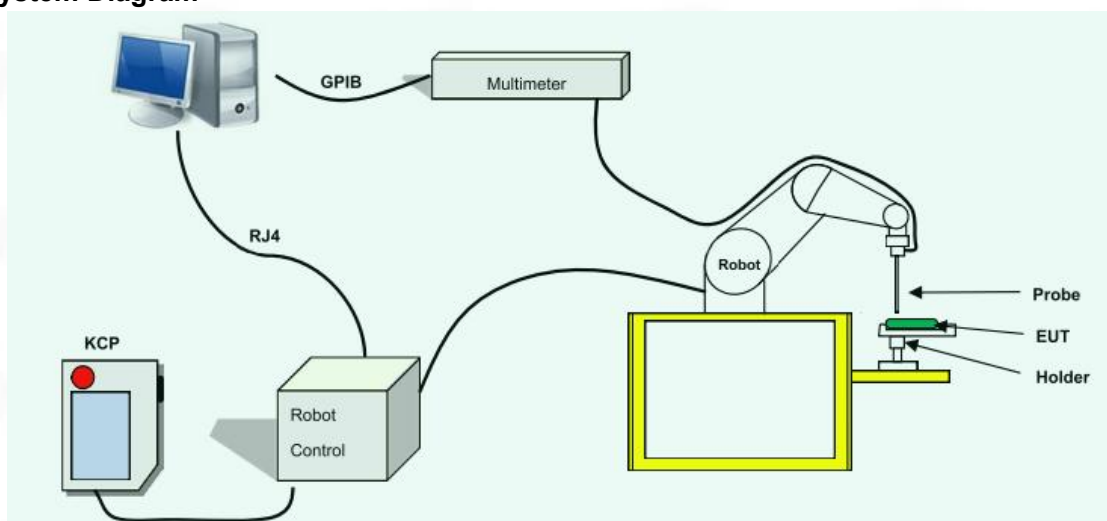
- a) RF immunity in microphone mode
- b) RF immunity in T-coil mode

## 4.2 HAC RF Test Configuration and Setting

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

## 4.3 MVG HAC System

MVG HAC System Diagram



#### 4.3.1 Robot



A standard high precision 6-axis robot (Denso) with a scanning system

- It must be able to scan all the volume of the phantom to evaluate the tridimensional distribution of SAR.
- Must be able to set the probe orthogonal to the surface of the phantom ( $\pm 30^\circ$ ).
- Detects stresses on the probe and stop itself if necessary to keep the integrity of the probe.

#### 4.3.2 E-Field Probe

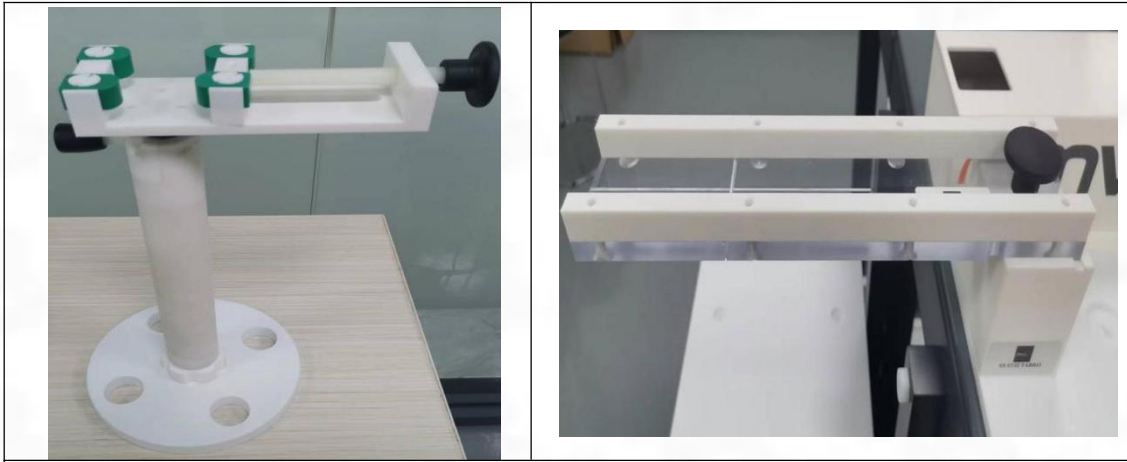


Figure 1 – MVG COMOHAC E field Probe

|                                            |        |
|--------------------------------------------|--------|
| Probe Length                               | 330 mm |
| Length of Individual Dipoles               | 3.3 mm |
| Maximum external diameter                  | 8 mm   |
| Probe Tip External Diameter                | 5 mm   |
| Distance between dipoles / probe extremity | 3 mm   |

|                                          |                                                                         |
|------------------------------------------|-------------------------------------------------------------------------|
| Device Type                              | COMOHAC E FIELD PROBE                                                   |
| Manufacturer                             | MVG                                                                     |
| Model                                    | SCE                                                                     |
| Serial Number                            | SN 07/22 EPH50                                                          |
| Product Condition (new / used)           | New                                                                     |
| Frequency Range of Probe                 | 0.7GHz-2.5GHz                                                           |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.208 MΩ<br>Dipole 2: R2=0.220 MΩ<br>Dipole 3: R3=0.212 MΩ |

#### 4.3.3 Device Holder/DUT positioner



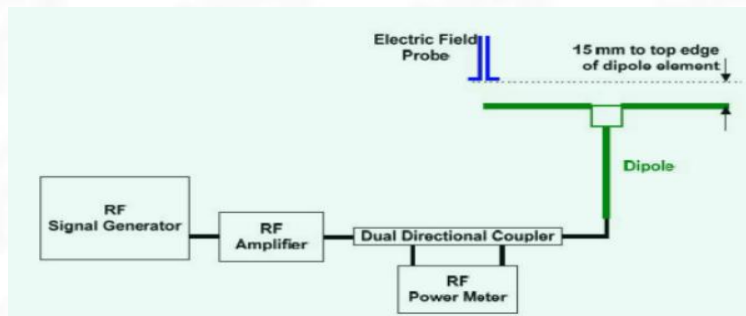
During test, use DUT positioner adjust DUT to check if the Speaker is aligned with the positioner center.

