# SAR TEST REPORT

| | |
|---|---|
| **Applicant** | Snap Inc. |
| **FCC ID** | 2AIRN-002 |
| **Product** | Wearable video camera |
| **Trademark** | Spectacles |
| **Model** | 002 |
| **Report No.** | R1801A0004-S2V5 |
| **Issue Date** | April 4, 2018 |

TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **IEEE 1528- 2013, ANSI C95.1: 1992/IEEE C95.1: 1991.** The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Jiangpeng Lan  Kai Xu

*Performed by: Jiangpeng Lan*  *Approved by: Kai Xu*


## TA Technology (Shanghai) Co., Ltd.

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# 1 Test Laboratory

## 1.1 Notes of the Test Report

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

## 1.2 Test facility

**CNAS (accreditation number:L2264)**

TA Technology (Shanghai) Co., Ltd. has obtained the accreditation of China National Accreditation Service for Conformity Assessment (CNAS).

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

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

**IC (recognition number is 8510A)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Canada to perform electromagnetic emission measurement.

**VCCI (recognition number is C-4595, T-2154, R-4113, G-10766)**

TA Technology (Shanghai) Co., Ltd. has been listed by industry Japan to perform electromagnetic emission measurement.

**A2LA (Certificate Number: 3857.01)**

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

## 1.3 Testing Location

| | |
|---|---|
| Company: | TA Technology (Shanghai) Co., Ltd. |
| Address: | No.145, Jintang Rd, Tangzhen Industry Park, Pudong Shanghai, China |
| City: | Shanghai |
| Post code: | 201201 |
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| Website: | http://www.ta-shanghai.com |
| E-mail: | xukai@ta-shanghai.com |

## 1.4 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. Reflection of surrounding objects is minimized and in compliance with requirement of standards. | |

# 2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for the EUT are as follows:
Table 2.1: Highest Reported SAR

| Mode | Highest Reported SAR (W/kg) | |
|---|---|---|
| | 1g Head SAR (Separation 0mm) | 1g Body SAR (Separation 0mm) |
| Wi-Fi (2.4G) | 0.593 | 0.538 |
| Wi-Fi (5G) | 1.079 | 0.987 |
| Date of Testing: | January 12, 2018 and January 31, 2018 and March 13, 2018 and March 27, 2018 ~ March 28, 2018 | |
| Note: The device is in compliance with SAR for Uncontrolled Environment /General Population exposure limits (1.6 W/kg and 4.0 W/kg) specified in ANSI C95.1: 1992/IEEE C95.1: 1991, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013. | | |

# 3 Description of Equipment under Test

**Client Information**

| | |
|---|---|
| **Applicant** | Snap Inc. |
| **Applicant address** | 63 Market Street, Venice, CA 90291, USA |

**General Technologies**

| | |
|---|---|
| Application Purpose: | Original Grant |
| EUT Stage | Identical Prototype |
| Model: | 002 |
| SN | / |
| Hardware Version: | / |
| Software Version: | / |
| Antenna Type: | Internal Antenna |
| EUT Accessory | |
| Battery | Manufacturer: /<br>Model: SC03<br>Power Rating: DC 3.8V, 96mAh |

**Wireless Technology and Frequency Range**

| Wireless Technology | | Modulation | Operating mode | Tx (MHz) |
|---|---|---|---|---|
| BT | 2.4G | Version 4.2 LE | | 2402 ~2480 |
| Wi-Fi | 2.4G | DSSS,OFDM | 802.11b/g/n HT20 | 2412 ~ 2462 |
| | | OFDM | 802.11n HT40 | 2422 ~ 2452 |
| | 5G | OFDM | 802.11a/n 20M/40M/<br>ac 20M/40M/80M | 5150 ~ 5350<br>5470 ~ 5850 |
| | Does this device support MIMO ☐Yes ☒No | | | |

# 4 Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE 1528- 2013, ANSI C95.1: 1992/IEEE C95.1: 1991, the following FCC Published RF exposure KDB procedures:

248227 D01 802.11 Wi-Fi SAR v02r02
447498 D01 General RF Exposure Guidance v06
865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
865664 D02 RF Exposure Reporting v01r02

# 5 Operational Conditions during Test

## 5.1 Measurement Variability

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:
1) When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
3) A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4) Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

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.

## 5.2 Test Configuration

### 5.2.1 Wi-Fi Test Configuration

This device is a camera, and Wi-Fi is used either with the device as an access point (AP) or via Wi-Fi Direct to transfer videos from the device to the user's smart phone. It's enabled from the smart phone, and turns off when the transfer is complete.

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations,

which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported* SAR for the *initial test position* is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported* SAR is ≤ 0.8 W/kg or all required test positions are tested.
    - ✧ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
    - ✧ When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required test channels are considered.
    - ✧ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

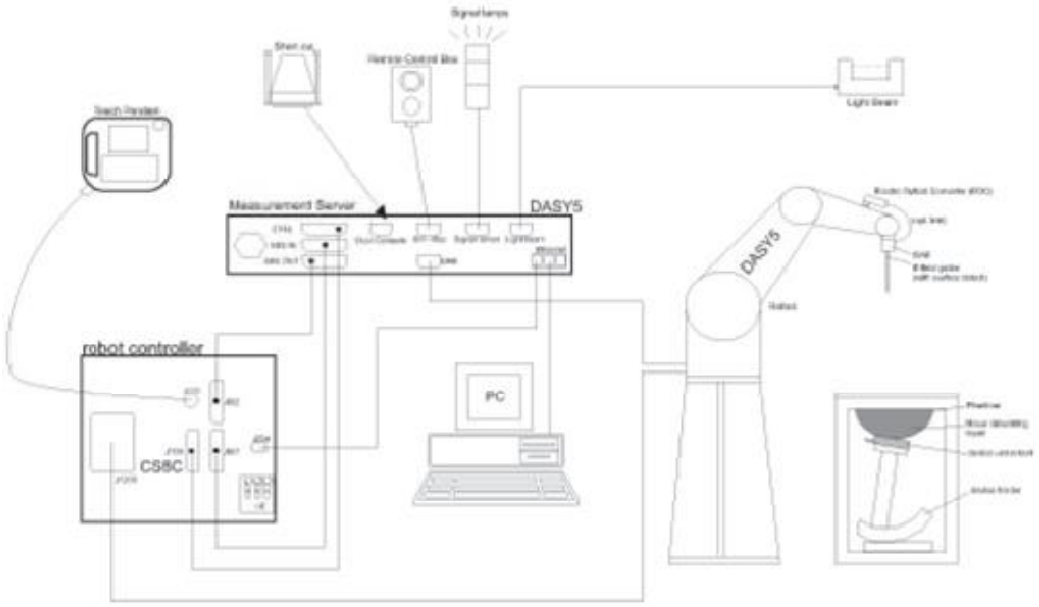
To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered the worst case position; thus used as the initial test position.

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement.

# 6 SAR Measurements System Configuration

## 6.1 SAR Measurement Set-up

The DASY system 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 DASY 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.

## 6.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

**EX3DV4 Probe Specification**

| | |
|---|---|
| Construction | 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<br>(30 MHz to 6 GHz) |
| Directivity | ± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis) |
| Dynamic Range | 10 µW/g to > 100 mW/g Linearity: ± 0.2dB (noise: typically < 1 µW/g) |
| Dimensions | Overall length: 330 mm (Tip: 20 mm) 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). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%. |

**E-field Probe Calibration**

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based

temperature probe is used in conjunction with the E-field probe.

$$SAR=C\Delta T/\Delta t$$

Where: $\Delta t$ = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

$\Delta T$ = Temperature increase due to RF exposure.

Or

$$SAR=|E|^2\sigma/\rho$$

Where: $\sigma$ = Simulated tissue conductivity,

$\rho$ = Tissue density ($kg/m^3$).

## 6.3 SAR Measurement Procedure

**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. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

**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 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 FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

| | ≤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: ΔxArea, ΔyArea | ≤ 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. | |

**Zoom Scan**

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes 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 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><td colspan="3"></td><td>≤3GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: $\triangle x_{zoom}$ $\triangle y_{zoom}$</td><td>≤2GHz: ≤8mm<br>2 – 3GHz: ≤5mm*</td><td>3 – 4GHz: ≤5mm*<br>4 – 6GHz: ≤4mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">Uniform grid: $\triangle z_{zoom}(n)$</td><td>≤5mm</td><td>3 – 4GHz: ≤4mm<br>4 – 5GHz: ≤3mm<br>5 – 6GHz: ≤2mm</td></tr>
<tr><td rowspan="2">Graded grid</td><td>$\triangle z_{zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤4mm</td><td>3 – 4GHz: ≤3mm<br>4 – 5GHz: ≤2.5mm<br>5 – 6GHz: ≤2mm</td></tr>
<tr><td>$\triangle z_{zoom}(n>1)$: between subsequent points</td><td colspan="2">≤1.5•$\triangle z_{zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">X, y, z</td><td>≥30mm</td><td>3 – 4GHz: ≥28mm<br>4 – 5GHz: ≥25mm<br>5 – 6GHz: ≥22mm</td></tr>
<tr><td colspan="5">Note: δ 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 <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4W/kg, ≤8mm, ≤7mm and ≤5mm zoom scan resolution may be applied, respectively, for 2GHz to 3GHz, 3GHz to 4GHz and 4GHz to 6GHz.</td></tr>
</table>

**Volume Scan Procedures**

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

**Power Drift Monitoring**

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

# 7 Main Test Equipment

| Name of Equipment | Manufacturer | Type/Model | Serial Number | Last Cal. | Cal. Due Date |
|---|---|---|---|---|---|
| Network analyzer | Agilent | E5071B | MY42404014 | 2017-05-20 | 2018-05-19 |
| Dielectric Probe Kit | HP | 85070E | US44020115 | 2017-05-20 | 2018-05-19 |
| Power meter | Agilent | E4417A | GB41291714 | 2017-05-21 | 2018-05-20 |
| Power sensor | Agilent | N8481H | MY50350004 | 2017-05-21 | 2018-05-20 |
| Power sensor | Agilent | E9327A | US40441622 | 2017-05-20 | 2018-05-19 |
| Dual directional coupler | Agilent | 777D | 50146 | 2017-05-20 | 2018-05-19 |
| Amplifier | INDEXSAR | IXA-020 | 0401 | 2017-05-20 | 2018-05-19 |
| Wideband radio communication tester | R&S | CMW 500 | 113645 | 2017-05-20 | 2018-05-19 |
| BT Base Station Simulator | R&S | CBT | 100271 | 2017-05-14 | 2018-05-13 |
| E-field Probe | SPEAG | EX3DV4 | 3677 | 2017-01-23 | 2018-01-22 |
| E-field Probe | SPEAG | EX3DV4 | 3898 | 2017-06-27 | 2018-06-26 |
| DAE | SPEAG | DAE4 | 1291 | 2017-10-31 | 2018-10-30 |
| Validation Kit 2450MHz | SPEAG | D2450V2 | 786 | 2017-08-29 | 2020-08-28 |
| Validation Kit 5GHz | SPEAG | D5GHzV2 | 1151 | 2017-01-05 | 2020-01-04 |
| Temperature Probe | Tianjin jinming | JM222 | AA1009129 | 2017-05-17 | 2018-05-16 |
| Hygrothermograph | Anymetr | NT-311 | 20150731 | 2017-05-17 | 2018-05-16 |
| Software for Test | Speag | DASY5 | 52.8.8.1222 | / | / |
| Software for Tissue | Agilent | 85070 | E06.01.36 | / | / |

# 8 Tissue Dielectric Parameter Measurements & System Verification

## 8.1 Tissue Verification

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°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.

**Target values**

| Frequency (MHz) | | Water (%) | Salt (%) | Sugar (%) | Glycol (%) | Preventol (%) | Cellulose (%) | $\varepsilon_r$ | σ(s/m) |
|---|---|---|---|---|---|---|---|---|---|
| Head | 2450 | 62.7 | 0.5 | 0 | 36.8 | 0 | 0 | 39.2 | 1.80 |
| Body | 2450 | 73.2 | 0.1 | 0 | 26.7 | 0 | 0 | 52.7 | 1.95 |
| **Frequency (MHz)** | | **Water (%)** | **Diethylenglycol monohexylether** | | | **Triton X-100** | | **$\varepsilon_r$** | **σ(s/m)** |
| Head | 5250 | 65.53 | 17.24 | | | 17.23 | | 35.9 | 4.71 |
| | 5600 | 65.53 | 17.24 | | | 17.23 | | 35.5 | 5.07 |
| | 5750 | 65.53 | 17.24 | | | 17.23 | | 35.4 | 5.22 |
| Body | 5250 | 72.52 | 13.74 | | | 13.74 | | 48.9 | 5.36 |
| | 5600 | 72.52 | 13.74 | | | 13.74 | | 48.5 | 5.77 |
| | 5750 | 72.52 | 13.74 | | | 13.74 | | 48.3 | 5.94 |

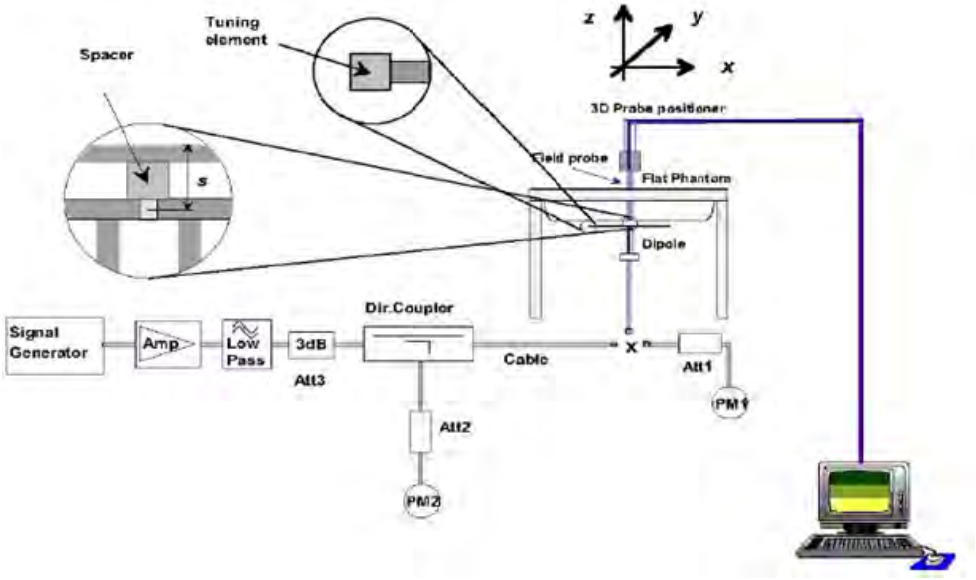
**Measurements results**

| Frequency (MHz) | | Test Date | Temp ℃ | Measured Dielectric Parameters | | Target Dielectric Parameters | | Limit (Within ±5%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | $\varepsilon_r$ | σ(s/m) | $\varepsilon_r$ | σ(s/m) | Dev $\varepsilon_r$(%) | Dev σ(%) |
| 2450 | Head | 1/12/2018 | 21.5 | 38.6 | 1.81 | 39.2 | 1.80 | -1.53 | 0.56 |
| | Body | 1/31/2018 | 21.5 | 52.5 | 1.98 | 52.7 | 1.95 | -0.38 | 1.54 |
| 5250 | Head | 3/27/2018 | 21.5 | 35.5 | 4.80 | 35.9 | 4.71 | -1.11 | 1.91 |
| | Body | 3/27/2018 | 21.5 | 48.1 | 5.32 | 48.9 | 5.36 | -1.64 | -0.75 |
| 5600 | Head | 3/13/2018 | 21.5 | 34.5 | 5.19 | 35.5 | 5.07 | -2.82 | 2.37 |
| | Body | 3/27/2018 | 21.5 | 47.8 | 5.88 | 48.5 | 5.77 | -1.44 | 1.91 |
| 5750 | Head | 3/28/2018 | 21.5 | 35.0 | 5.28 | 35.4 | 5.22 | -1.13 | 1.15 |
| | Body | 3/28/2018 | 21.5 | 47.6 | 6.14 | 48.3 | 5.94 | -1.45 | 3.37 |
| Note: The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz. | | | | | | | | | |

## 8.2 System Performance Check

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured using the dielectric probe kit and the network analyzer. A system check measurement for every day was made following the determination of the dielectric parameters of the Tissue simulates, using the dipole validation kit. The dipole antenna was placed under the flat section of the twin SAM phantom.

System check is performed regularly on all frequency bands where tests are performed with the DASY system.




**Picture 1 System Performance Check setup**

**Picture 2 Setup Photo**

**Justification for Extended SAR Dipole Calibrations**

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (< - 20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB 865664 D01:

| Dipole | | Date of Measurement | Return Loss (dB) | Δ % | Impedance (Ω) | ΔΩ |
|---|---|---|---|---|---|---|
| Dipole D5GHzV2 SN: 1151 (5250MHz) | Head Liquid | 1/5/2017 | -24.5 | / | 48.4 | / |
| | | 1/4/2018 | -24.2 | 1.2% | 48.7 | 0.3Ω |
| | Body Liquid | 1/5/2017 | -24.7 | / | 50.4 | / |
| | | 1/4/2018 | -24.4 | 1.2% | 49.9 | -0.5Ω |
| Dipole D5GHzV2 SN: 1151 (5600MHz) | Head Liquid | 1/5/2017 | -22.8 | / | 55.5 | / |
| | | 1/4/2018 | -22.4 | 1.8% | 55.2 | -0.3Ω |
| | Body Liquid | 1/5/2017 | -23.3 | / | 57.2 | / |
| | | 1/4/2018 | -23.4 | -0.4% | 56.8 | -0.4Ω |
| Dipole D5GHzV2 SN: 1151 (5750MHz) | Head Liquid | 1/5/2017 | -26.5 | / | 52.4 | / |
| | | 1/4/2018 | -26.8 | -1.1% | 52.5 | 0.1Ω |
| | Body Liquid | 1/5/2017 | -24.9 | / | 56.0 | / |
| | | 1/4/2018 | -25.2 | -1.2% | 56.4 | 0.4Ω |

**System Check results**

| Frequency (MHz) | | Test Date | Temp ℃ | 250mW/ 100mW Measured $SAR_{1g}$ (W/kg) | 1W Normalized $SAR_{1g}$ (W/kg) | 1W Target $SAR_{1g}$ (W/kg) | Δ % (Limit ±10%) | Plot No. |
|---|---|---|---|---|---|---|---|---|
| 2450 | Head | 1/12/2018 | 21.5 | 13.70 | 54.80 | 52.60 | 4.18 | 1 |
| | Body | 1/31/2018 | 21.5 | 12.50 | 50.00 | 50.80 | -1.57 | 2 |
| 5250 | Head | 3/27/2018 | 21.5 | 7.76 | 77.60 | 78.40 | -1.02 | 3 |
| | Body | 3/27/2018 | 21.5 | 7.46 | 74.60 | 75.60 | -1.32 | 4 |
| 5600 | Head | 3/13/2018 | 21.5 | 7.94 | 79.40 | 81.50 | -2.58 | 5 |
| | Body | 3/27/2018 | 21.5 | 8.04 | 80.40 | 80.20 | 0.25 | 6 |
| 5750 | Head | 3/28/2018 | 21.5 | 7.72 | 77.20 | 80.50 | -4.10 | 7 |
| | Body | 3/28/2018 | 21.5 | 7.15 | 71.50 | 74.60 | -4.16 | 8 |
| Note：Target Values used derive from the calibration certificate Data Storage and Evaluation. | | | | | | | | |

