



**SAR EVALUATION REPORT**

**FCC 47 CFR § 2.1093  
IEEE Std 1528-2013**

*For*  
**Desktop Wireless Charger**

**FCC ID: 2ADNG-NF230  
Model Name: NF-230**

**Report Number: 12150954-S1V3  
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NVLAP LAB CODE 200065-0

**Revision History**

| Rev. | Date      | Revisions                                | Revised By      |
|------|-----------|--|-----------------|
| V1   | 3/9/2018  | Initial Issue                            | --              |
| V2   | 3/12/2018 | Updated maximum 918MHz power to 29.0 dBm | Dave Weaver     |
| V3   | 4/2/2018  | Test distance changed to 25 mm           | Coltyce Sanders |
|      |           |  |                 |

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# 1. Attestation of Test Results

|   |   |  |
|---|---|--|
| Applicant Name                                | Energous Corporation  |  |
| FCC ID  | 2ADNG-NF230   |  |
| Model Name                                    | NF-230  |  |
| Applicable Standards                          | FCC 47 CFR § 2.1093<br>Published RF exposure KDB procedures<br>IEEE Std 1528-2013 |  |
| Exposure Category                             | SAR Limits (W/Kg)   |  |
|   | Peak spatial-average(1g of tissue)  | Extremities (hands, wrists, ankles, etc.)<br>(10g of tissue) |
| General population /<br>Uncontrolled exposure | 1.6   | 4  |
| RF Exposure Conditions                        | Equipment Class - Highest Reported SAR (W/kg)                                     |  |
|   | CW  | DTS  |
| Body  | 0.856   | N/A  |
| Simultaneous TX                               | 0.864   |  |
| Date Tested                                   | 4/2/2018 to 4/4/2018  |  |
| Test Results                                  | Pass  |  |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

|  |  |
|--|--|
| Approved & Released By:<br> | Prepared By:<br> |
| Dave Weaver<br>Operations Leader<br>UL Verification Services Inc.  | Tony Soares<br>Laboratory Technician<br>UL Verification Services Inc.                                |

## 2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 680106 D01 RF Exposure Wireless Charging Apps v02
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- [TCB workshop](#) October, 2016; Page 7, RF Exposure Procedures (Bluetooth Duty Factor)

## 3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

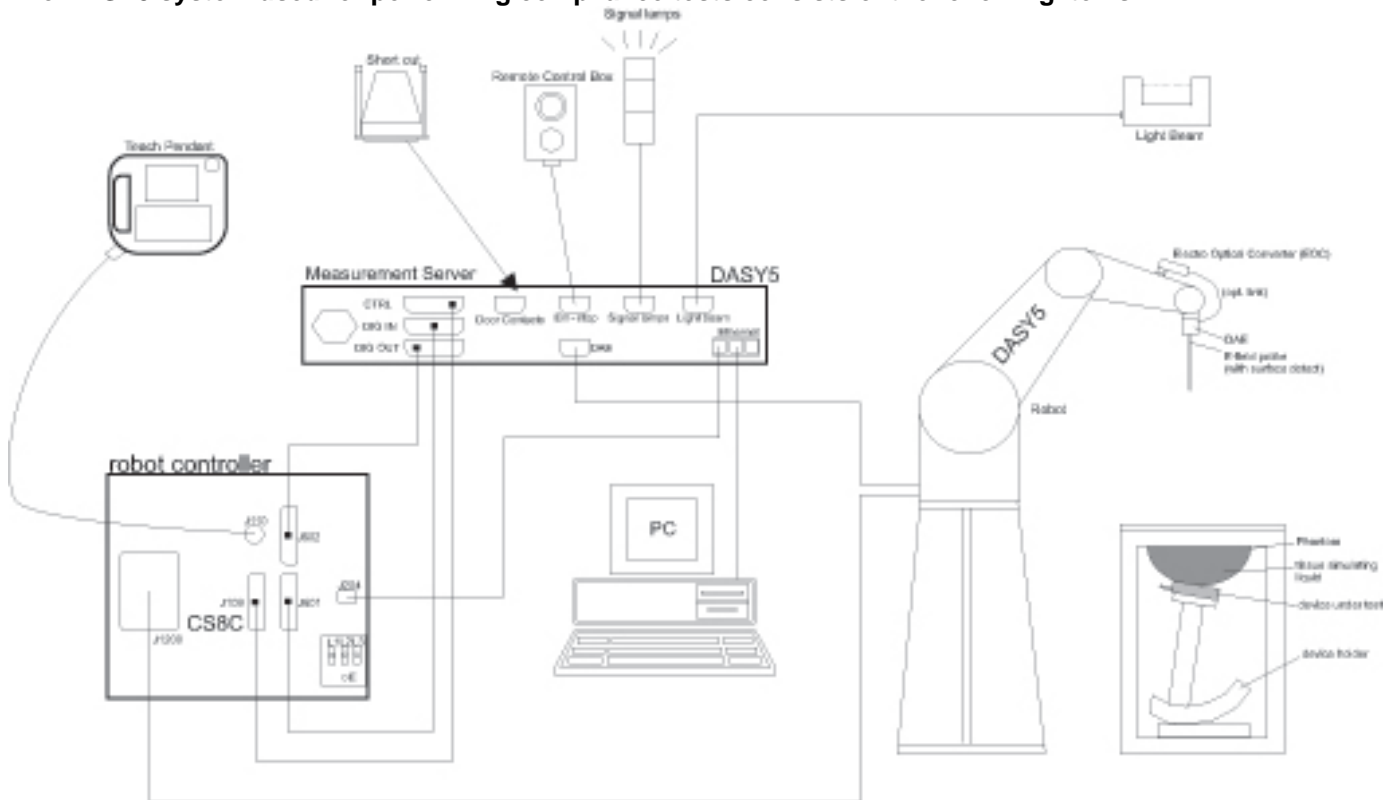
| 47173 Benicia Street | 47266 Benicia Street |
|----------------------|----------------------|
| SAR Lab A            | SAR Lab 1            |
| SAR Lab B            | SAR Lab 2            |
| SAR Lab C            | SAR Lab 3            |
| SAR Lab D            | SAR Lab 4            |
| SAR Lab E            |                      |
| SAR Lab F            |                      |
| SAR Lab G            |                      |
| SAR Lab H            |                      |

