



**KES Co., Ltd.**  
C-3701, Simin-daero 365-40,  
Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea  
Tel: +82-31-425-6200 / Fax: +82-31-424-0450  
www.kes.co.kr

Test report No.:  
KES-SR-15T0024  
Page ( 1 ) of (20)

## SAR EVALUATION REPORT

**Equipment under test** GMRS/FRS 2-way Radio

**Model name** T65A

**FCC ID** MMAT65A

**Applicant** Midland Radio Corporation

**Manufacturer** Global Link Corporation Ltd.

**Date of test(s)** 2015.08.27~2015.08.28

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**Midland Radio Corporation**

5900 Parretta Drive, Kansas City, Missouri United States 64120

Tel.: +1-816-241-8500 / Fax.: +1-816-241-5713


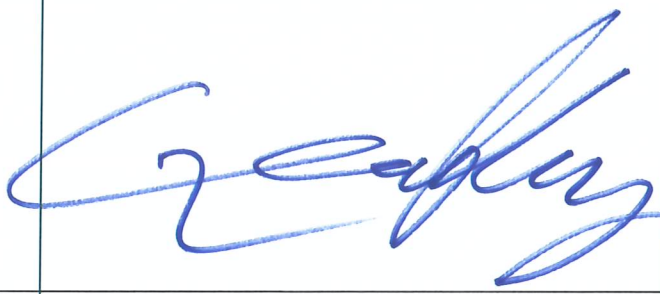
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**KES Co., Ltd.**

C-3701, Simin-daero 365-40, Dongan-gu, Anyang-si,  
Gyeonggi-do, 14057, Korea

473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, 12658, Korea

Tel.: +82-31-425-6200 / Fax: +82-31-424-0450

| Test and report completed by :  | Report approval by :   |
|---|--|
|  |  |
| Kwang-Yeol Choo<br>Test engineer  | Jeff Do<br>Technical manager   |

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### Revision history

| Revision | Date of issue | Test report No. | Description |
|----------|---------------|-----------------|-------------|
| -        | 2015.09.04    | KES-SR-15T0024  | Initial     |

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## 1. General information

### 1.1. EUT description

|                             |  |
|-----------------------------|--|
| <b>Equipment under test</b> | GMRS/FRS 2-way Radio   |
| <b>Model name</b>           | T65A   |
| <b>Serial number</b>        | N/A  |
| <b>Frequency range</b>      | 462.550 0 MHz ~ 462.725 0 MHz(GMRS),<br>467.562 5 MHz ~ 467.712 5 MHz(FRS) |
| <b>Modulation type</b>      | FM   |
| <b>Exposure category</b>    | General population / Uncontrolled exposure                                 |
| <b>Body worn accessory</b>  | Belt clip and earphone   |
| <b>Antenna type</b>         | Integrated antenna   |
| <b>Power source</b>         | DC 3.6 V(Rechargeable Ni-MH Battery)                                       |

### 1.2. Short description of the equipment under test(EUT)

The spatial peak SAR values were assessed for systems. Battery and accessories shall be specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

### 1.3. Highest SAR summary

| Equipment class | Frequency band                | Tissue type | Reported SAR value<br>1g-SAR (W/kg) |
|-----------------|-------------------------------|-------------|-------------------------------------|
| GMRS/FRS        | 462.550 0 MHz ~ 467.712 5 MHz | Head        | 0.207                               |
|                 |                               | Body        | 0.316                               |

Notes:

#### Face-Held Configuration

Face-held Configuration- per FCC KDB447498 page 22: "A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements."

#### Body-worn Configuration

Body-worn measurements-per FCC KDB447498 page 22 "When body-worn accessory SAR testing is required, the body-worn accessory requirements in section 4.2.2 should be applied. PTT two-way radios that support held-to-ear operating mode must also be tested according to the exposure configurations required for handsets. This generally does not apply to cellphones with PTT options that have already been tested in more conservative configurations in applicable wireless modes for SAR compliance at 100% duty factor."

