# SAR EVALUATION REPORT

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

*For*
**GERAN/UMTS/2.4 GHz Qollector Activity Monitor**

**FCC ID: C9O-QOLL2**
**Model Name: QOLLECTOR2**

**Report Number: 15U21180-S1V4**
**Issue Date: 11/19/2015**

*Prepared for*
**SRAM LLC**
**1000 W Fulton Market, 4th Floor**
**Chicago, IL, 60607 United States**

*Prepared by*
**UL VERIFICATION SERVICES INC.**
**47173 BENICIA STREET**
**FREMONT, CA 94538, U.S.A.**
**TEL: (510) 771-1000**
**FAX: (510) 661-0888**

NVLAP LAB CODE 200065-0

**Revision History**

| Rev. | Date | Revisions | Revised By |
|---|---|---|---|
| V1 | 9/15/2015 | Initial Issue | -- |
| V2 | 11/2/2015 | 1. Duty Cycle updated<br>2. Section 7 updated<br>3. FCC ID updated<br>4. Added ANT+ | Lance Fleischer |
| V3 | 11/4/2015 | 1. Added data for Front Test Position<br>2. Updated Appendices A/B/C/E/F to V2<br>3. Section 12: Added Simultaneous Analysis | Coltyce Sanders |
| V4 | 11/19/2015 | 1. Added data for Edges 2/3/4 Test Positions<br>2. Updated Appendices A/B/C/E/F to V3 | Coltyce Sanders |

**Table of Contents**

# 1. Attestation of Test Results

| | | | | |
|---|---|---|---|---|
| Applicant Name | SRAM LLC | | | |
| FCC ID | C9O-QOLL2 | | | |
| Model Name | QOLLECTOR2 | | | |
| Applicable Standards | FCC 47 CFR § 2.1093<br>Published RF exposure KDB procedures<br>IEEE Std 1528-2013 | | | |
| **SAR Limits (W/Kg)** | | | | |
| Exposure Category | Peak spatial-average(1g of tissue) | | | |
| General population / Uncontrolled exposure | 1.6 | | | |
| **The Highest Reported SAR (W/kg)** | | | | |
| **RF Exposure Conditions** | **Equipment Class** | | | |
| | **Licensed** | **DTS** | **U-NII** | **ANT+** |
| Body-worn | 1.268 | N/A | N/A | N/A |
| Simultaneous Transmission | 1.394 | | | |
| Date Tested | 8/3/2015 to 9/1/2015 and 11/3/2015 to 11/4/2015 and 11/18/2015 to 11/19/2015 | | | |
| Test Results | Pass | | | |

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

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

| Approved & Released By: | Prepared By: |
|---|---|
|  |  |
| Devin Chang<br>Senior Engineer<br>UL Verification Services Inc. | Lance Fleischer<br>Laboratory Technician<br>UL Verification Services Inc. |

# 2. Test Specification, Methods and Procedures

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

- 447498 D01 General RF Exposure Guidance v06
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- 941225 D01 3G SAR Procedures v03r01

# 3. Facilities and Accreditation

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

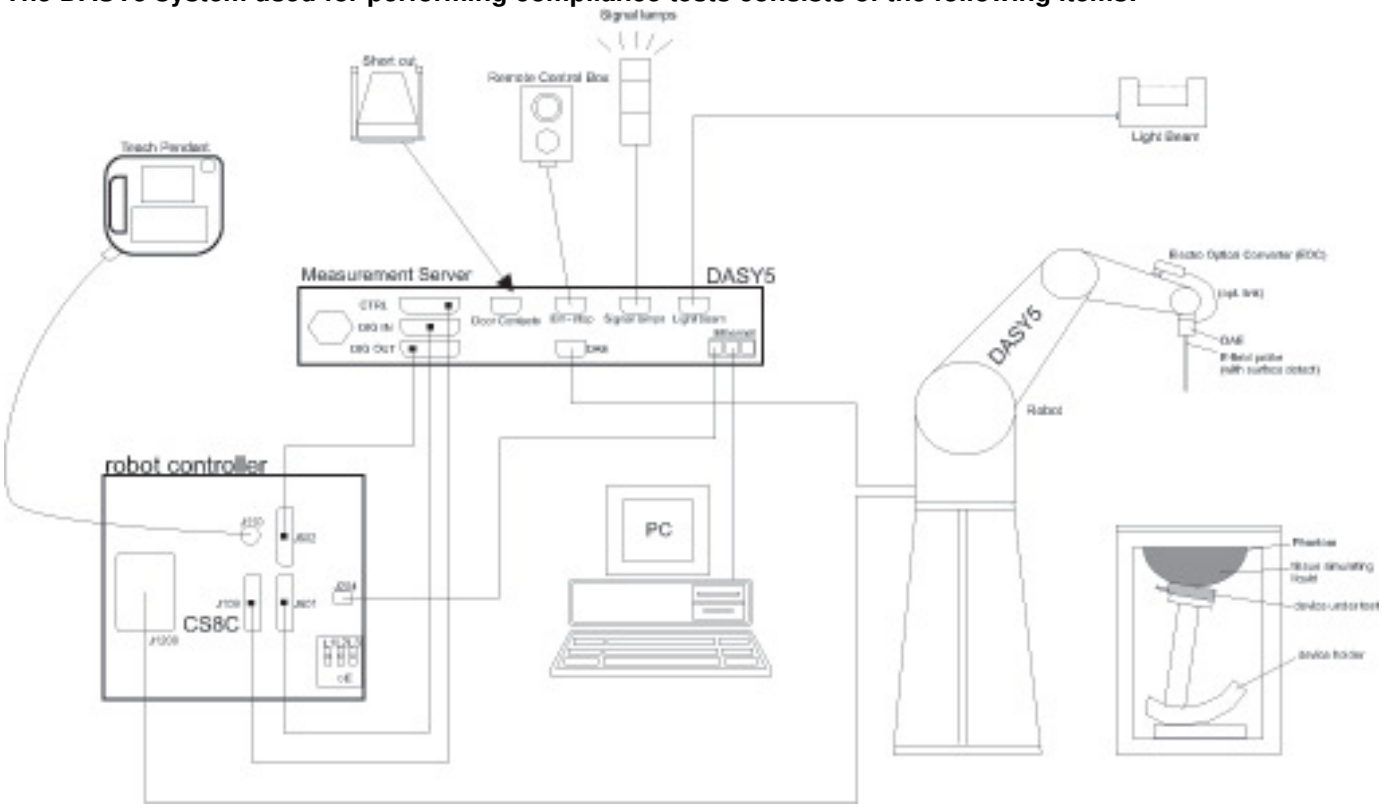
| 47173 Benicia Street | 47266 Benicia Street |
|---|---|
| SAR Lab A | SAR Lab 1 |
| SAR Lab B | SAR Lab 2 |
| SAR Lab C | SAR Lab 3 |
| SAR Lab D | SAR Lab 4 |
| SAR Lab E | SAR Lab 5 |
| SAR Lab F | |
| SAR Lab G | |
| SAR Lab H | |

