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# TEST REPORT

## SPECIFIC ABSORPTION RATE (SAR) EVALUATION REPORT

For Baby Monitor - Parent Unit

Model Number: TM8112 PU, TM8112-2 PU
Brand Name: vtech

FCC ID: EW780-1496-01

Prepared for
VTech Telecommunications Ltd.
23/F., Tai Ping Industrial Centre, Block 1,
57 Ting Kok Road, Tai Po,
Hong Kong.

| PREPARED AND CHECKED BY: | APPROVED BY: |
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| Date: November 19, 2021 | Date: November 19, 2021 |

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# TEST REPORT

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# TEST REPORT

## 1. TEST RESULT SUMMARY

| | |
|---|---|
| **Applicant:** | VTech Telecommunications Ltd. |
| **Applicant Address:** | 23/F., Tai Ping Industrial Centre, Block 1,<br>57 Ting Kok Road, Tai Po, Hong Kong. |
| **Model:** | TM8112 PU, TM8112-2 PU |
| **Brand Name:** | vtech |
| **Serial Number:** | N/A |
| **FCC ID:** | EW780-1496-01 |
| **Test Device:** | Production Unit |
| **Exposure Category:** | General Population/Uncontrolled Exposure |
| **Date of Test:** | November 13, 2021 |
| **Place of Testing:** | Intertek Testing Services Hong Kong<br>Unit 3, G/F, World-Wide Industrial Centre,<br>43-47 Shan Mei Street, Fo Tan, Sha Tin. |
| **Environmental Conditions:** | Temperature: +18 to 25°C<br>Humidity 25 to 75% |
| **Test Specification:** | ANSI/IEEE C95.1<br>IEEE Std 1528: 2013<br>FCC KDB Publication 447498 D01 v06<br>FCC KDB Publication 865664 D01 v01r04<br>FCC KDB Publication 865664 D02 v01r02 |

The maximum spatial peak SAR value for the sample device averaged over 1g was found to be:

| Band | Operating Mode | TX Frequency (MHz) | Highest Reported SAR | |
|---|---|---|---|---|
| | | | 1 g Head | 1g Body-Worn |
| 1.9GHz DECT | Voice | 1921.536 – 1928.448 | 0.0396 W/kg | 0.0383 W/kg |

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment / general population exposure limits specified in ANSI/IEEE C95.1.

# TEST REPORT

## 2. GENERAL INFORMATION

### 2.1. Description of Equipment under test (EUT)

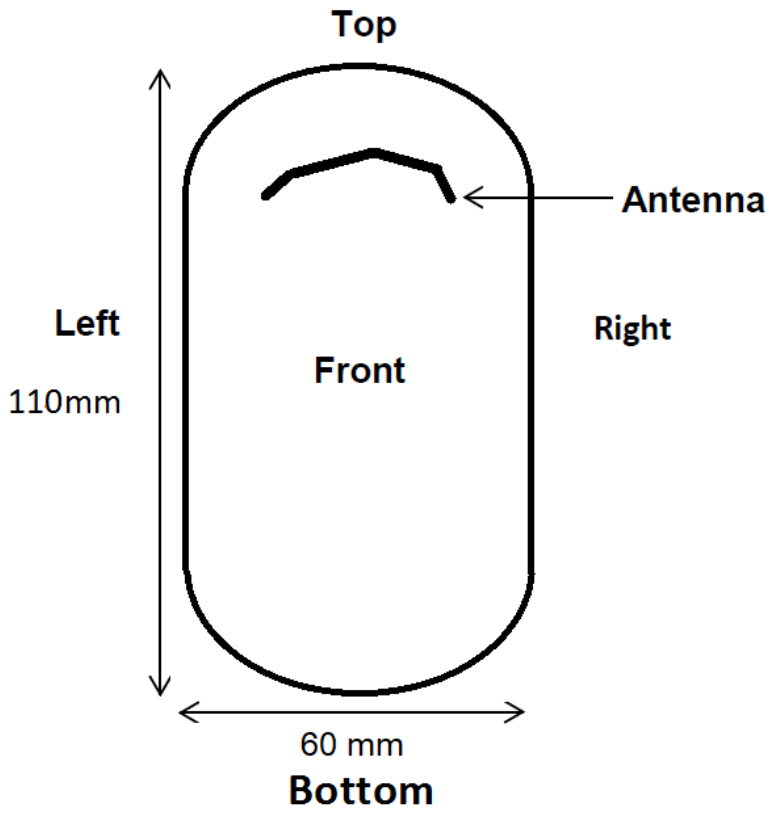
| | |
|---|---|
| **Manufacturer:** | VTech (Dongguan) Telecommunications Limited. |
| **Manufacturer Address:** | VTech Science Park, Xia Ling Bei Management Zone, Liaobu, Dongguan, Guangdong, China. |
| **Device dimension (L x W) :** | 60 (mm) x 110 (mm) |
| **Device thickness:** | 45 (mm) |
| **Antenna Gain:** | 0dBi |
| **Operating Configuration(s) / mode:** | Held to head (Voice call)<br>Body-worn (Voice call) |
| **Tx Frequency (MHz):** | 1921.536MHz to 1928.448MHz |
| **Duty Cycle*:** | 1/24 |
| **H/W Version:** | N/A |
| **S/W Version:** | N/A |
| **Battery Type:** | 2.4VDC (1 x 2.4V 400mAh Ni-MH type rechargeable battery)<br>- Model: Corun, NI-MH AAA400*2 |
| **Body-worn Accessories:** | Belt-clip |

*Note:

1. DECT has a TDD/TDMA frame structure with a complete frame of 10ms duration with 24 time slots. And under these 24 time slots, the first 12 slots are allocated for the transmission from base station to handsets, and the other 12 slots are for the transmission from handsets to base station. During a call, the handset of this product will use one of 24 time slots to transmit under worst case, which gives a duty cycle of 1/24 ( = 4.17%).

# TEST REPORT

## 2.2. EUT Antenna Locations




Details of antenna specification are shown in separate antenna dimension document.

# TEST REPORT

## 2.3. Nominal and Maximum Output Power Specifications

The EUT operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498.

| Band | Operating Mode | TX Frequency (MHz) | Output Power | |
|---|---|---|---|---|
| | | | Nominal (dBm) | Maximum (dBm) |
| 1.9GHz DECT | Voice | 1921.536 – 1928.448 | 19.0 | 21.0 |

**TEST REPORT**

## 3. SAR MEASUREMENT SYSTEM DESCRIPTION

SAR is related to the rate at which energy is absorbed per unit mass in object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and occupational/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.
The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of given mass density (ρ). The equation description is as below:

$$\mathrm{SAR} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\mathrm{d}m}\right) = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\rho \mathrm{d}V}\right)$$

SAR is expressed in units of Watts per kilogram (W/Kg)
SAR can be obtained using either of the following equations:

$$\mathrm{SAR} = \frac{\sigma E^2}{\rho}$$

$$\mathrm{SAR} = c_h \left.\frac{\mathrm{d}T}{\mathrm{d}t}\right|_{t=0}$$

Where

SAR is the specific absorption rate in watts per kilogram;
E is the r.m.s. value of the electric field strength in the tissue in volts per meter;
σ is the conductivity of the tissue in siemens per metre;
ρ is the density of the tissue in kilograms per cubic metre;
$c_h$ is the heat capacity of the tissue in joules per kilogram and Kelvin;

$\left.\frac{\mathbf{dT}}{\mathbf{dt}}\right|\mathbf{t=0}$ is the initial time derivative of temperature in the tissue in kelvins per second

## TEST REPORT

An SAR measurement system usually consists of a small diameter isotropic electric field probe, a multiple axis probe positioning system, a test device holder, one or more phantom models, the field probe instrumentation, a computer and other electronic equipment for controlling the probe and making the measurements. Other supporting equipment, such as a network analyzer, power meters and RF signal generators, are also required to measure the dielectric parameters of the simulated tissue media and to verify the measurement accuracy of the SAR system.

The SAR measurement system being used is COMOSAR system, which consists following items for performing compliance tests

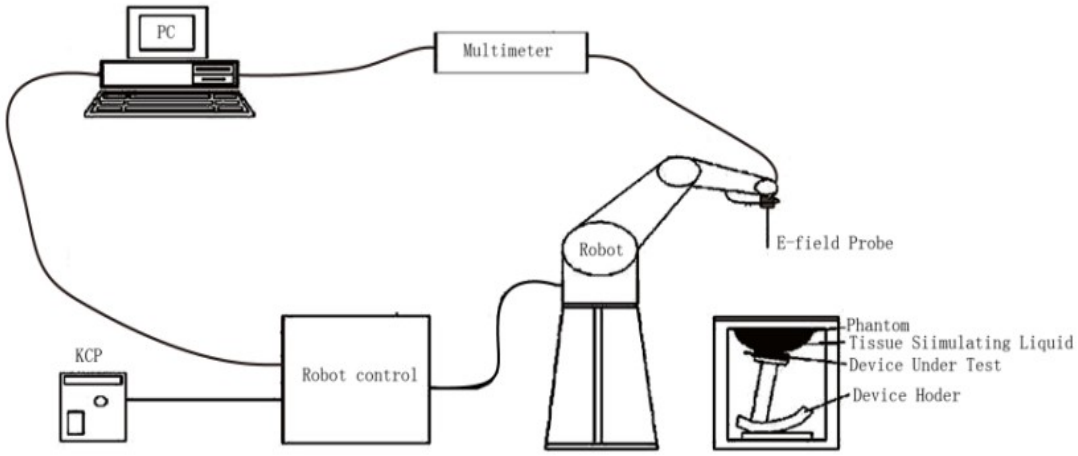



*Figure 1: Schematic diagram of the SAR measurement system*

- The PC. It controls most of the bench devices and stores measurement data. A computer running WinXP and the Opensar software
- The E-Field probe. The probe is a 3-axis system made of 3 distinct dipoles. Each dipole returns a voltage in function of the ambient electric field.
- The Keithley multimeter measures each probe dipole voltages.
- The SAM phantom simulates a human head. The measurement of the electric field is made inside the phantom.
- The liquids simulate the dielectric properties of the human head tissues
- The network emulator controls the mobile phone under test.
- The validation dipoles are used to measure a reference SAR. They are used to periodically check the bench to make sure that there is no drift of the system characteristics over time.
- The phantom, the device holder and other accessories according to the targeted measurement.

# TEST REPORT

## ROBOT

The COMOSAR system uses the KUKA robot from SATIMO SA (France).For the 6-axis controller COMOSAR system, the KUKA robot controller version from SATIMO is used.
The XL robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

# TEST REPORT

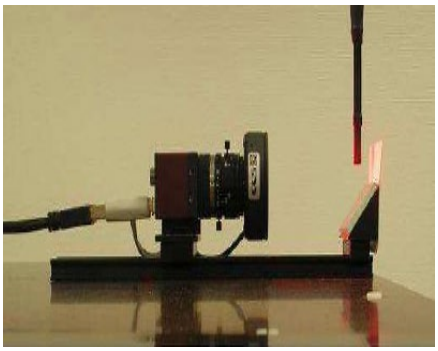
## COMOSAR E-FIELD PROBE

The SAR measurement is conducted with the dissymmetric probe manufactured by SATIMO. The probe is specially designed and calibrated for use in liquid with high permittivity. The dissymmetric probe has special calibration in liquid at different frequency. SATIMO conducts the probe calibration in compliance with international and national standards (e.g. IEEE Std 1528-2013 and relevant KDB files). The calibration data are in Appendix C.

| | |
|---|---|
| **Model** | SSE2 |
| **Manufacture** | MVG |
| **Frequency** | 0.45GHz-6GHz<br>Linearity:±0.08dB |
| **Dynamic Range** | 0.01W/Kg-100W/Kg<br>Linearity:±0.08dB |
| **Dimensions** | Overall length:330mm<br>Length of individual dipoles:2mm<br>Maximum external diameter:8mm<br>Probe Tip external diameter:2.5mm<br>Distance between dipoles/ probe extremity:1mm |

# TEST REPORT

## VIDEO POSITIONING SYSTEM



The video positioning system is used in OpenSAR to check the probe. Which is composed of a camera, LED, mirror and mechanical parts. The camera is piloted by the main computer with firewire link.