#### 1.4. Guidance applied

- IEEE 1528-2013
- FCC KDB Publication 865664 D01 v01r04 (SAR measurement up to 6 GHz)
- FCC KDB Publication 447498 D01 v05r02 (General SAR guidance)
- FCC KDB Publication 643646 D01 v01r02 (PTT Radios)
- FCC KDB Publication 865664 D02 v01r01 (SAR reporting)

#### 1.5. Test conditions

|                                 |                 |
|---------------------------------|-----------------|
| <b>Ambient temperature</b>      | (22 ± 2) °C     |
| <b>Tissue simulating liquid</b> | (22 ± 2) °C     |
| <b>Humidity</b>                 | (55 ± 5) % R.H. |

#### 1.6. SAR definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Figure 1).

$$SAR = \frac{d}{dt} \left( \frac{dU}{dm} \right) = \frac{d}{dt} \left( \frac{dU}{\rho dV} \right)$$

Figure 1. SAR Mathematical equation

SAR is expressed in units of Watts per Kilogram(W/kg)

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

Where:

$\sigma$  = Conductivity of the tissue-simulating material (S/m)

$\rho$  = Mass density of the tissue-simulating material (kg/m<sup>3</sup>)

$E$  = Total RMS electric field strength (V/m)

NOTE:

The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.



## 1.7. Accessories of EUT

| Accessory           | Description | Other    |
|---------------------|-------------|----------|
| Audio Accessory     | Earphone    | 1.2m     |
| Body Worn Accessory | Belt clip   | Standard |