## 5. System Validation

According to ANSI C63.19, before hearing aid testing commences, the experimental setup shall be validated. Sub clauses 6.3.1 through 6.3.5 include a set of pretest procedures designed to validate the experimental setup to ensure the accuracy of the results. To verify that the hearing aid performs per the manufacturer's specifications, 6.3.5 advises that the hearing aid be pretested per ANSI S3.22.

### 5.1 System Validation Setup

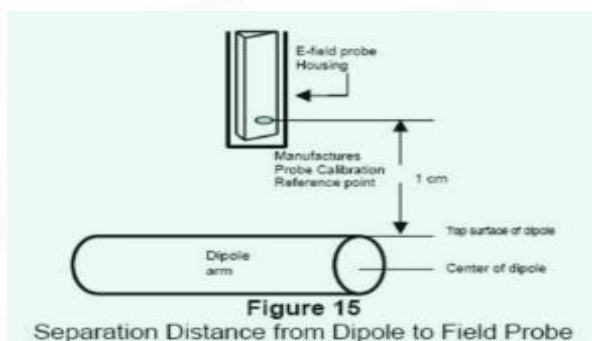
Using this setup configuration, the signal generator was adjusted for the desired output power 20dBm (100mW) at a specified frequency. The reference power from the coupled port of the directional coupler is recorded. Next, the output cable is connected to the reference dipole



### 5.2 System Check Procedure

The input signal was an unmodulated continuous wave. The following points were taken into consideration in performing this check:

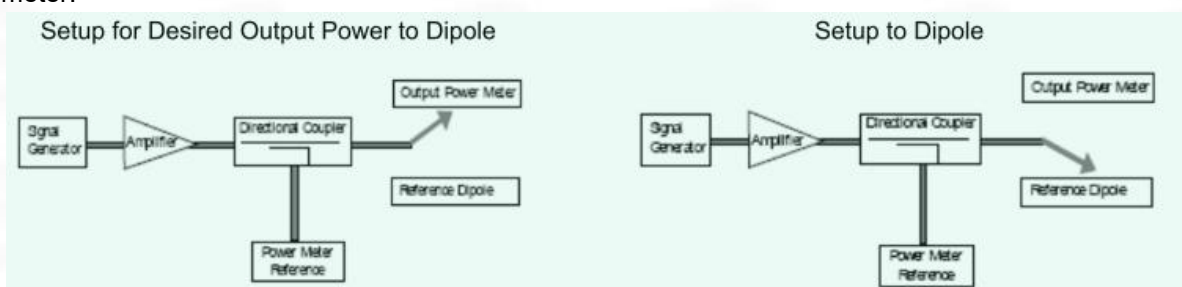
- Average Input Power  $P = 100\text{mW RMS}$  (20dBm RMS) after adjustment for return loss
- The test fixture must meet the 2 wavelength separation criterion
- The proper measurement of the 1 cm probe to dipole separation, which is measured from top surface of the dipole to the calibration reference point of the sensor, defined by the probe manufacturer is shown in the following diagram:



RF power was recorded using both an average reading meter and a peak reading meter. Readings of the probe are provided by the measurement system. To assure proper operation of the near-field measurement probe the input power to the dipole shall be commensurate with the full rated output power of the wireless device (e.g. – for a cellular phone wireless device the average peak antenna input power will be on the order of 100mW (i.e. - 20dBm) RMS after adjustment for any mismatch.

### 5.3 System Validation Procedure

A dipole antenna meeting the requirements given in C63.19 was placed in the position normally occupied by the WD. The length of the dipole was scanned with both E-field and H-field probes and the maximum values for each were recorded. Using the near-field measurement system, scan the antenna over the radiating dipole and record the greatest field reading observed. Due to the nature of E-fields about free-space dipoles, the two E-field peaks measured over the dipole are averaged to compensate for non-parallelity of the setup see manufacturer method on dipole calibration certificates, Field strength measurements shall be made only when the probe is stationary. RF power was recorded using both an average and a peak power reading meter.



