

## HAC RF Emission TEST REPORT

**Applicant Name:**

**SAMSUNG Electronics Co., Ltd.**

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**Date of Issue:** 09. 18, 2018

**Test Report No.:** HCT-SR-1809-FC007-R2

**Test Site:** HCT CO., LTD.

**FCC ID:**

**A3LSMJ410G**

**Equipment Type:**

**Mobile Phone**

**Application Type**

**Certification**

**FCC Rule Part(s):**

**CFR §20.19 , ANSI C63.19-2011**

**Model Name:**

**SM-J410G/DS**

**Date of Test:**

**09/10/2018 ~ 09/12/2018**

**C63.19-2011  
HAC Category**

**M4 (RF EMISSION CATEGORY)**

This wireless portable device has been shown to be hearing-aid compatible under the above rated category, specified in ANSI/IEEE Std. C63.19-2011 and had been tested in accordance with the specified measurement procedures. Hearing-Aid Compatibility is based on the assumption that all production units will be designed electrically identical to the device tested in this report.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

**Tested By**



**Reviewed By**



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## **DOCUMENT HISTORY**

| Rev.                 | DATE         | DESCRIPTION           |
|----------------------|--------------|-----------------------|
| HCT-SR-1809-FC007    | 09. 13, 2018 | First Approval Report |
| HCT-SR-1809-FC007-R1 | 09. 17, 2018 | Sec.8.4 was revised.  |
| HCT-SR-1809-FC007-R2 | 09. 17, 2018 | Sec.8.3 was revised   |

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## 1. ATTESTATION OF TEST RESULT OF DEVICE UNDER TEST

| Test Laboratory |                                                                                          |
|-----------------|------------------------------------------------------------------------------------------|
| Company Name:   | HCT Co., LTD                                                                             |
| Address:        | 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of Korea |
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| Attestation of SAR test result |                               |
|--------------------------------|-------------------------------|
| Applicant Name:                | SAMSUNG Electronics Co., Ltd. |
| FCC ID:                        | A3LSMJ410G                    |
| Model:                         | SM-J410G/DS                   |
| Additional FCC Model(s):       | SM-J410G                      |
| EUT Type:                      | Mobile Phone                  |
| Application Type:              | Certification                 |

### 1.1 Test Methodology

The Tests document in this report were performed in accordance with ANSI C63.19-2011 method of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids, FCC published KDB 285076 D01 HAC Guidance v05, FCC Published KDB285076 D03 HAC FAQ v01 and TCB Workshop updates .

## 2. DEVICE UNDER TEST DESCRIPTION

### 2.1 DUT specification

| Device Wireless specification overview |                                                                                                          |                       |
|----------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------|
| Band & Mode                            | Operating Mode                                                                                           | Tx Frequency          |
| GSM 850                                | Voice / Data                                                                                             | 824.2 ~ 848.8 MHz     |
| GSM 1900                               | Voice / Data                                                                                             | 1 850.2 ~ 1 909.8 MHz |
| UMTS 850                               | Voice / Data                                                                                             | 826.4 ~ 846.6 MHz     |
| UMTS 1700                              | Voice / Data                                                                                             | 1 712.4 ~ 1 752.6 MHz |
| UMTS 1900                              | Voice / Data                                                                                             | 1 852.4 ~ 1 907.6 MHz |
| LTE Band 2 (PCS)                       | Voice / Data                                                                                             | 1 850.7 ~ 1 909.3 MHz |
| LTE Band 4 (AWS)                       | Voice / Data                                                                                             | 1 710.7 ~ 1 754.3 MHz |
| LTE Band 5 (Cell)                      | Voice / Data                                                                                             | 824.7 ~ 848.3 MHz     |
| LTE Band 12                            | Voice / Data                                                                                             | 699.7 ~ 715.3 MHz     |
| LTE Band 13                            | Voice / Data                                                                                             | 779.5 ~ 784.5 MHz     |
| LTE Band 17                            | Voice / Data                                                                                             | 706.5 ~ 713.5 MHz     |
| LTE TDD Band 41                        | Voice / Data                                                                                             | 2 498.5 ~ 2 687.5 MHz |
| LTE Band 66 (AWS)                      | Voice / Data                                                                                             | 1 712.5 ~ 1 777.5 MHz |
| 2.4GHz WLAN                            | Voice / Data                                                                                             | 2 412 ~ 2 462 MHz     |
| Bluetooth / LE 4.2                     | Data                                                                                                     | 2 402 ~ 2 480 MHz     |
| Device Description                     |                                                                                                          |                       |
| Device Dimension                       | Overall (Length x Width): 160.3 mm x 76.5 mm<br>Overall Diagonal: 170.5 mm<br>Display Diagonal: 152.4 mm |                       |
| Battery Options:                       | Standard (Li-ion Polymer Battery)                                                                        |                       |
|                                        | Battery Model Name: EB-BG610ABE (SDI)                                                                    |                       |
| Device Serial Numbers                  | Mode                                                                                                     | Serial Number         |
|                                        | GSM 850/ GSM 1900/ UMTS 850/1700/1900<br>LTE Band 2/4/5/12/13/17/41/66<br>2.4GHz WLAN/Bluetooth          | R38K70S3YTT           |

### 2.2. Power Reduction for WIFI

This device uses an independent fixed level power reduction mechanism for all WIFI operations during voice or VoIP held to ear scenarios. Reduced powers were used to evaluate for low-power exemption for WIFI. Detailed descriptions of the power reduction mechanism are included in the operational description.

### 3. HAC MEASUREMENT SET-UP

These measurements are performed using the DASY5 automated dosimetric assessment system. It is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland. It consists of high precision robotics system (Staubli), robot controller, Pentium IV computer, near-field probe, probe alignment sensor. The robot is a six-axis industrial robot performing precise movements.

A cell controller system contains the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The PC consists of the HP Pentium IV 3.0 GHz computer with Windows XP system and HAC Measurement Software DASY5, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

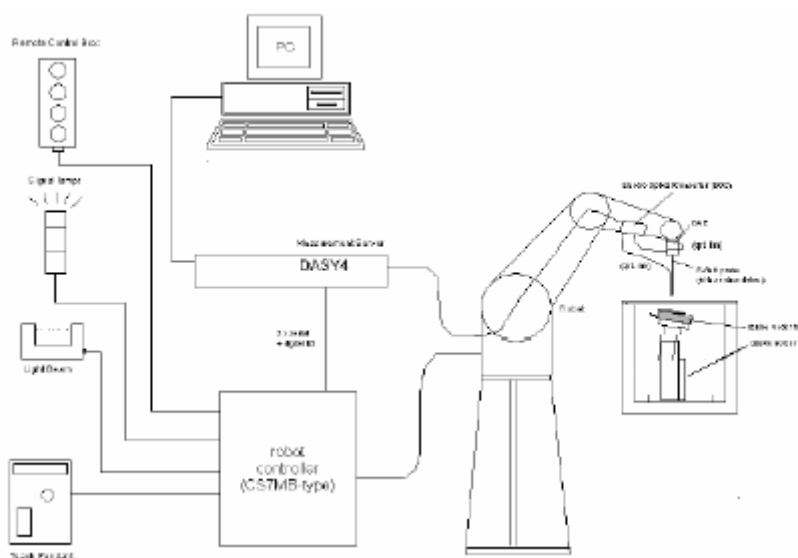


Figure 1. HAC Test Measurement Set-up

The DAE4 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. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

## 4. SYSTEM SPECIFICATIONS

### 4.1 Probe

#### E-Field Probe Description

|               |                                                                                                                                |                                                                                                              |
|---------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Construction  | One dipole parallel, two dipoles normal to probe axis<br>Built-in shielding against static charges                             |  <p>[ E-Field Probe ]</p> |
| Calibration   | In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$ , $k = 2$ )                                                      |                                                                                                              |
| Frequency     | 100 MHz to > 6 GHz; Linearity: $\pm 0.2$ dB (100 MHz to 3 GHz)                                                                 |                                                                                                              |
| Directivity   | $\pm 0.2$ dB in air (rotation around probe axis)<br>$\pm 0.4$ dB in air (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: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 1.5 mm |                                                                                                              |

## 4.2 Phantom & Device Holder



Figure 2. HAC Phantom & Device Holder

The Test Arch phantom should be positioned horizontally on a stable surface. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot.

The devices can be easily, accurately, and repeatably positioned according to the FCC specifications.

## 4.3 Robotic System Specifications

### Specifications

**POSITIONER:** Stäubli Unimation Corp. Robot Model: TX90 XLspeag  
**Repeatability:** 0.02 mm  
**No. of axis:** 6

### Data Acquisition Electronic (DAE) System

#### Cell Controller

**Processor:** Core i7  
**Clock Speed:** 3.0 GHz  
**Operating System:** Windows 7  
**Data Card:** DASY5 PC-Board  
**Data Converter**  
**Features:** Signal Amplifier, multiplexer, A/D converter, and control logic  
**Software:** DASY5 software  
**Connecting Lines:** Optical downlink for data and status info.  
 Optical uplink for commands and clock

### PC Interface Card

**Function:** 24 bit (64 MHz) DSP for real time processing  
 Link to DAE  
 16 bit A/D converter for surface detection system  
 serial link to robot  
 direct emergency stop output for robot

## 5. EUT ARRANGEMENT

### 5.1 WD RF Emission Measurement Reference and Plane

Figure 3. Illustrate the references and reference plane that shall be used in the WD emissions measurement.

- The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids.
- The grid is centered on the audio frequency output transducer of the WD (speaker or T-coil).
- The grid is in a reference plane, which is defined as the planar area that contains the highest point in the area of the phone that normally rests against the user's ear. It is parallel to the centerline of the receiver area of the phone and is defined by the points of the receiver-end of the WD handset, which, in normal handset use, rest against the ear.
- The measurement plane is parallel to, and 1.5 cm in front of, the reference plane.



Figure 3. WD reference and plane for RF emission measurements

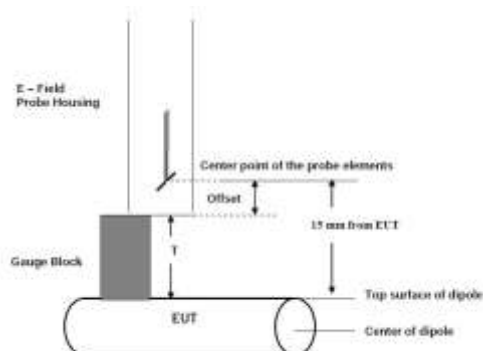


Figure 4. Gauge Block with E-Field Probe

## 6. SYSTEM VALIDATION

The test setup was validated when configured and verified periodically thereafter to ensure proper function. The procedure is a validation procedure using dipole antennas for which the field levels were computed by FDTD modeling.

### 6.1 Validation Procedure

Place a dipole antenna meeting the requirements given in ANSI-C63.19 in the position normally occupied by the WD. The dipole antenna serves as a known source for an electrical and magnetic output. Position the E-field probe so that:

- the probes and their cables are parallel to the coaxial feed of the dipole antenna
- the probe cables and the coaxial feed of the dipole antenna approach the measurement area from opposite directions; and
- the probes are 15 mm from the surface of the dipole elements.

Scan the length of the dipole with E-field probe and record the maximum values for each. Compare the readings to expected values.

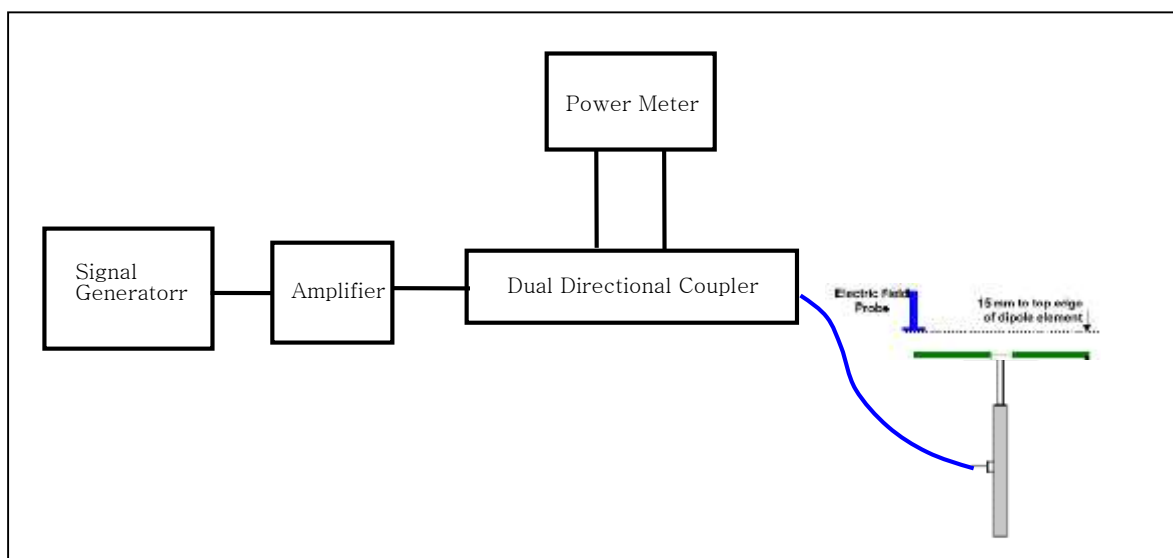


Figure 5. Dipole Validation SET-UP

## 6.2 SYSTEM Validation Result

| Mode | Date       | Dipole Type_Seria_ Freq.   | Input Power [dBm] | MAX. Measured from   |                     | Average max. above arm [V/m] | Target Value [V/m] SPEAG | Dev. [%] |
|------|------------|----------------------------|-------------------|----------------------|---------------------|------------------------------|--------------------------|----------|
|      |            |                            |                   | Above high end (V/m) | Above low end (V/m) |                              |                          |          |
| CW   | 09/10/2018 | CD835V3_SN:1024_(835MHz)   | 20                | 119.67               | 119.54              | 119.61                       | 110.5                    | 8.2      |
| CW   | 09/10/2018 | CD1880V3_SN:1019_(1880MHz) | 20                | 94.73                | 87.40               | 91.07                        | 89.8                     | 1.4      |
| CW   | 09/12/2018 | CD2600V3_SN:1009_(2600MHz) | 20                | 84.92                | 82.13               | 83.53                        | 87.0                     | -4.0     |

Notes:

- 1) Deviation (%) =  $100 * (\text{Measured value} - \text{Target value}) / \text{Target value}$ .  
ANSI-C63.19 requires values to be within 25 % of their targets. 12 % is deviation and 13 % is measurement uncertainty.
- 2) The maximum E-field was evaluated and compared to the target values provided by SPEAG in the calibration certificate of specific dipoles.
- 3) Please refer to the attachment for detailed measurement data and plot.

## 7. LTE TDD UPLINK-DOWNLINK CONFIGURATION

### 7.1 Uplink-Downlink Configuration Investigation

An investigation was performed on each supported power class for LTE TDD to determine the worst case Uplink-Downlink configuration for RFE testing.

Per 3GPP TS 36.211, the total frame length for each TDD radio frame of length  $T_f = 307200 \cdot T_s = 10\text{ms}$ , where  $T_s$  is a number of time units equal to  $1/(15000 \times 2048)$  seconds. Additionally, each radio frame consists of 10 subframes, each of length  $30720 \cdot T_s = 1\text{ms}$ , and subframes can be designated as uplink (U), downlink (D), or special subframe (S), depending on the Uplink-Downlink configuration as indicated in Table 4.2-2 of 3GPP TS 36.211. In the transmission duty factor calculation, the special subframe configuration with the shortest UpPTS duration within the special subframe is used and will be applied for measurement. From 3GPP TS 36.211 Table 4.2-1, the shortest UpPTS is  $2192 \cdot T_s$  which occurs in the normal cyclic prefix and special subframe configuration 4.

See table below outlining the calculated transmission duty cycles for each Uplink-Downlink configuration:

| Uplink-Downlink configuration | Downlink-to-Uplink Switch-point periodicity | Subframe number |   |   |   |   |   |   |   |   |   | Calculated Transmission Duty Cycle [%] |
|-------------------------------|---------------------------------------------|-----------------|---|---|---|---|---|---|---|---|---|----------------------------------------|
|                               |                                             | 0               | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |                                        |
| 0                             | 5 ms                                        | D               | S | U | U | U | D | S | U | U | U | 61.4                                   |
| 1                             | 5 ms                                        | D               | S | U | U | D | D | S | U | U | D | 41.4                                   |
| 2                             | 5 ms                                        | D               | S | U | D | D | D | S | U | D | D | 21.4                                   |
| 3                             | 10 ms                                       | D               | S | U | U | U | D | D | D | D | D | 30.7                                   |
| 4                             | 10 ms                                       | D               | S | U | U | D | D | D | D | D | D | 20.7                                   |
| 5                             | 10 ms                                       | D               | S | U | D | D | D | D | D | D | D | 10.7                                   |
| 6                             | 5 ms                                        | D               | S | U | U | U | D | S | U | U | D | 51.4                                   |

Uplink-Downlink Configurations for Type 2 Frame Structures

LTE TDD was evaluated with the following radio configuration: channel 40620, 20MHz BW, 16QAM, 1RB, 0RB offset. All configurations (0-6) are supported. The configuration which resulted in the worst Audio Interference Level was used for full testing. See Table for investigation results. The configuration determined in the investigation below was used to measure the MIF values in sec. 8.2.

| Mode                | Channel      | UL-DL Config. | Mod.         | BW        | RB Size  | RB offset | Time Avg. Filed [V/m] | Audio Interference Level [dBV/m] | FCC Limit [dBV/m] | FCC Margin [dB] | MIF          | Result    | Exclusion Block |
|---------------------|--------------|---------------|--------------|-----------|----------|-----------|-----------------------|----------------------------------|-------------------|-----------------|--------------|-----------|-----------------|
| LTE TDD/<br>Band 41 | 40620        | 0             | 16QAM        | 20        | 1        | 0         | 21.73                 | 23.69                            | 35                | 11.31           | -3.05        | M4        | none            |
|                     | <b>40620</b> | <b>1</b>      | <b>16QAM</b> | <b>20</b> | <b>1</b> | <b>0</b>  | <b>18.64</b>          | <b>23.83</b>                     | <b>35</b>         | <b>11.17</b>    | <b>-1.58</b> | <b>M4</b> | <b>none</b>     |
|                     | 40620        | 2             | 16QAM        | 20        | 1        | 0         | 13.51                 | 23.73                            | 35                | 11.27           | 1.12         | M4        | none            |
|                     | 40620        | 3             | 16QAM        | 20        | 1        | 0         | 15.76                 | 22.63                            | 35                | 12.37           | -1.32        | M4        | none            |
|                     | 40620        | 4             | 16QAM        | 20        | 1        | 0         | 12.09                 | 22.05                            | 35                | 12.95           | 0.40         | M4        | none            |
|                     | 40620        | 5             | 16QAM        | 20        | 1        | 0         | 9.07                  | 22.17                            | 35                | 12.83           | 3.02         | M4        | none            |
|                     | 40620        | 6             | 16QAM        | 20        | 1        | 0         | 20.80                 | 23.76                            | 35                | 11.24           | -2.60        | M4        | none            |

### 7.2 Conclusion

Per the investigations above, UL-DL configuration 1 was used for LTE TDD.

## 8. Modulation Interference Factor

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.

### 8.1 Measuring Modulation Interference Factors

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.

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 or a conducted RF signal:

- 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.
- Measure the steady-state RMS level at the output of the fast probe or sensor.
- Measure the steady-state average level at the weighting output.
- 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.
- 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.
- The MIF for the specific modulation characteristic is provided by the ratio of the step e) measurement to the step b) measurement, expressed in dB ( $20 \times \log(\text{step e})/\text{step b})$ ).

The following procedure was used to measure the MIF using the SPEAG audio interference Analyzer (AIA), Serial No.:1060:

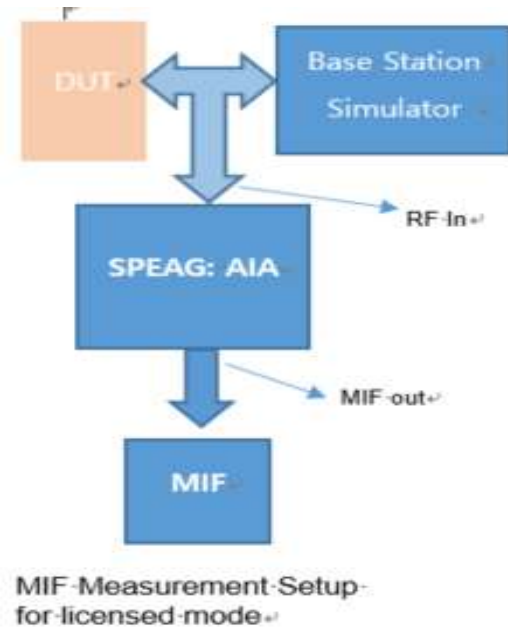
- The device was placed into a simulated call using a base station simulator or set to transmit using test software for a given model.
- The device was then set to continuously transmit at maximum power.
- Using a coupler if needed, the device output signal was connected to the RF In port of the AIA, which was connected to a desktop computer. Alternatively, a radiated RF signal may be used with the AIA's built-in antenna.
- The MIF measurement procedure in the DASY software was run, and the resulting MIF value was recorded.
- Steps 1-4 were repeated for all CMRS air interfaces, frequency bands, and modulations.

The modulation interference factors obtained were applied to readings taken of the actual wireless device in order to obtain an accurate audio interference level reading using the formula:

$$\text{Audio interference Level [dB (V/m)]} = 20 * \log [\text{Raw Field Value (V/m)}] + \text{MIF (dB)}$$

Because the MIF value is output power independent, MIF values for a given mode should be constant across all devices; however, per C63.19-2011 §D.7, MIF values should be measured for each device being evaluated. The voice modes for this device have been investigated in this section of the report.