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

# 4. SAR Measurement System & Test Equipment

## 4.1. SAR Measurement System

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




- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

## 4.2. SAR Scan Procedures

**Step 1: Power Reference Measurement**

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

**Step 2: Area Scan**

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

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

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

**Step 3: Zoom Scan**

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

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

| | | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|---|
| Maximum zoom scan spatial resolution: $\Delta x_{Zoom}$, $\Delta y_{Zoom}$ | | | ≤ 2 GHz: ≤ 8 mm<br>2 – 3 GHz: ≤ 5 mm* | 3 – 4 GHz: ≤ 5 mm*<br>4 – 6 GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{Zoom}(n)$ | | ≤ 5 mm | 3 – 4 GHz: ≤ 4 mm<br>4 – 5 GHz: ≤ 3 mm<br>5 – 6 GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface | ≤ 4 mm | 3 – 4 GHz: ≤ 3 mm<br>4 – 5 GHz: ≤ 2.5 mm<br>5 – 6 GHz: ≤ 2 mm |
| | | $\Delta z_{Zoom}(n>1)$: between subsequent points | ≤ 1.5·$\Delta z_{Zoom}(n-1)$ | |
| Minimum zoom scan volume | x, y, z | | ≥ 30 mm | 3 – 4 GHz: ≥ 28 mm<br>4 – 5 GHz: ≥ 25 mm<br>5 – 6 GHz: ≥ 22 mm |

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.

* When zoom scan is required and the *reported* SAR from the area scan based *1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

**Step 4: Power drift measurement**

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

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

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

## 4.3. Test Equipment

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

**The following test equipment was used during test dates 08/03/2015 to 09/01/2015**

**Dielectric Property Measurements**

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Network Analyzer | Agilent | 8753ES | MY40001647 | 7/28/2016 |
| Dielectric Probe kit | SPEAG | DAK-3.5 | 1082 | 9/16/2015 |
| Shorting block | SPEAG | DAK-3.5 Short | SM DAK 200 BA | N/A |
| Thermometer | Control Company | Traceable | 140493798 | 8/4/2016 |

**System Check**

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| HP Signal Generator | HP | 8665B | 3546A00784 | 6/27/2016 |
| Power Meter | Agilent | N1911A | MY53060007 | 9/15/2015 |
| Power Meter | Agilent | N1911A | MY53060016 | 8/7/2015 |
| Power Sensor | Agilent | N1921A | MY53020038 | 3/16/2016 |
| Power Sensor | Agilent | N10149 | MY52260009 | 12/15/2015 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1622052 | N/A |
| Bi-directional coupler | Werlatone, Inc. | C8060-102 | 2711 | N/A |
| DC Power Supply | Sorensen Ametek | XT15-4 | 1319A02780 | N/A |
| Synthesized Signal Generator | Agilent | 8665B | 3438A00633 | 8/29/2015 |
| Power Meter | HP | 437B | 3125U09516 | 8/27/2015 |
| Power Meter | HP | 437B | 3125U11347 | 10/6/2015 |
| Power Sensor | HP | 8481A | 3318A95392 | 10/6/2015 |
| Power Sensor | HP | 8481A | 1926A16917 | 10/10/2015 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1808938 | N/A |
| Bi-directional coupler | Werlatone, Inc. | C8060-102 | 2710 | N/A |
| DC Power Supply | HP | 6296A | 2841A-05955 | N/A |
| E-Field Probe (SAR Lab 1) | SPEAG | EX3DV4 | 7356 | 4/22/2016 |
| E-Field Probe (SAR Lab 2) | SPEAG | EX3DV4 | 3990 | 3/18/2016 |
| E-Field Probe (SAR Lab 3) | SPEAG | EX3DV4 | 3749 | 1/26/2016 |
| E-Field Probe (SAR Lab 5) | SPEAG | EX3DV4 | 3773 | 4/22/2016 |
| Data Acquisition Electronics (SAR Lab 1) | SPEAG | DAE4 | 1352 | 11/7/2015 |
| Data Acquisition Electronics (SAR Lab 2) | SPEAG | DAE4 | 1259 | 1/14/2016 |
| Data Acquisition Electronics (SAR Lab 3) | SPEAG | DAE4 | 1434 | 4/16/2016 |
| Data Acquisition Electronics (SAR Lab 5) | SPEAG | DAE4 | 1239 | 4/16/2016 |
| System Validation Dipole | SPEAG | D835V2 | 4d142 | 9/9/2015 |
| System Validation Dipole | SPEAG | D1750V2 | 1050 | 4/15/2016 |
| System Validation Dipole | SPEAG | D1750V2 | 1053 | 8/11/2016 |
| System Validation Dipole | SPEAG | D1900V2 | 5d163 | 9/11/2015 |
| Thermometer (SAR Lab 1) | EXTECH | 445703 | CCS-205 | 3/20/2016 |
| Thermometer (SAR Lab 2) | EXTECH | 445703 | CCS-203 | 3/19/2016 |
| Thermometer (SAR Lab 3) | EXTECH | 445703 | CCS-237 | 6/5/2016 |
| Thermometer (SAR Lab 5) | EXTECH | 445703 | CCS-239 | 6/5/2016 |

**Other**

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Base Station Simulator | R & S | CMW500 | 137875 | 6/25/2016 |

## The following test equipment was used during test dates 11/03/2015 to 11/04/2015

### Dielectric Property Measurements

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Network Analyzer | Agilent | 8753ES | MY40000980 | 4/17/2016 |
| Dielectric Probe kit | SPEAG | DAK-3.5 | 1087 | 11/11/2015 |
| Shorting block | SPEAG | DAK-3.5 Short | SM DAK 200 BA | N/A |
| Thermometer | Traceable Calibration Control Co. | 4242 | 140562250 | 8/24/2016 |

### System Check

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Synthesized Signal Generator | HP | 8665B | 3744A01084 | 5/8/2016 |
| Power Meter | Keysight | N1912A | MY55196004 | 7/1/2016 |
| Power Meter | Agilent | N1912A | MY50001018 | 10/19/2016 |
| Power Sensor | Agilent | E9323A | MY53070007 | 3/2/2016 |
| Power Sensor | Agilent | E9323A | MY53070005 | 4/29/2016 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1795093 | N/A |
| Directional coupler | Werlatone | C8060-102 | 2149 | N/A |
| DC Power Supply | AMETEK | XT 15-4 | 1319A02778 | N/A |
| Synthesized Signal Generator | HP | 8665B | 3744A01155 | 3/18/2016 |
| Power Meter | HP | 437B | 3125U16345 | 6/15/2016 |
| Power Meter | HP | 437B | 3125U12345 | 7/31/2016 |
| Power Sensor | HP | 8481A | 2702A76223 | 9/3/2016 |
| Power Sensor | HP | 8481A | 1926A27048 | 8/3/2016 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1795092 | N/A |
| Directional coupler | Werlatone | C8060-102 | 2141 | N/A |
| DC Power Supply | BK PRECISION | 1611 | 215-02292 | N/A |
| E-Field Probe (SAR Lab F) | SPEAG | EX3DV4 | 3929 | 4/22/2016 |
| E-Field Probe (SAR Lab G) | SPEAG | EX3DV4 | 3991 | 5/19/2016 |
| Data Acquisition Electronics (SAR Lab F) | SPEAG | DAE4 | 1359 | 2/18/2016 |
| Data Acquisition Electronics (SAR Lab G) | SPEAG | DAE4 | 1433 | 3/12/2016 |
| System Validation Dipole | SPEAG | D835V2 | 4d002 | 11/13/2015 |
| System Validation Dipole | SPEAG | D1750V2 | 1053 | 8/11/2016 |
| System Validation Dipole | SPEAG | D1900V2 | 5d043 | 11/7/2015 |

