



# HAC TEST REPORT

|                   |                |
|-------------------|----------------|
| <b>Applicant</b>  | PCD, LLC       |
| <b>FCC ID</b>     | 2ALJJU40       |
| <b>Product</b>    | mobile phone   |
| <b>Brand</b>      | PCD            |
| <b>Model</b>      | U40            |
| <b>Report No.</b> | R2203A0317-H1  |
| <b>Issue Date</b> | March 30, 2022 |

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **ANSI C63.19-2011**. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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# 1 Test Laboratory

## 1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **TA Technology (Shanghai) Co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

## 1.2. Test facility

### **FCC (Designation number: CN1179, Test Firm Registration Number: 446626)**

TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

### **A2LA (Certificate Number: 3857.01)**

TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

## 1.2 Testing Location

Company: TA Technology (Shanghai) Co., Ltd.  
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### 1.3 Laboratory Environment

|                                                                                                                                                                                                 |                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Temperature                                                                                                                                                                                     | Min. = 18°C, Max. = 28 °C |
| Relative humidity                                                                                                                                                                               | Min. = 0%, Max. = 80%     |
| Ground system resistance                                                                                                                                                                        | < 0.5 $\Omega$            |
| Ambient noise is checked and found very low and in compliance with requirement of standards.<br>Reflection of surrounding objects is minimized and in compliance with requirement of standards. |                           |

## 2 Statement of Compliance

Table 2.1: The Total M-rating of each tested band

| Mode                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rating |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| GSM 850                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | M4     |
| GSM 1900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | M4     |
| WCDMA & LTE – FDD                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | M4     |
| The Total M-rating is M4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        |
| Date of Testing: November 28, 2021                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |
| Date of Sample Receiving: November 23, 2021 and March 27, 2022                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |
| Note:<br>1. Refer to section 7 Evaluation for Low-power Exemption. RF Emission testing for this device is required only for GSM voice modes. WCDMA and LTE mode applicable air-interfaces are exempt from testing in accordance with C93.19-2011 Clause 4.4 and are rated M4.<br>2. All indications of Pass/Fail in this report are opinions expressed by TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. |        |

**This report only adds LTE Band 2, no change in product. Other test values duplicated from the original report (Report No.: R2111A1040-H1V1)**

### 3 Description of Equipment under Test

#### Client Information

|                             |                                                             |
|-----------------------------|-------------------------------------------------------------|
| <b>Applicant</b>            | PCD, LLC                                                    |
| <b>Applicant address</b>    | 1500 Tradeport Drive, Suite A, Orlando, United States 32824 |
| <b>Manufacturer</b>         | PCD, LLC                                                    |
| <b>Manufacturer address</b> | 1500 Tradeport Drive, Suite A, Orlando, United States 32824 |

#### General Technologies

|                                      |                                                                                                              |                 |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Device Type:</b>                  | Portable Device                                                                                              |                 |
| <b>State of Sample:</b>              | Prototype Unit                                                                                               |                 |
| <b>Model:</b>                        | U40                                                                                                          |                 |
| <b>IMEI:</b>                         | 355613056775647                                                                                              |                 |
| <b>Hardware Version:</b>             | L500_MB_V1.0                                                                                                 |                 |
| <b>Software Version:</b>             | PCD_U40_CLARO_PR_V1.0                                                                                        |                 |
| <b>Antenna Type:</b>                 | Internal Antenna                                                                                             |                 |
| <b>Power Class:</b>                  | GSM 850: 4<br>GSM 1900: 1<br>WCDMA Band II/V: 3<br>LTE FDD Band 2/4/5/12/66: 3                               |                 |
| <b>Power Level</b>                   | GSM 850: level 5<br>GSM 1900: level 0<br>WCDMA Band II/V: All up bits<br>LTE FDD Band 2/4/5/12/66: max power |                 |
| <b>Test Modulation:</b>              | (GSM)GMSK; (WCDMA) QPSK; (LTE) QPSK, 16QAM;                                                                  |                 |
| <b>Operating Frequency Range(s):</b> | <b>Mode</b>                                                                                                  | <b>Tx (MHz)</b> |
|                                      | GSM 850                                                                                                      | 824 ~ 849       |
|                                      | GSM 1900                                                                                                     | 1850 ~ 1910     |
|                                      | WCDMA Band II                                                                                                | 1850 ~ 1910     |
|                                      | WCDMA Band V                                                                                                 | 824 ~ 849       |
|                                      | LTE FDD 2                                                                                                    | 1850 ~ 1910     |
|                                      | LTE FDD 4                                                                                                    | 1710 ~ 1755     |
|                                      | LTE FDD 5                                                                                                    | 824 ~ 849       |
|                                      | LTE FDD 12                                                                                                   | 699 ~ 716       |
|                                      | LTE FDD 66                                                                                                   | 1710 ~ 1780     |
|                                      | BT                                                                                                           | 2402 ~2480      |
| <b>Accessory Equipment</b>           |                                                                                                              |                 |
| <b>Battery</b>                       | Manufacturer: CXD<br>Model: U40                                                                              |                 |



Note: The EUT is sent from the applicant to TA and the information of the EUT is declared by the applicant.

| Air-Interface  | Band (MHz) | Type | ANSI C63.19 tested | Simultaneous Transmissions | Voice over Digital Transport OTT Capability | Name of Voice Service | Power Reduction |
|----------------|------------|------|--------------------|----------------------------|---------------------------------------------|-----------------------|-----------------|
| GSM            | 850        | VO   | Yes                | Yes<br>BT                  | N/A                                         | #                     | No              |
|                | 1900       |      |                    |                            |                                             |                       |                 |
|                | GPRS/EGPRS | DT   | No                 |                            | No                                          |                       |                 |
| WCDMA          | Band II    | VO   | Yes                | Yes<br>BT                  | N/A                                         | #                     | No              |
|                | Band V     |      |                    |                            |                                             |                       |                 |
|                | HSPA       | DT   | No                 |                            | No                                          |                       |                 |
| LTE            | Band 2     | VD   | Yes                | Yes<br>BT                  | No                                          | Yes###                | No              |
|                | Band 4     |      |                    |                            |                                             |                       |                 |
|                | Band 5     |      |                    |                            |                                             |                       |                 |
|                | Band 12    |      |                    |                            |                                             |                       |                 |
|                | Band 66    |      |                    |                            |                                             |                       |                 |
| Bluetooth (BT) | 2450       | DT   | No                 | Yes<br>GSM, WCDMA, LTE,    | N/A                                         | NA                    | No              |

VO= legacy Cellular Voice Service from Table 7.1 in 7.4.2.1 of ANSI C63.19-2011

DT= Digital Transport only (no voice)

VD= IP voice service over digital transport.

#: Ref Lev in accordance with 7.4.2.1 of ANSI C63.19-2011

###: Ref Lev in accordance with the July 2012 VoLTE interpretation.

**Remark:**

1. It applies the low power exemption based on ANSI C63.19-2011



## **4 Test Specification and Operational Conditions**

### **4.1 Test Specification**

The tests documented in this report were performed in accordance with the following:

**FCC CFR47 Part 20.19**

**ANSI C63.19-2011**

**KDB 285076 D01 HAC Guidance v05**

**KDB 285076 D02 T-Coil Testing v03**

## 5 Test Information

### 5.1 Operational Conditions during Test

#### 5.1.1 General Description of Test Procedures

The phone was tested in all normal configurations for the ear use. The EUT is mounted in the device holder equivalent as for classic dosimeter measurements. The acoustic output of the EUT shall coincide with the center point of the area formed by the dielectric wire and the middle bar of the arch's top frame. The EUT shall be moved vertically upwards until it touches the frame. The fine adjustment is possible by sliding the complete. The EUT holder is on the yellow base plate of the Test Arch phantom. These test configurations are tested at the high, middle and low frequency channels of each applicable operating mode.

A communication link is set up with a System Simulator (SS) by air link, and a call is established. The EUT is commanded to operate at maximum transmitting power.

### 5.2 HAC RF Measurements System Configuration

#### 5.2.1 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 (Stäubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor. The robot is a six-axis industrial robot performing precise movements. Cell controller systems contain the power supply, robot controller, teach pendant (Joystick) and remote control, and are used to drive the robot motors. The Stäubli 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.

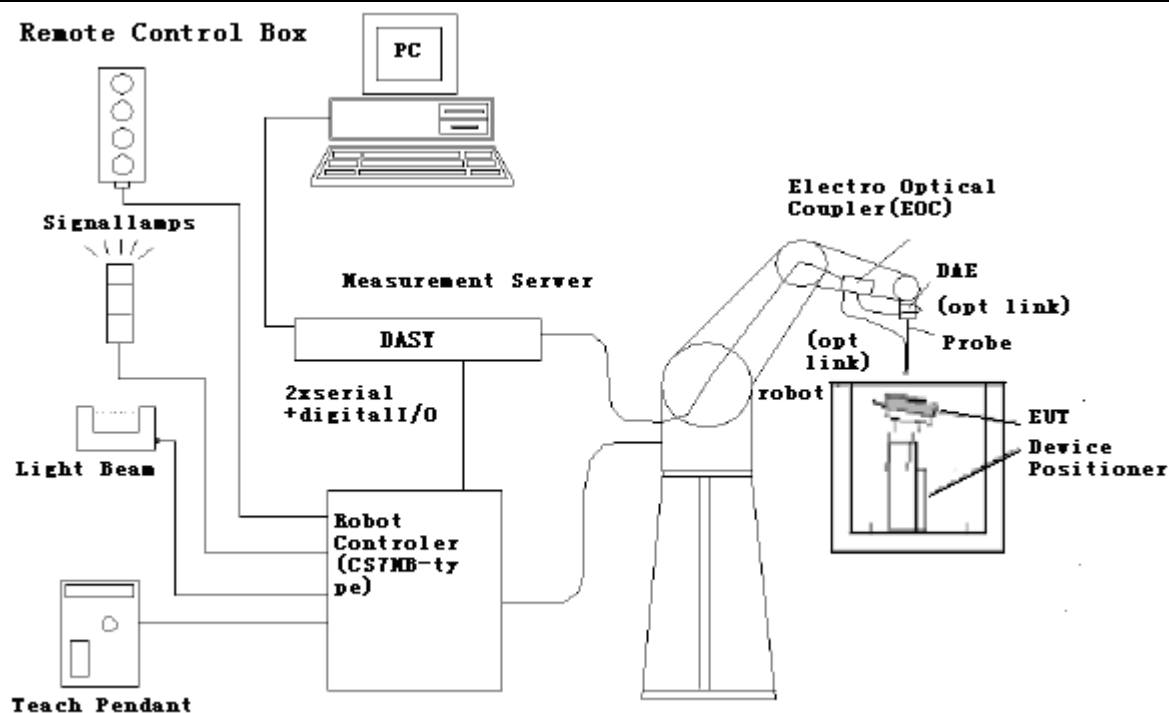


**Figure 1 HAC Test Measurement Set-up**

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.

