



REPORT No.: SZ23040391S05

# Hearing Aid Compatibility (HAC) RF Emission Test Report

**APPLICANT** : Reliance Communications LLC  
**PRODUCT NAME** : Orbic Trophy 5G UW  
**MODEL NAME** : R667L5U  
**BRAND NAME** : Orbic  
**FCC ID** : 2ABGH-R667L5U  
**STANDARD(S)** : FCC 47 CFR Part 20 (20.19)  
ANSI C63.19-2019  
**RECEIPT DATE** : 2024-02-04  
**TEST DATE** : 2024-03-19  
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| Change History |            |                   |
|----------------|------------|-------------------|
| Version        | Date       | Reason for change |
| 1.0            | 2024-04-17 | First edition     |
|                |            |                   |



# 1. Statement of RF Emission

The lowest RF audio interference level found during test as bellows:

| Air Interface  | Frequency Band | RF <sub>AIL</sub> (dBm) |
|----------------|----------------|-------------------------|
| GSM CMRS Voice | GSM850         | 33.31                   |
|                | GSM1900        | 29.22                   |

**Note:**

1. This device is in compliance with compliance with RF<sub>AIL</sub> requirements specified in FCC 47 CFR Part 20.19 and tested in accordance with the measurement methods and procedures specified in ANSI C63.19-2019 and FCC KDB publications.
2. When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.



## 2. Technical Information

**Note:** Provide by applicant.

### 2.1. Applicant and Manufacturer Information

|                              |                                                                                          |
|------------------------------|------------------------------------------------------------------------------------------|
| <b>Applicant:</b>            | Reliance Communications LLC                                                              |
| <b>Applicant Address:</b>    | 555 Wireless Blvd. Hauppauge, NY 11788, USA                                              |
| <b>Manufacturer:</b>         | Unimaxcomm                                                                               |
| <b>Manufacturer Address:</b> | 35F,HBC HuiLong Center Building-II Minzhi Street,Longhua,<br>Shenzhen, P.R. China 518110 |

### 2.2. Equipment under Test (EUT) Description

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Product Name:</b>     | Orbic Trophy 5G UW                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>EUT IMEI:</b>         | 351352440026300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Hardware Version:</b> | V1.0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Software Version:</b> | R667L5U_v1.1.2_BVZ                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Frequency Bands:</b>  | GSM 850: 824 MHz ~ 849 MHz<br>GSM 1900: 1850 MHz ~ 1910 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 48: 3550 MHz ~ 3700 MHz<br>LTE Band 66: 1710 MHz ~ 1780 MHz<br>5G NR n2 (NSA): 1850 MHz ~ 1910 MHz<br>5G NR n5 (NSA): 824 MHz ~ 849 MHz<br>5G NR n66 (NSA): 1710 MHz ~ 1780 MHz<br>5G NR n77 (NSA): 3450 MHz ~ 3550 MHz; 3700 MHz ~ 3980 MHz<br>WLAN 2.4GHz: 2412 MHz ~ 2462 MHz<br>WLAN 5.2GHz: 5180 MHz ~ 5240 MHz<br>WLAN 5.3GHz: 5260 MHz ~ 5320 MHz<br>WLAN 5.5GHz: 5500 MHz ~ 5720 MHz<br>WLAN 5.8GHz: 5745 MHz ~ 5825 MHz |



|                               |                                                                                                                                                                                                                                                                                                                                 |                      |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
|                               | Bluetooth: 2402 MHz ~ 2480 MHz<br>NFC: 13.56 MHz                                                                                                                                                                                                                                                                                |                      |
| <b>Modulation Mode:</b>       | GSM/GPRS: GMSK<br>EDGE: 8PSK<br>WCDMA: QPSK, 16QAM<br>LTE: QPSK, 16QAM, 64QAM<br>5G NR: DFT-s-OFDM/CP-OFDM, PI/2 BPSK<br>QPSK, 16QAM, 64QAM, 256QAM<br>802.11b: DSSS<br>802.11a/g/n-HT20/HT40/ac-VHT20/40/80: OFDM<br>BR+EDR: GFSK(1Mbps), $\pi/4$ -DQPSK(2Mbps), 8-DPSK(3Mbps)<br>Bluetooth LE: GFSK(1Mbps, 2Mbps)<br>NFC: ASK |                      |
| <b>Antenna type:</b>          | WWAN: PIFA Antenna<br>WLAN: PIFA Antenna<br>Bluetooth: PIFA Antenna<br>NFC: Loop Antenna                                                                                                                                                                                                                                        |                      |
| <b>VoLTE Mode:</b>            | Support                                                                                                                                                                                                                                                                                                                         |                      |
| <b>VoWi-Fi Mode:</b>          | Support                                                                                                                                                                                                                                                                                                                         |                      |
| <b>SIM Cards Description:</b> | SIM 1                                                                                                                                                                                                                                                                                                                           | GSM+WCDMA +LTE+5G NR |
|                               | SIM 2                                                                                                                                                                                                                                                                                                                           | GSM+WCDMA +LTE+5G NR |
|                               | For dual SIM card version, both the SIM 1 and SIM 2 are the same chipset unit and tested as a single chipset, the SIM 1 was selected for testing.                                                                                                                                                                               |                      |

**Note:** For more detailed description, please refer to specification or user manual supplied by the applicant and/or manufacturer.