# 9 Normal and Maximum Output Power

KDB 447498 D01 at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

## 9.1 WLAN Mode

| Wi-Fi 2.4G | Channel | Frequency (MHz) | Average Conducted Power (dBm) for Data Rates (bps) | Tune-up Limit (dBm) |
|---|---|---|---|---|
| Mode | | | 1M | |
| 802.11b | 1 | 2412 | 12.65 | 13.00 |
| | 6 | 2437 | 12.30 | 13.00 |
| | 11 | 2462 | 11.84 | 13.00 |
| Mode | Channel | Frequency (MHz) | 6M | Tune-up Limit (dBm) |
| 802.11g | 1 | 2412 | 11.79 | 13.00 |
| | 6 | 2437 | 11.56 | 13.00 |
| | 11 | 2462 | 11.13 | 13.00 |
| Mode | Channel | Frequency (MHz) | 6.5M | Tune-up Limit (dBm) |
| 802.11n (HT20) | 1 | 2412 | 12.15 | 13.00 |
| | 6 | 2437 | 11.93 | 13.00 |
| | 11 | 2462 | 11.41 | 13.00 |
| Mode | Channel | Frequency (MHz) | 13.5M | Tune-up Limit (dBm) |
| 802.11n (HT40) | 3 | 2422 | 12.13 | 13.00 |
| | 6 | 2437 | 11.62 | 13.00 |
| | 9 | 2452 | 12.35 | 13.00 |
| Note: The Power provided by customers | | | | |

| Wi-Fi 5G | Channel | Frequency (MHz) | Average Conducted Power (dBm) Data Rate (bps) | Tune-up Limit (dBm) |
|---|---|---|---|---|
| Mode | | | 6M | |
| 802.11a | 36 | 5180 | 9.40 | 10.00 |
| | 40 | 5200 | 9.41 | 10.00 |
| | 44 | 5220 | 9.43 | 10.00 |
| | 48 | 5240 | 9.30 | 10.00 |
| | 52 | 5260 | 9.17 | 10.00 |
| | 56 | 5280 | 8.71 | 10.00 |

| | | | | |
|---|---|---|---|---|
| | 60 | 5300 | 8.72 | 10.00 |
| | 64 | 5320 | 8.59 | 10.00 |
| | 100 | 5500 | 8.48 | 10.00 |
| | 116 | 5580 | 9.46 | 10.00 |
| | 132 | 5660 | 9.32 | 10.00 |
| | 140 | 5700 | 9.35 | 10.00 |
| | 149 | 5745 | 8.31 | 10.00 |
| | 157 | 5785 | 8.53 | 10.00 |
| | 165 | 5825 | 8.87 | 10.00 |
| Mode | Channel | Frequency (MHz) | MCS0 | Tune-up Limit (dBm) |
| 802.11n (HT20) | 36 | 5180 | 9.05 | 10.00 |
| | 40 | 5200 | 9.11 | 10.00 |
| | 44 | 5220 | 9.18 | 10.00 |
| | 48 | 5240 | 9.11 | 10.00 |
| | 52 | 5260 | 8.84 | 10.00 |
| | 56 | 5280 | 8.44 | 10.00 |
| | 60 | 5300 | 8.48 | 10.00 |
| | 64 | 5320 | 8.33 | 10.00 |
| | 100 | 5500 | 8.27 | 10.00 |
| | 116 | 5580 | 9.33 | 10.00 |
| | 132 | 5660 | 9.21 | 10.00 |
| | 140 | 5700 | 9.15 | 10.00 |
| | 149 | 5745 | 9.68 | 10.00 |
| | 157 | 5785 | 8.85 | 10.00 |
| | 165 | 5825 | 8.64 | 10.00 |
| Mode | Channel | Frequency (MHz) | MCS0 | Tune-up Limit (dBm) |
| 802.11n (HT40) | 38 | 5190 | 9.50 | 10.00 |
| | 46 | 5230 | 9.32 | 10.00 |
| | 54 | 5270 | 8.80 | 10.00 |
| | 62 | 5310 | 8.74 | 10.00 |
| | 102 | 5510 | 8.24 | 10.00 |
| | 110 | 5550 | 9.31 | 10.00 |
| | 118 | 5590 | 9.36 | 10.00 |
| | 134 | 5670 | 9.67 | 10.00 |
| | 151 | 5755 | 9.44 | 10.00 |
| | 159 | 5795 | 9.09 | 10.00 |

| Mode | Channel | Frequency (MHz) | MCS0 | Tune-up Limit (dBm) |
|---|---|---|---|---|
| 802.11ac (HT20) | 36 | 5180 | 9.03 | 10.00 |
| | 40 | 5200 | 9.12 | 10.00 |
| | 44 | 5220 | 9.17 | 10.00 |
| | 48 | 5240 | 9.10 | 10.00 |
| | 52 | 5260 | 8.82 | 10.00 |
| | 56 | 5280 | 8.41 | 10.00 |
| | 60 | 5300 | 8.45 | 10.00 |
| | 64 | 5320 | 8.35 | 10.00 |
| | 100 | 5500 | 8.23 | 10.00 |
| | 116 | 5580 | 9.30 | 10.00 |
| | 132 | 5660 | 9.14 | 10.00 |
| | 140 | 5700 | 9.08 | 10.00 |
| | 149 | 5745 | 9.53 | 10.00 |
| | 157 | 5785 | 8.57 | 10.00 |
| | 165 | 5825 | 8.46 | 10.00 |
| Mode | Channel | Frequency (MHz) | MCS0 | Tune-up Limit (dBm) |
| 802.11ac (HT40) | 38 | 5190 | 9.11 | 10.00 |
| | 46 | 5230 | 9.02 | 10.00 |
| | 54 | 5270 | 8.37 | 10.00 |
| | 62 | 5310 | 8.58 | 10.00 |
| | 102 | 5510 | 8.27 | 10.00 |
| | 110 | 5550 | 9.18 | 10.00 |
| | 118 | 5590 | 9.32 | 10.00 |
| | 134 | 5670 | 9.31 | 10.00 |
| | 151 | 5755 | 9.24 | 10.00 |
| | 159 | 5795 | 8.77 | 10.00 |
| Mode | Channel | Frequency (MHz) | MCS0 | Tune-up Limit (dBm) |
| 802.11ac (HT80) | 42 | 5210 | 9.22 | 10.00 |
| | 58 | 5290 | 8.20 | 10.00 |
| | 106 | 5530 | 9.15 | 10.00 |
| | 122 | 5610 | 9.87 | 10.00 |
| | 155 | 5775 | 9.66 | 10.00 |
| Note. The Power provided by customers | | | | |

## 9.2 Bluetooth Mode

| BT | Conducted Power(dBm) | | | Tune-up Limit (dBm) |
|---|---|---|---|---|
| | Channel/Frequency(MHz) | | | |
| | Ch 0/2402 MHz | Ch 39/2441 MHz | Ch 78/2480 MHz | |
| GFSK | 8.99 | 9.00 | 8.48 | 9.50 |
| π/4DQPSK | 8.30 | 8.35 | 7.82 | 9.50 |
| 8DPSK | 7.36 | 7.37 | 6.78 | 8.50 |
| **BLE** | **Ch 0/2402 MHz** | **Ch 19/2440 MHz** | **Ch 39/2480 MHz** | **Tune-up Limit (dBm)** |
| GFSK | -2.66 | -2.55 | -2.42 | -1.00 |

# 10 Measured and Reported (Scaled) SAR Results

## 10.1 EUT Antenna Locations

**The Antenna Locations diagram is detailed in *SAR Test Setup and Antenna Locations FCC.***

| Overall (Length x Width x High ): 137mm x 140mm x 50mm | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Distance of the Antenna to the EUT surface | | | | | | | | |
| Antenna | Back Side (Close) | Back Side (Open Outside) | Back Side (Open Inside) | Front Side | Left Side | Right Side | Top Side | Bottom Side |
| BT/Wi-Fi Antenna | ＜25mm | ＞25mm | ＜25mm | ＜25mm | ＞25mm | ＜25mm | ＜25mm | ＜25mm |
| Positions for SAR tests | | | | | | | | |
| BT/Wi-Fi Antenna | Yes | N/A | Yes | Yes | N/A | Yes | Yes | Yes |

Note: 1. Per FCC KDB Publication 447498 D01, if the reported (scaled) SAR measured at the middle channel or highest output power channel for each test configuration is ≤ 0.8 W/kg (for 1g SAR) or ≤ 2 W/kg (for 10g SAR) then testing at the other channels is not required for such test configuration(s).
2. When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.

## 10.2 Standalone SAR test exclusion considerations

Per KDB 447498 D01, 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

- 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

Per KDB 447498 D01, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Mode | Distance (mm) | MAX Power (dBm) | Frequency (MHz) | Ratio | Evaluation |
|---|---|---|---|---|---|
| Bluetooth | 5 | 9.50 | 2480 | 2.81 | No |

## 10.3 Measured SAR Results

**Table 1: Wi-Fi (2.4G)**

| Test Position | Cover Type | Channel/ Frequency (MHz) | Mode 802.11b | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Area Scan Max.SAR (W/Kg) | Measured $SAR_{1g}$ (W/kg) | Scaling Factor | Reported $SAR_{1g}$ (W/kg) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Head SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.024 | 0.238 | 0.256 | 1.08 | 0.277 | / |
| Back Side (Open Inside) | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.000 | 0.001 | 0.001 | 1.08 | 0.001 | / |
| Front Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | -0.023 | 0.433 | 0.424 | 1.08 | 0.460 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.035 | 0.495 | 0.547 | 1.08 | 0.593 | 9 |
| Top Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.025 | 0.039 | 0.041 | 1.08 | 0.044 | / |
| Bottom Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.029 | 0.015 | 0.010 | 1.08 | 0.011 | / |
| **Body SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.032 | 0.222 | 0.238 | 1.08 | 0.258 | / |
| Back Side (Open Inside) | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.011 | 0.001 | 0.001 | 1.08 | 0.001 | / |
| Front Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | -0.009 | 0.395 | 0.387 | 1.08 | 0.419 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.042 | 0.450 | 0.496 | 1.08 | 0.538 | 10 |
| Top Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.033 | 0.046 | 0.047 | 1.08 | 0.051 | / |
| Bottom Side | standard | 1/2412 | DSSS | 99.12% | 13.00 | 12.65 | 0.037 | 0.024 | 0.020 | 1.08 | 0.022 | / |

Note: 1. The value with blue color is the maximum SAR Value of each test band.

2. Initial test configuration is 802.11b mode, since the highest maximum output power.

| MAX Adjusted SAR | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mode | Test Position | Channel/ Frequency(MHz) | MAX Reported $SAR_{1g}$ (W/kg) | 802.11b Tune-up limit (dBm) | Tune-up limit (dBm) | Scaling Factor | Adjusted $SAR_{1g}$ (W/kg) |
| 802.11g | Right Side | 1/2412 | 0.593 | 13.00 | 13.00 | 1.00 | 0.593 |
| 802.11n HT20 | Right Side | 1/2412 | 0.593 | 13.00 | 13.00 | 1.00 | 0.593 |
| 802.11n HT40 | Right Side | 1/2412 | 0.593 | 13.00 | 13.00 | 1.00 | 0.593 |
| Note: SAR is not required for other modes when the highest reported SAR for initial test configuration is adjusted by the ratio of specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg. | | | | | | | |

**Table 2: Wi-Fi (5G, U-NII-1)**

Per 248227, for band U-NII-1 and U-NII-2A, when the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, each band is tested independently for SAR.

| Test Position | Cover Type | Channel/ Frequency (MHz) | Mode 802.11n HT40 | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Area Scan Max.SAR (W/Kg) | Measured $SAR_{1g}$ (W/kg) | Scaling Factor | Reported $SAR_{1g}$ (W/kg) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Head SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.032 | 0.028 | 0.029 | 1.24 | 0.035 | / |
| Back Side (Open Inside) | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.000 | 0.002 | 0.004 | 1.24 | 0.005 | / |
| Front Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.013 | 0.771 | 0.835 | 1.24 | 1.033 | 11 |
| | | 46/5230 | OFDM | 90.68% | 10.00 | 9.32 | 0.071 | 0.644 | 0.716 | 1.29 | 0.923 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | -0.053 | 0.431 | 0.583 | 1.24 | 0.722 | / |
| Top Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.118 | 0.119 | 0.107 | 1.24 | 0.132 | / |
| Bottom Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.066 | 0.014 | 0.014 | 1.24 | 0.017 | / |
| Front Side | Repeated | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | -0.060 | 0.766 | 0.820 | 1.24 | 1.015 | / |
| **Body SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.025 | 0.036 | 0.037 | 1.24 | 0.045 | / |
| Back Side (Open Inside) | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.000 | 0.001 | 0.002 | 1.24 | 0.002 | / |
| Front Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.058 | 0.732 | 0.784 | 1.24 | 0.970 | 12 |
| | | 46/5230 | OFDM | 90.68% | 10.00 | 9.32 | -0.040 | 0.628 | 0.711 | 1.29 | 0.917 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.008 | 0.502 | 0.520 | 1.24 | 0.643 | / |
| Top Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | -0.105 | 0.116 | 0.105 | 1.24 | 0.130 | / |
| Bottom Side | standard | 38/5190 | OFDM | 90.68% | 10.00 | 9.50 | 0.127 | 0.024 | 0.024 | 1.24 | 0.029 | / |

Note: 1. The value with blue color is the maximum SAR Value of each test band.

2. Initial test configuration is 802.11n HT40 mode, since the highest maximum output power.

| Measurement Variability | | | | |
|---|---|---|---|---|
| **Test Position** | **Channel/ Frequency(MHz)** | **MAX Measured $SAR_{1g}$ (W/kg)** | **1st Repeated $SAR_{1g}$ (W/kg)** | **Ratio** |
| Front Side | 38/5190 | 0.835 | 0.820 | 1.02 |
| Note: 1) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit). | | | | |

**Table 3: Wi-Fi (5G, U-NII-2C)**

| Test Position | Cover Type | Channel/ Frequency (MHz) | Mode 802.11n HT40 | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Area Scan Max.SAR (W/Kg) | Measured $SAR_{1g}$ (W/kg) | Scaling Factor | Reported $SAR_{1g}$ (W/kg) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Head SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | -0.062 | 0.043 | 0.029 | 1.19 | 0.034 | / |
| Back Side (Open Inside) | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.000 | 0.002 | 0.003 | 1.19 | 0.004 | / |
| Front Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.031 | 1.180 | 0.907 | 1.19 | 1.079 | 13 |
| | | 118/5590 | OFDM | 90.68% | 10.00 | 9.36 | 0.024 | 0.977 | 0.816 | 1.28 | 1.043 | / |
| | | 102/5510 | OFDM | 90.68% | 10.00 | 8.24 | -0.008 | 0.812 | 0.650 | 1.65 | 1.075 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | -0.044 | 0.729 | 0.624 | 1.19 | 0.742 | / |
| Top Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.021 | 0.040 | 0.066 | 1.19 | 0.079 | / |
| Bottom Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.060 | 0.013 | 0.026 | 1.19 | 0.031 | / |
| Front Side | Repeated | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.020 | 1.060 | 0.886 | 1.19 | 1.054 | / |
| **Body SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | -0.031 | 0.044 | 0.033 | 1.19 | 0.039 | / |
| Back Side (Open Inside) | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.000 | 0.001 | 0.001 | 1.19 | 0.002 | / |
| Front Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.049 | 0.726 | 0.830 | 1.19 | 0.987 | 14 |
| | | 118/5590 | OFDM | 90.68% | 10.00 | 9.36 | -0.005 | 0.603 | 0.712 | 1.28 | 0.910 | / |
| | | 102/5510 | OFDM | 90.68% | 10.00 | 8.24 | 0.090 | 0.570 | 0.562 | 1.65 | 0.929 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.032 | 0.586 | 0.503 | 1.19 | 0.598 | / |
| Top Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.097 | 0.042 | 0.062 | 1.19 | 0.074 | / |
| Bottom Side | standard | 134/5670 | OFDM | 90.68% | 10.00 | 9.67 | 0.057 | 0.020 | 0.031 | 1.19 | 0.037 | / |

Note: 1. The value with blue color is the maximum SAR Value of each test band.

2. Initial test configuration is 802.11n HT40 mode, since the highest maximum output power.

| Measurement Variability | | | | |
|---|---|---|---|---|
| Test Position | Channel/ Frequency(MHz) | MAX Measured $SAR_{1g}$ (W/kg) | 1st Repeated $SAR_{1g}$ (W/kg) | Ratio |
| Front Side | 134/5670 | 0.907 | 0.886 | 1.02 |
| Note: 1) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit). | | | | |

**Table 4: Wi-Fi (5G, U-NII-3)**

| Test Position | Cover Type | Channel/ Frequency (MHz) | Mode 802.11n HT20 | Duty Cycle | Tune-up limit (dBm) | Conducted Power (dBm) | Drift (dB) | Area Scan Max.SAR (W/Kg) | Measured $SAR_{1g}$ (W/kg) | Scaling Factor | Reported $SAR_{1g}$ (W/kg) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Head SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.032 | 0.049 | 0.043 | 1.15 | 0.050 | / |
| Back Side (Open Inside) | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.000 | 0.002 | 0.002 | 1.15 | 0.003 | / |
| Front Side | standard | 165/5825 | OFDM | 93.46% | 10.00 | 8.64 | -0.055 | 0.506 | 0.670 | 1.46 | 0.981 | / |
| | | 157/5785 | OFDM | 93.46% | 10.00 | 8.85 | 0.009 | 0.548 | 0.704 | 1.39 | 0.982 | / |
| | | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.077 | 0.601 | 0.859 | 1.15 | 0.989 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 165/5825 | OFDM | 93.46% | 10.00 | 8.64 | 0.063 | 0.501 | 0.610 | 1.46 | 0.893 | / |
| | | 1575785 | OFDM | 93.46% | 10.00 | 8.85 | 0.108 | 0.530 | 0.762 | 1.39 | 1.063 | / |
| | | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | -0.163 | 0.679 | 0.925 | 1.15 | 1.065 | 15 |
| Top Side | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.171 | 0.122 | 0.112 | 1.15 | 0.129 | / |
| Bottom Side | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.001 | 0.008 | 0.024 | 1.15 | 0.028 | / |
| Right Side | Repeated | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.014 | 0.677 | 0.903 | 1.15 | 1.040 | / |
| **Body SAR (Distance 0mm)** | | | | | | | | | | | | |
| Back Side (Close) | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.010 | 0.053 | 0.048 | 1.15 | 0.056 | / |
| Back Side (Open Inside) | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.000 | 0.001 | 0.001 | 1.15 | 0.001 | / |
| Front Side | standard | 165/5825 | OFDM | 93.46% | 10.00 | 8.64 | 0.044 | 0.541 | 0.550 | 1.46 | 0.805 | / |
| | | 1575785 | OFDM | 93.46% | 10.00 | 8.85 | 0.030 | 0.610 | 0.624 | 1.39 | 0.870 | / |
| | | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.010 | 0.743 | 0.758 | 1.15 | 0.873 | / |
| Left Side | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Right Side | standard | 165/5825 | OFDM | 93.46% | 10.00 | 8.64 | 0.095 | 0.533 | 0.540 | 1.46 | 0.790 | / |
| | | 1575785 | OFDM | 93.46% | 10.00 | 8.85 | -0.067 | 0.650 | 0.672 | 1.39 | 0.937 | / |
| | | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | -0.046 | 0.707 | 0.816 | 1.15 | 0.940 | 16 |
| Top Side | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | 0.118 | 0.117 | 0.108 | 1.15 | 0.125 | / |
| Bottom Side | standard | 149/5745 | OFDM | 93.46% | 10.00 | 9.68 | -0.036 | 0.018 | 0.032 | 1.15 | 0.037 | / |

Note: 1. The value with blue color is the maximum SAR Value of each test band.