**The following test equipment was used during test dates 11/18/2015 to 11/19/2015**

**Dielectric Property Measurements**

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Network Analyzer | Agilent | 8753ES | MY40000980 | 4/17/2016 |
| Dielectric Probe kit | SPEAG | DAK-3.5 | 1082 | 9/15/2016 |
| Shorting block | SPEAG | DAK-3.5 Short | SM DAK 200 BA | N/A |
| Thermometer | Traceable Calibration Control Co. | 4242 | 140562250 | 8/24/2016 |

**System Check**

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal. Due Date |
|---|---|---|---|---|
| Synthesized Signal Generator | HP | 8665B | 3744A01084 | 5/8/2016 |
| Power Meter | Keysight | N1912A | MY55196004 | 7/1/2016 |
| Power Meter | Agilent | N1912A | MY50001018 | 10/19/2016 |
| Power Sensor | Agilent | E9323A | MY53070007 | 3/2/2016 |
| Power Sensor | Agilent | E9323A | MY53070005 | 4/29/2016 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1795093 | N/A |
| Directional coupler | Werlatone | C8060-102 | 2149 | N/A |
| DC Power Supply | AMETEK | XT 15-4 | 1319A02778 | N/A |
| Synthesized Signal Generator | HP | 8665B | 3744A01155 | 3/18/2016 |
| Power Meter | HP | 437B | 3125U16345 | 6/15/2016 |
| Power Meter | HP | 437B | 3125U12345 | 7/31/2016 |
| Power Sensor | HP | 8481A | 2702A76223 | 9/3/2016 |
| Power Sensor | HP | 8481A | 1926A27048 | 8/3/2016 |
| Amplifier | MITEQ | AMF-4D-00400600-50-30P | 1795092 | N/A |
| Directional coupler | Werlatone | C8060-102 | 2141 | N/A |
| DC Power Supply | BK PRECISION | 1611 | 215-02292 | N/A |
| E-Field Probe (SAR Lab E) | SPEAG | EX3DV4 | 3772 | 2/23/2016 |
| E-Field Probe (SAR Lab G) | SPEAG | EX3DV4 | 3991 | 5/19/2016 |
| Data Acquisition Electronics (SAR Lab E) | SPEAG | DAE4 | 1439 | 7/30/2016 |
| Data Acquisition Electronics (SAR Lab G) | SPEAG | DAE4 | 1433 | 3/12/2016 |
| System Validation Dipole | SPEAG | D835V2 | 4d117 | 5/18/2016 |
| System Validation Dipole | SPEAG | D1750V2 | 1053 | 8/11/2016 |
| System Validation Dipole | SPEAG | D1900V2 | 5d163 | 9/21/2016 |

# 5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

# 6. Device Under Test (DUT) Information

## 6.1. DUT Description

| | | | |
|---|---|---|---|
| Device Dimension | Overall (Length x Width): 98.9 mm x 55.6 mm<br>Overall Diagonal: 101.4 mm | | |
| Back Cover | ☒ The rechargeable battery is not user accessible. | | |
| Battery Options | ☒ The rechargeable battery is not user accessible. | | |
| Wireless Router (Hotspot) | Device does not support Hotspot mode | | |
| Wi-Fi Direct | Device does not support Wi-Fi Direct | | |
| Test sample information | **S/N** | **IMEI** | **Notes** |
| | ADR21520 | 351579055495624 | SAR Radiated Test Sample |
| | ADR11179 | 351579055511529 | SAR Radiated Test Sample |
| Hardware Version | Qollector2 | | |
| Software Version | 12.00.026 | | |

## 6.2. Wireless Technologies

| Wireless technologies | Frequency bands | Operating mode | | Duty Cycle used for SAR testing |
|---|---|---|---|---|
| GSM | 850<br>1900 | GPRS (GMSK)<br>EGPRS (8PSK) | GPRS Multi-Slot Class:<br>☐ Class 8 - 1 Up, 4 Down<br>☒ Class 10 - 2 Up, 4 Down<br>☐ Class 12 - 4 Up, 4 Down<br>☐ Class 33 - 4 Up, 5 Down | (E)GPRS: 1 Slot: 12.5%<br>2 Slots: 25% |
| | Does this device support DTM (Dual Transfer Mode)? ☐ Yes ☒ No | | | |
| W-CDMA (UMTS) | Band II<br>Band IV<br>Band V | UMTS Rel. 99 (Voice & Data) | | 100% |
| ANT+ | 2.4 GHz | ANT+ | | N/A |

## 6.3. Testing Rationale

A Reduced Duty Cycle is used in order to determine the Final Reported SAR. Per manufacturer's Theory of Operation document, the device will operate with a 33% worst case Duty Cycle for GSM and WCDMA.

## 6.4. Nominal and Maximum Output Power

KDB 447498 sec.4.1.(3) 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

| Upper limit (dB): -1.0 ~ 0.5 | | Max. RF Output Power (dBm) | | |
|---|---|---|---|---|
| RF Air interface | Mode | Target | Max. tune-up tolerance limit | |
| | | | Burst | Frame |
| GSM850 | GPRS 1 slot | 32.5 | **33.0** | **23.97** |
| | GPRS 2 slots | 32.5 | **33.0** | **26.98** |
| | EGPRS 1 slot | 26.5 | **27.0** | **17.97** |
| | EGPRS 2 slots | 26.5 | **27.0** | **20.98** |
| GSM1900 | GPRS 1 slot | 29.5 | **30.0** | **20.97** |
| | GPRS 2 slots | 29.5 | **30.0** | **23.98** |
| | EGPRS 1 slot | 25.0 | **25.5** | **16.47** |
| | EGPRS 2 slots | 25.0 | **25.5** | **19.48** |

| Upper limit (dB): -0.5 ~ 0.5 | | Max. RF Output Power (dBm) | |
|---|---|---|---|
| RF Air interface | Mode | Target | Max. tune-up tolerance limit |
| W-CDMA Band V | R99 | 22.0 | **22.5** |
| W-CDMA Band IV | R99 | 22.0 | **22.5** |
| W-CDMA Band II | R99 | 22.0 | **22.5** |

| RF Air interface | Mode | Max tune-up limit (dBm) |
|---|---|---|
| ANT+ | | **4.0** |

# 7. RF Exposure Conditions (Test Configurations)

Refer to “SAR Photos and Ant locations” Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

| Wireless technologies | RF Exposure Conditions | DUT-to-User Separation | Test Position | Antenna-to-edge/surface | | SAR Required |
|---|---|---|---|---|---|---|
| WWAN | Body | 0 mm | Rear | | N/A | Yes |
| | | 0 mm | Front | | N/A | Yes |
| | | 0 mm | Edge 2 | | N/A | Yes |
| | | 0 mm | Edge 3 | | N/A | Yes |
| | | 0 mm | Edge 4 | | N/A | Yes |