## 2.3. Photographs of the EUT

**Note:** Please refer to the External Photos for the Photos of the EUT

## 2.4. Applied Reference Documents

**Leading reference documents for testing:**

| Identity                   | Document Title                                                                                                              | Method determination /Remark |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------|------------------------------|
| FCC 47 CFR Part 20 (20.19) | Hearing aid-compatible mobile handsets                                                                                      | No deviation                 |
| ANSI C63.19-2019           | American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids | No deviation                 |
| KDB 285076 D01v06r04       | HAC Guidance                                                                                                                | No deviation                 |

### 3. Air Interface and Operating Mode

| Air Interface     | Band            | Transport Type | Simultaneous Transmitter | Name of Voice Service | Power Reduction |
|-------------------|-----------------|----------------|--------------------------|-----------------------|-----------------|
| GSM               | GSM850          | VO             | WLAN, BT                 | CMRS Voice            | No              |
|                   | GSM1900         |                |                          |                       | No              |
| WCDMA (UMTS)      | Band II         | VO             | WLAN, BT                 | CMRS Voice            | No              |
|                   | Band IV         |                |                          |                       | No              |
|                   | Band V          |                |                          |                       | No              |
| FDD-LTE & TDD-LTE | Band 2          | VD             | WLAN, BT                 | VoLTE                 | No              |
|                   | Band 4          |                |                          |                       | No              |
|                   | Band 5          |                |                          |                       | No              |
|                   | Band 7          |                |                          |                       | No              |
|                   | Band 12         |                |                          |                       | No              |
|                   | Band 13         |                |                          |                       | No              |
|                   | Band 48         |                |                          |                       | No              |
|                   | Band 66         |                |                          |                       | No              |
| 5G NR             | n2 (NSA)        | DT             | WLAN, BT                 | N/A                   | No              |
|                   | n5 (NSA)        |                |                          |                       | No              |
|                   | n66 (NSA)       |                |                          |                       | No              |
|                   | n77 (NSA)       |                |                          |                       | No              |
| WiFi              | 2450            | VD             | GSM, UMTS, LTE, 5G NR    | VoWiFi                | No              |
|                   | 5200 (U-NII-1)  |                |                          |                       | No              |
|                   | 5300 (U-NII-2A) |                |                          |                       | No              |
|                   | 5500 (U-NII-2C) |                |                          |                       | No              |
|                   | 5800 (U-NII-3)  |                |                          |                       | No              |
| BT                | 2450            | DT             | GSM, UMTS, LTE, 5G NR    | N/A                   | No              |

**Note:**

- 1) Air Interface/Band MHz: List of all air interfaces and bands supported by the handset.
- 2) Type: For each air interface, indicate the type of voice transport mode:
  - i. VO = legacy Cellular Voice Service, from ANSI C63.19-2019;
  - ii. DT = Digital Transport only (no voice); and
  - iii. VD = IP Voice Service over Digital Transport.
- 3) Simultaneous Transmitter: Indicate any air interface/bands that operate in simultaneous or



concurrent service transmission mode.

- 4) Name of Voice Service: See Q4 in 285076 D03 HAC FAQ for further clarification.
- 5) Power Reduction: If the 1900 MHz band GSM air interface was tested using the option to reduce the power, state in the test report the maximum power in the 1900 MHz band, and the reduced power used for testing compliance to demonstrate compliance to the requirement that power be reduced by no more than 2.5 dB.

## 4. WD Emission Requirements

According to ANSI C63.19-2019, the WD's conducted power must be at or below either the stated  $RF_{AIPL}$  (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  $RF_{AIL}$  (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<br>(MHz)                                    | $RF_{AIPL}$<br>(dBm) |
| <960                                                        | 29                   |
| 960–2000                                                    | 26                   |
| >2000                                                       | 25                   |

| Table 4.2—Wireless device RF peak power level |                             |
|-----------------------------------------------|-----------------------------|
| Frequency Range<br>(MHz)                      | $RF_{Peak\ Power}$<br>(dBm) |
| <960                                          | 35                          |
| 960–2000                                      | 32                          |
| >2000                                         | 31                          |

| Table 4.3—Wireless device RF audio interference level |                     |
|-------------------------------------------------------|---------------------|
| Frequency Range<br>(MHz)                              | $RF_{AIL}$<br>(dBm) |
| <960                                                  | 39                  |
| 960–2000                                              | 36                  |
| >2000                                                 | 35                  |

| Table 4.4—Wireless device RF peak near-field level |                          |
|----------------------------------------------------|--------------------------|
| Frequency Range<br>(MHz)                           | $RF_{Peak}$<br>[dB(V/m)] |
| <960                                               | 45                       |
| 960–2000                                           | 42                       |
| >2000                                              | 41                       |