## 6. Modulation Interference Factor (MIF)

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

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

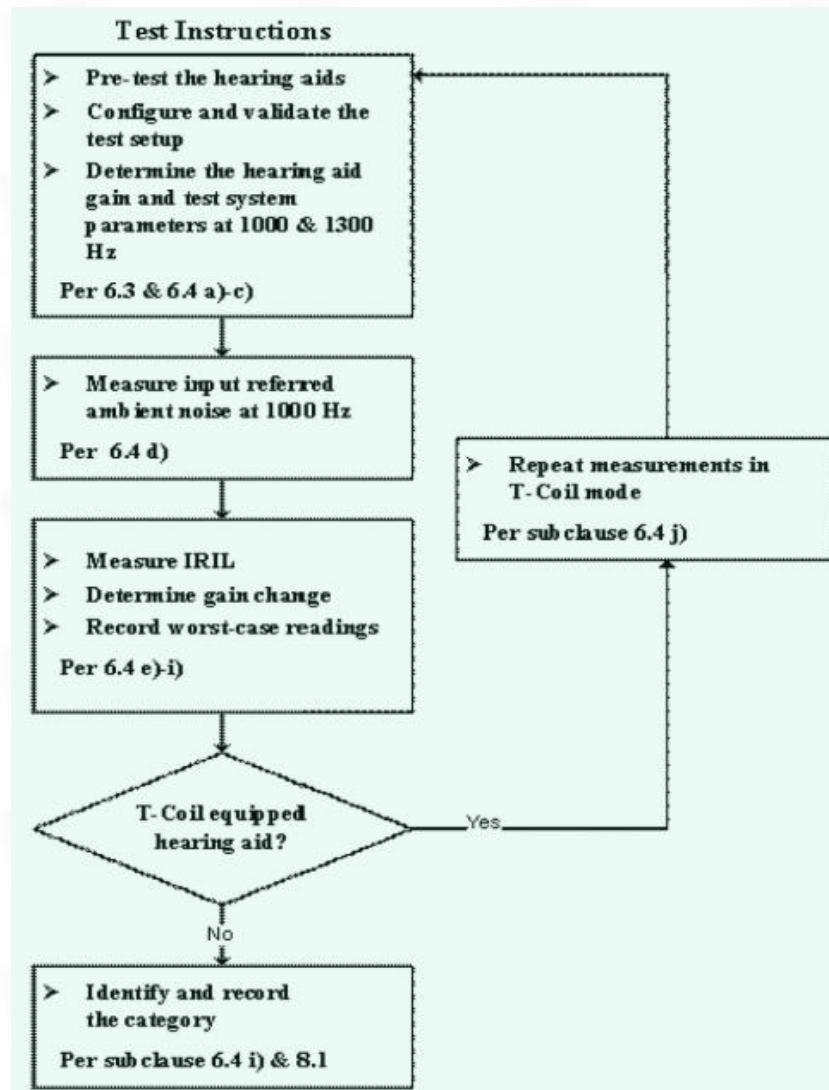
- a) Verify the slope accuracy and dynamic range capability over the desired operating frequency band of a fast probe or sensor, square-law detector, as specified in D.3, and weighting system as specified in D.4 and D.5. For the probe and instrumentation included in the measurement of MIF, additional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

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

| Modulation group | Modulation characteristics        | MIF   |
|------------------|-----------------------------------|-------|
| CW               | CW                                | -99.0 |
| GSM              | TDMA                              | 3.3   |
| WCDMA            | UMTS-FDD                          | -27.2 |
| LTE              | LTE-FDD / RB=1 / BW=20 MHz / QPSK | -15.6 |

## 7. HAC Immunity Measurement Procedures

### 7.1 HAC Measurement Process Diagram



## 7.2 HAC RF Test Setup



WD reference and plane for RF emission measurements

## 7.3 RF Emission Measurement Procedures

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

- Proper operation of the field probe, probe measurement system, other instrumentation, and the positioning system was confirmed.
- WD is positioned in its intended test position, acoustic output point of the device perpendicular to the field probe.
- WD operation for maximum rated RF output power was configured and confirmed with the base station simulator, at the test channel and other normal operating parameters as intended for the test. The battery was ensured to be fully charged before each test.
- center sub-grid was centered over the center of the acoustic output (also audio band magnetic output, if applicable). The WD audio output was positioned tangent (as physically possible) to the measurement plane.
- surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.
- measurement system measured the field strength at the reference location

## 8. Max. Conducted RF Output Power

### 2G

| Mode: GSM850  | Maximum Tune-up(dBm) | Burst Average Power (dBm) |           |           |
|---------------|----------------------|---------------------------|-----------|-----------|
|               |                      | CH128                     | CH190     | CH251     |
|               |                      | 824.2MHz                  | 836.6MHz  | 848.8MHz  |
| GSM           | 32.00                | 31.71                     | 31.95     | 31.92     |
| Mode: GSM1900 | Maximum Tune-up(dBm) | Burst Average Power (dBm) |           |           |
|               |                      | CH512                     | CH661     | CH810     |
|               |                      | 1850.2MHz                 | 1880.0MHz | 1909.8MHz |
| GSM           | 26.00                | 25.57                     | 25.56     | 25.11     |

### 3G

| Mode      | Maximum Tune-up(dBm) | WCDMA Band II         |        |        |
|-----------|----------------------|-----------------------|--------|--------|
|           |                      | Conducted Power (dBm) |        |        |
|           |                      | CH9262                | CH9400 | CH9538 |
| RMC 12.2K | 23.00                | 1852.4                | 1880.0 | 1907.6 |
|           |                      | 22.49                 | 22.48  | 22.81  |
| Mode      | Maximum Tune-up(dBm) | WCDMA Band IV         |        |        |
|           |                      | Conducted Power (dBm) |        |        |
|           |                      | CH1312                | CH1413 | CH1513 |
| RMC 12.2K | 23.50                | 1712.4                | 1732.6 | 1752.6 |
|           |                      | 23.36                 | 23.25  | 22.92  |
| Mode      | Maximum Tune-up(dBm) | WCDMA Band V          |        |        |
|           |                      | Conducted Power (dBm) |        |        |
|           |                      | CH4132                | CH4183 | CH4233 |
| RMC 12.2K | 26.00                | 826.4                 | 836.6  | 846.6  |
|           |                      | 25.48                 | 25.55  | 25.59  |