# 8. Dielectric Property Measurements & System Check

## 8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 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; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

**Tissue Dielectric Parameters**

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

| Target Frequency (MHz) | Head | | Body | |
|---|---|---|---|---|
| | $\varepsilon_r$ | $\sigma$ (S/m) | $\varepsilon_r$ | $\sigma$ (S/m) |
| 150 | 52.3 | 0.76 | 61.9 | 0.80 |
| 300 | 45.3 | 0.87 | 58.2 | 0.92 |
| 450 | 43.5 | 0.87 | 56.7 | 0.94 |
| 835 | 41.5 | 0.90 | 55.2 | 0.97 |
| 900 | 41.5 | 0.97 | 55.0 | 1.05 |
| 915 | 41.5 | 0.98 | 55.0 | 1.06 |
| 1450 | 40.5 | 1.20 | 54.0 | 1.30 |
| 1610 | 40.3 | 1.29 | 53.8 | 1.40 |
| 1800 – 2000 | 40.0 | 1.40 | 53.3 | 1.52 |
| 2450 | 39.2 | 1.80 | 52.7 | 1.95 |
| 3000 | 38.5 | 2.40 | 52.0 | 2.73 |
| 5000 | 36.2 | 4.45 | 49.3 | 5.07 |
| 5100 | 36.1 | 4.55 | 49.1 | 5.18 |
| 5200 | 36.0 | 4.66 | 49.0 | 5.30 |
| 5300 | 35.9 | 4.76 | 48.9 | 5.42 |
| 5400 | 35.8 | 4.86 | 48.7 | 5.53 |
| 5500 | 35.6 | 4.96 | 48.6 | 5.65 |
| 5600 | 35.5 | 5.07 | 48.5 | 5.77 |
| 5700 | 35.4 | 5.17 | 48.3 | 5.88 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |

**IEEE Std 1528-2013**

Refer to Table 3 within the IEEE Std 1528-2013

**Dielectric Property Measurements Results:**

**SAR Lab 1**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 8/10/2015 | Body 835 | e' | 52.7400 | Relative Permittivity ($\epsilon_r$): | 52.74 | 55.20 | -4.46 | 5 |
| | | e" | 21.8800 | Conductivity (σ): | 1.02 | 0.97 | 4.73 | 5 |
| | Body 820 | e' | 52.8900 | Relative Permittivity ($\epsilon_r$): | 52.89 | 55.28 | -4.32 | 5 |
| | | e" | 21.9600 | Conductivity (σ): | 1.00 | 0.97 | 3.39 | 5 |
| | Body 850 | e' | 52.5800 | Relative Permittivity ($\epsilon_r$): | 52.58 | 55.16 | -4.67 | 5 |
| | | e" | 21.8800 | Conductivity (σ): | 1.03 | 0.99 | 4.76 | 5 |

**SAR Lab 2**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 8/11/2015 | Body 1750 | e' | 52.0200 | Relative Permittivity ($\epsilon_r$): | 52.02 | 53.44 | -2.66 | 5 |
| | | e" | 15.1600 | Conductivity (σ): | 1.48 | 1.49 | -0.74 | 5 |
| | Body 1710 | e' | 52.1500 | Relative Permittivity ($\epsilon_r$): | 52.15 | 53.54 | -2.60 | 5 |
| | | e" | 15.1000 | Conductivity (σ): | 1.44 | 1.46 | -1.77 | 5 |
| | Body 1755 | e' | 52.0000 | Relative Permittivity ($\epsilon_r$): | 52.00 | 53.43 | -2.67 | 5 |
| | | e" | 15.1700 | Conductivity (σ): | 1.48 | 1.49 | -0.60 | 5 |
| 8/28/2015 | Body 1750 | e' | 51.8000 | Relative Permittivity ($\epsilon_r$): | 51.80 | 53.44 | -3.07 | 5 |
| | | e" | 15.4300 | Conductivity (σ): | 1.50 | 1.49 | 1.03 | 5 |
| | Body 1710 | e' | 51.8800 | Relative Permittivity ($\epsilon_r$): | 51.88 | 53.54 | -3.11 | 5 |
| | | e" | 15.3800 | Conductivity (σ): | 1.46 | 1.46 | 0.06 | 5 |
| | Body 1755 | e' | 51.7900 | Relative Permittivity ($\epsilon_r$): | 51.79 | 53.43 | -3.07 | 5 |
| | | e" | 15.4600 | Conductivity (σ): | 1.51 | 1.49 | 1.30 | 5 |

**SAR Lab 3**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 8/3/2015 | Body 1900 | e' | 50.9800 | Relative Permittivity ($\epsilon_r$): | 50.98 | 53.30 | -4.35 | 5 |
| | | e" | 14.3000 | Conductivity (σ): | 1.51 | 1.52 | -0.61 | 5 |
| | Body 1850 | e' | 51.2500 | Relative Permittivity ($\epsilon_r$): | 51.25 | 53.30 | -3.85 | 5 |
| | | e" | 14.1200 | Conductivity (σ): | 1.45 | 1.52 | -4.44 | 5 |
| | Body 1910 | e' | 50.8700 | Relative Permittivity ($\epsilon_r$): | 50.87 | 53.30 | -4.56 | 5 |
| | | e" | 14.2800 | Conductivity (σ): | 1.52 | 1.52 | -0.23 | 5 |
| 8/11/2015 | Body 1900 | e' | 52.0200 | Relative Permittivity ($\epsilon_r$): | 52.02 | 53.30 | -2.40 | 5 |
| | | e" | 14.3800 | Conductivity (σ): | 1.52 | 1.52 | -0.05 | 5 |
| | Body 1850 | e' | 52.2500 | Relative Permittivity ($\epsilon_r$): | 52.25 | 53.30 | -1.97 | 5 |
| | | e" | 14.2400 | Conductivity (σ): | 1.46 | 1.52 | -3.63 | 5 |
| | Body 1910 | e' | 51.9300 | Relative Permittivity ($\epsilon_r$): | 51.93 | 53.30 | -2.57 | 5 |
| | | e" | 14.3800 | Conductivity (σ): | 1.53 | 1.52 | 0.47 | 5 |
| 8/31/2015 | Body 1900 | e' | 51.1900 | Relative Permittivity ($\epsilon_r$): | 51.19 | 53.30 | -3.96 | 5 |
| | | e" | 14.3200 | Conductivity (σ): | 1.51 | 1.52 | -0.47 | 5 |
| | Body 1850 | e' | 51.4000 | Relative Permittivity ($\epsilon_r$): | 51.40 | 53.30 | -3.56 | 5 |
| | | e" | 14.1300 | Conductivity (σ): | 1.45 | 1.52 | -4.38 | 5 |
| | Body 1910 | e' | 51.0800 | Relative Permittivity ($\epsilon_r$): | 51.08 | 53.30 | -4.17 | 5 |
| | | e" | 14.3500 | Conductivity (σ): | 1.52 | 1.52 | 0.26 | 5 |