## 2. SAR measurement system

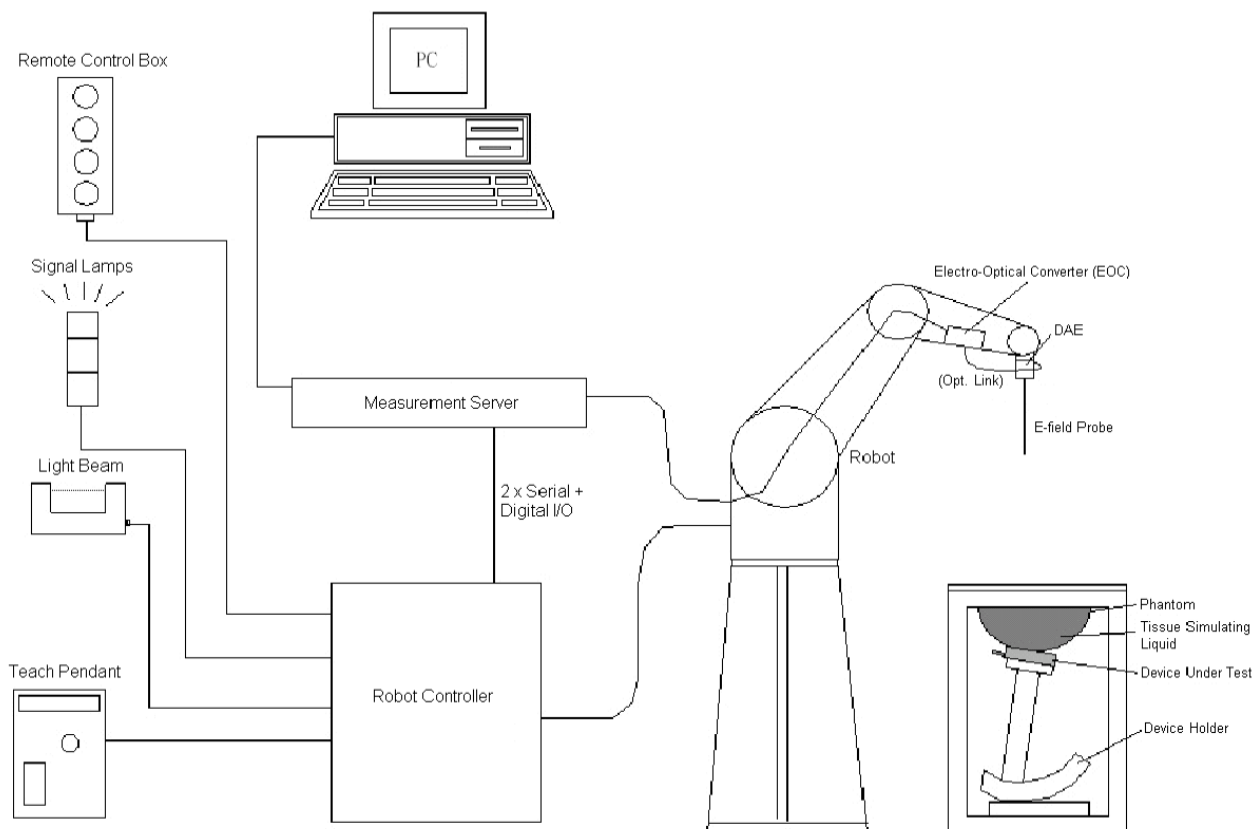


Figure 2. SPEAG DASY system configuration

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom and/or ELI phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

## 2.1. Robot

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability  $\pm 0.035$  mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)



Figure 3. SPEAG DASY 4

## 2.2. Probe

The SAR measurement is conducted with the dosimetric probe. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.


|                      |   |   |
|----------------------|---|---|
| <b>Model</b>         | ES3DV3  |  |
| <b>Construction</b>  | Symmetrical design with triangular core<br>Interleaved sensors Built-in shielding against static charges<br>PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |   |
| <b>Frequency</b>     | 10 MHz to 4 GHz;<br>Linearity: $\pm 0.2$ dB (30 MHz to 4 GHz)   |   |
| <b>Directivity</b>   | $\pm 0.2$ dB in TSL (rotation around probe axis)<br>$\pm 0.3$ dB in TSL (rotation normal to probe axis)   |   |
| <b>Dynamic Range</b> | 5 $\mu$ W/g to > 100 mW/g;<br>Linearity: $\pm 0.2$ dB   |   |
| <b>Dimensions</b>    | Overall length: 337 mm (Tip: 20 mm)<br>Tip diameter: 3.9 mm (Body: 12 mm)<br>Distance from probe tip to dipole centers: 2.0 mm  |   |

Figure 4. Probe



### 2.3. Data Acquisition Electronics (DAE)


|                             |  |   |
|-----------------------------|--|---|
| <b>Model</b>                | DAE4   |  |
| <b>Construction</b>         | 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. |   |
| <b>Measurement Range</b>    | -100 to +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)   |   |
| <b>Input Offset Voltage</b> | $\pm 0.2$ dB in HSL (rotation around probe axis)<br>$\pm 0.3$ dB in tissue material (rotation normal to probe axis)  |   |
| <b>Input Bias Current</b>   | < 50 fA  |   |
| <b>Dimensions</b>           | 60 x 60 x 68 mm  |   |

Figure 5. DAE

### 2.4. Phantoms


|                        |   |  |
|------------------------|---|--|
| <b>Model</b>           | Twin SAM  |  |
| <b>Construction</b>    | 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. |  |
| <b>Material</b>        | Vinylester, glass fiber reinforced (VE-GF)  |  |
| <b>Shell Thickness</b> | $2 \pm 0.2$ mm ( $6 \pm 0.2$ mm at ear point)   |  |
| <b>Dimensions</b>      | Length: 1000 mm<br>Width: 500 mm<br>Height: adjustable feet   |  |
| <b>Filling Volume</b>  | approx. 25 liters   |  |

Figure 6. Twin SAM


|                        |   |   |
|------------------------|---|---|
| <b>Model</b>           | ELI   |  |
| <b>Construction</b>    | 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. |   |
| <b>Material</b>        | Vinylester, glass fiber reinforced (VE-GF)  |   |
| <b>Shell Thickness</b> | $2.0 \pm 0.2$ mm (bottom plate)   |   |
| <b>Dimensions</b>      | Major axis: 600 mm<br>Minor axis: 400 mm  |   |
| <b>Filling Volume</b>  | approx. 30 liters   |   |

Figure 7. ELI

## 2.5. Device holder


|                     |   |   |
|---------------------|---|---|
| <b>Model</b>        | Mounting device   |  |
| <b>Construction</b> | In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). |   |
| <b>Material</b>     | POM   |   |

Figure 8. Mounting device


|                     |   |   |
|---------------------|---|---|
| <b>Model</b>        | Laptop extensions kit   |  |
| <b>Construction</b> | Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.). It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. |   |
| <b>Material</b>     | POM, Acrylic glass, Foam  |   |