## 8.2 Measured Modulation Interference Factors



| Mode | GSM850 |      |      | GSM1900 |      |     |
|------|--------|------|------|---------|------|-----|
|      | 128    | 190  | 251  | 512     | 661  | 810 |
| GSM  | 3.46   | 3.46 | 3.46 | 3.46    | 3.48 | 3.5 |

GSM Modulation Interference Factors

| Mode |               | WCDMA850 |        |        | WCDMA1700 |        |        | WCDMA1900 |        |        |
|------|---------------|----------|--------|--------|-----------|--------|--------|-----------|--------|--------|
|      |               | 4132     | 4183   | 4233   | 1312      | 1412   | 1513   | 9262      | 9400   | 9538   |
| UMTS | 12.2kbps RMC  | -26.14   | -26.31 | -24.22 | -25.58    | -25.06 | -25.16 | -24.87    | -24.55 | -23.17 |
|      | 12.2 kbps AMR | -25.58   | -26.1  | -24.06 | -25.97    | -25.06 | -25.5  | -24.65    | -25.03 | -23.08 |

UMTS Modulation Interference Factors

Note :

Measured MIF value maybe lower than sample MIF values provide in ANSI C63.19-2011 Annex D.7 Table D.5 due to manufacturing variations for each device. However per Annex D.7, the sample MIF values of table D.5 are not intended to substitute for measurements of actual devices under test and their respective operating mode

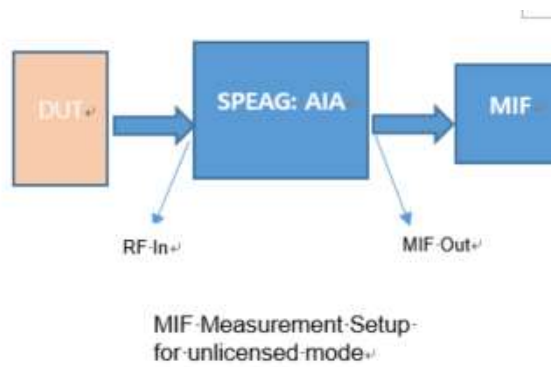
| LTE Band | Frequency [MHz] | Channel | Bandwidth [MHz] | Modulation | RB Size | RB offset | MIF [dB] |
|----------|-----------------|---------|-----------------|------------|---------|-----------|----------|
| 2        | 1880            | 18900   | 20              | 16QAM      | 1       | 0         | -9.67    |
| 5        | 836.5           | 20525   | 10              | 16QAM      | 1       | 0         | -9.67    |
| 4        | 1732.5          | 20175   | 20              | 16QAM      | 1       | 0         | -9.53    |
| 12       | 707.5           | 23095   | 10              | 16QAM      | 1       | 0         | -9.74    |
| 13       | 782             | 23230   | 10              | 16QAM      | 1       | 0         | -9.89    |
| 66       | 1745            | 132322  | 20              | 16QAM      | 1       | 0         | -9.51    |
| 17       | 710             | 23790   | 10              | 16QAM      | 1       | 0         | -9.72    |
| 66       | 1745            | 132322  | 20              | QPSK       | 1       | 0         | -13.11   |
| 66       | 1745            | 132322  | 20              | 16QAM      | 1       | 50        | -9.55    |
| 66       | 1745            | 132322  | 20              | 16QAM      | 1       | 99        | -9.55    |
| 66       | 1745            | 132322  | 20              | 16QAM      | 50      | 0         | -15.02   |
| 66       | 1745            | 132322  | 20              | 16QAM      | 100     | 0         | -14.85   |
| 66       | 1745            | 132322  | 15              | 16QAM      | 1       | 0         | -9.52    |
| 66       | 1745            | 132322  | 10              | 16QAM      | 1       | 0         | -9.53    |
| 66       | 1745            | 132322  | 5               | 16QAM      | 1       | 0         | -9.54    |
| 66       | 1745            | 132322  | 3               | 16QAM      | 1       | 0         | -9.55    |
| 66       | 1745            | 132322  | 1.4             | 16QAM      | 1       | 0         | -9.52    |
| 66       | 1720            | 132072  | 20              | 16QAM      | 1       | 0         | -9.51    |
| 66       | 1770            | 132572  | 20              | 16QAM      | 1       | 0         | -9.57    |

LTE FDD Modulation Interference Factors

| LTE Band | Frequency [MHz] | Channel | Bandwidth [MHz] | Modulation | RB Size | RB offset | MIF [dB] |
|----------|-----------------|---------|-----------------|------------|---------|-----------|----------|
| 41       | 2593            | 40620   | 20              | 16QAM      | 1       | 0         | -1.58    |
| 41       | 2593            | 40620   | 20              | QPSK       | 1       | 0         | -1.68    |
| 41       | 2593            | 40620   | 20              | 16QAM      | 1       | 50        | -1.59    |
| 41       | 2593            | 40620   | 20              | 16QAM      | 1       | 99        | -1.60    |
| 41       | 2593            | 40620   | 20              | 16QAM      | 50      | 0         | -1.76    |
| 41       | 2593            | 40620   | 20              | 16QAM      | 100     | 0         | -1.79    |
| 41       | 2593            | 40620   | 15              | 16QAM      | 1       | 0         | -1.59    |
| 41       | 2593            | 40620   | 10              | 16QAM      | 1       | 0         | -1.59    |
| 41       | 2593            | 40620   | 5               | 16QAM      | 1       | 0         | -1.60    |
| 41       | 2506            | 39750   | 20              | 16QAM      | 1       | 0         | -1.60    |
| 41       | 2549.5          | 40185   | 20              | 16QAM      | 1       | 0         | -1.58    |
| 41       | 2636.5          | 41055   | 20              | 16QAM      | 1       | 0         | -1.61    |
| 41       | 2680            | 41490   | 20              | 16QAM      | 1       | 0         | -1.60    |

LTE TDD Modulation Interference Factors

All FDD LTE bands were found to have substantially similar MIF values given similar RB,BW and modulation configurations.



| Mode    | 802.11b MIF Measurements [dB] |       |       |       |
|---------|-------------------------------|-------|-------|-------|
|         | Data Rate [Mbps]              |       |       |       |
|         | 1                             | 2     | 5.5   | 11    |
| 802.11b | -10.34                        | -9.57 | -7.68 | -6.67 |

WLAN 802.11b Modulation Interference Factors

| Mode    | 802.11g MIF Measurements [dB] |       |       |       |       |       |       |       |
|---------|-------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         | Data Rate [Mbps]              |       |       |       |       |       |       |       |
|         | 6                             | 9     | 12    | 18    | 24    | 36    | 48    | 54    |
| 802.11g | -8.05                         | -6.88 | -6.27 | -6.13 | -5.15 | -4.89 | -5.02 | -5.14 |

WLAN 802.11g Modulation Interference Factors

| Mode    | 802.11n MIF Measurements [dB] |       |       |       |       |       |       |       |
|---------|-------------------------------|-------|-------|-------|-------|-------|-------|-------|
|         | Data Rate [Mbps]              |       |       |       |       |       |       |       |
|         | 6.5                           | 13    | 19.5  | 26    | 39    | 52    | 58.5  | 65    |
| 802.11n | -7.43                         | -6.12 | -5.48 | -5.05 | -4.85 | -5.05 | -5.18 | -5.33 |

WLAN 802.11n Modulation Interference Factors

### 8.3 Analysis of RF Air interface Technologies

An analysis was performed, following the guidance of 4.3 and 4.4 of the ANSI standard, of the RF air interface technologies being evaluated. The factors that will affect the RF interference Potential were evaluated, and the worst case operating modes were identified and used in the evaluation. A WD's interference potential is a function both of the WD's average near-field field strength and of the signal's audio-frequency amplitude modulation characteristics. Per 4.4, RF air interface technologies that have low power have been found to produce sufficiently low RF interference potential, so it is possible to exempt them from the product testing specified in Clause 5 of the ANSI standard. An RF air interface technology of a device is exempt from testing When its average antenna input power plus its MIF is  $\leq 17\text{dBm}$  for all of its operating modes.

The worst case MIF plus the worst case average antenna input power for all modes are investigated below to determine the testing requirements for this device.

### Air Interfaces and Operating Mode

| Air-Interface                                                                                                           | Band (MHz) | Type | HAC Tested      | Simultaneous Transmissions<br>Note: Not to be tested  | Name of Voice service | Power Reduction |
|-------------------------------------------------------------------------------------------------------------------------|------------|------|-----------------|-------------------------------------------------------|-----------------------|-----------------|
| GSM                                                                                                                     | 850        | VO   | Yes             | Yes: BT, WLAN                                         | CMRS Voice            | N/A             |
|                                                                                                                         | 1900       |      |                 |                                                       |                       |                 |
|                                                                                                                         | GPRS /EDGE | DT   | N/A             | Yes: BT, WLAN                                         | google Duo            | N/A             |
| WCDMA                                                                                                                   | 850        | VO   | No <sup>1</sup> | Yes: BT, WLAN                                         | CMRS Voice            | N/A             |
|                                                                                                                         | 1700       |      |                 |                                                       |                       |                 |
|                                                                                                                         | 1900       | DT   | N/A             | Yes: BT, WLAN                                         | google Duo            | N/A             |
| LTE (FDD)                                                                                                               | HSPA       |      |                 |                                                       |                       |                 |
|                                                                                                                         | 700 (B12)  | VD   | No <sup>1</sup> | Yes: BT, WLAN                                         | VOLTE,google Duo      | N/A             |
|                                                                                                                         | 700 (B17)  |      |                 |                                                       |                       |                 |
|                                                                                                                         | 780 (B13)  |      |                 |                                                       |                       |                 |
|                                                                                                                         | 850 (B5)   |      |                 |                                                       |                       |                 |
|                                                                                                                         | 1700 (B4)  |      |                 |                                                       |                       |                 |
|                                                                                                                         | 1700 (B66) |      |                 |                                                       |                       |                 |
|                                                                                                                         | 1900 (B2)  |      |                 |                                                       |                       |                 |
| LTE (TDD)                                                                                                               | 2600 (B41) | VD   | Yes             | Yes: BT, WLAN                                         | google Duo            | N/A             |
| WLAN                                                                                                                    | 2450       | VD   | No <sup>1</sup> | Yes: GSM, WCDMA, or LTE                               | VoWIFI<br>google Duo  | Yes             |
| BT                                                                                                                      | 2450       | DT   | N/A             | Yes: GSM, WCDMA, or LTE                               | N/A                   | N/A             |
| Type Transport<br>VO = CMRS Voice Service<br>DT = Digital Transport<br>VD = CMRS IP Voice Service and Digital Transport |            |      |                 | Note<br>1. Evaluated for MIF and low power exemption. |                       |                 |

## 8.4 Individual Mode Evaluations

| Air Interface | Maximum Average Power [dBm] | Worst case MIF [dBm] | Total (Power + MIF) [dBm] | C63.19 Testing Required |
|---------------|-----------------------------|----------------------|---------------------------|-------------------------|
| GSM850        | 33.5                        | 3.46                 | 36.96                     | Yes                     |
| GSM1900       | 31.0                        | 3.50                 | 34.5                      | Yes                     |
| UMTS Band 2   | 23.5                        | -23.08               | 0.42                      | No                      |
| UMTS Band 4   | 24.0                        | -25.06               | -1.06                     | No                      |
| UMTS Band 5   | 24.7                        | -24.06               | 0.64                      | No                      |
| LTE Band 2    | 24.0                        | -9.67                | 14.33                     | No                      |
| LTE Band 4    | 24.0                        | -9.53                | 14.47                     | No                      |
| LTE Band 5    | 24.5                        | -9.67                | 14.83                     | No                      |
| LTE Band 12   | 24.0                        | -9.74                | 14.26                     | No                      |
| LTE Band 13   | 24.0                        | -9.89                | 14.11                     | No                      |
| LTE Band 17   | 24.0                        | -9.72                | 14.28                     | No                      |
| LTE Band 66   | 24.0                        | -9.51                | 14.49                     | No                      |
| LTE Band 41   | 24.0                        | -1.58                | 22.42                     | Yes                     |
| 802.11b       | 15.0                        | -6.67                | 8.33                      | No                      |
| 802.11g       | 14.5                        | -4.89                | 9.61                      | No                      |
| 802.11n       | 15.0                        | -4.85                | 10.15                     | No                      |

Max. Power + MIF calculations for Low Power Exemptions

## 8.5 Low-Power Exemption Conclusions

Per ANSI C63.19-2011, RF Emissions testing for this device is required only for GSM, and LTE TDD voice modes. All other applicable air interfaces are exempt.

## 9. RF Conducted Power Measurements

Sample pre-testing of the various modes were performed at the worst case probe location as part of subset testing justification. See below for measured conducted power for applicable device modes:

### 9.1 GSM/UMTS/LTE Conducted Output Power

#### GSM Maximum Conducted Output Power

| Mode      | GSM850 |       |       | GSM1900 |       |       |
|-----------|--------|-------|-------|---------|-------|-------|
|           | 128    | 190   | 251   | 512     | 661   | 810   |
| GSM (dBm) | 31.79  | 31.83 | 32.06 | 29.59   | 29.40 | 29.87 |

GSM Conducted output powers (Burst-Average)

#### UMTS Maximum Conducted Output Power

| Mode          |                  | WCDMA850 |       |       | WCDMA1700 |       |       | WCDMA1900 |       |       |
|---------------|------------------|----------|-------|-------|-----------|-------|-------|-----------|-------|-------|
|               |                  | 4132     | 4183  | 4233  | 1312      | 1412  | 1513  | 9262      | 9400  | 9538  |
| UMTS<br>(dBm) | 12.2kbps<br>RMC  | 24.13    | 23.93 | 23.91 | 23.38     | 23.39 | 23.49 | 23.08     | 23.42 | 23.10 |
|               | 12.2 kbps<br>AMR | 24.07    | 23.88 | 23.89 | 23.38     | 23.37 | 23.48 | 23.05     | 23.36 | 23.10 |

UMTS Average Conducted output powers

## LTE Maximum Conducted Output Power

### LTE Band 2

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP<br>[dB] | MPR<br>[dB] |
|-----------|------------|---------|-----------|--------------------------|----------|------------|------------------------------|-------------|
|           |            |         |           | 18607                    | 18900    | 19193      |                              |             |
|           |            |         |           | 1850.7 MHz               | 1880 MHz | 1909.3 MHz |                              |             |
| 1.4 MHz   | QPSK       | 1       | 0         | 23.44                    | 23.31    | 23.62      | 0                            | 0           |
|           |            | 1       | 3         | 23.46                    | 23.48    | 23.56      | 0                            | 0           |
|           |            | 1       | 5         | 23.56                    | 23.42    | 23.52      | 0                            | 0           |
|           |            | 3       | 0         | 23.54                    | 23.34    | 23.36      | 0                            | 0           |
|           |            | 3       | 1         | 23.35                    | 23.41    | 23.34      | 0                            | 0           |
|           |            | 3       | 3         | 23.38                    | 23.30    | 23.31      | 0                            | 0           |
|           | 16QAM      | 6       | 0         | 22.88                    | 22.75    | 22.94      | 0-1                          | 1           |
|           |            | 1       | 0         | 22.26                    | 22.73    | 22.66      | 0-1                          | 1           |
|           |            | 1       | 3         | 22.59                    | 22.59    | 22.20      | 0-1                          | 1           |
|           |            | 1       | 5         | 22.48                    | 22.44    | 22.11      | 0-1                          | 1           |
|           |            | 3       | 0         | 22.58                    | 22.78    | 22.87      | 0-1                          | 1           |
|           |            | 3       | 1         | 22.66                    | 22.90    | 22.76      | 0-1                          | 1           |
|           |            | 3       | 3         | 22.59                    | 22.70    | 22.64      | 0-1                          | 1           |
|           |            | 6       | 0         | 21.62                    | 21.68    | 21.66      | 0-2                          | 2           |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP<br>[dB] | MPR<br>[dB] |
|-----------|------------|---------|-----------|--------------------------|----------|------------|------------------------------|-------------|
|           |            |         |           | 18615                    | 18900    | 19185      |                              |             |
|           |            |         |           | 1851.5 MHz               | 1880 MHz | 1908.5 MHz |                              |             |
| 3 MHz     | QPSK       | 1       | 0         | 23.58                    | 23.43    | 23.37      | 0                            | 0           |
|           |            | 1       | 7         | 23.82                    | 23.41    | 23.51      | 0                            | 0           |
|           |            | 1       | 14        | 23.34                    | 23.49    | 23.70      | 0                            | 0           |
|           |            | 8       | 0         | 22.85                    | 22.86    | 22.93      | 0-1                          | 1           |
|           |            | 8       | 3         | 22.83                    | 22.86    | 22.99      | 0-1                          | 1           |
|           |            | 8       | 7         | 22.82                    | 22.87    | 22.91      | 0-1                          | 1           |
|           |            | 15      | 0         | 22.83                    | 22.80    | 22.93      | 0-1                          | 1           |
|           | 16QAM      | 1       | 0         | 22.40                    | 22.86    | 22.26      | 0-1                          | 1           |
|           |            | 1       | 7         | 22.54                    | 22.49    | 22.35      | 0-1                          | 1           |
|           |            | 1       | 14        | 22.86                    | 22.35    | 22.70      | 0-1                          | 1           |
|           |            | 8       | 0         | 21.93                    | 21.88    | 21.94      | 0-2                          | 2           |
|           |            | 8       | 3         | 21.85                    | 21.93    | 21.91      | 0-2                          | 2           |
|           |            | 8       | 7         | 21.97                    | 21.94    | 21.99      | 0-2                          | 2           |
|           |            | 15      | 0         | 21.99                    | 21.87    | 21.88      | 0-2                          | 2           |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 18625                    | 18900    | 19175      |                      |      |
|           |            |         |           | 1852.5 MHz               | 1880 MHz | 1907.5 MHz | [dB]                 | [dB] |
| 5 MHz     | QPSK       | 1       | 0         | 23.45                    | 23.23    | 23.38      | 0                    | 0    |
|           |            | 1       | 12        | 23.70                    | 23.67    | 23.60      | 0                    | 0    |
|           |            | 1       | 24        | 23.36                    | 23.40    | 23.37      | 0                    | 0    |
|           |            | 12      | 0         | 22.84                    | 22.80    | 22.87      | 0-1                  | 1    |
|           |            | 12      | 6         | 22.81                    | 22.77    | 22.89      | 0-1                  | 1    |
|           |            | 12      | 11        | 22.79                    | 22.85    | 22.97      | 0-1                  | 1    |
|           |            | 25      | 0         | 22.77                    | 22.95    | 22.96      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.83                    | 22.11    | 22.88      | 0-1                  | 1    |
|           |            | 1       | 12        | 22.54                    | 22.66    | 22.11      | 0-1                  | 1    |
|           |            | 1       | 24        | 22.28                    | 22.42    | 22.94      | 0-1                  | 1    |
|           |            | 12      | 0         | 21.56                    | 21.66    | 21.78      | 0-2                  | 2    |
|           |            | 12      | 6         | 21.69                    | 21.82    | 21.71      | 0-2                  | 2    |
|           |            | 12      | 11        | 21.94                    | 21.77    | 21.99      | 0-2                  | 2    |
|           |            | 25      | 0         | 21.83                    | 21.93    | 21.93      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |          | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|----------|----------------------|------|
|           |            |         |           | 18650                    | 18900    | 19150    |                      |      |
|           |            |         |           | 1855 MHz                 | 1880 MHz | 1905 MHz | [dB]                 | [dB] |
| 10 MHz    | QPSK       | 1       | 0         | 23.69                    | 23.33    | 23.37    | 0                    | 0    |
|           |            | 1       | 24        | 23.67                    | 23.85    | 23.30    | 0                    | 0    |
|           |            | 1       | 49        | 23.29                    | 23.49    | 23.56    | 0                    | 0    |
|           |            | 25      | 0         | 22.84                    | 22.79    | 22.84    | 0-1                  | 1    |
|           |            | 25      | 12        | 22.84                    | 22.93    | 22.82    | 0-1                  | 1    |
|           |            | 25      | 24        | 22.71                    | 22.92    | 22.88    | 0-1                  | 1    |
|           |            | 50      | 0         | 22.74                    | 22.94    | 22.90    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.36                    | 22.22    | 22.23    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.38                    | 22.21    | 22.45    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.32                    | 22.53    | 22.62    | 0-1                  | 1    |
|           |            | 25      | 0         | 21.95                    | 21.83    | 21.69    | 0-2                  | 2    |
|           |            | 25      | 12        | 21.97                    | 21.97    | 21.91    | 0-2                  | 2    |
|           |            | 25      | 24        | 21.90                    | 21.95    | 21.91    | 0-2                  | 2    |
|           |            | 50      | 0         | 21.96                    | 21.88    | 21.97    | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 18675                    | 18900    | 19125      |                      |      |
|           |            |         |           | 1857.5 MHz               | 1880 MHz | 1902.5 MHz | [dB]                 | [dB] |
| 15 MHz    | QPSK       | 1       | 0         | 23.55                    | 23.27    | 23.54      | 0                    | 0    |
|           |            | 1       | 36        | 23.59                    | 23.64    | 23.35      | 0                    | 0    |
|           |            | 1       | 74        | 23.11                    | 23.60    | 23.62      | 0                    | 0    |
|           |            | 36      | 0         | 22.89                    | 22.85    | 22.89      | 0-1                  | 1    |
|           |            | 36      | 18        | 22.86                    | 22.95    | 22.72      | 0-1                  | 1    |
|           |            | 36      | 38        | 22.67                    | 22.95    | 22.80      | 0-1                  | 1    |
|           |            | 75      | 0         | 22.82                    | 22.87    | 22.85      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.95                    | 22.56    | 22.54      | 0-1                  | 1    |
|           |            | 1       | 36        | 22.91                    | 22.54    | 22.53      | 0-1                  | 1    |
|           |            | 1       | 74        | 22.31                    | 22.91    | 22.64      | 0-1                  | 1    |
|           |            | 36      | 0         | 21.66                    | 21.81    | 21.66      | 0-2                  | 2    |
|           |            | 36      | 18        | 21.74                    | 21.91    | 21.55      | 0-2                  | 2    |
|           |            | 36      | 38        | 21.67                    | 21.98    | 21.71      | 0-2                  | 2    |
|           |            | 75      | 0         | 21.82                    | 21.81    | 21.70      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |          | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|----------|----------------------|------|
|           |            |         |           | 18700                    | 18900    | 19100    |                      |      |
|           |            |         |           | 1860 MHz                 | 1880 MHz | 1900 MHz | [dB]                 | [dB] |
| 20 MHz    | QPSK       | 1       | 0         | 23.57                    | 23.25    | 23.63    | 0                    | 0    |
|           |            | 1       | 49        | 23.44                    | 23.54    | 23.41    | 0                    | 0    |
|           |            | 1       | 99        | 23.21                    | 23.43    | 23.64    | 0                    | 0    |
|           |            | 50      | 0         | 22.89                    | 22.75    | 22.94    | 0-1                  | 1    |
|           |            | 50      | 25        | 22.77                    | 22.91    | 22.82    | 0-1                  | 1    |
|           |            | 50      | 49        | 22.67                    | 22.96    | 22.75    | 0-1                  | 1    |
|           |            | 100     | 0         | 22.74                    | 22.84    | 22.94    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.29                    | 22.37    | 22.22    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.08                    | 22.93    | 22.65    | 0-1                  | 1    |
|           |            | 1       | 99        | 22.71                    | 22.92    | 22.55    | 0-1                  | 1    |
|           |            | 50      | 0         | 21.81                    | 21.80    | 21.80    | 0-2                  | 2    |
|           |            | 50      | 25        | 21.81                    | 21.85    | 21.67    | 0-2                  | 2    |
|           |            | 50      | 49        | 21.61                    | 21.96    | 21.85    | 0-2                  | 2    |
|           |            | 100     | 0         | 21.80                    | 21.84    | 21.80    | 0-2                  | 2    |