**SAR Lab 5**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 9/1/2015 | Body 835 | e' | 53.6400 | Relative Permittivity ($\epsilon_r$): | 53.64 | 55.20 | -2.83 | 5 |
| | | e" | 21.6900 | Conductivity (σ): | 1.01 | 0.97 | 3.82 | 5 |
| | Body 820 | e' | 53.8500 | Relative Permittivity ($\epsilon_r$): | 53.85 | 55.28 | -2.58 | 5 |
| | | e" | 21.9200 | Conductivity (σ): | 1.00 | 0.97 | 3.20 | 5 |
| | Body 850 | e' | 53.5200 | Relative Permittivity ($\epsilon_r$): | 53.52 | 55.16 | -2.97 | 5 |
| | | e" | 21.6400 | Conductivity (σ): | 1.02 | 0.99 | 3.61 | 5 |

**SAR Lab E**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 11/16/2015 | Body 835 | e' | 53.5900 | Relative Permittivity ($\epsilon_r$): | 53.59 | 55.20 | -2.92 | 5 |
| | | e" | 21.1500 | Conductivity (σ): | 0.98 | 0.97 | 1.23 | 5 |
| | Body 820 | e' | 53.7000 | Relative Permittivity ($\epsilon_r$): | 53.70 | 55.28 | -2.85 | 5 |
| | | e" | 21.2600 | Conductivity (σ): | 0.97 | 0.97 | 0.09 | 5 |
| | Body 850 | e' | 53.4000 | Relative Permittivity ($\epsilon_r$): | 53.40 | 55.16 | -3.19 | 5 |
| | | e" | 21.1600 | Conductivity (σ): | 1.00 | 0.99 | 1.31 | 5 |

**SAR Lab F**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 11/2/2015 | Body 835 | e' | 53.1800 | Relative Permittivity ($\epsilon_r$): | 53.18 | 55.20 | -3.66 | 5 |
| | | e" | 21.8100 | Conductivity (σ): | 1.01 | 0.97 | 4.39 | 5 |
| | Body 820 | e' | 53.3400 | Relative Permittivity ($\epsilon_r$): | 53.34 | 55.28 | -3.50 | 5 |
| | | e" | 21.8900 | Conductivity (σ): | 1.00 | 0.97 | 3.06 | 5 |
| | Body 850 | e' | 53.0100 | Relative Permittivity ($\epsilon_r$): | 53.01 | 55.16 | -3.89 | 5 |
| | | e" | 21.7400 | Conductivity (σ): | 1.03 | 0.99 | 4.09 | 5 |

**SAR Lab G**

| Date | Freq. (MHz) | Liquid Parameters | | | Measured | Target | Delta (%) | Limit ±(%) |
|---|---|---|---|---|---|---|---|---|
| 11/2/2015 | Body 1900 | e' | 51.3800 | Relative Permittivity ($\epsilon_r$): | 51.38 | 53.30 | -3.60 | 5 |
| | | e" | 14.8600 | Conductivity (σ): | 1.57 | 1.52 | 3.28 | 5 |
| | Body 1850 | e' | 51.5100 | Relative Permittivity ($\epsilon_r$): | 51.51 | 53.30 | -3.36 | 5 |
| | | e" | 14.8300 | Conductivity (σ): | 1.53 | 1.52 | 0.36 | 5 |
| | Body 1910 | e' | 51.3400 | Relative Permittivity ($\epsilon_r$): | 51.34 | 53.30 | -3.68 | 5 |
| | | e" | 14.8700 | Conductivity (σ): | 1.58 | 1.52 | 3.90 | 5 |
| 11/3/2015 | Body 1750 | e' | 51.1500 | Relative Permittivity ($\epsilon_r$): | 51.15 | 53.44 | -4.29 | 5 |
| | | e" | 15.2700 | Conductivity (σ): | 1.49 | 1.49 | -0.02 | 5 |
| | Body 1710 | e' | 51.2900 | Relative Permittivity ($\epsilon_r$): | 51.29 | 53.54 | -4.21 | 5 |
| | | e" | 15.2200 | Conductivity (σ): | 1.45 | 1.46 | -0.99 | 5 |
| | Body 1755 | e' | 51.1400 | Relative Permittivity ($\epsilon_r$): | 51.14 | 53.43 | -4.28 | 5 |
| | | e" | 15.2600 | Conductivity (σ): | 1.49 | 1.49 | -0.01 | 5 |
| 11/16/2015 | Body 1900 | e' | 51.9000 | Relative Permittivity ($\epsilon_r$): | 51.90 | 53.30 | -2.63 | 5 |
| | | e" | 14.6700 | Conductivity (σ): | 1.55 | 1.52 | 1.96 | 5 |
| | Body 1850 | e' | 52.0100 | Relative Permittivity ($\epsilon_r$): | 52.01 | 53.30 | -2.42 | 5 |
| | | e" | 14.7400 | Conductivity (σ): | 1.52 | 1.52 | -0.25 | 5 |
| | Body 1910 | e' | 51.8300 | Relative Permittivity ($\epsilon_r$): | 51.83 | 53.30 | -2.76 | 5 |
| | | e" | 14.6600 | Conductivity (σ): | 1.56 | 1.52 | 2.43 | 5 |
| 11/18/2015 | Body 1750 | e' | 51.4800 | Relative Permittivity ($\epsilon_r$): | 51.48 | 53.44 | -3.67 | 5 |
| | | e" | 15.0900 | Conductivity (σ): | 1.47 | 1.49 | -1.20 | 5 |
| | Body 1710 | e' | 51.5300 | Relative Permittivity ($\epsilon_r$): | 51.53 | 53.54 | -3.76 | 5 |
| | | e" | 15.0300 | Conductivity (σ): | 1.43 | 1.46 | -2.22 | 5 |
| | Body 1755 | e' | 51.4700 | Relative Permittivity ($\epsilon_r$): | 51.47 | 53.43 | -3.67 | 5 |
| | | e" | 15.0900 | Conductivity (σ): | 1.47 | 1.49 | -1.12 | 5 |

## 8.2. System Check

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

**System Performance Check Measurement Conditions:**

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

**Reference Target SAR Values**

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

| System Dipole | Serial No. | Cal. Date | Freq. (MHz) | Target SAR Values (W/kg) | | |
|---|---|---|---|---|---|---|
| | | | | 1g/10g | Head | Body |
| D835V2 | 4d002 | 11/13/2014 | 835 | 1g | 9.23 | 9.33 |
| | | | | 10g | 5.99 | 6.12 |
| D835V2 | 4d142 | 9/9/2014 | 835 | 1g | 8.91 | 9.22 |
| | | | | 10g | 5.77 | 6.05 |
| D835V2 | 4d117 | 5/18/2015 | 835 | 1g | 9.08 | 9.38 |
| | | | | 10g | 5.93 | 6.20 |
| D1750V2 | 1050 | 4/15/2015 | 1750 | 1g | 36.40 | 37.00 |
| | | | | 10g | 19.30 | 19.90 |
| D1750V2 | 1053 | 8/11/2015 | 1750 | 1g | 37.10 | 37.50 |
| | | | | 10g | 19.80 | 20.30 |
| D1900V2 | 5d163 | 9/11/2014 | 1900 | 1g | 40.80 | 40.60 |
| | | | | 10g | 21.20 | 21.40 |
| D1900V2 | 5d043 | 11/7/2014 | 1900 | 1g | 40.60 | 40.00 |
| | | | | 10g | 21.10 | 21.30 |
| D1900V2 | 5d163 | 9/21/2015 | 1900 | 1g | 40.10 | 39.90 |
| | | | | 10g | 21.00 | 21.00 |