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

## 4. SAR Measurement System & Test Equipment

### 4.1. SAR Measurement System

The DASY5 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- 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 from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 4.2. SAR Scan Procedures

### Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift 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 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

### Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

|  | $\leq 3$ 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. |  |

**Step 3: Zoom Scan**

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

|  |                                    | $\leq 3$ GHz   | $> 3$ GHz   |  |
|--|------------------------------------|--|---|--|
| 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.<br>* 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. |                                    |  |   |  |

**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.

**Step 5: Z-Scan (FCC only)**

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be larger than the step size in Z-direction.



### 4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

#### **Dielectric Property Measurements**

| Name of Equipment    | Manufacturer                      | Type/Model    | Serial No.    | Cal. Due Date |
|----------------------|-----------------------------------|---------------|---------------|---------------|
| Network Analyzer     | Agilent                           | 8753ES        | MY40001647    | 9/15/2018     |
| Dielectric Probe kit | SPEAG                             | DAK-3.5       | 1087          | 1/30/2019     |
| Shorting block       | SPEAG                             | DAK-3.5 Short | SM DAK 200 BA | 11/14/2018    |
| Thermometer          | Traceable Calibration Control Co. | 4242          | 122529162     | 12/8/2018     |

#### **System Check**

| Name of Equipment            | Manufacturer | Type/Model             | Serial No. | Cal. Due Date |
|------------------------------|--------------|------------------------|------------|---------------|
| Synthesized Signal Generator | Agilent      | N5181A                 | MY50140630 | 5/16/2018     |
| Power Meter                  | HP           | 437B                   | 3125U12345 | 8/10/2018     |
| Power Meter                  | HP           | 437B                   | 3125U11347 | 8/15/2018     |
| Power Sensor                 | HP           | 8481A                  | 1926A27048 | 8/10/2018     |
| Power Sensor                 | HP           | 8481A                  | 3318A92374 | 8/15/2018     |
| Amplifier                    | MITEQ        | AMF-4D-00400600-50-30P | 1795093    | N/A           |
| Directional coupler          | Werlatone    | C8060-102              | 2149       | N/A           |
| DC Power Supply              | BK PRECISION | E3610A                 | KR24104150 | N/A           |