## LTE Band 4

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|----------------------|------|
|           |            |         |           | 19957                    | 20175      | 20393      |                      |      |
|           |            |         |           | 1710.7 MHz               | 1732.5 MHz | 1754.3 MHz | [dB]                 | [dB] |
| 1.4 MHz   | QPSK       | 1       | 0         | 23.19                    | 23.16      | 23.23      | 0                    | 0    |
|           |            | 1       | 3         | 23.36                    | 23.28      | 23.20      | 0                    | 0    |
|           |            | 1       | 5         | 23.19                    | 23.13      | 23.32      | 0                    | 0    |
|           |            | 3       | 0         | 23.13                    | 23.05      | 23.24      | 0                    | 0    |
|           |            | 3       | 1         | 23.18                    | 23.21      | 23.36      | 0                    | 0    |
|           |            | 3       | 3         | 23.26                    | 23.24      | 23.27      | 0                    | 0    |
|           | 16QAM      | 6       | 0         | 22.78                    | 22.71      | 22.77      | 0-1                  | 1    |
|           |            | 1       | 0         | 22.67                    | 22.30      | 22.27      | 0-1                  | 1    |
|           |            | 1       | 3         | 22.37                    | 22.41      | 22.50      | 0-1                  | 1    |
|           |            | 1       | 5         | 22.25                    | 22.09      | 22.23      | 0-1                  | 1    |
|           |            | 3       | 0         | 22.54                    | 22.57      | 22.49      | 0-1                  | 1    |
|           |            | 3       | 1         | 22.85                    | 22.64      | 22.66      | 0-1                  | 1    |
|           |            | 3       | 3         | 22.96                    | 22.57      | 22.63      | 0-1                  | 1    |
|           |            | 6       | 0         | 21.52                    | 21.44      | 21.70      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|----------------------|------|
|           |            |         |           | 19965                    | 20175      | 20385      |                      |      |
|           |            |         |           | 1711.5 MHz               | 1732.5 MHz | 1753.5 MHz | [dB]                 | [dB] |
| 3 MHz     | QPSK       | 1       | 0         | 23.42                    | 23.18      | 23.16      | 0                    | 0    |
|           |            | 1       | 7         | 23.40                    | 23.14      | 23.45      | 0                    | 0    |
|           |            | 1       | 14        | 23.34                    | 23.18      | 23.46      | 0                    | 0    |
|           |            | 8       | 0         | 22.67                    | 22.81      | 22.71      | 0-1                  | 1    |
|           |            | 8       | 3         | 22.82                    | 22.78      | 22.79      | 0-1                  | 1    |
|           |            | 8       | 7         | 22.77                    | 22.77      | 22.76      | 0-1                  | 1    |
|           |            | 15      | 0         | 22.74                    | 22.73      | 22.73      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.50                    | 22.18      | 22.03      | 0-1                  | 1    |
|           |            | 1       | 7         | 22.26                    | 22.23      | 22.12      | 0-1                  | 1    |
|           |            | 1       | 14        | 22.33                    | 22.23      | 22.15      | 0-1                  | 1    |
|           |            | 8       | 0         | 21.90                    | 21.72      | 21.80      | 0-2                  | 2    |
|           |            | 8       | 3         | 21.81                    | 21.71      | 21.79      | 0-2                  | 2    |
|           |            | 8       | 7         | 21.77                    | 21.85      | 21.88      | 0-2                  | 2    |
|           |            | 15      | 0         | 21.53                    | 21.82      | 21.81      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|----------------------|------|
|           |            |         |           | 19975                    | 20175      | 20375      |                      |      |
|           |            |         |           | 1712.5 MHz               | 1732.5 MHz | 1752.5 MHz | [dB]                 | [dB] |
| 5 MHz     | QPSK       | 1       | 0         | 23.36                    | 23.24      | 23.32      | 0                    | 0    |
|           |            | 1       | 12        | 23.45                    | 23.31      | 23.73      | 0                    | 0    |
|           |            | 1       | 24        | 23.31                    | 23.29      | 23.60      | 0                    | 0    |
|           |            | 12      | 0         | 22.68                    | 22.73      | 22.92      | 0-1                  | 1    |
|           |            | 12      | 6         | 22.73                    | 22.76      | 22.92      | 0-1                  | 1    |
|           |            | 12      | 11        | 22.84                    | 22.71      | 22.87      | 0-1                  | 1    |
|           |            | 25      | 0         | 22.78                    | 22.74      | 22.81      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.06                    | 22.07      | 22.19      | 0-1                  | 1    |
|           |            | 1       | 12        | 22.45                    | 22.50      | 22.45      | 0-1                  | 1    |
|           |            | 1       | 24        | 22.26                    | 22.25      | 22.12      | 0-1                  | 1    |
|           |            | 12      | 0         | 21.63                    | 21.56      | 21.53      | 0-2                  | 2    |
|           |            | 12      | 6         | 21.91                    | 21.55      | 21.59      | 0-2                  | 2    |
|           |            | 12      | 11        | 21.72                    | 21.62      | 21.61      | 0-2                  | 2    |
|           |            | 25      | 0         | 21.67                    | 21.53      | 21.70      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |          | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|----------|----------------------|------|
|           |            |         |           | 20000                    | 20175      | 20350    |                      |      |
|           |            |         |           | 1715 MHz                 | 1732.5 MHz | 1750 MHz | [dB]                 | [dB] |
| 10 MHz    | QPSK       | 1       | 0         | 23.34                    | 23.23      | 23.32    | 0                    | 0    |
|           |            | 1       | 24        | 23.58                    | 23.43      | 23.66    | 0                    | 0    |
|           |            | 1       | 49        | 23.69                    | 23.12      | 23.44    | 0                    | 0    |
|           |            | 25      | 0         | 22.76                    | 22.76      | 22.77    | 0-1                  | 1    |
|           |            | 25      | 12        | 22.84                    | 22.67      | 22.81    | 0-1                  | 1    |
|           |            | 25      | 24        | 22.75                    | 22.79      | 22.73    | 0-1                  | 1    |
|           |            | 50      | 0         | 22.79                    | 22.74      | 22.83    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.61                    | 22.11      | 22.25    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.55                    | 22.55      | 22.19    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.53                    | 22.19      | 22.04    | 0-1                  | 1    |
|           |            | 25      | 0         | 21.77                    | 21.67      | 21.73    | 0-2                  | 2    |
|           |            | 25      | 12        | 21.74                    | 21.72      | 21.75    | 0-2                  | 2    |
|           |            | 25      | 24        | 21.66                    | 21.78      | 21.72    | 0-2                  | 2    |
|           |            | 50      | 0         | 21.79                    | 21.90      | 21.93    | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|----------------------|------|
|           |            |         |           | 20025                    | 20175      | 20325      |                      |      |
|           |            |         |           | 1717.5 MHz               | 1732.5 MHz | 1747.5 MHz | [dB]                 | [dB] |
| 15 MHz    | QPSK       | 1       | 0         | 23.21                    | 23.24      | 23.50      | 0                    | 0    |
|           |            | 1       | 36        | 23.60                    | 23.49      | 23.74      | 0                    | 0    |
|           |            | 1       | 74        | 23.47                    | 23.22      | 23.59      | 0                    | 0    |
|           |            | 36      | 0         | 22.94                    | 22.81      | 22.80      | 0-1                  | 1    |
|           |            | 36      | 18        | 22.85                    | 22.77      | 22.76      | 0-1                  | 1    |
|           |            | 36      | 38        | 22.83                    | 22.74      | 22.77      | 0-1                  | 1    |
|           |            | 75      | 0         | 22.90                    | 22.79      | 22.86      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.33                    | 22.14      | 22.46      | 0-1                  | 1    |
|           |            | 1       | 36        | 22.59                    | 22.66      | 22.82      | 0-1                  | 1    |
|           |            | 1       | 74        | 22.51                    | 22.43      | 22.70      | 0-1                  | 1    |
|           |            | 36      | 0         | 21.76                    | 21.60      | 21.77      | 0-2                  | 2    |
|           |            | 36      | 18        | 21.88                    | 21.78      | 21.75      | 0-2                  | 2    |
|           |            | 36      | 38        | 21.97                    | 21.76      | 21.77      | 0-2                  | 2    |
|           |            | 75      | 0         | 21.93                    | 21.71      | 21.74      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 20175                    | [dB]                 | [dB] |
|           |            |         |           | 1732.5 MHz               |                      |      |
| 20 MHz    | QPSK       | 1       | 0         | 23.53                    | 0                    | 0    |
|           |            | 1       | 49        | 23.54                    | 0                    | 0    |
|           |            | 1       | 99        | 23.33                    | 0                    | 0    |
|           |            | 50      | 0         | 22.79                    | 0-1                  | 1    |
|           |            | 50      | 25        | 22.79                    | 0-1                  | 1    |
|           |            | 50      | 49        | 22.76                    | 0-1                  | 1    |
|           |            | 100     | 0         | 22.70                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.89                    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.94                    | 0-1                  | 1    |
|           |            | 1       | 99        | 22.31                    | 0-1                  | 1    |
|           |            | 50      | 0         | 21.63                    | 0-2                  | 2    |
|           |            | 50      | 25        | 21.73                    | 0-2                  | 2    |
|           |            | 50      | 49        | 21.79                    | 0-2                  | 2    |
|           |            | 100     | 0         | 21.67                    | 0-2                  | 2    |

**Note:** LTE Band 4 (AWS) at 20 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## LTE Band 5

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|----------------------|------|
|           |            |         |           | 20407                    | 20525     | 20643     |                      |      |
|           |            |         |           | 824.7 MHz                | 836.5 MHz | 848.3 MHz | [dB]                 | [dB] |
| 1.4 MHz   | QPSK       | 1       | 0         | 23.32                    | 23.23     | 23.14     | 0                    | 0    |
|           |            | 1       | 3         | 23.23                    | 23.56     | 23.35     | 0                    | 0    |
|           |            | 1       | 5         | 23.19                    | 23.48     | 23.17     | 0                    | 0    |
|           |            | 3       | 0         | 23.28                    | 23.40     | 23.15     | 0                    | 0    |
|           |            | 3       | 1         | 23.36                    | 23.44     | 23.21     | 0                    | 0    |
|           |            | 3       | 3         | 23.36                    | 23.38     | 23.14     | 0                    | 0    |
|           | 16QAM      | 6       | 0         | 21.48                    | 21.62     | 21.24     | 0-1                  | 1    |
|           |            | 1       | 0         | 21.61                    | 21.90     | 21.23     | 0-1                  | 1    |
|           |            | 1       | 3         | 21.57                    | 21.48     | 21.33     | 0-1                  | 1    |
|           |            | 1       | 5         | 21.51                    | 21.26     | 21.20     | 0-1                  | 1    |
|           |            | 3       | 0         | 21.60                    | 21.77     | 21.40     | 0-1                  | 1    |
|           |            | 3       | 1         | 21.54                    | 21.73     | 21.39     | 0-1                  | 1    |
|           |            | 3       | 3         | 21.62                    | 21.59     | 21.32     | 0-1                  | 1    |
|           |            | 6       | 0         | 20.66                    | 20.68     | 20.43     | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|----------------------|------|
|           |            |         |           | 20415                    | 20525     | 20635     |                      |      |
|           |            |         |           | 825.5 MHz                | 836.5 MHz | 847.5 MHz | [dB]                 | [dB] |
| 3 MHz     | QPSK       | 1       | 0         | 23.30                    | 23.45     | 23.25     | 0                    | 0    |
|           |            | 1       | 7         | 23.52                    | 23.55     | 23.09     | 0                    | 0    |
|           |            | 1       | 14        | 23.33                    | 23.48     | 23.02     | 0                    | 0    |
|           |            | 8       | 0         | 21.52                    | 21.66     | 21.43     | 0-1                  | 1    |
|           |            | 8       | 3         | 21.53                    | 21.71     | 21.34     | 0-1                  | 1    |
|           |            | 8       | 7         | 21.54                    | 21.65     | 21.31     | 0-1                  | 1    |
|           | 16QAM      | 15      | 0         | 21.49                    | 21.66     | 21.39     | 0-1                  | 1    |
|           |            | 1       | 0         | 21.54                    | 21.55     | 21.90     | 0-1                  | 1    |
|           |            | 1       | 7         | 22.06                    | 21.57     | 21.77     | 0-1                  | 1    |
|           |            | 1       | 14        | 22.00                    | 21.52     | 21.67     | 0-1                  | 1    |
|           |            | 8       | 0         | 20.77                    | 20.93     | 20.75     | 0-2                  | 2    |
|           |            | 8       | 3         | 20.84                    | 20.95     | 20.61     | 0-2                  | 2    |
|           |            | 8       | 7         | 20.89                    | 20.99     | 20.60     | 0-2                  | 2    |
|           |            | 15      | 0         | 20.81                    | 20.86     | 20.72     | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP [dB] | MPR [dB] |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|---------------------------|----------|
|           |            |         |           | 20425                    | 20525     | 20625     |                           |          |
|           |            |         |           | 826.5 MHz                | 836.5 MHz | 846.5 MHz | [dB]                      | [dB]     |
| 5 MHz     | QPSK       | 1       | 0         | 23.10                    | 23.25     | 23.21     | 0                         | 0        |
|           |            | 1       | 12        | 23.46                    | 23.53     | 23.29     | 0                         | 0        |
|           |            | 1       | 24        | 23.29                    | 23.26     | 23.07     | 0                         | 0        |
|           |            | 12      | 0         | 21.55                    | 21.60     | 21.54     | 0-1                       | 1        |
|           |            | 12      | 6         | 21.60                    | 21.59     | 21.54     | 0-1                       | 1        |
|           |            | 12      | 11        | 21.49                    | 21.62     | 21.33     | 0-1                       | 1        |
|           |            | 25      | 0         | 21.50                    | 21.63     | 21.37     | 0-1                       | 1        |
|           | 16QAM      | 1       | 0         | 21.51                    | 21.53     | 21.23     | 0-1                       | 1        |
|           |            | 1       | 12        | 21.75                    | 21.56     | 21.34     | 0-1                       | 1        |
|           |            | 1       | 24        | 21.44                    | 21.57     | 21.08     | 0-1                       | 1        |
|           |            | 12      | 0         | 20.67                    | 20.70     | 20.65     | 0-2                       | 2        |
|           |            | 12      | 6         | 20.83                    | 20.69     | 20.65     | 0-2                       | 2        |
|           |            | 12      | 11        | 20.78                    | 20.87     | 20.47     | 0-2                       | 2        |
|           |            | 25      | 0         | 20.71                    | 20.83     | 20.70     | 0-2                       | 2        |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 20525                    | [dB]                 | [dB] |
|           |            |         |           | 836.5 MHz                |                      |      |
| 10 MHz    | QPSK       | 1       | 0         | 23.20                    | 0                    | 0    |
|           |            | 1       | 24        | 23.54                    | 0                    | 0    |
|           |            | 1       | 49        | 23.28                    | 0                    | 0    |
|           |            | 25      | 0         | 21.68                    | 0-1                  | 1    |
|           |            | 25      | 12        | 21.67                    | 0-1                  | 1    |
|           |            | 25      | 24        | 21.50                    | 0-1                  | 1    |
|           |            | 50      | 0         | 21.53                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.62                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.04                    | 0-1                  | 1    |
|           |            | 1       | 49        | 21.98                    | 0-1                  | 1    |
|           |            | 25      | 0         | 20.91                    | 0-2                  | 2    |
|           |            | 25      | 12        | 20.98                    | 0-2                  | 2    |
|           |            | 25      | 24        | 20.93                    | 0-2                  | 2    |
|           |            | 50      | 0         | 20.85                    | 0-2                  | 2    |

**Note:** LTE Band 5 at 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## LTE Band 12

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|----------------------|------|
|           |            |         |           | 23017                    | 23095     | 23173     |                      |      |
|           |            |         |           | 699.7 MHz                | 707.5 MHz | 715.3 MHz | [dB]                 | [dB] |
| 1.4 MHz   | QPSK       | 1       | 0         | 23.17                    | 23.53     | 23.55     | 0                    | 0    |
|           |            | 1       | 3         | 23.17                    | 23.72     | 23.57     | 0                    | 0    |
|           |            | 1       | 5         | 23.15                    | 23.50     | 23.33     | 0                    | 0    |
|           |            | 3       | 0         | 23.13                    | 23.60     | 23.55     | 0                    | 0    |
|           |            | 3       | 1         | 23.18                    | 23.61     | 23.56     | 0                    | 0    |
|           |            | 3       | 3         | 23.26                    | 23.50     | 23.45     | 0                    | 0    |
|           | 16QAM      | 6       | 0         | 22.19                    | 22.50     | 22.49     | 0-1                  | 1    |
|           |            | 1       | 0         | 21.64                    | 21.81     | 22.07     | 0-1                  | 1    |
|           |            | 1       | 3         | 22.24                    | 22.06     | 21.99     | 0-1                  | 1    |
|           |            | 1       | 5         | 21.68                    | 21.86     | 22.02     | 0-1                  | 1    |
|           |            | 3       | 0         | 22.08                    | 22.30     | 22.31     | 0-1                  | 1    |
|           |            | 3       | 1         | 22.06                    | 22.55     | 22.41     | 0-1                  | 1    |
|           |            | 3       | 3         | 22.13                    | 22.58     | 22.20     | 0-1                  | 1    |
|           |            | 6       | 0         | 21.16                    | 21.36     | 21.41     | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|----------------------|------|
|           |            |         |           | 23025                    | 23095     | 23165     |                      |      |
|           |            |         |           | 700.5 MHz                | 707.5 MHz | 714.5 MHz | [dB]                 | [dB] |
| 3 MHz     | QPSK       | 1       | 0         | 23.34                    | 23.51     | 23.51     | 0                    | 0    |
|           |            | 1       | 7         | 23.54                    | 23.62     | 23.52     | 0                    | 0    |
|           |            | 1       | 14        | 23.44                    | 23.47     | 23.35     | 0                    | 0    |
|           |            | 8       | 0         | 22.32                    | 22.56     | 22.49     | 0-1                  | 1    |
|           |            | 8       | 3         | 22.39                    | 22.55     | 22.46     | 0-1                  | 1    |
|           |            | 8       | 7         | 22.41                    | 22.53     | 22.38     | 0-1                  | 1    |
|           |            | 15      | 0         | 22.28                    | 22.50     | 22.47     | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.68                    | 21.69     | 22.49     | 0-1                  | 1    |
|           |            | 1       | 7         | 22.10                    | 22.12     | 22.14     | 0-1                  | 1    |
|           |            | 1       | 14        | 21.85                    | 21.89     | 21.88     | 0-1                  | 1    |
|           |            | 8       | 0         | 21.13                    | 21.51     | 21.53     | 0-2                  | 2    |
|           |            | 8       | 3         | 21.19                    | 21.57     | 21.57     | 0-2                  | 2    |
|           |            | 8       | 7         | 21.45                    | 21.66     | 21.64     | 0-2                  | 2    |
|           |            | 15      | 0         | 21.24                    | 21.61     | 21.64     | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |           |           | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|-----------|-----------|----------------------|------|
|           |            |         |           | 23035                    | 23095     | 23155     |                      |      |
|           |            |         |           | 701.5 MHz                | 707.5 MHz | 713.5 MHz | [dB]                 | [dB] |
| 5 MHz     | QPSK       | 1       | 0         | 23.14                    | 23.35     | 23.30     | 0                    | 0    |
|           |            | 1       | 12        | 23.23                    | 23.35     | 23.47     | 0                    | 0    |
|           |            | 1       | 24        | 23.25                    | 23.29     | 23.39     | 0                    | 0    |
|           |            | 12      | 0         | 22.76                    | 22.80     | 22.91     | 0-1                  | 1    |
|           |            | 12      | 6         | 22.68                    | 22.89     | 22.89     | 0-1                  | 1    |
|           |            | 12      | 11        | 22.68                    | 22.79     | 22.87     | 0-1                  | 1    |
|           |            | 25      | 0         | 22.69                    | 22.91     | 22.92     | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.16                    | 22.40     | 22.64     | 0-1                  | 1    |
|           |            | 1       | 12        | 22.24                    | 22.52     | 22.51     | 0-1                  | 1    |
|           |            | 1       | 24        | 22.01                    | 22.83     | 22.47     | 0-1                  | 1    |
|           |            | 12      | 0         | 21.49                    | 21.75     | 21.75     | 0-2                  | 2    |
|           |            | 12      | 6         | 21.55                    | 21.85     | 21.72     | 0-2                  | 2    |
|           |            | 12      | 11        | 21.51                    | 21.76     | 21.59     | 0-2                  | 2    |
|           |            | 25      | 0         | 21.64                    | 21.84     | 21.81     | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 23095                    | [dB]                 | [dB] |
|           |            |         |           | 707.5 MHz                |                      |      |
| 10 MHz    | QPSK       | 1       | 0         | 23.30                    | 0                    | 0    |
|           |            | 1       | 24        | 23.49                    | 0                    | 0    |
|           |            | 1       | 49        | 23.46                    | 0                    | 0    |
|           |            | 25      | 0         | 22.94                    | 0-1                  | 1    |
|           |            | 25      | 12        | 22.86                    | 0-1                  | 1    |
|           |            | 25      | 24        | 22.75                    | 0-1                  | 1    |
|           |            | 50      | 0         | 22.87                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.86                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.85                    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.51                    | 0-1                  | 1    |
|           |            | 25      | 0         | 21.92                    | 0-2                  | 2    |
|           |            | 25      | 12        | 21.89                    | 0-2                  | 2    |
|           |            | 25      | 24        | 21.77                    | 0-2                  | 2    |
|           |            | 50      | 0         | 21.80                    | 0-2                  | 2    |