### 5.2.2 Probe System

The HAC measurements were conducted with the E-Field Probe ER3DV6 and the H-Field Probe H3DV6 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

#### E-Field Probe Description

|              |                                                                                                                               |
|--------------|-------------------------------------------------------------------------------------------------------------------------------|
| Construction | One dipole parallel, two dipoles normal to probe axis<br>Built-in shielding against static charges<br>PEEK enclosure material |
| Calibration  | In air from 100 MHz to 3.0 GHz (absolute accuracy $\pm 6.0\%$ , $k=2$ )                                                       |
| Frequency    | 40 MHz to > 6 GHz (can be extended to < 20 MHz)<br>Linearity: $\pm 0.2$ dB (100 MHz to 3 GHz)                                 |



**Figure 2 ER3DV6 E-field**

|               |                                                                                                                              |              |
|---------------|------------------------------------------------------------------------------------------------------------------------------|--------------|
| Directivity   | $\pm 0.2$ dB in air (rotation around probe axis)<br>$\pm 0.4$ dB in air (rotation normal to probe axis)                      | <b>Probe</b> |
| Dynamic Range | 2 V/m to > 1000 V/m; Linearity: $\pm 0.2$ dB                                                                                 |              |
| Dimensions    | Overall length: 330 mm (Tip: 16 mm)<br>Tip diameter: 8 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.5 mm |              |
| Application   | General near-field measurements up to 6 GHz<br>Field component measurements<br>Fast automatic scanning in phantoms           |              |

### 5.2.3 Test Arch Phantom & Phone Positioner

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. It enables easy and well defined positioning of the phone and validation dipoles as well as simple teaching of the robot (Dimensions: 370 x 370 x 370 mm).

The Device reference point is set for the EUT at 6.3 mm, the Grid reference point is on the upper surface at the origin of the coordinates, and the “user point \Height Check 0.5 mm” is 0.5mm above the center, allowing verification of the gap of 0.5mm while the probe is positioned there.

The Phone Positioner supports accurate and reliable positioning of any phone with effect on near field  $< \pm 0.5$  dB.

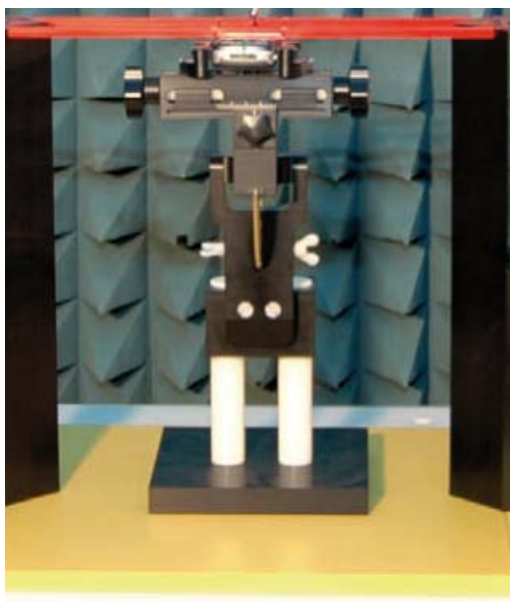


**Figure 3 HAC Phantom & Device Holder**

### 5.3 RF Test Procedures

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 gauge block can simplify this positioning. Note that a separate E-field gauge block will be needed if the center of the probe sensor elements is at different distances from the tip of the probe.
3. Configure the WD normal operation for maximum rated RF output power, at the desired channel and other operating parameters (e.g., test mode), as intended for the test.
4. The center sub-grid shall center on the center of the axial measurement point or the acoustic output, as appropriate. Locate the field probe at the initial test position in the 50 mm by 50 mm grid, which is contained in the measurement plane. If the field alignment method is used, align the probe for maximum field reception.
5. Record the reading.
6. Scan the entire 50 mm by 50 mm region in equally spaced increments and record the reading at each measurement point. The grid is 5 cm by 5 cm area that is divided into 9 evenly sized blocks or sub-grids. The distance between measurement points shall be sufficient to assure the identification of the maximum reading.
7. Identify the five contiguous sub-grids around the center sub-grid with the lowest maximum field strength readings. Thus the six areas to be used to determine the WD's highest emissions are identified and outlined for the final manual scan. Please note that a maximum of five blocks can be excluded for both E-field measurements for the WD output being measured. Stated another way, the center sub-grid and three others must be common to both the E-field measurements.
8. Identify the maximum field reading within the non-excluded sub-grids identified in Step 7.
9. 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 factor and the calibration.
10. Repeat Step 1 through Step 10 for both the E-field measurements.
11. Compare this reading to the categories in ANSI C63.19 Clause 8 and record the resulting category. The lowest category number listed in 8.2, Table 8.3 obtained in Step 10 for either E-field determines the M category for the audio coupling mode assessment. Record the WD category rating.



Figure 4 WD reference and plane for RF emission measurements

## 5.4 System Check

### Validation Procedure

Place a dipole antenna meeting the requirements given in ANSI C63.19 D.11 in the position normally occupied by the WD. The dipole antenna serves as a known source for an electrical 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.

Position the E-field probe at a 15 mm distance from the center of the probe element to the top surface. Validation was performed to verify that measured E-field is within +/-18% from the target reference values provided by the manufacturer. "Values within +/-18% are acceptable. Of which 12% is deviation and 13% is measurement uncertainty."

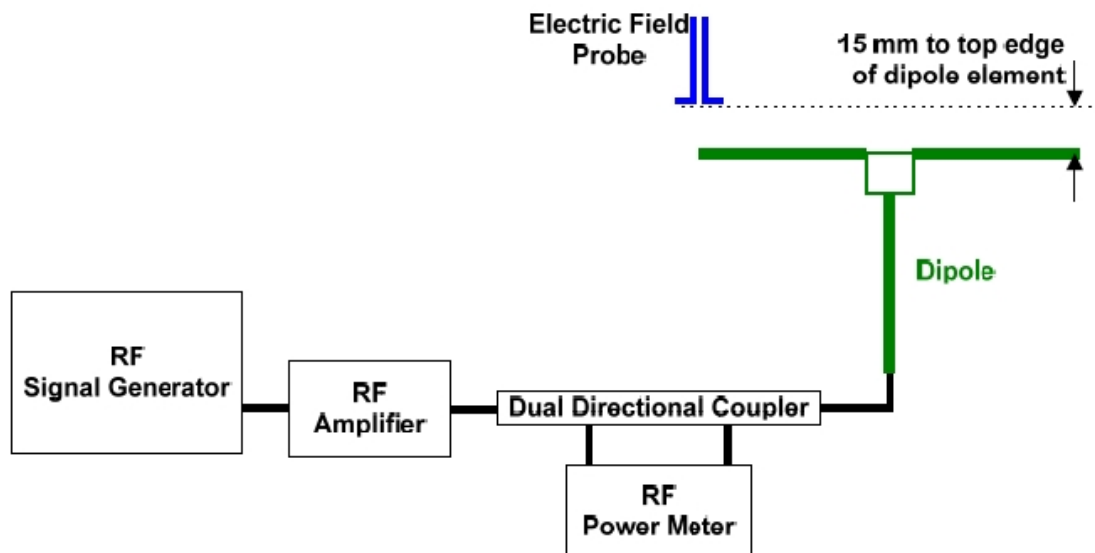


Figure 5 Dipole Validation Setup

| Frequency (MHz) | Input Power (mW) | Target <sup>1</sup> Value (V/m) | Measured <sup>2</sup> Value (V/m) | Deviation <sup>3</sup> (%) | Test Date  |
|-----------------|------------------|---------------------------------|-----------------------------------|----------------------------|------------|
| 835             | 100              | 106.6                           | 107.3                             | -0.65                      | 2021/11/28 |
| 1880            | 100              | 90.5                            | 92.1                              | 1.77                       | 2021/11/28 |

## 5.5 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

The MIF may be determined using a radiated RF field or a conducted RF signal,

- b) Using RF illumination or conducted coupling, apply the specific modulated signal in question to the measurement system at a level within its confirmed operating dynamic range.
- c) Measure the steady-state rms level at the output of the fast probe or sensor.
- d) Measure the steady-state average level at the weighting output.
- e) Without changing the square-law detector or weighting system, and using RF illumination or conducted coupling, substitute for the specific modulated signal a 1kHz, 80% amplitude modulated carrier at the same frequency and adjust its strength until the level at the weighting output equals the step d) measurement.
- f) Without changing the carrier level from step e), remove the 1 kHz modulation and again measure the steady-state rms level indicated at the output of the fast probe or sensor.
- g) The MIF for the specific modulation characteristic is provided by the ratio of the step f) measurement to the step c) measurement, expressed in dB ( $20 \times \log(\text{step f})/\text{step c})$ ).