During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

# TEST REPORT

## SAM TWIN PHANTOM

The SAM twin phantom is a fiberglass shell phantom with 2mm ± 0.2 mm shell thickness (except the ear region where shell thickness increases to 6mm± 0.2 mm), relative permittivity εr = 3.4 and loss tangent δ = 0.02. It has three measurement areas:

- Left head
- Right head
- Flat phantom

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

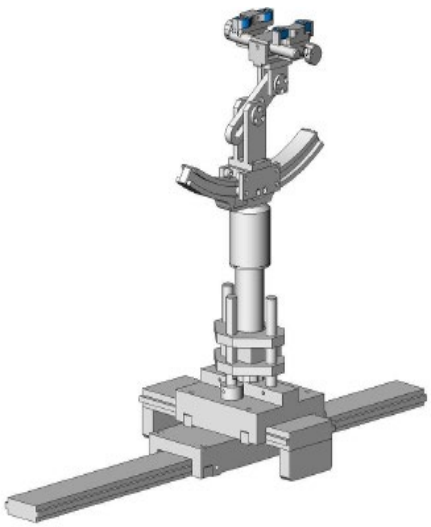
# TEST REPORT

## ELLIPTICAL PHANTOM

The elliptical phantom is a fiberglass shell phantom with

- 2mm ± 0.2 mm shell thickness
- relative permittivity εr = 3.4
- loss tangent δ = 0.02

## DEVICE HOLDER



The COMOSAR device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

The COMOSAR device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity εr =3.7 and loss tangent δ = 0.005. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

## TEST REPORT

During measurement, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom scanning area is greater than the projection of EUT and antenna.

Area Scan Parameters extracted from KDB 865664

| | ≤ 3 GHz | > 3 GHz |
|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | 5 mm ± 1 mm | ½·δ·ln(2) mm ± 0.5 mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | 30° ± 1° | 20° ± 1° |
| Maximum area scan spatial resolution: $\Delta x_{Area}$, $\Delta y_{Area}$ | ≤ 2 GHz: ≤ 15 mm<br>2 – 3 GHz: ≤ 12 mm | 3 – 4 GHz: ≤ 12 mm<br>4 – 6 GHz: ≤ 10 mm |
| | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |

When the maximum SAR point has been found, the system will then carry out a zoom (3D) scan centered at that point to determine volume averaged SAR level.

Zoom Scan Parameters extracted from KDB 865664

| | | | | |
|---|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.<br>* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. | | | | |

# TEST REPORT

## 4. TISSUE VERIFICATION

For SAR measurement of field distribution inside phantom, homogeneous tissue simulating liquid as below liquid recipes were filled to a depth of 15cm ± 0.5cm for below 3GHz measurement and of 10cm ± 0.5cm for above 3GHz.

### HEAD TISSUE RECIPES

| Frequency | Ingredients | | | | | |
|---|---|---|---|---|---|---|
| | De-ionized Water | Salt | 1,2 propanediol | DGBE | DGMH | Triton X100 |
| 450 MHz | 33.5% | 3.4% | 63.1% | | | |
| 750 MHz | 34.2% | 1.4% | 64.4% | | | |
| 900 MHz | 35.3% | 1.0% | 63.7% | | | |
| 1800 MHz | 55.2% | 0.6% | | 13.8% | | 30.4% |
| 1900 MHz | 55.3% | 0.5% | | 13.8% | | 30.4% |
| 2000 MHz | 55.3% | 0.4% | | 13.8% | | 30.5% |
| 2450 MHz | 55.7% | 0.3% | | 18.7% | | 25.3% |
| 5000 MHz | 65.3% | | | | 17.2% | 17.5% |

### BODY TISSUE RECIPES

| Frequency | Ingredients | | | | | |
|---|---|---|---|---|---|---|
| | De-ionized Water | Salt | 1,2 propanediol | DGBE | DGMH | Triton X100 |
| 450 MHz | 52.4% | 1.9% | 45.7% | | | |
| 750 MHz | 55.4% | 1.3% | 43.3% | | | |
| 900 MHz | 52.9% | 1.0% | 46.1% | | | |
| 1800 MHz | 70.8% | 0.5% | | 8.7% | | 20.0% |
| 1900 MHz | 70.1% | 0.4% | | 8.9% | | 20.6% |
| 2000 MHz | 70.2% | 0.3% | | 8.6% | | 20.9% |
| 2450 MHz | 70.8% | 0.3% | | 8.7% | | 20.2% |
| 5000 MHz | 77.8% | | | | 11.7% | 11.5% |

## TEST REPORT

The head tissue dielectric parameters recommended by the IEEE Std 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. For other head and body tissue parameters, they are recommended by KDB 865664.

| Target Frequency | head | | body | |
|---|---|---|---|---|
| (MHz) | εr | σ (S/m) | εr | σ (S/m) |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 1.01 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800 – 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |

(εr = relative permittivity, σ = conductivity and ρ = 1000 kg/m3)

When a transmission band overlaps with one of the target frequencies, the tissue dielectric parameters of the tissue medium at the middle of a device transmission band should be within ±5% of the parameters specified at that target frequency.

## TEST REPORT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using SATIMO Dielectric Probe Kit and R&S Network Analyzer ZVL6.

The dielectric parameters were:

Head Liquid

| Freq. (MHz) | Temp. (˚C) | $\varepsilon_r$ / Relative Permittivity | | | σ / Conductivity | | | ρ **(kg/m³) |
|---|---|---|---|---|---|---|---|---|
| | | measured | Target* | Δ (±5%) | measured | Target* | Δ (±5%) | |
| 1900 | 21.1 | 40.53 | 40 | 1.33 | 1.42 | 1.4 | 1.43 | 1000 |
| 1920 | 21.1 | 39.42 | 40 | -1.45 | 1.43 | 1.4 | 2.14 | 1000 |
| 1930 | 21.1 | 41.05 | 40 | 2.62 | 1.41 | 1.4 | 0.71 | 1000 |

** Target values refer to KDB 865664*
*** Worst-case assumption*

Note:
1. Date of tissue verification measurement: November 13, 2021

2. Ambient temperature: 21.9 deg C

3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

Body

| Freq. (MHz) | Temp. (˚C) | $\varepsilon_r$ / Relative Permittivity | | | σ / Conductivity | | | ρ **(kg/m³) |
|---|---|---|---|---|---|---|---|---|
| | | measured | Target* | Δ (±5%) | measured | Target* | Δ (±5%) | |
| 1900 | 20.9 | 54.24 | 53.3 | 1.76 | 1.46 | 1.52 | -3.95 | 1000 |
| 1920 | 20.9 | 54.31 | 53.3 | 1.89 | 1.47 | 1.52 | -3.29 | 1000 |
| 1930 | 20.9 | 54.72 | 53.3 | 2.66 | 1.48 | 1.52 | -2.63 | 1000 |

** Target values refer to KDB 865664*
*** Worst-case assumption*

Note:
1. Date of tissue verification measurement: November 13, 2021

2. Ambient temperature: 21.9 deg C

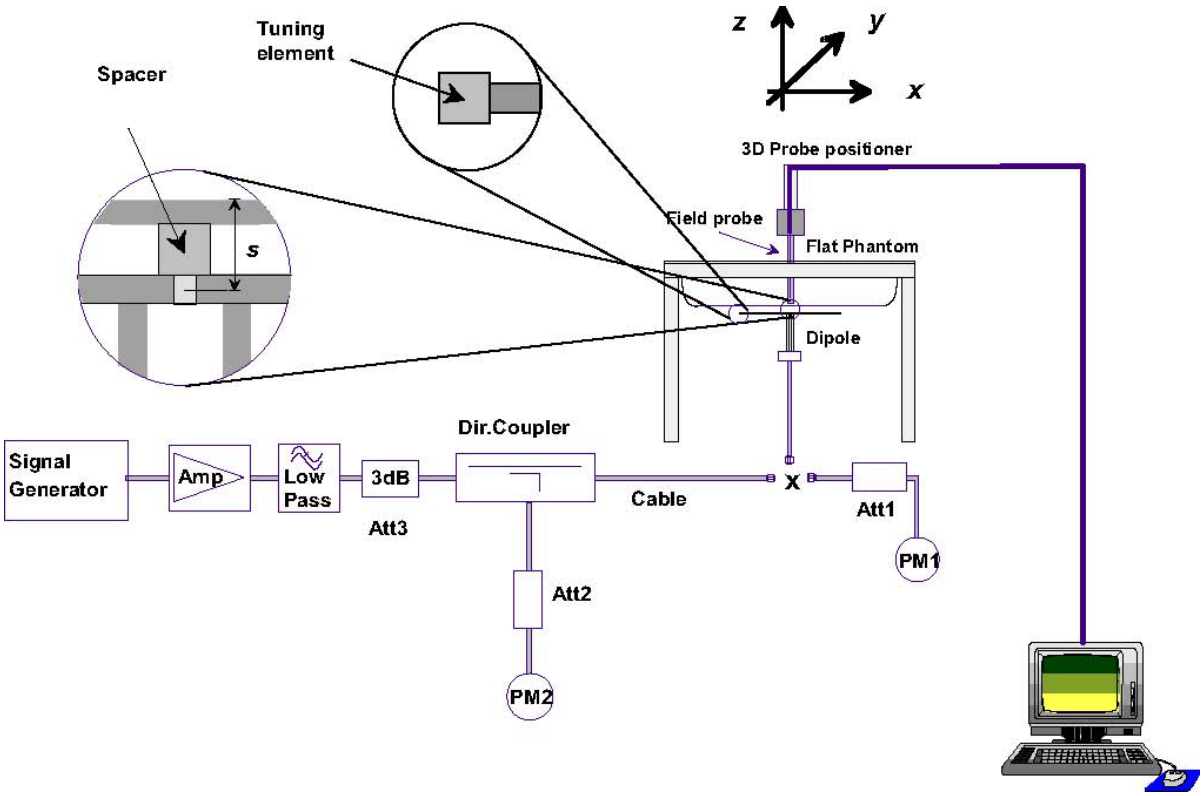
3. The temperature condition is within +/- 2 deg. C during the SAR measurements.

## TEST REPORT

## 5. SAR MEASUREMENT SYSTEM VERIFICATION

Each SATIMO system is equipped with one or more system check kits. These units, together with the predefined measurement procedures within the SATIMO software, enable user to conduct the system check. System kit includes a dipole, and dipole device holder.

The system check verifies that the system operates within its specifications. It's performed daily or before every SAR measurement. The system check uses normal SAR measurement in the flat section of the phantom with a matched dipole at a specified distance. The system check setup is shown as below.



# TEST REPORT

## VALIDATION DIPOLE

The dipoles used is based on the IEEE Std 1528, and is complied with mechanical and electrical specifications in line with the requirements of both FCC and KDB requirement.

## SYSTEM CHECK RESULTS

| System Verification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Freq. (MHz)** | **Liquid Type** | **System Diople** | **Serial No.** | **Target $SAR_{1g}$ (W/kg)** | **Measured $SAR_{1g}$ (W/kg)** | **Normalized $SAR_{1g}$ (W/kg)** | **Deviation (±10%)** |
| Nov 13, 2021 | 1900 | Head | 1900MHz | SN 15/16 DIP 1G900-402 | 41.69 | 3.953 | 39.53 | -5.18% |

* the target was quoted from dipole calibration report
* Input power level = 20dBm (0.1W)

| System Verification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date** | **Freq. (MHz)** | **Liquid Type** | **System Diople** | **Serial No.** | **Target $SAR_{1g}$ (W/kg)** | **Measured $SAR_{1g}$ (W/kg)** | **Normalized $SAR_{1g}$ (W/kg)** | **Deviation (±10%)** |
| Nov 13, 2021 | 1900 | Body | 1900MHz | SN 15/16 DIP 1G900-402 | 41.27 | 3.863 | 38.63 | -6.40% |

* the target was quoted from dipole calibration report
* Input power level = 20dBm (0.1W)

$SAR_{1g}$ ambient measured value < 12 mW/kg

Details of System Verification plots are shown in the Appendix A - plot 1 and 2.