**Note:** LTE Band 12 at 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## LTE Band 13

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 23230                    |                      |      |
|           |            |         |           | 782 MHz                  | [dB]                 | [dB] |
| 5 MHz     | QPSK       | 1       | 0         | 23.46                    | 0                    | 0    |
|           |            | 1       | 12        | 23.39                    | 0                    | 0    |
|           |            | 1       | 24        | 23.15                    | 0                    | 0    |
|           |            | 12      | 0         | 22.81                    | 0-1                  | 1    |
|           |            | 12      | 6         | 22.81                    | 0-1                  | 1    |
|           |            | 12      | 11        | 22.73                    | 0-1                  | 1    |
|           |            | 25      | 0         | 22.79                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.30                    | 0-1                  | 1    |
|           |            | 1       | 12        | 22.49                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.30                    | 0-1                  | 1    |
|           |            | 12      | 0         | 21.84                    | 0-2                  | 2    |
|           |            | 12      | 6         | 21.66                    | 0-2                  | 2    |
|           |            | 12      | 11        | 21.62                    | 0-2                  | 2    |
|           |            | 25      | 0         | 21.76                    | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 23230                    |                      |      |
|           |            |         |           | 782 MHz                  | [dB]                 | [dB] |
| 10 MHz    | QPSK       | 1       | 0         | 23.46                    | 0                    | 0    |
|           |            | 1       | 24        | 23.15                    | 0                    | 0    |
|           |            | 1       | 49        | 23.08                    | 0                    | 0    |
|           |            | 25      | 0         | 22.72                    | 0-1                  | 1    |
|           |            | 25      | 12        | 22.73                    | 0-1                  | 1    |
|           |            | 25      | 24        | 22.66                    | 0-1                  | 1    |
|           |            | 50      | 0         | 22.79                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.90                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.54                    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.53                    | 0-1                  | 1    |
|           |            | 25      | 0         | 21.78                    | 0-2                  | 2    |
|           |            | 25      | 12        | 21.86                    | 0-2                  | 2    |
|           |            | 25      | 24        | 21.88                    | 0-2                  | 2    |
|           |            | 50      | 0         | 21.71                    | 0-2                  | 2    |

**Note:** LTE Band 13 at 5 MHz/ 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## LTE Band 17

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 23790                    | [dB]                 | [dB] |
|           |            |         |           | 710 MHz                  |                      |      |
| 5 MHz     | QPSK       | 1       | 0         | 23.47                    | 0                    | 0    |
|           |            | 1       | 12        | 23.30                    | 0                    | 0    |
|           |            | 1       | 24        | 23.39                    | 0                    | 0    |
|           |            | 12      | 0         | 22.74                    | 0-1                  | 1    |
|           |            | 12      | 6         | 22.76                    | 0-1                  | 1    |
|           |            | 12      | 11        | 22.72                    | 0-1                  | 1    |
|           |            | 25      | 0         | 22.81                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.09                    | 0-1                  | 1    |
|           |            | 1       | 12        | 22.41                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.20                    | 0-1                  | 1    |
|           |            | 12      | 0         | 21.74                    | 0-2                  | 2    |
|           |            | 12      | 6         | 21.69                    | 0-2                  | 2    |
|           |            | 12      | 11        | 21.69                    | 0-2                  | 2    |
|           |            | 25      | 0         | 21.77                    | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------------------|------|
|           |            |         |           | 23790                    | [dB]                 | [dB] |
|           |            |         |           | 710 MHz                  |                      |      |
| 10 MHz    | QPSK       | 1       | 0         | 23.39                    | 0                    | 0    |
|           |            | 1       | 24        | 23.56                    | 0                    | 0    |
|           |            | 1       | 49        | 23.34                    | 0                    | 0    |
|           |            | 25      | 0         | 22.90                    | 0-1                  | 1    |
|           |            | 25      | 12        | 22.88                    | 0-1                  | 1    |
|           |            | 25      | 24        | 22.71                    | 0-1                  | 1    |
|           |            | 50      | 0         | 22.71                    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 22.68                    | 0-1                  | 1    |
|           |            | 1       | 24        | 22.33                    | 0-1                  | 1    |
|           |            | 1       | 49        | 22.18                    | 0-1                  | 1    |
|           |            | 25      | 0         | 21.94                    | 0-2                  | 2    |
|           |            | 25      | 12        | 21.87                    | 0-2                  | 2    |
|           |            | 25      | 24        | 21.84                    | 0-2                  | 2    |
|           |            | 50      | 0         | 21.79                    | 0-2                  | 2    |

**Note:** LTE Band 17 at 5 MHz & 10 MHz Bandwidth does not support three non-overlapping channels. Per KDB 941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the mid channel of the group of overlapping channels should be selected for testing.

## LTE TDD Band 41

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|------------|------------|----------------------|------|
|           |            |         |           | 39675                    | 40148      | 40620      | 41093      | 41565      | [dB]                 | [dB] |
|           |            |         |           | 2498.5 MHz               | 2545.8 MHz | 2593.0 MHz | 2640.3 MHz | 2687.5 MHz |                      |      |
| 5 MHz     | QPSK       | 1       | 0         | 23.02                    | 23.39      | 23.33      | 23.58      | 22.70      | 0                    | 0    |
|           |            | 1       | 12        | 23.12                    | 23.25      | 23.42      | 23.35      | 23.35      | 0                    | 0    |
|           |            | 1       | 24        | 23.33                    | 23.15      | 23.46      | 23.38      | 22.94      | 0                    | 0    |
|           |            | 12      | 0         | 22.08                    | 22.09      | 22.59      | 22.13      | 22.09      | 0-1                  | 1    |
|           |            | 12      | 6         | 21.81                    | 22.26      | 22.49      | 22.11      | 22.01      | 0-1                  | 1    |
|           |            | 12      | 11        | 22.03                    | 22.16      | 22.46      | 22.09      | 22.01      | 0-1                  | 1    |
|           |            | 25      | 0         | 22.10                    | 22.05      | 22.52      | 22.30      | 22.05      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.57                    | 21.79      | 21.98      | 21.76      | 21.40      | 0-1                  | 1    |
|           |            | 1       | 12        | 21.49                    | 21.71      | 21.90      | 21.74      | 21.41      | 0-1                  | 1    |
|           |            | 1       | 24        | 21.56                    | 21.66      | 21.92      | 21.79      | 21.34      | 0-1                  | 1    |
|           |            | 12      | 0         | 20.82                    | 21.01      | 21.13      | 20.98      | 20.60      | 0-2                  | 2    |
|           |            | 12      | 6         | 20.84                    | 21.06      | 21.14      | 20.97      | 20.59      | 0-2                  | 2    |
|           |            | 12      | 11        | 20.76                    | 21.10      | 21.11      | 20.94      | 20.50      | 0-2                  | 2    |
|           |            | 25      | 0         | 21.06                    | 21.28      | 21.61      | 21.54      | 20.61      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|------------|------------|----------------------|------|
|           |            |         |           | 39700                    | 40160      | 40620      | 41080      | 41540      | [dB]                 | [dB] |
|           |            |         |           | 2501.0 MHz               | 2547.0 MHz | 2593.0 MHz | 2639.0 MHz | 2685.0 MHz |                      |      |
| 10 MHz    | QPSK       | 1       | 0         | 22.93                    | 23.24      | 23.35      | 23.04      | 22.99      | 0                    | 0    |
|           |            | 1       | 24        | 23.06                    | 23.29      | 23.40      | 23.13      | 22.92      | 0                    | 0    |
|           |            | 1       | 49        | 23.48                    | 23.17      | 23.23      | 23.09      | 22.76      | 0                    | 0    |
|           |            | 25      | 0         | 21.95                    | 22.32      | 22.41      | 22.07      | 22.20      | 0-1                  | 1    |
|           |            | 25      | 12        | 21.95                    | 22.12      | 22.48      | 22.41      | 21.91      | 0-1                  | 1    |
|           |            | 25      | 24        | 22.17                    | 22.08      | 22.55      | 22.30      | 21.93      | 0-1                  | 1    |
|           |            | 50      | 0         | 22.07                    | 22.15      | 22.53      | 22.43      | 21.99      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.40                    | 21.72      | 22.15      | 21.93      | 22.17      | 0-1                  | 1    |
|           |            | 1       | 24        | 21.61                    | 21.76      | 21.96      | 21.94      | 22.08      | 0-1                  | 1    |
|           |            | 1       | 49        | 21.74                    | 21.60      | 21.65      | 21.69      | 21.31      | 0-1                  | 1    |
|           |            | 25      | 0         | 20.97                    | 21.54      | 21.24      | 21.30      | 20.73      | 0-2                  | 2    |
|           |            | 25      | 12        | 21.06                    | 21.41      | 21.39      | 21.35      | 20.63      | 0-2                  | 2    |
|           |            | 25      | 24        | 21.16                    | 21.02      | 21.52      | 21.52      | 20.66      | 0-2                  | 2    |
|           |            | 50      | 0         | 21.14                    | 21.15      | 21.51      | 21.51      | 20.82      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|------------|------------|----------------------|------|
|           |            |         |           | 39725                    | 40173      | 40620      | 41068      | 41515      |                      |      |
|           |            |         |           | 2503.5 MHz               | 2548.3 MHz | 2593.0 MHz | 2637.8 MHz | 2682.5 MHz | [dB]                 | [dB] |
| 15 MHz    | QPSK       | 1       | 0         | 23.01                    | 23.49      | 23.51      | 23.04      | 23.17      | 0                    | 0    |
|           |            | 1       | 36        | 23.43                    | 23.89      | 23.43      | 23.66      | 22.95      | 0                    | 0    |
|           |            | 1       | 74        | 23.21                    | 23.71      | 23.28      | 23.77      | 22.70      | 0                    | 0    |
|           |            | 36      | 0         | 21.98                    | 22.40      | 22.26      | 22.45      | 22.28      | 0-1                  | 1    |
|           |            | 36      | 18        | 21.91                    | 22.26      | 22.28      | 22.37      | 22.04      | 0-1                  | 1    |
|           |            | 36      | 39        | 22.15                    | 21.99      | 22.10      | 22.42      | 22.04      | 0-1                  | 1    |
|           |            | 75      | 0         | 22.11                    | 22.19      | 22.19      | 22.40      | 22.07      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.42                    | 21.96      | 21.94      | 22.56      | 21.86      | 0-1                  | 1    |
|           |            | 1       | 36        | 21.57                    | 21.70      | 22.17      | 22.41      | 21.51      | 0-1                  | 1    |
|           |            | 1       | 74        | 21.67                    | 21.52      | 21.67      | 22.46      | 21.22      | 0-1                  | 1    |
|           |            | 36      | 0         | 20.67                    | 21.16      | 21.25      | 21.43      | 20.89      | 0-2                  | 2    |
|           |            | 36      | 18        | 20.80                    | 21.03      | 21.28      | 21.35      | 20.72      | 0-2                  | 2    |
|           |            | 36      | 39        | 20.90                    | 21.04      | 21.23      | 21.34      | 20.62      | 0-2                  | 2    |
|           |            | 75      | 0         | 20.90                    | 21.08      | 21.27      | 21.27      | 20.83      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |            |            |            |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|------------|------------|------------|------------|----------------------|------|
|           |            |         |           | 39750                    | 40185      | 40620      | 41055      | 41490      |                      |      |
|           |            |         |           | 2506.0 MHz               | 2549.5 MHz | 2593.0 MHz | 2636.5 MHz | 2680.0 MHz | [dB]                 | [dB] |
| 20 MHz    | QPSK       | 1       | 0         | 23.02                    | 23.30      | 23.44      | 23.25      | 23.36      | 0                    | 0    |
|           |            | 1       | 49        | 23.18                    | 23.17      | 23.47      | 23.46      | 23.32      | 0                    | 0    |
|           |            | 1       | 99        | 23.17                    | 23.03      | 23.07      | 23.28      | 22.83      | 0                    | 0    |
|           |            | 50      | 0         | 22.07                    | 22.34      | 22.34      | 22.09      | 22.37      | 0-1                  | 1    |
|           |            | 50      | 25        | 22.16                    | 22.07      | 22.46      | 22.23      | 22.25      | 0-1                  | 1    |
|           |            | 50      | 49        | 22.15                    | 21.99      | 22.38      | 22.38      | 22.08      | 0-1                  | 1    |
|           |            | 100     | 0         | 22.09                    | 22.08      | 22.44      | 22.39      | 22.28      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.47                    | 21.93      | 22.67      | 21.78      | 21.91      | 0-1                  | 1    |
|           |            | 1       | 49        | 21.86                    | 21.87      | 22.16      | 21.92      | 21.76      | 0-1                  | 1    |
|           |            | 1       | 99        | 21.75                    | 21.47      | 21.57      | 21.80      | 21.10      | 0-1                  | 1    |
|           |            | 50      | 0         | 21.05                    | 21.05      | 21.15      | 21.04      | 20.93      | 0-2                  | 2    |
|           |            | 50      | 25        | 21.14                    | 21.10      | 21.13      | 21.18      | 20.82      | 0-2                  | 2    |
|           |            | 50      | 49        | 21.01                    | 21.15      | 21.06      | 21.09      | 20.59      | 0-2                  | 2    |
|           |            | 100     | 0         | 20.87                    | 21.21      | 21.20      | 21.13      | 20.79      | 0-2                  | 2    |

## LTE Band 66

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 131979                   | 132322   | 132665     |                      |      |
|           |            |         |           | 1710.7 MHz               | 1745 MHz | 1779.3 MHz | [dB]                 | [dB] |
| 1.4 MHz   | QPSK       | 1       | 0         | 23.32                    | 23.32    | 23.35      | 0                    | 0    |
|           |            | 1       | 3         | 23.37                    | 23.38    | 23.53      | 0                    | 0    |
|           |            | 1       | 5         | 23.22                    | 23.33    | 23.51      | 0                    | 0    |
|           |            | 3       | 0         | 23.24                    | 23.28    | 23.45      | 0                    | 0    |
|           |            | 3       | 1         | 23.28                    | 23.34    | 23.61      | 0                    | 0    |
|           |            | 3       | 3         | 23.23                    | 23.39    | 23.55      | 0                    | 0    |
|           |            | 6       | 0         | 21.61                    | 21.62    | 21.76      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.21                    | 21.17    | 21.29      | 0-1                  | 1    |
|           |            | 1       | 3         | 21.38                    | 21.53    | 21.61      | 0-1                  | 1    |
|           |            | 1       | 5         | 20.94                    | 21.36    | 21.26      | 0-1                  | 1    |
|           |            | 3       | 0         | 21.43                    | 21.40    | 21.52      | 0-1                  | 1    |
|           |            | 3       | 1         | 21.42                    | 21.12    | 21.66      | 0-1                  | 1    |
|           |            | 3       | 3         | 21.42                    | 21.35    | 21.57      | 0-1                  | 1    |
|           |            | 6       | 0         | 20.32                    | 20.37    | 20.60      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 131987                   | 132322   | 132657     |                      |      |
|           |            |         |           | 1711.5 MHz               | 1745 MHz | 1778.5 MHz | [dB]                 | [dB] |
| 3 MHz     | QPSK       | 1       | 0         | 23.46                    | 23.40    | 23.36      | 0                    | 0    |
|           |            | 1       | 7         | 23.28                    | 23.37    | 23.34      | 0                    | 0    |
|           |            | 1       | 14        | 23.33                    | 23.42    | 23.57      | 0                    | 0    |
|           |            | 8       | 0         | 21.59                    | 21.70    | 21.75      | 0-1                  | 1    |
|           |            | 8       | 3         | 21.62                    | 21.70    | 21.77      | 0-1                  | 1    |
|           |            | 8       | 7         | 21.57                    | 21.68    | 21.82      | 0-1                  | 1    |
|           |            | 15      | 0         | 21.59                    | 21.70    | 21.76      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.16                    | 21.79    | 20.85      | 0-1                  | 1    |
|           |            | 1       | 7         | 21.35                    | 21.71    | 21.29      | 0-1                  | 1    |
|           |            | 1       | 14        | 21.81                    | 21.85    | 21.42      | 0-1                  | 1    |
|           |            | 8       | 0         | 20.59                    | 20.72    | 20.81      | 0-2                  | 2    |
|           |            | 8       | 3         | 20.60                    | 20.74    | 20.93      | 0-2                  | 2    |
|           |            | 8       | 7         | 20.67                    | 20.70    | 20.99      | 0-2                  | 2    |
|           |            | 15      | 0         | 20.66                    | 20.67    | 20.87      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 131997                   | 132322   | 132647     |                      |      |
|           |            |         |           | 1712.5 MHz               | 1745 MHz | 1777.5 MHz | [dB]                 | [dB] |
| 5 MHz     | QPSK       | 1       | 0         | 23.21                    | 23.54    | 23.43      | 0                    | 0    |
|           |            | 1       | 12        | 23.42                    | 23.62    | 23.88      | 0                    | 0    |
|           |            | 1       | 24        | 23.30                    | 23.59    | 23.57      | 0                    | 0    |
|           |            | 12      | 0         | 21.48                    | 21.80    | 21.82      | 0-1                  | 1    |
|           |            | 12      | 6         | 21.51                    | 21.90    | 22.04      | 0-1                  | 1    |
|           |            | 12      | 11        | 21.62                    | 21.85    | 21.99      | 0-1                  | 1    |
|           |            | 25      | 0         | 21.61                    | 21.74    | 22.09      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.06                    | 21.52    | 21.98      | 0-1                  | 1    |
|           |            | 1       | 12        | 21.19                    | 21.49    | 21.68      | 0-1                  | 1    |
|           |            | 1       | 24        | 21.08                    | 21.42    | 21.97      | 0-1                  | 1    |
|           |            | 12      | 0         | 20.45                    | 20.72    | 20.66      | 0-2                  | 2    |
|           |            | 12      | 6         | 20.49                    | 20.77    | 20.83      | 0-2                  | 2    |
|           |            | 12      | 11        | 20.61                    | 20.74    | 20.87      | 0-2                  | 2    |
|           |            | 25      | 0         | 20.82                    | 20.81    | 21.05      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |          | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|----------|----------------------|------|
|           |            |         |           | 132022                   | 132322   | 132622   |                      |      |
|           |            |         |           | 1715 MHz                 | 1745 MHz | 1775 MHz | [dB]                 | [dB] |
| 10 MHz    | QPSK       | 1       | 0         | 23.37                    | 23.52    | 23.53    | 0                    | 0    |
|           |            | 1       | 24        | 23.60                    | 23.65    | 23.55    | 0                    | 0    |
|           |            | 1       | 49        | 23.28                    | 23.51    | 23.74    | 0                    | 0    |
|           |            | 25      | 0         | 21.02                    | 21.39    | 21.46    | 0-1                  | 1    |
|           |            | 25      | 12        | 21.11                    | 21.45    | 21.40    | 0-1                  | 1    |
|           |            | 25      | 24        | 21.09                    | 21.34    | 21.44    | 0-1                  | 1    |
|           |            | 50      | 0         | 21.09                    | 21.36    | 21.39    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.39                    | 21.10    | 21.57    | 0-1                  | 1    |
|           |            | 1       | 24        | 21.79                    | 21.54    | 21.43    | 0-1                  | 1    |
|           |            | 1       | 49        | 21.83                    | 21.33    | 21.63    | 0-1                  | 1    |
|           |            | 25      | 0         | 20.15                    | 20.25    | 20.36    | 0-2                  | 2    |
|           |            | 25      | 12        | 20.06                    | 20.41    | 20.38    | 0-2                  | 2    |
|           |            | 25      | 24        | 20.07                    | 20.43    | 20.62    | 0-2                  | 2    |
|           |            | 50      | 0         | 20.20                    | 20.44    | 20.47    | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |            | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|------------|----------------------|------|
|           |            |         |           | 132047                   | 132322   | 132597     |                      |      |
|           |            |         |           | 1717.5 MHz               | 1745 MHz | 1772.5 MHz | [dB]                 | [dB] |
| 15 MHz    | QPSK       | 1       | 0         | 23.29                    | 23.64    | 23.38      | 0                    | 0    |
|           |            | 1       | 36        | 23.39                    | 23.74    | 23.54      | 0                    | 0    |
|           |            | 1       | 74        | 23.22                    | 23.41    | 23.73      | 0                    | 0    |
|           |            | 36      | 0         | 21.64                    | 21.82    | 21.85      | 0-1                  | 1    |
|           |            | 36      | 18        | 21.63                    | 21.83    | 21.87      | 0-1                  | 1    |
|           |            | 36      | 38        | 21.44                    | 21.75    | 21.90      | 0-1                  | 1    |
|           |            | 75      | 0         | 21.43                    | 21.86    | 21.83      | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.24                    | 20.92    | 21.62      | 0-1                  | 1    |
|           |            | 1       | 36        | 21.93                    | 21.23    | 21.46      | 0-1                  | 1    |
|           |            | 1       | 74        | 21.73                    | 20.91    | 21.45      | 0-1                  | 1    |
|           |            | 36      | 0         | 20.63                    | 20.75    | 20.93      | 0-2                  | 2    |
|           |            | 36      | 18        | 20.76                    | 20.89    | 20.94      | 0-2                  | 2    |
|           |            | 36      | 38        | 20.57                    | 20.83    | 21.11      | 0-2                  | 2    |
|           |            | 75      | 0         | 20.57                    | 20.81    | 20.91      | 0-2                  | 2    |

| Bandwidth | Modulation | RB Size | RB Offset | Max. Average Power (dBm) |          |          | MPR Allowed Per 3GPP | MPR  |
|-----------|------------|---------|-----------|--------------------------|----------|----------|----------------------|------|
|           |            |         |           | 132072                   | 132322   | 132572   |                      |      |
|           |            |         |           | 1720 MHz                 | 1745 MHz | 1770 MHz | [dB]                 | [dB] |
| 20 MHz    | QPSK       | 1       | 0         | 23.28                    | 23.52    | 23.56    | 0                    | 0    |
|           |            | 1       | 49        | 23.66                    | 23.71    | 23.73    | 0                    | 0    |
|           |            | 1       | 99        | 23.47                    | 23.39    | 23.77    | 0                    | 0    |
|           |            | 50      | 0         | 21.81                    | 21.95    | 21.90    | 0-1                  | 1    |
|           |            | 50      | 25        | 21.67                    | 21.83    | 21.94    | 0-1                  | 1    |
|           |            | 50      | 49        | 21.67                    | 21.82    | 21.98    | 0-1                  | 1    |
|           |            | 100     | 0         | 21.67                    | 21.81    | 21.93    | 0-1                  | 1    |
|           | 16QAM      | 1       | 0         | 21.25                    | 22.08    | 21.63    | 0-1                  | 1    |
|           |            | 1       | 49        | 21.76                    | 21.20    | 22.10    | 0-1                  | 1    |
|           |            | 1       | 99        | 21.27                    | 20.95    | 22.16    | 0-1                  | 1    |
|           |            | 50      | 0         | 20.66                    | 20.77    | 20.85    | 0-2                  | 2    |
|           |            | 50      | 25        | 20.67                    | 20.92    | 21.06    | 0-2                  | 2    |
|           |            | 50      | 49        | 20.64                    | 20.92    | 20.95    | 0-2                  | 2    |
|           |            | 100     | 0         | 20.67                    | 20.82    | 20.98    | 0-2                  | 2    |

**Note;**

The EUT enables maximum power reduction in accordance with 3GPP 36.101. The MPR settings are configured during the manufacture process and are not configurable by the network, carrier, or end user.