Based on the KDB285076 D01v05, the handset can also use the MIF values predetermined by the test equipment manufacturer, and the following table lists the MIF values evaluated by DASY manufacturer (SPEAG), and the test result will be calculated with the MIF parameter automatically.

| SPEAG UID | UID version | Communication system                  | MIF(dB) |
|-----------|-------------|---------------------------------------|---------|
| 10011     | CAB         | UMTS-FDD (WCDMA)                      | -27.23  |
| 10021     | DAC         | GSM-FDD (TDMA, GMSK)                  | 3.63    |
| 10175     | CAG         | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | -15.63  |
| 10169     | CAE         | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | -15.63  |

## 5.6 Justification of Held to Ear Modes Tested

### 5.6.1 Analysis of RF Air Interface Technologies

a. According to the April 2013 TCB workshop slides, LTE and other OTT data services are outside the current definition of a managed CMRS service and are currently not required to be evaluated.

b. No associated T-coil measurements for VoIP over WIFI CMRS have been made in accordance with the guidance issued by OET in KDB publication 285076 D02 T-Coil testing for CMRS IP.

c. 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 <17dBm for all of its operating modes. RF air interface technologies exempted from testing in this manner are automatically assigned an M4 rating to be used in determining the overall rating for the WD.

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.

### 5.6.2 Average Antenna Input Power & Evaluation for Low-power Exemption

An RF air interface technology of a device is exempt from testing when its average antenna input power plus its **MIF is  $\leq 17$  dBm** for any of its operating modes. If a device supports multiple RF air interfaces, each RF air interface shall be evaluated individually.

| Band                                                                                                | Maximum Average Antenna Input Power (dBm) | Worst Case MIF (dB) | Maximum Average Antenna Input Power + MIF (dBm) | Low power exemption |
|-----------------------------------------------------------------------------------------------------|-------------------------------------------|---------------------|-------------------------------------------------|---------------------|
| GSM 850                                                                                             | 32.00                                     | 3.63                | 35.63                                           | No                  |
| GSM 1900                                                                                            | 29.00                                     | 3.63                | 32.63                                           | No                  |
| WCDMA Band II                                                                                       | 23.00                                     | -27.23              | -4.23                                           | Yes                 |
| WCDMA Band V                                                                                        | 23.00                                     | -27.23              | -4.23                                           | Yes                 |
| LTE FDD 2                                                                                           | 23.50                                     | -15.63              | 7.87                                            | Yes                 |
| LTE FDD 4                                                                                           | 23.50                                     | -15.63              | 7.87                                            | Yes                 |
| LTE FDD 5                                                                                           | 23.50                                     | -15.63              | 7.87                                            | Yes                 |
| LTE FDD 12                                                                                          | 23.50                                     | -15.63              | 7.87                                            | Yes                 |
| LTE FDD 66                                                                                          | 23.50                                     | -15.63              | 7.87                                            | Yes                 |
| Note: 1. MIF values applied in this test report were provided by the HAC equipment provider, SPEAG. |                                           |                     |                                                 |                     |

## 6 Test Results

### 6.1 ANSI C63.19-2011 Limits

| Category    | Telephone RF parameters<br>< 960 MHz | Telephone RF parameters<br>> 960 MHz |
|-------------|--------------------------------------|--------------------------------------|
| Near field  | E-field emissions                    |                                      |
| Category M1 | 50 to 55 dB (V/m)                    | 40 to 45 dB (V/m)                    |
| Category M2 | 45 to 50 dB (V/m)                    | 35 to 40 dB (V/m)                    |
| Category M3 | 40 to 45 dB (V/m)                    | 30 to 35 dB (V/m)                    |
| Category M4 | < 40 dB (V/m)                        | < 30 dB (V/m)                        |

## 6.2 Summary Test Results

| Band     | Channel /Frequency (MHz) | MIF (dB) | E-field (dBV/m) | Power Drift (dB) | Category | Graph Results |
|----------|--------------------------|----------|-----------------|------------------|----------|---------------|
| GSM 850  | 128/824.2                | 3.63     | 34.74           | 0.01             | M4       | 1             |
|          | 190/836.6                | 3.63     | 34.63           | -0.01            | M4       | 2             |
|          | 251/848.8                | 3.63     | 34.73           | -0.03            | M4       | 3             |
| GSM 1900 | 512/1850.2               | 3.63     | 22.89           | 0.02             | M4       | 4             |
|          | 661/1880                 | 3.63     | 22.54           | -0.10            | M4       | 5             |
|          | 810/1909.8               | 3.63     | 22.93           | -0.09            | M4       | 6             |



## 7 Measurement Uncertainty

Measurement uncertainty evaluation template for DUT HAC RF test

| Error source                             | Type | Uncertainty Value ( $\pm$ %) | Prob. Dist. | k     | $c_{ij}E$ | $c_{ij}H$ | Standard Uncertainty $u_i$ ( $\pm$ %) E | Degree of freedom $V_{eff}$ or $v_i$ |
|------------------------------------------|------|------------------------------|-------------|-------|-----------|-----------|-----------------------------------------|--------------------------------------|
| <b>Measurement system</b>                |      |                              |             |       |           |           |                                         |                                      |
| Probe Calibration                        | B    | 5.1                          | N           | 1     | 1         | 1         | 5.1                                     | $\infty$                             |
| Axial Isotropy                           | B    | 4.7                          | R           | 1.732 | 1         | 1         | 2.7                                     | $\infty$                             |
| Sensor Displacement                      | B    | 16.5                         | R           | 1.732 | 1         | 0.145     | 9.5                                     | $\infty$                             |
| Boundary Effects                         | B    | 2.4                          | R           | 1.732 | 1         | 1         | 1.4                                     | $\infty$                             |
| Test Arch                                | B    | 7.2                          | R           | 1.732 | 1         | 0         | 4.2                                     | $\infty$                             |
| Linearity                                | B    | 4.7                          | R           | 1.732 | 1         | 1         | 2.7                                     | $\infty$                             |
| Scaling to Peak Envelope Power           | B    | 2.0                          | R           | 1.732 | 1         | 1         | 1.2                                     | $\infty$                             |
| System Detection Limit                   | B    | 1.0                          | R           | 1.732 | 1         | 1         | 0.6                                     | $\infty$                             |
| Readout Electronics                      | B    | 0.3                          | N           | 1     | 1         | 1         | 0.3                                     | $\infty$                             |
| Response Time                            | B    | 0.8                          | R           | 1.732 | 1         | 1         | 0.5                                     | $\infty$                             |
| Integration Time                         | B    | 2.6                          | R           | 1.732 | 1         | 1         | 1.5                                     | $\infty$                             |
| RF Ambient Conditions                    | B    | 3.0                          | R           | 1.732 | 1         | 1         | 1.7                                     | $\infty$                             |
| RF Reflections                           | B    | 12.0                         | R           | 1.732 | 1         | 1         | 6.9                                     | $\infty$                             |
| Probe Positioner                         | B    | 1.2                          | R           | 1.732 | 1         | 0.67      | 0.7                                     | $\infty$                             |
| Probe Positioning                        | A    | 4.7                          | R           | 1.732 | 1         | 0.67      | 2.7                                     | $\infty$                             |
| Extra. And Interpolation                 | B    | 1.0                          | R           | 1.732 | 1         | 1         | 0.6                                     | $\infty$                             |
| <b>Test sample related</b>               |      |                              |             |       |           |           |                                         |                                      |
| Device Positioning Vertical              | B    | 4.7                          | R           | 1.732 | 1         | 0.67      | 2.7                                     | $\infty$                             |
| Device Positioning Lateral               | B    | 1.0                          | R           | 1.732 | 1         | 1         | 0.6                                     | $\infty$                             |
| Device Holder and Phantom                | B    | 2.4                          | R           | 1.732 | 1         | 1         | 1.4                                     | $\infty$                             |
| Power Drift                              | B    | 5.0                          | R           | 1.732 | 1         | 1         | 2.9                                     | $\infty$                             |
| <b>Phantom and Setup related</b>         |      |                              |             |       |           |           |                                         |                                      |
| Phantom Thickness                        | B    | 2.4                          | R           | 1.732 | 1         | 0.67      | 1.4                                     | $\infty$                             |
| Combined standard uncertainty (%)        |      |                              |             |       |           |           | 15.3                                    |                                      |
| Expanded Std. uncertainty on power (K=2) |      |                              |             |       |           |           | 30.6                                    |                                      |
| Expanded Std. uncertainty on field (K=2) |      |                              |             |       |           |           | 15.3                                    |                                      |



## 8 Main Test Instruments

| Name                                | Manufacturer | Type          | Serial Number | Calibration Date | Expiration Time |
|-------------------------------------|--------------|---------------|---------------|------------------|-----------------|
| Power meter                         | Agilent      | E4417A        | GB41291714    | 2021-05-15       | 2022-05-14      |
| Power sensor                        | Agilent      | N8481H        | MY50350004    | 2021-05-15       | 2022-05-14      |
| Signal Generator                    | Agilent      | N5181A        | MY50140143    | 2021-05-15       | 2022-05-14      |
| Amplifier                           | INDEXSAR     | IXA-020       | 0401          | 2021-05-15       | 2022-05-14      |
| Wideband radio communication tester | R&S          | CMW500        | 146734        | 2021-05-15       | 2022-05-14      |
| E-Field Probe                       | SPEAG        | EF3DV3        | 4048          | 2021-03-04       | 2022-03-03      |
| DAE                                 | SPEAG        | DAE4          | 1648          | 2021-05-17       | 2022-05-16      |
| Validation Kit 835MHz               | SPEAG        | CD835V3       | 1133          | 2020-10-12       | 2023-10-11      |
| Validation Kit 1880MHz              | SPEAG        | CD1880V3      | 1115          | 2020-10-12       | 2023-10-11      |
| Hygrothermograph                    | Anymetr      | NT-311        | 20150731      | 2021-05-18       | 2022-05-17      |
| HAC Phantom                         | SPEAG        | SD HAC P01 BB | 1117          | /                | /               |
| Software for Test                   | Speag        | DASY5         | /             | /                | /               |
| Software for Tissue                 | Agilent      | 85070         | /             | /                | /               |