Figure 9. Laptop extensions kit

### 3. SAR measurement procedure

#### Step 1: Power reference measurement

The power reference measurement and power reference measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

#### Step 2 and 3: Area scan & zoom scan procedures

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

1. The extraction of the measured data (grid and values) from the zoom scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1 g and 10 g.

|   |                                    |  | $\leq 3$ GHz   | $> 3$ GHz   |
|---|------------------------------------|--|--|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface  |                                    |  | $5 \pm 1$ mm   | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm                            |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location   |                                    |  | $30^{\circ} \pm 1^{\circ}$   | $20^{\circ} \pm 1^{\circ}$  |
| Maximum area scan spatial resolution: $\Delta x_{Area}$ , $\Delta y_{Area}$   |                                    |  | $\leq 2$ GHz: $\leq 15$ mm<br>2 – 3 GHz: $\leq 12$ mm  | 3 – 4 GHz: $\leq 12$ mm<br>4 – 6 GHz: $\leq 10$ 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 $\leq$ 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: $\Delta x_{Zoom}$ , $\Delta y_{Zoom}$   |                                    |  | $\leq 2$ GHz: $\leq 8$ mm<br>2 – 3 GHz: $\leq 5$ mm*   | 3 – 4 GHz: $\leq 5$ mm*<br>4 – 6 GHz: $\leq 4$ mm*                            |
| Maximum zoom scan spatial resolution, normal to phantom surface   | uniform grid: $\Delta z_{Zoom}(n)$ |  | $\leq 5$ mm  | 3 – 4 GHz: $\leq 4$ mm<br>4 – 5 GHz: $\leq 3$ mm<br>5 – 6 GHz: $\leq 2$ mm    |
|   | graded grid                        | $\Delta z_{Zoom}(1)$ : between 1 <sup>st</sup> two points closest to phantom surface | $\leq 4$ mm  | 3 – 4 GHz: $\leq 3$ mm<br>4 – 5 GHz: $\leq 2.5$ mm<br>5 – 6 GHz: $\leq 2$ mm  |
|   |                                    | $\Delta z_{Zoom}(n>1)$ : between subsequent points                                   | $\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$  |   |
| Minimum zoom scan volume  | x, y, z                            |  | $\geq 30$ mm   | 3 – 4 GHz: $\geq 28$ mm<br>4 – 5 GHz: $\geq 25$ mm<br>5 – 6 GHz: $\geq 22$ mm |
| Note: $\delta$ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.   |                                    |  |  |   |
| * When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is $\leq 1.4$ W/kg, $\leq 8$ mm, $\leq 7$ mm and $\leq 5$ 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. |                                    |  |  |   |

Figure 10. Area and zoom scan resolutions per FCC KDB Publication 865664 D01v01r04

#### Step 4: Power drift measurement

The power drift measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The power drift measurement gives the field difference in dB from the reading conducted within the last power reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

#### 4. Tissue simulating liquids

For the measurement of the field distribution inside the phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in figure 11.