### 4G

| LTE-FDD Band 2 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |           |           |
|----------------|------------|---------------|-----------|----------------------|----------------------|-----------|-----------|
| Bandwidth      | Modulation | RB allocation | RB offset |                      | 18700                | 18900     | 19100     |
|                |            |               |           |                      | 1860.0MHz            | 1880.0MHz | 1900.0MHz |
| 20MHz          | QPSK       | 1             | 0         | 21.50                | 21.04                | 20.89     | 21.11     |
|                |            |               | 50        | 22.00                | 21.48                | 21.55     | 21.78     |
|                |            |               | 99        | 21.50                | 20.91                | 21.06     | 21.31     |
|                |            | 50            | 0         | 20.50                | 20.42                | 20.32     | 20.46     |
|                |            |               | 25        | 21.00                | 20.30                | 20.30     | 20.53     |
|                |            |               | 50        | 21.00                | 20.32                | 20.29     | 20.51     |
|                |            | 100           | 0         | 21.00                | 20.40                | 20.35     | 20.51     |
|                | 16QAM      | 1             | 0         | 21.00                | 20.25                | 20.06     | 20.55     |
|                |            |               | 50        | 21.50                | 20.58                | 20.71     | 21.06     |
|                |            |               | 99        | 21.00                | 19.96                | 20.30     | 20.83     |
|                |            | 50            | 0         | 19.50                | 19.48                | 19.33     | 19.45     |
|                |            |               | 25        | 20.00                | 19.36                | 19.35     | 19.53     |
|                |            |               | 50        | 20.00                | 19.38                | 19.35     | 19.55     |
|                |            | 100           | 0         | 20.00                | 19.44                | 19.41     | 19.55     |

| LTE-FDD Band 4 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |           |           |
|----------------|------------|---------------|-----------|----------------------|----------------------|-----------|-----------|
| Bandwidth      | Modulation | RB allocation | RB offset |                      | 20050                | 20175     | 20300     |
|                |            |               |           |                      | 1720.0MHz            | 1732.5MHz | 1745.0MHz |
| 20MHz          | QPSK       | 1             | 0         | 22.50                | 22.07                | 21.82     | 21.77     |
|                |            |               | 50        | <b>22.50</b>         | <b>22.39</b>         | 22.36     | 22.14     |
|                |            |               | 99        | 22.00                | 21.79                | 21.73     | 21.53     |
|                |            | 50            | 0         | 21.50                | <b>21.31</b>         | 21.40     | 21.17     |
|                |            |               | 25        | 21.50                | 21.27                | 21.25     | 21.08     |
|                |            |               | 50        | 21.50                | 21.10                | 21.18     | 20.91     |
|                |            | 100           | 0         | 21.50                | 21.24                | 21.29     | 21.05     |
|                | 16QAM      | 1             | 0         | 21.50                | 21.45                | 21.09     | 21.17     |
|                |            |               | 50        | 22.00                | 21.88                | 21.62     | 21.44     |
|                |            |               | 99        | 21.50                | 21.47                | 21.01     | 20.64     |
|                |            | 50            | 0         | 20.50                | 20.21                | 20.42     | 20.13     |
|                |            |               | 25        | 20.50                | 20.24                | 20.29     | 20.04     |
|                |            |               | 50        | 20.50                | 20.06                | 20.19     | 19.88     |
|                |            | 100           | 0         | 20.50                | 20.18                | 20.29     | 20.04     |

| LTE-FDD Band 5 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |          |          |
|----------------|------------|---------------|-----------|----------------------|----------------------|----------|----------|
| Bandwidth      | Modulation | RB allocation | RB offset |                      | 20450                | 20525    | 20600    |
|                |            |               |           |                      | 829.0MHz             | 836.5MHz | 844.0MHz |
| 10MHz          | QPSK       | 1             | 0         | 24.50                | 24.16                | 24.05    | 24.11    |
|                |            |               | 25        | 24.50                | 24.42                | 24.32    | 24.40    |
|                |            |               | 49        | 24.50                | 24.05                | 24.15    | 24.16    |
|                |            | 25            | 0         | 23.50                | 23.17                | 23.13    | 23.12    |
|                |            |               | 13        | 23.50                | 23.14                | 23.11    | 23.05    |
|                |            |               | 25        | 23.50                | 23.08                | 23.00    | 23.03    |
|                |            | 50            | 0         | 23.50                | 23.10                | 23.03    | 23.08    |
|                | 16QAM      | 1             | 0         | 23.50                | 23.13                | 23.46    | 22.91    |
|                |            |               | 25        | 24.00                | 23.34                | 23.71    | 23.12    |
|                |            |               | 49        | 23.50                | 23.20                | 23.28    | 22.91    |
|                |            | 25            | 0         | 22.50                | 22.15                | 22.25    | 22.15    |
|                |            |               | 13        | 22.50                | 22.13                | 22.22    | 22.10    |
|                |            |               | 25        | 22.50                | 22.15                | 22.09    | 22.16    |
|                |            | 50            | 0         | 22.50                | 22.12                | 22.16    | 22.13    |

| LTE-FDD Band 12 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |          |              |
|-----------------|------------|---------------|-----------|----------------------|----------------------|----------|--------------|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 23060                | 23095    | 23130        |
|                 |            |               |           |                      | 704.0MHz             | 707.5MHz | 711.0MHz     |
| 10MHz           | QPSK       | 1             | 0         | 24.50                | 23.95                | 23.97    | 24.14        |
|                 |            |               | 25        | <b>24.50</b>         | 24.29                | 24.36    | <b>24.40</b> |
|                 |            |               | 49        | 24.50                | 24.14                | 24.15    | 24.35        |
|                 |            | 25            | 0         | 23.50                | 23.32                | 23.01    | 22.93        |
|                 |            |               | 13        | 23.50                | 23.18                | 23.18    | <b>23.14</b> |
|                 |            |               | 25        | 23.50                | 23.33                | 23.14    | 22.92        |
|                 |            | 50            | 0         | 23.50                | 23.33                | 23.13    | 22.94        |
|                 | 16QAM      | 1             | 0         | 23.50                | 22.98                | 23.43    | 22.97        |
|                 |            |               | 25        | 24.00                | 23.40                | 23.65    | 23.36        |
|                 |            |               | 49        | 24.00                | 23.16                | 23.54    | 23.12        |
|                 |            | 25            | 0         | 22.50                | 22.28                | 22.01    | 21.91        |
|                 |            |               | 13        | 22.50                | 22.11                | 22.14    | 22.13        |
|                 |            |               | 25        | 22.50                | 22.30                | 22.15    | 21.94        |
|                 |            | 50            | 0         | 22.50                | 22.28                | 22.02    | 21.90        |

