# FCC SAR TEST REPORT

| | |
|---|---|
| **Application No:** | ZR/2019/C0018 |
| **Applicant:** | VTech Telecommunications Ltd. |
| **Manufacturer:** | VTech Telecommunications Ltd. |
| **Factory:** | VTech (Dongguan) Telecommunications Limited. |
| **Product Name:** | DECT Audio Baby monitor |
| **Model No.(EUT):** | DM1212 PU, DM1212-2 PU, DM1212-ab PU |
| **Trade Mark:** | VTech |
| **FCC ID:** | EW780-1993-01 |
| **Standards:** | FCC 47CFR §2.1093 |
| **Date of Receipt:** | 2019-12-12 |
| **Date of Test:** | 2020-01-13 to 2020-01-13 |
| **Date of Issue:** | 2020-03-24 |
| **Test Result:** | **PASS *** |

* In the configuration tested, the EUT detailed in this report complied with the standards specified above.

Authorized Signature:

Derek Yang

Wireless Laboratory Manager

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# REVISION HISTORY

| Report Number | Revision | Description | Issue Date |
|---|---|---|---|
| ZR/2019/C001801 | 01 | Original | 2020-02-22 |
| ZR/2019/C001801 | 02 | 1st revised | 2020-03-24 |
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# TEST SUMMARY

| Frequency Band | Maximum Report SAR(W/kg) |
|---|---|
| | Body 0mm |
| 1.9GHz | **0.04** |
| SAR Limited(W/kg) | 1.60 |

**Approved & Released by**

Simon Ling

Simon Ling

SAR Manager

**Tested by**

Jackson Li

Jackson Li

SAR Engineer

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# 1 General Information

## 1.1 Details of Client

| | |
|---|---|
| Applicant: | VTech Telecommunications Ltd. |
| Address: | 23/F., Tai Ping Ind Center Block 1, 57 Ting Kok Rd Tai Po NT Hong Kong |
| Manufacturer: | VTech Telecommunications Ltd. |
| Address: | 23/F., Tai Ping Ind Center Block 1, 57 Ting Kok Rd Tai Po NT Hong Kong |
| Factory: | VTech (Dongguan) Telecommunications Limited. |
| Address: | VTech Science Park, Xia Ling Bei Management Zone, Liaobu, Dongguan, Guangdong, China |

## 1.2 Test Location

| | |
|---|---|
| Company: | SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch E&E Lab |
| Address: | No. 1 Workshop, M-10, Middle section, Science & Technology Park, Shenzhen, Guangdong, China |
| Post code: | 518057 |
| Telephone: | +86 (0) 755 2601 2053 |
| Fax: | +86 (0) 755 2671 0594 |
| E-mail: | ee.shenzhen@sgs.com |

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## 1.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

**• CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

**• A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation (A2LA). Certificate No. 3816.01.

**• VCCI**

The 10m Semi-anechoic chamber and Shielded Room of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-823, R-4188, T-1153 and C-2383 respectively.

**• FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

**• Industry Canada (IC)**

Two 3m Semi-anechoic chambers and the 10m Semi-anechoic chamber of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab have been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 4620C-1, 4620C-2, 4620C-3.

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## 1.4 General Description of EUT

| | | | |
|---|---|---|---|
| Product Name: | DECT Audio Baby monitor | | |
| Model No.(EUT): | DM1212 PU, DM1212-2 PU, DM1212-ab PU | | |
| Trade Mark: | VTech | | |
| Product Phase: | production unit | | |
| Device Type: | portable device | | |
| Exposure Category: | uncontrolled environment / general population | | |
| FCC ID: | EW780-1993-01 | | |
| Hardware Version: | 35-201312PU | | |
| Software Version: | B004P1104 | | |
| Antenna Type: | Inner Antenna | | |
| **Device Operating Configurations:** | | | |
| Modulation Mode: | GFSK | | |
| Frequency Bands: | Band | Tx (MHz) | Rx (MHz) |
| | 1.9G | 1921.536~1928.448 | |
| Battery Information: | Model: | NI-MH AAA750*2 | |
| | Nominal Voltage: | 2.4V | |
| | Rated Capacity: | 750mAh | |
| | Manufacturer: | YIYANG CORUN BATTARY CO.,LTD | |

**Declaration of EUT Family Grouping:**

Model No.: DM1212 PU, DM1212-2 PU

Only the model DM1212 PU was tested, since the electrical circuit design, layout, components used, internal wiring and functions were identical for the above models, with only difference on color and model No. and others as below:

a=any alphanumeric character or blank is presenting number of parent unit.

b = any alphanumeric character or blank is presenting color of enclosure.

