SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
SMARTPHONE

FCC ID: BCG-E8441A, BCG-E8442A

Model Name:
A3106, A3108

Report Number: 14523773-S1V3
Issue Date: 8/24/2023

Prepared for
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CERT #0751.05

Revision History

Rev.	Date	Revisions	Revised By
V1	8/10/2023	Initial Issue	--
V2	8/18/2023	Added iPD test results	Coltyce Sanders
V3	8/24/2023	Section 1 & 7: Updated note	Coltyce Sanders

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1. Attestation of Test Results

Applicant Name	APPLE INC.						
FCC ID	BCG-E8441A, BCG-E8442A						
Model Name	A3106, A3108						
Applicable Standards	FCC 47 CFR § 2.1093 IEEE Std 1528-2013						
Exposure Category	SAR Limits (W/Kg)						
	Peak spatial-average (1g of tissue)				Extremities (hands, wrists, ankles, etc.) (10g of tissue)		
General population / Uncontrolled exposure	1.6				4		
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)						
	TNE	PCE	CBE	DTS	NII	DSS	DXX (10g)
Worst Case from **BCG-E8440A** (A3105)	0.938	0.947	0.949	1.132	1.107	0.917	0.017
Variant Models	Worst-Case SAR for Variant Models						
BCG-E8441A (A3106)	0.791	0.797	0.852	0.903	0.662	0.927	0.004
BCG-E8442A (A3108)	N/A	0.784	0.775	0.778	0.691	0.632	0.006
Exposure Category / Applicable limit	Radiofrequency (RF) Radiation Exposure (above 6GHz)						
	☒ Uncontrolled (mW/cm^2 over 4 cm^2) 30 min average				☐ Occupational/controlled (mW/cm^2 over 4 cm^2) 6 min average		
	1.0				5		
Worst Case from **BCG-E8440A** (A3105)	Highest Reported PD Result (mW/cm^2 over 4cm^2)						
	0.702						
BCG-E8441A (A3106)	0.569						
BCG-E8442A (A3108)	0.604						
Date Tested	7/20/2023 to 8/4/2023 and 8/18/2023						
Test Results	Pass						

This application for certification is leveraging the data reuse procedure from TCB workshop April 2021; RF Exposure Procedures (Remarks on Test Reductions via Data Referencing for Closely Related Products) based on reference FCC ID: **BCG-E8440A** (UL SAR report# 14523772-S1) and (UL PD report # 14523772-S10) to cover variants FCC ID: **BCG-ECG8441A** and **BCG-ECG8442A.** The major difference between the reference model and the variant models is that support for some LTE/5GNR bands and MSS is disabled via software in the variant models. All other circuitry and features are identical. The data reuse test plan was approved via manufacturer KDB inquiry.

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested can demonstrate compliance with the requirements as documented in this report.

This report contains data provided by the customer which can impact the validity of results. UL Verification Services Inc. is only responsible for the validity of results after the integration of the data provided by the customer.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not considered unless noted otherwise.

Approved & Released By:	Prepared By:
Devin Chang Senior Test Engineer UL Verification Services Inc.	Christopher Kuwatani Laboratory Engineer 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:

- 248227 D01 802.11 Wi-Fi SAR v02r02
- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 648474 D04 Handset SAR v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02
- 941225 D01 3G SAR Procedures v03r01
- 941225 D05 SAR for LTE Devices v02r05
- 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01r02
- 941225 D06 Hotspot Mode v02r01

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

- **TCB workshop** October 2014; RF Exposure Procedures (Other LTE Considerations)
- **TCB workshop** April 2015; RF Exposure Procedures (Overlapping LTE Bands)
- **TCB workshop** October 2015; RF Exposure Procedures (KDB 941225 D05A)
- **TCB workshop** April 2016; RF Exposure Procedures (LTE Carrier Aggregation for DL)
- **TCB workshop** October 2016; RF Exposure Procedures (LTE Carrier Aggregation for UL)
- **TCB workshop** October 2016; RF Exposure Procedures (Bluetooth Duty Factor)
- **TCB workshop** October 2016; RF Exposure Procedures (DUT Holder Perturbations)
- **TCB workshop** May 2017; RF Exposure Procedures (Broadband Liquid Above 3 GHz)
- **TCB workshop** May 2017; RF Exposure Procedures (LTE Band 41 Power Class 2)
- **TCB workshop** November 2017; RF Exposure Procedures (LTE UL/DL Carrier Aggregation SAR)
- **TCB workshop** April 2018; RF Exposure Procedures (LTE DL CA SAR Test Exclusion)
- **TCB workshop** October 2018; RF Exposure Procedures (LTE Inter-Band Uplink Carrier Aggregation – Interim Procedures)
- **TCB workshop** April 2019; RF Exposure Procedures (802.11ax SAR Testing)
- **TCB workshop** November 2019; RF Exposure Policy Updates (5G NR FR1 NSA EN-DCUE SAR Evaluations)
- **TCB workshop** October 2020; 5G and RF Exposure Procedures (U-NII 6-7 GHz SAR Testing)
- **TCB workshop** April 2021; RF Exposure Procedures (Remarks on Test Reductions via Data Referencing for Closely Related Products)