**System Check Results**

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

**SAR Lab 1**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 8/10/2015 | D835V2 | 4d142 | Body | 1g | 0.86 | 8.64 | 9.22 | **-6.29** | 1,2 |
| | | | | 10g | 0.57 | 5.71 | 6.05 | -5.62 | |

**SAR Lab 2**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 8/11/2015 | D1750V2 | 1050 | Body | 1g | 3.89 | 38.90 | 37.00 | **5.14** | 3,4 |
| | | | | 10g | 2.07 | 20.70 | 19.90 | 4.02 | |
| 8/28/2015 | D1750V2 | 1053 | Body | 1g | 3.90 | 39.00 | 37.50 | **4.00** | 5,6 |
| | | | | 10g | 2.08 | 20.80 | 20.30 | 2.46 | |

**SAR Lab 3**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 8/3/2105 | D1900V2 | 5d163 | Body | 1g | 4.14 | 41.40 | 40.60 | 1.97 | |
| | | | | 10g | 2.15 | 21.50 | 21.40 | 0.47 | |
| 8/11/2105 | D1900V2 | 5d163 | Body | 1g | 4.19 | 41.90 | 40.60 | **3.20** | 7,8 |
| | | | | 10g | 2.18 | 21.80 | 21.40 | 1.87 | |
| 8/31/2015 | D1900V2 | 5d163 | Body | 1g | 3.96 | 39.60 | 40.60 | -2.46 | |
| | | | | 10g | 2.05 | 20.50 | 21.40 | -4.21 | |

**SAR Lab 5**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 9/1/2015 | D835V2 | 4d142 | Body | 1g | 0.96 | 9.59 | 9.22 | **4.01** | 9,10 |
| | | | | 10g | 0.63 | 6.32 | 6.05 | 4.46 | |

**SAR Lab E**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 11/16/2015 | D835V2 | 4d117 | Body | 1g | 0.93 | 9.33 | 9.38 | **-0.53** | 11,12 |
| | | | | 10g | 0.62 | 6.15 | 6.20 | -0.81 | |

**SAR Lab F**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 11/2/2015 | D835V2 | 4d002 | Body | 1g | 0.98 | 9.84 | 9.33 | **5.47** | 13,14 |
| | | | | 10g | 0.65 | 6.51 | 6.12 | 6.37 | |

**SAR Lab G**

| Date Tested | System Dipole | | T.S. Liquid | | Measured Results | | Target (Ref. Value) | Delta ±10 % | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | | | Zoom Scan to 100 mW | Normalize to 1 W | | | |
| 11/2/2015 | D1900V2 | 5d043 | Body | 1g | 4.11 | 41.10 | 40.00 | **2.75** | 15,16 |
| | | | | 10g | 2.12 | 21.20 | 21.30 | -0.47 | |
| 11/3/2015 | D1750V2 | 1053 | Body | 1g | 3.83 | 38.3 | 37.50 | **2.13** | 17,18 |
| | | | | 10g | 2.03 | 20.3 | 20.3 | 0.00 | |
| 11/16/2015 | D1900V2 | 5d163 | Body | 1g | 4.10 | 41.00 | 39.90 | **2.76** | 19,20 |
| | | | | 10g | 2.10 | 21.00 | 21.00 | 0.00 | |
| 11/18/2015 | D1750V2 | 1053 | Body | 1g | 3.99 | 39.90 | 37.50 | **6.40** | 21,22 |
| | | | | 10g | 2.12 | 21.20 | 20.3 | 4.43 | |

# 9. Conducted Output Power Measurements

## 9.1. GSM

**GSM850 Measured Results**

| Band | Mode | Coding Scheme | Time Slots | Ch No. | Freq. (MHz) | Max. Pwr | |
|---|---|---|---|---|---|---|---|
| | | | | | | Burst (dBm) | Frame (dBm) |
| 850 | GPRS (GMSK) | CS1 | 1 | 128 | 824.2 | 32.3 | 23.3 |
| | | | | 190 | 836.6 | 32.1 | 23.1 |
| | | | | 251 | 848.8 | 32.1 | 23.1 |
| | | | 2 | 128 | 824.2 | 32.3 | 26.3 |
| | | | | 190 | 836.6 | 32.1 | 26.1 |
| | | | | 251 | 848.8 | 32.1 | 26.1 |
| | EGPRS (8PSK) | MCS5 | 1 | 128 | 824.2 | 26.7 | 17.7 |
| | | | | 190 | 836.6 | 26.4 | 17.4 |
| | | | | 251 | 848.8 | 26.4 | 17.4 |
| | | | 2 | 128 | 824.2 | 26.6 | 20.6 |
| | | | | 190 | 836.6 | 26.3 | 20.3 |
| | | | | 251 | 848.8 | 26.3 | 20.3 |

**Notes:**

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Body-worn: GMSK (GPRS) mode with 2 time slots for Max power, based on the output power measurements above.
- SAR is not required for EGPRS (8PSK) mode because its output power is less than that of GPRS Mode

**GSM1900 Measured Results**

| Band | Mode | Coding Scheme | Time Slots | Ch No. | Freq. (MHz) | Max. Pwr | |
|---|---|---|---|---|---|---|---|
| | | | | | | Burst (dBm) | Frame (dBm) |
| 1900 | GPRS (GMSK) | CS1 | 1 | 512 | 1850.2 | 29.0 | 20.0 |
| | | | | 661 | 1880.0 | 29.1 | 20.1 |
| | | | | 810 | 1909.8 | 29.2 | 20.2 |
| | | | 2 | 512 | 1850.2 | 29.0 | 23.0 |
| | | | | 661 | 1880.0 | 29.1 | 23.1 |
| | | | | 810 | 1909.8 | 29.2 | 23.2 |
| | EGPRS (8PSK) | MCS5 | 1 | 512 | 1850.2 | 25.1 | 16.1 |
| | | | | 661 | 1880.0 | 25.2 | 16.2 |
| | | | | 810 | 1909.8 | 25.3 | 16.3 |
| | | | 2 | 512 | 1850.2 | 25.1 | 19.1 |
| | | | | 661 | 1880.0 | 25.2 | 19.2 |
| | | | | 810 | 1909.8 | 25.3 | 19.3 |

**Notes:**

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Body-worn: GMSK (GPRS) mode with 2 time slots for Max power, based on the output power measurements above.
- SAR is not required for EGPRS (8PSK) mode because its output power is less than that of GPRS Mode

## 9.2. W-CDMA

**Release 99 Setup Procedures used to establish the test signals**

The following tests were completed according to the test requirements outlined in section 5.2 of the 3GPP TS34.121-1 specification. The DUT supports power Class 3, which has a nominal maximum output power of 24 dBm (+1.7/-3.7).

| Mode | Subtest | Rel99 |
|---|---|---|
| WCDMA General Settings | Loopback Mode | Test Mode 2 |
| | Rel99 RMC | 12.2kbps RMC |
| | Power Control Algorithm | Algorithm2 |
| | βc/βd | 8/15 |