| LTE-FDD Band 13 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |  |
|-----------------|------------|---------------|-----------|----------------------|----------------------|--|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 23230                |  |
|                 |            |               |           |                      | 782.0MHz             |  |
| 10MHz           | QPSK       | 1             | 0         | 24.50                | 24.33                |  |
|                 |            |               | 25        | <b>24.50</b>         | <b>24.46</b>         |  |
|                 |            |               | 49        | 24.50                | 24.32                |  |
|                 |            | 25            | 0         | 24.00                | <b>23.54</b>         |  |
|                 |            |               | 13        | 23.50                | 23.39                |  |
|                 |            |               | 25        | 23.50                | 23.45                |  |
|                 |            | 50            | 0         | 23.50                | 23.49                |  |
|                 | 16QAM      | 1             | 0         | 23.50                | 23.17                |  |
|                 |            |               | 25        | 23.50                | 23.49                |  |
|                 |            |               | 49        | 23.50                | 23.13                |  |
|                 |            | 25            | 0         | 23.00                | 22.59                |  |
|                 |            |               | 13        | 22.50                | 22.44                |  |
|                 |            |               | 25        | 22.50                | 22.49                |  |
|                 |            | 50            | 0         | 22.50                | 22.47                |  |

| LTE-FDD Band 25 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |           |           |
|-----------------|------------|---------------|-----------|----------------------|----------------------|-----------|-----------|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 26140                | 26365     | 26590     |
|                 |            |               |           |                      | 1860.0MHz            | 1882.5MHz | 1905.0MHz |
| 20MHz           | QPSK       | 1             | 0         | 20.50                | 20.29                | 20.46     | 20.41     |
|                 |            |               | 50        | 21.50                | 20.65                | 21.11     | 20.99     |
|                 |            |               | 99        | 21.00                | 20.29                | 20.47     | 20.97     |
|                 |            | 50            | 0         | 20.00                | 19.64                | 19.96     | 19.74     |
|                 |            |               | 25        | 20.00                | 19.52                | 19.87     | 19.87     |
|                 |            |               | 50        | 20.00                | 19.66                | 19.78     | 19.99     |
|                 |            | 100           | 0         | 20.00                | 19.63                | 19.91     | 19.91     |
|                 | 16QAM      | 1             | 0         | 20.00                | 19.83                | 19.55     | 19.47     |
|                 |            |               | 50        | 20.50                | 20.08                | 20.26     | 20.27     |
|                 |            |               | 99        | 20.50                | 19.67                | 19.57     | 20.09     |
|                 |            | 50            | 0         | 19.50                | 18.74                | 19.06     | 18.78     |
|                 |            |               | 25        | 19.00                | 18.54                | 18.97     | 18.91     |
|                 |            |               | 50        | 19.50                | 18.66                | 18.87     | 19.04     |
|                 |            | 100           | 0         | 19.00                | 18.72                | 18.99     | 18.98     |

| LTE-TDD Band 41 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |           |           |
|-----------------|------------|---------------|-----------|----------------------|----------------------|-----------|-----------|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 39750                | 40620     | 41490     |
|                 |            |               |           |                      | 2506.0MHz            | 2593.0MHz | 2680.0MHz |
| 20MHz           | QPSK       | 1             | 0         | 24.50                | 22.23                | 23.19     | 24.23     |
|                 |            |               | 50        | 25.00                | 22.78                | 23.93     | 24.63     |
|                 |            |               | 99        | 24.50                | 22.38                | 23.61     | 24.03     |
|                 |            | 50            | 0         | 24.00                | 21.63                | 22.68     | 23.57     |
|                 |            |               | 25        | 23.50                | 21.49                | 22.69     | 23.35     |
|                 |            |               | 50        | 23.50                | 21.55                | 22.70     | 23.23     |
|                 |            | 100           | 0         | 23.50                | 21.62                | 22.67     | 23.37     |
|                 | 16QAM      | 1             | 0         | 23.50                | 21.28                | 21.91     | 23.34     |
|                 |            |               | 50        | 23.50                | 21.85                | 22.52     | 23.39     |
|                 |            |               | 99        | 23.00                | 21.31                | 22.59     | 22.91     |
|                 |            | 50            | 0         | 23.00                | 20.57                | 21.61     | 22.52     |
|                 |            |               | 25        | 22.50                | 20.41                | 21.64     | 22.29     |
|                 |            |               | 50        | 22.50                | 20.40                | 21.65     | 22.12     |
|                 |            | 100           | 0         | 22.50                | 20.48                | 21.62     | 22.34     |

| LTE-FDD Band 66 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |           |           |
|-----------------|------------|---------------|-----------|----------------------|----------------------|-----------|-----------|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 132072               | 132322    | 132572    |
|                 |            |               |           |                      | 1720.0MHz            | 1745.0MHz | 1770.0MHz |
| 20MHz           | QPSK       | 1             | 0         | 20.50                | 19.26                | 19.98     | 20.44     |
|                 |            |               | 50        | 21.00                | 20.12                | 20.24     | 21.00     |
|                 |            |               | 99        | 20.50                | 20.06                | 20.12     | 20.08     |
|                 |            | 50            | 0         | 20.00                | 18.76                | 19.25     | 19.74     |
|                 |            |               | 25        | 20.00                | 19.03                | 19.22     | 19.71     |
|                 |            |               | 50        | 20.00                | 19.15                | 19.30     | 19.52     |
|                 |            | 100           | 0         | 20.00                | 18.96                | 19.26     | 19.61     |
|                 | 16QAM      | 1             | 0         | 20.00                | 18.15                | 18.92     | 19.56     |
|                 |            |               | 50        | 20.50                | 19.13                | 19.11     | 20.13     |
|                 |            |               | 99        | 20.00                | 19.23                | 18.91     | 19.58     |
|                 |            | 50            | 0         | 19.00                | 17.66                | 18.20     | 18.56     |
|                 |            |               | 25        | 19.00                | 17.98                | 18.17     | 18.56     |
|                 |            |               | 50        | 18.50                | 18.08                | 18.21     | 18.44     |
|                 |            | 100           | 0         | 19.00                | 17.89                | 18.21     | 18.51     |