**TEST REPORT**

# 6. SAR EVALUATION

## 6.1. Device test positions relative to the head

This practice specifies two handset test positions against the head phantom—the “cheek” position and the “tilt” position. These two test positions are defined in the following subclauses. The handset should be tested in both positions on left and right sides of the SAM phantom. If handset construction is such that the handset positioning procedures described below to represent normal use conditions cannot be used, e.g., some asymmetric handsets, alternative alignment procedures should be adapted with all details provided in the test report. These alternative procedures should replicate intended use conditions as closely as possible according to the intent of the procedures described in this subclause.

# TEST REPORT

## DEFINITION OF THE CHEEK POSITION

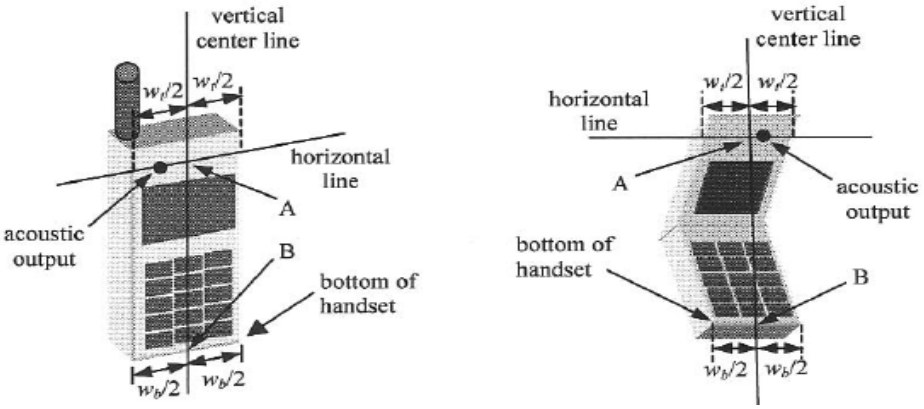
The cheek position is established as follows:

**1.** Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece (flip cover), open the cover. If the handset can transmit with the cover closed, both configurations must be tested.

**2.** Define two imaginary lines on the handset—the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset—the midpoint of the width wt of the handset at the level of the acoustic output (point A in below figure), and the midpoint of the width wb of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see below left figure). The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centerline is not necessarily parallel to the front face of the handset (see right figure), especially for clamshell handsets, handsets with flip covers, and other irregularly-shaped handsets.

**3.** Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see the figure as next page), such that the plane defined by the vertical centerline and the horizontal line of the handset is approximately parallel to the sagittal plane of the phantom.

**4.** Translate the handset towards the phantom along the line passing through RE and LE until handset point A touches the pinna at the ERP.

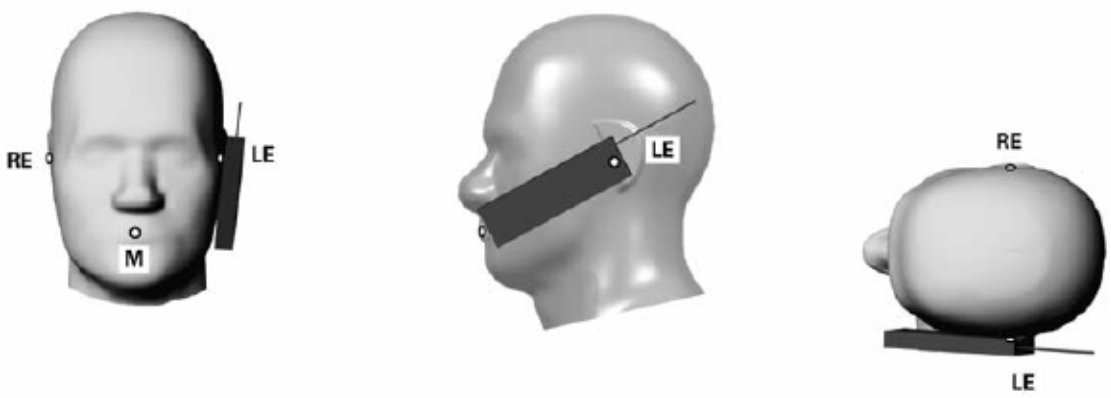


## TEST REPORT

**5.** While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to the plane containing B-M and N-F lines, i.e., the Reference Plane.

**6.** Rotate the handset around the vertical centerline until the handset (horizontal line) is parallel to the N-F line.

**7.** While maintaining the vertical centerline in the Reference Plane, keeping point A on the line passing through RE and LE, and maintaining the handset contact with the pinna, rotate the handset about the N-F line until any point on the handset is in contact with a phantom point below the pinna on the cheek.



# TEST REPORT

## DEFINITION OF THE TILT POSITION

The tilt position is established as follows:

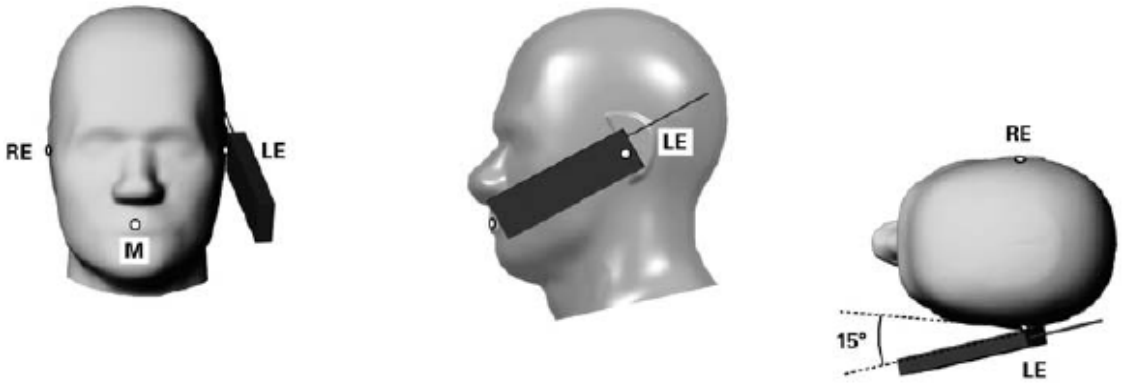
**1.** Repeat steps to place the device in the cheek position.

**2.** While maintaining the orientation of the handset, move the handset away from the pinna along the line passing through RE and LE far enough to allow a rotation of the handset away from the cheek by 15°.

**3.** Rotate the handset around the horizontal line by 15°.

**4.** While maintaining the orientation of the handset, move the handset towards the phantom on the line passing through RE and LE until any part of the handset touches the ear. The tilt position is obtained when the contact point is on the pinna. See the figure as below. If contact occurs at any location other than the pinna, e.g., the antenna at the back of the phantom head, the angle of the handset should be reduced.

**5.** In this case, the tilt position is obtained if any point on the handset is in contact with the pinna and a second point on the handset is in contact with the phantom, e.g., the antenna with the back of the head.



# TEST REPORT

## 6.2. Device test positions relative to body-worn accessory

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per FCC KDB Publication 648474, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body worn accessories. The body-worn accessory procedures in FCC KDB Publication 447498 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is >1.2W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be reported for that body-worn accessory with a headset attached to the handset.

SAR evaluation is required for body-worn accessories supplied with the host device. The test configurations must be conservative for supporting the body-worn accessory use conditions expected by users. Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components, either supplied with the product or available as an option from the device manufacturer, must be tested in conjunction with the host device to demonstrate compliance

Body-worn accessories may not always be supplied or available as options for some devices intended to be authorized for body-worn use. In this case, a test configuration with a separation distance between the back of the device and the flat phantom is used. Test position spacing was documented. Transmitters that are designed to operate in front of a person's face, as in push-to-talk configurations, are tested for SAR compliance with the front of the device positioned to face the flat phantom in head fluid.

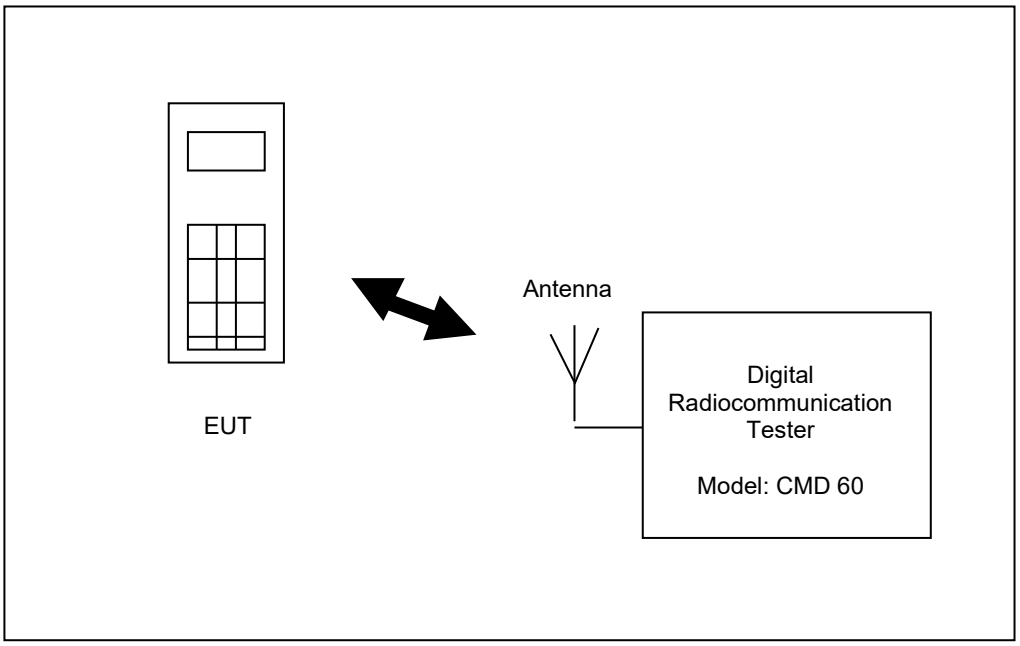
# TEST REPORT

## 6.3. General Device Setup

The device was first charged on a charger over a duration defined by the applicant to make sure the installed battery was fully charged.

The device was then placed into TBR6 test mode to simulate the worst case voice call configuration through highest power channel, where the operating parameters established in this TBR6 test mode is identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequency is corresponded to actual channel frequencies defined for domestic use.

During testing, the device was evaluated with a fully charged battery, power saving function disabled and was configured to operate at maximum output power. A receive antenna and a base station simulator – Digital Radiocommunication Tester, model: CMD60 were placed with a distance > 50cm away from the device to established the voice call communication and monitor the transmission states.



# TEST REPORT

## 6.4. RF Output Power Measurements

| Frequency | Channel | Duty Cycle | Maximum tune-up power (dBm) | Measured Conducted Power (Peak) (dBm) | Measured Conducted Power (Time average) (dBm) |
|---|---|---|---|---|---|
| 1.9GHz DECT | Low – 4 | 1/24 | 21.0 | 19.26 | 5.5 |
| | Middle – 2 | | | 19.27 | 5.5 |
| | High - 0 | | | 19.20 | 5.4 |

Note:

1. Time Average power (dBm) = Peak power (dBm) + Time Average factor.

2. Time Average factor = 10*log(duty cycle)

3. Per KDB 447498, the tested device was within the specified tune-up tolerances range, but not more than 2dB lower than the maximum tune-up tolerance limit.

4. Per KDB 447498, when antenna port was not available on the device to support conducted power measurement and test software was used to establish transmitter power levels, the power level was verified separately according to design and component specifications and product development information specified by the manufacturer.

# TEST REPORT

## 6.5. Exposure Conditions

**Head Exposure Conditions**

| Test Configurations | Operation Mode | SAR Required | Note |
|---|---|---|---|
| Front | Voice | Yes | |

**Body-worn Exposure Conditions**

| Test Configurations | Distance to phantom | Operation Mode | SAR Required | Note |
|---|---|---|---|---|
| Back | 0 mm | Voice | Yes | |

Note:
1. Highest reported SAR test configuration was repeated for additional supported batteries.

# TEST REPORT

## 6.6. Test Result

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detailed measurement data and plots, which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix B.