**W-CDMA Band II Measured Results**

| Band | Mode | | UL Ch No. | Freq. (MHz) | MPR (dB) | Max. Pwr (dBm) |
|---|---|---|---|---|---|---|
| W-CDMA Band II | Rel 99 | RMC, 12.2 kbps | 9262 | 1852.4 | N/A | 22.2 |
| | | | 9400 | 1880.0 | N/A | 22.4 |
| | | | 9538 | 1907.6 | N/A | 21.9 |

**W-CDMA Band IV Measured Results**

| Band | Mode | | UL Ch No. | Freq. (MHz) | MPR (dB) | Max. Pwr (dBm) |
|---|---|---|---|---|---|---|
| W-CDMA Band IV | Rel 99 | RMC, 12.2 kbps | 1312 | 1712.4 | N/A | 22.1 |
| | | | 1413 | 1732.6 | N/A | 22.1 |
| | | | 1513 | 1752.6 | N/A | 21.7 |

**W-CDMA Band V Measured Results**

| Band | Mode | | UL Ch No. | Freq. (MHz) | MPR (dB) | Max. Pwr (dBm) |
|---|---|---|---|---|---|---|
| W-CDMA Band V | Rel 99 | RMC, 12.2 kbps | 4132 | 826.4 | N/A | 22.4 |
| | | | 4183 | 836.6 | N/A | 22.3 |
| | | | 4233 | 846.6 | N/A | 22.2 |

## 9.3. ANT+

Maximum tune-up tolerance limit is 4dBm. This power level qualifies for exclusion of SAR testing.

# 10. Measured and Reported (Scaled) SAR Results

**SAR Test Reduction criteria are as follows:**

**KDB 447498 D01 General RF Exposure Guidance:**

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

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

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

**KDB 941225 D01 SAR test for 3G devices:**

When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode

## 10.1. GSM850

**Results with Time Based Averaging Applied:**

| RF Exposure Conditions | Mode | Dist. (mm) | Test Position | Ch #. | Freq. (MHz) | Power (dBm) | | 1-g SAR (W/kg) | | Duty Cycle | Final Reported SAR | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tune-up limit | Meas. | Meas. | Scaled | | | |
| Body-worn | GPRS 2 Slots | 0 | Rear | 128 | 824.2 | 33.0 | 32.3 | 3.270 | 3.842 | 33% | **1.268** | 1 |
| | | | | 190 | 836.6 | 33.0 | 32.1 | 2.950 | 3.629 | 33% | 1.198 | |
| | | | | 251 | 848.8 | 33.0 | 32.1 | 2.790 | 3.432 | 33% | 1.133 | |
| | | | Front | 190 | 836.6 | 33.0 | 32.1 | 1.620 | 1.993 | 33% | **0.658** | 2 |
| | | | Edge 2 | 190 | 836.6 | 33.0 | 32.1 | 1.710 | 2.104 | 33% | **0.694** | 3 |
| | | | Edge 3 | 190 | 836.6 | 33.0 | 32.1 | 0.420 | 0.517 | 33% | **0.171** | 4 |
| | | | Edge 4 | 128 | 824.2 | 33.0 | 32.3 | 2.120 | 2.491 | 33% | **0.822** | 5 |
| | | | | 190 | 836.6 | 33.0 | 32.1 | 1.990 | 2.448 | 33% | 0.808 | |
| | | | | 251 | 848.8 | 33.0 | 32.1 | 1.950 | 2.399 | 33% | 0.792 | |

## 10.2. GSM1900

**Results with Time Based Averaging Applied:**

| RF Exposure Conditions | Mode | Dist. (mm) | Test Position | Ch #. | Freq. (MHz) | Power (dBm) | | 1-g SAR (W/kg) | | Duty Cycle | Final Reported SAR | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tune-up limit | Meas. | Meas. | Scaled | | | |
| Body-worn | GPRS 2 Slots | 0 | Rear | 661 | 1880.0 | 30.0 | 29.1 | 1.870 | 2.301 | 33% | **0.759** | 6 |
| | | | Front | 661 | 1880.0 | 30.0 | 29.1 | 1.050 | 1.292 | 33% | **0.426** | 7 |
| | | | Edge 2 | 661 | 1880.0 | 30.0 | 29.1 | 0.937 | 1.153 | 33% | **0.380** | 8 |
| | | | Edge 3 | 661 | 1880.0 | 30.0 | 29.1 | 0.363 | 0.447 | 33% | **0.147** | 9 |
| | | | Edge 4 | 661 | 1880.0 | 30.0 | 29.1 | 1.740 | 2.141 | 33% | **0.706** | 10 |

## 10.3. W-CDMA Band II

**Results with Time Based Averaging Applied:**

| RF Exposure Conditions | Mode | Dist. (mm) | Test Position | Ch #. | Freq. (MHz) | Power (dBm) | | 1-g SAR (W/kg) | | Duty Cycle | Final Reported SAR | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tune-up limit | Meas. | Meas. | Scaled | | | |
| Body-worn | Rel 99 RMC | 0 | Rear | 9400 | 1880.0 | 22.5 | 22.4 | 2.140 | 2.190 | 33% | **0.723** | 11 |
| | | | Front | 9400 | 1880.0 | 22.5 | 22.4 | 2.010 | 2.057 | 33% | **0.679** | 12 |
| | | | Edge 2 | 9400 | 1880.0 | 22.5 | 22.4 | 0.946 | 0.968 | 33% | **0.319** | 13 |
| | | | Edge 3 | 9400 | 1880.0 | 22.5 | 22.4 | 0.356 | 0.364 | 33% | **0.120** | 14 |
| | | | Edge 4 | 9400 | 1880.0 | 22.5 | 22.4 | 1.820 | 1.862 | 33% | **0.615** | 15 |

## 10.4. W-CDMA Band IV

**Results with Time Based Averaging Applied:**

| RF Exposure Conditions | Mode | Dist. (mm) | Test Position | Ch #. | Freq. (MHz) | Power (dBm) | | 1-g SAR (W/kg) | | Duty Cycle | Final Reported SAR | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tune-up limit | Meas. | Meas. | Scaled | | | |
| Body-worn | Rel 99 RMC | 0 | Rear | 1413 | 1732.6 | 22.5 | 22.1 | 1.900 | 2.083 | 33% | **0.687** | 16 |
| | | | Front | 1413 | 1732.6 | 22.5 | 22.1 | 1.830 | 2.007 | 33% | **0.662** | 17 |
| | | | Edge 2 | 1413 | 1732.6 | 22.5 | 22.1 | 1.270 | 1.393 | 33% | **0.460** | 18 |
| | | | Edge 3 | 1413 | 1732.6 | 22.5 | 22.1 | 0.566 | 0.621 | 33% | **0.205** | 19 |
| | | | Edge 4 | 1413 | 1732.6 | 22.5 | 22.1 | 0.915 | 1.003 | 33% | **0.331** | 20 |

## 10.5. W-CDMA Band V

**Results with Time Based Averaging Applied:**

| RF Exposure Conditions | Mode | Dist. (mm) | Test Position | Ch #. | Freq. (MHz) | Power (dBm) | | 1-g SAR (W/kg) | | Duty Cycle | Final Reported SAR | Plot No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tune-up limit | Meas. | Meas. | Scaled | | | |
| Body-worn | Rel 99 RMC | 0 | Rear | 4183 | 836.6 | 22.5 | 22.3 | 1.420 | 1.487 | 33% | **0.491** | 21 |
| | | | Front | 4183 | 836.6 | 22.5 | 22.3 | 1.640 | 1.717 | 33% | **0.567** | 22 |
| | | | Edge 2 | 4183 | 836.6 | 22.5 | 22.3 | 0.790 | 0.827 | 33% | **0.273** | 23 |
| | | | Edge 3 | 4183 | 836.6 | 22.5 | 22.3 | 0.194 | 0.203 | 33% | **0.067** | 24 |
| | | | Edge 4 | 4183 | 836.6 | 22.5 | 22.3 | 0.947 | 0.992 | 33% | **0.327** | 25 |

## 10.6. ANT+

SAR test exclusion in accordance with KDB 447498.