## 9.2 WiFi Conducted Output Power

### WiFi Maximum Conducted Power

#### IEEE 802.11 Average Conducted Power

| Mode              | Freq. | Channel | IEEE 802.11 (2.4 GHz)<br>Conducted Power |
|-------------------|-------|---------|------------------------------------------|
|                   | [MHz] |         | [dBm]                                    |
| 802.11b           | 2 412 | 1       | 16.01                                    |
|                   | 2 417 | 2       | 14.97                                    |
|                   | 2 437 | 6       | 15.03                                    |
|                   | 2 457 | 10      | 15.17                                    |
|                   | 2 462 | 11      | 14.52                                    |
| 802.11g           | 2 412 | 1       | 10.48                                    |
|                   | 2 417 | 2       | 13.42                                    |
|                   | 2 437 | 6       | 13.74                                    |
|                   | 2 457 | 10      | 13.71                                    |
|                   | 2 462 | 11      | 12.02                                    |
| 802.11n<br>(HT20) | 2 412 | 1       | 10.49                                    |
|                   | 2 417 | 2       | 12.38                                    |
|                   | 2 437 | 6       | 15.74                                    |
|                   | 2 457 | 10      | 15.73                                    |
|                   | 2 462 | 11      | 11.01                                    |

### WiFi Reduced Conducted Power (Held to ear VoIP)

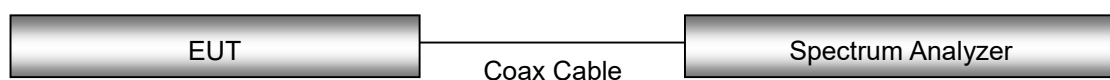
#### IEEE 802.11 Reduced Average RF Conducted Power

| Mode               | Freq. | Channel | IEEE 802.11 (2.4 GHz)<br>Conducted Power |
|--------------------|-------|---------|------------------------------------------|
|                    | [MHz] |         | [dBm]                                    |
| 802.11b            | 2 412 | 1       | 14.54                                    |
|                    | 2 437 | 6       | 14.47                                    |
|                    | 2 462 | 11      | 14.02                                    |
| 802.11n(6ch ~10ch) | 2 437 | 6       | 14.37                                    |
|                    | 2 457 | 10      | 14.28                                    |

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission mode with the same maximum output power specification, powers were measured for the largest channel bandwidth, lowest order modulation and lowest data rate.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.
- For each transmission mode configuration, powers were measured for the highest and lowest channels; and at the mid-band channel(s) when there were at least 3 channels supported. For configurations with multiple mid-band channels, due to an even number of channels, both channels were measured.

### Test Configuration



## 10. TEST PROCEDURE

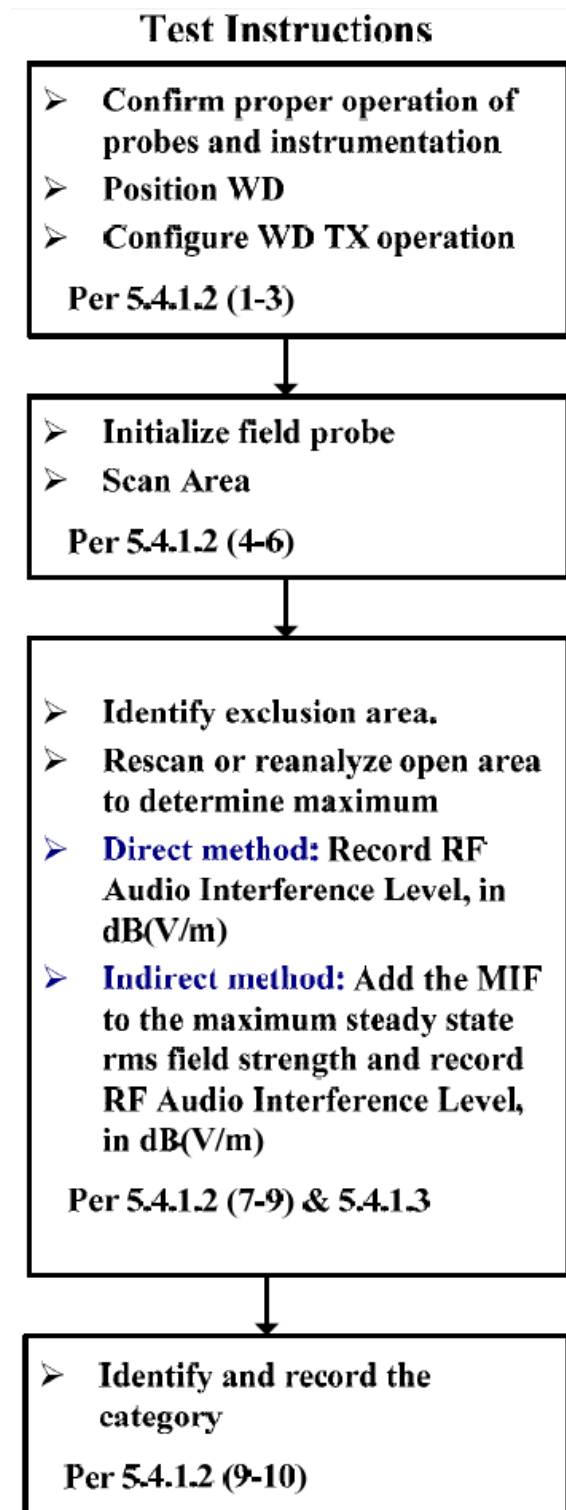


Figure 6. WD near-field emission automated test flowchart

**The evaluation was performed with the following procedure:**

1. Confirm 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. The measurement should be performed at a distance 1.5 cm from the probe elements so the gauge block can simplify this positioning.
3. Configure the WD normal operation for maximum rated RF output power, at the desired channel and other operating parameters, as intended for the test.
4. The center sub-grid shall be centered on the center of the WD output (acoustic or T-Coil output), as appropriate.
5. A Surface calibration was performed before each setup change to ensure repeatable spacing and proper maintenance of the measurement plane using the HAC Phantom.
6. Locate the field probe at reference location and measure the field strength.
7. Scan the entire 5 cm by 5 cm region at 5 mm increments and record the reading at each measurement point.
8. Identify the maximum field reading within the non-excluded sub-grids identified in Step 7.
9. Move the probe to the location of maximum scan measurement and then 360° rotating the probe to align it for the maximum reading at that position.
10. Locate the field probe at the reference location and measure the field strength for drift evaluation. If conducted power deviations of more than 5 % occurred, the tests were repeated.
11. Convert the maximum field strength reading identified in Step 8 to V/m or A/m, as appropriate. For probes which require a probe modulation factor, this conversion shall be done using the appropriate probe modulation.
12. Repeat Step 1 through Step 11 for both the E field measurements.

## 11. ANSI/IEEE C63.19 PERFORMANCE CATEGORIES

The EUT must meet the following M3 or M4 category:

| Emission Categories | E-field emissions<br>dB [V/m] |           |
|---------------------|-------------------------------|-----------|
|                     | < 960 MHz                     | > 960 MHz |
| Category M1         | 50 to 55                      | 40 to 45  |
| Category M2         | 45 to 50                      | 35 to 40  |
| Category M3         | 40 to 45                      | 30 to 35  |
| Category M4         | < 40                          | < 30      |

Telephone near-field categories in linear units

## 12. MEASUREMENT UNCERTAINTIES

| Error Description                  | Uncertainty value<br>[±%] | Probe Dist. | Div.       | (Ci)<br>E | (Ci)<br>H | Std. Unc.<br>E<br>[±%] | Std. Unc.<br>H<br>[±%] |
|------------------------------------|---------------------------|-------------|------------|-----------|-----------|------------------------|------------------------|
| <b>Measurement System</b>          |                           |             |            |           |           |                        |                        |
| Probe Calibration                  | 5.1                       | N           | 1          | 1         | 1         | 5.1                    | 5.1                    |
| Axial Isotropy                     | 4.7                       | R           | $\sqrt{3}$ | 1         | 1         | 2.7                    | 2.7                    |
| Sensor Displacement                | 16.5                      | R           | $\sqrt{3}$ | 1         | 0.145     | 9.5                    | 1.4                    |
| Boundary Effects                   | 2.4                       | R           | $\sqrt{3}$ | 1         | 1         | 1.4                    | 1.4                    |
| Phantom Boundary Effect            | 7.2                       | R           | $\sqrt{3}$ | 1         | 0         | 4.1                    | 0.0                    |
| Linearity                          | 4.7                       | R           | $\sqrt{3}$ | 1         | 1         | 2.7                    | 2.7                    |
| Scaling with PMR calibration       | 10.0                      | R           | $\sqrt{3}$ | 1         | 1         | 5.8                    | 5.8                    |
| System Detection Limit             | 1.0                       | R           | $\sqrt{3}$ | 1         | 1         | 0.6                    | 0.6                    |
| Readout Electronics                | 0.3                       | N           | 1          | 1         | 1         | 0.3                    | 0.3                    |
| Response Time                      | 0.8                       | R           | $\sqrt{3}$ | 1         | 1         | 0.5                    | 0.5                    |
| Integration Time                   | 2.6                       | R           | $\sqrt{3}$ | 1         | 1         | 1.5                    | 1.5                    |
| RF Ambient Conditions              | 3.0                       | R           | $\sqrt{3}$ | 1         | 1         | 1.7                    | 1.7                    |
| RF Reflections                     | 12                        | R           | $\sqrt{3}$ | 1         | 1         | 6.9                    | 6.9                    |
| Probe Positioner                   | 1.2                       | R           | $\sqrt{3}$ | 1         | 0.67      | 0.7                    | 0.5                    |
| Probe Positioning                  | 4.7                       | R           | $\sqrt{3}$ | 1         | 0.67      | 2.7                    | 1.8                    |
| Extrap. and Interpolation          | 1.0                       | R           | $\sqrt{3}$ | 1         | 1         | 0.6                    | 0.6                    |
| <b>Test Sample Related</b>         |                           |             |            |           |           |                        |                        |
| Device Positioning Vertical        | 4.7                       | R           | $\sqrt{3}$ | 1         | 0.67      | 2.7                    | 1.8                    |
| Device Positioning Lateral         | 1.0                       | R           | $\sqrt{3}$ | 1         | 1         | 0.6                    | 0.6                    |
| Device Holder and Phantom          | 2.4                       | R           | $\sqrt{3}$ | 1         | 1         | 1.4                    | 1.4                    |
| Power Drift                        | 5.0                       | R           | $\sqrt{3}$ | 1         | 1         | 2.9                    | 2.9                    |
| <b>Phantom and Setup Related</b>   |                           |             |            |           |           |                        |                        |
| Phantom Thickness                  | 2.4                       | R           | $\sqrt{3}$ | 1         | 0.67      | 1.4                    | 0.9                    |
| Combined Std. Uncertainty          |                           |             |            |           |           | 16.3                   | 12.3                   |
| Expanded Std. Uncertainty on Power |                           |             |            |           |           | <b>32.6</b>            | <b>24.6</b>            |
| Expanded Std. Uncertainty on Field |                           |             |            |           |           | <b>16.3</b>            | <b>12.3</b>            |

## 13. HAC TEST DATA SUMMARY

### E-Field Measurement Result (GSM850/GSM1900)

| Mode    | Channel | Conducted Power [dBm] | Time Avg. Filed [V/m] | Audio Inteference Level [dBV/m] | FCC Limit [dBV/m] | FCC Margin [dB] | MIF  | Result | Exclusion Block |
|---------|---------|-----------------------|-----------------------|---------------------------------|-------------------|-----------------|------|--------|-----------------|
| GSM850  | 128     | 31.79                 | 47.92                 | 37.07                           | 45                | 7.93            | 3.46 | M4     | none            |
|         | 190     | 31.83                 | 52.42                 | 37.85                           | 45                | 7.15            | 3.46 | M4     | none            |
|         | 251     | 32.06                 | 45.24                 | 36.57                           | 45                | 8.43            | 3.46 | M4     | none            |
| GSM1900 | 512     | 29.59                 | 18.71                 | 28.90                           | 35                | 6.10            | 3.46 | M4     | none            |
|         | 661     | 29.40                 | 18.99                 | 29.05                           | 35                | 5.95            | 3.48 | M4     | none            |
|         | 810     | 29.87                 | 17.54                 | 28.38                           | 35                | 6.62            | 3.50 | M4     | none            |

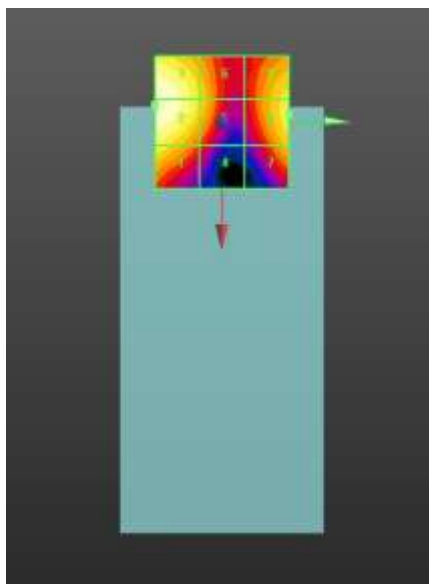
### E-Field Measurement Result (LTE TDD)

| Mode             | Channel | Mod.  | BW | RB Size | RB offset | Conducted Power [dBm] | Time Avg. Filed [V/m] | Audio Inteference Level [dBV/m] | FCC Limit [dBV/m] | FCC Margin [dB] | MIF   | Result | Exclusion Block |
|------------------|---------|-------|----|---------|-----------|-----------------------|-----------------------|---------------------------------|-------------------|-----------------|-------|--------|-----------------|
| LTE TDD/ Band 41 | 39750   | 16QAM | 20 | 1       | 0         | 21.47                 | 17.16                 | 23.09                           | 35                | 11.91           | -1.60 | M4     | none            |
|                  | 40185   | 16QAM | 20 | 1       | 0         | 21.93                 | 18.71                 | 23.86                           | 35                | 11.14           | -1.58 | M4     | none            |
|                  | 40620   | 16QAM | 20 | 1       | 0         | 22.67                 | 18.64                 | 23.83                           | 35                | 11.17           | -1.58 | M4     | none            |
|                  | 41055   | 16QAM | 20 | 1       | 0         | 21.78                 | 16.63                 | 22.81                           | 35                | 12.19           | -1.61 | M4     | none            |
|                  | 41490   | 16QAM | 20 | 1       | 0         | 21.91                 | 15.69                 | 22.31                           | 35                | 12.69           | -1.60 | M4     | none            |

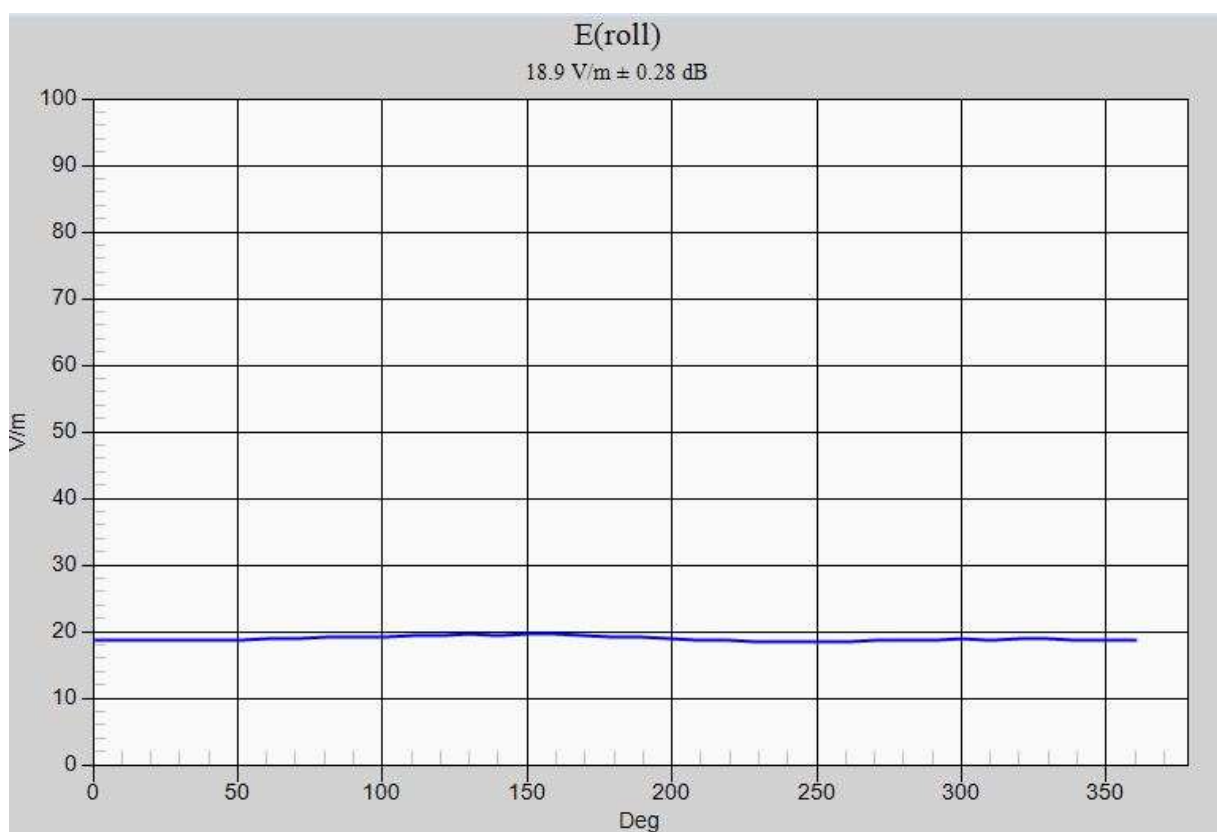
## 12.3 Worst-case Configuration Evaluation

| Mode    | Channel | Time Avg. Filed [V/m] | Audio Inteference Level [dBV/m] | FCC Limit [dBV/m] | FCC Margin [dB] | MIF  | Result | Exclusion Block |
|---------|---------|-----------------------|---------------------------------|-------------------|-----------------|------|--------|-----------------|
| GSM1900 | 661     | 19.52                 | 29.29                           | 35                | 5.71            | 3.48 | M4     | none            |

Peak Reading 360° Probe Rotation at Azimuth axis



Sample E-field Scan Overlay  
(See Test setup Photographs for actual WD overlay)



Worst-case Probe Rotation about Azimuth axis

## 14. HAC TEST EQUIPMENT LIST

| Manufacturer | Type / Model                               | S/N             | Calib. Date | Calib.Interval | Calib.Due  |
|--------------|--------------------------------------------|-----------------|-------------|----------------|------------|
| SPEAG        | HAC Phantom                                | -               | N/A         | N/A            | N/A        |
| HP           | SAR System Control PC                      | -               | N/A         | N/A            | N/A        |
| Staubli      | TX90 XLSpeag                               | F11/5K3RA1/A/01 | N/A         | N/A            | N/A        |
| Staubli      | CS8Cspeag-TX90                             | F11/5K3RA1/C/01 | N/A         | N/A            | N/A        |
| Staubli      | Teach Pendant (Joystick)                   | S-1203 0309     | N/A         | N/A            | N/A        |
| SPEAG        | DAE4                                       | 1417            | 01/16/2018  | Annual         | 01/16/2019 |
| SPEAG        | E-Field Probe EF3DV3                       | 4034            | 02/15/2018  | Annual         | 02/15/2019 |
| SPEAG        | Dipole CD835V3                             | 1024            | 02/20/2018  | Annual         | 02/20/2019 |
| SPEAG        | Dipole CD1880V3                            | 1019            | 02/20/2018  | Annual         | 02/20/2019 |
| SPEAG        | Dipole CD2450V3                            | 1022            | 02/20/2018  | Annual         | 02/20/2019 |
| SPEAG        | Audio Interference Analyzer                | 1060            | N/A         | CBT*           | N/A        |
| Agilent      | Power Meter E4419B                         | MY41291386      | 10/11/2017  | Annual         | 10/11/2018 |
| Agilent      | Power Sensor 8481A                         | SG1091286       | 10/12/2017  | Annual         | 10/12/2018 |
| Agilent      | Power Sensor 8481A                         | MY41090873      | 10/12/2017  | Annual         | 10/12/2018 |
| Agilent      | Base Station E5515C                        | GB44400269      | 02/02/2018  | Annual         | 02/02/2019 |
| HP           | Signal Generator E4433B                    | US40052109      | 03/06/2018  | Annual         | 03/06/2019 |
| HP           | 11636B/Power Divider                       | 58698           | 03/06/2018  | Annual         | 03/06/2019 |
| TESTO        | 175-H1/Thermometer                         | 40331949309     | 02/06/2018  | Annual         | 02/06/2019 |
| EMPOWER      | RF Power Amplifier                         | 1084            | 06/11/2018  | Annual         | 06/11/2019 |
| MICRO LAB    | LP Filter / LA-15N                         | 10453           | 10/12/2017  | Annual         | 10/12/2018 |
| MICRO LAB    | LP Filter / LA-30N                         | -               | 10/12/2017  | Annual         | 10/12/2018 |
| Apitech      | Attenuator (3dB) 18B-03                    | 1               | 06/07/2018  | Annual         | 06/07/2019 |
| Agilent      | Attenuator (20dB) 33340C                   | 13311           | 05/10/2018  | Annual         | 05/10/2019 |
| Agilent      | Directional Bridge                         | 3140A03878      | 06/11/2018  | Annual         | 06/11/2019 |
| R&S          | Wideband Radio Communication Tester CMW500 | 162431          | 07/26/2018  | Annual         | 07/26/2019 |
| Agilent      | Signal Analyzer N9020A                     | MY50510407      | 11/02/2017  | Annual         | 11/02/2018 |

\*note: CBT (calibrated Before Testing).Prior to testing, AIA Perform self calibration procedures.