| LTE-FDD Band 71 |            |               |           | Maximum Tune-up(dBm) | Conducted Power(dBm) |          |          |
|-----------------|------------|---------------|-----------|----------------------|----------------------|----------|----------|
| Bandwidth       | Modulation | RB allocation | RB offset |                      | 133222               | 133322   | 133372   |
|                 |            |               |           |                      | 673.0MHz             | 683.0MHz | 688.0MHz |
| 20MHz           | QPSK       | 1             | 0         | 23.50                | 23.26                | 23.25    | 23.20    |
|                 |            |               | 50        | 24.00                | 23.68                | 23.56    | 23.61    |
|                 |            |               | 99        | 23.50                | 23.29                | 23.33    | 23.48    |
|                 |            | 50            | 0         | 23.00                | 22.67                | 22.32    | 22.66    |
|                 |            |               | 25        | 23.00                | 22.62                | 22.47    | 22.50    |
|                 |            |               | 50        | 23.00                | 22.81                | 22.42    | 22.72    |
|                 |            | 100           | 0         | 23.00                | 22.70                | 22.35    | 22.67    |
|                 | 16QAM      | 1             | 0         | 23.00                | 22.59                | 22.23    | 21.99    |
|                 |            |               | 50        | 23.50                | 23.06                | 22.59    | 22.43    |
|                 |            |               | 99        | 23.00                | 22.65                | 22.33    | 22.24    |
|                 |            | 50            | 0         | 22.00                | 21.64                | 21.29    | 21.57    |
|                 |            |               | 25        | 22.00                | 21.55                | 21.42    | 21.48    |
|                 |            |               | 50        | 22.00                | 21.74                | 21.38    | 21.70    |
|                 |            | 100           | 0         | 22.00                | 21.68                | 21.34    | 21.66    |

## 9. Low-Power Exemption

### 9.1 Tune-up Power

| Mode        | Tune-up Power (dBm) |
|-------------|---------------------|
| GSM 850     | 32.00               |
| GSM 1900    | 26.00               |
| WCDMA II    | 23.00               |
| WCDMA IV    | 23.50               |
| WCDMA V     | 26.00               |
| LTE Band 2  | 22.00               |
| LTE Band 4  | 22.50               |
| LTE Band 5  | 24.50               |
| LTE Band 12 | 24.50               |
| LTE Band 13 | 24.50               |
| LTE Band 25 | 21.50               |
| LTE Band 41 | 25.00               |
| LTE Band 66 | 21.00               |
| LTE Band 71 | 24.00               |

### 9.2 RF Emissions Lower Power Exemption

| Mode        | Tune-up Power (dBm) | MIF   | Power + MIF(dB) | C63.19<br>Test Required? |
|-------------|---------------------|-------|-----------------|--------------------------|
| GSM 850     | 32.00               | 3.3   | 35.3            | Yes                      |
| GSM 1900    | 26.00               | 3.3   | 29.3            | Yes                      |
| WCDMA II    | 23.00               | -27.2 | -4.2            | No                       |
| WCDMA IV    | 23.50               | -27.2 | -3.7            | No                       |
| WCDMA V     | 26.00               | -27.2 | -1.2            | No                       |
| LTE Band 2  | 22.00               | -15.6 | 6.4             | No                       |
| LTE Band 4  | 22.50               | -15.6 | 6.9             | No                       |
| LTE Band 5  | 24.50               | -15.6 | 8.9             | No                       |
| LTE Band 12 | 24.50               | -15.6 | 8.9             | No                       |
| LTE Band 13 | 24.50               | -15.6 | 8.9             | No                       |
| LTE Band 25 | 21.50               | -15.6 | 5.9             | No                       |
| LTE Band 41 | 25.00               | -15.6 | 9.4             | No                       |
| LTE Band 66 | 21.00               | -15.6 | 5.4             | No                       |
| LTE Band 71 | 24.00               | -15.6 | 8.4             | No                       |

## 10. Test Equipment List

| Description                              | Manufacturer      | Model         | Serial No./Version | Cal. Date  | Cal. Due   |
|------------------------------------------|-------------------|---------------|--------------------|------------|------------|
| PC                                       | Dell              | N/A           | N/A                | N/A        | N/A        |
| Test Software                            | MVG               | N/A           | OpenHAC V5.1.3     | N/A        | N/A        |
| COMOHAC E-field Probe                    | MVG               | SCE           | 07/22 EPH50        | 2023/02/06 | 2024/02/05 |
| COMOHAC 800-950MHz<br>reference dipole   | MVG               | SIDB835       | 07/22 DHA69        | 2023/02/06 | 2024/02/05 |
| COMOHAC 1700-2000MHz<br>reference dipole | MVG               | SIDB1900      | 07/22 DHB70        | 2023/02/06 | 2024/02/05 |
| 6 1/2 Digital Multimeter                 | Keithley          | DMM6500       | 4527164            | 2022/11/24 | 2023/11/23 |
| MXG Vector Signal Generator              | Agilent           | N5182A        | MY46240163         | 2022/11/24 | 2023/11/23 |
| E-Series Avg. Power Sensor               | KEYSIGHT          | E9300A        | MY55050017         | 2023/03/24 | 2024/03/23 |
| EPM Series Power Meter                   | KEYSIGHT          | E4418B        | MY41293435         | 2023/03/24 | 2024/03/23 |
| 10DB Attenuator                          | MIDWEST MICROWAVE | 263-10dB      | /                  | 2023/03/24 | 2024/03/23 |
| Coupler                                  | MERRIMAC          | CWM-10R-10.8G | LOT-83391          | 2023/03/24 | 2024/03/23 |
| Wideband Radio Communication<br>Tester   | ROHDE & SCHWARZ   | CMW500        | 161997             | 2022/11/24 | 2023/11/23 |