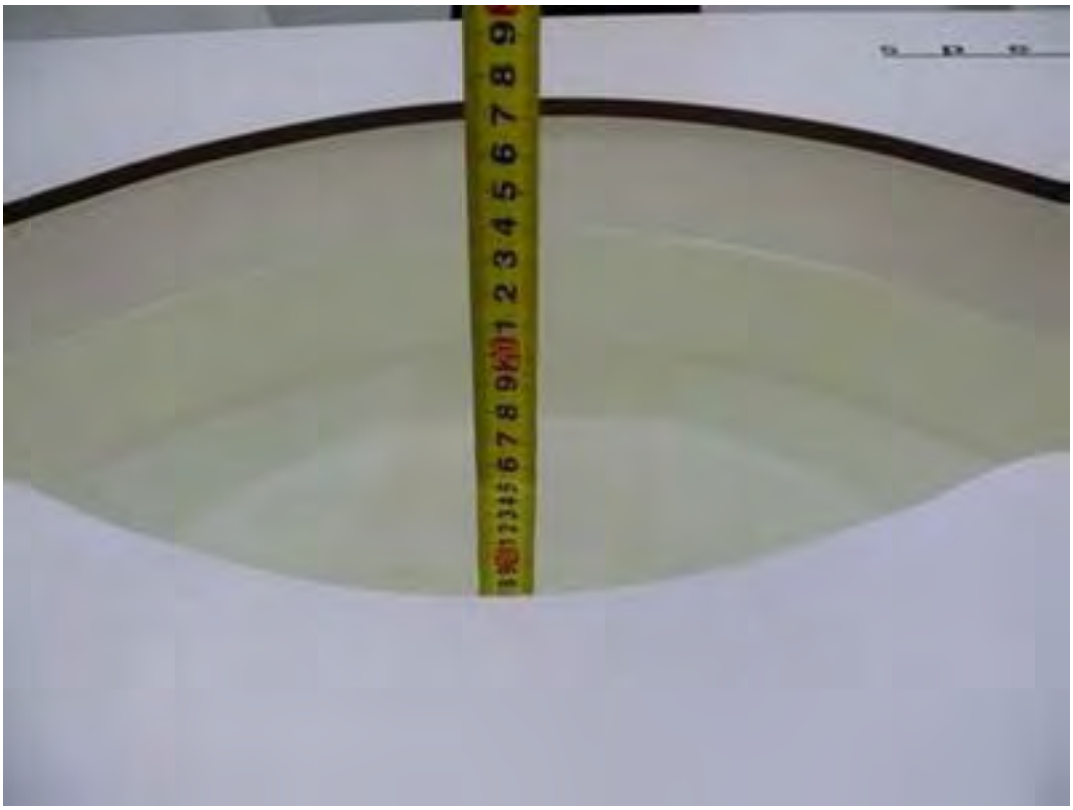
2. Initial test configuration is 802.11n HT20 mode, since the highest maximum output power.

| Measurement Variability | | | | |
|---|---|---|---|---|
| **Test Position** | **Channel/ Frequency(MHz)** | **MAX Measured $SAR_{1g}$ (W/kg)** | **1st Repeated $SAR_{1g}$ (W/kg)** | **Ratio** |
| Right Side | 149/5745 | 0.925 | 0.903 | 1.02 |
| Note: 1) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit). | | | | |

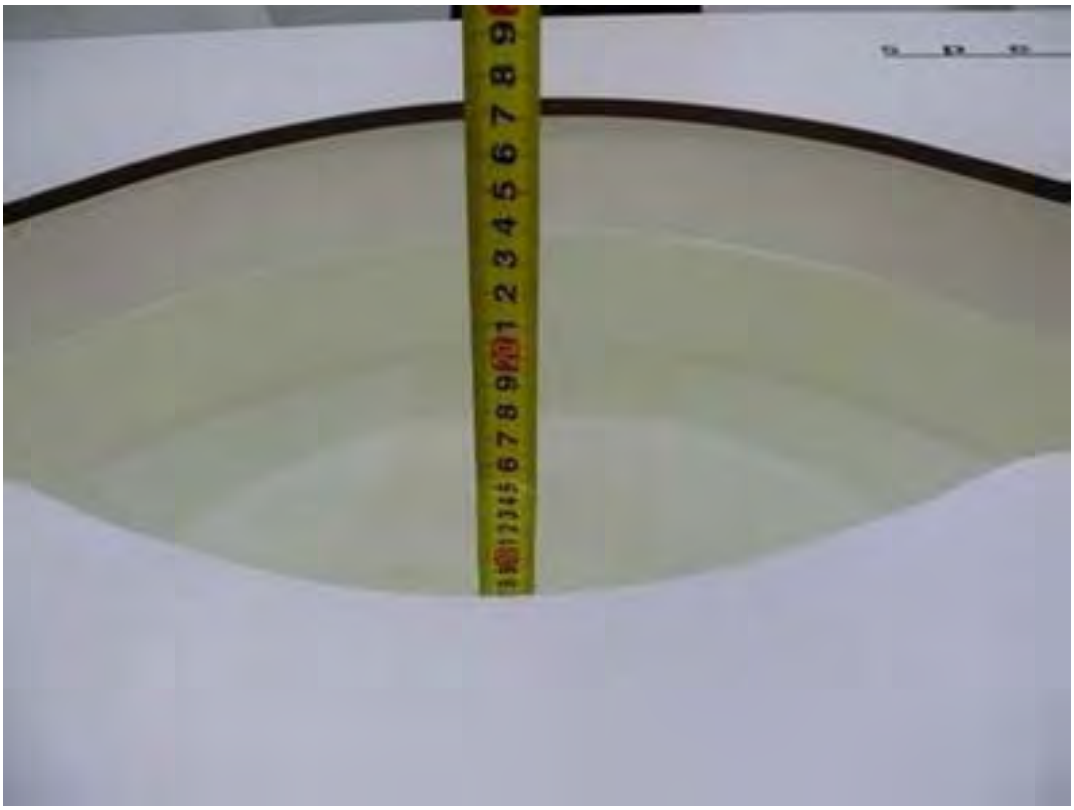
# 11 Measurement Uncertainty

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, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528- 2013 is not required in SAR reports submitted for equipment approval.

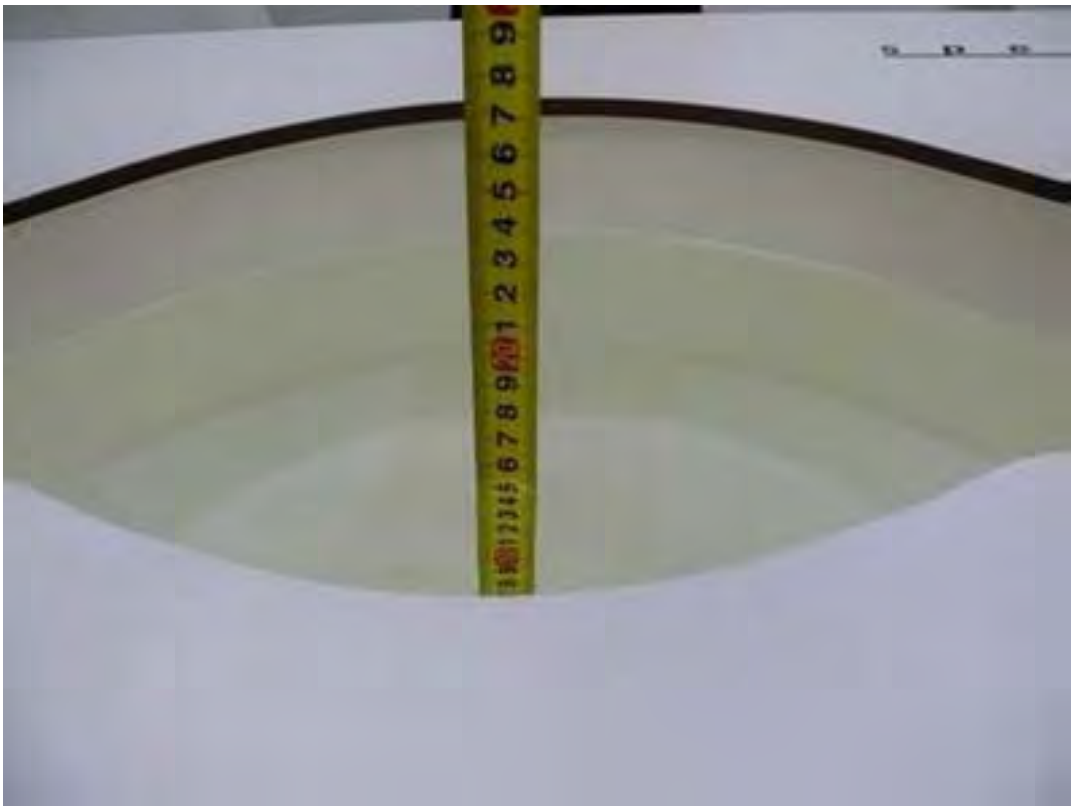
# ANNEX A: Test Layout



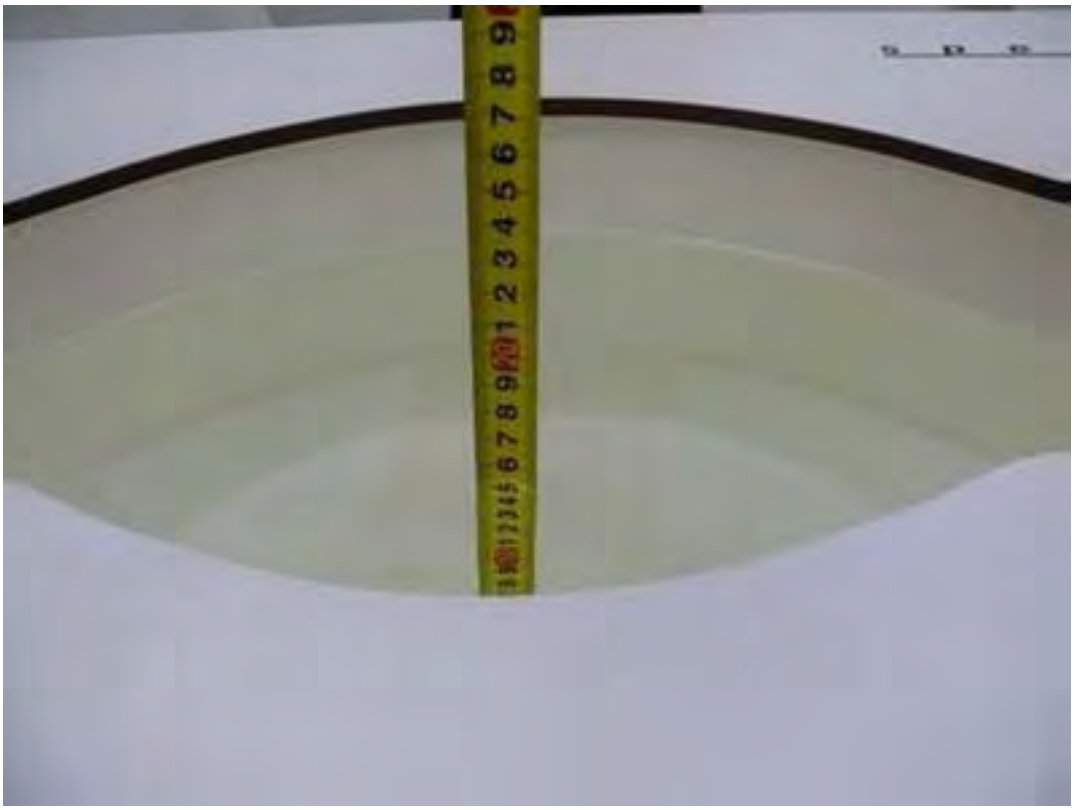
Picture 3: Liquid depth in the flat Phantom (2450 MHz, 15.3cm depth)



Picture 4: Liquid depth in the flat Phantom (5250 MHz, 15.3cm depth)



Picture 5: Liquid depth in the flat Phantom (5600 MHz, 15.3cm depth)



Picture 6: Liquid depth in the flat Phantom (5750 MHz, 15.0cm depth)

# ANNEX B: System Check Results

## Plot 1 System Performance Check at 2450 MHz Head TSL

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786**

Date: 1/12/2018

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; $\sigma$ = 1.81 mho/m; $\varepsilon_r$ = 38.6; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.90, 7.90, 7.90); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (41x71x1):** Measurement grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 18.2 mW/g

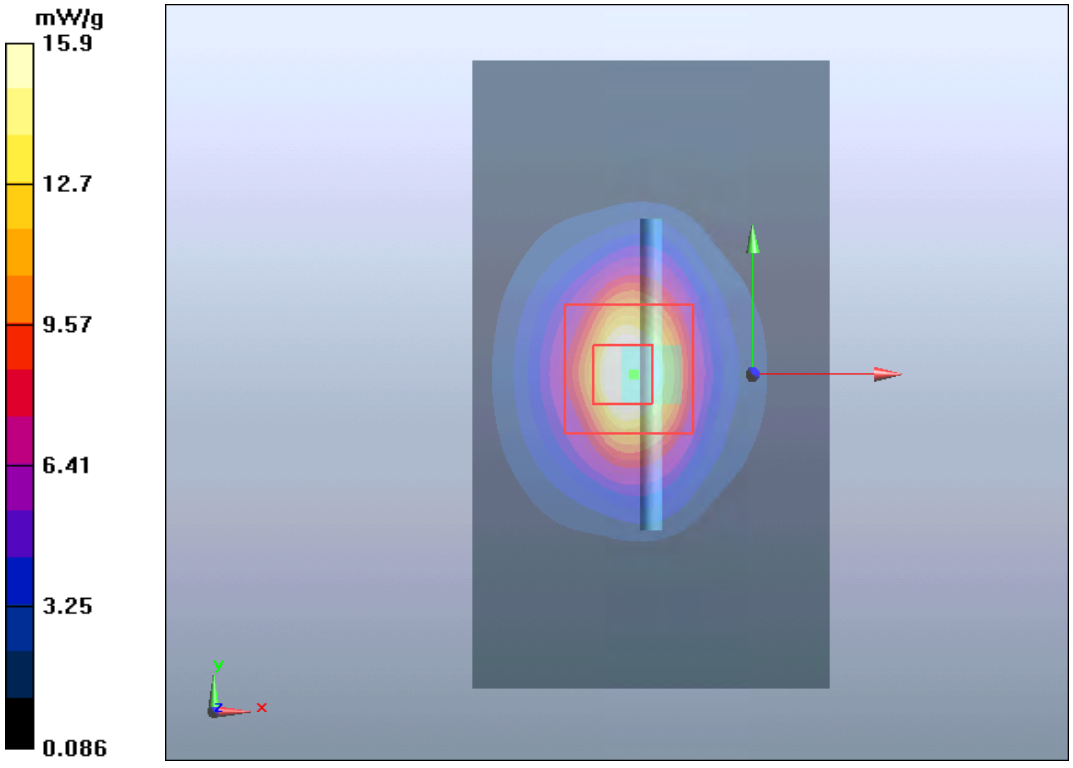
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.8 V/m; Power Drift = 0.075 dB

Peak SAR (extrapolated) = 30 W/kg

**SAR(1 g) = 13.7 mW/g; SAR(10 g) = 6.22 mW/g**

Maximum value of SAR (measured) = 15.9 mW/g



## Plot 2 System Performance Check at 2450 MHz Body TSL

**DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 786**

Date: 1/31/2018

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; $\sigma$ = 1.98 mho/m; $\varepsilon_r$ = 52.5; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(7.85, 7.85, 7.85); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (41x71x1):** Measurement grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 16 mW/g

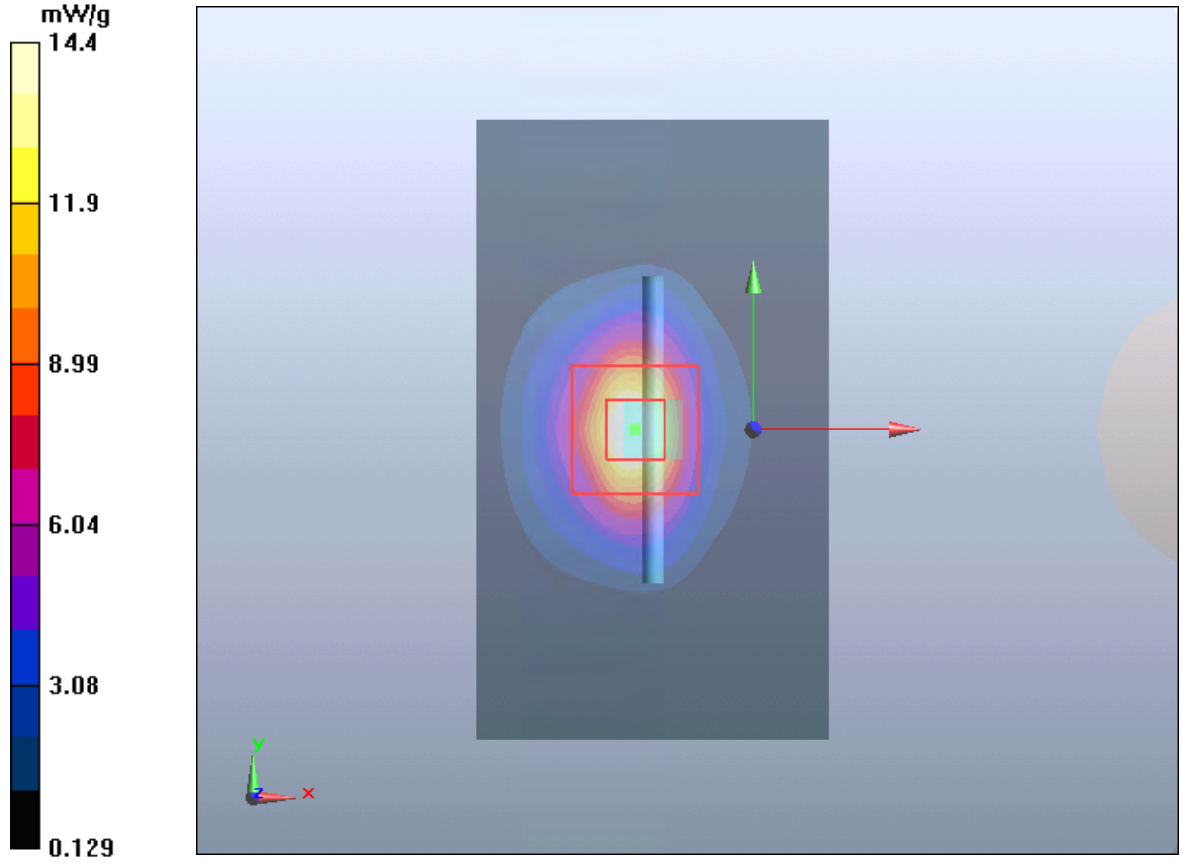
**d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 81.2 V/m; Power Drift = 0.003 dB

Peak SAR (extrapolated) = 25.4 W/kg

**SAR(1 g) = 12.5 mW/g; SAR(10 g) = 6.20 mW/g**

Maximum value of SAR (measured) = 14.4 mW/g



## Plot 3 System Performance Check at 5250 MHz Head TSL

**DUT: Dipole 5250 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/27/2018

Communication System: CW; Frequency: 5250 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5200 MHz; $\sigma$ = 4.80 mho/m; $\varepsilon_r$ = 35.5; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.62, 5.62, 5.62); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=100mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 9.10 mW/g

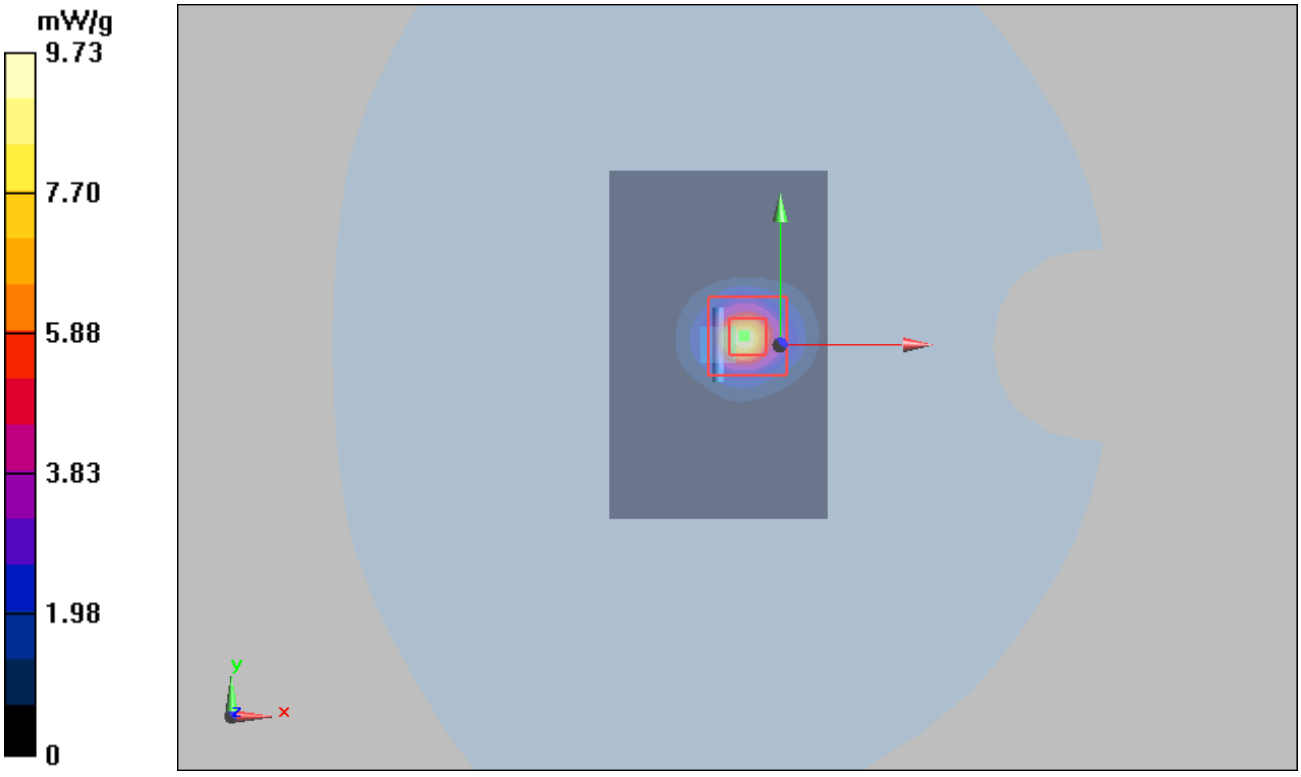
**d=10mm, Pin=100mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 33.6 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 52.2 W/kg

**SAR(1 g) = 7.76 mW/g; SAR(10 g) = 2.23 mW/g**

Maximum value of SAR (measured) = 9.73 mW/g



## Plot 4 System Performance Check at 5250 MHz Body TSL

**DUT: Dipole 5250 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/27/2018

Communication System: CW; Frequency: 5250 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5250 MHz; $\sigma$ = 5.32 mho/m; $\varepsilon_r$ = 48.1; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.13, 5.13, 5.13); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 7.69 mW/g