## **15. CONCLUSION**

The HAC measurement indicates that the EUT complies with the HAC limits of the ANSI-C63.19-2011. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise Laboratory measures were taken to assure repeatability of the tests.

## Attachment 1. HAC RF Emission Test Plots

Measurement Standard DASYS[IEEE/IEC/ANSI C63.19-2011]

GSM Frequency: 836.6 MHz;Duty Cycle: 1:8.6896

DASY5 Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

## GSM850 E-Field 190ch

**Hearing Aid Compatibility Test (101x101x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 48.15 V/m; Power Drift = 0.04 dB

Applied MIF = 3.46 dB

RF audio interference level = 37.85 dBV/m

Emission category: M4

MIF scaled E-field

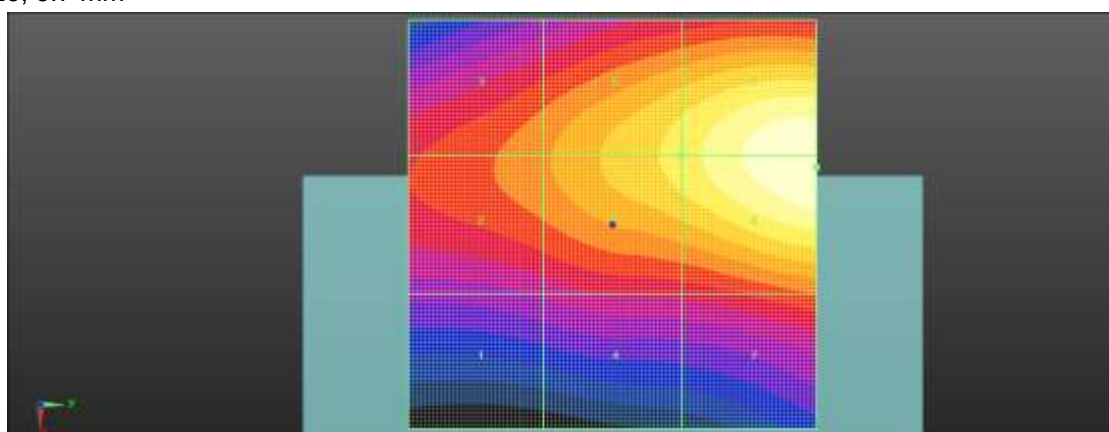
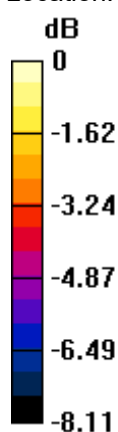
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M4<br>33.13 dBV/m | Grid 2 M4<br>35.07 dBV/m | Grid 3 M4<br>35.06 dBV/m |
| Grid 4 M4<br>33.7 dBV/m  | Grid 5 M4<br>36.52 dBV/m | Grid 6 M4<br>36.52 dBV/m |
| Grid 7 M4<br>34.63 dBV/m | Grid 8 M4<br>37.85 dBV/m | Grid 9 M4<br>37.82 dBV/m |

### Cursor:

Total = 37.85 dBV/m

E Category: M4

Location: -7, 25, 8.7 mm



0 dB = 78.08 V/m = 37.85 dBV/m

Measurement Standard DASYS[IEEE/IEC/ANSI C63.19-2011]  
GSM1900/ Frequency: 1880 MHz;Duty Cycle: 1:8.6896

DASY5 Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

## GSM1900 E-Field 661ch

**Hearing Aid Compatibility Test (101x101x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 8.463 V/m; Power Drift = -0.06 dB

Applied MIF = 3.48 dB

RF audio interference level = 29.05 dBV/m

Emission category: M4

MIF scaled E-field

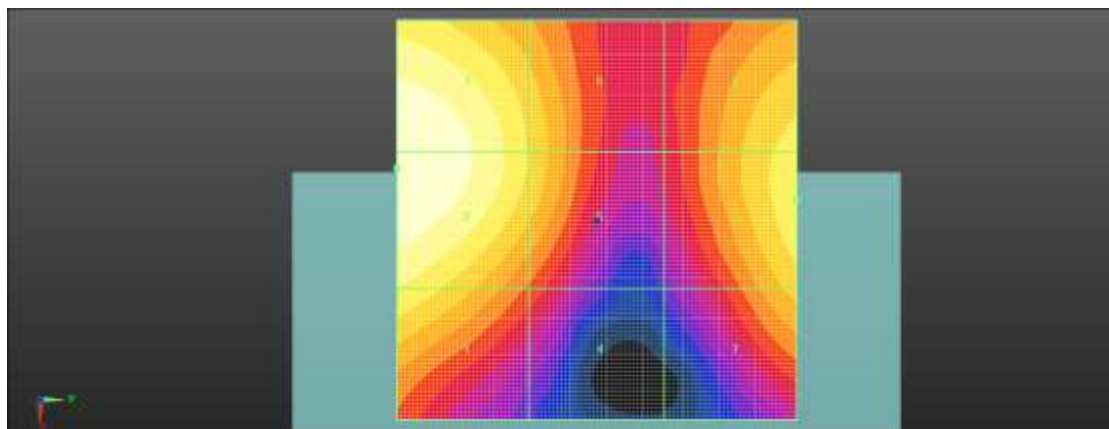
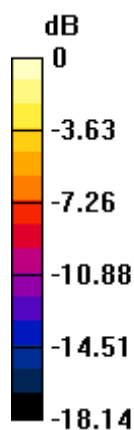
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M4<br>26.64 dBV/m | Grid 2 M4<br>29.05 dBV/m | Grid 3 M4<br>29.03 dBV/m |
| Grid 4 M4<br>21.6 dBV/m  | Grid 5 M4<br>25.39 dBV/m | Grid 6 M4<br>25.37 dBV/m |
| Grid 7 M4<br>24.73 dBV/m | Grid 8 M4<br>26.27 dBV/m | Grid 9 M4<br>26 dBV/m    |

### Cursor:

Total = 29.05 dBV/m

E Category: M4

Location: -6.5, -25, 8.7 mm



0 dB = 28.36 V/m = 29.05 dBV/m

**Measurement Standard DASY5[IEEE/IEC/ANSI C63.19-2011]**

LTE-TDD /Frequency: 2549.5 MHz;Duty Cycle: 1:2.41

DASY5 Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

**LTE Band41 E-Field 20MHz 16QAM 1RB 0offset 40620ch**
**Hearing Aid Compatibility Test (101x101x1):** Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 16.55 V/m; Power Drift = -0.03 dB

Applied MIF = -1.58 dB

RF audio interference level = 23.86 dBV/m

**Emission category: M4**

MIF scaled E-field

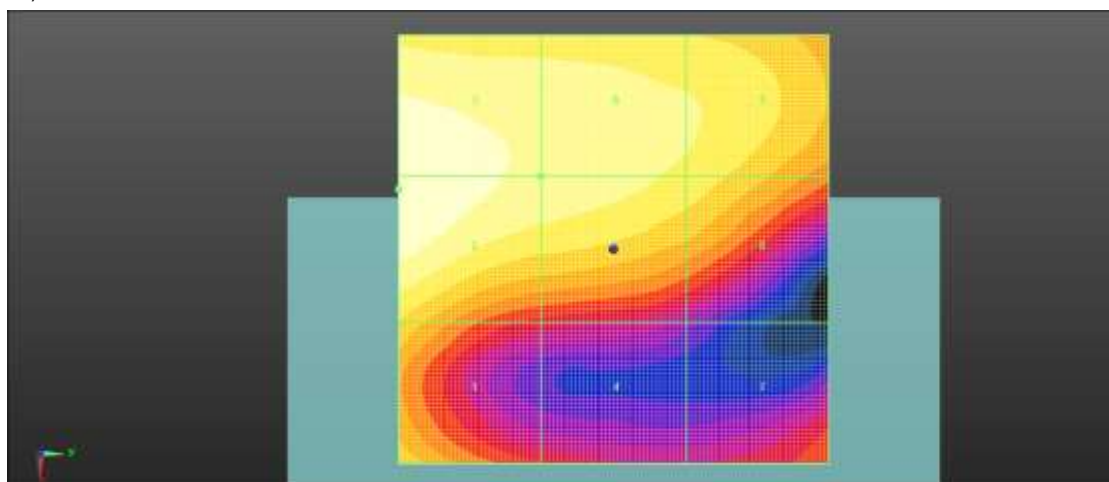
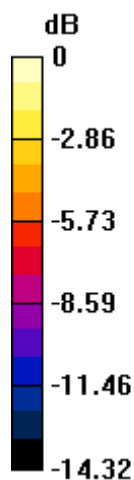
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M4<br>20.97 dBV/m | Grid 2 M4<br>23.86 dBV/m | Grid 3 M4<br>23.84 dBV/m |
| Grid 4 M4<br>17.33 dBV/m | Grid 5 M4<br>22.67 dBV/m | Grid 6 M4<br>22.77 dBV/m |
| Grid 7 M4<br>18.23 dBV/m | Grid 8 M4<br>21.66 dBV/m | Grid 9 M4<br>22.09 dBV/m |

**Cursor:**

Total = 23.86 dBV/m

E Category: M4

Location: -7, -25, 8.7 mm



0 dB = 15.60 V/m = 23.86 dBV/m

## Attachment 2. System Validation Plots

**DUT: HAC-Dipole 835 MHz; Type: D835V3**

Frequency: 835 MHz;Duty Cycle: 1:1

DASY5 Configuration:

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

**835MHz E-Field Validation**

Hearing Aid Compatibility Test (41x361x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 56.34 V/m; Power Drift = -0.04 dB

Applied MIF = 0.00 dB

RF audio interference level = 41.56 dBV/m

Emission category: M3

**MIF scaled E-field**

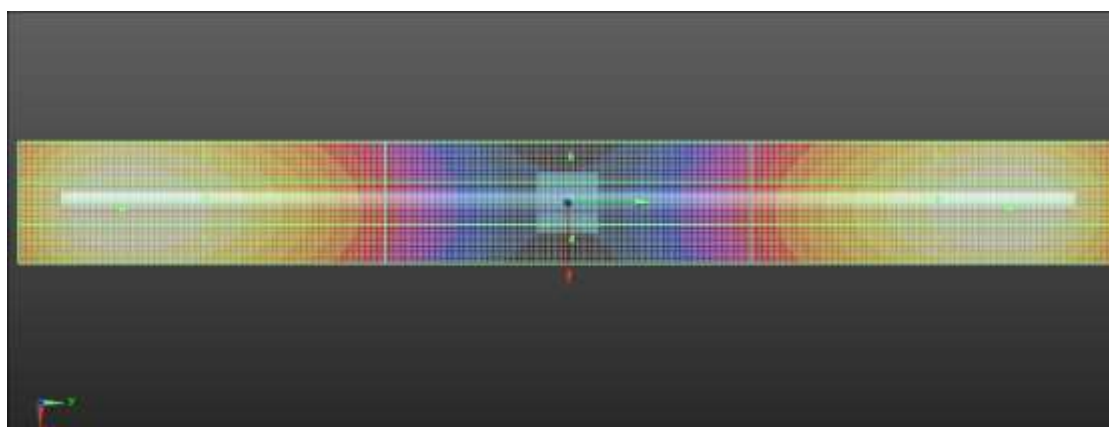
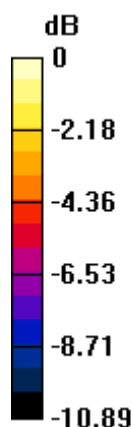
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M3<br>41.48 dBV/m | Grid 2 M3<br>41.56 dBV/m | Grid 3 M3<br>41.27 dBV/m |
| Grid 4 M4<br>36.36 dBV/m | Grid 5 M4<br>36.41 dBV/m | Grid 6 M4<br>36.16 dBV/m |
| Grid 7 M3<br>41.45 dBV/m | Grid 8 M3<br>41.55 dBV/m | Grid 9 M3<br>41.25 dBV/m |

**Cursor:**

Total = 41.56 dBV/m

E Category: M3

Location: 1, -73, 10.7 mm



0 dB = 119.7 V/m = 41.56 dBV/m

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3**

Frequency: 1880 MHz; Duty Cycle: 1:1

**DASY5 Configuration:**

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

**1880MHz E-Field Validation**

Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 70.95 V/m; Power Drift = 0.00 dB

Applied MIF = 0.00 dB

RF audio interference level = 39.53 dBV/m

Emission category: M2

**MIF scaled E-field**

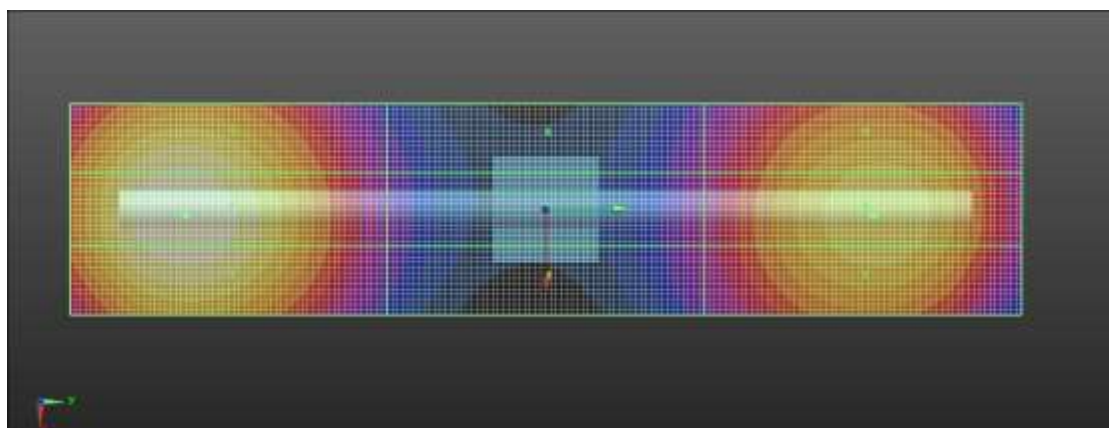
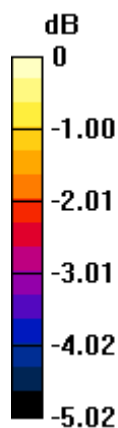
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M2<br>39.43 dBV/m | Grid 2 M2<br>39.53 dBV/m | Grid 3 M2<br>39.28 dBV/m |
| Grid 4 M2<br>36.59 dBV/m | Grid 5 M2<br>36.62 dBV/m | Grid 6 M2<br>36.5 dBV/m  |
| Grid 7 M2<br>38.72 dBV/m | Grid 8 M2<br>38.83 dBV/m | Grid 9 M2<br>38.63 dBV/m |

**Cursor:**

Total = 39.53 dBV/m

E Category: M2

Location: 0.5, -34, 10.7 mm



0 dB = 94.72 V/m = 39.53 dBV/m

**DUT: HAC Dipole 2600 MHz; Type: CD2600V3**

Frequency: 2600 MHz; Duty Cycle: 1:1

**DASY5 Configuration:**

- Probe: EF3DV3 - SN4034; ConvF(1, 1, 1); Calibrated: 2/15/2018;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn1417; Calibrated: 1/16/2018
- Phantom: HAC Test Arch with AMCC\_RF\_2018\_04\_27
- Measurement SW: DASY52, Version 52.8 (8);

**2600MHz E-Field Validation**

Hearing Aid Compatibility Test (41x181x1): Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 75.78 V/m; Power Drift = 0.01 dB

Applied MIF = 0.00 dB

RF audio interference level = 38.58 dBV/m

Emission category: M2

**MIF scaled E-field**

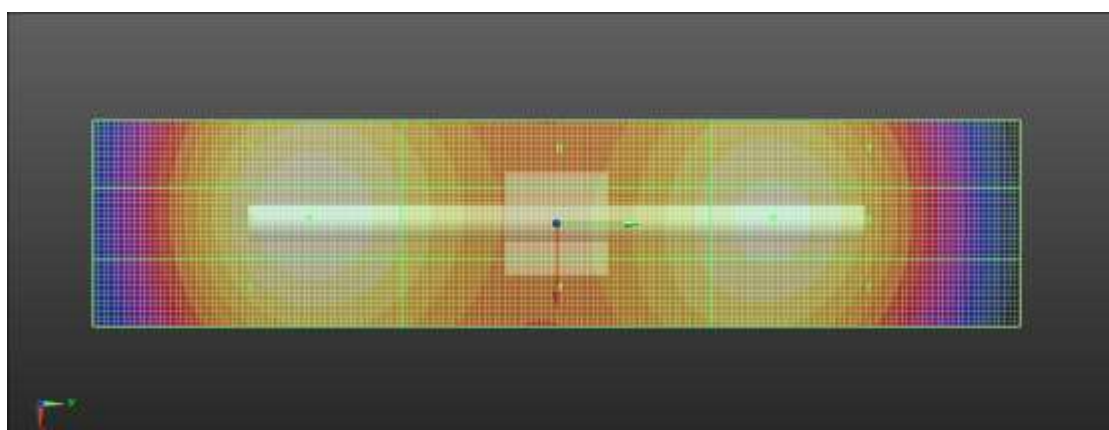
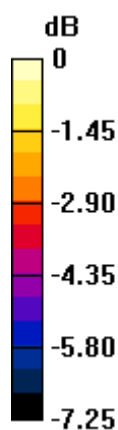
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M2<br>38.35 dBV/m | Grid 2 M2<br>38.58 dBV/m | Grid 3 M2<br>38.47 dBV/m |
| Grid 4 M2<br>37.76 dBV/m | Grid 5 M2<br>37.84 dBV/m | Grid 6 M2<br>37.73 dBV/m |
| Grid 7 M2<br>38.14 dBV/m | Grid 8 M2<br>38.29 dBV/m | Grid 9 M2<br>38.17 dBV/m |

**Cursor:**

Total = 38.58 dBV/m

E Category: M2

Location: -0.5, -24, 10.7 mm



0 dB = 84.94 V/m = 38.58 dBV/m

## Attachment 3. Probe Calibration Data

**Calibration Laboratory of  
Schmid & Partner  
Engineering AG**  
Zeughausstrasse 43, 8004 Zurich, Switzerland



**S** Schweizerischer Kalibrierdienst  
**C** Service suisse d'étalonnage  
**S** Servizio svizzero di taratura  
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)  
The Swiss Accreditation Service is one of the signatories to the EA  
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **EF3-4034\_Feb18**

## CALIBRATION CERTIFICATE

Object **EF3DV3 - SN:4034**

Calibration procedure(s) **QA CAL-02.v8, QA CAL-25.v6**  
Calibration procedure for E-field probes optimized for close near field  
evaluations in air

Calibration date: **February 15, 2018**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^\circ\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&E critical for calibration)

| Primary Standards          | ID               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|----------------------------|------------------|-----------------------------------|------------------------|
| Power meter NRP            | SN: 10477B       | 04-Apr-17 (No. 217-02521/02522)   | Apr-18                 |
| Power sensor NRP-Z91       | SN: 103244       | 04-Apr-17 (No. 217-02521)         | Apr-18                 |
| Power sensor NRP-Z91       | SN: 103245       | 04-Apr-17 (No. 217-02525)         | Apr-18                 |
| Reference 20 dB Attenuator | SN: S5277 (20x)  | 07-Apr-17 (No. 217-02528)         | Apr-18                 |
| Reference Probe ER3DV6     | SN: 2328         | 10-Oct-17 (No. ER3-2328_Oct17)    | Oct-18                 |
| DAE4                       | SN: 789          | 2-Aug-17 (No. DAE4-789_Aug17)     | Aug-18                 |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A        | SN: MY41498067   | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E  | SN: US37390585   | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

|                                                                                                                 | Name          | Function              | Signature |
|-----------------------------------------------------------------------------------------------------------------|---------------|-----------------------|-----------|
| Calibrated by:                                                                                                  | Michael Weber | Laboratory Technician |           |
| Approved by:                                                                                                    | Katja Pokovic | Technical Manager     |           |
| Issued: February 17, 2018                                                                                       |               |                       |           |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |               |                       |           |

Certificate No: EF3-4034\_Feb18

Page 1 of 11

| 결<br>재 | 담<br>당<br>자  | 화<br>인<br>자  |
|--------|--------------|--------------|
| 직위/성명  | SW 18.04.18  | HW 18.04.18  |
| 일 자    | 2018. 10. 06 | 2018. 10. 06 |

**Calibration Laboratory of**  
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Accreditation No.: **SCS 0108**

**Glossary:**

|                        |                                                                                                                                                   |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| NORM <sub>x,y,z</sub>  | sensitivity in free space                                                                                                                         |
| DCP                    | diode compression point                                                                                                                           |
| CF                     | crest factor (1/duty_cycle) of the RF signal                                                                                                      |
| A, B, C, D             | modulation dependent linearization parameters                                                                                                     |
| Polarization $\varphi$ | $\varphi$ rotation around probe axis                                                                                                              |
| Polarization $\theta$  | $\theta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\theta = 0$ is normal to probe axis |
| Connector Angle        | information used in DASY system to align probe sensor X to the robot coordinate system                                                            |

**Calibration is Performed According to the Following Standards:**

- IEEE Std 1309-2005, "IEEE Standard for calibration of electromagnetic field sensors and probes, excluding antennas, from 9 kHz to 40 GHz", December 2005
- CTIA Test Plan for Hearing Aid Compatibility, Rev 3.0, November 2013

**Methods Applied and Interpretation of Parameters:**

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\theta = 0$  for XY sensors and  $\theta = 90$  for Z sensor ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide).
- NORM( $f$ )<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* frequency\_response (see Frequency Response Chart).
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A<sub>x,y,z</sub>; B<sub>x,y,z</sub>; C<sub>x,y,z</sub>; D<sub>x,y,z</sub>; VR<sub>x,y,z</sub>; A, B, C, D** are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- Spherical isotropy (3D deviation from isotropy)**: in a locally homogeneous field realized using an open waveguide setup.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM<sub>x</sub> (no uncertainty required).

EF3DV3 – SN:4034

February 15, 2018

# Probe EF3DV3

## SN:4034

Manufactured: August 22, 2013  
Calibrated: February 15, 2018

Calibrated for DASY/EASY Systems  
(Note: non-compatible with DASY2 system!)