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

## ANNEX A: System Check Results

### HAC\_System Performance Check at 835MHz\_E

DUT: Dipole 835 MHz; Type: CD835V3; SN:1023

Date: 2021/11/28

Communication System: CW; Frequency: 835 MHz;Duty Cycle: 1:1

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**E Scan - measurement distance from the probe sensor center to CD835 Dipole = 15mm**

**2/Hearing Aid Compatibility Test (41x361x1):** Measurement grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 91 V/m; Power Drift = 0.003 dB

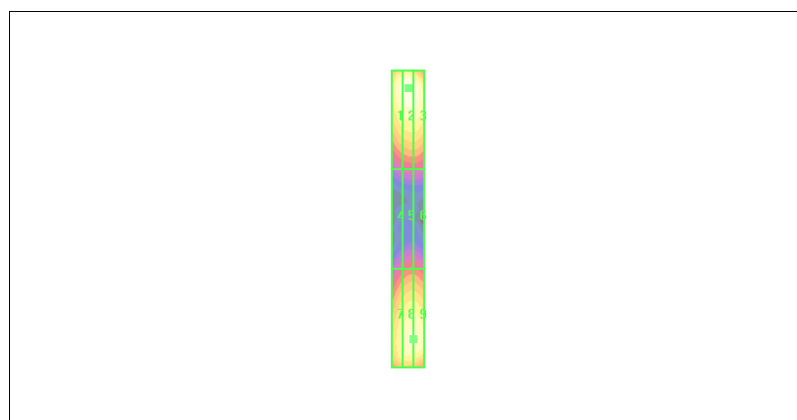
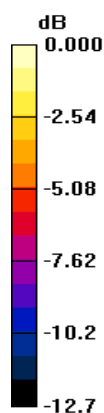
Applied MIF = 0.00 dB

Maximum value of peak Total field = 107.3 V/m

**Hearing Aid Near-Field Category: M4 (AWF 0 dB)**

Peak E-field in V/m

|                           |                           |                           |
|---------------------------|---------------------------|---------------------------|
| Grid 1<br><b>101.2 M4</b> | Grid 2<br><b>104.3 M4</b> | Grid 3<br><b>101.5 M4</b> |
| Grid 4<br><b>61.2 M4</b>  | Grid 5<br><b>64.23 M4</b> | Grid 6<br><b>62.39 M4</b> |
| Grid 7<br><b>104.5 M4</b> | Grid 8<br><b>107.3 M4</b> | Grid 9<br><b>104.3 M4</b> |



0 dB = 107.3V/m

## HAC\_System Performance Check at 1880MHz\_E

DUT: Dipole 1880 MHz; Type: CD1880V3; SN: 1018

Date: 2021/11/28

Communication System: CW; Frequency: 1880 MHz; Duty Cycle: 1:1

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**E Scan - measurement distance from the probe sensor center to CD1880 Dipole =**

**15mm/Hearing Aid Compatibility Test (41x181x1):** Measurement grid: dx=0.5000 mm, dy=0.5000 mm

Device Reference Point: 0, 0, -6.3 mm

Reference Value = 86V/m; Power Drift = 0.002 dB

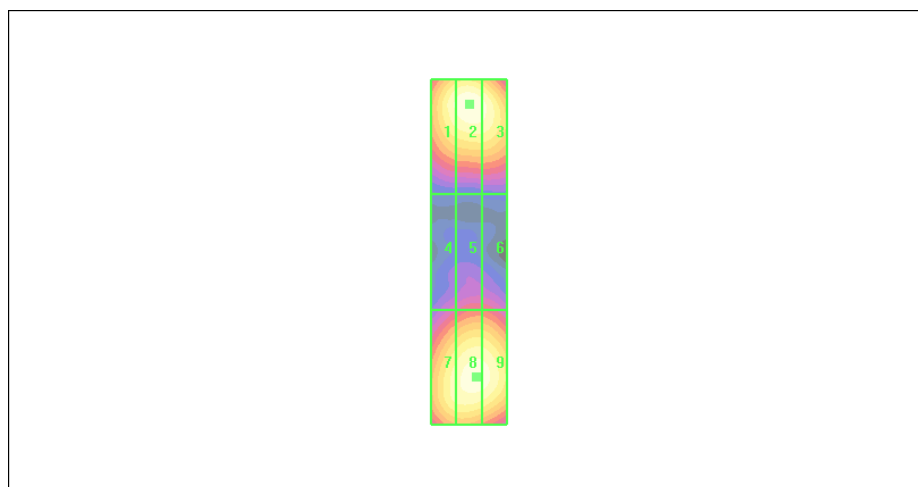
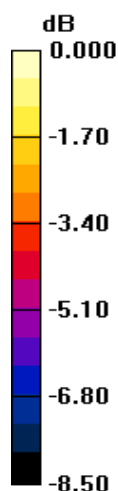
Applied MIF = 0.00 dB

Maximum value of peak Total field = 92.1 V/m

**Hearing Aid Near-Field Category: M2 (AWF 0 dB)**

Peak E-field in V/m

|                           |                           |                           |
|---------------------------|---------------------------|---------------------------|
| Grid 1<br><b>91.78 M2</b> | Grid 2<br><b>98.10 M2</b> | Grid 3<br><b>93.42M2</b>  |
| Grid 4<br><b>71.76 M3</b> | Grid 5<br><b>73.56 M3</b> | Grid 6<br><b>71.17 M3</b> |
| Grid 7<br><b>87.15 M2</b> | Grid 8<br><b>89.46 M2</b> | Grid 9<br><b>89.01 M2</b> |



0 dB = 98.10V/m

## ANNEX B: Graph Results

### Plot 1 HAC RF E-Field GSM 850 Low

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 824.2 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM850 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device Low/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 = 39.38 V/m; Power Drift = 0.01 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.74 dBV/m

**Emission category: M4**

MIF scaled E-field

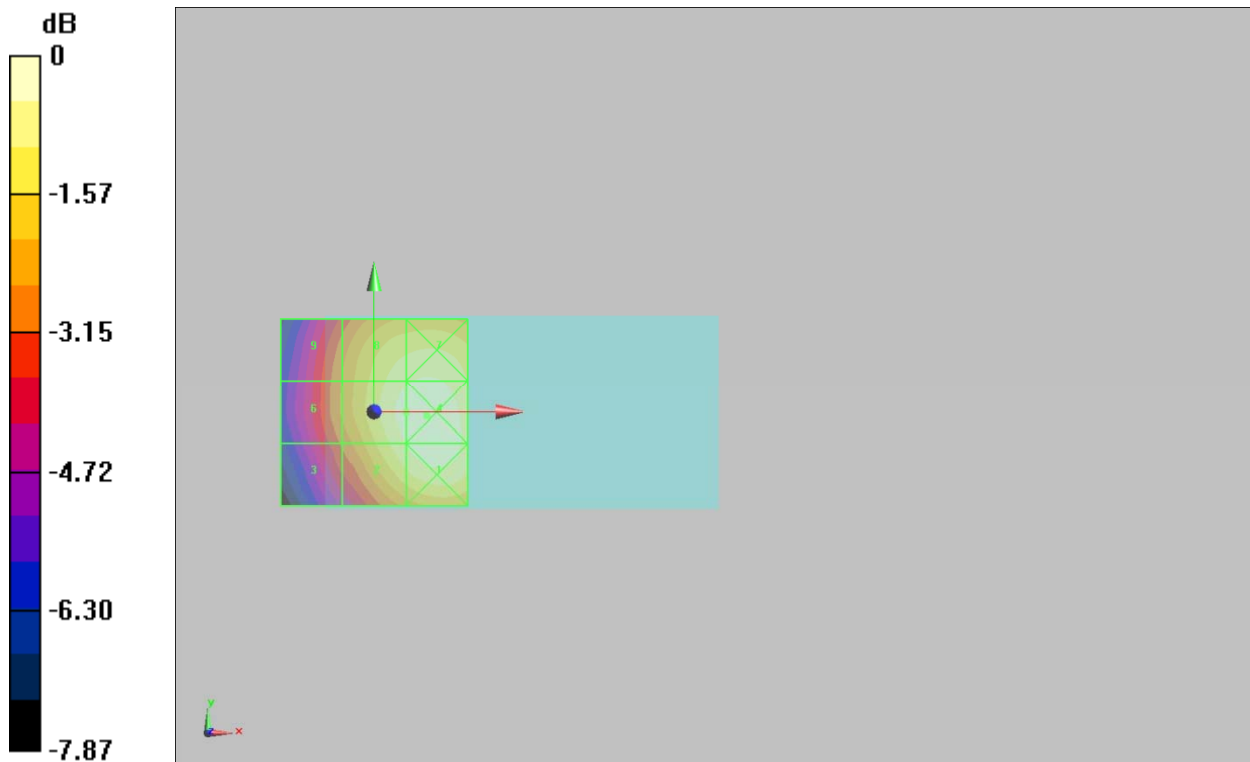
|                                 |                                 |                                 |
|---------------------------------|---------------------------------|---------------------------------|
| Grid 1 <b>M4</b><br>34.75 dBV/m | Grid 2 <b>M4</b><br>34.44 dBV/m | Grid 3 <b>M4</b><br>31.93 dBV/m |
| Grid 4 <b>M4</b><br>34.95 dBV/m | Grid 5 <b>M4</b><br>34.74 dBV/m | Grid 6 <b>M4</b><br>32.46 dBV/m |
| Grid 7 <b>M4</b><br>34.5 dBV/m  | Grid 8 <b>M4</b><br>34.34 dBV/m | Grid 9 <b>M4</b><br>32.38 dBV/m |