**Note:**

Considering to the difference, we were only tested the DM1212 PU model in this report for SAR test, and the DM1212-2 PU model refer to the report of the DM1212 PU model.

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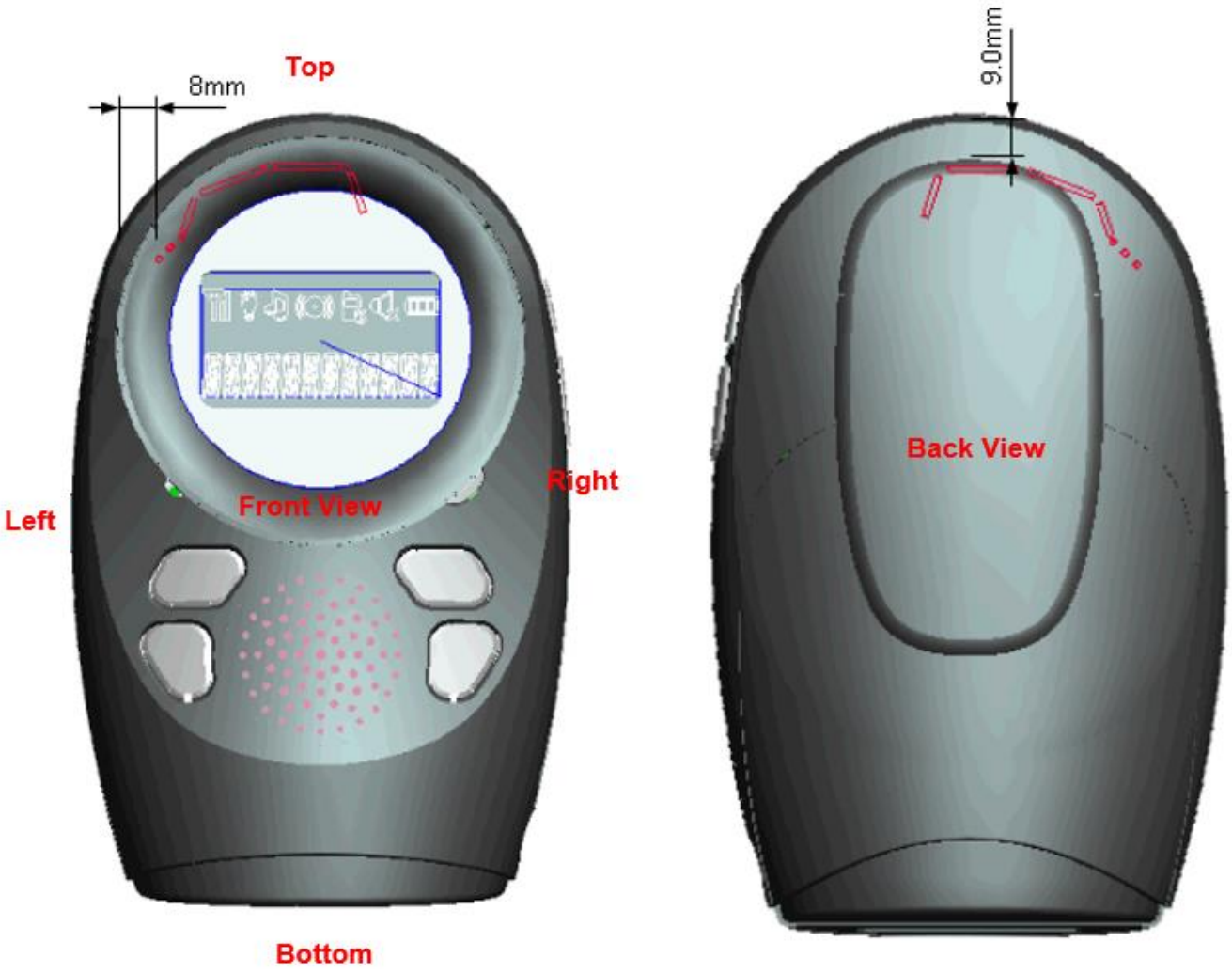
### 1.4.1 DUT Antenna Locations

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### 1.4.2 Stand-alone SAR test evaluation

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition is satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions.
The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
• f(GHz) is the RF channel transmit frequency in GHz
• Power and distance are rounded to the nearest mW and mm before calculation
• The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Freq. Band | Frequency (GHz) | Position | Average Power | | Test Separation (mm) | Calculate Value | Exclusion Threshold | Exclusion (Y/N) |
|---|---|---|---|---|---|---|---|---|
| | | | dBm | mW | | | | |
| 1.9GHz | 1.928 | Head | 7.0 | 5.01 | 5 | 1.72 | 3 | Y |
| | | Body | 7.0 | 5.01 | 5 | 1.72 | 3 | Y |

**Note:**

Although testing can be excluded for the head and body, we still test the all sides of the body at a conservative distance of 0mm.