**Head SAR**

| Measurement Result | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chan | Freq. (MHz) | Battery | Mode | Test Position | Maximum Allowed Power (dBm) | Measured Power (dBm) | SAR Drift (%) | Measured $SAR_{1g}$ (W/kg) | Scaling factor | Reported $SAR_{1g}$ (W/kg) | Plot |
| 2 | 1924 | 2.4V Corun | Voice | Front 0mm | 21.0 | 19.27 | -0.84 | 0.0266 | 1.49 | 0.0396 | 1 |
| 0 | 1924 | 2.4V Corun | Voice | Front 0mm | 21.0 | 19.20 | 1.02 | 0.0154 | 1.51 | 0.0233 | |
| 4 | 1924 | 2.4V Corun | Voice | Front 0mm | 21.0 | 19.26 | -0.65 | 0.0203 | 1.49 | 0.0303 | |

Note:
1. Fully charged batteries were used at the beginning of each SAR measurement.
2. There was no power reduction used for any band/mode implemented in this device.
3. Reported SAR results were scaled to the maximum allowed power with the scaling factor equation -10^[(Maximum power – measured power) / 10].
4. Per KDB 447498 D01, when the maximum output power variation across the required test channels was < 0.5 dB, measurement on middle channel was required.
5. Per KDB 865664 D01, repeated measurement was not required when the original highest measured SAR was < 0.8W/kg.

# TEST REPORT

## 6.6 Test Result (Cont'd)

### Body-worn SAR

| Measurement Result | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chan | Freq. (MHz) | Battery | Mode | Test Position | Maximum Allowed Power (dBm) | Measured Power (dBm) | SAR Drift (%) | Measured $SAR_{1g}$(W/kg) | Scaling factor | Reported $SAR_{1g}$ (W/kg) | Plot |
| 2 | 1924 | 2.4V Corun | Voice | Back 0mm | 21.0 | 19.27 | 0.57 | 0.0257 | 1.49 | 0.0383 | 2 |
| 0 | 1924 | 2.4V Corun | Voice | Back 0mm | 21.0 | 19.20 | -0.45 | 0.0185 | 1.51 | 0.0280 | |
| 4 | 1924 | 2.4V Corun | Voice | Back 0mm | 21.0 | 19.26 | -1.38 | 0.0216 | 1.49 | 0.0322 | |

Note:

1. Fully charged batteries were used at the beginning of each SAR measurement.
2. Reported SAR results were scaled to the maximum allowed power with the scaling factor equation -10^[(Maximum power – measured power) / 10].
3. Per KDB 447498 D01, when the maximum output power variation across the required test channels was < 0.5dB, measurement on middle channel was required.
4. Per KDB 865664 D01, repeated measurement was not required when the original highest measured SAR was < 0.8W/kg.
5. Per KDB 447498 D01, if the reported SAR value was ≤ 0.8 W/kg and the transmission band was ≤ 100MHz, SAR testing was not required for the other test channels in the band.
6. There was no power reduction used for any band/mode implemented in this device.

# TEST REPORT

## 6.7. SAR Limits

The following FCC limits (Std. C95.1-1992) for SAR apply to devices operate in General Population/Uncontrolled Exposure and Controlled environment:

**GENERAL POPULATION / UNCONTROLLED ENVIRONMENTS:**

Defined as location where there is the exposure of individuals who have no knowledge or control of their exposure.

| EXPOSURE (General Population/Uncontrolled Exposure environment) | SAR (W/kg) |
|---|---|
| Spatial Peak SAR (Head)* | 1.60 |
| Spatial Peak SAR (Partial Body)* | 1.60 |
| Spatial Peak SAR (Whole Body)* | 0.08 |
| Spatial Peak SAR (Hands / Wrists / Feet / Ankles)** | 4.00 |

**OCCUPATIONAL / CONTROLLED ENVIRONMENTS:**

Defined as location where there is the exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation)

| EXPOSURE (Occupational/Controlled Exposure environment) | SAR (W/kg) |
|---|---|
| Spatial Peak SAR (Head)* | 8.00 |
| Spatial Peak SAR (Partial Body)* | 8.00 |
| Spatial Peak SAR (Whole Body)* | 0.40 |
| Spatial Peak SAR (Hands / Wrists / Feet / Ankles)** | 20.00 |

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue.
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

** The Spatial Peak value of the SAR averaged over any 10 gram of tissue.
(defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

## TEST REPORT

## 7. TEST EQUIPMENT LIST

| Equipment | Registration No. | Manufacturer | Model No. | Calibration Date | Calibration Due Date |
|---|---|---|---|---|---|
| SAR System | EW-3211 | MVG | SATIMO System (OpenSAR Software V4_02_34) | N/A | N/A |
| Phantom | EW-3211 | SATIMO | COMOSAR SAM PHANTOM | N/A | N/A |
| Digital Multimeter | EW-3206 | KEITHLEY | 2000 | 27 Apr 2021 | 27 Apr 2022 |
| SAR Probe | EW-3210 | MVG | SSE2 (SN 36/20 EPGO347) | 02 Nov 2021 | 02 Nov 2022 |
| SAR Dipole | EW-3212 | MVG | SN 15/16 DIP 1G900-402 | 02 Nov 2021 | 02 Nov 2024 |
| Dielectric Probe for SAR Test | EW-3213 | EW-3213 | Liquid Measurement Kit (SN 24/16 OCPG 76) | 02 Nov 2021 | 02 Nov 2022 |
| Head Liquid Tissue | N/A | MVG | Head Liquid 1900MHz | Refer to Section 4 | |
| Body Liquid Tissue | N/A | MVG | Body Liquid 1900MHz | Refer to Section 4 | |
| Network Analyzer | EW-3192 | Rhode & Schwarz | ZVL6 | 27 Apr 2021 | 27 Apr 2022 |
| Vector Signal Generator | EW-3063 | ROHDESCHWARZ | SMBV100A | 23 Mar 2021 | 23 Mar 2022 |
| Dual-directional coupler (0.1-2.0)GHz | EW-3189 | KEYSIGHT | 778D | 07 Dec 2020 | 07 Dec 2021 |
| Digital Radio-communication Tester for DECT | EW-2250 | ROHDESCHWARZ | CMD60 | 17 Aug 2021 | 17 Aug 2022 |
| Dual-directional coupler (2-18)GHz | EW-3188 | KEYSIGHT | 773D | 23 Dec 2020 | 23 Dec 2021 |
| EMI Test Receiver (9kHz to 26.5GHz) | EW-3156 | ROHDESCHWARZ | FSP30 | 25 Jan 2021 | 25 Jan 2022 |
| VTL 5400 Amplifier 10 - 2500 MHz 3W | EW-3185 | INDEXSAR | VTL 5400 | 07 Dec 2020 | 07 Dec 2021 |

**TEST REPORT**

## 8. MEASUREMENT UNCERTAINTY

Per FCC KDB 865884, the extensive SAR measurement uncertainty analysis was not required when the highest measured SAR was < 1.5W/kg for all frequency band.

## 9. E-FIELD PROBE AND DIPOLE ANTENNA CALIBRATION

Probe calibration factors and dipole antenna calibration are included in Appendix C.

# TEST REPORT

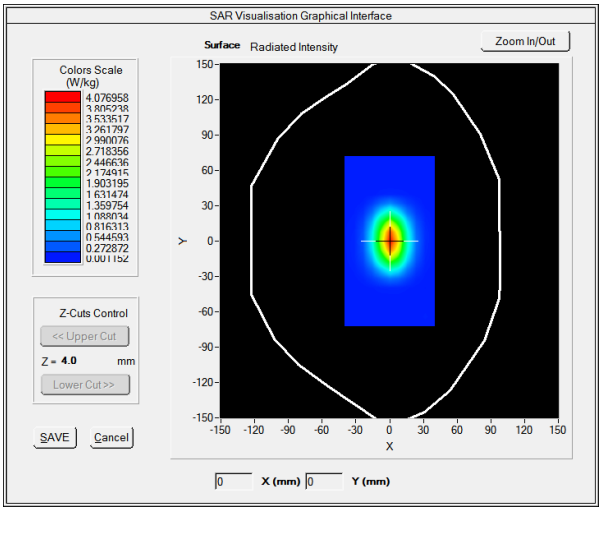
## APPENDIX A – SYSTEM CHECK DATA

Plot #1

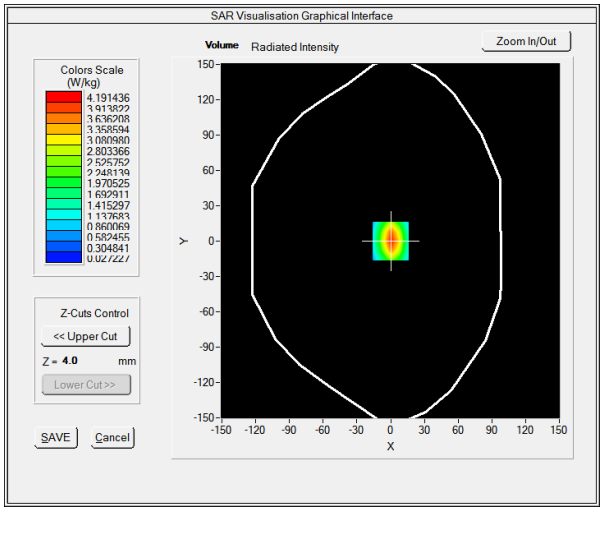
Operating Frequency: 1900MHz
Test Date: 13 November 2021

| | | |
|---|---|---|
| Medium (Liquid Type) | : | 1900 Head |
| Relative permittivity εr | : | 40.53 |
| Conductivity σ: | : | 1.42 |
| Probe | : | Model: SSE2; Serial No.: SN 36/20 EPGO347 |
| Crest factor | : | 1.0 |
| Conversion Factor | : | 2.08 |
| Area Scan | : | dx=8mm, dy=8mm |
| Zoom Scan | : | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | : | SAM phantom |
| Device Position | : | Dipole |
| SAR Drift (%) | : | 3.75% |
| Maximum location | : | X=0.00, Y=0.00 |
| SAR Peak (W/kg) | : | 6.91W/kg |
| SAR 10g (W/kg) | : | 1.924 W/kg |
| SAR 1g (W/kg) | : | 3.953 W/kg |

**SURFACE SAR**




**VOLUME SAR**



# TEST REPORT

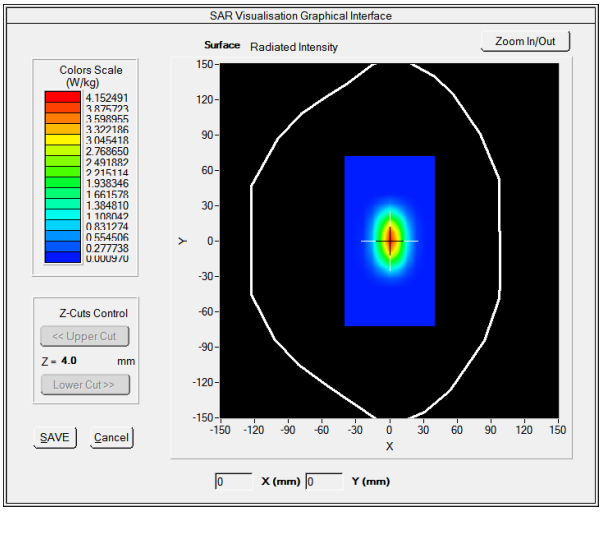
## APPENDIX A – SYSTEM CHECK DATA

Plot #2

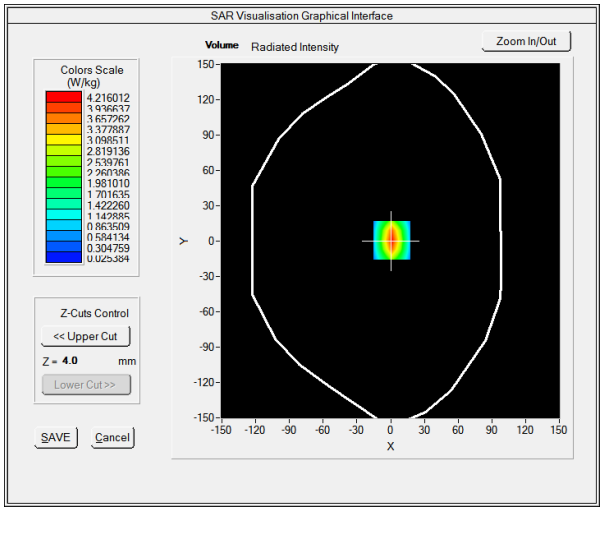
Operating Frequency: 1900MHz
Test Date: 13 November 2021

| | | |
|---|---|---|
| Medium (Liquid Type) | : | 1900 Head |
| Relative permittivity εr | : | 54.24 |
| Conductivity σ: | : | 1.46 |
| Probe | : | Model: SSE2; Serial No.: SN 36/20 EPGO347 |
| Crest factor | : | 1.0 |
| Conversion Factor | : | 2.35 |
| Area Scan | : | dx=8mm, dy=8mm |
| Zoom Scan | : | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | : | SAM phantom |
| Device Position | : | Dipole |
| SAR Drift (%) | : | -0.24% |
| Maximum location | : | X=1.00, Y=1.00 |
| SAR Peak (W/kg) | : | 6.76 W/kg |
| SAR 10g (W/kg) | : | 1.882 W/kg |
| SAR 1g (W/kg) | : | 3.863 W/kg |