## 5. HAC (RF) Measurement System

### 5.1. RF Measurement Setup

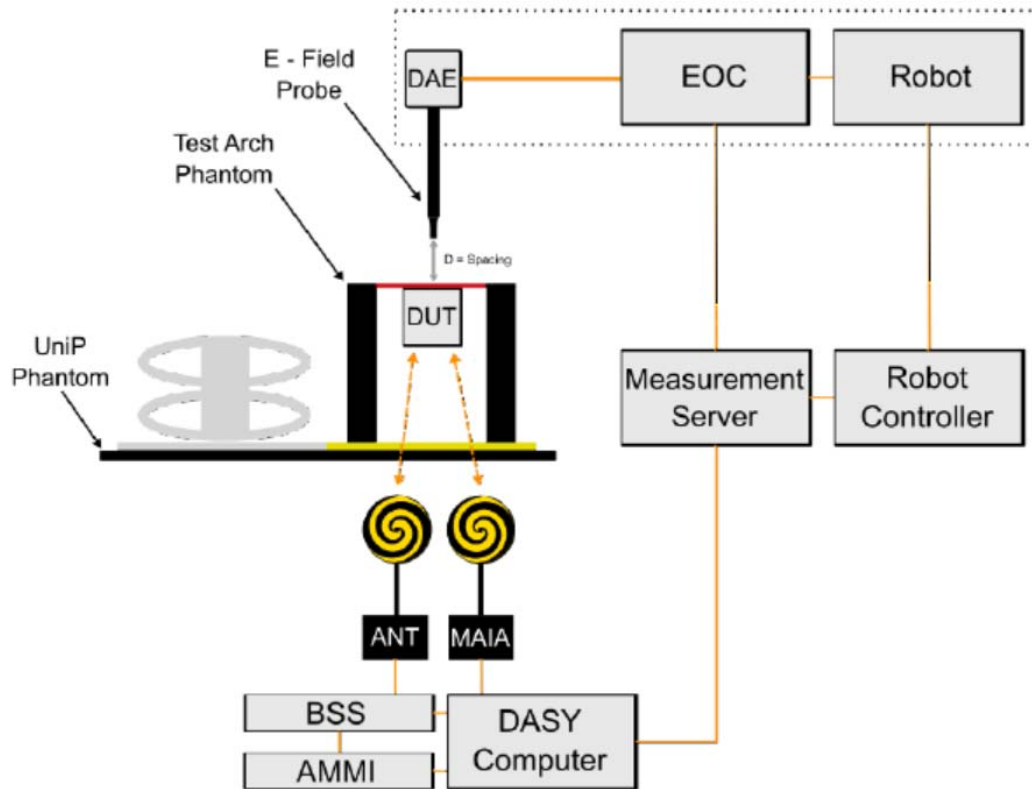


Fig 5.1 Typical DASY6/8 setup for HAC RF signal test

## 5.2. E-Field Probe

The RF measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use with high permittivity. The dosimetric probe has special calibration at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

### E-Field Probe Specification

#### <ER3DV6>

|               |                                                                                                                              |                                                                                      |
|---------------|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Construction  | One dipole parallel, two dipoles normal to probe axis<br>Built-in shielding against static charges                           |  |
| Calibration   | In air from 100 MHz to 3.0 GHz<br>(Absolute accuracy $\pm 6.0\%$ , $k=2$ )                                                   |                                                                                      |
| Frequency     | 10 MHz to 6 GHz; Linearity: $\pm 0.2$ dB                                                                                     |                                                                                      |
| Directivity   | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.4$ dB in HSL (rotation normal to probe axis)                      |                                                                                      |
| Dynamic Range | 2 V/m to 1000 V/m<br>(M3 or better device readings fall well below diode compression point)                                  |                                                                                      |
| Linearity     | $\pm 0.2$ dB                                                                                                                 |                                                                                      |
| Dimensions    | Overall length: 330 mm (Tip: 16 mm)<br>Tip diameter: 8 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.5 mm |                                                                                      |

Fig 5.2 Photo of ER3DV6

#### Probe Tip Description:

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

### <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:

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

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

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

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

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  $V_{\text{idB}\sqrt{\mu\text{V}}}$  is the linearized voltage in  $\text{dB}\sqrt{\mu\text{V}}$

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

Where  $V_{\text{idB}\sqrt{\mu\text{V}}}$  = 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  $\mu\text{V}$ :

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

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

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

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

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

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

where     n = the number of measurement grid point  
          E<sub>i</sub> = the E-field measured at point i.