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## 1.5 Test Specification

| Identity | Document Title |
|---|---|
| FCC 47CFR §2.1093 | Radiofrequency Radiation Exposure Evaluation: Portable Devices |
| IEEE Std C95.1 – 1991 | IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz. |
| IEEE 1528-2013 | Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques |
| KDB447498 D01 | General RF Exposure Guidance v06 |
| KDB 865664 D01 | SAR Measurement 100 MHz to 6 GHz v01r04 |
| KDB 865664 D02 | RF Exposure Reporting v01r02 |
| KDB 690783 D01 | SAR Listings on Grants v01r03 |

## 1.6 RF exposure limits

| Human Exposure | Uncontrolled Environment General Population | Controlled Environment Occupational |
|---|---|---|
| **Spatial Peak SAR*** (Brain*Trunk) | **1.60 mW/g** | 8.00 mW/g |
| **Spatial Average SAR**** (Whole Body) | 0.08 mW/g | 0.40 mW/g |
| **Spatial Peak SAR***** (Hands/Feet/Ankle/Wrist) | 4.00 mW/g | 20.00 mW/g |

**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 Average value of the SAR averaged over the whole body.

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

**Uncontrolled Environments** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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

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# 2 Laboratory Environment

| | |
|---|---|
| Temperature | Min. = 18°C, Max. = 25 °C |
| Relative humidity | Min. = 30%, Max. = 70% |
| Ground system resistance | < 0.5 Ω |
| 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. | |

Table 1： The Ambient Conditions

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# 3 SAR Measurements System Configuration

## 3.1 The SAR Measurement System

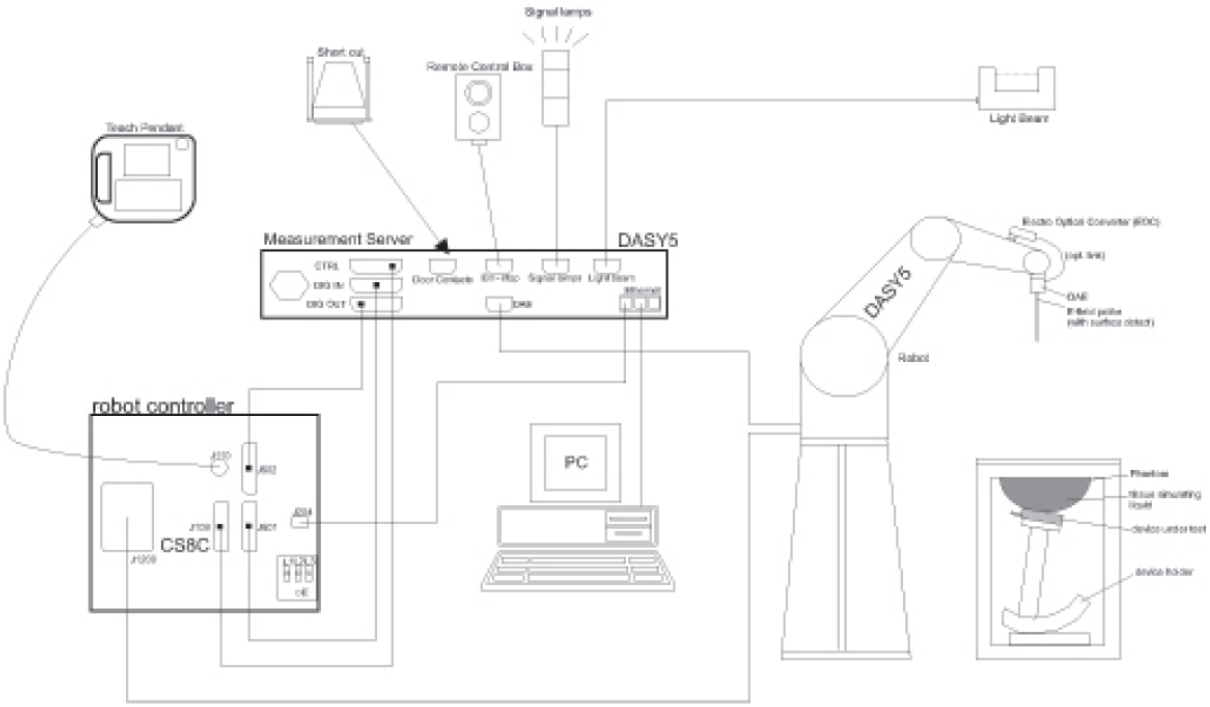
This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY5 professional system). A E-field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= σ (|Ei|2)/ ρ where σ and ρ are the conductivity and mass density of the tissue-Simulate.