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances

≤ 50 mm are determined by:

*[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)]* ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

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

**SAR Exclusion Calculation Table for Portable Devices (separation distance < 50mm)**

| Max. tune-up tolerance limit | | Min. test separation distance (mm) | Frequency (GHz) | SAR test exclusion Result* | Estimated 1-g SAR (W/kg) |
|---|---|---|---|---|---|
| (dBm) | (mW) | | | | |
| 4.0 | 3 | 5 | 2.480 | 0.9 | 0.126 |

**Conclusion:**

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

# 11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is <0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or 3 (1-g or 10-g respectively) or when the original or repeated measurement is ≥ 1.45 or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 or 3 (1-g or 10-g respectively).

| Frequency Band (MHz) | Air Interface | RF Exposure Conditions | Test Position | Repeated SAR (Yes/No) | Highest Measured SAR (W/kg) | First Repeated | | Second Repeated | | Third Repeated |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Measured SAR (W/kg) | Largest to Smallest SAR Ratio | Measured SAR (W/kg) | Largest to Smallest SAR Ratio | Measured SAR (W/kg) |
| 850 | GSM 850 | Body | Rear | Yes | 3.270 | 3.110 | 1.05 | 3.270 | 1.00 | N/A |
| | WCDMA Band V | Body | Front | No | 1.640 | N/A | N/A | N/A | N/A | N/A |
| 1900 | GSM 1900 | Body | Rear | No | 1.870 | N/A | N/A | N/A | N/A | N/A |
| | WCDMA Band II | Body | Rear | Yes | 2.140 | 2.080 | 1.03 | 2.020 | 1.06 | N/A |
| 1700 | WCDMA Band IV | Body | Rear | Yes | 1.900 | 1.890 | 1.01 | 1.870 | 1.02 | N/A |

**Note(s):**

Third Repeated Measurement is not required since the original, first, or second repeated measurement is not ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is not > 1.20 or 3 (1-g or 10-g respectively).

# 12. Simultaneous Transmission SAR Analysis

| RF Exposure Condition | Item | Capable Transmit Configurations | | |
|---|---|---|---|---|
| Body-worn | 1 | GSM(GPRS/EDGE) | + | ANT+ |
| | 2 | W-CDMA | + | ANT+ |

## 12.1. Sum of the SAR for GSM850 & ANT+

| RF Exposure conditions | Test Position | Standalone SAR (W/kg) | | ∑ 1-g SAR (W/kg) |
|---|---|---|---|---|
| | | WWAN | ANT+ | WWAN + ANT+ |
| | | ① | ② | ① + ② |
| Body-worn | Rear | 1.268 | 0.126 | **1.394** |
| | Front | 0.658 | 0.126 | 0.784 |
| | Edge 2 | 0.694 | 0.126 | 0.820 |
| | Edge 3 | 0.171 | 0.126 | 0.297 |
| | Edge 4 | 0.822 | 0.126 | 0.948 |

## 12.2. Sum of the SAR for GSM1900 & ANT+

| RF Exposure conditions | Test Position | Standalone SAR (W/kg) | | ∑ 1-g SAR (W/kg) |
|---|---|---|---|---|
| | | WWAN | ANT+ | WWAN + ANT+ |
| | | ① | ② | ① + ② |
| Body-worn | Rear | 0.759 | 0.126 | 0.885 |
| | Front | 0.426 | 0.126 | 0.552 |
| | Edge 2 | 0.380 | 0.126 | 0.506 |
| | Edge 3 | 0.147 | 0.126 | 0.273 |
| | Edge 4 | 0.706 | 0.126 | 0.832 |

## 12.3. Sum of the SAR for W-CDMA Band II & ANT+

| RF Exposure conditions | Test Position | Standalone SAR (W/kg) | | ∑ 1-g SAR (W/kg) |
|---|---|---|---|---|
| | | WWAN | ANT+ | WWAN + ANT+ |
| | | ① | ② | ① + ② |
| Body-worn | Rear | 0.723 | 0.126 | 0.849 |
| | Front | 0.679 | 0.126 | 0.805 |
| | Edge 2 | 0.319 | 0.126 | 0.445 |
| | Edge 3 | 0.120 | 0.126 | 0.246 |
| | Edge 4 | 0.615 | 0.126 | 0.741 |

## 12.4. Sum of the SAR for W-CDMA Band IV & ANT+

| RF Exposure conditions | Test Position | Standalone SAR (W/kg) | | ∑ 1-g SAR (W/kg) |
|---|---|---|---|---|
| | | WWAN | ANT+ | WWAN + ANT+ |
| | | ① | ② | ① + ② |
| Body-worn | Rear | 0.687 | 0.126 | 0.813 |
| | Front | 0.662 | 0.126 | 0.788 |
| | Edge 2 | 0.460 | 0.126 | 0.586 |
| | Edge 3 | 0.205 | 0.126 | 0.331 |
| | Edge 4 | 0.331 | 0.126 | 0.457 |

## 12.5. Sum of the SAR for W-CDMA Band V & ANT+

| RF Exposure conditions | Test Position | Standalone SAR (W/kg) | | ∑ 1-g SAR (W/kg) |
|---|---|---|---|---|
| | | WWAN | ANT+ | WWAN + ANT+ |
| | | ① | ② | ① + ② |
| Body-worn | Rear | 0.491 | 0.126 | 0.617 |
| | Front | 0.567 | 0.126 | 0.693 |
| | Edge 2 | 0.273 | 0.126 | 0.399 |
| | Edge 3 | 0.067 | 0.126 | 0.193 |
| | Edge 4 | 0.327 | 0.126 | 0.453 |

**Conclusion:**

Simultaneous transmission SAR measurement (Volume Scan) is not required because the sum of the 1-g SAR is < 1.6 W/kg.

# Appendixes

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

**15U21180-S1V3 SAR_App A Photos & Ant. Locations**

**15U21180-S1V3 SAR_App B System Check Plots**

**15U21180-S1V3 SAR_App C Highest Test Plots**

**15U21180-S1V1 SAR_App D Tissue Ingredients**

**15U21180-S1V3 SAR_App E Probe Cal. Certificates (1 of 2)**

**15U21180-S1V3 SAR_App E Probe Cal. Certificates (2 of 2)**

**15U21180-S1V3 SAR_App F Dipole Cal. Certificates**

**END OF REPORT**