**<RFail Calculation>**

The RFail is finally computed with

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

Where     RFail = the Radio Frequency Audio Interference Level in dB(V/m)  
          E<sub>avg</sub> = the averaged E-field in (V/m) calculated  
          MIF = the Modulation Interference Factor in dB.

### 5.3. Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



**Fig 5.3 Photo of DAE**

## 6. RF Emission Measurement Procedure

### 6.1. Test Procedure: Direct Measurement—Alternative

The following methods are example step-by-step test procedures. Other comparable procedures may be used. Either manual or automatic test procedures may be used. The automated test procedure is preferred.

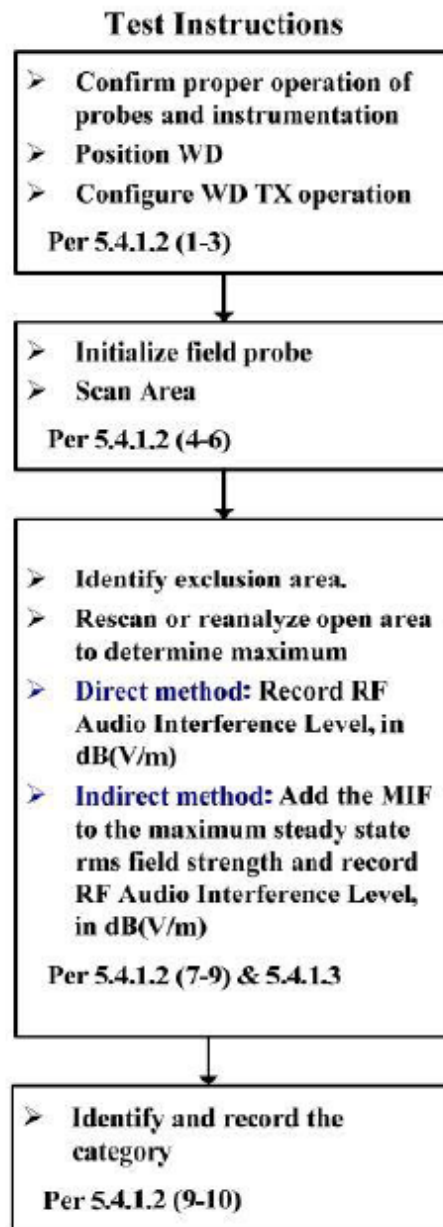
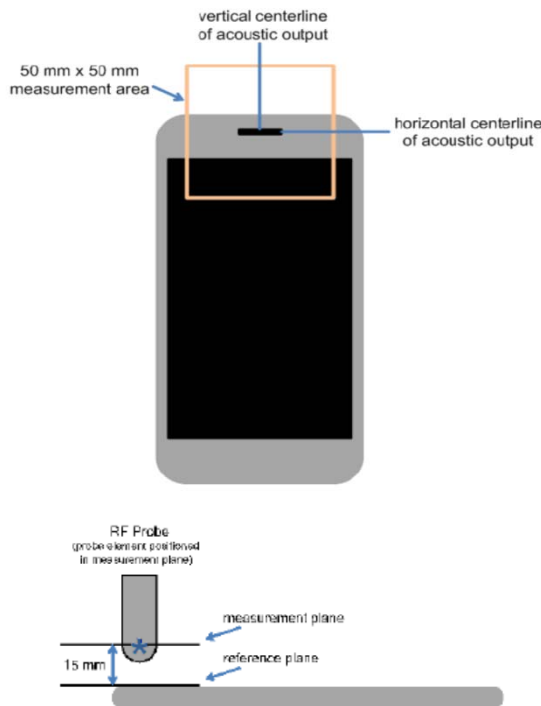
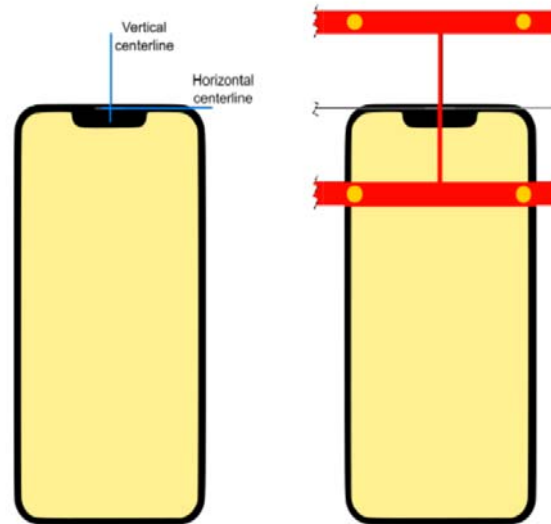