#### **Lab Equipment**

| Name of Equipment                        | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|--|--------------|------------|------------|---------------|
| E-Field Probe (SAR Lab A)                | SPEAG        | EX3DV4     | 7463       | 7/5/2018      |
| Data Acquisition Electronics (SAR Lab A) | SPEAG        | DAE4       | 1434       | 4/19/2018     |
| System Validation Dipole                 | SPEAG        | D900V2     | 108        | 11/22/2018    |

#### **Other**

| Name of Equipment | Manufacturer | Type/Model | T Number | Serial No. | Cal. Due Date |
|-------------------|--------------|------------|----------|------------|---------------|
| Power Meter       | Agilent      | N1912A     | T1263    | MY55196004 | 7/14/2018     |
| Power Sensor      | Agilent      | N1921A     | T 309    | MY52270022 | 12/28/2018    |

## 5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be  $\leq 30\%$ , for a confidence interval of  $k = 2$ . If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

## 6. Device Under Test (DUT) Information

### 6.1. DUT Description

|                         |   |                    |   |
|-------------------------|---|--------------------|---|
| Device Dimensions       | Overall (Length x Width): 72 mm x 72 mm x 22 mm |                    |   |
| Test sample information | <b>S/N</b><br>DD0172114010                      | <b>IMEI</b><br>N/A | <b>Notes</b><br>Radiated and Conducted Unit |
| Hardware Version        | V.1   |                    |   |
| Software Version        | 3.0.1.64  |                    |   |

### 6.2. Wireless Technologies

| Wireless technologies | Frequency bands | Operating mode         | Duty Cycle used for SAR testing |
|-----------------------|-----------------|------------------------|---------------------------------|
| CW                    | 918 MHz         | Charging Client Device | 100%                            |
| BLE                   | 2.4 GHz         | N/A                    | N/A <sup>1</sup>                |

#### Notes:

1. Measured Duty Cycle is not required due to SAR test exemption.

### 6.3. Maximum Output Power

| RF Air interface | Mode | Antenna | Max. RF Output Power (dBm) |
|------------------|------|---------|----------------------------|
| 918              | CW   | 1       | <b>29.0</b>                |
|                  |      | 2       | <b>29.0</b>                |

| RF Air interface | Mode | Antenna | Max. RF Output Power (dBm) |
|------------------|------|---------|----------------------------|
| 2.4 GHz          | BLE  | BLE     | <b>0.0</b>                 |

## 7. RF Exposure Conditions (Test Configurations)

The DUT is a desktop Wireless Power transfer device and is not intended for handheld or body worn use.

The DUT is powered from an external 5V power supply and will only operate when connected to such.

The DUT was assessed at 25 mm from the sides and the top surface in accordance with FCC guidance.

Wireless power transfer is only possible when a client device is placed upon the top surface of the DUT.

Testing was performed with a client device placed upon the surface of the DUT. The DUT supports two WPT antennas. The antennas are identical but placed at right angles to each other. Only one of the antennas is active at a time depending upon the position of the client device on the DUT.

Full testing (Top and four sides) was performed with antenna 1 active. This was then repeated with antenna 2 active.

The client device used for testing was an Energous Corporation NF-230A s/n KEY71

## 8. Dielectric Property Measurements & System Check

### 8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within  $\pm 2^\circ\text{C}$  of the temperature when the tissue parameters are characterized.

The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

The dielectric constant ( $\epsilon_r$ ) and conductivity ( $\sigma$ ) of typical tissue-equivalent media recipes are expected to be within  $\pm 5\%$  of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEEE Std 1528-2013, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for  $\epsilon_r$  and  $\sigma$  may be relaxed to  $\pm 10\%$ . This is limited to frequencies  $\leq 3$  GHz.

#### Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

| Target Frequency (MHz) | Head         |                | Body         |                |
|------------------------|--------------|----------------|--------------|----------------|
|                        | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150                    | 52.3         | 0.76           | 61.9         | 0.80           |
| 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         | 0.98           | 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           |
| 5000                   | 36.2         | 4.45           | 49.3         | 5.07           |
| 5100                   | 36.1         | 4.55           | 49.1         | 5.18           |
| 5200                   | 36.0         | 4.66           | 49.0         | 5.30           |
| 5300                   | 35.9         | 4.76           | 48.9         | 5.42           |
| 5400                   | 35.8         | 4.86           | 48.7         | 5.53           |
| 5500                   | 35.6         | 4.96           | 48.6         | 5.65           |
| 5600                   | 35.5         | 5.07           | 48.5         | 5.77           |
| 5700                   | 35.4         | 5.17           | 48.3         | 5.88           |
| 5800                   | 35.3         | 5.27           | 48.2         | 6.00           |

#### IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

#### Dielectric Property Measurements Results:

| SAR Lab | Date     | Band (MHz) | Tissue Type | Frequency (MHz) | Relative Permittivity ( $\epsilon_r$ ) |        |           | Conductivity ( $\sigma$ ) |        |           |
|---------|----------|------------|-------------|-----------------|--|--------|-----------|---------------------------|--------|-----------|
|         |          |            |             |                 | Measured                               | Target | Delta (%) | Measured                  | Target | Delta (%) |
| A       | 4/2/2018 | 900        | Body        | 900             | 54.21                                  | 55.00  | -1.44     | 1.11                      | 1.05   | 5.81      |
|         |          |            |             | 880             | 54.51                                  | 55.07  | -1.02     | 1.10                      | 1.02   | 7.30      |
|         |          |            |             | 920             | 53.99                                  | 54.99  | -1.82     | 1.13                      | 1.06   | 6.66      |

## 8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

### System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0  $\pm$ 0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be  $\geq$  15.0 cm for SAR measurements  $\leq$  3 GHz and  $\geq$  10.0 cm for measurements  $>$  3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.  
For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.  
For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

### System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

| SAR Lab | Date     | Tissue Type | Dipole Type<br>Serial # | Dipole<br>Cal. Due Data | Measured Results for 1g SAR |                  |                     |                  | Measured Results for 10g SAR |                  |                     |                  | Plot No. |
|---------|----------|-------------|-------------------------|-------------------------|-----------------------------|------------------|---------------------|------------------|------------------------------|------------------|---------------------|------------------|----------|
|         |          |             |                         |                         | Zoom Scan to 100 mW         | Normalize to 1 W | Target (Ref. Value) | Delta $\pm$ 10 % | Zoom Scan to 100 mW          | Normalize to 1 W | Target (Ref. Value) | Delta $\pm$ 10 % |          |
| A       | 4/2/2018 | Body        | D900V2 SN:108           | 11/22/2018              | 1.15                        | 11.50            | 10.86               | 5.89             | 0.749                        | 7.49             | 7.16                | 4.61             | 1,2      |

## 9. Conducted Output Power Measurements

### 9.1. CW 918MHz

| Band (MHz) | Mode | Freq. (MHz) | Antenna | Max. Meas. Avg Pwr (dBm) | Max. Output Pwr (dBm) |
|------------|------|-------------|---------|--------------------------|-----------------------|
|            |      |             |         | 918 MHz                  | 918 MHz               |
| 918        | CW   | 918         | 1       | 28.8                     | 29.0                  |
|            |      |             | 2       | 28.7                     | 29.0                  |

## 10. Measured and Reported (Scaled) SAR Results

### SAR Test Reduction criteria are as follows:

Reported SAR(W/kg) for WWAN= Measured SAR \*Tune-up Scaling Factor

Reported SAR(W/kg) for Wi-Fi and Bluetooth= Measured SAR \* Tune-up scaling factor \* Duty Cycle scaling factor

### KDB 447498 D01 General RF Exposure Guidance:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- $\leq 0.8$  W/kg or  $2.0$  W/kg, for 1-g or 10-g respectively, when the transmission band is  $\leq 100$  MHz
- $\leq 0.6$  W/kg or  $1.5$  W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- $\leq 0.4$  W/kg or  $1.0$  W/kg, for 1-g or 10-g respectively, when the transmission band is  $\geq 200$  MHz