EF3DV3 – SN:4034

February 15, 2018

## DASY/EASY - Parameters of Probe: EF3DV3 - SN:4034

### Basic Calibration Parameters

|                          | Sensor X | Sensor Y | Sensor Z | Unc (k=2)    |
|--------------------------|----------|----------|----------|--------------|
| Norm ( $\mu V/(V/m)^2$ ) | 0.92     | 0.76     | 1.33     | $\pm 10.1\%$ |
| DCP (mV) <sup>a</sup>    | 96.9     | 96.1     | 96.5     |              |

### Modulation Calibration Parameters

| UID       | Communication System Name                      |   | A<br>dB | B<br>dB $\sqrt{\mu V}$ | C    | D<br>dB | VR<br>mV | Unc <sup>b</sup><br>(k=2) |
|-----------|------------------------------------------------|---|---------|------------------------|------|---------|----------|---------------------------|
| 0         | CW                                             | X | 0.0     | 0.0                    | 1.0  | 0.00    | 146.4    | $\pm 3.0\%$               |
|           |                                                | Y | 0.0     | 0.0                    | 1.0  |         | 174.0    |                           |
|           |                                                | Z | 0.0     | 0.0                    | 1.0  |         | 137.9    |                           |
| 10021-DAC | GSM-FDD (TDMA, GMSK)                           | X | 1.79    | 66.5                   | 13.1 | 9.39    | 127.7    | $\pm 1.7\%$               |
|           |                                                | Y | 2.27    | 66.8                   | 14.7 |         | 137.0    |                           |
|           |                                                | Z | 2.24    | 70.4                   | 15.5 |         | 142.4    |                           |
| 10061-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)      | X | 3.13    | 71.3                   | 21.1 | 3.60    | 136.8    | $\pm 0.7\%$               |
|           |                                                | Y | 2.93    | 68.9                   | 19.4 |         | 120.6    |                           |
|           |                                                | Z | 3.01    | 70.2                   | 20.4 |         | 128.7    |                           |
| 10069-CAC | IEEE 802.11a/n WiFi 5 GHz (OFDM, 54 Mbps)      | X | 11.04   | 70.7                   | 24.8 | 10.56   | 141.0    | $\pm 2.2\%$               |
|           |                                                | Y | 10.72   | 69.6                   | 23.9 |         | 121.0    |                           |
|           |                                                | Z | 10.77   | 70.0                   | 24.3 |         | 130.3    |                           |
| 10077-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps) | X | 9.84    | 69.4                   | 24.6 | 11.00   | 117.8    | $\pm 3.3\%$               |
|           |                                                | Y | 10.32   | 71.1                   | 25.6 |         | 140.8    |                           |
|           |                                                | Z | 10.22   | 71.0                   | 25.7 |         | 148.8    |                           |
| 10173-CAD | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, 16-QAM)        | X | 6.37    | 73.3                   | 26.3 | 9.48    | 141.2    | $\pm 2.5\%$               |
|           |                                                | Y | 6.29    | 72.4                   | 25.5 |         | 124.7    |                           |
|           |                                                | Z | 6.12    | 72.3                   | 25.7 |         | 131.3    |                           |
| 10295-AAB | CDMA2000, RC1, SC03, 1/8th Rate 25 fr.         | X | 5.44    | 69.2                   | 26.2 | 12.49   | 116.4    | $\pm 1.2\%$               |
|           |                                                | Y | 5.62    | 69.9                   | 26.2 |         | 105.1    |                           |
|           |                                                | Z | 5.30    | 68.8                   | 26.0 |         | 108.8    |                           |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

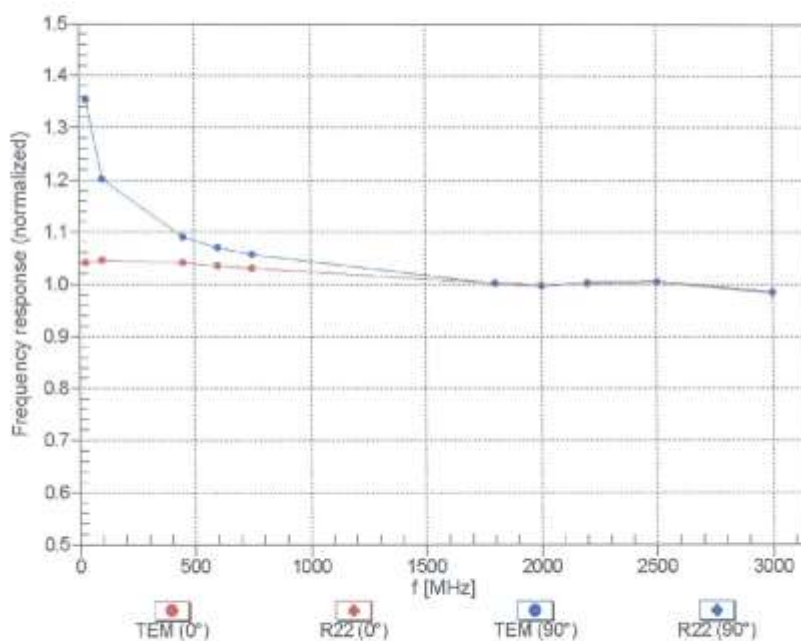
<sup>a</sup> Numerical linearization parameter; uncertainty not required.

<sup>b</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EF3DV3 – SN:4034

February 15, 2018

### Frequency Response of E-Field (TEM-Cell: ifi110 EXX, Waveguide: R22)

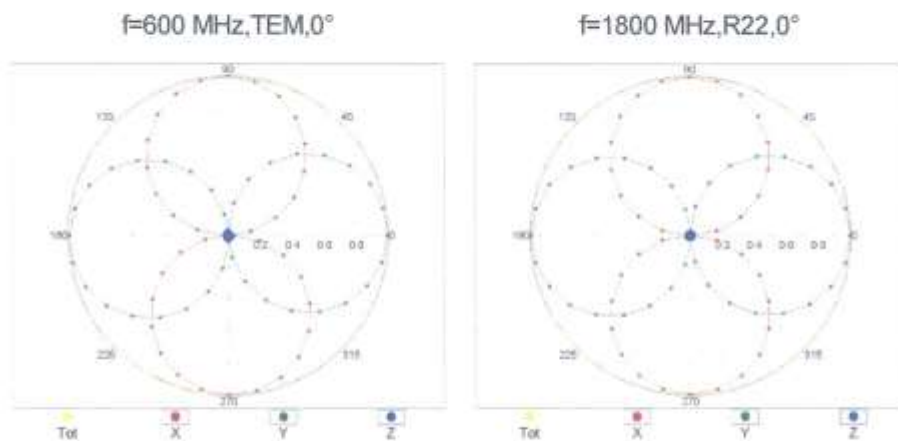


Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

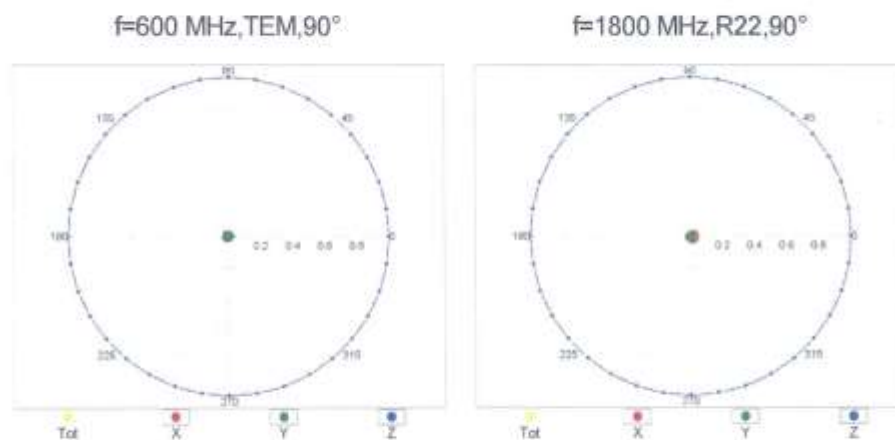
EF3DV3 – SN:4034

February 15, 2018

### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$



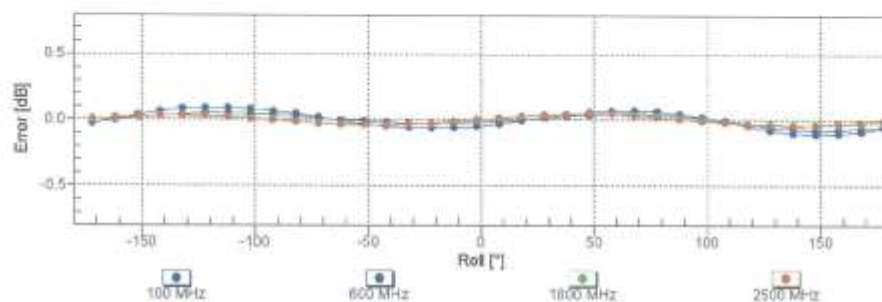
### Receiving Pattern ( $\phi$ ), $\theta = 90^\circ$



EF3DV3 – SN:4034

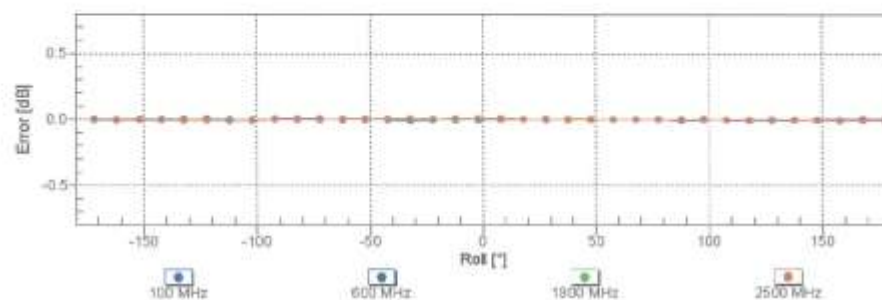
February 15, 2018

### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$



Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

### Receiving Pattern ( $\phi$ ), $\theta = 90^\circ$

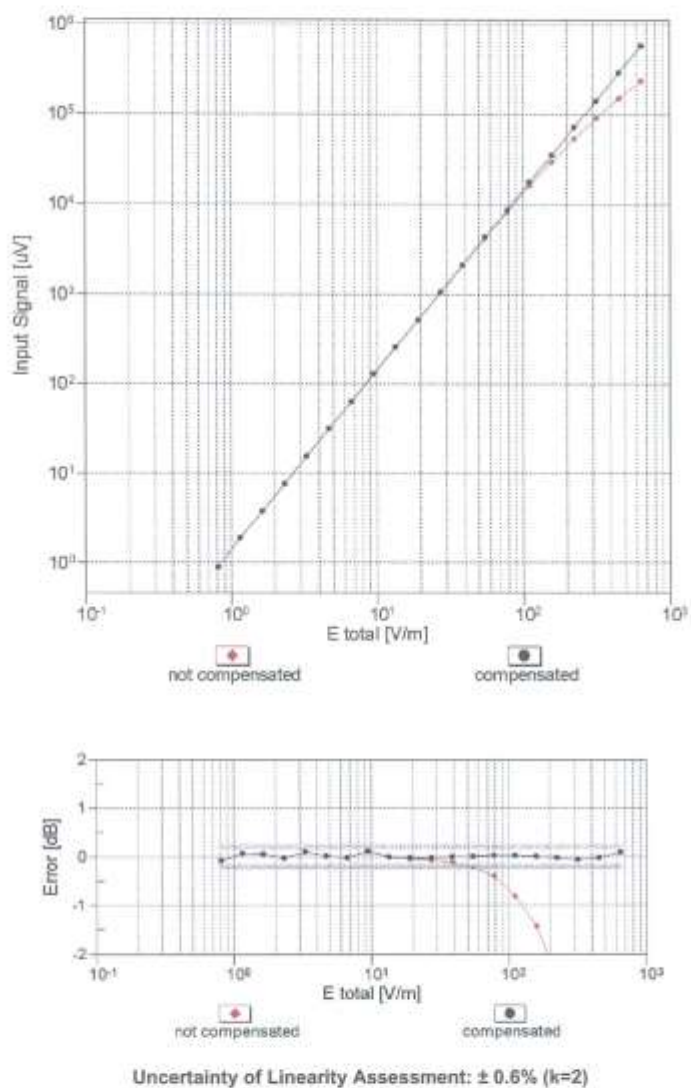


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

EF3DV3 – SN:4034

February 15, 2018

### Dynamic Range f(E-field) (TEM cell , f = 900 MHz)

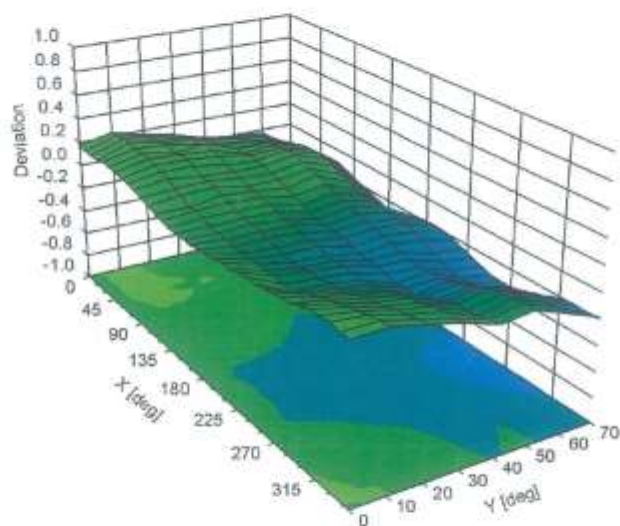


EF3DV3 – SN:4034

February 15, 2018

### Deviation from Isotropy in Air

Error ( $\phi$ ,  $\theta$ ),  $f = 900$  MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

EF3DV3 – SN:4034

February 15, 2018

## DASY/EASY - Parameters of Probe: EF3DV3 - SN:4034

### Other Probe Parameters

|                                         |             |
|-----------------------------------------|-------------|
| Sensor Arrangement                      | Rectangular |
| Connector Angle (°)                     | 8           |
| Mechanical Surface Detection Mode       | enabled     |
| Optical Surface Detection Mode          | disabled    |
| Probe Overall Length                    | 335 mm      |
| Probe Body Diameter                     | 12 mm       |
| Tip Length                              | 25 mm       |
| Tip Diameter                            | 4 mm        |
| Probe Tip to Sensor X Calibration Point | 2.5 mm      |
| Probe Tip to Sensor Y Calibration Point | 2.5 mm      |
| Probe Tip to Sensor Z Calibration Point | 2.5 mm      |

EF3DV3 – SN:4034

February 15, 2018

## Appendix (Additional assessments outside the scope of SCS 0108)

### Calibration Parameters for 3-4 GHz

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>a</sup> | 1.06     | 0.89     | 1.46     | ± 10.1 %  |
| DCP (mV) <sup>b</sup>                                     | 96.9     | 96.1     | 96.5     |           |

### Calibration Parameters for 5-6 GHz

|                                                           | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-----------------------------------------------------------|----------|----------|----------|-----------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) <sup>a</sup> | 1.25     | 1.04     | 1.74     | ± 10.1 %  |
| DCP (mV) <sup>b</sup>                                     | 96.9     | 96.1     | 96.5     |           |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>a</sup> Numerical linearization parameter; uncertainty not required.

<sup>b</sup> Calibration procedure for frequencies above 3 GHz is pending accreditation.

## Attachment 4. Dipole Calibration Data

**Calibration Laboratory of**  
**Schmid & Partner**  
**Engineering AG**  
 Zeughausstrasse 43, 8004 Zurich, Switzerland



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 Swiss Calibration Service

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 Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **CD835V3-1024\_Feb18**

## CALIBRATION CERTIFICATE

Object **CD835V3 - SN: 1024**

Calibration procedure(s) **QA CAL-20.v6**  
 Calibration procedure for dipoles in air

Calibration date: **February 20, 2018**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
 The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature ( $22 \pm 3$ )°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)      | Scheduled Calibration |
|-----------------------------|--------------------|---------------------------------|-----------------------|
| Power meter NRP             | SN: 104778         | 04-Apr-17 (No. 217-02521/02522) | Apr-18                |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-17 (No. 217-02521)       | Apr-18                |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-17 (No. 217-02522)       | Apr-18                |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 07-Apr-17 (No. 217-02528)       | Apr-18                |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529)       | Apr-18                |
| Probe EF3DV3                | SN: 4013           | 14-Jun-17 (No. EF3-4013_Jun17)  | Jun-18                |
| DAE4                        | SN: 781            | 17-Jan-18 (No. DAE4-781_Jan18)  | Jan-19                |

| Secondary Standards       | ID #           | Check Date (in house)             | Scheduled Check        |
|---------------------------|----------------|-----------------------------------|------------------------|
| Power meter Agilent 4419B | SN: GB42420191 | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP E4412A    | SN: US38485102 | 05-Jan-10 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP 8482A     | SN: US37295597 | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| RF generator R&S SMT-06   | SN: 832283/011 | 27-Aug-12 (in house check Oct-17) | In house check: Oct-20 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

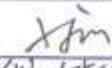
|                | Name          | Function              | Signature                                                                             |
|----------------|---------------|-----------------------|---------------------------------------------------------------------------------------|
| Calibrated by: | Leif Klysner  | Laboratory Technician |  |
| Approved by:   | Katja Pokovic | Technical Manager     |   |

Issued: February 20, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: CD835V3-1024\_Feb18

Page 1 of 5

| 결     | 담당자                                                                                  | 확인자                                                                                   |
|-------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 재     |  |  |
| 작위/성명 | SW 17543                                                                             | 4013 2018                                                                             |
| 일 자   | 2018 03.06                                                                           | 2018 03.06                                                                            |

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Accreditation No.: **SCS 0108**

#### References

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

#### Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

### Measurement Conditions

DASY system configuration, as far as not given on page 1.

|                                    |                     |          |
|------------------------------------|---------------------|----------|
| DASY Version                       | DASY5               | V52.10.0 |
| Phantom                            | HAC Test Arch       |          |
| Distance Dipole Top - Probe Center | 15 mm               |          |
| Scan resolution                    | dx, dy = 5 mm       |          |
| Frequency                          | 835 MHz $\pm$ 1 MHz |          |
| Input power drift                  | < 0.05 dB           |          |

### Maximum Field values at 835 MHz

| E-field 15 mm above dipole surface | condition          | Interpolated maximum         |
|------------------------------------|--------------------|------------------------------|
| Maximum measured above high end    | 100 mW input power | 110.7 V/m = 40.88 dBV/m      |
| Maximum measured above low end     | 100 mW input power | 110.3 V/m = 40.85 dBV/m      |
| Averaged maximum above arm         | 100 mW input power | 110.5 V/m $\pm$ 12.8 % (k=2) |

### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters

| Frequency | Return Loss | Impedance                       |
|-----------|-------------|---------------------------------|
| 800 MHz   | 16.5 dB     | 39.1 $\Omega$ - 7.7 j $\Omega$  |
| 835 MHz   | 21.5 dB     | 54.2 $\Omega$ + 7.7 j $\Omega$  |
| 880 MHz   | 15.9 dB     | 64.0 $\Omega$ - 11.7 j $\Omega$ |
| 900 MHz   | 15.9 dB     | 54.2 $\Omega$ - 16.3 j $\Omega$ |
| 945 MHz   | 21.8 dB     | 48.9 $\Omega$ + 8.0 j $\Omega$  |

#### 3.2 Antenna Design and Handling

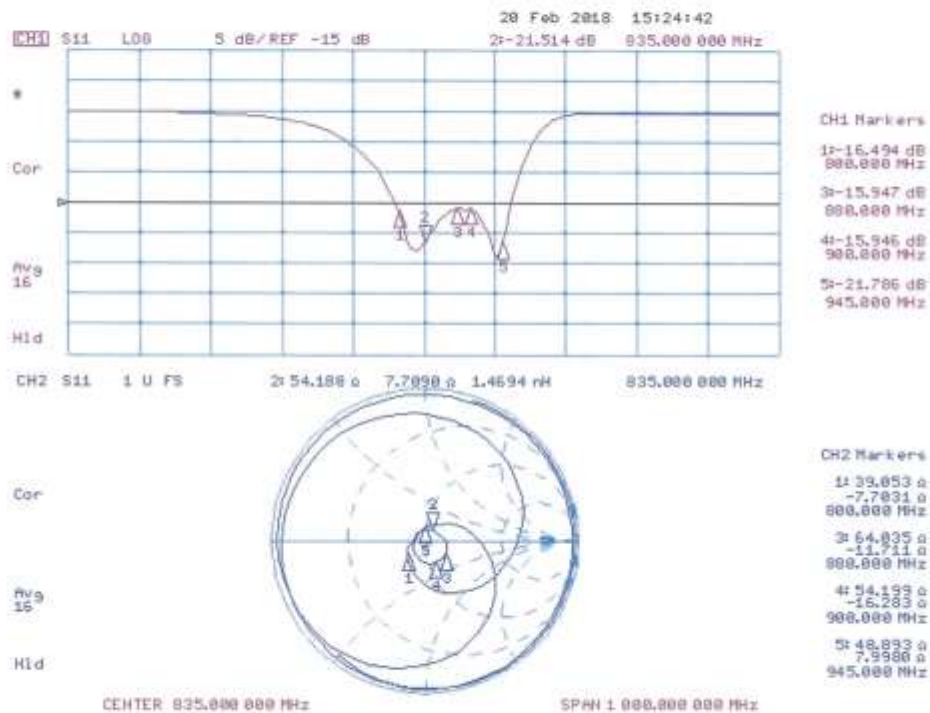
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

# Impedance Measurement Plot



## DASY5 E-field Result

Date: 20.02.2018

Test Laboratory: SPEAG Lab2

**DUT: HAC-Dipole 835 MHz; Type: CD835V3; Serial: CD835V3 - SN: 1024**

Communication System: UID 0 - CW ; Frequency: 835 MHz  
Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: RF Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

### DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF{1, 1, 1}; Calibrated: 14.06.2017;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn781; Calibrated: 17.01.2018
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

**Dipole E-Field measurement @ 835MHz/E-Scan - 835MHz d=15mm/Hearing Aid Compatibility Test (41x361x1):**

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 131.6 V/m; Power Drift = -0.02 dB