Fig 6.1 WD near-field emission scan flowchart



**Fig 6.2 WD measurement and reference planes for RF emission measurements**



**Fig 6.3 Device Under Test Positioning under the Test Arch**

## 6.2. Test Procedure: Indirect Measurement—Preferred

1. Confirm the proper operation of the field probe, probe measurement system, and other instrumentation and the positioning system.
2. Position the WD in its intended test position. A gauge block, depicted in A.1.2, can simplify this positioning.
3. Set the WD to transmit a fixed and repeatable combination of signal power and modulation characteristic that is representative of the worst case (highest interference potential) encountered in normal use. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration. Transiently occurring start-up, changeover, or termination conditions, or other operations likely to occur less than 1% of the time during normal operation, may be excluded from consideration.
4. The measurement area shall be centered on the acoustic output or the T-Coil mode measurement reference point, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm measurement area, which is contained in the measurement plane, described in 4.5.2 and illustrated in Figure A.1. If the field alignment method is used, align the probe for maximum field reception.



5. Record the reading at the output of the measurement system.
6. Scan the entire 50 mm by 50 mm 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 4.5.3.
7. Calculate the average of the measurements taken in Step 6.
8. Convert the average value found in Step g) 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 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:

$$\text{RF audio interference level in db (V/m)} = 20 \cdot \log (R_{\text{ave}}^{1/2} / \text{TF})$$

Where  $R_{\text{ave}}$  is the average reading

9. Compare this RF audio interference level to the limits in 4.7 of ANSI C63.19-2019 and record the result.



## 7. Test Equipment List

| Manufacturer  | Name of Equipment                     | Type/Model | Serial Number | Calibration |            |
|---------------|---------------------------------------|------------|---------------|-------------|------------|
|               |                                       |            |               | Last Cal.   | Due Date   |
| SPEAG         | DOSIMETRIC ASSESSMENT SYSTEM Software | cDASY6 HAC | V1.2          | NCR         | NCR        |
| SPEAG         | Isotropic E-Field Probe               | ER3DV6     | 2434          | 2024.02.17  | 2025.02.16 |
| SPEAG         | Audio Holder                          | N/A        | 1094          | NCR         | NCR        |
| SPEAG         | 835MHz Calibration Dipole             | CD835V3    | 1113          | 2021.10.23  | 2024.10.22 |
| SPEAG         | 1880MHz Calibration Dipole            | CD1880V3   | 1111          | 2021.10.23  | 2024.10.22 |
| SPEAG         | Data Acquisition Electronics          | DAE4       | 480           | 2023.09.19  | 2024.09.18 |
| SPEAG         | Test Arch Phantom                     | N/A        | N/A           | NCR         | NCR        |
| SPEAG         | Phone Positioner                      | N/A        | N/A           | NCR         | NCR        |
| R&S           | Power Sensor                          | NRP8S      | 103215        | 2024.01.25  | 2025.01.24 |
| Agilent       | Power Meter                           | E4416A     | MY45102093    | 2023.09.19  | 2024.09.18 |
| R&S           | Power Sensor                          | NRP8S      | 103240        | 2024.01.25  | 2025.01.24 |
| Anritsu       | Power Meter                           | E4418B     | GB43318055    | 2023.06.21  | 2024.06.20 |
| Agilent       | Signal Generator                      | N5182B     | MY53050509    | 2023.09.19  | 2024.09.18 |
| R&S           | Base Station                          | CMU200     | 107082        | 2023.06.21  | 2024.06.20 |
| R&S           | Base Station                          | CMW500     | 165755        | 2024.01.25  | 2025.01.24 |
| PASTERNAK     | Dual Directional Coupler              | PE2214-10  | N/A           | NA          | NA         |
| Woken         | Attenuator                            | WK0602-XX  | N/A           | NA          | NA         |
| Mini-Circuits | Power Amplifier                       | ZHL-42W+   | 608501717     | NCR         | NCR        |

## 8. 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.

### 8.1. Test setup

1. In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator.
2. Position the E-field probe at a 15 mm distance from the top surface of the dipole, which is also fixed in an appropriate fixture.
3. Make sure that the desired measuring channel of the probe is aligned for maximum reception of the E-field generated by the dipole. This may be accomplished by rotating the probe until the maximum value is located. The E-field probe shall have been calibrated over the frequency range to be measured using standard calibration techniques.
4. Adjust the power level (20dBm→100mW) of the signal generator at the initial starting frequency such that the desired E-field strength at the 15 mm distance from the tip of the dipole is achieved. Setting the field strength to be in the range of category M2 is advised.
5. Step the frequency in increments of  $\leq 1\%$ , adjusting the power fed into the dipole such that the desired E-field strength is maintained.