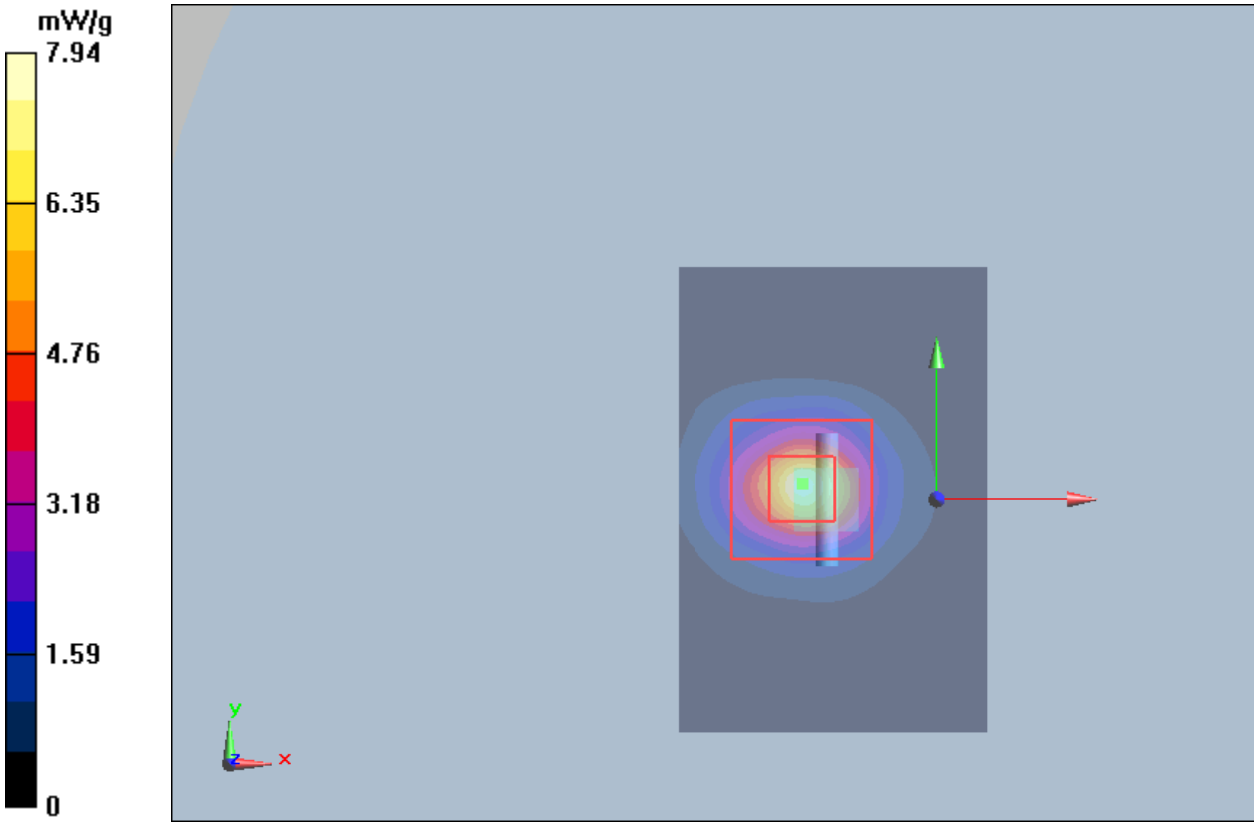
**d=10mm, Pin=250mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 36.3 V/m; Power Drift = 0.0277 dB

Peak SAR (extrapolated) = 47.7 W/kg

**SAR(1 g) = 7.46 mW/g; SAR(10 g) = 2.26 mW/g**

Maximum value of SAR (measured) = 7.94 mW/g



## Plot 5 System Performance Check at 5600 MHz Head TSL

**DUT: Dipole 5600 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/13/2018

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5600 MHz; $\sigma$ = 5.19 mho/m; $\varepsilon_r$ = 34.5; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.03, 5.03, 5.03); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=100mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 8.31 mW/g

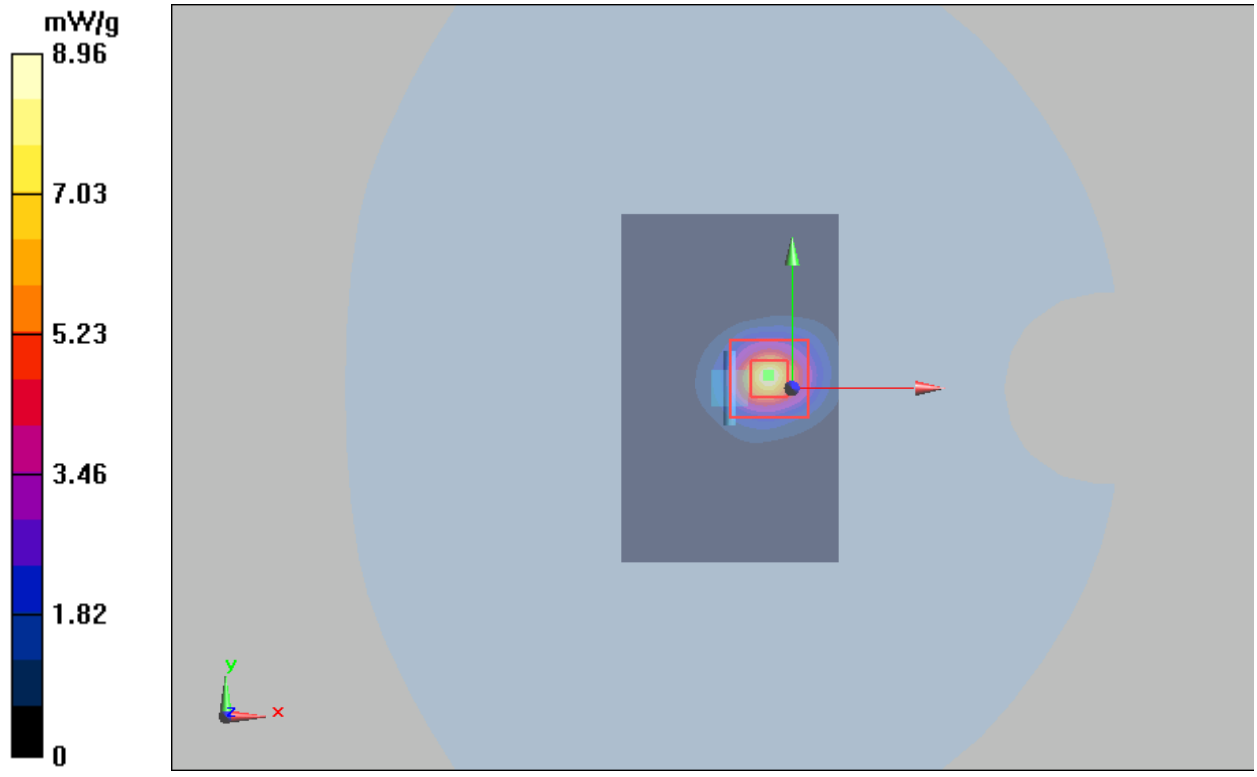
**d=10mm, Pin=100mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 23.1 V/m; Power Drift = 0.044 dB

Peak SAR (extrapolated) = 23.4 W/kg

**SAR(1 g) = 7.94 mW/g; SAR(10 g) = 2.29 mW/g**

Maximum value of SAR (measured) = 8.96 mW/g



## Plot 6 System Performance Check at 5600 MHz Body TSL

**DUT: Dipole 5600 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/27/2018

Communication System: CW; Frequency: 5600 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5600 MHz; $\sigma$ = 5.88 mho/m; $\varepsilon_r$ = 47.8; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(4.14, 4.14, 4.14); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 7.8 mW/g

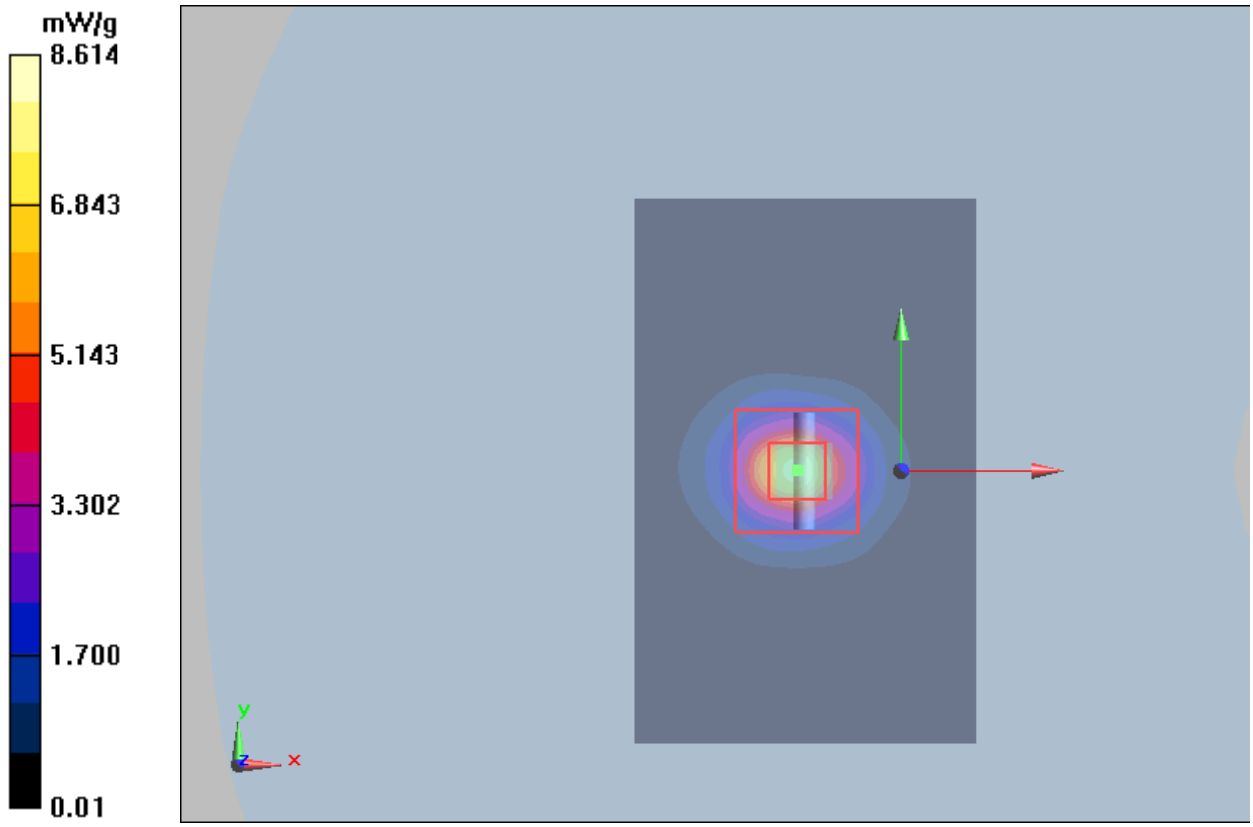
**d=10mm, Pin=250mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 38.12 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 22.67 W/kg

**SAR(1 g) = 8.04 mW/g; SAR(10 g) = 2.21 mW/g**

Maximum value of SAR (measured) = 8.614 mW/g



## Plot 7 System Performance Check at 5750 MHz Head TSL

**DUT: Dipole 5750 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/28/2018

Communication System: CW; Frequency: 5750 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5800 MHz; $\sigma$ = 5.28 mho/m; $\varepsilon_r$ = 35; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.18, 5.18, 5.18); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=100mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 8.25 mW/g

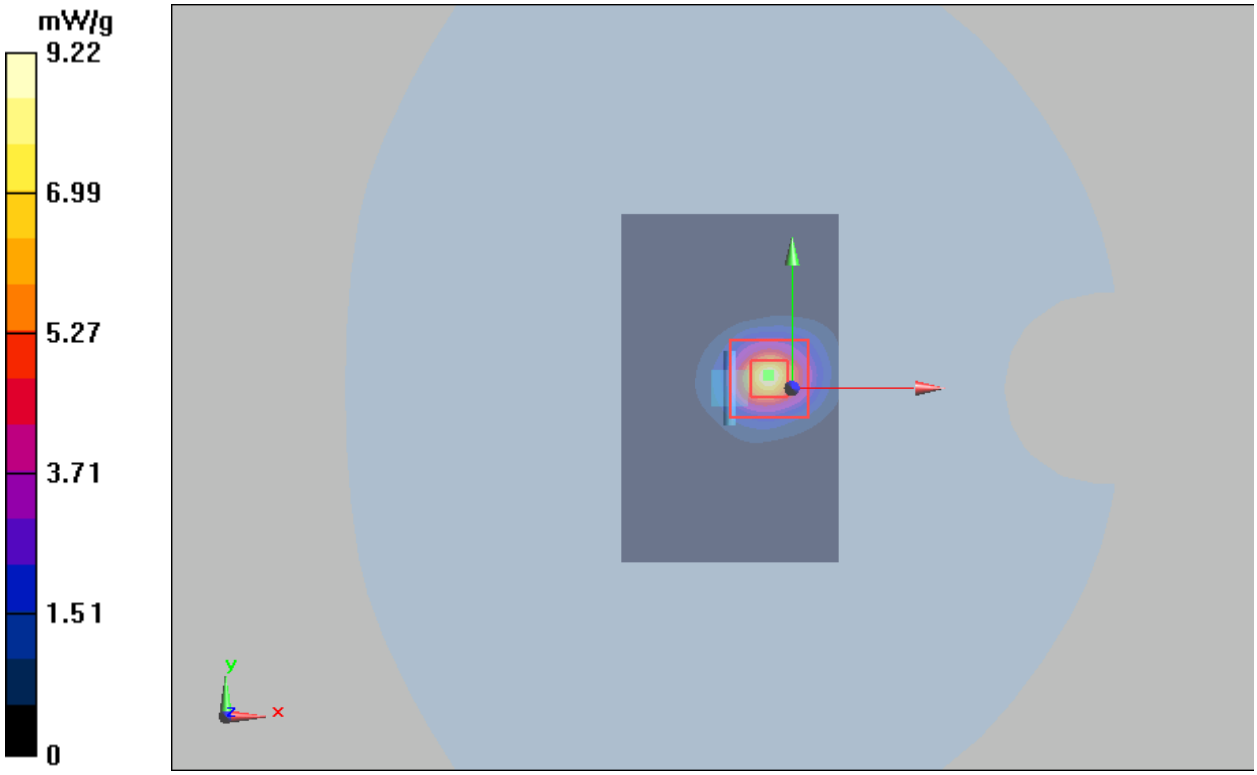
**d=10mm, Pin=100mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 23.1 V/m; Power Drift = -0.008 dB

Peak SAR (extrapolated) = 22.9 W/kg

**SAR(1 g) = 7.72 mW/g; SAR(10 g) = 2.13 mW/g**

Maximum value of SAR (measured) = 9.22 mW/g



## Plot 8 System Performance Check at 5750 MHz Body TSL

**DUT: Dipole 5750 MHz; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1151**

Date: 3/28/2018

Communication System: CW; Frequency: 5750 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5750 MHz; $\sigma$ = 6.14 mho/m; $\varepsilon_r$ = 47.6; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(4.50, 4.50, 4.50); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**d=10mm, Pin=250mW/Area Scan (61x101x1):** Measurement grid: dx=1.000mm, dy=1.000mm

Maximum value of SAR (interpolated) = 7.84 mW/g

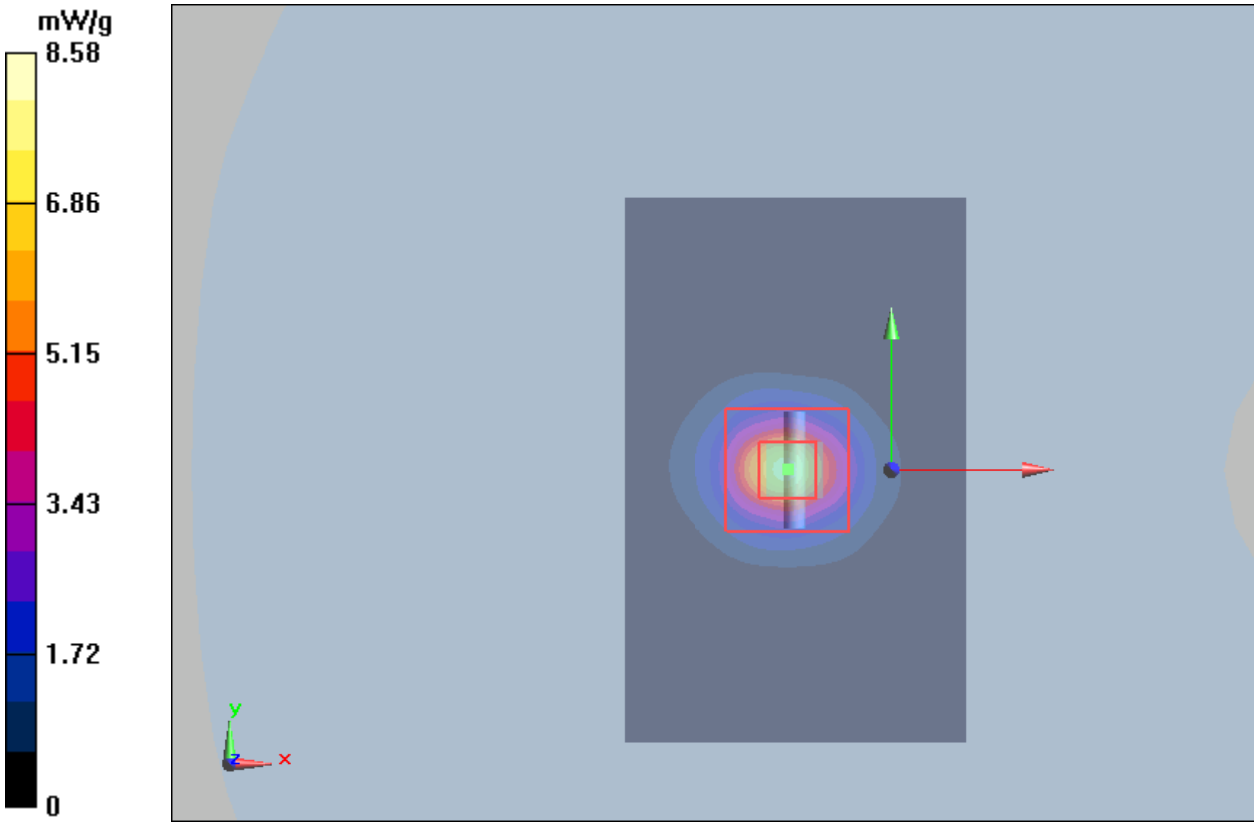
**d=10mm, Pin=250mW/Zoom Scan (7x7x12)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 38 V/m; Power Drift = -0.018 dB

Peak SAR (extrapolated) = 22.6 W/kg

**SAR(1 g) = 7.15 mW/g; SAR(10 g) = 1.99 mW/g**

Maximum value of SAR (measured) = 8.58 mW/g



# ANNEX C: Highest Graph Results

## Plot 9 802.11b Right Side Low (Head)

Date: 1/12/2018

Communication System: UID 0, 802.11b (0); Frequency: 2412 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2412 MHz; $\sigma$ = 1.801 S/m; $\varepsilon_r$ = 39.308; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3677; ConvF(7.90, 7.90, 7.90); Calibrated: 1/23/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Side Low/Area Scan (81x51x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.696 W/kg

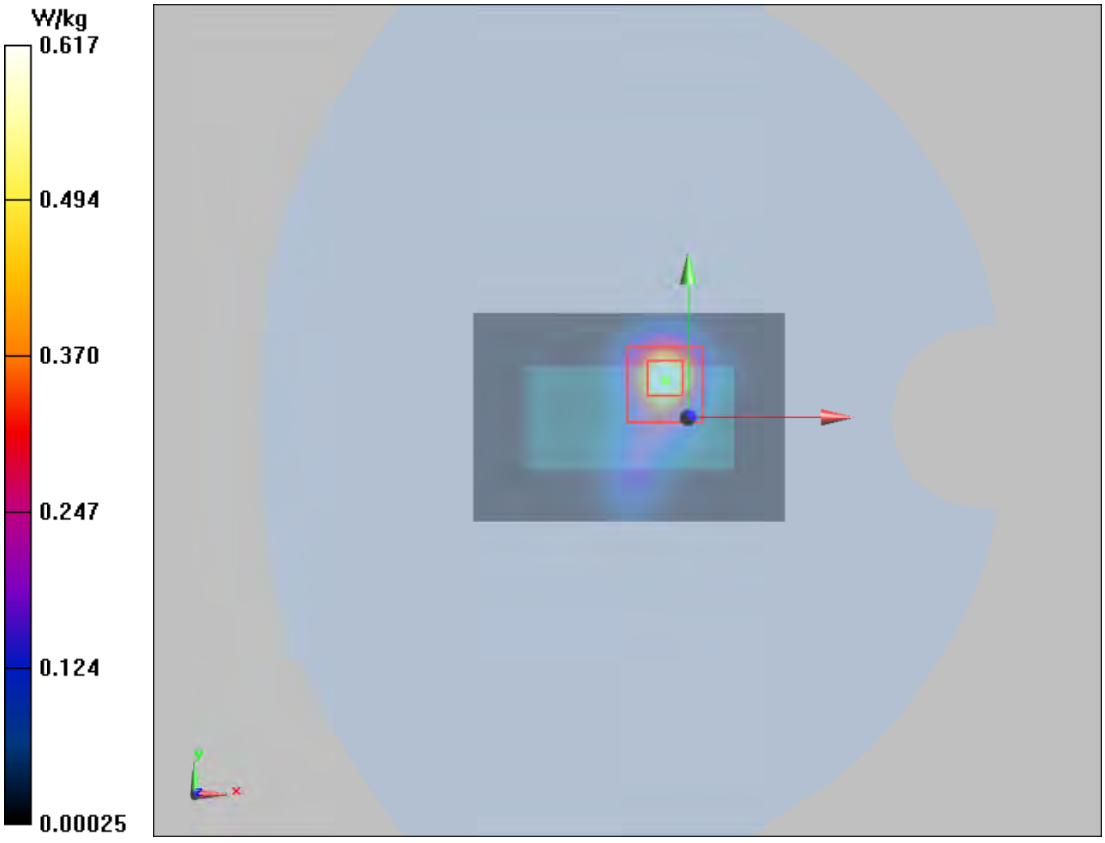
**Right Side Low/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 9.092 V/m; Power Drift = 0.035 dB