## ANNEX A HAC RF System Validation Result

| E-Field Scan |                 |                  |                        |                      |               |           |
|--------------|-----------------|------------------|------------------------|----------------------|---------------|-----------|
| Mode         | Frequency (MHz) | Input Power (mW) | Measured Value (dBV/m) | Target Value (dBV/m) | Deviation (%) | Limit (%) |
| CW           | 835             | 100              | 215.88                 | 210.0                | -2.80         | ±25       |
| CW           | 1900            | 100              | 146.86                 | 146.1                | -0.52         | ±25       |

### System check at 835.00 MHz

Date of measurement: 7/7/2023

### Experimental Conditions

|                 |               |
|-----------------|---------------|
| Probe           | SN_0722_EPH50 |
| Signal          | CW            |
| Band            | CW835         |
| Channels        | middle        |
| Frequency (MHz) | 835.00        |

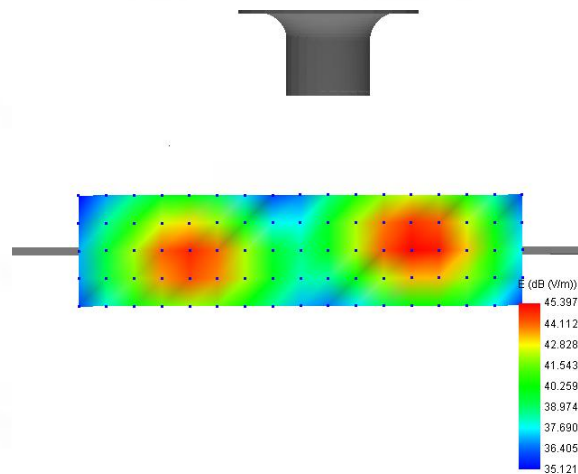
### Results

|                                 |        |
|---------------------------------|--------|
| E-field average [dB(V/m)]       | 215.88 |
| Right E-field maximum [dB(V/m)] | 215.56 |
| Left E-field maximum [dB(V/m)]  | 216.51 |

### Scan parameter

|                                              |              |
|----------------------------------------------|--------------|
| Scan area: length (mm), width (mm)           | 20.00, 80.00 |
| Measurement point spacing (mm)               | 5            |
| distance to reference plane (mm)             | 10.00        |
| X and Y offset with the reference point (mm) | 0.00, 0.00   |
| Number of measurement points                 | 85           |

### RF audio interference near field



## System check at 1900.00 MHz

Date of measurement: 7/7/2023

## Experimental Conditions

|                 |               |
|-----------------|---------------|
| Probe           | SN_0722_EPH50 |
| Signal          | CW            |
| Band            | CW1900        |
| Channels        | middle        |
| Frequency (MHz) | 1900.00       |

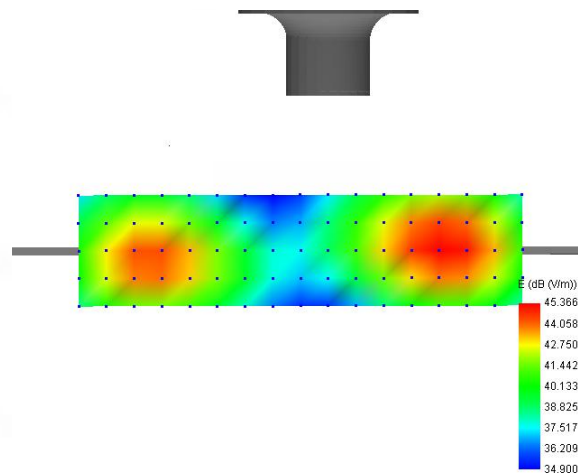
## Results

|                                 |        |
|---------------------------------|--------|
| E-field average [dB(V/m)]       | 146.86 |
| Right E-field maximum [dB(V/m)] | 146.32 |
| Left E-field maximum [dB(V/m)]  | 147.91 |

## Scan parameter

|                                              |              |
|----------------------------------------------|--------------|
| Scan area: length (mm), width (mm)           | 20.00, 80.00 |
| Measurement point spacing (mm)               | 5            |
| distance to reference plane (mm)             | 10.00        |
| X and Y offset with the reference point (mm) | 0.00, 0.00   |
| Number of measurement points                 | 85           |

## RF audio interference near field



## ANNEX B HAC RF Measurement Result

| Band    | Channel     | Frequency (MHz) | RF audio interference level [dB(V/m)] | Device compliant | Plot |
|---------|-------------|-----------------|---------------------------------------|------------------|------|
| GSM850  | Low (128)   | 824.2MHz        | 31.81                                 | Yes              | /    |
|         | Middle(190) | 836.6MHz        | 31.52                                 | Yes              | /    |
|         | High(251)   | 848.8MHz        | <b>32.05</b>                          | Yes              | 1#   |
| GSM1900 | Low (512)   | 1850.2MHz       | 23.35                                 | Yes              | /    |
|         | Middle(661) | 1880.0MHz       | 24.12                                 | Yes              | /    |
|         | High(810)   | 1909.8MHz       | <b>26.02</b>                          | Yes              | 2#   |