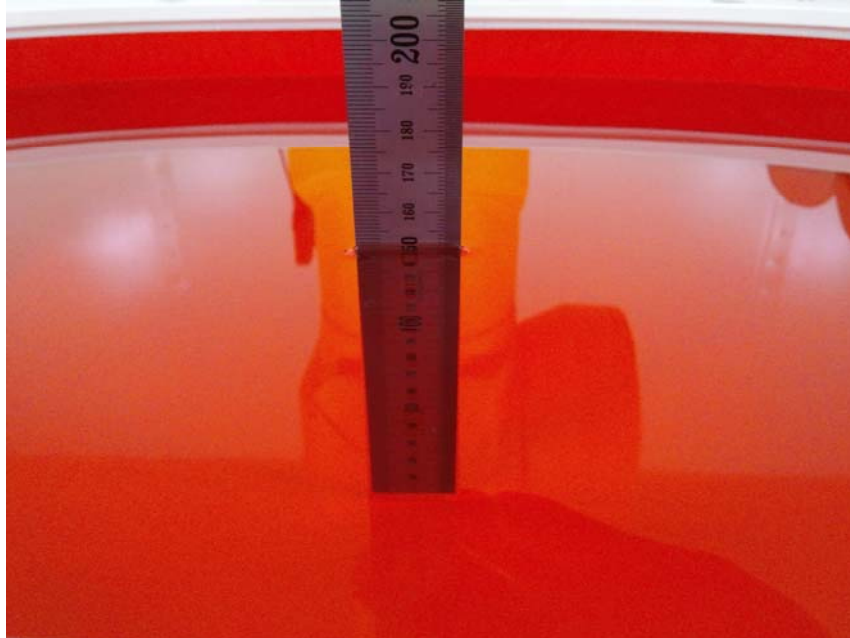


Figure 11. Liquid height photo

The dielectric parameters of the liquids were verified prior to the SAR evaluation using an Agilent dielectric probe kit and an Agilent network analyzer.

The following table shows the measuring results for simulating liquid.

| Frequency (MHz) | Tissue type | Liquid temp.(°C) | Parameters                    | Target value | Measured value | Deviation (%) | Limit (%) | Data       |
|-----------------|-------------|------------------|-------------------------------|--------------|----------------|---------------|-----------|------------|
| 450             | Head        | 21.9             | Permittivity ( $\epsilon_r$ ) | 43.5         | 43.0           | -1.15         | $\pm 5$   | 2015.08.28 |
|                 |             |                  | Conductivity ( $\sigma$ )     | 0.87         | 0.833          | -4.25         | $\pm 5$   | 2015.08.28 |
| 450             | Body        | 21.9             | Permittivity ( $\epsilon_r$ ) | 56.7         | 55.2           | -2.65         | $\pm 5$   | 2015.08.27 |
|                 |             |                  | Conductivity ( $\sigma$ )     | 0.94         | 0.899          | -4.36         | $\pm 5$   | 2015.08.27 |