Peak SAR (extrapolated) = 1.57 W/kg

**SAR(1 g) = 0.547 W/kg; SAR(10 g) = 0.202 W/kg**

Maximum value of SAR (measured) = 0.617 W/kg



## Plot 10 802.11b Right Side Low (Body)

Date: 1/31/2018

Communication System: UID 0, 802.11b (0); Frequency: 2412 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2412 MHz; $\sigma$ = 1.902 S/m; $\varepsilon_r$ = 51.597; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(7.85, 7.85, 7.85); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Side Low/Area Scan (81x51x1):** Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.982 W/kg

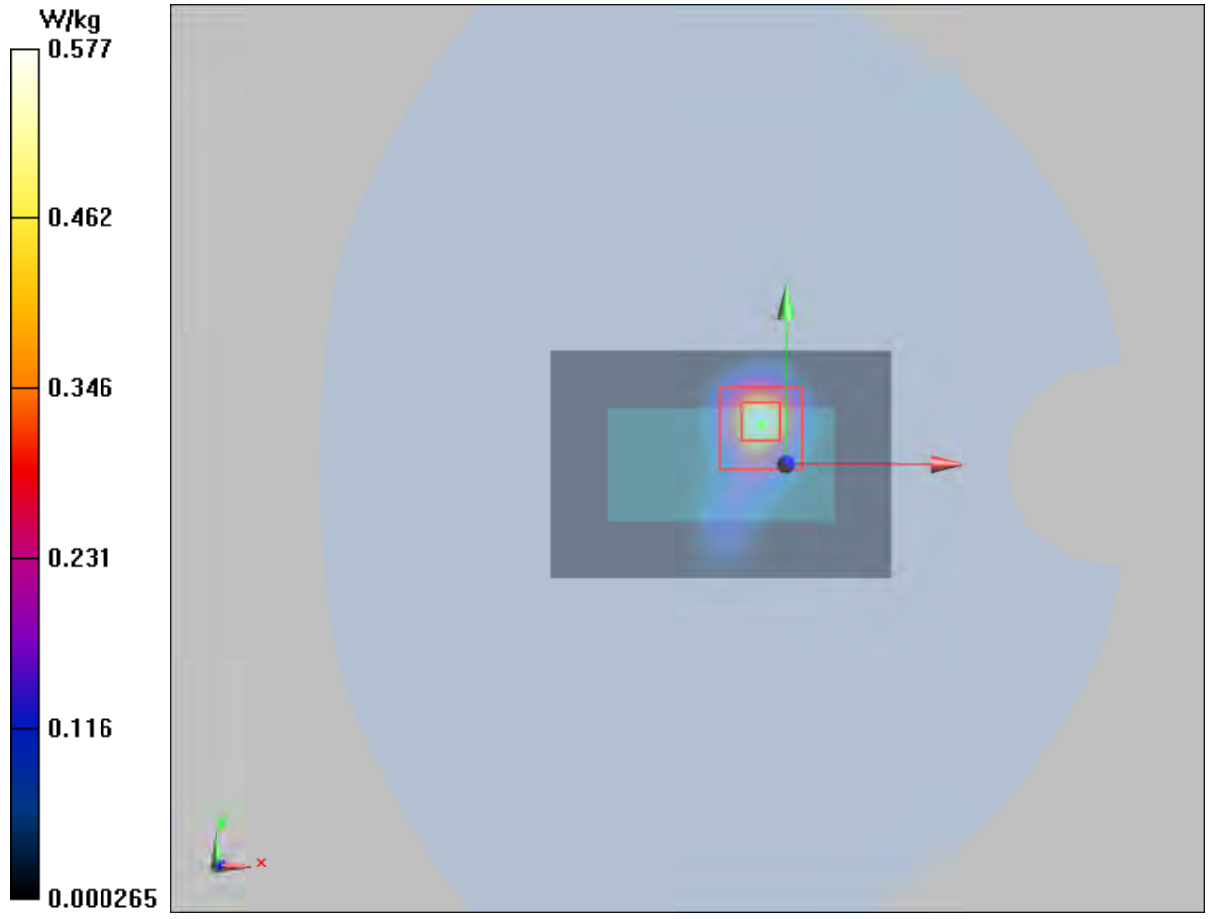
**Right Side Low/Zoom Scan (7x7x7)/Cube 0:** Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 8.674 V/m; Power Drift = 0.042 dB

Peak SAR (extrapolated) = 1.04 W/kg

**SAR(1 g) = 0.496 W/kg; SAR(10 g) = 0.205 W/kg**

Maximum value of SAR (measured) = 0.577 W/kg



## Plot 11 802.11n HT40 U-NII-1 Front Side CH38 (Head)

Date: 3/27/2018

Communication System: UID 0, 802.11n(40M) (0); Frequency: 5190 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5190 MHz; $\sigma$ = 4.677 S/m; $\varepsilon_r$ = 36.13; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.62, 5.62, 5.62); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Side Low/Area Scan (91x61x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.917 W/kg

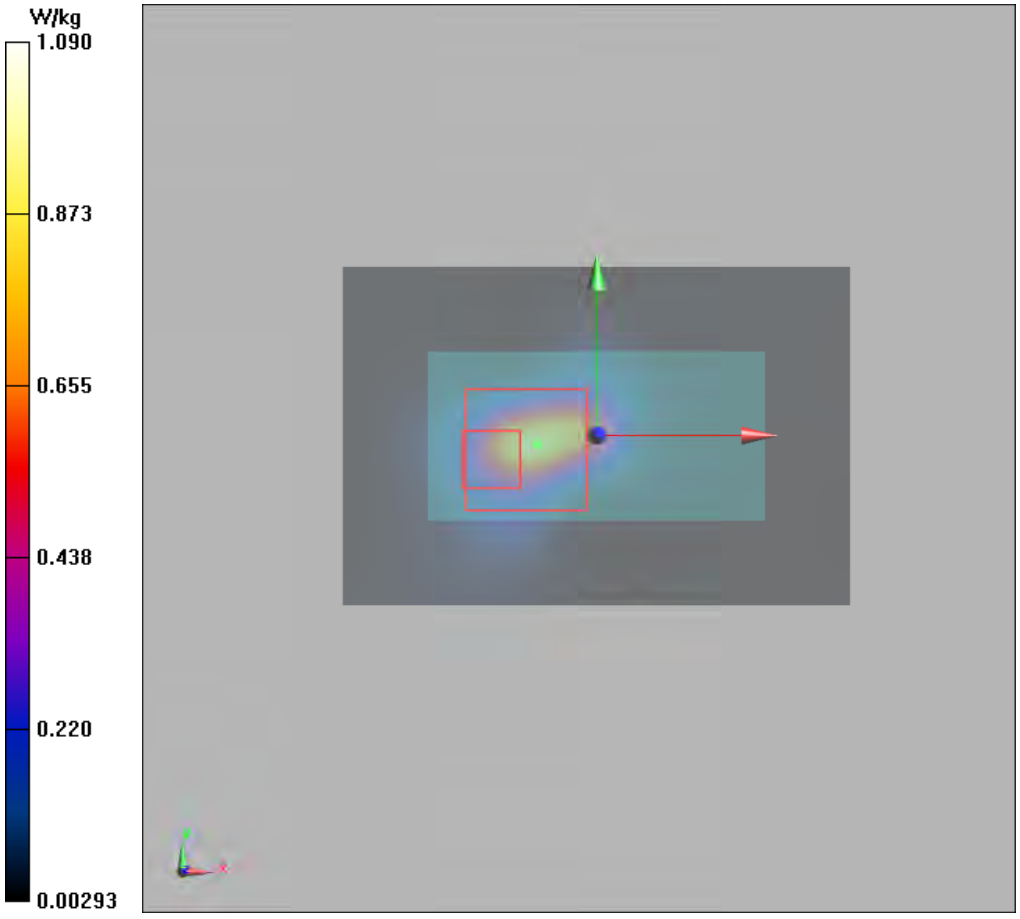
**Right Side Low/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 11.68 V/m; Power Drift = 0.013 dB

Peak SAR (extrapolated) = 4.87 W/kg

**SAR(1 g) = 0.835 W/kg; SAR(10 g) = 0.224 W/kg**

Maximum value of SAR (measured) = 1.09 W/kg



## Plot 12 802.11n HT40 U-NII-1 Front Side CH38 (Body)

Date: 3/27/2018

Communication System: UID 0, 802.11n(40M) (0); Frequency: 5190 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5190 MHz; $\sigma$ = 5.304 S/m; $\varepsilon_r$ = 48.069; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.13, 5.13, 5.13); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Front Side Low/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.901 W/kg

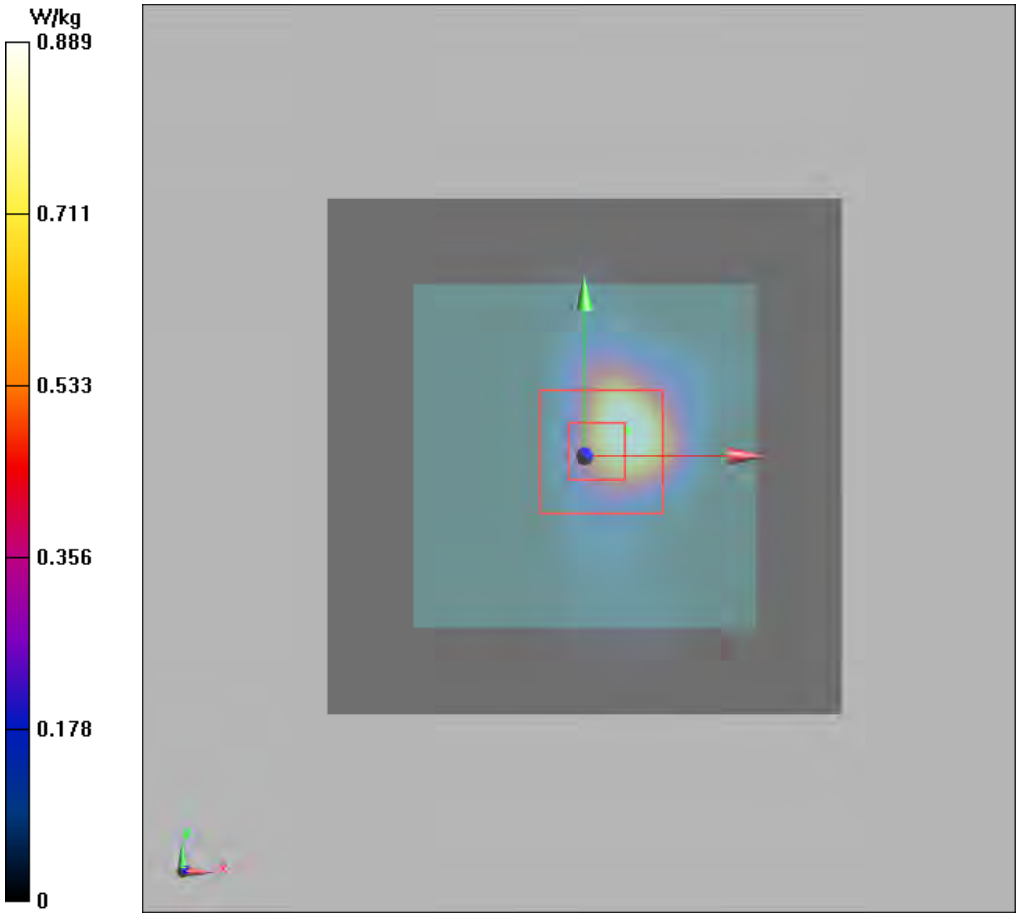
**Front Side Low/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 9.17 V/m; Power Drift = 0.058 dB

Peak SAR (extrapolated) = 2.11 W/kg

**SAR(1 g) = 0.784 W/kg; SAR(10 g) = 0.211 W/kg**

Maximum value of SAR (measured) = 0.889 W/kg



## Plot 13 802.11n HT40 U-NII-2C Front Side CH134 (Head)

Date: 3/13/2018

Communication System: UID 0, 802.11n(40M) (0); Frequency: 5670 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5670 MHz; $\sigma$ = 5.288 S/m; $\varepsilon_r$ = 34.873; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.03, 5.03, 5.03); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Front Side High/Area Scan (91x91x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.26 W/kg

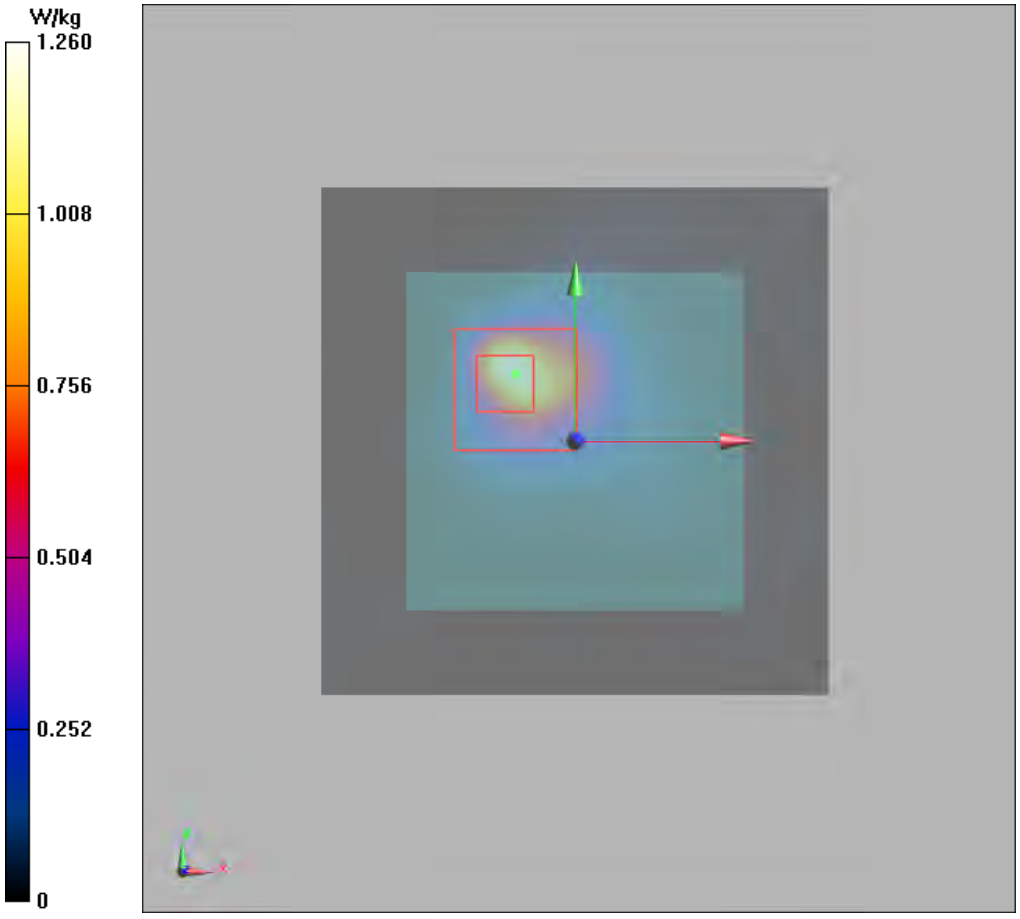
**Front Side High/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 7.560 V/m; Power Drift = 0.031 dB

Peak SAR (extrapolated) = 2.81 W/kg

**SAR(1 g) = 0.907 W/kg; SAR(10 g) = 0.254 W/kg**

Maximum value of SAR (measured) = 1.26 W/kg



## Plot 14 802.11n HT40 U-NII-2C Front Side CH134 (Body)

Date: 3/27/2018

Communication System: UID 0, 802.11n HT40 (0); Frequency: 5670 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5600 MHz; $\sigma$ = 5.957 S/m; $\varepsilon_r$ = 47.494; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(4.14, 4.14, 4.14); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Front Side High/Area Scan (91x61x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.892 W/kg

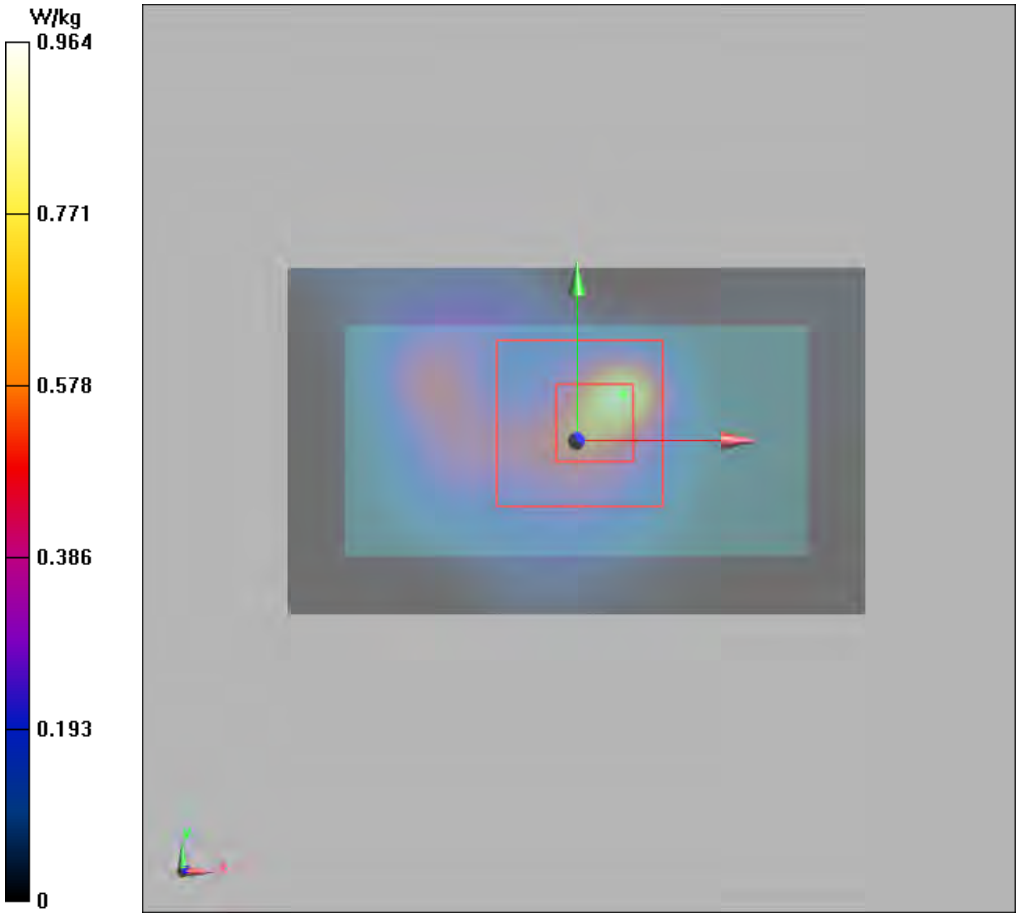
**Front Side High/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 16.20 V/m; Power Drift = 0.049 dB

Peak SAR (extrapolated) = 2.84 W/kg

**SAR(1 g) = 0.830 W/kg; SAR(10 g) = 0.271 W/kg**

Maximum value of SAR (measured) = 0.964 W/kg



## Plot 15 802.11n HT20 U-NII-3 Right Side CH149 (Head)

Date: 3/28/2018

Communication System: UID 0, 802.11n HT20 (0); Frequency: 5745 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5745 MHz; $\sigma$ = 5.385 S/m; $\varepsilon_r$ = 34.693; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(5.18, 5.18, 5.18); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM 2; Type: SAM;

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Side Low/Area Scan (91x61x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.14 W/kg