The DASY5 system for performing compliance tests consists of the following items:
A standard high precision 6-axis robot (Stabile RX family) with controller, teach pendant and software .An arm extension for accommodation the data acquisition electronics (DAE).

A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.




F-1. SAR Measurement System Configuration

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- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7.
- DASY5 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand, right-hand and Body Worn usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validating the proper functioning of the system.

## 3.2 Isotropic E-field Probe EX3DV4

| | |
|---|---|
| | Symmetrical design with triangular core<br>Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| **Calibration** | ISO/IEC 17025 calibration service available. |
| **Frequency** | 10 MHz to > 6 GHz<br>Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| **Directivity** | ± 0.3 dB in TSL (rotation around probe axis)<br>± 0.5 dB in TSL (rotation normal to probe axis) |
| **Dynamic Range** | 10 µW/g to > 100 mW/g<br>Linearity: ± 0.2 dB (noise: typically < 1 µW/g) |
| **Dimensions** | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 2.5 mm (Body: 12 mm)<br>Typical distance from probe tip to dipole centers: 1 mm |
| **Application** | High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |
| **Compatibility** | DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI |

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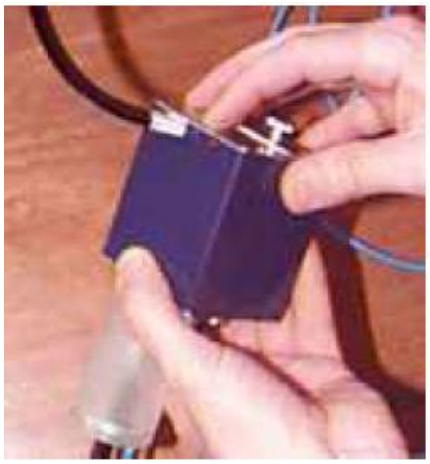
## 3.3 Data Acquisition Electronics (DAE)

| | | |
|---|---|---|
| **Model** | DAE |  |
| **Construction** | Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop. | |
| **Measurement Range** | -100 to +300 mV (16 bit resolution and two range settings: 4mV,400mV) | |
| **Input Offset Voltage** | < 5µV (with auto zero) | |
| **Input Bias Current** | < 50 f A | |
| **Dimensions** | 60 x 60 x 68 mm | |

## 3.4 SAM Twin Phantom

| | | |
|---|---|---|
| **Material** | Vinylester, glass fiber reinforced (VE-GF) | |
| **Liquid Compatibility** | Compatible with all SPEAG tissue simulating liquids (incl. DGBE type) | |
| **Shell Thickness** | 2 ± 0.2 mm (6 ± 0.2 mm at ear point) | |
| **Dimensions (incl. Wooden Support)** | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet | |
| **Filling Volume** | approx. 25 liters | |
| **Wooden Support** | SPEAG standard phantom table | |

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.

Twin SAM V5.0 has the same shell geometry and is manufactured from the same material as Twin SAM V4.0, but has reinforced top structure.

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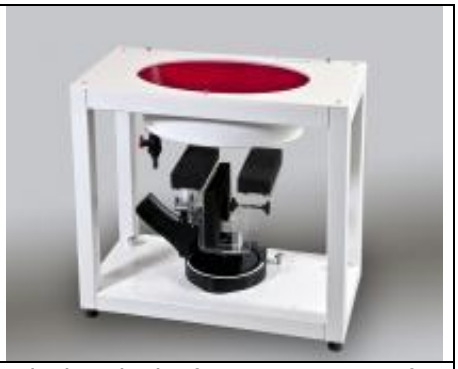
## 3.5 ELI Phantom

| | | |
|---|---|---|
| **Material** | Vinylester, glass fiber reinforced (VE-GF) |  |
| **Liquid Compatibility** | Compatible with all SPEAG tissue simulating liquids (incl. DGBE type) | |
| **Shell Thickness** | 2.0 ± 0.2 mm (bottom plate) | |
| **Dimensions** | Major axis: 600 mm<br>Minor axis: 400 mm | |
| **Filling Volume** | approx. 30 liters | |
| **Wooden Support** | SPEAG standard phantom table | |

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

ELI V5.0 has the same shell geometry and is manufactured from the same material as ELI4, but has reinforced top structure.