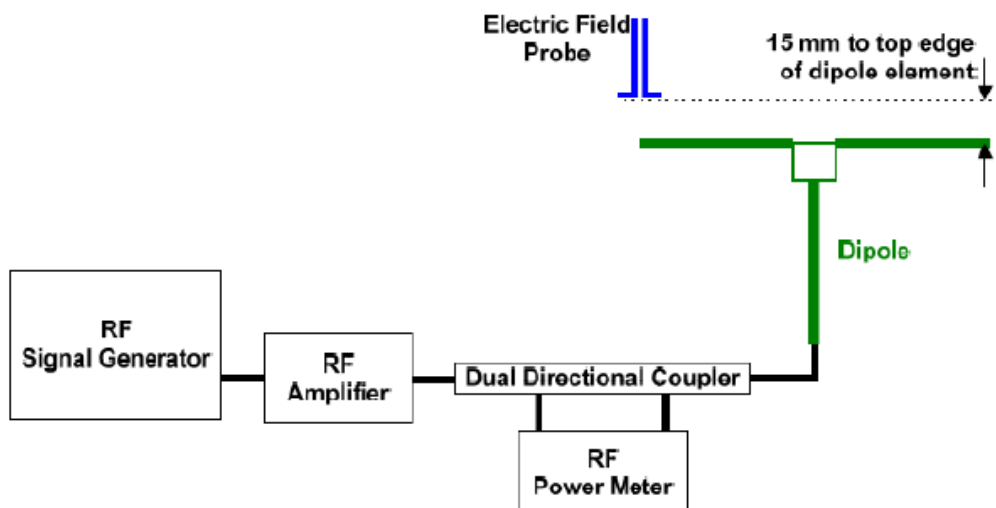


Fig 8.1 WD dipole calibration procedure



## 8.2. Validation Result

After testing, record the frequency and signal generator setting at each frequency for use during the actual immunity test. Comparing to the original E-field value provided by SPEAG, the verification data should be within its specification of 25 %. Table 6.1 shows the target value and measured value. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to appendix A of this report. Deviation = ((Average E-field Value) - (Target value)) / (Target value) \* 100%

| Frequency<br>(MHz) | Input Power<br>(mW) | Target Value<br>(V/m) | E <sub>max</sub><br>(V/m) | Deviation<br>(%) | Limit<br>(%) | Date       |
|--------------------|---------------------|-----------------------|---------------------------|------------------|--------------|------------|
| 835                | 100                 | 110.8                 | 109                       | -1.62            | ±12.8        | 2024.03.19 |
| 1880               | 100                 | 89.5                  | 98.1                      | 9.61             | ±12.8        | 2024.03.19 |

## 9. 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.

1. 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.
2. 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.
3. Measure the steady-state rms level at the output of the fast probe or sensor.
4. Measure the steady-state average level at the weighting output.
5. 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.
6. 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.
7. The MIF for the specific modulation characteristic is given by the ratio of the Step 6 measurement to the Step 3 measurement, expressed in decibels ( $20 \cdot \log(\text{step 6}/\text{step 3})$ ).

In practice, Step 5 and Step 6 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.

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 Low-power Exemption.



| UID   | Communication System Name                         | MIF(dB) |
|-------|---------------------------------------------------|---------|
| 10021 | GSM-FDD(TDMA,GMSK)                                | 3.63    |
| 10025 | EDGE-FDD (TDMA, 8PSK, TN 0)                       | 3.75    |
| 10460 | UMTS-FDD(WCDMA, AMR)                              | -25.43  |
| 10225 | UMTS-FDD (HSPA+)                                  | -20.39  |
| 10081 | CDMA2000 (1xRTT, RC3 Full Rate)                   | -19.71  |
| 10295 | CDMA2000 (1xRTT, RC1 SO3, 1/8th Rate 25 fr.)      | 3.26    |
| 10403 | CDMA2000 (1xEV-DO)                                | -17.67  |
| 10169 | LTE-FDD(SC-FDMA,1RB,20MHz,QPSK)                   | -15.63  |
| 10170 | LTE-FDD(SC-FDMA,1RB,20MHz,16-QAM)                 | -9.76   |
| 10179 | LTE-FDD(SC-FDMA,1RB,20MHz,64-QAM)                 | -9.93   |
| 10181 | LTE-FDD(SC-FDMA,1RB,15MHz,QPSK)                   | -15.63  |
| 10175 | LTE-FDD(SC-FDMA,1RB,10MHz,QPSK)                   | -15.63  |
| 10177 | LTE-FDD(SC-FDMA,1RB,5MHz,QPSK)                    | -15.63  |
| 10184 | LTE-FDD(SC-FDMA,1RB,3MHz,QPSK)                    | -15.62  |
| 10187 | LTE-FDD(SC-FDMA,1RB,1.4MHz,QPSK)                  | -15.62  |
| 10172 | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK)             | -1.62   |
| 10173 | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)           | -1.44   |
| 10174 | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 64-QAM)           | -1.54   |
| 10240 | LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK)             | -1.62   |
| 10237 | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK)             | -1.62   |
| 10234 | LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK)              | -1.62   |
| 10231 | LTE-TDD (SC-FDMA, 1 RB, 3 MHz, QPSK)              | -1.62   |
| 10228 | LTE-TDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)            | -1.62   |
| 10061 | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)         | -2.02   |
| 10077 | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)    | 0.12    |
| 10427 | IEEE 802.11n (HT Greeneld, 150 Mbps, 64-QAM)      | -13.44  |
| 10069 | IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)         | -3.15   |
| 10616 | IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle) | -5.57   |