**SURFACE SAR**




**VOLUME SAR**



# TEST REPORT

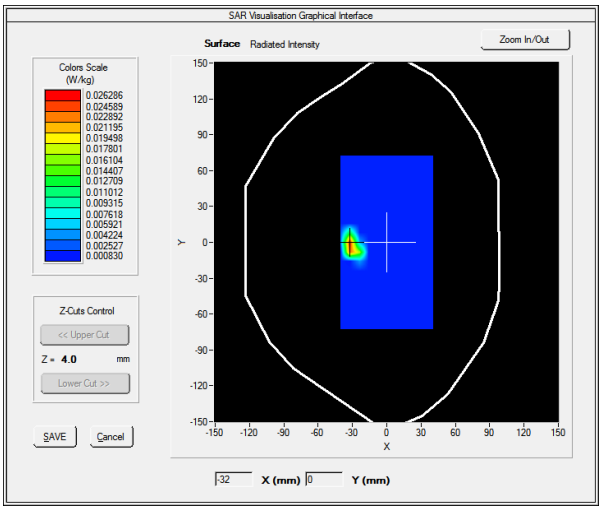
## APPENDIX B – SAR EVALUATION DATA

Plot #1

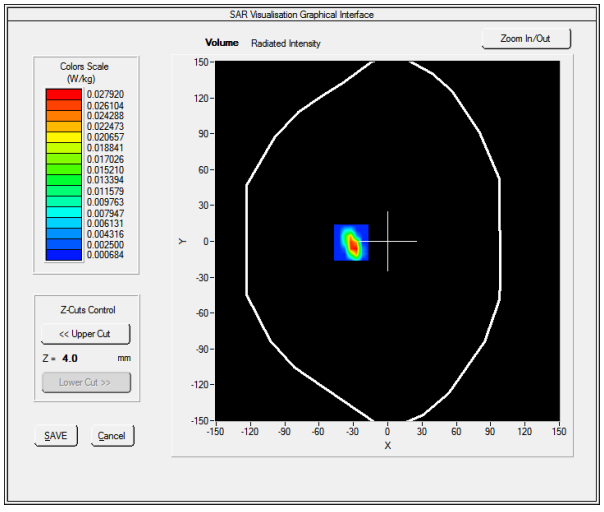
Operating Frequency : 1924.992MHz
Product Description: Baby Monitor - Parent Unit
Model: TM8112 PU (2.4VDC 400mAh Ni-MH type rechargeable battery)
Test Date: 13 November 2021

| | | |
|---|---|---|
| Medium (Liquid Type) | : | 1900 Head |
| Relative permittivity εr | : | 40.53 |
| Conductivity σ: | : | 1.42 |
| Probe | : | Model: SSE2; Serial No.: SN 36/20 EPGO347 |
| Crest factor | : | 4.17 |
| Conversion Factor | : | 2.08 |
| Area Scan | : | dx=8mm, dy=8mm |
| Zoom Scan | : | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | : | SAM phantom |
| Device Position | : | Front 0mm separation |
| SAR Drift (%) | : | -0.84% |
| Maximum location | : | X=-32.00, Y=-1.00 |
| SAR Peak (W/kg) | : | 0.08 W/kg |
| SAR 10g (W/kg) | : | 0.0058 W/kg |
| SAR 1g (W/kg) | : | 0.0266 W/kg |

**SURFACE SAR**




**VOLUME SAR**



# TEST REPORT

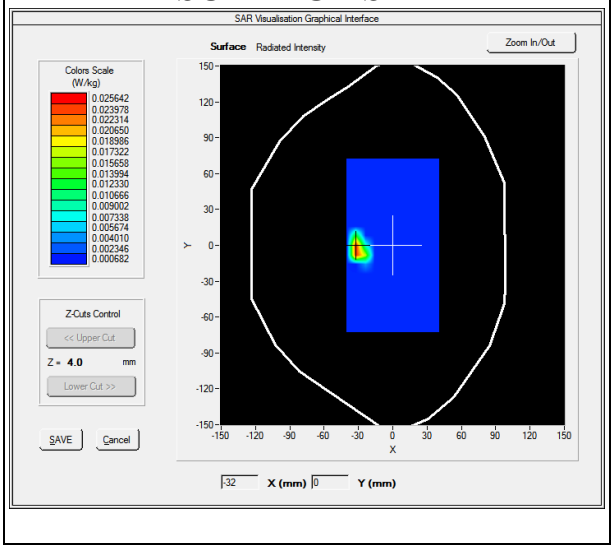
## APPENDIX B – SAR EVALUATION DATA

Plot #2

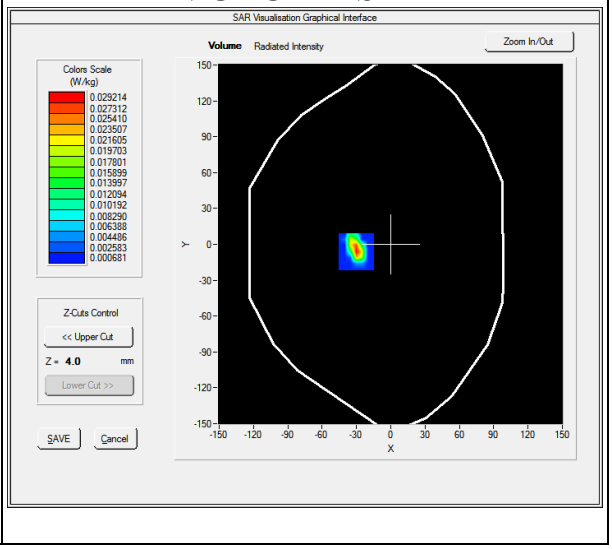
Operating Frequency : 1924.992MHz
Product Description: Baby Monitor - Parent Unit
Model: TM8112 PU (2.4VDC 400mAh Ni-MH type rechargeable battery)
Test Date: 13 November 2021

| | | |
|---|---|---|
| Medium (Liquid Type) | : | 1900 Body |
| Relative permittivity εr | : | 54.24 |
| Conductivity σ: | : | 1.46 |
| Probe | : | Model: SSE2; Serial No.: SN 36/20 EPGO347 |
| Crest factor | : | 4.17 |
| Conversion Factor | : | 2.35 |
| Area Scan | : | dx=8mm, dy=8mm |
| Zoom Scan | : | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | : | SAM phantom |
| Device Position | : | Back 0mm separation |
| SAR Drift (%) | : | 0.57% |
| Maximum location | : | X=-30.00, Y=6.00 |
| SAR Peak (W/kg) | : | 0.08 W/kg |
| SAR 10g (W/kg) | : | 0.0055 W/kg |
| SAR 1g (W/kg) | : | 0.0257 W/kg |

**SURFACE SAR**




**VOLUME SAR**



# TEST REPORT

# APPENDIX C – E-FIELD PROBE AND DIPOLE ANTENNA CALIBRATION

# COMOSAR E-Field Probe Calibration Report

Ref : ACR.307.26.21.BES.B

Cancel and replace the report ACR.307.26.21.BES.A

## INTERTEK TESTING SERVICES HONG KONG LIMITED

**WORKSHOP NO. 3 G/F, WORLD-WIDE INDUSTRIAL CENTRE, 43-47 SHAN MEI STREET,**

**FO TAN, SHA TIN, N.T. HONG KONG**

## MVG COMOSAR DOSIMETRIC E-FIELD PROBE

**SERIAL NO.: SN 36/20 EPGO347**

**Calibrated at MVG**

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

**Calibration date: 11/2/2021**

Accreditations #2-6789
Scope available on www.cofrac.fr

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*Summary:*

This document presents the method and results from an accredited COMOSAR E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| *Prepared by :* | Jérôme Le Gall | Measurement Responsible | 11/3/2021 | |
| *Checked by :* | Jérôme Luc | Technical Manager | 11/3/2021 | |
| *Approved by :* | Yann Toutain | Laboratory Director | 11/10/2021 | Yann TOUTAIN 2021.11.10 12:01:37 +01'00' |

| | Customer Name |
|---|---|
| *Distribution :* | Intertek Testing Services Hong Kong Limited |

| Issue | Name | Date | Modifications |
|---|---|---|---|
| A | Jérôme Luc | 11/3/2021 | Initial release |
| B | Jérôme Luc | 11/10/2021 | Add EN standard |
| | | | |
| | | | |



***Template_ACR.DDD.N.YY.MVGB.ISSUE_COMOSAR Probe vK***
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# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | SN 36/20 EPGO347 |
| Product Condition (new / used) | Used |
| Frequency Range of Probe | 0.15 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.227 MΩ<br>Dipole 2: R2=0.231 MΩ<br>Dipole 3: R3=0.211 MΩ |

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards.

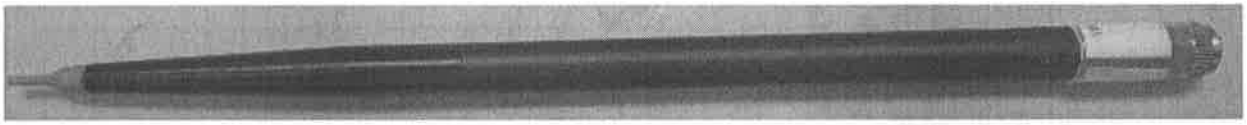

**Figure 1** – *MVG COMOSAR Dosimetric E field Dipole*

| | |
|---|---|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 2 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 2.5 mm |
| Distance between dipoles / probe extremity | 1 mm |

# 3 MEASUREMENT METHOD

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

## 3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.


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### 3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

### 3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

### 3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

### 3.1 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and $d_{be} + d_{step}$ along lines that are approximately normal to the surface:

$$\mathrm{SAR}_{\mathrm{uncertainty}}[\%] = \delta\mathrm{SAR}_{be}\,\frac{(d_{be}+d_{step})^2}{2d_{step}}\,\frac{\left(e^{-d_{be}/(\delta/2)}\right)}{\delta/2} \quad \text{for } (d_{be}+d_{step}) < 10\ \mathrm{mm}$$

where

| | |
|---|---|
| $\mathrm{SAR}_{\mathrm{uncertainty}}$ | is the uncertainty in percent of the probe boundary effect |
| $d_{be}$ | is the distance between the surface and the closest *zoom-scan* measurement point, in millimetre |
| $\Delta_{step}$ | is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible |
| $\delta$ | is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz; |
| $\Delta\mathrm{SAR}_{be}$ | in percent of SAR is the deviation between the measured SAR value, at the distance $d_{be}$ from the boundary, and the analytical SAR value. |



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The measured worst case boundary effect SARuncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty associated with an E-field probe calibration using the waveguide technique. All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

| Uncertainty analysis of the probe calibration in waveguide | | | | | |
|---|---|---|---|---|---|
| **ERROR SOURCES** | **Uncertainty value (%)** | **Probability Distribution** | **Divisor** | **ci** | **Standard Uncertainty (%)** |
| **Expanded uncertainty** 95 % confidence level k = 2 | | | | | 14 % |