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## 3.6 Device Holder for Transmitters

F-2. **Device Holder for Transmitters**

- The DASY 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 centres for both scales are the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.
- The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ=0.02. 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.

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## 3.7 Measurement procedure

### 3.7.1 Scanning procedure

#### Step 1: Power reference measurement

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure.

#### Step 2: *Area scan*

The SAR distribution at the exposed side of the head was measured at a distance of 4mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 15mm*15mm or 12mm*12mm or 10mm*10mm.Based on the area scan data, the area of the maximum absorption was determined by spline interpolation.

#### Step 3: *Zoom scan*

Around this point, a volume of 32mm*32mm*30mm (f≤2GHz), 30mm*30mm*30mm (f for 2-3GHz) and 24mm*24mm*22mm (f for 5-6GHz) was assessed by measuring 5x5x7 points (f≤2GHz), 7x7x7 points (f for 2-3GHz) and 7x7x12 points (f for 5-6GHz). On this basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

The data at the surface was extrapolated, since the centre of the dipoles is 2.0mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.2mm. (This can be variable. Refer to the probe specification).The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip. The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3D-Spline interpolation algorithm. The volume was integrated with the trapezoidal algorithm. One thousand points were interpolated to calculate the average. All neighbouring volumes were evaluated until no neighboring volume with a higher average value was found.

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std. 1528-2013.

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| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | | 5 ± 1 mm | ½·δ·ln(2) ± 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. | |
| 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·$\Delta z_{Zoom}(n-1)$ | |
| 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 |

## Step 4: Power reference measurement (drift)

The Power Drift Measurement job measures the field at the same location as the most recent power reference measurement job within the same procedure, and with the same settings. The indicated drift is mainly the variation of the DUT's output power and should vary max. ± 5 %

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### 3.7.2 Data Storage

The DASY software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DAE4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated. The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [m W/g], [m W/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

### 3.7.3 Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters: - Sensitivity Normi, ai0, ai1, ai2
- Conversion factor ConvFi
- Diode compression point Dcpi
Device parameters: - Frequency f
- Crest factor cf
Media parameters: - Conductivity ε
- Density ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf / dcp_i$$

With Vi = compensated signal of channel i ( i = x, y, z )
Ui = input signal of channel i ( i = x, y, z )
cf = crest factor of exciting field (DASY parameter)
dcp i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$$

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H-field probes:

$$H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1} f + a_{i2} f^2) / f$$

With Vi = compensated signal of channel i (i = x, y, z)
Normi = sensor sensitivity of channel I (i = x, y, z)
[mV/(V/m)2] for E-field Probes
ConvF = sensitivity enhancement in solution
aij = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
Ei = electric field strength of channel i in V/m
Hi = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_x^2 + E_Y^2 + E_z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (Etot^2 \cdot \sigma) / (\varepsilon \cdot 1000)$$

with SAR = local specific absorption rate in mW/g
Etot = total field strength in V/m
σ= conductivity in [mho/m] or [Siemens/m]
ε= equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = E_{tot}{}^2{}_2 / 3770 \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with Ppwe = equivalent power density of a plane wave in mW/cm2
Etot = total electric field strength in V/m
Htot = total magnetic field strength in A/m

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# 4 SAR measurement variability and uncertainty

## 4.1 SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r04, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.

2) When the original highest measured SAR is ⩾ 0.80 W/kg, repeat that measurement once.

3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ⩾ 1.45 W/kg (~ 10% from the 1-g SAR limit).

4) Perform a third repeated measurement only if the original, first or second repeated measurement is ⩾1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

## 4.2 SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

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# 5 Description of Test Position

## 5.1 Body Exposure Condition

### 5.1.1 Wireless Router exposure conditions

Some battery-operated handsets have the capability to transmit and receive user data through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 where SAR test considerations for handsets (L x W ≥ 9 cm x 5 cm) are based on a composite test separation distance of 10 mm from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges, determined from general mixed use conditions for this type of devices. For devices with form factors smaller than 9 cm x 5 cm, a test separation distance of ≤5 mm is required.