## 10. RF Audio Interference Power Level Evaluation

### ➤ General Guidance

1. The maximum conducted power including tune-up limit of each air interface will be used to plusing the MIF and evaluating whether it complies with the  $RF_{AIPL}$  requirements defined in ANSI C63.19-2019 section 4.7 Table 4.1, or the RF Emission should be measured and the test results complies with RF audio interference level requirements of Table 4.3.
2. The EDGE mode is not required since it is less than the GSM Voice mode for the conducted power including tune-up limit.
3. When the results that the maximum conducted power each air interface plus MIF complies with the  $RF_{AIPL}$  requirements, means it complies with the WD emission requirements per ANSI C63.19-2019.
4. The maximum power of higher frequency bands of FDD-LTE and TDD-LTE will be used to determining the  $RF_{AIPL}$ .
5. The maximum power including tune-up limit of each air interface was recorded in SAR report SZ23040391S01.

### ➤ $RF_{AIPL}$ Evaluation

#### <WWAN>

| Air Interface | Max Tune-up Limit (dBm) | Worst Case MIF (dB) | Power + MIF(dB) | Lowest $RF_{AIPL}$ (dBm) | C63.19 Test Required |
|---------------|-------------------------|---------------------|-----------------|--------------------------|----------------------|
| GSM 850       | 32.70                   | 3.63                | 36.33           | 29                       | Yes                  |
| GSM 1900      | 30.50                   | 3.63                | 34.13           | 26                       | Yes                  |
| UMTS          | 25.30                   | -25.43              | -0.13           | 26                       | No                   |
| FDD - LTE     | 24.80                   | -9.76               | 15.04           | 25                       | No                   |
| TDD - LTE     | 22.80                   | -1.62               | 21.18           | 25                       | No                   |

#### <WWAN>

| Air Interface  | Max Tune-up Limit (dBm) | Worst Case MIF (dB) | Power + MIF(dB) | Lowest $RF_{AIPL}$ (dBm) | C63.19 Test Required |
|----------------|-------------------------|---------------------|-----------------|--------------------------|----------------------|
| 802.11b        | 18.00                   | -2.02               | 15.98           | 25                       | No                   |
| 802.11g        | 17.00                   | 0.12                | 17.12           | 25                       | No                   |
| 802.11n-HT20   | 19.00                   | -13.44              | 5.56            | 25                       | No                   |
| 802.11n-HT40   | 19.50                   | -13.44              | 6.06            | 25                       | No                   |
| 802.11a        | 18.50                   | -3.15               | 15.35           | 25                       | No                   |
| 802.11n-HT20   | 19.50                   | -13.44              | 6.06            | 25                       | No                   |
| 802.11n-HT40   | 20.00                   | -13.44              | 6.56            | 25                       | No                   |
| 802.11ac-VHT20 | 19.50                   | -5.57               | 13.93           | 25                       | No                   |



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|                |       |       |       |    |    |
|----------------|-------|-------|-------|----|----|
| 802.11ac-VHT40 | 20.50 | -5.57 | 14.93 | 25 | No |
| 802.11ac-VHT80 | 20.50 | -5.57 | 14.93 | 25 | No |



## 11. Summary Test Results

### ➤ General Guidance

This device was tested under the maximum volume, backlight off and mute on.