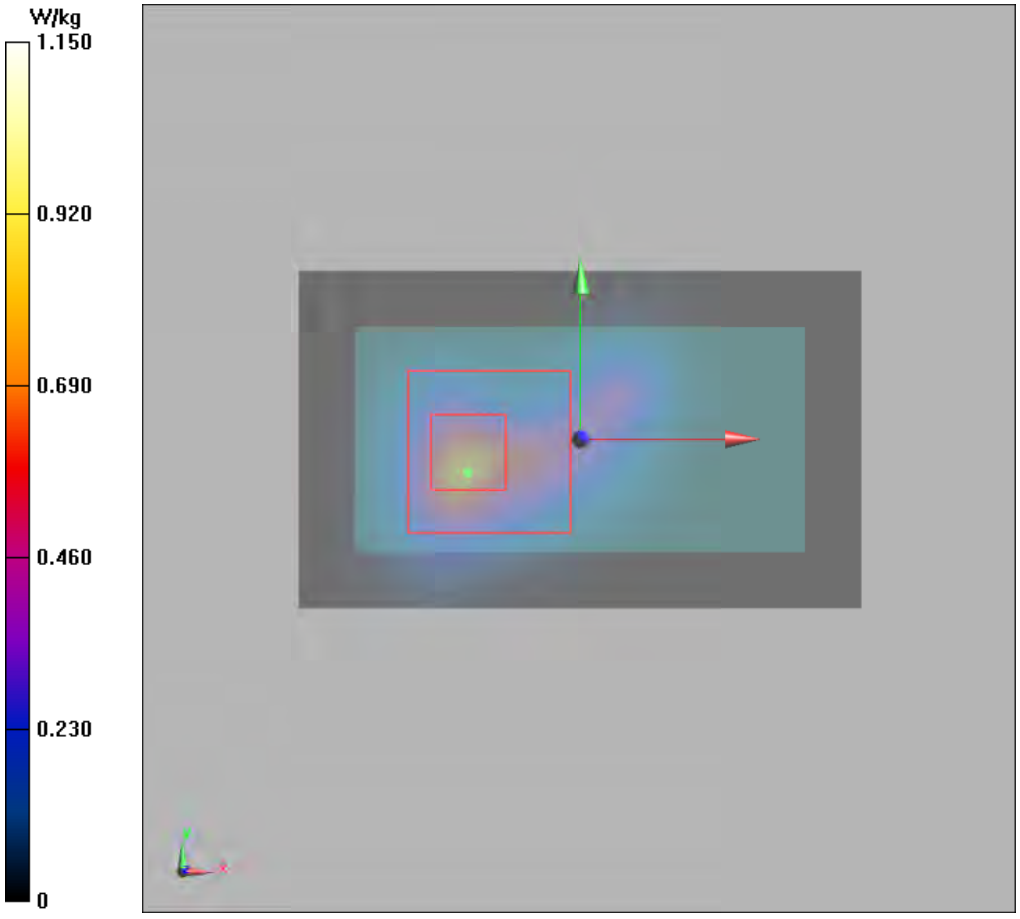
**Right Side Low/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 13.18 V/m; Power Drift = -0.163 dB

Peak SAR (extrapolated) = 3.24 W/kg

**SAR(1 g) = 0.925 W/kg; SAR(10 g) = 0.246 W/kg**

Maximum value of SAR (measured) = 1.15 W/kg



## Plot 16 802.11n HT20 U-NII-3 Right Side CH149 (Body)

Date: 3/28/2018

Communication System: UID 0, 802.11n HT20 (0); Frequency: 5745 MHz;Duty Cycle: 1:1

Medium parameters used: f = 5745 MHz; $\sigma$ = 6.06 S/m; $\varepsilon_r$ = 47.742; $\rho$ = 1000 kg/m$^3$

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN3898; ConvF(4.50, 4.50, 4.50); Calibrated: 6/27/2017;

Electronics: DAE4 Sn1291; Calibrated: 10/31/2017

Phantom: SAM1; Type: SAM; Serial: TP-1534

Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

**Right Side Low/Area Scan (91x61x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 0.966 W/kg

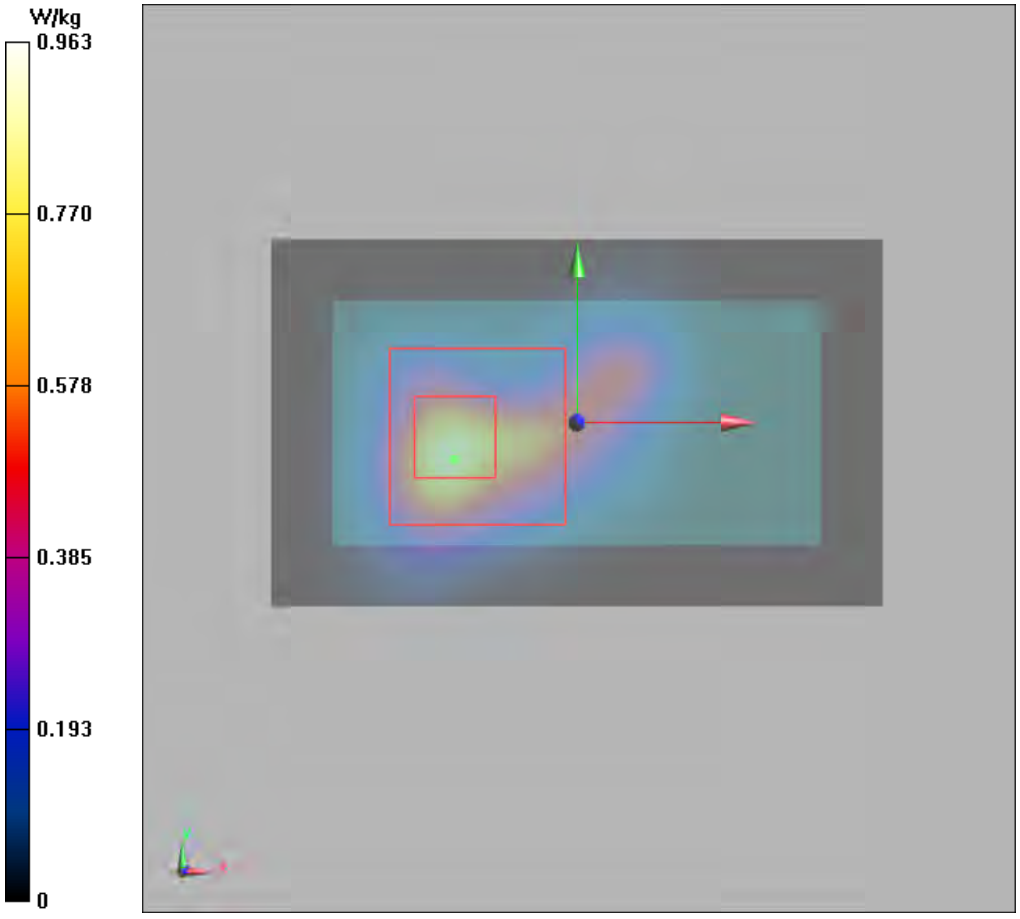
**Right Side Low/Zoom Scan (7x7x11)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 10.16 V/m; Power Drift = -0.046 dB

Peak SAR (extrapolated) = 3.11 W/kg

**SAR(1 g) = 0.816 W/kg; SAR(10 g) = 0.213 W/kg**

Maximum value of SAR (measured) = 0.963 W/kg



# ANNEX D: Probe Calibration Certificate (SN: 3677)

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国际互认
校准
CALIBRATION
CNAS L0570

Client TA(Shanghai) Certificate No: Z17-97012

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3677

Calibration Procedure(s) FD-Z11-004-01
Calibration Procedures for Dosimetric E-field Probes

Calibration date: January 23, 2017

This calibration Certificate documents the traceability to national standards, which realize the physical units of measurements(SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature(22±3)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date(Calibrated by, Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power Meter NRP2 | 101919 | 27-Jun-16 (CTTL, No.J16X04777) | Jun-17 |
| Power sensor NRP-Z91 | 101547 | 27-Jun-16 (CTTL, No.J16X04777) | Jun-17 |
| Power sensor NRP-Z91 | 101548 | 27-Jun-16 (CTTL, No.J16X04777) | Jun-17 |
| Reference10dBAttenuator | 18N50W-10dB | 13-Mar-16(CTTL,No.J16X01547) | Mar-18 |
| Reference20dBAttenuator | 18N50W-20dB | 13-Mar-16(CTTL, No.J16X01548) | Mar-18 |
| Reference Probe EX3DV4 | SN 7433 | 26-Sep-16(SPEAG,No.EX3-7433_Sep16) | Sep-17 |
| DAE4 | SN 549 | 13-Dec-16(SPEAG, No.DAE4-549_Dec16) | Dec -17 |
| **Secondary Standards** | **ID #** | **Cal Date(Calibrated by, Certificate No.)** | **Scheduled Calibration** |
| SignalGeneratorMG3700A | 6201052605 | 27-Jun-16 (CTTL, No.J16X04776) | Jun-17 |
| Network Analyzer E5071C | MY46110673 | 26-Jan-16 (CTTL, No.J16X00894) | Jan -17 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Yu Zongying | SAR Test Engineer | |
| Reviewed by: | Qi Dianyuan | SAR Project Leader | |
| Approved by: | Lu Bingsong | Deputy Director of the laboratory | |

Issued: January 24, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: Z17-97012 Page 1 of 11

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**Glossary:**

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A,B,C,D | modulation dependent linearization parameters |
| Polarization Φ | Φ rotation around probe axis |
| Polarization θ | θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i θ=0 is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

**Calibration is Performed According to the Following Standards:**

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300MHz to 3GHz)", February 2005

c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010

d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Methods Applied and Interpretation of Parameters:**

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect the $E^2$-field uncertainty inside TSL (see below ConvF).
- *NORM(f)x,y,z = NORMx,y,z* frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics.
- *Ax,y,z; Bx,y,z; Cx,y,z;VRx,y,z:*A,B,C are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx,y,z* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from±50MHz to±100MHz.
- *Spherical isotropy (3D deviation from isotropy):* in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset:* The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle:* The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

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# Probe EX3DV4

# SN: 3677

Calibrated: January 23, 2017

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm(μV/(V/m)$^2$)$^A$ | 0.39 | 0.44 | 0.38 | ±10.8% |
| DCP(mV)$^B$ | 97.3 | 102.2 | 101.1 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc$^E$ (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 180.5 | ±2.0% |
| | | Y | 0.0 | 0.0 | 1.0 | | 195.3 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 177.9 | |

The reported uncertainty of measurement is stated as the standard uncertainty of Measurement multiplied by the coverage factor k=2, which for a normal distribution Corresponds to a coverage probability of approximately 95%.

$^A$ The uncertainties of Norm X, Y, Z do not affect the $E^2$-field uncertainty inside TSL (see Page 5 and Page 6).
$^B$ Numerical linearization parameter: uncertainty not required.
$^E$ Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

## Calibration Parameter Determined in Head Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 9.58 | 9.58 | 9.58 | 0.30 | 0.75 | ±12% |
| 835 | 41.5 | 0.90 | 9.31 | 9.31 | 9.31 | 0.11 | 1.55 | ±12% |
| 1750 | 40.1 | 1.37 | 8.60 | 8.60 | 8.60 | 0.24 | 1.07 | ±12% |
| 1900 | 40.0 | 1.40 | 8.39 | 8.39 | 8.39 | 0.23 | 1.10 | ±12% |
| 2300 | 39.5 | 1.67 | 8.13 | 8.13 | 8.13 | 0.53 | 0.74 | ±12% |
| 2450 | 39.2 | 1.80 | 7.90 | 7.90 | 7.90 | 0.61 | 0.71 | ±12% |
| 2600 | 39.0 | 1.96 | 7.64 | 7.64 | 7.64 | 0.68 | 0.68 | ±12% |
| 5250 | 35.9 | 4.71 | 5.66 | 5.66 | 5.66 | 0.40 | 1.20 | ±13% |
| 5600 | 35.5 | 5.07 | 4.99 | 4.99 | 4.99 | 0.40 | 1.40 | ±13% |
| 5750 | 35.4 | 5.22 | 5.00 | 5.00 | 5.00 | 0.40 | 1.40 | ±13% |

[C] Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

## Calibration Parameter Determined in Body Tissue Simulating Media

| f [MHz][C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha[G] | Depth[G] (mm) | Unct. (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 9.99 | 9.99 | 9.99 | 0.30 | 0.95 | ±12% |
| 835 | 55.2 | 0.97 | 9.74 | 9.74 | 9.74 | 0.14 | 1.66 | ±12% |
| 1750 | 53.4 | 1.49 | 8.39 | 8.39 | 8.39 | 0.21 | 1.16 | ±12% |
| 1900 | 53.3 | 1.52 | 7.98 | 7.98 | 7.98 | 0.22 | 1.24 | ±12% |
| 2300 | 52.9 | 1.81 | 7.97 | 7.97 | 7.97 | 0.55 | 0.80 | ±12% |
| 2450 | 52.7 | 1.95 | 7.85 | 7.85 | 7.85 | 0.50 | 0.86 | ±12% |
| 2600 | 52.5 | 2.16 | 7.63 | 7.63 | 7.63 | 0.44 | 0.91 | ±12% |
| 5250 | 48.9 | 5.36 | 5.03 | 5.03 | 5.03 | 0.50 | 1.60 | ±13% |
| 5600 | 48.5 | 5.77 | 4.34 | 4.34 | 4.34 | 0.54 | 1.66 | ±13% |
| 5750 | 48.3 | 5.94 | 4.52 | 4.52 | 4.52 | 0.57 | 1.95 | ±13% |

[C] Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequency below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ±10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ±5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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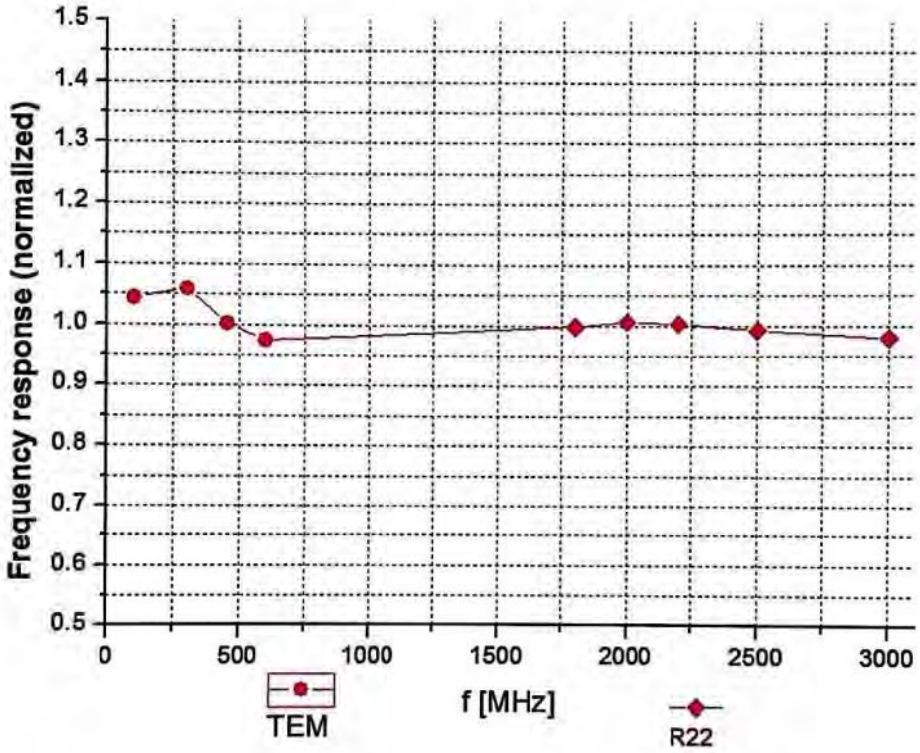
## Frequency Response of E-Field
## (TEM-Cell: ifi110 EXX, Waveguide: R22)




**Uncertainty of Frequency Response of E-field: ±7.5% (k=2)**

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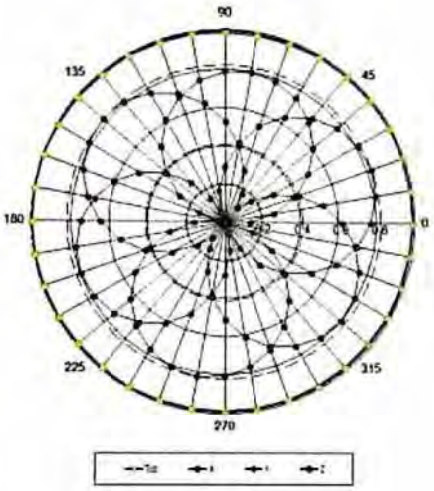
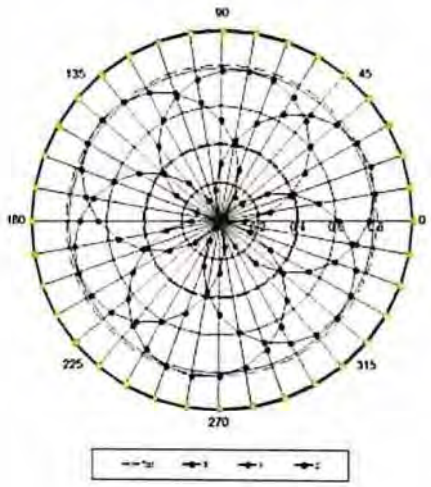
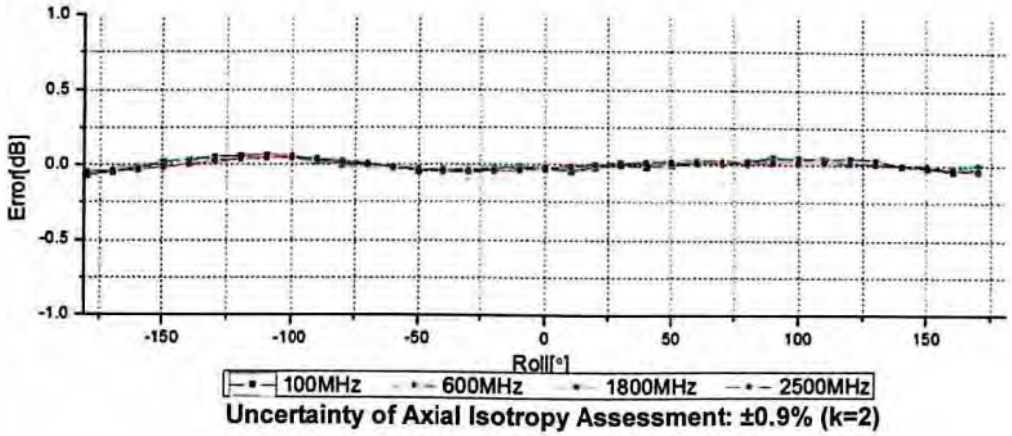
# Receiving Pattern (Φ), θ=0°

## f=600 MHz, TEM




## f=1800 MHz, R22




**Uncertainty of Axial Isotropy Assessment: ±0.9% (k=2)**

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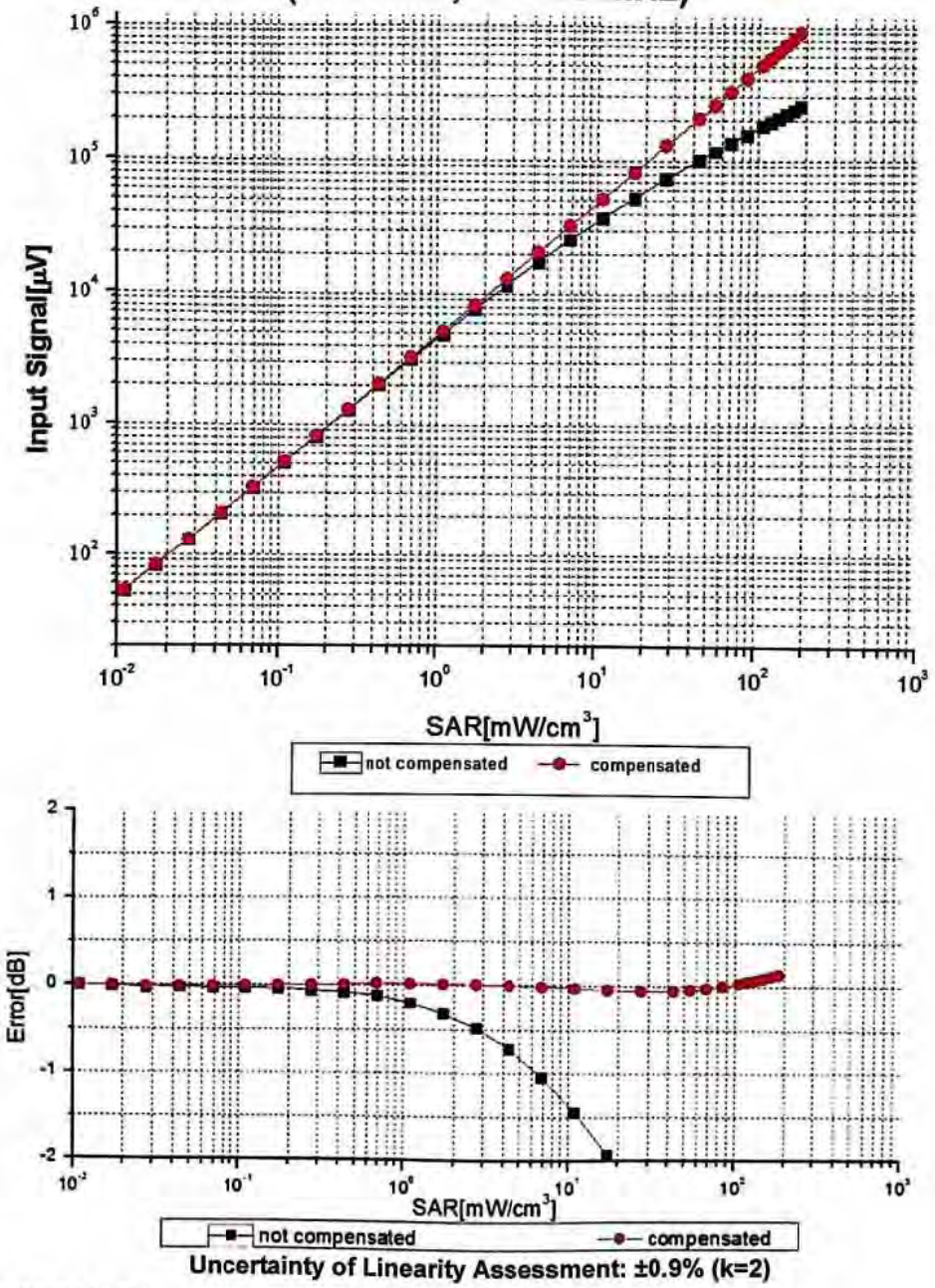
## Dynamic Range f($SAR_{head}$)
## (TEM cell, f = 900 MHz)