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# 6 SAR System Verification Procedure

## 6.1 Tissue Simulate Liquid

### 6.1.1 Recipes for Tissue Simulate Liquid

The bellowing tables give the recipes for tissue simulating liquids to be used in different frequency bands：

| Ingredients (% by weight) | Frequency (MHz) | | | | |
|---|---|---|---|---|---|
| | 450 | 900 | 1800-2000 | 2300-2500 | 2500-2700 |
| Water | 38.56 | 40.30 | 55.24 | 55.00 | 54.92 |
| Salt (NaCl) | 3.95 | 1.38 | 0.31 | 0.2 | 0.23 |
| Sucrose | 56.32 | 57.90 | 0 | 0 | 0 |
| HEC | 0.98 | 0.24 | 0 | 0 | 0 |
| Bactericide | 0.19 | 0.18 | 0 | 0 | 0 |
| Tween | 0 | 0 | 44.45 | 44.80 | 44.85 |

Salt: 99+% Pure Sodium Chloride
Water: De-ionized, 16 MΩ+ resistivity
Tween: Polyoxyethylene (20) sorbitan monolaurate
Sucrose: 98+% Pure Sucrose
HEC: Hydroxyethyl Cellulose

HSL5GHz is composed of the following ingredients：
Water：50-65%
Mineral oil：10-30%
Emulsifiers：8-25%
Sodium salt：0-1.5%

Table 2： Recipe of Tissue Simulate Liquid

### 6.1.2 Measurement for Tissue Simulate Liquid

The dielectric properties for this Tissue Simulate Liquids were measured by using the Agilent Model 85070E Dielectric Probe in conjunction with Agilent E5071C Network Analyzer (300 KHz-8500 MHz). The Conductivity (σ) and Permittivity (ρ) are listed in Table 4. For the SAR measurement given in this report. The temperature variation of the Tissue Simulate Liquids was 22±2°C.

| Tissue Type | Measured Frequency （MHz） | Target Tissue (±5%) | | Measured Tissue | | Liquid Temp. | Measured Date |
|---|---|---|---|---|---|---|---|
| | | $\varepsilon_r$ | σ(S/m) | $\varepsilon_r$ | σ(S/m) | (℃) | |
| 1900 Head | 1900 | 40 (38.00~42.00) | 1.4 (1.33~1.47) | 40.321 | 1.416 | 22.3 | 2020/1/13 |

Table 3： Measurement result of Tissue electric parameters

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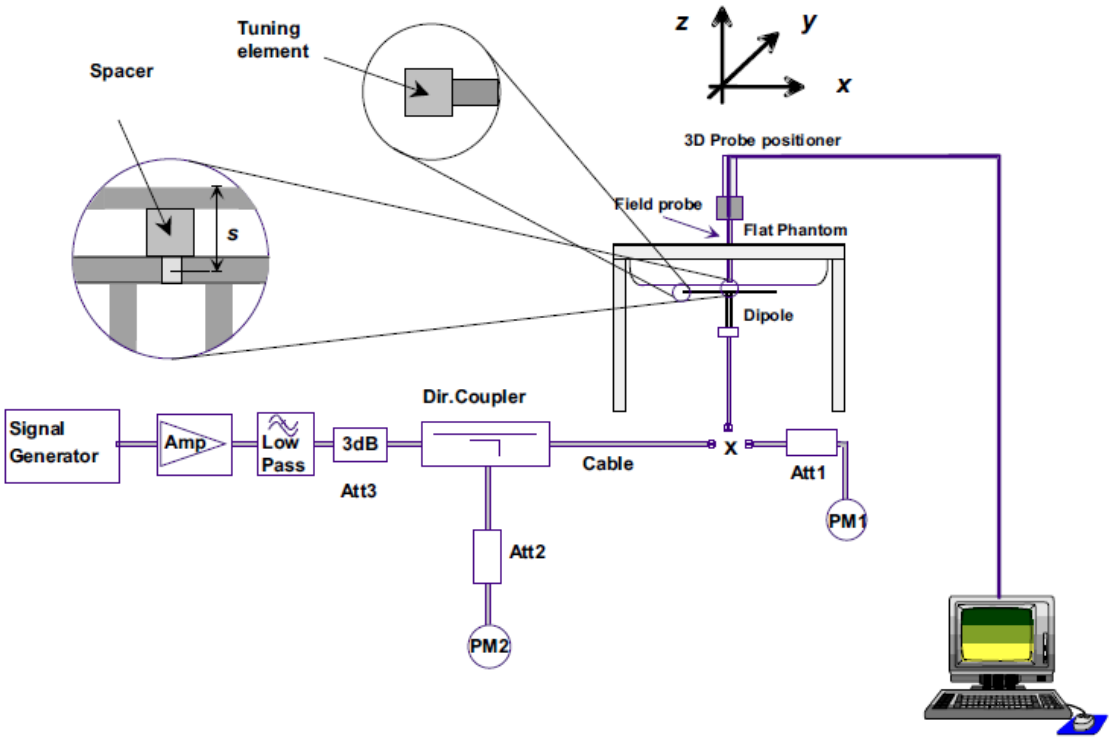
## 6.2 SAR System Check