### ➤ RF<sub>AIL</sub> Test Results

| Plot No. | Air Interface | Mode      | Channel | RF <sub>AIL</sub> (dB V/m) | Verdict |
|----------|---------------|-----------|---------|----------------------------|---------|
|          | GSM850        | GSM Voice | 128     | 33.34                      | PASS    |
|          | GSM850        | GSM Voice | 189     | 34.78                      | PASS    |
|          | GSM850        | GSM Voice | 251     | 33.31                      | PASS    |
|          |               |           |         |                            |         |
|          | GSM1900       | GSM Voice | 512     | 29.23                      | PASS    |
|          | GSM1900       | GSM Voice | 661     | 29.22                      | PASS    |
|          | GSM1900       | GSM Voice | 810     | 29.23                      | PASS    |

## 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 observations 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 %.



| HAC Uncertainty Budget For ANSI C63.19-2019<br>600 - 6000 MHz, Scanning distance 15mm |                        |                |       |          |                                 |
|---------------------------------------------------------------------------------------|------------------------|----------------|-------|----------|---------------------------------|
| Error Description                                                                     | Uncertainty Value (±%) | Probe Distance | Div.  | (Ci) Eav | Standard Uncertainty (Eav) (±%) |
| <b>Measurement System</b>                                                             |                        |                |       |          |                                 |
| Probe Calibration                                                                     | 5.1                    | N              | 1     | 1        | 5.1                             |
| Axial Isotropy                                                                        | 4.7                    | R              | 1.732 | 1        | 2.7                             |
| Sensor Displacement                                                                   | 7.2                    | R              | 1.732 | 0.5      | 2.1                             |
| Boundary Effects                                                                      | 2.4                    | R              | 1.732 | 1        | 1.4                             |
| Phantom Boundary Effect                                                               | 7.2                    | R              | 1.732 | 1        | 4.2                             |
| Probe Linearity                                                                       | 4.7                    | R              | 1.732 | 1        | 2.7                             |
| Scaling to Peak Power with MIF                                                        | 10.0                   | R              | 1.732 | 1        | 5.8                             |
| System Detection Limit                                                                | 1.0                    | R              | 1.732 | 1        | 0.6                             |
| Readout Electronics                                                                   | 0.3                    | N              | 1     | 1        | 0.3                             |
| Response Time                                                                         | 0.8                    | R              | 1.732 | 0        | 0                               |
| Integration Time                                                                      | 0.8                    | R              | 1.732 | 0        | 0                               |
| RF Ambient Conditions                                                                 | 2.6                    | R              | 1.732 | 1        | 1.7                             |
| RF Reflections                                                                        | 3.0                    | R              | 1.732 | 1        | 6.9                             |
| RF Reflections                                                                        | 12.2                   | R              | 1.732 | 1        | 6.9                             |
| Probe Positioner                                                                      | 1.2                    | R              | 1.732 | 1        | 0.7                             |
| Probe Positioning                                                                     | 3.0                    | R              | 1.732 | 1        | 1.7                             |
| Extrapolation and Interpolation                                                       | 1.0                    | R              | 1.732 | 1        | 0.6                             |
| <b>Test Sample Related</b>                                                            |                        |                |       |          |                                 |
| Device Positioning Vertical                                                           | 4.7                    | R              | 1.732 | 1        | 2.7                             |
| Device Positioning Lateral                                                            | 1.0                    | R              | 1.732 | 1        | 0.6                             |
| Device Holder and Phantom                                                             | 2.4                    | R              | 1.732 | 1        | 1.4                             |
| Power Drift                                                                           | 5.0                    | R              | 1.732 | 1        | 2.9                             |
| <b>Phantom and Setup Related</b>                                                      |                        |                |       |          |                                 |
| Phantom Thickness                                                                     | 2.4                    | R              |       |          |                                 |
| Combined Std. Uncertainty                                                             |                        |                |       |          | 13.2                            |
| <b>Expanded Std. Uncertainty on Power</b>                                             |                        |                |       |          | 26.4                            |
| <b>Expanded Std. Uncertainty on Field</b>                                             |                        |                |       |          | 13.2                            |



## Annex A General Information

### 1. Identification of the Responsible Testing Laboratory

|                     |                                                                                                                                          |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Laboratory Name:    | Shenzhen Morlab Communications Technology Co., Ltd.                                                                                      |
| Laboratory Address: | FL.1-3, Building A, FeiYang Science Park, No.8<br>LongChang Road, Block 67, BaoAn District, ShenZhen,<br>GuangDong Province, P. R. China |
| Telephone:          | +86 755 36698555                                                                                                                         |
| Facsimile:          | +86 755 36698525                                                                                                                         |

### 2. Identification of the Responsible Testing Location

|          |                                                                                                                                          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------|
| Name:    | Shenzhen Morlab Communications Technology Co., Ltd.                                                                                      |
| Address: | FL.1-3, Building A, FeiYang Science Park, No.8<br>LongChang Road, Block 67, BaoAn District, ShenZhen,<br>GuangDong Province, P. R. China |



## **Annex B Test Setup Photos**

The annex B will be submitted separately.

## **Annex C Plots of Performance System Check**

The annex C will be submitted separately.

## **Annex D Plots of RF Emission**

The annex D will be submitted separately.

## **Annex E DASY Calibration Certificate**

The annex E will be submitted separately.

\*\*\*\*\* END OF MAIN REPORT \*\*\*\*\*