**Cursor:**

Total = 34.95 dBV/m

E Category: M4

Location: 14, -1, 7.7 mm



0 dB = 55.91 V/m = 34.95 dBV/m

**Plot 2 HAC RF E-Field GSM 850 Middle**

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 836.6 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM850 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device Middle/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 = 38.93 V/m; Power Drift = -0.01 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.63 dBV/m

**Emission category: M4**

MIF scaled E-field

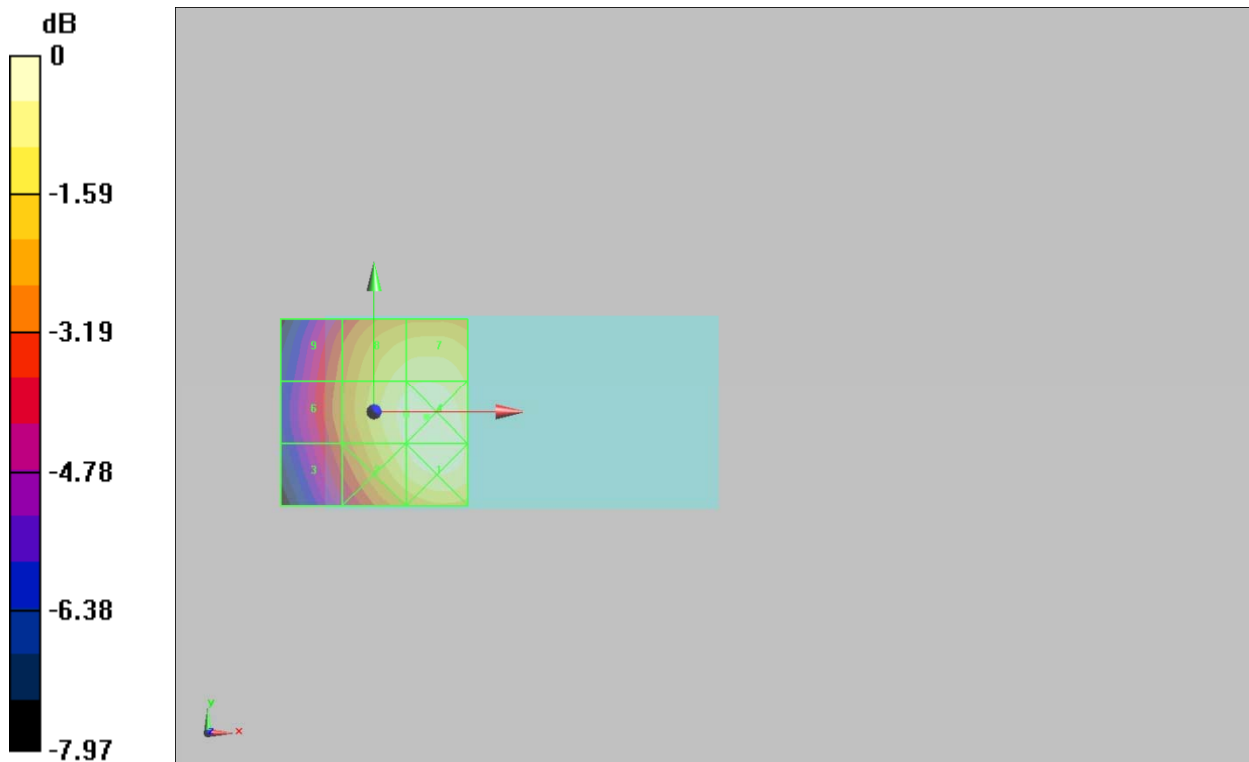
|                                        |                                        |                                        |
|----------------------------------------|----------------------------------------|----------------------------------------|
| Grid 1 <b>M4</b><br><b>34.75 dBV/m</b> | Grid 2 <b>M4</b><br><b>34.38 dBV/m</b> | Grid 3 <b>M4</b><br><b>31.81 dBV/m</b> |
| Grid 4 <b>M4</b><br><b>34.87 dBV/m</b> | Grid 5 <b>M4</b><br><b>34.63 dBV/m</b> | Grid 6 <b>M4</b><br><b>32.24 dBV/m</b> |
| Grid 7 <b>M4</b><br><b>34.31 dBV/m</b> | Grid 8 <b>M4</b><br><b>34.15 dBV/m</b> | Grid 9 <b>M4</b><br><b>32.05 dBV/m</b> |

**Cursor:**

Total = 34.87 dBV/m

E Category: M4

Location: 14, -1.5, 7.7 mm



0 dB = 55.37 V/m = 34.87 dBV/m

### Plot 3 HAC RF E-Field GSM 850 High

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 848.6 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM850 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device High/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 = 39.92 V/m; Power Drift = -0.03 dB

Applied MIF = 3.63 dB

RF audio interference level = 34.73 dBV/m

**Emission category: M4**

MIF scaled E-field

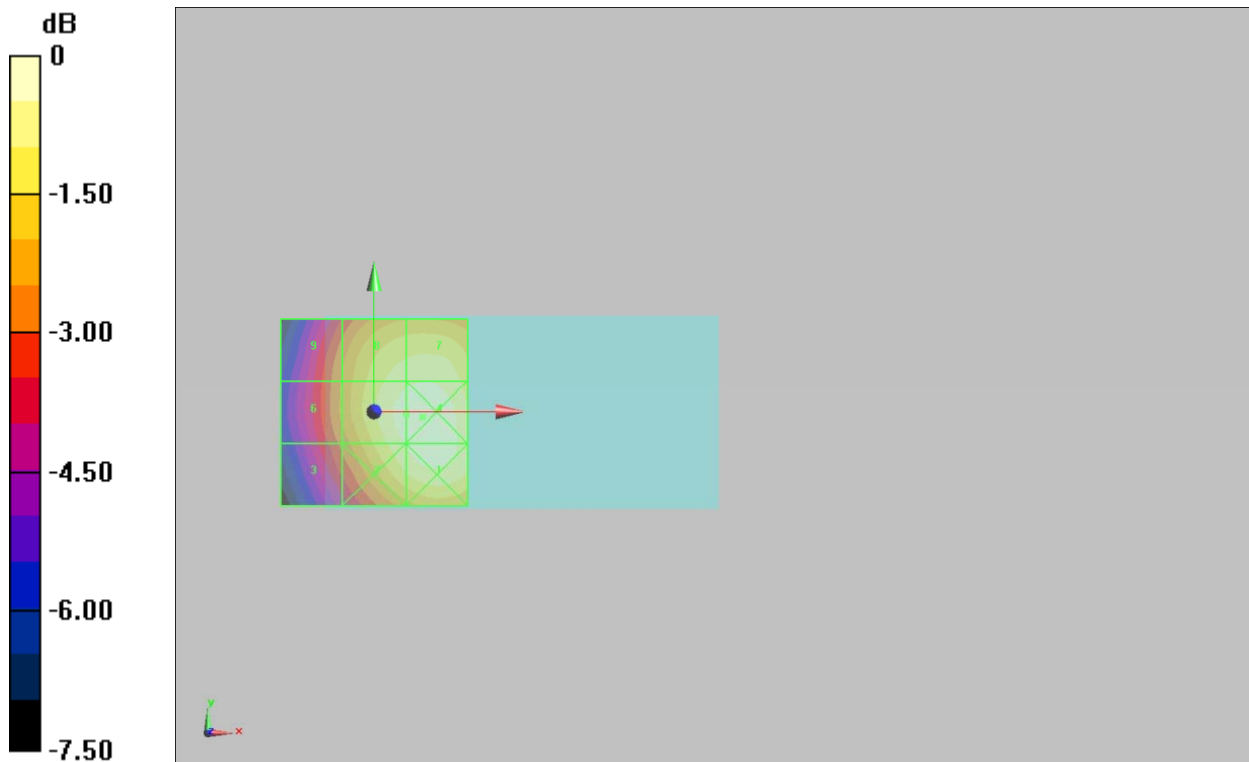
|                          |                          |                          |
|--------------------------|--------------------------|--------------------------|
| Grid 1 M4<br>34.72 dBV/m | Grid 2 M4<br>34.45 dBV/m | Grid 3 M4<br>32.08 dBV/m |
| Grid 4 M4<br>34.9 dBV/m  | Grid 5 M4<br>34.73 dBV/m | Grid 6 M4<br>32.56 dBV/m |
| Grid 7 M4<br>34.39 dBV/m | Grid 8 M4<br>34.27 dBV/m | Grid 9 M4<br>32.47 dBV/m |

**Cursor:**

Total = 34.90 dBV/m

E Category: M4

Location: 13, -1.5, 7.7 mm



0 dB = 55.57 V/m = 34.90 dBV/m

**Plot 4 HAC RF E-Field GSM 1900 Low**

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 1850.2 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM1900 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device Low/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 = 8.515 V/m; Power Drift = 0.02 dB