The microwave circuit arrangement for system Check is sketched in F-3. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. The tests were conducted on the same days as the measurement of the EUT. The obtained results from the system accuracy verification are displayed in the following table (A power level of 250mW (below 3GHz) or 100mW (3-6GHz) was input to the dipole antenna). During the tests, the ambient temperature of the laboratory was in the range 22±2°C, the relative humidity was in the range 60% and the liquid depth above the ear reference points was above 15±0.5 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.




F-3. the microwave circuit arrangement used for SAR system check

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### 6.2.1 Justification for Extended SAR Dipole Calibrations

1) Referring to KDB865664 D01 requirements for dipole calibration, instead of the typical annual calibration recommended by measurement standards, longer calibration intervals of up to three years may be considered when it is demonstrated that the SAR target, impedance and return loss of a dipole have remain stable according to the following requirements. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
a) There is no physical damage on the dipole;
b) System check with specific dipole is within 10% of calibrated value;
c) Return-loss is within 10% of calibrated measurement;
d) Impedance is within 5Ω from the previous measurement.

2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

### 6.2.2 Summary System Check Result(s)

| Validation Kit | | Measured SAR 250mW | Measured SAR 250mW | Measured SAR (normalized to 1W) | Measured SAR (normalized to 1W) | Target SAR (normalized to 1W) (±10%) | Target SAR (normalized to 1W) (±10%) | Liquid Temp. (℃) | Measured Date |
|---|---|---|---|---|---|---|---|---|---|
| | | 1g (W/kg) | 10g (W/kg) | 1g (W/kg) | 10g (W/kg) | 1-g(W/kg) | 10-g(W/kg) | | |
| D1900V2 | Head | 10.50 | 5.41 | 42.00 | 21.64 | 39.3 (35.37~43.23) | 20.2 (18.18~22.22) | 22.3 | 2020/1/13 |

Table 4： SAR System Check Result

### 6.2.3 Detailed System Check Results

Please see the Appendix A

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# 7 Test Configuration

## 7.1 Operation Configurations

### 7.1.1 Test Configuration

For the SAR tests, a communication link is set up with the test mode software for Dect test mode test. GFSK Gaussian frequency shift keying to divide the transmitted data into packets and transmit the packets respectively through 5 designated channels. The Radio Frequency Channel Number (RFCN) is allocated to 0, 2 and 4 respectively in the case of 1921.536~1928.448 MHz during the test at each test frequency channel, the EUT is operated at the RF continuous emission mode.

## 7.2 Measurement of RF conducted Power

| Channel | Frequency | Average Conducted Power(dBm) | Tune up (dBm) |
|---|---|---|---|
| 0 | 1928.448 | 6.33 | 7.00 |
| 2 | 1924.992 | 6.35 | 7.00 |
| 4 | 1921.536 | 6.01 | 7.00 |

Table 5： conducted Power.