## 5 CALIBRATION MEASUREMENT RESULTS

| Calibration Parameters | |
|---|---|
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 0.80 | 0.59 | 0.77 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 109 | 110 | 109 |

Calibration curves ei=f(V) (i=1,2,3) allow to obtain E-field value using the formula:

$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



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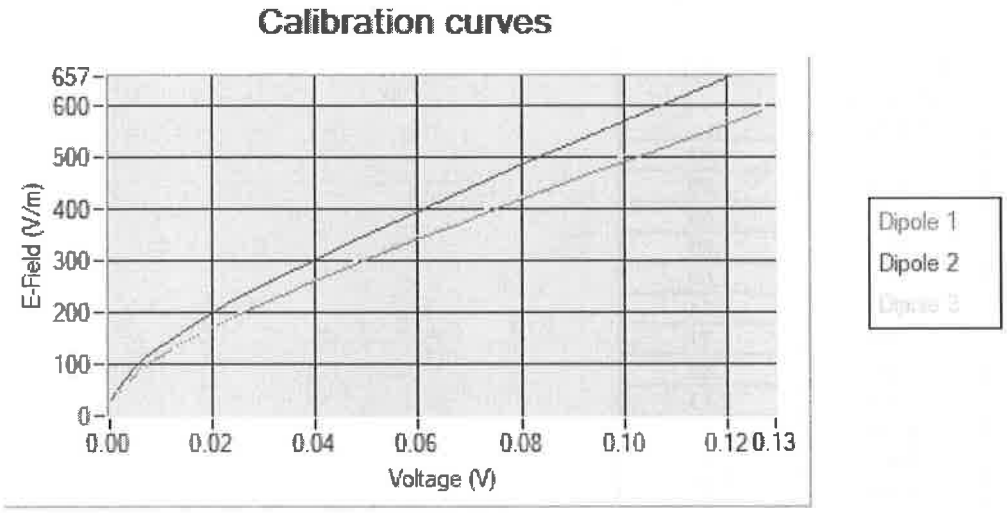
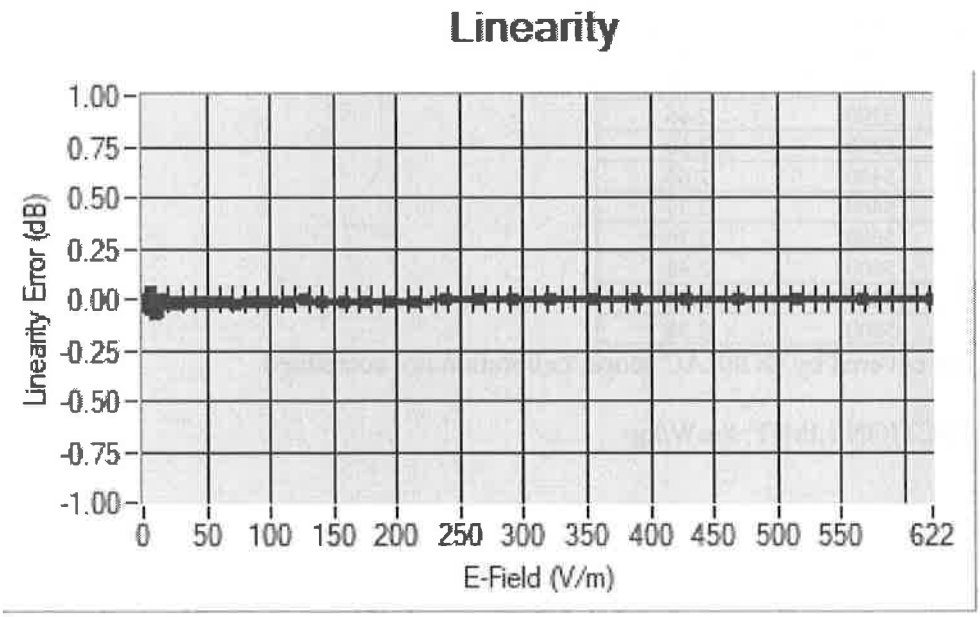



## 5.2 LINEARITY




Linearity:+/-1.70% (+/-0.07dB)



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## 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz +/- 100MHz) | ConvF |
|---|---|---|
| HL450* | 450 | 1.93 |
| BL450* | 450 | 1.90 |
| HL750 | 750 | 1.69 |
| BL750 | 750 | 1.80 |
| HL850 | 835 | 1.69 |
| BL850 | 835 | 1.74 |
| HL900 | 900 | 1.77 |
| BL900 | 900 | 1.80 |
| HL1800 | 1800 | 2.13 |
| BL1800 | 1800 | 2.17 |
| HL1900 | 1900 | 2.08 |
| BL1900 | 1900 | 2.35 |
| HL2000 | 2000 | 2.40 |
| BL2000 | 2000 | 2.58 |
| HL2300 | 2300 | 2.53 |
| BL2300 | 2300 | 2.85 |
| HL2450 | 2450 | 2.36 |
| BL2450 | 2450 | 2.85 |
| HL2600 | 2600 | 2.42 |
| BL2600 | 2600 | 2.77 |
| HL5200 | 5200 | 2.66 |
| BL5200 | 5200 | 2.60 |
| HL5400 | 5400 | 2.60 |
| BL5400 | 5400 | 2.39 |
| HL5600 | 5600 | 2.70 |
| BL5600 | 5600 | 2.48 |
| HL5800 | 5800 | 2.56 |
| BL5800 | 5800 | 2.50 |

* Frequency not covered by COFRAC scope, calibration not accredited

LOWER DETECTION LIMIT: 8mW/kg



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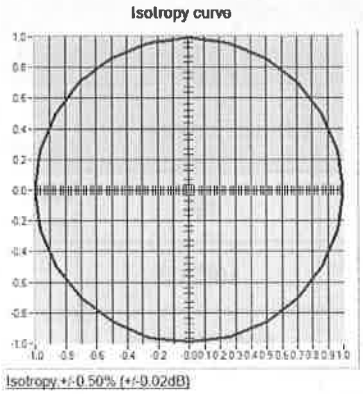
## 5.4 ISOTROPY

**HL1800 MHz**



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## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| CALIPROBE Test Bench | Version 2 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2021 | 08/2024 |
| Network Analyzer | Agilent 8753ES | MY40003210 | 10/2019 | 10/2022 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 05/2019 | 05/2022 |
| Network Analyzer – Calibration kit | HP 85033D | 3423A08186 | 06/2021 | 06/2027 |
| Multimeter | Keithley 2000 | 1160271 | 02/2020 | 02/2023 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 04/2019 | 04/2022 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2021 | 06/2024 |
| Power Meter | Rohde & Schwarz NRVD | 832839-056 | 11/2019 | 11/2022 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide | MVG | SN 32/16 WG4_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_0G900_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG6_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G500_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG8_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800B_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800H_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG10_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_3G500_1 | Validated. No cal required. | Validated. No cal required. |



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| | | | | |
|---|---|---|---|---|
| Waveguide | MVG | SN 32/16 WG12_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_5G000_1 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |



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# SAR Reference Dipole Calibration Report

Ref : ACR.307.32.21.BES.B

Cancel and replace the report ACR.307.32.21.BES.A

## INTERTEK TESTING SERVICES HONG KONG LIMITED

**WORKSHOP NO. 3 G/F, WORLD-WIDE INDUSTRIAL CENTRE, 43-47 SHAN MEI STREET,**
**FO TAN, SHA TIN, N.T. HONG KONG**

## MVG COMOSAR REFERENCE DIPOLE

**FREQUENCY: 1900 MHZ**
**SERIAL NO.: SN 15/16 DIP1G900-402**

**Calibrated at MVG**
**Z.I. de la pointe du diable**
**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**
**29280 PLOUZANE - FRANCE**

**Calibration date: 11/2/2021**

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

**The use of the Cofrac brand and the accreditation references is prohibited from any reproduction.**

*Summary:*

This document presents the method and results from an accredited SAR reference dipole calibration performed in MVG using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme Le Gall | Measurement Responsible | 11/3/2021 | |
| *Checked by :* | Jérôme Luc | Technical Manager | 11/3/2021 | |
| *Approved by :* | Yann Toutain | Laboratory Director | 11/10/2021 | Yann TOUTAIN 2021.11.10 12:06:30 +01'00' |

| | *Customer Name* |
|---|---|
| *Distribution :* | Intertek Testing Services Hong Kong Limited |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Jérôme Luc | 11/3/2021 | Initial release |
| B | Jérôme Luc | 11/10/2021 | Add EN standard |
| | | | |
| | | | |



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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 1900 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID1900 |
| Serial Number | SN 15/16 DIP1G900-402 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only.

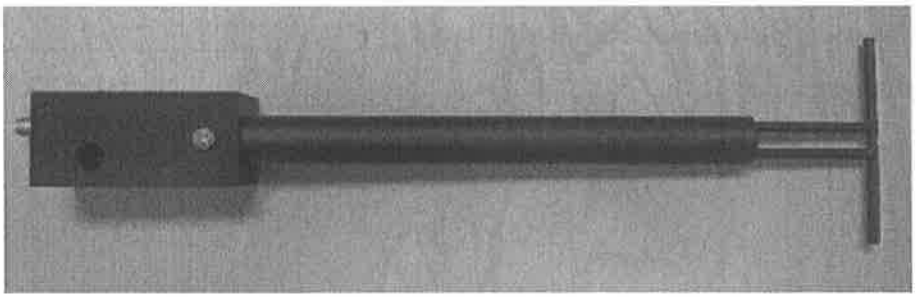

**Figure 1** – *MVG COMOSAR Validation Dipole*


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# 4 MEASUREMENT METHOD

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

## 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.2 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

# 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

## 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|---|---|
| 400-6000MHz | 0.08 LIN |

## 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|---|---|
| 0 - 300 | 0.20 mm |
| 300 - 450 | 0.44 mm |

## 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.


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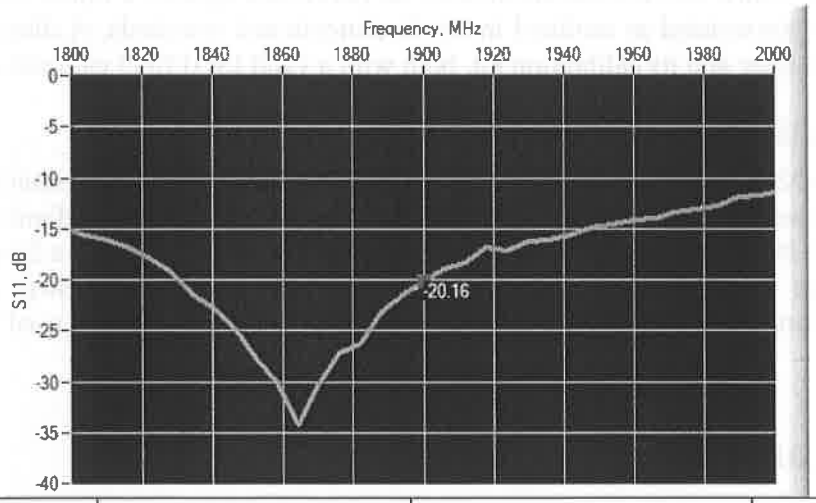
| Scan Volume | Expanded Uncertainty |
|---|---|
| 1 g | 19 % (SAR) |
| 10 g | 19 % (SAR) |