Applied MIF = 3.63 dB

RF audio interference level = 22.89 dBV/m

**Emission category: M4**

MIF scaled E-field

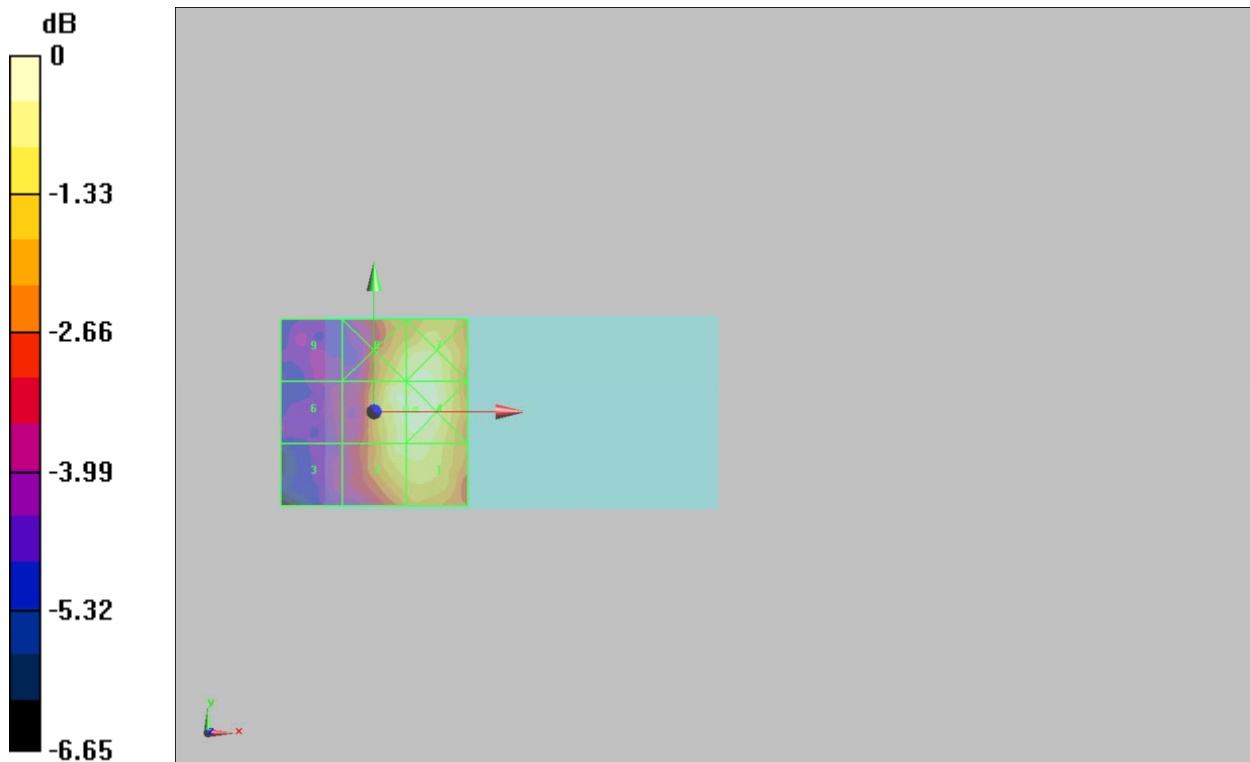
|                                 |                                 |                                 |
|---------------------------------|---------------------------------|---------------------------------|
| Grid 1 <b>M4</b><br>22.43 dBV/m | Grid 2 <b>M4</b><br>22.38 dBV/m | Grid 3 <b>M4</b><br>19.44 dBV/m |
| Grid 4 <b>M4</b><br>23.08 dBV/m | Grid 5 <b>M4</b><br>22.89 dBV/m | Grid 6 <b>M4</b><br>19.44 dBV/m |
| Grid 7 <b>M4</b><br>22.79 dBV/m | Grid 8 <b>M4</b><br>22.48 dBV/m | Grid 9 <b>M4</b><br>19.04 dBV/m |

**Cursor:**

Total = 23.08 dBV/m

E Category: M4

Location: 11, 0.5, 7.7 mm



0 dB = 14.26 V/m = 23.08 dBV/m

## Plot 5 HAC RF E-Field GSM 1900 Middle

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 1880 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM1900 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device Middle/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 = 8.566 V/m; Power Drift = -0.10 dB

Applied MIF = 3.63 dB

RF audio interference level = 22.54 dBV/m

**Emission category: M4**

MIF scaled E-field

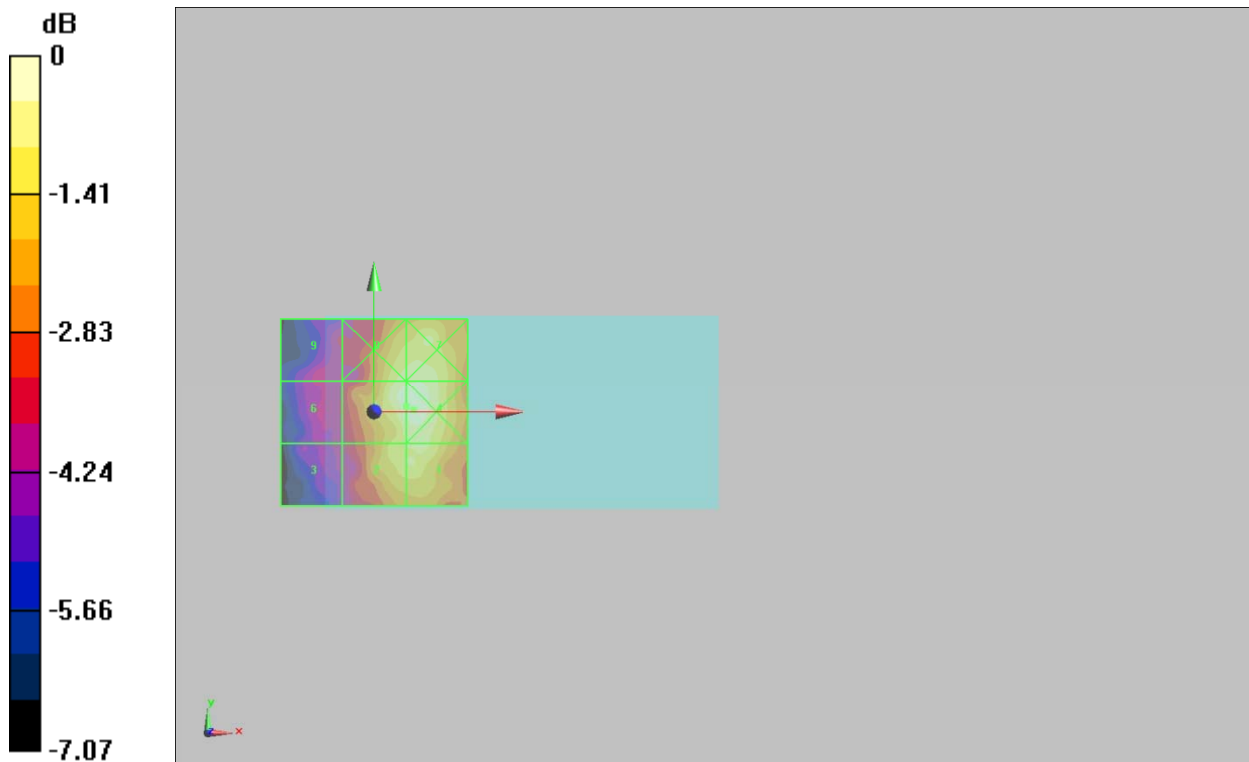
|                                 |                                 |                                 |
|---------------------------------|---------------------------------|---------------------------------|
| Grid 1 <b>M4</b><br>21.93 dBV/m | Grid 2 <b>M4</b><br>21.81 dBV/m | Grid 3 <b>M4</b><br>18.84 dBV/m |
| Grid 4 <b>M4</b><br>22.73 dBV/m | Grid 5 <b>M4</b><br>22.54 dBV/m | Grid 6 <b>M4</b><br>19.09 dBV/m |
| Grid 7 <b>M4</b><br>22.23 dBV/m | Grid 8 <b>M4</b><br>22.1 dBV/m  | Grid 9 <b>M4</b><br>19.08 dBV/m |

**Cursor:**

Total = 22.73 dBV/m

E Category: M4

Location: 10.5, 0.5, 7.7 mm



0 dB = 13.69 V/m = 22.73 dBV/m

# Plot 6 HAC RF E-Field GSM 1900 High

Date: 2021/11/28

Communication System: UID 10021 - DAC, GSM-FDD (TDMA, GMSK); Frequency: 1909.8 MHz; Duty Cycle: 1:8.69961

Medium parameters used:  $\sigma = 0$  S/m,  $\epsilon_r = 1$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Ambient Temperature: 22.3 °C Liquid Temperature: 21.5 °C

Phantom section: RF Section

DASY5 Configuration:

Sensor-Surface: 0mm (Mechanical Surface Detection)

Probe: EF3DV3 - SN4048; ConvF(1, 1, 1); Calibrated: 2021/3/4

Electronics: DAE4 Sn1648; Calibrated: 2021/5/17

Phantom: HAC Test Arch with AMCC; Type: SD HAC P01 BA

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

**U40 GSM1900 HAC RF E-Field/E Scan - ER3D: 15 mm from Probe Center to the Device High/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 = 9.520 V/m; Power Drift = -0.09 dB