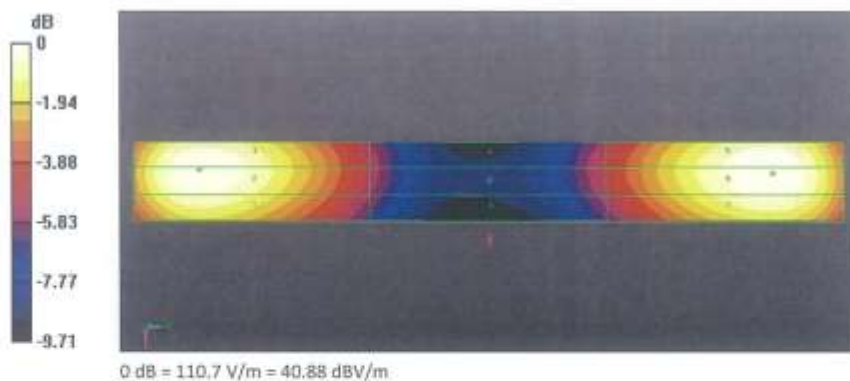
Applied MIF = 0.00 dB

RF audio interference level = 40.88 dBV/m

Emission category: M3

MIF scaled E-field

|             |             |             |
|-------------|-------------|-------------|
| Grid 1 M3   | Grid 2 M3   | Grid 3 M3   |
| 40.25 dBV/m | 40.85 dBV/m | 40.85 dBV/m |
| Grid 4 M4   | Grid 5 M4   | Grid 6 M4   |
| 35.6 dBV/m  | 36.1 dBV/m  | 36.09 dBV/m |
| Grid 7 M3   | Grid 8 M3   | Grid 9 M3   |
| 40.43 dBV/m | 40.88 dBV/m | 40.86 dBV/m |



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **HCT (Dymstec)**

Certificate No: **CD1880V3-1019\_Feb18**

## CALIBRATION CERTIFICATE

Object **CD1880V3 - SN: 1019**

Calibration procedure(s) **QA CAL-20.v6  
Calibration procedure for dipoles in air**

Calibration date: **February 20, 2018**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP             | SN: 104778         | 04-Apr-17 (No. 217-02521/02522)   | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-17 (No. 217-02521)         | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-17 (No. 217-02522)         | Apr-18                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 07-Apr-17 (No. 217-02528)         | Apr-18                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529)         | Apr-18                 |
| Probe EF3DV3                | SN: 4013           | 14-Jun-17 (No. EF3-4013_Jun17)    | Jun-18                 |
| DAE4                        | SN: 781            | 17-Jan-18 (No. DAE4-781_Jan18)    | Jan-19                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter Agilent 4419B   | SN: GB42420191     | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP E4412A      | SN: US38485102     | 05-Jan-10 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP B4B2A       | SN: US37295597     | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| RF generator R&S SMT-06     | SN: 832283011      | 27-Aug-12 (in house check Oct-17) | In house check: Oct-20 |
| Network Analyzer HP 8753E   | SN: US37390585     | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

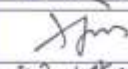
|                |               |                       |                                                                                       |
|----------------|---------------|-----------------------|---------------------------------------------------------------------------------------|
|                | Name          | Function              | Signature                                                                             |
| Calibrated by: | Leif Klysner  | Laboratory Technician |  |
| Approved by:   | Katja Pokovic | Technical Manager     |  |

Issued: February 20, 2018

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: CD1880V3-1019\_Feb18

Page 1 of 5

| 결     | 담당자                                                                                  | 확인자                                                                                   |
|-------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| 재     |  |  |
| 직위/성명 | SW 1789A3 GS 12544                                                                   |                                                                                       |
| 일 자   | 2018 / 03.06                                                                         | 2018 / 03.06                                                                          |

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Accreditation No.: **SCS 0108**

#### References

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

#### Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminated by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

### Measurement Conditions

DASY system configuration, as far as not given on page 1.

|                                    |                      |          |
|------------------------------------|----------------------|----------|
| DASY Version                       | DASY5                | V52.10.0 |
| Phantom                            | HAC Test Arch        |          |
| Distance Dipole Top - Probe Center | 15 mm                |          |
| Scan resolution                    | dx, dy = 5 mm        |          |
| Frequency                          | 1880 MHz $\pm$ 1 MHz |          |
| Input power drift                  | < 0.05 dB            |          |

### Maximum Field values at 1880 MHz

| E-field 15 mm above dipole surface | condition          | Interpolated maximum        |
|------------------------------------|--------------------|-----------------------------|
| Maximum measured above high end    | 100 mW input power | 90.0 V/m = 39.08 dBV/m      |
| Maximum measured above low end     | 100 mW input power | 89.5 V/m = 39.04 dBV/m      |
| Averaged maximum above arm         | 100 mW input power | 89.8 V/m $\pm$ 12.8 % (k=2) |

### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters

| Frequency | Return Loss | Impedance                      |
|-----------|-------------|--------------------------------|
| 1730 MHz  | 28.4 dB     | 53.8 $\Omega$ + 1.0 j $\Omega$ |
| 1880 MHz  | 20.0 dB     | 55.9 $\Omega$ + 8.9 j $\Omega$ |
| 1900 MHz  | 19.7 dB     | 59.2 $\Omega$ + 6.5 j $\Omega$ |
| 1950 MHz  | 24.0 dB     | 56.6 $\Omega$ - 1.5 j $\Omega$ |
| 2000 MHz  | 26.1 dB     | 49.1 $\Omega$ + 4.8 j $\Omega$ |

#### 3.2 Antenna Design and Handling

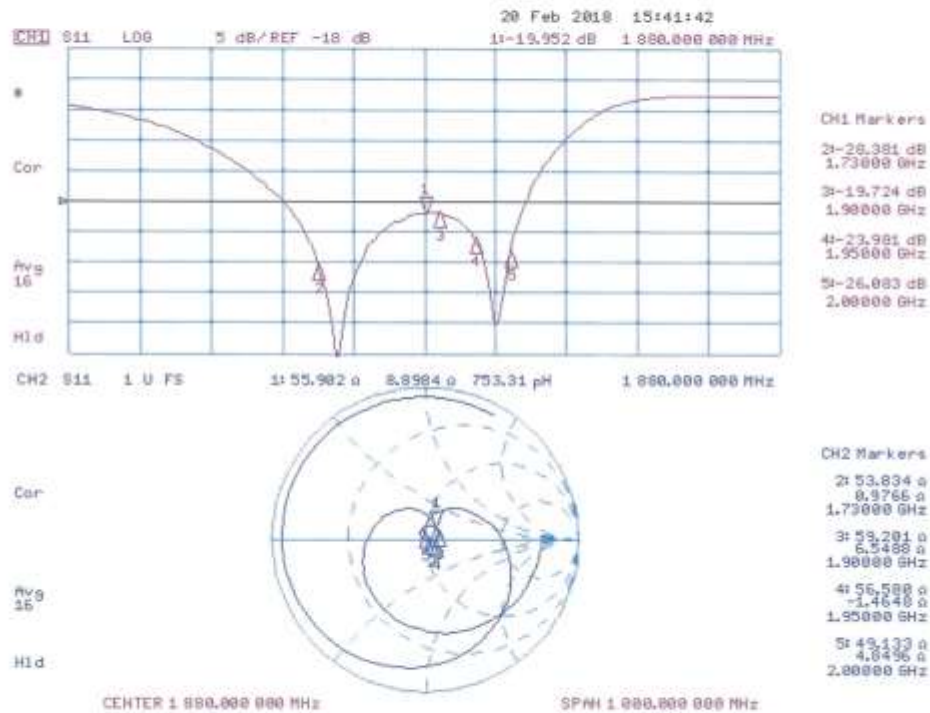
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

# Impedance Measurement Plot



## DASY5 E-field Result

Date: 20.02.2018

Test Laboratory: SPEAG Lab2

**DUT: HAC Dipole 1880 MHz; Type: CD1880V3; Serial: CD1880V3 - SN: 1019**

Communication System: UID 0 - CW ; Frequency: 1880 MHz  
Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: RF Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

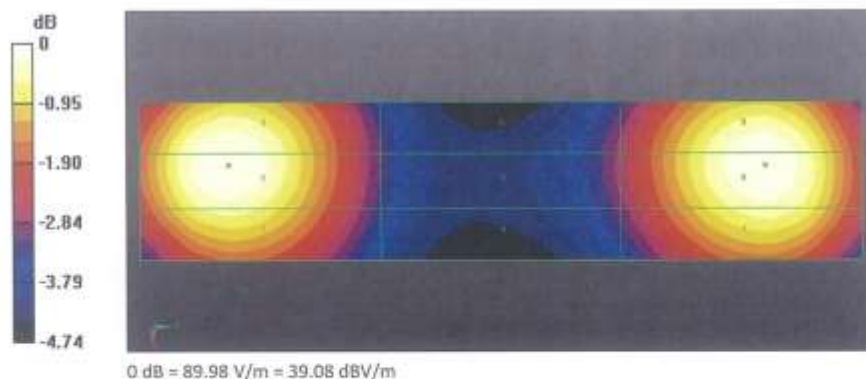
- Probe: EF3DV3 - SN4013; ConvF{1, 1, 1}; Calibrated: 14.06.2017;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 5n781; Calibrated: 17.01.2018
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

**Dipole E-Field measurement @ 1880MHz/E-Scan - 1880MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):**

Interpolated grid: dx=0.5000 mm, dy=0.5000 mm  
Device Reference Point: 0, 0, -6.3 mm  
Reference Value = 154.8 V/m; Power Drift = -0.03 dB  
Applied MIF = 0.00 dB  
RF audio interference level = 39.08 dBV/m  
Emission category: M2

MIF scaled E-field

|             |             |             |
|-------------|-------------|-------------|
| Grid 1 M2   | Grid 2 M2   | Grid 3 M2   |
| 38.6 dBV/m  | 39.08 dBV/m | 39.05 dBV/m |
| Grid 4 M2   | Grid 5 M2   | Grid 6 M2   |
| 36.13 dBV/m | 36.39 dBV/m | 36.37 dBV/m |
| Grid 7 M2   | Grid 8 M2   | Grid 9 M2   |
| 38.66 dBV/m | 39.04 dBV/m | 39.01 dBV/m |



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Accreditation No.: **SCS 0108**

Client **UL Korea (Dymstec)**

Certificate No: **CD2600V3-1009\_Jan18**

## CALIBRATION CERTIFICATE

Object **CD2600V3 - SN: 1009**

Calibration procedure(s) **QA CAL-20.v6  
Calibration procedure for dipoles in air**

Calibration date: **January 17, 2018**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).  
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  and humidity  $< 70\%$ .

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)        | Scheduled Calibration  |
|-----------------------------|--------------------|-----------------------------------|------------------------|
| Power meter NRP             | SN: 104778         | 04-Apr-17 (No. 217-02521/02522)   | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103244         | 04-Apr-17 (No. 217-02521)         | Apr-18                 |
| Power sensor NRP-Z91        | SN: 103245         | 04-Apr-17 (No. 217-02522)         | Apr-18                 |
| Reference 20 dB Attenuator  | SN: 5058 (20k)     | 07-Apr-17 (No. 217-02528)         | Apr-18                 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 07-Apr-17 (No. 217-02529)         | Apr-18                 |
| Probe EF3DV3                | SN: 4013           | 14-Jun-17 (No. EF3-4013_Jun17)    | Jun-18                 |
| DAE4                        | SN: 654            | 24-Jul-17 (No. DAE4-654_Jul17)    | Jul-18                 |
| Secondary Standards         | ID #               | Check Date (in house)             | Scheduled Check        |
| Power meter Agilent 4419B   | SN: GB42420191     | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP E4412A      | SN: US38485102     | 05-Jan-10 (in house check Oct-17) | In house check: Oct-20 |
| Power sensor HP 8482A       | SN: US37295597     | 09-Oct-09 (in house check Oct-17) | In house check: Oct-20 |
| RF generator R&S SMT-06     | SN: 832283/011     | 27-Aug-12 (in house check Oct-17) | In house check: Oct-20 |
| Network Analyzer HP 8753E   | SN: US37390585     | 18-Oct-01 (in house check Oct-17) | In house check: Oct-18 |

Calibrated by: **Leif Klysner** Name: **Leif Klysner** Function: **Laboratory Technician** Signature: *[Signature]*

Approved by: **Katja Pokovic** Name: **Katja Pokovic** Function: **Technical Manager** Signature: *[Signature]*

Issued: January 17, 2018

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**S** Swiss Calibration Service

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Accreditation No.: **SCS 0108**

## References

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

## Methods Applied and Interpretation of Parameters:

- **Coordinate System:** y-axis is in the direction of the dipole arms. z-axis is from the basis of the antenna (mounted on the table) towards its feed point between the two dipole arms. x-axis is normal to the other axes. In coincidence with the standards [1], the measurement planes (probe sensor center) are selected to be at a distance of 15 mm above the top metal edge of the dipole arms.
- **Measurement Conditions:** Further details are available from the hardcopies at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated. The forward power to the dipole connector is set with a calibrated power meter connected and monitored with an auxiliary power meter connected to a directional coupler. While the dipole under test is connected, the forward power is adjusted to the same level.
- **Antenna Positioning:** The dipole is mounted on a HAC Test Arch phantom using the matching dipole positioner with the arms horizontal and the feeding cable coming from the floor. The measurements are performed in a shielded room with absorbers around the setup to reduce the reflections. It is verified before the mounting of the dipole under the Test Arch phantom, that its arms are perfectly in a line. It is installed on the HAC dipole positioner with its arms parallel below the dielectric reference wire and able to move elastically in vertical direction without changing its relative position to the top center of the Test Arch phantom. The vertical distance to the probe is adjusted after dipole mounting with a DASY5 Surface Check job. Before the measurement, the distance between phantom surface and probe tip is verified. The proper measurement distance is selected by choosing the matching section of the HAC Test Arch phantom with the proper device reference point (upper surface of the dipole) and the matching grid reference point (tip of the probe) considering the probe sensor offset. The vertical distance to the probe is essential for the accuracy.
- **Feed Point Impedance and Return Loss:** These parameters are measured using a HP 8753E Vector Network Analyzer. The impedance is specified at the SMA connector of the dipole. The influence of reflections was eliminating by applying the averaging function while moving the dipole in the air, at least 70cm away from any obstacles.
- **E-field distribution:** E field is measured in the x-y-plane with an isotropic ER3D-field probe with 100 mW forward power to the antenna feed point. In accordance with [1], the scan area is 20mm wide, its length exceeds the dipole arm length (180 or 90mm). The sensor center is 15 mm (in z) above the metal top of the dipole arms. Two 3D maxima are available near the end of the dipole arms. Assuming the dipole arms are perfectly in one line, the average of these two maxima (in subgrid 2 and subgrid 8) is determined to compensate for any non-parallelity to the measurement plane as well as the sensor displacement. The E-field value stated as calibration value represents the maximum of the interpolated 3D-E-field, in the plane above the dipole surface.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k=2$ , which for a normal distribution corresponds to a coverage probability of approximately 95%.

### Measurement Conditions

DASY system configuration, as far as not given on page 1.

|                                    |                      |          |
|------------------------------------|----------------------|----------|
| DASY Version                       | DASY5                | V52.10.0 |
| Phantom                            | HAC Test Arch        |          |
| Distance Dipole Top - Probe Center | 15 mm                |          |
| Scan resolution                    | dx, dy = 5 mm        |          |
| Frequency                          | 2600 MHz $\pm$ 1 MHz |          |
| Input power drift                  | < 0.05 dB            |          |

### Maximum Field values at 2600 MHz

| E-field 15 mm above dipole surface | condition          | Interpolated maximum        |
|------------------------------------|--------------------|-----------------------------|
| Maximum measured above high end    | 100 mW input power | 87.6 V/m = 38.85 dBV/m      |
| Maximum measured above low end     | 100 mW input power | 86.4 V/m = 38.73 dBV/m      |
| Averaged maximum above arm         | 100 mW input power | 87.0 V/m $\pm$ 12.8 % (k=2) |

### Appendix (Additional assessments outside the scope of SCS 0108)

#### Antenna Parameters

| Frequency | Return Loss | Impedance                      |
|-----------|-------------|--------------------------------|
| 2450 MHz  | 19.8 dB     | 44.2 $\Omega$ - 7.8 j $\Omega$ |
| 2550 MHz  | 32.6 dB     | 48.1 $\Omega$ + 1.2 j $\Omega$ |
| 2600 MHz  | 38.1 dB     | 50.8 $\Omega$ + 0.9 j $\Omega$ |
| 2650 MHz  | 33.0 dB     | 52.1 $\Omega$ - 0.8 j $\Omega$ |
| 2750 MHz  | 20.5 dB     | 50.1 $\Omega$ - 9.5 j $\Omega$ |

#### 3.2 Antenna Design and Handling

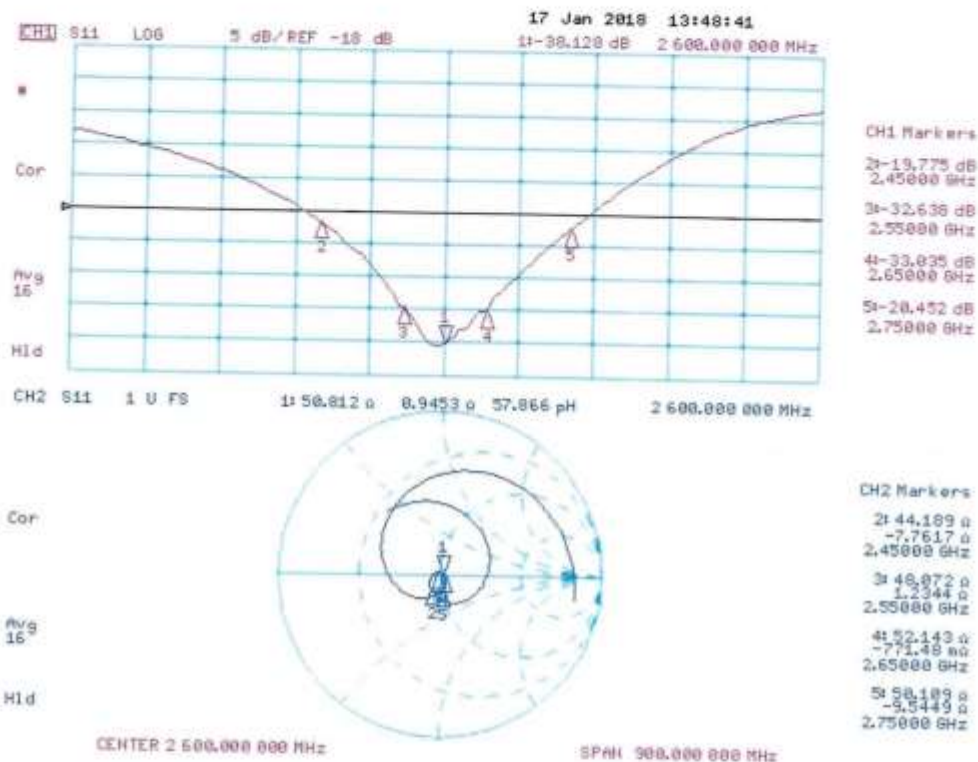
The calibration dipole has a symmetric geometry with a built-in two stub matching network, which leads to the enhanced bandwidth.

The dipole is built of standard semirigid coaxial cable. The internal matching line is open ended. The antenna is therefore open for DC signals.

Do not apply force to dipole arms, as they are liable to bend. The soldered connections near the feedpoint may be damaged. After excessive mechanical stress or overheating, check the impedance characteristics to ensure that the internal matching network is not affected.

After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

# Impedance Measurement Plot



## DASY5 E-field Result

Date: 17.01.2018

Test Laboratory: SPEAG Lab2

**DUT: HAC Dipole 2600 MHz; Type: CD2600V3; Serial: CD2600V3 - SN: 1009**

Communication System: UID 0 - CW ; Frequency: 2600 MHz  
Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>  
Phantom section: RF Section  
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

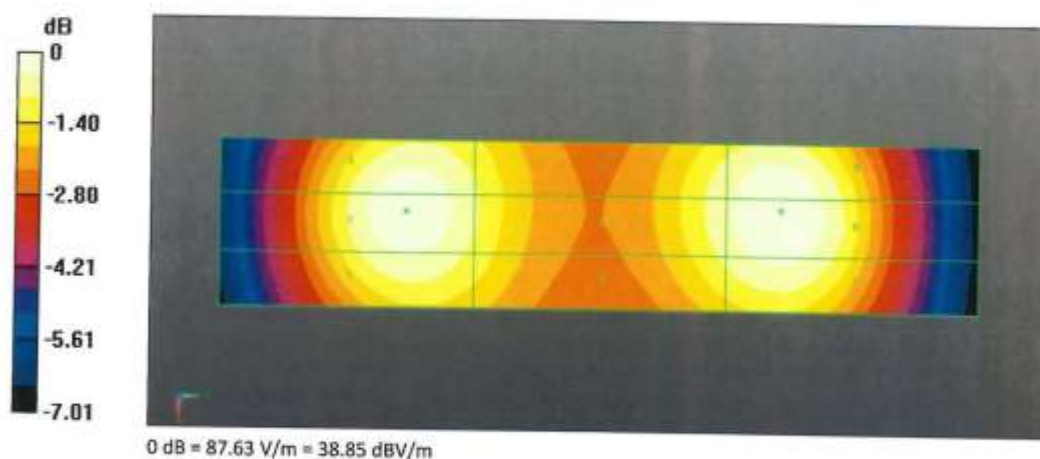
DASY52 Configuration:

- Probe: EF3DV3 - SN4013; ConvF(1, 1, 1); Calibrated: 14.06.2017;
- Sensor-Surface: (Fix Surface)
- Electronics: DAE4 Sn654; Calibrated: 24.07.2017
- Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA; Serial: 1070
- DASY52 52.10.0(1446); SEMCAD X 14.6.10(7417)

**Dipole E-Field measurement @ 2600MHz/E-Scan - 2600MHz d=15mm/Hearing Aid Compatibility Test (41x181x1):**  
Interpolated grid: dx=0.5000 mm, dy=0.5000 mm  
Device Reference Point: 0, 0, -6.3 mm  
Reference Value = 64.27 V/m; Power Drift = -0.01 dB  
Applied MIF = 0.00 dB  
RF audio interference level = 38.85 dBV/m  
**Emission category: M2**

MIF scaled E-field

|             |             |             |
|-------------|-------------|-------------|
| Grid 1 M2   | Grid 2 M2   | Grid 3 M2   |
| 38.41 dBV/m | 38.73 dBV/m | 38.68 dBV/m |
| Grid 4 M2   | Grid 5 M2   | Grid 6 M2   |
| 38.04 dBV/m | 38.34 dBV/m | 38.31 dBV/m |
| Grid 7 M2   | Grid 8 M2   | Grid 9 M2   |
| 38.5 dBV/m  | 38.85 dBV/m | 38.81 dBV/m |



## Attachment 5. HAC RF Emission Setup Photo