## 5. System verification

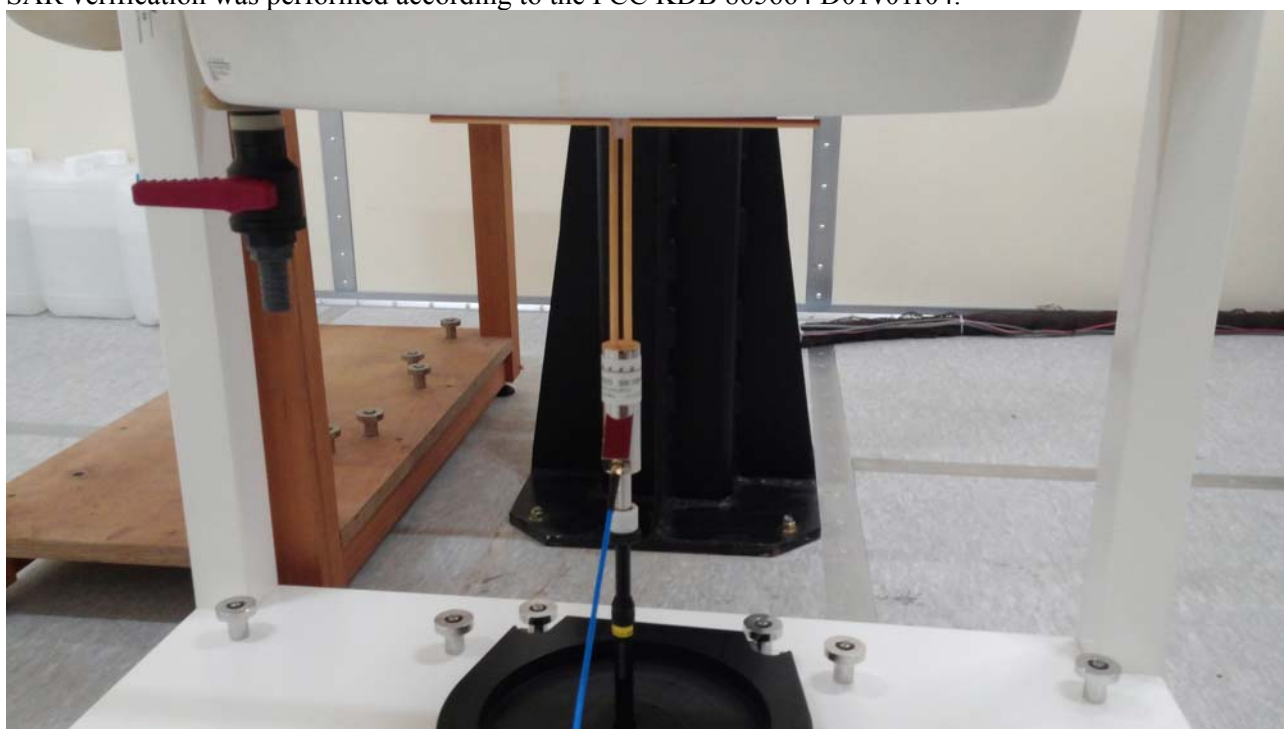
### 5.1. Procedure

SAR measurement was prior to assessment, the system is verified to the  $\pm 10\%$  of the specifications at each frequency band by using the system verification kit.

- Cabling the system, using the verification kit equipment.
- Generate about 250 mW input level from the signal generator to the dipole antenna.
- Dipole antenna was placed below the flat phantom.
- The measured one-gram SAR at the surface of the phantom above the dipole feed-point should be within 10 % of the target reference value.
- The results are normalized to 1 W input power.

Note;

SAR verification was performed according to the FCC KDB 865664 D01v01r04.



### 5.2. System verification

| Frequency (MHz) | Tissue type | Probe (S/N) | Antenna (S/N) | 1 W Target SAR <sub>1g</sub> (W/kg) | Measured SAR <sub>1g</sub> (W/kg) | 1 W Normalized SAR <sub>1g</sub> (W/kg) | Deviation (%) | Limit (%) | Data       |
|-----------------|-------------|-------------|---------------|-------------------------------------|-----------------------------------|---|---------------|-----------|------------|
| 450             | Head        | 3879        | 1081          | 4.56                                | 1.20                              | 4.80                                    | 5.26          | $\pm 10$  | 2015.08.28 |
|                 | Body        | 3879        | 1081          | 4.56                                | 1.06                              | 4.24                                    | -7.02         | $\pm 10$  | 2015.08.27 |



## 6. RF exposure limits

### Uncontrolled environment

Uncontrolled environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

### Controlled environment

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). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

|   | Uncontrolled environment<br>general population (W/kg) or (mW/g) | Controlled environment<br>occupational (W/kg) or (mW/g) |
|---|---|---|
| Spatial peak SAR<br>head                        | 1.60  | 8.00  |
| Spatial average SAR<br>whole body               | 0.08  | 0.40  |
| Spatial peak SAR<br>hands, feet, ankles, wrists | 4.00  | 20.00   |

Figure 12. RF exposure limits

## 7. Test results summary

### 7.1. RF conducted power

#### 7.1.1. Power measurement procedures

According KDB 447498 D01 General RF Exposure Guidance v05r01Section 4.1 2) states that “Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged ERP applies to MPE. When an antenna port is not available on the device to support conducted power measurement, such as FRS and certain Part 15 transmitters with built-in integral antennas, the maximum output power allowed for production units should be used to determine RF exposure test exclusion and compliance.”

#### 7.1.2. RF conducted power

| Mode | Frequency (MHz) | Channel | Measured power (dBm) |
|------|-----------------|---------|----------------------|
| GMRS | 462.637 5       | 4       | 27.68                |
| FRS  | 467.637 5       | 11      | 24.33                |

#### 7.1.2. Target power and Tune-up limits

| Mode | Frequency (MHz) | Channel | Target(dBm) | Tune-up limits(dBm) |
|------|-----------------|---------|-------------|---------------------|
| GMRS | 462.637 5       | 4       | 28.00       | 29.00               |
| FRS  | 467.637 5       | 11      | 24.00       | 25.00               |

Note:

1. The device operates using the following maximum output power specifications. The reported SAR is measured SAR value adjusted for maximum output power tolerance.
2. Tune up tolerance is  $\pm 1.0$  dB.