Uncertainty of Linearity Assessment: ±0.9% (k=2)

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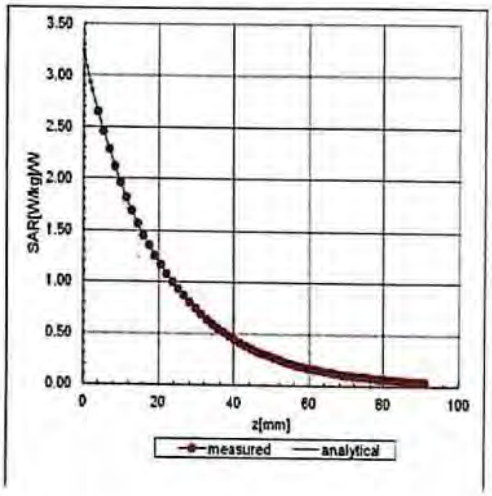
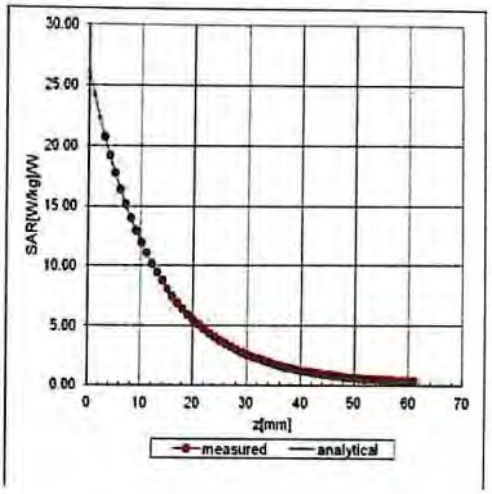
# Conversion Factor Assessment

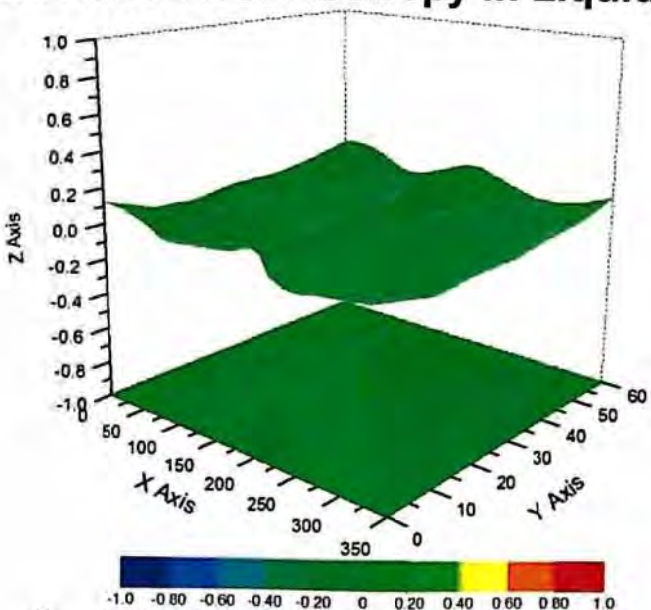
f=835 MHz, WGLS R9(H_convF)




f=1750 MHz, WGLS R22(H_convF)




# Deviation from Isotropy in Liquid




Uncertainty of Spherical Isotropy Assessment: ±2.8% (K=2)

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# DASY/EASY – Parameters of Probe: EX3DV4 – SN: 3677

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 117.9 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disable |
| Probe Overall Length | 337mm |
| Probe Body Diameter | 10mm |
| Tip Length | 9mm |
| Tip Diameter | 2.5mm |
| Probe Tip to Sensor X Calibration Point | 1mm |
| Probe Tip to Sensor Y Calibration Point | 1mm |
| Probe Tip to Sensor Z Calibration Point | 1mm |
| Recommended Measurement Distance from Surface | 1.4mm |

# ANNEX E: Probe Calibration Certificate (SN: 3898)

**Calibration Laboratory of**
Schmid & Partner
Engineering AG
**Zeughausstrasse 43, 8004 Zurich, Switzerland**

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
**The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates**

Accreditation No.: **SCS 0108**

Client **Auden** Certificate No: **EX3-3898_Jun17**

## CALIBRATION CERTIFICATE

Object EX3DV4 - SN:3898

Calibration procedure(s) QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6
Calibration procedure for dosimetric E-field probes

Calibration date: June 27, 2017

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 04-Apr-17 (No. 217-02521/02522) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-17 (No. 217-02521) | Apr-18 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-17 (No. 217-02525) | Apr-18 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 07-Apr-17 (No. 217-02528) | Apr-18 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-16 (No. ES3-3013_Dec16) | Dec-17 |
| DAE4 | SN: 660 | 7-Dec-16 (No. DAE4-660_Dec16) | Dec-17 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-16) | In house check: Jun-18 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-16) | In house check: Jun-18 |
| Network Analyzer HP 8753E | SN: US37390585 | 18-Oct-01 (in house check Oct-16) | In house check: Oct-17 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: June 28, 2017

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

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**Calibration Laboratory of**
Schmid & Partner
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Accreditation No.: **SCS 0108**

## Glossary:

| | |
|---|---|
| TSL | tissue simulating liquid |
| NORMx,y,z | sensitivity in free space |
| ConvF | sensitivity in TSL / NORMx,y,z |
| DCP | diode compression point |
| CF | crest factor (1/duty_cycle) of the RF signal |
| A, B, C, D | modulation dependent linearization parameters |
| Polarization φ | φ rotation around probe axis |
| Polarization ϑ | ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis |
| Connector Angle | information used in DASY system to align probe sensor X to the robot coordinate system |

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the $E^2$-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters*: Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

# Probe EX3DV4

## SN:3898

Manufactured: October 9, 2012
Calibrated: June 27, 2017

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

EX3DV4– SN:3898 June 27, 2017

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3898

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.38 | 0.35 | 0.31 | ± 10.1 % |
| DCP (mV)[B] | 99.1 | 99.4 | 100.3 | |

## Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 143.9 | ±2.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 142.2 | |
| | | Z | 0.0 | 0.0 | 1.0 | | 145.7 | |

Note: For details on UID parameters see Appendix.

## Sensor Model Parameters

| | C1 fF | C2 fF | α $V^{-1}$ | T1 $ms.V^{-2}$ | T2 $ms.V^{-1}$ | T3 ms | T4 $V^{-2}$ | T5 $V^{-1}$ | T6 |
|---|---|---|---|---|---|---|---|---|---|
| X | 32.49 | 240.5 | 35.09 | 11.03 | 0.713 | 4.958 | 1.269 | 0.147 | 1.005 |
| Y | 33.00 | 245.0 | 35.30 | 9.807 | 0.625 | 4.966 | 1.221 | 0.120 | 1.005 |
| Z | 31.60 | 235.2 | 35.43 | 7.345 | 0.706 | 4.969 | 1.116 | 0.151 | 1.005 |

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

EX3DV4– SN:3898 June 27, 2017

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3898

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 41.9 | 0.89 | 10.75 | 10.75 | 10.75 | 0.35 | 1.03 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 10.23 | 10.23 | 10.23 | 0.48 | 0.80 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 10.03 | 10.03 | 10.03 | 0.49 | 0.80 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 8.63 | 8.63 | 8.63 | 0.37 | 0.80 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.37 | 8.37 | 8.37 | 0.33 | 0.80 | ± 12.0 % |
| 2000 | 40.0 | 1.40 | 8.36 | 8.36 | 8.36 | 0.35 | 0.80 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.91 | 7.91 | 7.91 | 0.36 | 0.80 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.55 | 7.55 | 7.55 | 0.39 | 0.80 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 7.37 | 7.37 | 7.37 | 0.38 | 0.86 | ± 12.0 % |
| 3500 | 37.9 | 2.91 | 7.31 | 7.31 | 7.31 | 0.25 | 1.25 | ± 13.1 % |
| 5250 | 35.9 | 4.71 | 5.62 | 5.62 | 5.62 | 0.35 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 5.03 | 5.03 | 5.03 | 0.40 | 1.80 | ± 13.1 % |
| 5750 | 35.4 | 5.22 | 5.18 | 5.18 | 5.18 | 0.40 | 1.80 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

EX3DV4– SN:3898 June 27, 2017

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3898

## Calibration Parameter Determined in Body Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 750 | 55.5 | 0.96 | 10.45 | 10.45 | 10.45 | 0.52 | 0.82 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 10.40 | 10.40 | 10.40 | 0.49 | 0.80 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 10.32 | 10.32 | 10.32 | 0.47 | 0.80 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 8.50 | 8.50 | 8.50 | 0.39 | 0.80 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 8.17 | 8.17 | 8.17 | 0.35 | 0.84 | ± 12.0 % |
| 2000 | 53.3 | 1.52 | 8.35 | 8.35 | 8.35 | 0.44 | 0.80 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 7.95 | 7.95 | 7.95 | 0.41 | 0.80 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.85 | 7.85 | 7.85 | 0.32 | 0.95 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 7.51 | 7.51 | 7.51 | 0.26 | 0.95 | ± 12.0 % |
| 3500 | 51.3 | 3.31 | 6.97 | 6.97 | 6.97 | 0.28 | 1.25 | ± 13.1 % |
| 5250 | 48.9 | 5.36 | 5.13 | 5.13 | 5.13 | 0.40 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 4.14 | 4.14 | 4.14 | 0.50 | 1.90 | ± 13.1 % |
| 5750 | 48.3 | 5.94 | 4.50 | 4.50 | 4.50 | 0.50 | 1.90 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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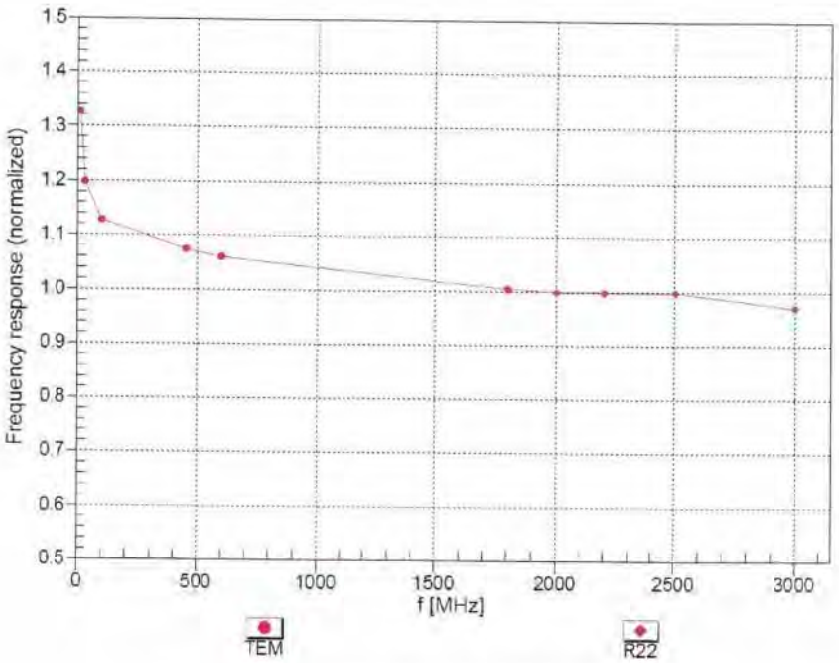
June 27, 2017

## Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)




Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

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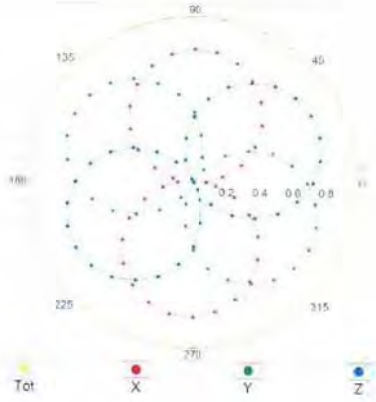
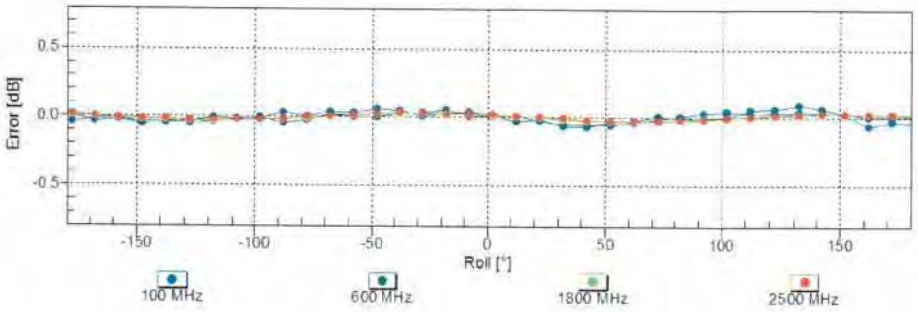
## Receiving Pattern ($\phi$), $\vartheta$ = 0°

f=600 MHz,TEM




f=1800 MHz,R22


**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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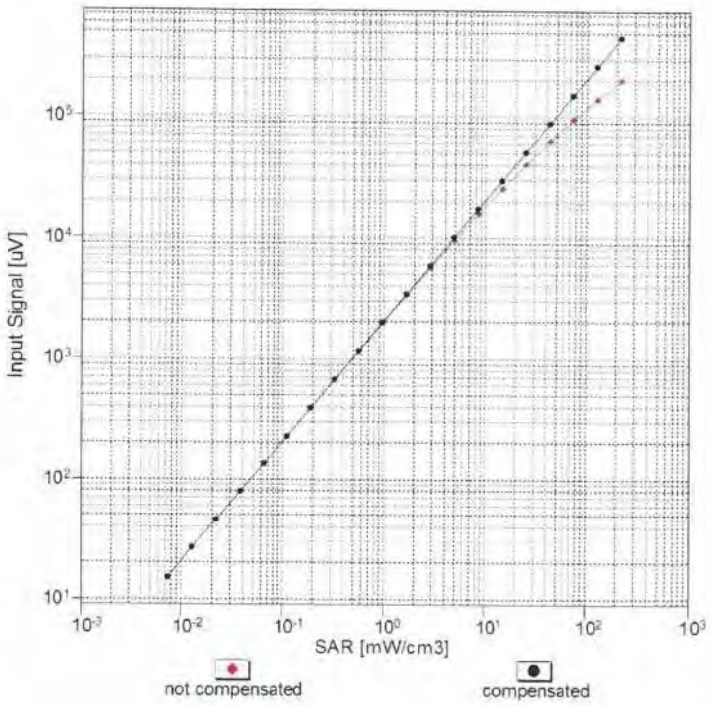
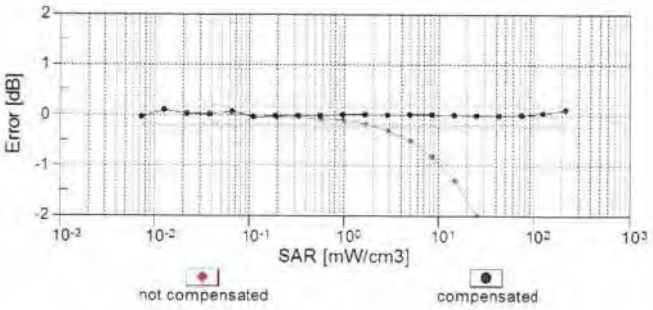
## Dynamic Range f($SAR_{head}$)
(TEM cell , $f_{eval}$= 1900 MHz)




**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

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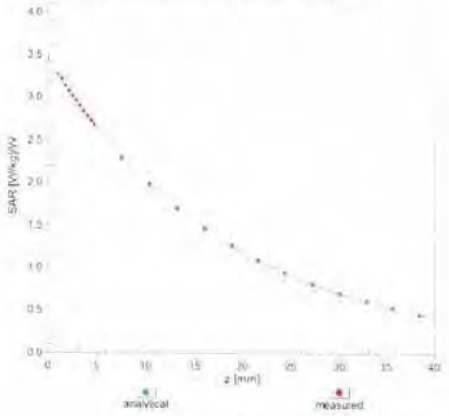
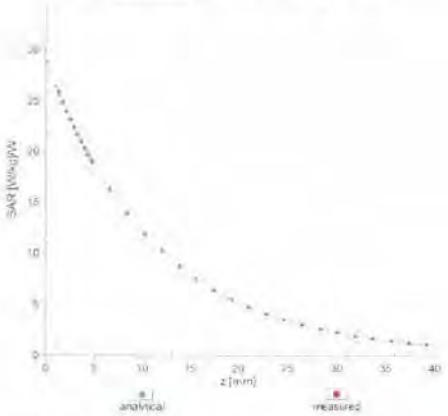
## Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

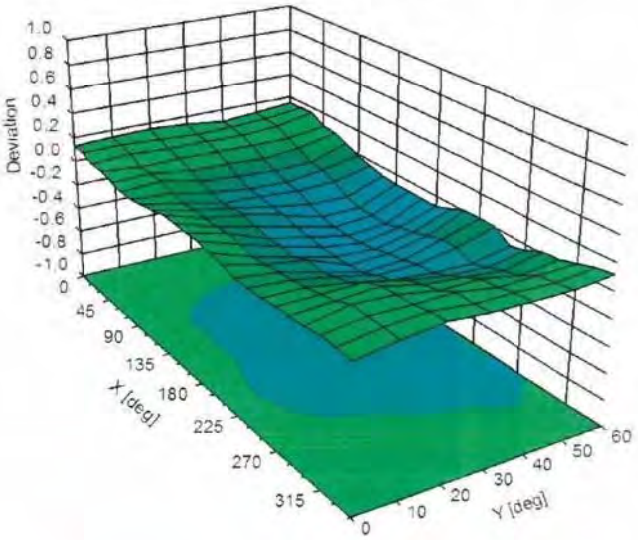



f = 1900 MHz,WGLS R22 (H_convF)




## Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:3898

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 112 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