Applied MIF = 3.63 dB

RF audio interference level = 22.93 dBV/m

**Emission category: M4**

MIF scaled E-field

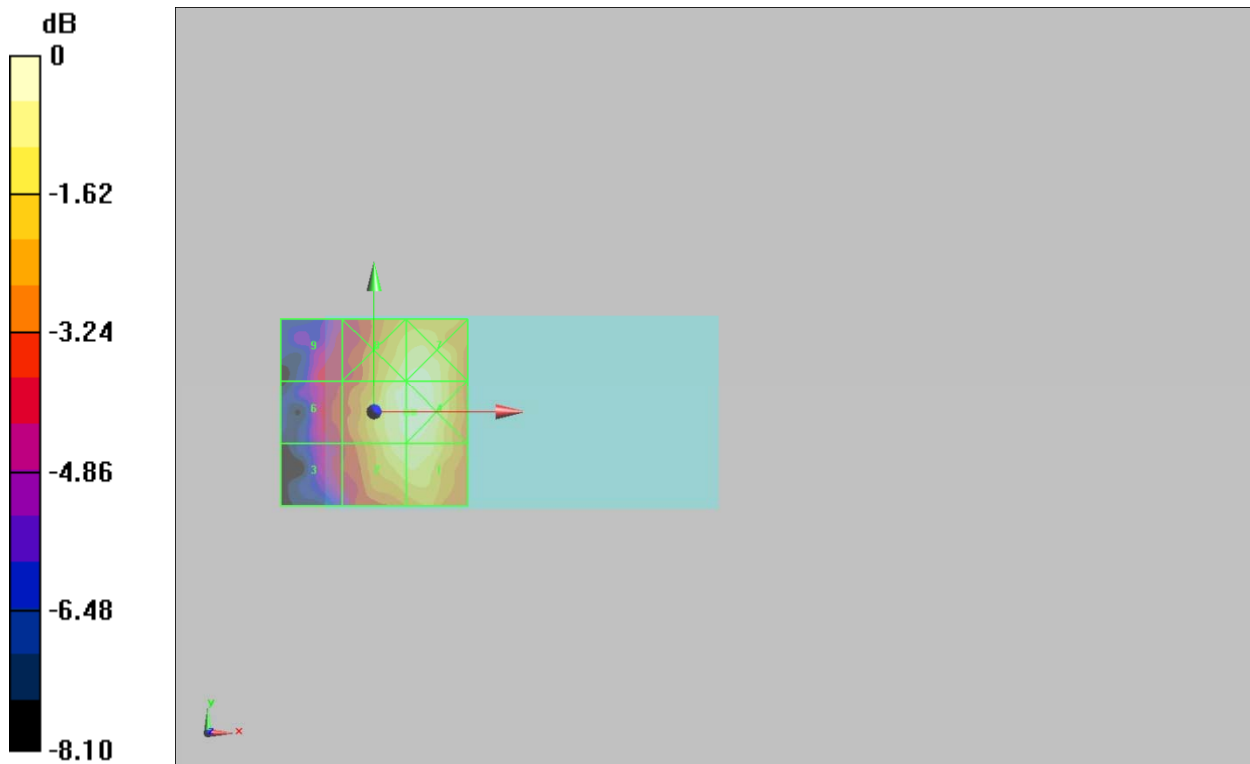
|                                 |                                 |                                 |
|---------------------------------|---------------------------------|---------------------------------|
| Grid 1 <b>M4</b><br>22.43 dBV/m | Grid 2 <b>M4</b><br>22.4 dBV/m  | Grid 3 <b>M4</b><br>19.36 dBV/m |
| Grid 4 <b>M4</b><br>23.07 dBV/m | Grid 5 <b>M4</b><br>22.93 dBV/m | Grid 6 <b>M4</b><br>19.8 dBV/m  |
| Grid 7 <b>M4</b><br>22.77 dBV/m | Grid 8 <b>M4</b><br>22.56 dBV/m | Grid 9 <b>M4</b><br>19.29 dBV/m |

**Cursor:**

Total = 23.07 dBV/m

E Category: M4

Location: 10.5, 0, 7.7 mm



0 dB = 14.25 V/m = 23.08 dBV/m

# ANNEX C: E-Probe Calibration Certificate

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  
S 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 **TA-SH (Auden)**

Certificate No: **EF3-4048\_Mar21**

## CALIBRATION CERTIFICATE

Object **EF3DV3- SN:4048**

Calibration procedure(s) **QA CAL-02.v9, QA CAL-25.v7  
Calibration procedure for E-field probes optimized for close near field  
evaluations in air**

Calibration date: **March 4, 2021**

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 ± 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       | 01-Apr-20 (No. 217-03100/03101)   | Apr-21                 |
| Power sensor NRP-Z91       | SN: 103244       | 01-Apr-20 (No. 217-03100)         | Apr-21                 |
| Power sensor NRP-Z91       | SN: 103245       | 01-Apr-20 (No. 217-03101)         | Apr-21                 |
| Reference 20 dB Attenuator | SN: CC2552 (20x) | 31-Mar-20 (No. 217-03106)         | Apr-21                 |
| DAE4                       | SN: 789          | 23-Dec-20 (No. DAE4-789_Dec20)    | Dec-21                 |
| Reference Probe ER3DV6     | SN: 2328         | 05-Oct-20 (No. ER3-2328_Oct20)    | Oct-21                 |
| Secondary Standards        | ID               | Check Date (in house)             | Scheduled Check        |
| Power meter E4419B         | SN: GB41293874   | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| Power sensor E4412A        | SN: MY41498087   | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| Power sensor E4412A        | SN: 000110210    | 06-Apr-16 (in house check Jun-20) | In house check: Jun-22 |
| RF generator HP 8648C      | SN: US3642U01700 | 04-Aug-99 (in house check Jun-20) | In house check: Jun-22 |
| Network Analyzer E8358A    | SN: US41080477   | 31-Mar-14 (in house check Oct-20) | In house check: Oct-21 |

|                                                                                                                 | Name          | Function              | Signature             |
|-----------------------------------------------------------------------------------------------------------------|---------------|-----------------------|-----------------------|
| Calibrated by:                                                                                                  | Michael Weber | Laboratory Technician |                       |
| Approved by:                                                                                                    | Katja Pokovic | Technical Manager     |                       |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |               |                       | Issued: March 4, 2021 |

Certificate No: EF3-4048\_Mar21

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**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  
**S** 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

#### 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                                                                                                           |
| En                       | incident E-field orientation normal to probe axis                                                                                                       |
| Ep                       | incident E-field orientation parallel to probe axis                                                                                                     |
| Polarization $\phi$      | $\phi$ rotation around probe axis                                                                                                                       |
| Polarization $\vartheta$ | $\vartheta$ rotation around an axis that is in the plane normal to probe axis (at measurement center),<br>i.e., $\vartheta = 0$ 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 3.1.1, May 2017

#### Methods Applied and Interpretation of Parameters:

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  for XY sensors and  $\vartheta = 90$  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).



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**DASY/EASY - Parameters of Probe: EF3DV3 - SN:4048****Basic Calibration Parameters**

|                                              | Sensor X | Sensor Y | Sensor Z | Unc (k=2)    |
|----------------------------------------------|----------|----------|----------|--------------|
| Norm ( $\mu\text{V}/(\text{V}/\text{m})^a$ ) | 0.61     | 0.60     | 1.13     | $\pm 10.1\%$ |
| DCP ( $\text{mV})^b$                         | 100.4    | 101.0    | 96.1     |              |

**Calibration results for Frequency Response (30 MHz – 6 GHz)**

| Frequency MHz | Target E-Field V/m | Measured E-field (En) V/m | Deviation E-normal in % | Measured E-field (Ep) V/m | Deviation E-normal in % | Unc (k=2) % |
|---------------|--------------------|---------------------------|-------------------------|---------------------------|-------------------------|-------------|
| 30            | 77.1               | 77.1                      | 0.0%                    | 77.5                      | 0.5%                    | $\pm 5.1\%$ |
| 100           | 77.2               | 78.3                      | 1.4%                    | 77.9                      | 0.9%                    | $\pm 5.1\%$ |
| 450           | 77.2               | 78.4                      | 1.6%                    | 77.9                      | 1.0%                    | $\pm 5.1\%$ |
| 600           | 77.1               | 77.9                      | 1.1%                    | 77.5                      | 0.5%                    | $\pm 5.1\%$ |
| 750           | 77.0               | 77.7                      | 0.9%                    | 77.3                      | 0.3%                    | $\pm 5.1\%$ |
| 1800          | 143.1              | 139.2                     | -2.7%                   | 139.3                     | -2.7%                   | $\pm 5.1\%$ |
| 2000          | 135.1              | 131.5                     | -2.7%                   | 131.5                     | -2.7%                   | $\pm 5.1\%$ |
| 2200          | 127.6              | 123.4                     | -3.3%                   | 124.5                     | -2.5%                   | $\pm 5.1\%$ |
| 2500          | 125.5              | 122.4                     | -2.5%                   | 123.4                     | -1.6%                   | $\pm 5.1\%$ |
| 3000          | 79.3               | 75.6                      | -4.8%                   | 76.7                      | -3.4%                   | $\pm 5.1\%$ |
| 3500          | 257.0              | 246.8                     | -4.0%                   | 245.3                     | -4.5%                   | $\pm 5.1\%$ |
| 3700          | 249.2              | 238.9                     | -4.1%                   | 238.7                     | -4.2%                   | $\pm 5.1\%$ |
| 5200          | 50.8               | 51.4                      | 1.3%                    | 51.6                      | 1.7%                    | $\pm 5.1\%$ |
| 5500          | 46.9               | 46.7                      | -0.4%                   | 48.2                      | 2.7%                    | $\pm 5.1\%$ |
| 5800          | 48.9               | 48.6                      | -0.6%                   | 47.1                      | -3.8%                   | $\pm 5.1\%$ |

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.