### 10.1. CW 918 MHz

| Frequency Band | Mode | RF Exposure Conditions | Dist. (mm) | Ant. | Test Position | Freq. (MHz) | Power (dBm)   |       | 1-g SAR (W/kg) |              | Plot No. |
|----------------|------|------------------------|------------|------|---------------|-------------|---------------|-------|----------------|--------------|----------|
|                |      |                        |            |      |               |             | Tune-up limit | Meas. | Meas.          | Scaled       |          |
| 918 MHz        | CW   | Body                   | 25         | 1    | Top           | 918.0       | 29.0          | 28.8  | 0.817          | <b>0.856</b> | 1        |
|                |      |                        |            |      | Edge 1        | 918.0       | 29.0          | 28.8  | 0.105          | 0.110        |          |
|                |      |                        |            |      | Edge 2        | 918.0       | 29.0          | 28.8  | 0.068          | 0.071        |          |
|                |      |                        |            |      | Edge 3        | 918.0       | 29.0          | 28.8  | 0.144          | 0.151        |          |
|                |      |                        |            |      | Edge 4        | 918.0       | 29.0          | 28.8  | 0.037          | 0.039        |          |
|                |      |                        |            | 2    | Top           | 918.0       | 29.0          | 28.7  | 0.744          | <b>0.797</b> | 2        |
|                |      |                        |            |      | Edge 1        | 918.0       | 29.0          | 28.7  | 0.035          | 0.038        |          |
|                |      |                        |            |      | Edge 2        | 918.0       | 29.0          | 28.7  | 0.087          | 0.093        |          |
|                |      |                        |            |      | Edge 3        | 918.0       | 29.0          | 28.7  | 0.729          | 0.781        |          |
|                |      |                        |            |      | Edge 4        | 918.0       | 29.0          | 28.7  | 0.069          | 0.074        |          |

## 10.2. Standalone SAR Test Exclusion Considerations & Estimated SAR

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:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ , for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(\text{GHz})}$  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.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f_{(\text{GHz})}/x}] \text{ W/kg}$  for test separation distances ≤ 50 mm;  
where  $x = 7.5$  for 1-g SAR, and  $x = 18.75$  for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

| RF Air interface | RF Exposure Conditions | Frequency (GHz) | Max. tune-up tolerance Power |      | Min. test separation distance (mm) | SAR test exclusion Result* | Estimated 1-g SAR (W/kg) |
|------------------|------------------------|-----------------|------------------------------|------|------------------------------------|----------------------------|--------------------------|
|                  |                        |                 | (dBm)                        | (mW) |                                    |                            |                          |
| BLE              | Body                   | 2.480           | 0.0                          | 1    | 25                                 | 0.1                        | 0.008                    |

**Conclusion:**

\*: The computed value is ≤ 3; therefore, BLE qualifies for Standalone SAR test exclusion.

## 11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These 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 <math><0.8</math> or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is  $\geq 0.8$  or 2 W/kg (1-g or 10-g respectively), 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  $\geq 1.45$  or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
- 4) Perform a third repeated measurement only if the original, first, or second repeated measurement is  $\geq 1.5$  or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is  $> 1.20$ .

| Frequency Band (MHz) | Air Interface | RF Exposure Conditions | Test Position | Repeated SAR (Yes/No) | Highest Measured SAR (W/kg) | First Repeated      |                               |
|----------------------|---------------|------------------------|---------------|-----------------------|-----------------------------|---------------------|-------------------------------|
|                      |               |                        |               |                       |                             | Measured SAR (W/kg) | Largest to Smallest SAR Ratio |
| 918                  | CW            | Body                   | Top           | Yes                   | 0.817                       | 0.808               | 1.01                          |

**Note(s):**

Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is  $< 1.20$ .



## 12. Simultaneous Transmission SAR Analysis

According to KDB 447498 D01, General RF Exposure Guidance, simultaneous transmission SAR measurements can be excluded if the sum of the SAR from simultaneously transmitting antennas is less than the SAR limit.

The DUT supports simultaneous transmission between the 918 MHz and BLE transmitters.

The maximum reported SAR for 918 MHz is 0.856 W/kg

The estimated SAR value for BLE is 0.008 W/kg

The sum of the SAR is  $0.856 + 0.008 = \mathbf{0.864 \text{ W/kg}}$ .

The sum of the SAR is less than 1.6 W/kg therefore simultaneous transmission SAR measurements can be excluded.

## **Appendixes**

**Refer to separated files for the following appendixes.**

**12150954-S1V2 Appendix A: SAR Setup Photos**

**12150954-S1V2 Appendix B: SAR System Check Plots**

**12150954-S1V2 Appendix C: Highest SAR Test Plots**

**12150954-S1V1 Appendix D: SAR Liquid Tissue Ingredients**

**12150954-S1V2 Appendix E: SAR Probe Calibration Certificates**

**12150954-S1V1 Appendix F: SAR Dipole Calibration Certificates**

**END OF REPORT**