EX3DV4– SN:3898 June 27, 2017

## Appendix: Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Max Unc$^E$ (k=2) |
|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.00 | 0.00 | 1.00 | 0.00 | 143.9 | ± 2.7 % |
| | | Y | 0.00 | 0.00 | 1.00 | | 142.2 | |
| | | Z | 0.00 | 0.00 | 1.00 | | 145.7 | |
| 10010-CAA | SAR Validation (Square, 100ms, 10ms) | X | 2.36 | 65.22 | 10.01 | 10.00 | 20.0 | ± 9.6 % |
| | | Y | 2.38 | 65.50 | 10.11 | | 20.0 | |
| | | Z | 2.49 | 65.99 | 10.50 | | 20.0 | |
| 10011-CAB | UMTS-FDD (WCDMA) | X | 0.97 | 66.94 | 14.95 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.04 | 68.03 | 15.67 | | 150.0 | |
| | | Z | 0.97 | 66.89 | 14.93 | | 150.0 | |
| 10012-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps) | X | 1.16 | 63.59 | 14.83 | 0.41 | 150.0 | ± 9.6 % |
| | | Y | 1.18 | 63.88 | 15.16 | | 150.0 | |
| | | Z | 1.15 | 63.44 | 14.80 | | 150.0 | |
| 10013-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps) | X | 4.63 | 66.61 | 16.74 | 1.46 | 150.0 | ± 9.6 % |
| | | Y | 4.65 | 66.69 | 16.86 | | 150.0 | |
| | | Z | 4.62 | 66.62 | 16.77 | | 150.0 | |
| 10021-DAC | GSM-FDD (TDMA, GMSK) | X | 9.40 | 81.38 | 17.52 | 9.39 | 50.0 | ± 9.6 % |
| | | Y | 16.05 | 87.81 | 19.48 | | 50.0 | |
| | | Z | 22.43 | 92.46 | 21.10 | | 50.0 | |
| 10023-DAC | GPRS-FDD (TDMA, GMSK, TN 0) | X | 7.11 | 77.84 | 16.31 | 9.57 | 50.0 | ± 9.6 % |
| | | Y | 10.05 | 82.09 | 17.71 | | 50.0 | |
| | | Z | 11.78 | 84.47 | 18.73 | | 50.0 | |
| 10024-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 13.45 | 86.10 | 17.72 | 6.56 | 60.0 | ± 9.6 % |
| | | Y | 100.00 | 106.94 | 22.92 | | 60.0 | |
| | | Z | 100.00 | 108.65 | 23.66 | | 60.0 | |
| 10025-DAC | EDGE-FDD (TDMA, 8PSK, TN 0) | X | 3.63 | 65.06 | 22.13 | 12.57 | 50.0 | ± 9.6 % |
| | | Y | 5.18 | 76.12 | 28.60 | | 50.0 | |
| | | Z | 3.25 | 61.92 | 20.33 | | 50.0 | |
| 10026-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1) | X | 6.62 | 83.09 | 28.34 | 9.56 | 60.0 | ± 9.6 % |
| | | Y | 7.13 | 86.03 | 30.02 | | 60.0 | |
| | | Z | 5.66 | 79.86 | 27.23 | | 60.0 | |
| 10027-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 100.00 | 105.78 | 21.78 | 4.80 | 80.0 | ± 9.6 % |
| | | Y | 100.00 | 107.41 | 22.39 | | 80.0 | |
| | | Z | 100.00 | 109.53 | 23.24 | | 80.0 | |
| 10028-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 100.00 | 107.00 | 21.71 | 3.55 | 100.0 | ± 9.6 % |
| | | Y | 100.00 | 109.56 | 22.70 | | 100.0 | |
| | | Z | 100.00 | 112.11 | 23.68 | | 100.0 | |
| 10029-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1-2) | X | 4.64 | 75.90 | 24.34 | 7.80 | 80.0 | ± 9.6 % |
| | | Y | 4.68 | 76.87 | 25.15 | | 80.0 | |
| | | Z | 4.08 | 73.46 | 23.48 | | 80.0 | |
| 10030-CAA | IEEE 802.15.1 Bluetooth (GFSK, DH1) | X | 5.90 | 78.01 | 14.62 | 5.30 | 70.0 | ± 9.6 % |
| | | Y | 25.51 | 92.34 | 18.68 | | 70.0 | |
| | | Z | 25.49 | 93.66 | 19.29 | | 70.0 | |
| 10031-CAA | IEEE 802.15.1 Bluetooth (GFSK, DH3) | X | 100.00 | 106.02 | 20.18 | 1.88 | 100.0 | ± 9.6 % |
| | | Y | 100.00 | 109.92 | 21.67 | | 100.0 | |
| | | Z | 100.00 | 111.87 | 22.32 | | 100.0 | |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10032-CAA | IEEE 802.15.1 Bluetooth (GFSK, DH5) | X | 100.00 | 114.56 | 22.90 | 1.17 | 100.0 | ± 9.6 % |
| | | Y | 100.00 | 122.28 | 25.84 | | 100.0 | |
| | | Z | 100.00 | 123.55 | 26.18 | | 100.0 | |
| 10033-CAA | IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1) | X | 3.55 | 73.49 | 16.00 | 5.30 | 70.0 | ± 9.6 % |
| | | Y | 4.05 | 76.03 | 17.25 | | 70.0 | |
| | | Z | 3.36 | 73.75 | 16.36 | | 70.0 | |
| 10034-CAA | IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3) | X | 1.68 | 68.28 | 12.61 | 1.88 | 100.0 | ± 9.6 % |
| | | Y | 1.85 | 69.87 | 13.55 | | 100.0 | |
| | | Z | 1.56 | 68.16 | 12.68 | | 100.0 | |
| 10035-CAA | IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5) | X | 1.37 | 67.38 | 12.10 | 1.17 | 100.0 | ± 9.6 % |
| | | Y | 1.50 | 68.80 | 12.97 | | 100.0 | |
| | | Z | 1.28 | 67.19 | 12.08 | | 100.0 | |
| 10036-CAA | IEEE 802.15.1 Bluetooth (8-DPSK, DH1) | X | 3.90 | 74.92 | 16.61 | 5.30 | 70.0 | ± 9.6 % |
| | | Y | 4.61 | 77.96 | 18.03 | | 70.0 | |
| | | Z | 3.72 | 75.34 | 17.04 | | 70.0 | |
| 10037-CAA | IEEE 802.15.1 Bluetooth (8-DPSK, DH3) | X | 1.57 | 67.63 | 12.31 | 1.88 | 100.0 | ± 9.6 % |
| | | Y | 1.70 | 69.04 | 13.19 | | 100.0 | |
| | | Z | 1.45 | 67.44 | 12.35 | | 100.0 | |
| 10038-CAA | IEEE 802.15.1 Bluetooth (8-DPSK, DH5) | X | 1.37 | 67.55 | 12.30 | 1.17 | 100.0 | ± 9.6 % |
| | | Y | 1.50 | 69.01 | 13.19 | | 100.0 | |
| | | Z | 1.28 | 67.33 | 12.27 | | 100.0 | |
| 10039-CAB | CDMA2000 (1xRTT, RC1) | X | 1.30 | 69.04 | 12.94 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.55 | 71.17 | 14.03 | | 150.0 | |
| | | Z | 1.24 | 68.56 | 12.61 | | 150.0 | |
| 10042-CAB | IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate) | X | 5.68 | 76.10 | 14.67 | 7.78 | 50.0 | ± 9.6 % |
| | | Y | 9.76 | 82.03 | 16.60 | | 50.0 | |
| | | Z | 12.77 | 85.55 | 17.89 | | 50.0 | |
| 10044-CAA | IS-91/EIA/TIA-553 FDD (FDMA, FM) | X | 0.01 | 90.50 | 0.61 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 0.01 | 91.46 | 2.87 | | 150.0 | |
| | | Z | 0.01 | 90.61 | 1.44 | | 150.0 | |
| 10048-CAA | DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24) | X | 5.51 | 71.14 | 15.12 | 13.80 | 25.0 | ± 9.6 % |
| | | Y | 6.15 | 72.46 | 15.57 | | 25.0 | |
| | | Z | 6.71 | 73.40 | 16.16 | | 25.0 | |
| 10049-CAA | DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12) | X | 5.68 | 73.94 | 15.07 | 10.79 | 40.0 | ± 9.6 % |
| | | Y | 6.47 | 75.65 | 15.68 | | 40.0 | |
| | | Z | 7.05 | 76.86 | 16.35 | | 40.0 | |
| 10056-CAA | UMTS-TDD (TD-SCDMA, 1.28 Mcps) | X | 6.87 | 78.23 | 18.34 | 9.03 | 50.0 | ± 9.6 % |
| | | Y | 8.46 | 81.68 | 19.73 | | 50.0 | |
| | | Z | 7.33 | 79.69 | 19.06 | | 50.0 | |
| 10058-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3) | X | 3.79 | 72.47 | 22.17 | 6.55 | 100.0 | ± 9.6 % |
| | | Y | 3.76 | 72.88 | 22.68 | | 100.0 | |
| | | Z | 3.40 | 70.54 | 21.50 | | 100.0 | |
| 10059-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps) | X | 1.18 | 64.29 | 15.13 | 0.61 | 110.0 | ± 9.6 % |
| | | Y | 1.19 | 64.62 | 15.50 | | 110.0 | |
| | | Z | 1.15 | 64.01 | 15.07 | | 110.0 | |
| 10060-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps) | X | 2.28 | 80.40 | 19.85 | 1.30 | 110.0 | ± 9.6 % |
| | | Y | 3.16 | 86.37 | 22.34 | | 110.0 | |
| | | Z | 1.76 | 77.97 | 19.44 | | 110.0 | |

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|---|---|---|---|---|---|---|---|---|
| 10061-CAB | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps) | X | 1.88 | 72.36 | 18.12 | 2.04 | 110.0 | ± 9.6 % |
| | | Y | 1.96 | 73.75 | 19.06 | | 110.0 | |
| | | Z | 1.64 | 70.87 | 17.81 | | 110.0 | |
| 10062-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps) | X | 4.44 | 66.67 | 16.29 | 0.49 | 100.0 | ± 9.6 % |
| | | Y | 4.47 | 66.75 | 16.40 | | 100.0 | |
| | | Z | 4.43 | 66.68 | 16.31 | | 100.0 | |
| 10063-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps) | X | 4.45 | 66.73 | 16.35 | 0.72 | 100.0 | ± 9.6 % |
| | | Y | 4.47 | 66.82 | 16.46 | | 100.0 | |
| | | Z | 4.44 | 66.74 | 16.38 | | 100.0 | |
| 10064-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps) | X | 4.67 | 66.90 | 16.51 | 0.86 | 100.0 | ± 9.6 % |
| | | Y | 4.70 | 66.98 | 16.63 | | 100.0 | |
| | | Z | 4.66 | 66.90 | 16.54 | | 100.0 | |
| 10065-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps) | X | 4.54 | 66.69 | 16.54 | 1.21 | 100.0 | ± 9.6 % |
| | | Y | 4.57 | 66.78 | 16.66 | | 100.0 | |
| | | Z | 4.53 | 66.69 | 16.57 | | 100.0 | |
| 10066-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps) | X | 4.55 | 66.64 | 16.64 | 1.46 | 100.0 | ± 9.6 % |
| | | Y | 4.57 | 66.74 | 16.77 | | 100.0 | |
| | | Z | 4.53 | 66.63 | 16.67 | | 100.0 | |
| 10067-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps) | X | 4.82 | 66.89 | 17.07 | 2.04 | 100.0 | ± 9.6 % |
| | | Y | 4.85 | 67.00 | 17.21 | | 100.0 | |
| | | Z | 4.80 | 66.88 | 17.10 | | 100.0 | |
| 10068-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps) | X | 4.85 | 66.79 | 17.19 | 2.55 | 100.0 | ± 9.6 % |
| | | Y | 4.88 | 66.89 | 17.34 | | 100.0 | |
| | | Z | 4.84 | 66.77 | 17.22 | | 100.0 | |
| 10069-CAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps) | X | 4.91 | 66.79 | 17.35 | 2.67 | 100.0 | ± 9.6 % |
| | | Y | 4.94 | 66.90 | 17.51 | | 100.0 | |
| | | Z | 4.89 | 66.76 | 17.38 | | 100.0 | |
| 10071-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps) | X | 4.72 | 66.64 | 16.98 | 1.99 | 100.0 | ± 9.6 % |
| | | Y | 4.74 | 66.72 | 17.11 | | 100.0 | |
| | | Z | 4.70 | 66.64 | 17.01 | | 100.0 | |
| 10072-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps) | X | 4.66 | 66.81 | 17.11 | 2.30 | 100.0 | ± 9.6 % |
| | | Y | 4.68 | 66.91 | 17.25 | | 100.0 | |
| | | Z | 4.64 | 66.80 | 17.14 | | 100.0 | |
| 10073-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps) | X | 4.72 | 66.97 | 17.39 | 2.83 | 100.0 | ± 9.6 % |
| | | Y | 4.74 | 67.07 | 17.55 | | 100.0 | |
| | | Z | 4.70 | 66.94 | 17.43 | | 100.0 | |
| 10074-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps) | X | 4.74 | 66.94 | 17.53 | 3.30 | 100.0 | ± 9.6 % |
| | | Y | 4.76 | 67.04 | 17.69 | | 100.0 | |
| | | Z | 4.72 | 66.91 | 17.56 | | 100.0 | |
| 10075-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps) | X | 4.77 | 66.95 | 17.74 | 3.82 | 90.0 | ± 9.6 % |
| | | Y | 4.78 | 67.04 | 17.91 | | 90.0 | |
| | | Z | 4.74 | 66.89 | 17.77 | | 90.0 | |
| 10076-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps) | X | 4.81 | 66.85 | 17.91 | 4.15 | 90.0 | ± 9.6 % |
| | | Y | 4.82 | 66.94 | 18.08 | | 90.0 | |
| | | Z | 4.79 | 66.79 | 17.94 | | 90.0 | |
| 10077-CAB | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps) | X | 4.85 | 66.95 | 18.02 | 4.30 | 90.0 | ± 9.6 % |
| | | Y | 4.86 | 67.03 | 18.19 | | 90.0 | |
| | | Z | 4.82 | 66.88 | 18.05 | | 90.0 | |

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|---|---|---|---|---|---|---|---|---|
| 10081-CAB | CDMA2000 (1xRTT, RC3) | X | 0.66 | 64.51 | 10.46 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 0.73 | 65.64 | 11.22 | | 150.0 | |
| | | Z | 0.65 | 64.36 | 10.28 | | 150.0 | |
| 10082-CAB | IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate) | X | 0.56 | 57.02 | 2.34 | 4.77 | 80.0 | ± 9.6 % |
| | | Y | 0.50 | 57.27 | 2.55 | | 80.0 | |
| | | Z | 0.72 | 60.56 | 4.69 | | 80.0 | |
| 10090-DAC | GPRS-FDD (TDMA, GMSK, TN 0-4) | X | 12.76 | 85.53 | 17.57 | 6.56 | 60.0 | ± 9.6 % |
| | | Y | 100.00 | 106.92 | 22.92 | | 60.0 | |
| | | Z | 100.00 | 108.63 | 23.67 | | 60.0 | |
| 10097-CAB | UMTS-FDD (HSDPA) | X | 1.81 | 68.44 | 15.60 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.88 | 69.07 | 16.03 | | 150.0 | |
| | | Z | 1.81 | 68.48 | 15.60 | | 150.0 | |
| 10098-CAB | UMTS-FDD (HSUPA, Subtest 2) | X | 1.77 | 68.36 | 15.57 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.84 | 69.01 | 16.01 | | 150.0 | |
| | | Z | 1.77 | 68.40 | 15.57 | | 150.0 | |
| 10099-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-4) | X | 6.65 | 83.17 | 28.36 | 9.56 | 60.0 | ± 9.6 % |
| | | Y | 7.18 | 86.14 | 30.05 | | 60.0 | |
| | | Z | 5.69 | 79.94 | 27.25 | | 60.0 | |
| 10100-CAC | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 2.91 | 69.85 | 16.63 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 3.00 | 70.32 | 16.93 | | 150.0 | |
| | | Z | 2.90 | 69.77 | 16.63 | | 150.0 | |
| 10101-CAC | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM) | X | 3.08 | 67.30 | 15.83 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 3.12 | 67.53 | 16.02 | | 150.0 | |
| | | Z | 3.07 | 67.26 | 15.83 | | 150.0 | |
| 10102-CAC | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM) | X | 3.19 | 67.35 | 15.95 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 3.22 | 67.55 | 16.12 | | 150.0 | |
| | | Z | 3.18 | 67.32 | 15.96 | | 150.0 | |
| 10103-CAC | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 5.34 | 73.16 | 19.00 | 3.98 | 65.0 | ± 9.6 % |
| | | Y | 5.40 | 73.67 | 19.39 | | 65.0 | |
| | | Z | 4.60 | 71.12 | 18.33 | | 65.0 | |
| 10104-CAC | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 16-QAM) | X | 5.56 | 71.82 | 19.11 | 3.98 | 65.0 | ± 9.6 % |
| | | Y | 5.54 | 72.04 | 19.38 | | 65.0 | |
| | | Z | 5.21 | 71.00 | 18.89 | | 65.0 | |
| 10105-CAC | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, 64-QAM) | X | 5.34 | 70.90 | 19.01 | 3.98 | 65.0 | ± 9.6 % |
| | | Y | 5.32 | 71.12 | 19.27 | | 65.0 | |
| | | Z | 4.66 | 68.69 | 18.12 | | 65.0 | |
| 10108-CAD | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 2.51 | 69.21 | 16.45 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.58 | 69.70 | 16.77 | | 150.0 | |
| | | Z | 2.50 | 69.15 | 16.45 | | 150.0 | |
| 10109-CAD | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 16-QAM) | X | 2.72 | 67.32 | 15.69 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.77 | 67.58 | 15.90 | | 150.0 | |
| | | Z | 2.71 | 67.30 | 15.69 | | 150.0 | |
| 10110-CAD | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK) | X | 2.00 | 68.45 | 15.89 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.08 | 69.04 | 16.29 | | 150.0 | |
| | | Z | 1.99 | 68.40 | 15.88 | | 150.0 | |
| 10111-CAD | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM) | X | 2.48 | 68.76 | 16.00 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.54 | 69.09 | 16.25 | | 150.0 | |
| | | Z | 2.48 | 68.79 | 15.99 | | 150.0 | |

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|---|---|---|---|---|---|---|---|---|
| 10112-CAD | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM) | X | 2.85 | 67.43 | 15.79 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.89 | 67.66 | 15.98 | | 150.0 | |
| | | Z | 2.84 | 67.42 | 15.79 | | 150.0 | |
| 10113-CAD | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM) | X | 2.63 | 68.98 | 16.15 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.68 | 69.26 | 16.38 | | 150.0 | |
| | | Z | 2.62 | 69.01 | 16.14 | | 150.0 | |
| 10114-CAB | IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK) | X | 4.93 | 67.18 | 16.42 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 4.96 | 67.24 | 16.50 | | 150.0 | |
| | | Z | 4.93 | 67.19 | 16.45 | | 150.0 | |
| 10115-CAB | IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM) | X | 5.17 | 67.22 | 16.44 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 5.19 | 67.28 | 16.52 | | 150.0 | |
| | | Z | 5.16 | 67.22 | 16.46 | | 150.0 | |
| 10116-CAB | IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM) | X | 5.00 | 67.33 | 16.43 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 5.03 | 67.41 | 16.51 | | 150.0 | |
| | | Z | 5.00 | 67.33 | 16.45 | | 150.0 | |
| 10117-CAB | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 4.92 | 67.09 | 16.40 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 4.94 | 67.16 | 16.48 | | 150.0 | |
| | | Z | 4.91 | 67.08 | 16.41 | | 150.0 | |
| 10118-CAB | IEEE 802.11n (HT Mixed, 81 Mbps, 16-QAM) | X | 5.24 | 67.41 | 16.54 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 5.27 | 67.48 | 16.62 | | 150.0 | |
| | | Z | 5.23 | 67.40 | 16.55 | | 150.0 | |
| 10119-CAB | IEEE 802.11n (HT Mixed, 135 Mbps, 64-QAM) | X | 5.01 | 67.35 | 16.44 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 5.04 | 67.42 | 16.53 | | 150.0 | |
| | | Z | 5.01 | 67.36 | 16.47 | | 150.0 | |
| 10140-CAC | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 16-QAM) | X | 3.20 | 67.37 | 15.86 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 3.24 | 67.57 | 16.03 | | 150.0 | |
| | | Z | 3.19 | 67.34 | 15.86 | | 150.0 | |
| 10141-CAC | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, 64-QAM) | X | 3.33 | 67.58 | 16.07 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 3.37 | 67.75 | 16.23 | | 150.0 | |
| | | Z | 3.32 | 67.56 | 16.09 | | 150.0 | |
| 10142-CAD | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK) | X | 1.77 | 68.44 | 15.19 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.85 | 69.19 | 15.67 | | 150.0 | |
| | | Z | 1.75 | 68.38 | 15.13 | | 150.0 | |
| 10143-CAD | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM) | X | 2.28 | 69.18 | 15.08 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 2.37 | 69.74 | 15.46 | | 150.0 | |
| | | Z | 2.25 | 69.10 | 14.98 | | 150.0 | |
| 10144-CAD | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 64-QAM) | X | 1.90 | 65.81 | 12.85 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.97 | 66.25 | 13.19 | | 150.0 | |
| | | Z | 1.87 | 65.68 | 12.71 | | 150.0 | |
| 10145-CAD | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK) | X | 0.75 | 61.28 | 7.87 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 0.79 | 61.77 | 8.31 | | 150.0 | |
| | | Z | 0.72 | 60.96 | 7.53 | | 150.0 | |
| 10146-CAD | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM) | X | 0.94 | 60.26 | 6.31 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 0.97 | 60.64 | 6.68 | | 150.0 | |
| | | Z | 0.88 | 60.00 | 6.02 | | 150.0 | |
| 10147-CAD | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 64-QAM) | X | 0.98 | 60.58 | 6.58 | 0.00 | 150.0 | ± 9.6 % |
| | | Y | 1.02 | 61.02 | 6.98 | | 150.0 | |
| | | Z | 0.91 | 60.11 | 6.15 | | 150.0 | |