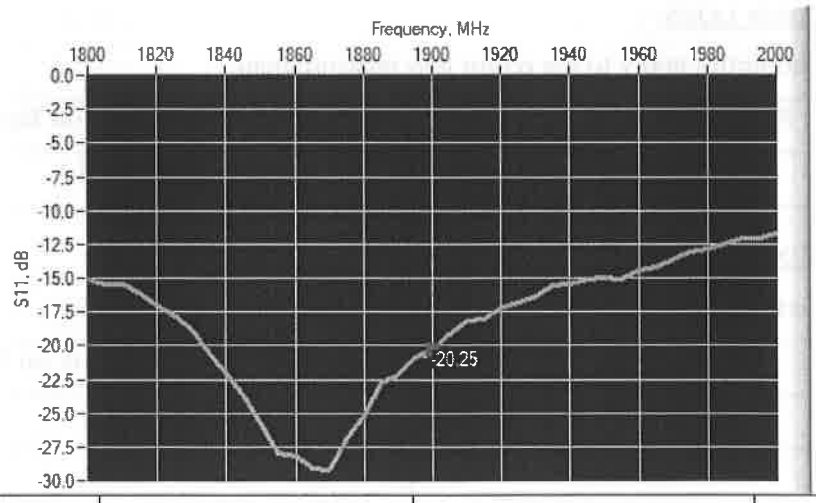
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -20.16 | -20 | 52.2 Ω + 9.5 jΩ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -20.25 | -20 | 50.1 Ω + 9.7 jΩ |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## 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---|---|---|---|---|---|---|
| | required | measured | required | measured | required | measured |
| 300 | 420.0 ±1 %. | | 250.0 ±1 %. | | 6.35 ±1 %. | |
| 450 | 290.0 ±1 %. | | 166.7 ±1 %. | | 6.35 ±1 %. | |
| 750 | 176.0 ±1 %. | | 100.0 ±1 %. | | 6.35 ±1 %. | |
| 835 | 161.0 ±1 %. | | 89.8 ±1 %. | | 3.6 ±1 %. | |
| 900 | 149.0 ±1 %. | | 83.3 ±1 %. | | 3.6 ±1 %. | |
| 1450 | 89.1 ±1 %. | | 51.7 ±1 %. | | 3.6 ±1 %. | |
| 1500 | 86.2 ±1 %. | | 50.0 ±1 %. | | 3.6 ±1 %. | |
| 1640 | 79.0 ±1 %. | | 45.7 ±1 %. | | 3.6 ±1 %. | |
| 1750 | 75.2 ±1 %. | | 42.9 ±1 %. | | 3.6 ±1 %. | |
| 1800 | 72.0 ±1 %. | | 41.7 ±1 %. | | 3.6 ±1 %. | |
| 1900 | 68.0 ±1 %. | - | 39.5 ±1 %. | - | 3.6 ±1 %. | - |
| 1950 | 66.3 ±1 %. | | 38.5 ±1 %. | | 3.6 ±1 %. | |
| 2000 | 64.5 ±1 %. | | 37.5 ±1 %. | | 3.6 ±1 %. | |
| 2100 | 61.0 ±1 %. | | 35.7 ±1 %. | | 3.6 ±1 %. | |
| 2300 | 55.5 ±1 %. | | 32.6 ±1 %. | | 3.6 ±1 %. | |
| 2450 | 51.5 ±1 %. | | 30.4 ±1 %. | | 3.6 ±1 %. | |
| 2600 | 48.5 ±1 %. | | 28.8 ±1 %. | | 3.6 ±1 %. | |
| 3000 | 41.5 ±1 %. | | 25.0 ±1 %. | | 3.6 ±1 %. | |
| 3300 | - | | - | | - | |
| 3500 | 37.0±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3700 | 34.7±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3900 | - | | - | | - | |
| 4200 | - | | - | | - | |
| 4600 | - | | - | | - | |
| 4900 | - | | - | | - | |

# 7 VALIDATION MEASUREMENT

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.


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## 7.1 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±10 % | | 0.87 ±10 % | |
| 450 | 43.5 ±10 % | | 0.87 ±10 % | |
| 750 | 41.9 ±10 % | | 0.89 ±10 % | |
| 835 | 41.5 ±10 % | | 0.90 ±10 % | |
| 900 | 41.5 ±10 % | | 0.97 ±10 % | |
| 1450 | 40.5 ±10 % | | 1.20 ±10 % | |
| 1500 | 40.4 ±10 % | | 1.23 ±10 % | |
| 1640 | 40.2 ±10 % | | 1.31 ±10 % | |
| 1750 | 40.1 ±10 % | | 1.37 ±10 % | |
| 1800 | 40.0 ±10 % | | 1.40 ±10 % | |
| 1900 | 40.0 ±10 % | 37.9 | 1.40 ±10 % | 1.43 |
| 1950 | 40.0 ±10 % | | 1.40 ±10 % | |
| 2000 | 40.0 ±10 % | | 1.40 ±10 % | |
| 2100 | 39.8 ±10 % | | 1.49 ±10 % | |
| 2300 | 39.5 ±10 % | | 1.67 ±10 % | |
| 2450 | 39.2 ±10 % | | 1.80 ±10 % | |
| 2600 | 39.0 ±10 % | | 1.96 ±10 % | |
| 3000 | 38.5 ±10 % | | 2.40 ±10 % | |
| 3300 | 38.2 ±10 % | | 2.71 ±10 % | |
| 3500 | 37.9 ±10 % | | 2.91 ±10 % | |
| 3700 | 37.7 ±10 % | | 3.12 ±10 % | |
| 3900 | 37.5 ±10 % | | 3.32 ±10 % | |
| 4200 | 37.1 ±10 % | | 3.63 ±10 % | |
| 4600 | 36.7 ±10 % | | 4.04 ±10 % | |
| 4900 | 36.3 ±10 % | | 4.35 ±10 % | |

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.



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| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 41/18 EPGO333 |
| Liquid | Head Liquid Values: eps' : 37.9 sigma : 1.43 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1900 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| Frequency MHz | 1 g SAR (W/kg/W) | | 10 g SAR (W/kg/W) | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 2.85 | | 1.94 | |
| 450 | 4.58 | | 3.06 | |
| 750 | 8.49 | | 5.55 | |
| 835 | 9.56 | | 6.22 | |
| 900 | 10.9 | | 6.99 | |
| 1450 | 29 | | 16 | |
| 1500 | 30.5 | | 16.8 | |
| 1640 | 34.2 | | 18.4 | |
| 1750 | 36.4 | | 19.3 | |
| 1800 | 38.4 | | 20.1 | |
| 1900 | 39.7 | 41.69 (4.17) | 20.5 | 21.19 (2.12) |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |
| 2450 | 52.4 | | 24 | |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3300 | - | | - | |
| 3500 | 67.1 | | 25 | |
| 3700 | 67.4 | | 24.2 | |
| 3900 | - | | - | |
| 4200 | - | | - | |
| 4600 | - | | - | |
| 4900 | - | | - | |



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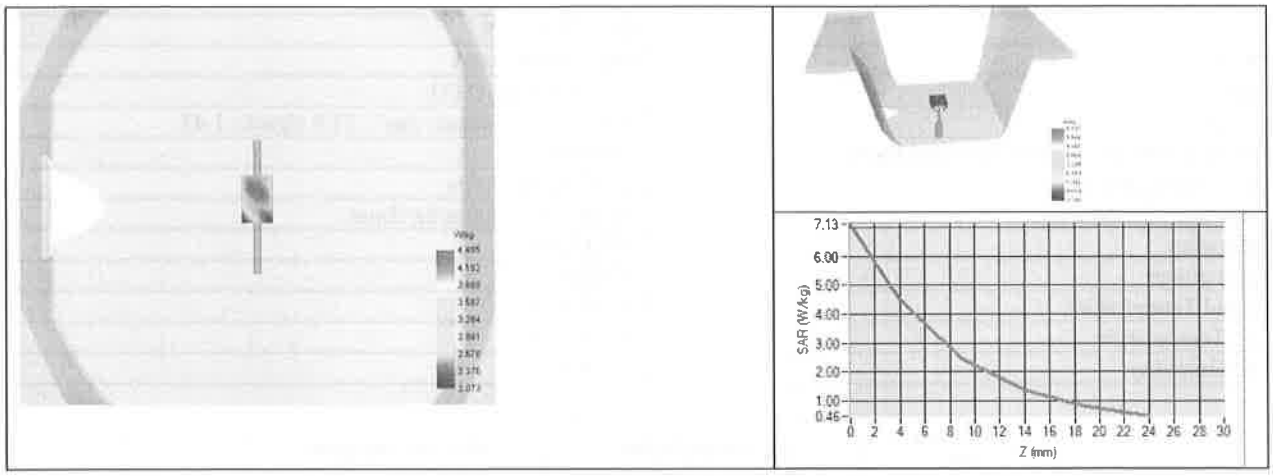




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## 7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 150 | 61.9 ±10 % | | 0.80 ±10 % | |
| 300 | 58.2 ±10 % | | 0.92 ±10 % | |
| 450 | 56.7 ±10 % | | 0.94 ±10 % | |
| 750 | 55.5 ±10 % | | 0.96 ±10 % | |
| 835 | 55.2 ±10 % | | 0.97 ±10 % | |
| 900 | 55.0 ±10 % | | 1.05 ±10 % | |
| 915 | 55.0 ±10 % | | 1.06 ±10 % | |
| 1450 | 54.0 ±10 % | | 1.30 ±10 % | |
| 1610 | 53.8 ±10 % | | 1.40 ±10 % | |
| 1800 | 53.3 ±10 % | | 1.52 ±10 % | |
| 1900 | 53.3 ±10 % | 55.0 | 1.52 ±10 % | 1.57 |
| 2000 | 53.3 ±10 % | | 1.52 ±10 % | |
| 2100 | 53.2 ±10 % | | 1.62 ±10 % | |
| 2300 | 52.9 ±10 % | | 1.81 ±10 % | |
| 2450 | 52.7 ±10 % | | 1.95 ±10 % | |
| 2600 | 52.5 ±10 % | | 2.16 ±10 % | |
| 3000 | 52.0 ±10 % | | 2.73 ±10 % | |
| 3300 | 51.6 ±10 % | | 3.08 ±10 % | |
| 3500 | 51.3 ±10 % | | 3.31 ±10 % | |
| 3700 | 51.0 ±10 % | | 3.55 ±10 % | |
| 3900 | 50.8 ±10 % | | 3.78 ±10 % | |
| 4200 | 50.4 ±10 % | | 4.13 ±10 % | |
| 4600 | 49.8 ±10 % | | 4.60 ±10 % | |
| 4900 | 49.4 ±10 % | | 4.95 ±10 % | |
| 5200 | 49.0 ±10 % | | 5.30 ±10 % | |
| 5300 | 48.9 ±10 % | | 5.42 ±10 % | |
| 5400 | 48.7 ±10 % | | 5.53 ±10 % | |
| 5500 | 48.6 ±10 % | | 5.65 ±10 % | |
| 5600 | 48.5 ±10 % | | 5.77 ±10 % | |
| 5800 | 48.2 ±10 % | | 6.00 ±10 % | |


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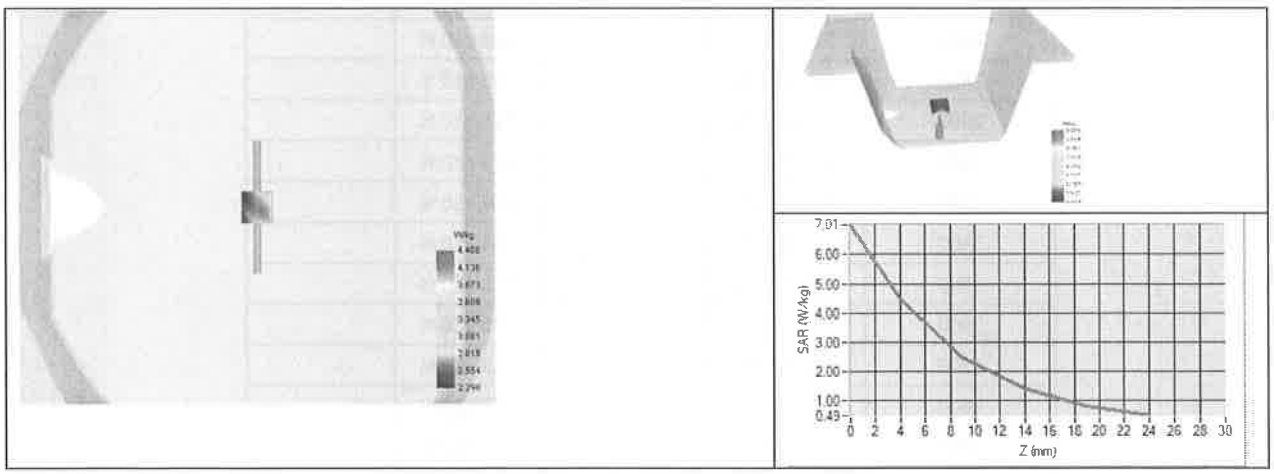
## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 41/18 EPGO333 |
| Liquid | Body Liquid Values: eps' : 55.0 sigma : 1.57 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1900 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| Frequency MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|---|---|---|
| | measured | measured |
| 1900 | 41.27 (4.13) | 20.94 (2.09) |