### Measurement at GSM850

Date of measurement: 7/7/2023

### Experimental Conditions

|                 |               |
|-----------------|---------------|
| Probe           | SN_0722_EPH50 |
| Signal          | GSM           |
| Band            | GSM850        |
| Channels        | high          |
| Channels Number | 251           |
| Frequency (MHz) | 848.80        |
| MIF             | 3.30          |

### Results

|                                                        |          |
|--------------------------------------------------------|----------|
| Maximum value of RF audio interference field [dB(V/m)] | 32.05    |
| Category                                               | M4       |
| Measurement status                                     | Complete |

### Grid visualisation

Legend:

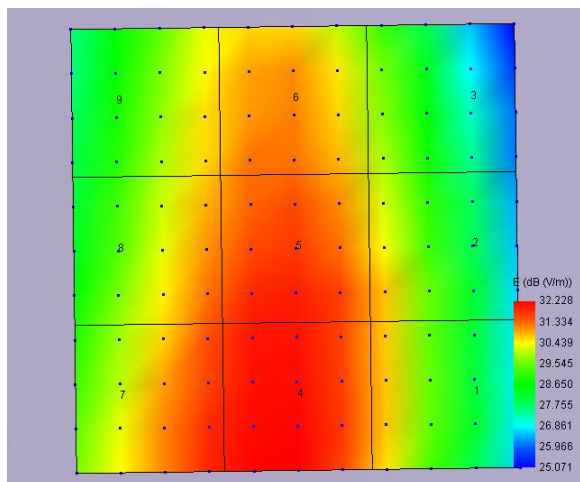
- Blue cells are excluded
- Red cell contains the maximum RF audio interference level

|                             |                             |                             |
|-----------------------------|-----------------------------|-----------------------------|
| Cell 1:<br>31.91<br>dB(V/m) | Cell 2:<br>31.36<br>dB(V/m) | Cell 3:<br>30.64<br>dB(V/m) |
| Cell 4:<br>32.28<br>dB(V/m) | Cell 5:<br>32.05<br>dB(V/m) | Cell 6:<br>31.31<br>dB(V/m) |
| Cell 7:<br>31.19<br>dB(V/m) | Cell 8:<br>31.20<br>dB(V/m) | Cell 9:<br>30.36<br>dB(V/m) |

### Scan parameter

|                                              |              |
|----------------------------------------------|--------------|
| Scan area: length (mm), width (mm)           | 50.00, 50.00 |
| Measurement point spacing (mm)               | 5            |
| distance to reference plane (mm)             | 15.00        |
| X and Y offset with the reference point (mm) | 0.00, 0.00   |
| Number of measurement points                 | 121          |

### RF audio interference near field



### Measurement at GSM1900

Date of measurement: 7/7/2023

### Experimental Conditions

|                 |               |
|-----------------|---------------|
| Probe           | SN_0722_EPH50 |
| Signal          | GSM           |
| Band            | GSM1900       |
| Channels        | high          |
| Channels Number | 810           |
| Frequency (MHz) | 1909.80       |
| MIF             | 3.30          |

### Results

|                                                        |          |
|--------------------------------------------------------|----------|
| Maximum value of RF audio interference field [dB(V/m)] | 26.02    |
| Category                                               | M4       |
| Measurement status                                     | Complete |

## Grid visualisation

Legend:

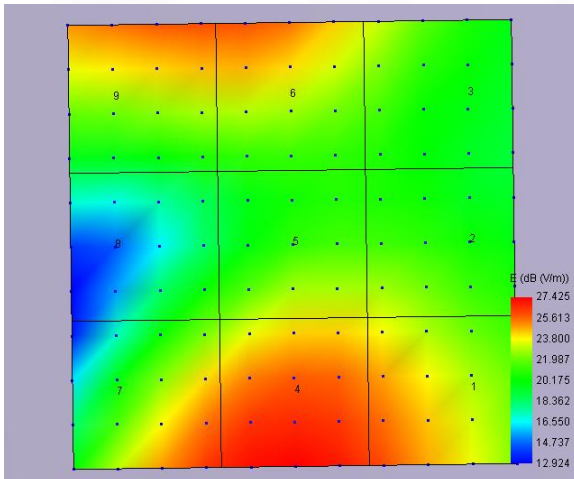
- Blue cells are excluded
- Red cell contains the maximum RF audio interference level

|                             |                             |                             |
|-----------------------------|-----------------------------|-----------------------------|
| Cell 1:<br>26.45<br>dB(V/m) | Cell 2:<br>21.13<br>dB(V/m) | Cell 3:<br>26.02<br>dB(V/m) |
| Cell 4:<br>27.43<br>dB(V/m) | Cell 5:<br>23.49<br>dB(V/m) | Cell 6:<br>26.02<br>dB(V/m) |
| Cell 7:<br>26.45<br>dB(V/m) | Cell 8:<br>23.29<br>dB(V/m) | Cell 9:<br>23.71<br>dB(V/m) |

## Scan parameter

|                                              |              |
|----------------------------------------------|--------------|
| Scan area: length (mm), width (mm)           | 50.00, 50.00 |
| Measurement point spacing (mm)               | 5            |
| distance to reference plane (mm)             | 15.00        |
| X and Y offset with the reference point (mm) | 0.00, 0.00   |
| Number of measurement points                 | 121          |

## RF audio interference near field



## ANNEX C Test Setup Photos



## ANNEX D EUT External & Internal Photos

Please refer to RF Report.

## ANNEX E Calibration Information

Please refer to the document "Calibration.pdf".

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**--END OF REPORT--**