## 7.2. SAR results

### 7.2.1. SAR measurement results

| Test Position | Frequency (MHz) | Channel | Tune up limit (dBm) | Power (dBm) | Measurement SAR <sub>lg</sub> (W/kg) |       | Power drift | Scaling factor | Reported SAR <sub>lg</sub> (W/kg) |       | Plot No. |
|---------------|-----------------|---------|---------------------|-------------|--------------------------------------|-------|-------------|----------------|-----------------------------------|-------|----------|
|               |                 |         |                     |             | Duty cycle                           |       |             |                | Duty cycle                        |       |          |
|               |                 |         |                     |             | 100 %                                | 50 %  |             |                | 100 %                             | 50 %  |          |
| Face          | 462.637 5       | 4       | 29.00               | 27.68       | 0.305                                | 0.153 | -0.104      | 1.36           | 0.413                             | 0.207 | 1        |
|               | 467.637 5       | 11      | 25.00               | 24.33       | 0.236                                | 0.118 | -0.099      | 1.17           | 0.275                             | 0.138 | 2        |
| Body          | 462.637 5       | 4       | 29.00               | 27.68       | 0.466                                | 0.233 | 0.144       | 1.36           | 0.632                             | 0.316 | 3        |
|               | 467.637 5       | 11      | 25.00               | 24.33       | 0.363                                | 0.182 | -0.145      | 1.17           | 0.424                             | 0.212 | 4        |

Note:

1. The EUT is fitted with Belt Clip accessory and placed directly against a phantom (no gap) in case of Face Down side.
2. This test was conducted in reference to KDB447498 D01 and KDB643646 D01.

## 8. Measurement equipments

| Equipment                    | Manufacturer | Model           | Serial No.      | Calibration interval | Calibration due. |
|------------------------------|--------------|-----------------|-----------------|----------------------|------------------|
| Stäubli Robot Unit           | Stäubli      | RX90B           | F02/5Q89A1/A/01 | N/A                  | N/A              |
| Data Acquisition Electronics | SPEAG        | DAE4            | 1344            | 1year                | 2015.11.12       |
| E-Field Probe                | SPEAG        | ES3DV3          | 3315            | 1year                | 2016.05.27       |
| Electro Optical Converter    | SPEAG        | EOC5            | N/A             | N/A                  | N/A              |
| 2mm Oval Phantom EL15        | SPEAG        | QD OVA 002 AA   | 1190            | N/A                  | N/A              |
| Dipole Antenna               | SPEAG        | D450V3          | 1081            | 3years               | H : 2017.05.19   |
|                              |              |                 |                 |                      | B : 2018.01.20   |
| S-Parameter Network Analyzer | Agilent      | 8753ES          | MY40000210      | 1year                | 2016.07.24       |
| Calibration Kit              | Agilent      | 85033D          | 3423A02429      | N/A                  | N/A              |
| EPM Series Power Meter       | HP           | E4419B          | GB37290599      | 1year                | 2016.07.23       |
| E-Series AVG Power Sensor    | HP           | E9300H          | MY41495967      | 1year                | 2016.07.23       |
| E-Series AVG Power Sensor    | HP           | E9300H          | US39215405      | 1year                | 2016.07.23       |
| Power Meter                  | Anritsu      | ML2495A         | 1438001         | 1year                | 2016.01.22       |
| Pulse Power Sensor           | Anritsu      | MA2411B         | 1339205         | 1year                | 2016.01.26       |
| RF Power Amplifier           | None         | RFSPA           | 001             | 1year                | 2016.07.24       |
| Dual Directional Coupler     | HP           | 778D-012        | 16468           | 1year                | 2016.07.23       |
| Vector Signal Generator      | R&S          | SMBV100A        | 1407.6004K02    | 1year                | 2016.07.23       |
| Signal Analyzer              | R&S          | FSV30           | 101389          | 1year                | 2016.01.22       |
| LP Filter                    | WEINSCHEL    | WLK1.0/18G-10TT | 1               | 1year                | 2016.07.24       |
| Attenuator                   | HP           | 8494B           | 2630A12857      | 1year                | 2016.01.22       |
| Hygro-Thermometer            | BODYCOM      | BJ5478          | N/A             | 1year                | 2016.07.25       |
| Dielectric Probe Kit         | Agilent      | 85070E          | MY44300696      | N/A                  | N/A              |
| Software                     | SPEAG        | DASY4 V4.7      | -               | N/A                  | N/A              |