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## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| SAM Phantom | MVG | SN 13/09 SAM68 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2021 | 08/2024 |
| Network Analyzer | Agilent 8753ES | MY40003210 | 10/2019 | 10/2022 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 05/2019 | 05/2022 |
| Network Analyzer – Calibration kit | HP 85033D | 3423A08186 | 06/2021 | 06/2027 |
| Calipers | Mitutoyo | SN 0009732 | 10/2019 | 10/2022 |
| Reference Probe | MVG | SN 41/18 EPGO333 | 10/2021 | 10/2022 |
| Multimeter | Keithley 2000 | 1160271 | 02/2020 | 02/2023 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 04/2019 | 04/2022 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2021 | 06/2024 |
| Power Meter | Rohde & Schwarz NRVD | 832839-056 | 11/2019 | 11/2022 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |


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# Dielectric Probe Calibration Report

Ref : ACR.307.37.21.BES.B

Cancel and replace the report ACR.307.37.21.BES.A

## INTERTEK TESTING SERVICES HONG KONG LIMITED

**WORKSHOP NO. 3 G/F, WORLD-WIDE INDUSTRIAL CENTRE, 43-47 SHAN MEI STREET, FO TAN, SHA TIN, N.T. HONG KONG**

## MVG LIMESAR DIELECTRIC PROBE

**FREQUENCY: 0.4-6 GHZ**

**SERIAL NO.: SN 24/16 OCPG76**

**Calibrated at MVG**

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

**Calibration date: 11/2/2021**

Accreditations #2-6789
Scope available on www.cofrac.fr

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*Summary:*

This document presents the method and results from an accredited Dielectric Probe calibration performed at MVG, using the LIMESAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme Le Gall | Measurement Responsible | 11/3/2021 | |
| *Checked by :* | Jérôme Luc | Technical Manager | 11/3/2021 | |
| *Approved by :* | Yann Toutain | Laboratory Director | 11/10/2021 | Yann TOUTAIN 2021.11.10 12:09:57 +01'00' |

| | *Customer Name* |
|---|---|
| *Distribution :* | Intertek Testing Services Hong Kong Limited |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Jérôme Luc | 11/3/2021 | Initial release |
| B | Jérôme Luc | 11/10/2021 | Add EN standard |
| | | | |
| | | | |



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# 1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards for liquid permittivity measurements and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | LIMESAR DIELECTRIC PROBE |
| Manufacturer | MVG |
| Model | SCLMP |
| Serial Number | SN 24/16 OCPG76 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's Dielectric Probes are built in accordance to the IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards. The product is designed for use with the LIMESAR test bench only.

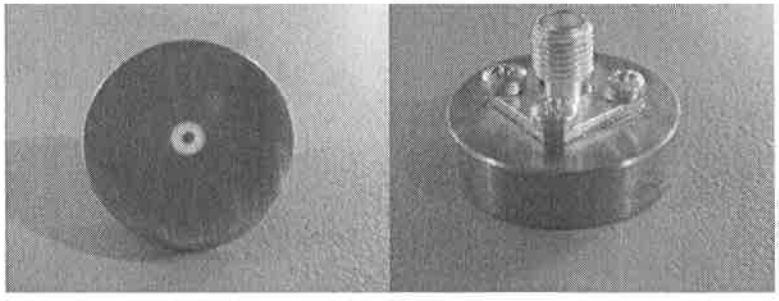

**Figure 1** – *MVG LIMESAR Dielectric Probe*



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## 4 MEASUREMENT METHOD

The IEC/IEEE 62209-1528, EN 62209-1/2 and FCC KDB865664 D01 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either DMS or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore mentioned standards.

### 4.1 LIQUID PERMITTIVITY MEASUREMENTS

The permittivity of a liquid with well established dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

## 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

### 5.1 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

| **Uncertainty analysis of Permittivity Measurement** | | | | | |
|---|---|---|---|---|---|
| **ERROR SOURCES** | **Uncertainty value (+/-%)** | **Probability Distribution** | **Divisor** | **ci** | **Standard Uncertainty (+/-%)** |
| **Expanded uncertainty (confidence level of 95%, k = 2)** | | | | | 10 % |

| **Uncertainty analysis of Conductivity Measurement** | | | | | |
|---|---|---|---|---|---|
| **ERROR SOURCES** | **Uncertainty value (+/-%)** | **Probability Distribution** | **Divisor** | **ci** | **Standard Uncertainty (+/-%)** |
| **Expanded uncertainty (confidence level of 95%, k = 2)** | | | | | 8.2% |

## 6 CALIBRATION MEASUREMENT RESULTS

Measurement Condition

| | |
|---|---|
| Software | LIMESAR |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |



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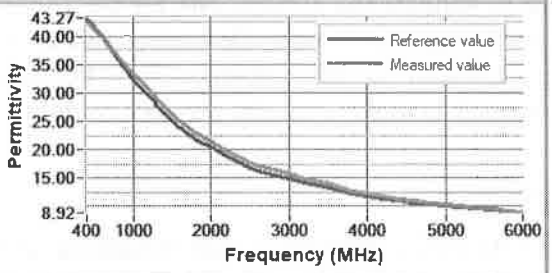
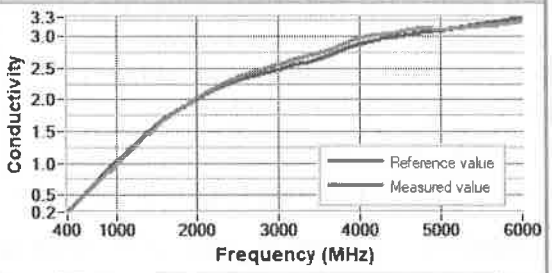
## 6.1 LIQUID PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol or ethanediol) is measured with the probe and the results (complex permittivity ε'+jε") are compared with the reference values for this liquid.




| Frequency (MHz) | Ethanediol Permittivity (Reference) | Ethanediol Permittivity (Measure) | Difference (%) | Limit (+/- %) |
|---|---|---|---|---|
| 400 | 43.27 | 42.67 | 1.4 | 10.0 |
| 600 | 40.02 | 39.97 | 0.1 | 10.0 |
| 800 | 36.16 | 36.73 | -1.6 | 10.0 |
| 1000 | 32.32 | 33.33 | -3.1 | 10.0 |
| 1200 | 29.59 | 30.64 | -3.6 | 10.0 |
| 1400 | 26.54 | 27.66 | -4.2 | 10.0 |
| 1600 | 23.82 | 25.06 | -5.2 | 10.0 |
| 1800 | 21.69 | 22.90 | -5.6 | 10.0 |
| 2000 | 20.42 | 21.49 | -5.2 | 10.0 |
| 2200 | 18.76 | 19.79 | -5.5 | 10.0 |
| 2400 | 17.52 | 18.50 | -5.6 | 10.0 |
| 2600 | 16.36 | 17.30 | -5.8 | 10.0 |
| 2800 | 15.51 | 16.46 | -6.2 | 10.0 |
| 3000 | 14.88 | 15.68 | -5.3 | 10.0 |
| 3200 | 14.17 | 14.90 | -5.1 | 10.0 |
| 3400 | 13.57 | 14.26 | -5.1 | 10.0 |
| 3600 | 12.85 | 13.54 | -5.4 | 10.0 |
| 3800 | 12.26 | 12.81 | -4.5 | 10.0 |
| 4000 | 11.64 | 12.18 | -4.6 | 10.0 |
| 4200 | 11.32 | 11.73 | -3.6 | 10.0 |
| 4400 | 10.97 | 11.36 | -3.6 | 10.0 |
| 4600 | 10.66 | 10.99 | -3.0 | 10.0 |
| 4800 | 10.38 | 10.63 | -2.4 | 10.0 |
| 5000 | 10.10 | 10.34 | -2.4 | 10.0 |
| 5200 | 9.85 | 10.04 | -2.0 | 10.0 |
| 5400 | 9.61 | 9.73 | -1.3 | 10.0 |
| 5600 | 9.40 | 9.52 | -1.3 | 10.0 |
| 5800 | 9.19 | 9.22 | -0.4 | 10.0 |
| 6000 | 8.92 | 8.98 | -0.8 | 10.0 |




| Frequency (MHz) | Ethanediol Conductivity (Reference) | Ethanediol Conductivity (Measure) | Difference (%) | Limit (+/- %) |
|---|---|---|---|---|
| 400 | 0.24 | 0.23 | 6.3 | 8.2 |
| 600 | 0.49 | 0.46 | 6.7 | 8.2 |
| 800 | 0.77 | 0.73 | 4.8 | 8.2 |
| 1000 | 1.03 | 0.98 | 5.2 | 8.2 |
| 1200 | 1.27 | 1.23 | 3.3 | 8.2 |
| 1400 | 1.50 | 1.47 | 2.4 | 8.2 |
| 1600 | 1.71 | 1.69 | 1.1 | 8.2 |
| 1800 | 1.87 | 1.87 | 0.0 | 8.2 |
| 2000 | 2.00 | 2.02 | -1.0 | 8.2 |
| 2200 | 2.16 | 2.18 | -1.0 | 8.2 |
| 2400 | 2.26 | 2.31 | -2.0 | 8.2 |
| 2600 | 2.35 | 2.41 | -2.5 | 8.2 |
| 2800 | 2.41 | 2.47 | -2.8 | 8.2 |
| 3000 | 2.48 | 2.57 | -3.5 | 8.2 |
| 3200 | 2.56 | 2.64 | -3.4 | 8.2 |
| 3400 | 2.61 | 2.70 | -3.6 | 8.2 |
| 3600 | 2.68 | 2.77 | -3.5 | 8.2 |
| 3800 | 2.78 | 2.88 | -3.5 | 8.2 |
| 4000 | 2.88 | 2.99 | -3.5 | 8.2 |
| 4200 | 2.93 | 3.03 | -3.3 | 8.2 |
| 4400 | 2.97 | 3.05 | -2.5 | 8.2 |
| 4600 | 3.02 | 3.10 | -2.8 | 8.2 |
| 4800 | 3.07 | 3.12 | -1.8 | 8.2 |
| 5000 | 3.09 | 3.12 | -0.9 | 8.2 |
| 5200 | 3.13 | 3.13 | -0.2 | 8.2 |
| 5400 | 3.17 | 3.16 | 0.2 | 8.2 |
| 5600 | 3.22 | 3.18 | 1.2 | 8.2 |
| 5800 | 3.27 | 3.20 | 2.0 | 8.2 |
| 6000 | 3.30 | 3.25 | 1.7 | 8.2 |



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# 7 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| LIMESAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Liquid measurement probe | MVG | SN 35/10 OCPG37 | 11/2021 | 11/2022 |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2021 | 08/2024 |
| Network Analyzer | Agilent 8753ES | MY40003210 | 10/2019 | 10/2022 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 05/2019 | 05/2022 |
| Network Analyzer – Calibration kit | HP 85033D | 3423A08186 | 06/2021 | 06/2027 |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |



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# TEST REPORT

## APPENDIX D – SAR SYSTEM VALIDATION

Per KDB 865664, SAR system validation status should be documented to confirm measurement accuracy. SAR measurement systems are validated according to procedures in KDB 865664. The validation status is documented according to the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters. When multiple SAR system is used, the validation status of each SAR system is needed to be documented separately according to the associated system components.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probe and tissue dielectric parameters are shown as below.

| | | | | | | CW Validation | | | Mod. Validation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Probe S/N | Tested Freq. (MHz) | Tissue Type | Perm | Cond | Sensitivity | Probe Linearity | Probe Isotropy | Mod. Type | Duty Factor | Peak to average power ratio |
| 13/11/2021 | EPGO 347 | 1900 | Head | 40.53 | 1.42 | PASS | PASS | PASS | GFSK | PASS | PASS |
| 13/11/2021 | EPGO 347 | 1900 | Body | 54.24 | 1.46 | PASS | PASS | PASS | GFSK | PASS | PASS |