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# 8 Test Result

## 8.1 Measurement of SAR Data

### 8.1.1 SAR Result

| Test position | Test ch./Freq. | SAR (W/kg) 1-g | SAR (W/kg) 10-g | Power drift (dB) | Conducted Power (dBm) | Tune up Limit (dBm) | Scaled factor | Scaled SAR 1-g (W/kg) | Scaled SAR 10-g (W/kg) | Liquid Temp. (℃) |
|---|---|---|---|---|---|---|---|---|---|---|
| Body Test Data (Separate 0mm) | | | | | | | | | | |
| Front side | 2/1924.992 | 0.030 | 0.017 | 0.03 | 6.35 | 7.00 | 1.161 | 0.035 | 0.020 | 21.8 |
| Back side | 2/1924.992 | 0.017 | 0.009 | 0.09 | 6.35 | 7.00 | 1.161 | 0.020 | 0.010 | 21.8 |
| Left side | 2/1924.992 | 0.027 | 0.013 | 0.00 | 6.35 | 7.00 | 1.161 | 0.031 | 0.015 | 21.8 |
| Right side | 2/1924.992 | 0.015 | 0.008 | -0.05 | 6.35 | 7.00 | 1.161 | 0.017 | 0.009 | 21.8 |
| Top side | 2/1924.992 | 0.022 | 0.012 | 0.09 | 6.35 | 7.00 | 1.161 | 0.026 | 0.014 | 21.8 |
| Bottom side | 2/1924.992 | 0.018 | 0.009 | -0.06 | 6.35 | 7.00 | 1.161 | 0.021 | 0.010 | 21.8 |
| Front side | 0/1928.448 | 0.030 | 0.017 | 0.03 | 6.33 | 7.00 | 1.167 | 0.035 | 0.019 | 21.8 |
| Front side | 4/1921.536 | 0.029 | 0.017 | 0.02 | 6.01 | 7.00 | 1.256 | **0.037** | 0.021 | 21.8 |

Table 6： SAR test record.

Note:

1) The maximum Scaled SAR value is marked in **bold**. Graph Results refer to Appendix B.

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# 9 Equipment list

| Test Platform | SPEAG DASY5 Professional |
|---|---|
| Location | SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch |
| Description | SAR Test System (Frequency range 300MHz-6GHz) |
| Software Reference | DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331) |

**Hardware Reference**

| | Equipment | Manufacturer | Model | Serial Number | Calibration Date | Due date of calibration |
|---|---|---|---|---|---|---|
| ☒ | Twin Phantom | SPEAG | SAM 8 | 1063 | NCR | NCR |
| ☒ | DAE | SPEAG | DAE4 | 896 | 2019-09-18 | 2020-09-17 |
| ☒ | E-Field Probe | SPEAG | EX3DV4 | 3793 | 2019-03-25 | 2020-03-24 |
| ☒ | Validation Kits | SPEAG | D1900V2 | 5d028 | 2019-12-17 | 2022-12-16 |
| ☒ | Agilent Network Analyzer | Agilent | E5071C | MY46523590 | 2019-04-12 | 2020-04-11 |
| ☒ | Dielectric Probe Kit | Agilent | 85070E | US01440210 | NCR | NCR |
| ☒ | RF Bi-Directional Coupler | Agilent | 86205-60001 | MY31400031 | NCR | NCR |
| ☒ | Signal Generator | Agilent | N5171B | MY53050736 | 2019-04-12 | 2020-04-11 |
| ☒ | Preamplifier | Mini-Circuits | ZHL-42W | 15542 | NCR | NCR |
| ☒ | Power Meter | Agilent | E4416A | GB41292095 | 2019-04-12 | 2020-04-11 |
| ☒ | Power Sensor | Agilent | 8481H | MY41091234 | 2019-04-12 | 2020-04-11 |
| ☒ | Power Sensor | R&S | NRP-Z92 | 100025 | 2019-04-12 | 2020-04-11 |
| ☒ | Digital Radiocommunication Tester | R&S | CMD60 | DE22558 | 2019-09-24 | 2020-09-23 |
| ☒ | Attenuator | SHX | TS2-3dB | 30704 | NCR | NCR |
| ☒ | Coaxial low pass filter | Mini-Circuits | VLF-2500(+) | NA | NCR | NCR |
| ☒ | Coaxial low pass filter | Microlab Fxr | LA-F13 | NA | NCR | NCR |
| ☒ | DC POWER SUPPLY | SAKO | SK1730SL5A | NA | NCR | NCR |
| ☒ | Speed reading thermometer | MingGao | T809 | NA | 2019-04-15 | 2020-04-14 |
| ☒ | Humidity and Temperature Indicator | KIMTOKA | KIMTOKA | NA | 2019-04-15 | 2020-04-14 |

Note: All the equipments are within the valid period when the tests are performed.

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## 10 Calibration certificate

Please see the Appendix C

## 11 Photographs

Please see the Appendix D

## Appendix A: Detailed System Check Results

## Appendix B: Detailed Test Results

## Appendix C: Calibration Certificate

## Appendix D: Photographs

**---END---**

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