## 9. Measurement Uncertainty

| DASY4 Uncertainty budget                     |                  |                          |             |      |                |                          |                       |
|--|------------------|--------------------------|-------------|------|----------------|--------------------------|-----------------------|
| Error Description                            | Section in P1528 | Uncertainty Value<br>± % | Prob. Dist. | Div. | $c_i$<br>(1 g) | $u_i(y)$<br>(1 g)<br>± % | $v_i$ or<br>$v_{eff}$ |
| Probe Calibration                            | E.2.1            | 6.55                     | N           | 1.00 | 1.00           | 6.55                     | ∞                     |
| Axial Isotropy                               | E.2.2            | 0.50                     | R           | 1.73 | 0.71           | 0.20                     | ∞                     |
| Hemispherical Isotropy                       | E.2.2            | 2.60                     | R           | 1.73 | 0.71           | 1.06                     | ∞                     |
| Boundary Effect                              | E.2.3            | 2.00                     | R           | 1.73 | 1.00           | 1.16                     | ∞                     |
| Linearity                                    | E.2.4            | 0.60                     | R           | 1.73 | 1.00           | 0.35                     | ∞                     |
| System Detection Limits                      | E.2.5            | 1.00                     | R           | 1.73 | 1.00           | 0.58                     | ∞                     |
| Readout Electronics                          | E.2.6            | 0.30                     | N           | 1.00 | 1.00           | 0.30                     | ∞                     |
| Response Time                                | E.2.7            | 0.50                     | R           | 1.73 | 1.00           | 0.29                     | ∞                     |
| Integration Time                             | E.2.8            | 2.60                     | R           | 1.73 | 1.00           | 1.50                     | ∞                     |
| RF Ambient Noise                             | E.6.1            | 3.00                     | R           | 1.73 | 1.00           | 1.73                     | ∞                     |
| RF Ambient Reflections                       | E.6.1            | 3.00                     | R           | 1.73 | 1.00           | 1.73                     | ∞                     |
| Probe Positioning<br>Mechanical Tolerance    | E.6.2            | 0.40                     | R           | 1.73 | 1.00           | 0.23                     | ∞                     |
| Probe Positioning<br>With Respect to Phantom | E.6.3            | 2.90                     | R           | 1.73 | 1.00           | 1.67                     | ∞                     |
| Max. SAR Eval.                               | E.5.2            | 2.00                     | R           | 1.73 | 1.00           | 1.15                     | ∞                     |
| Test sample positioning                      | E.4.2            | 2.30                     | N           | 1.00 | 1.00           | 2.30                     | 9                     |
| Device Holder Uncertainty                    | E.4.1            | 3.60                     | N           | 1.00 | 1.00           | 3.60                     | ∞                     |
| SAR Drift Measurement                        | 6.6.3            | 5.00                     | R           | 1.73 | 1.00           | 2.89                     | ∞                     |
| Phantom Uncertainty                          | E.3.1            | 6.10                     | R           | 1.73 | 1.00           | 3.52                     | ∞                     |
| Liquid Conductivity(target)                  | E.3.2            | 5.00                     | R           | 1.73 | 0.64           | 1.85                     | ∞                     |
| Liquid Conductivity(meas.)                   | E.3.2            | 0.30                     | N           | 1.00 | 0.64           | 0.19                     | 5                     |
| Liquid Permittivity(target)                  | E.3.3            | 5.00                     | R           | 1.73 | 0.60           | 1.73                     | ∞                     |
| Liquid Permittivity(meas.)                   | E.3.3            | 0.01                     | N           | 1.00 | 0.60           | 0.01                     | 5                     |
| Combined Std. Uncertainty(RSS)               |                  |                          |             |      |                | ± 10.19 %                | 10 301.933            |
| Expanded Uncertainty                         |                  |                          |             |      |                | ± 20.38 %                | $k = 2$               |



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**Appendix list**

**Appendix A. DASY4 report**

**Appendix B. Calibration certificate**