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## DASY/EASY - Parameters of Probe: EF3DV3 - SN:4048

### Calibration Results for Modulation Response

| UID       | Communication System Name   |   | A<br>dB | B<br>dB $\sqrt{\mu V}$ | C     | D<br>dB | VR<br>mV | Max<br>dev. | Max<br>Unc <sup>E</sup><br>(k=2) |
|-----------|-----------------------------|---|---------|------------------------|-------|---------|----------|-------------|----------------------------------|
| 0         | CW                          | X | 0.00    | 0.00                   | 1.00  | 0.00    | 148.7    | $\pm 3.5\%$ | $\pm 4.7\%$                      |
|           |                             | Y | 0.00    | 0.00                   | 1.00  |         | 198.8    |             |                                  |
|           |                             | Z | 0.00    | 0.00                   | 1.00  |         | 164.9    |             |                                  |
| 10352-AAA | Pulse Waveform (200Hz, 10%) | X | 3.28    | 67.28                  | 10.90 | 10.00   | 60.0     | $\pm 2.2\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 8.12    | 79.17                  | 17.49 |         | 60.0     |             |                                  |
|           |                             | Z | 7.23    | 77.60                  | 16.41 |         | 60.0     |             |                                  |
| 10353-AAA | Pulse Waveform (200Hz, 20%) | X | 1.96    | 65.62                  | 9.13  | 6.99    | 80.0     | $\pm 0.9\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 18.20   | 89.54                  | 19.50 |         | 80.0     |             |                                  |
|           |                             | Z | 20.00   | 90.33                  | 19.13 |         | 80.0     |             |                                  |
| 10354-AAA | Pulse Waveform (200Hz, 40%) | X | 1.10    | 64.95                  | 7.97  | 3.98    | 95.0     | $\pm 0.8\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 20.00   | 91.64                  | 18.81 |         | 95.0     |             |                                  |
|           |                             | Z | 20.00   | 91.70                  | 18.22 |         | 95.0     |             |                                  |
| 10355-AAA | Pulse Waveform (200Hz, 60%) | X | 20.00   | 86.71                  | 13.97 | 2.22    | 120.0    | $\pm 0.9\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 20.00   | 95.29                  | 19.36 |         | 120.0    |             |                                  |
|           |                             | Z | 20.00   | 94.60                  | 18.33 |         | 120.0    |             |                                  |
| 10387-AAA | QPSK Waveform, 1 MHz        | X | 2.05    | 70.87                  | 17.55 | 1.00    | 150.0    | $\pm 1.6\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 2.07    | 68.57                  | 16.94 |         | 150.0    |             |                                  |
|           |                             | Z | 1.92    | 68.52                  | 16.48 |         | 150.0    |             |                                  |
| 10388-AAA | QPSK Waveform, 10 MHz       | X | 2.58    | 71.18                  | 17.73 | 0.00    | 150.0    | $\pm 0.9\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 2.76    | 71.18                  | 17.52 |         | 150.0    |             |                                  |
|           |                             | Z | 2.61    | 70.63                  | 17.25 |         | 150.0    |             |                                  |
| 10396-AAA | 64-QAM Waveform, 100 kHz    | X | 2.75    | 72.17                  | 19.95 | 3.01    | 150.0    | $\pm 0.7\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 3.87    | 75.12                  | 20.96 |         | 150.0    |             |                                  |
|           |                             | Z | 2.93    | 71.68                  | 19.50 |         | 150.0    |             |                                  |
| 10399-AAA | 64-QAM Waveform, 40 MHz     | X | 3.60    | 67.89                  | 16.47 | 0.00    | 150.0    | $\pm 0.8\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 3.69    | 67.85                  | 16.39 |         | 150.0    |             |                                  |
|           |                             | Z | 3.67    | 67.82                  | 16.37 |         | 150.0    |             |                                  |
| 10414-AAA | WLAN CCDF, 64-QAM, 40MHz    | X | 4.81    | 65.86                  | 15.86 | 0.00    | 150.0    | $\pm 1.9\%$ | $\pm 9.6\%$                      |
|           |                             | Y | 5.00    | 65.70                  | 15.74 |         | 150.0    |             |                                  |
|           |                             | Z | 4.82    | 65.38                  | 15.61 |         | 150.0    |             |                                  |

Note: For details on UID parameters see Appendix

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>B</sup> Numerical linearization parameter: uncertainty not required.

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



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**DASY/EASY - Parameters of Probe: EF3DV3 - SN:4048****Sensor Frequency Model Parameters**

|                      | Sensor X | Sensor Y | Sensor Z |
|----------------------|----------|----------|----------|
| Frequency Corr. (LF) | 0.03     | 0.06     | 5.84     |
| Frequency Corr. (HF) | 2.82     | 2.82     | 2.82     |

**Sensor Model Parameters**

|   | C1<br>fF | C2<br>fF | $\alpha$<br>$V^{-1}$ | T1<br>$ms.V^{-2}$ | T2<br>$ms.V^{-1}$ | T3<br>ms | T4<br>$V^{-2}$ | T5<br>$V^{-1}$ | T6   |
|---|----------|----------|----------------------|-------------------|-------------------|----------|----------------|----------------|------|
| X | 43.6     | 281.72   | 35.56                | 6.29              | 0.39              | 4.92     | 1.28           | 0.00           | 1.00 |
| Y | 66.5     | 433.14   | 36.02                | 14.85             | 0.88              | 4.99     | 1.18           | 0.31           | 1.01 |
| Z | 52.7     | 349.97   | 37.21                | 9.42              | 0.62              | 5.01     | 1.06           | 0.17           | 1.00 |

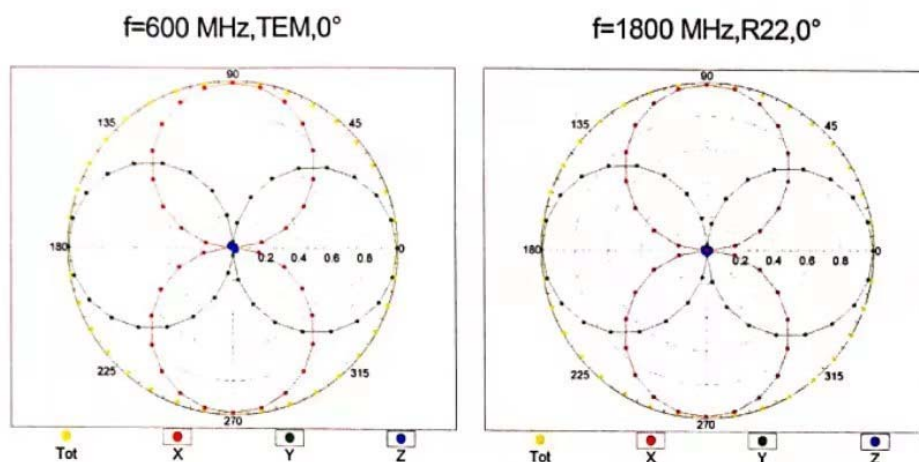
**Other Probe Parameters**

|                                         |             |
|-----------------------------------------|-------------|
| Sensor Arrangement                      | Rectangular |
| Connector Angle (°)                     | 156.6       |
| Mechanical Surface Detection Mode       | enabled     |
| Optical Surface Detection Mode          | disabled    |
| Probe Overall Length                    | 337 mm      |
| Probe Body Diameter                     | 12 mm       |
| Tip Length                              | 25 mm       |
| Tip Diameter                            | 4 mm        |
| Probe Tip to Sensor X Calibration Point | 1.5 mm      |
| Probe Tip to Sensor Y Calibration Point | 1.5 mm      |
| Probe Tip to Sensor Z Calibration Point | 1.5 mm      |

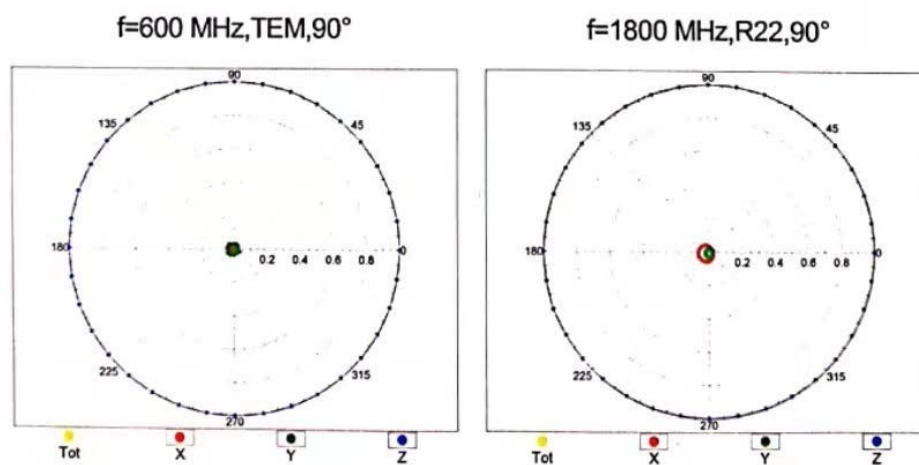
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### Receiving Pattern ( $\phi$ ), $\theta = 0^\circ$



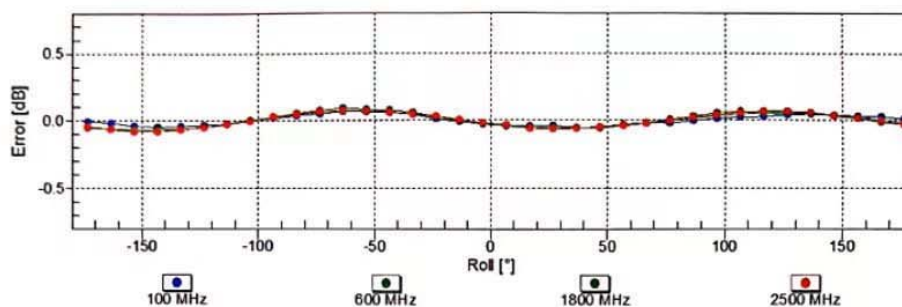
### Receiving Pattern ( $\phi$ ), $\theta = 90^\circ$



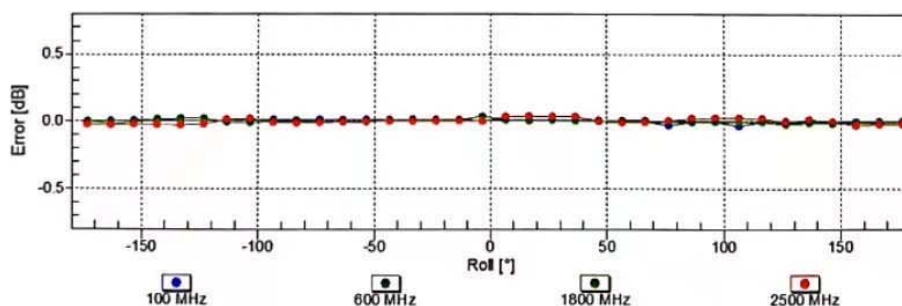
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### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$


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

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


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

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## Dynamic Range f(E-field)

(TEM cell, f = 900 MHz)