3. Facilities and Accreditation

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

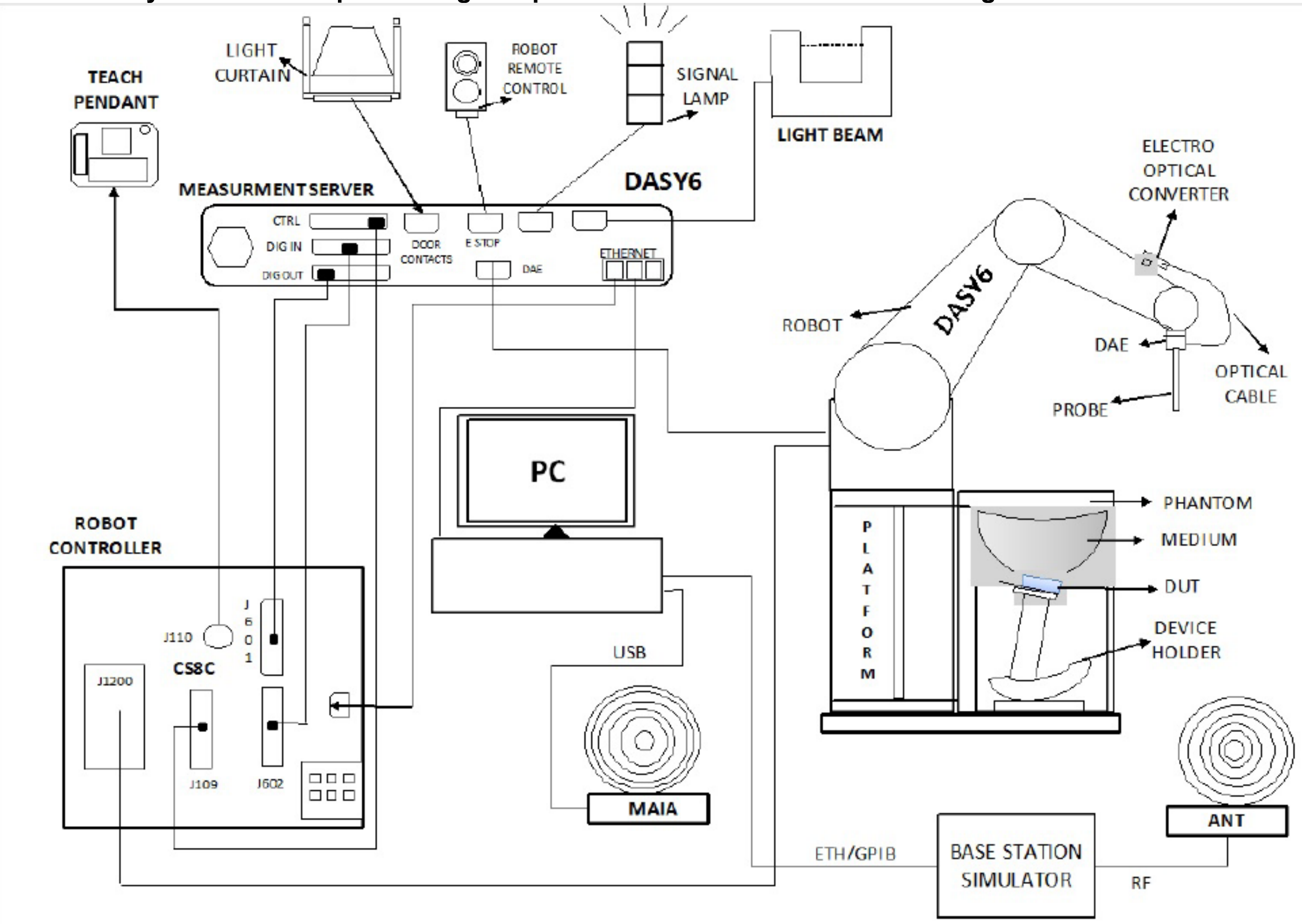
47173 Benicia Street	47266 Benicia Street
SAR Labs A to I	SAR Labs 1 to 19

UL Verification Services Inc. is accredited by A2LA, Certificate Number 0751.05

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY 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 Win10 and the DASY6/8[1] 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.

[1] DASY6/8 software used: DASY6.16.2 or DASY8.16.2 and older generations.

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 IEC/IEEE 62209-1528, 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: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 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

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</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.
* 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 ≤ 1.4 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.</td></tr>
</table>

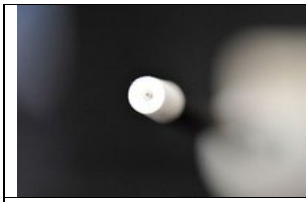
Step 4: Power drift measurement

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

4.3. Power Density Measurement System

4.3.1. EUmmWVx / E-Field 5G Probe

E-Field mm-Wave Probe for General Near-Field Measurements

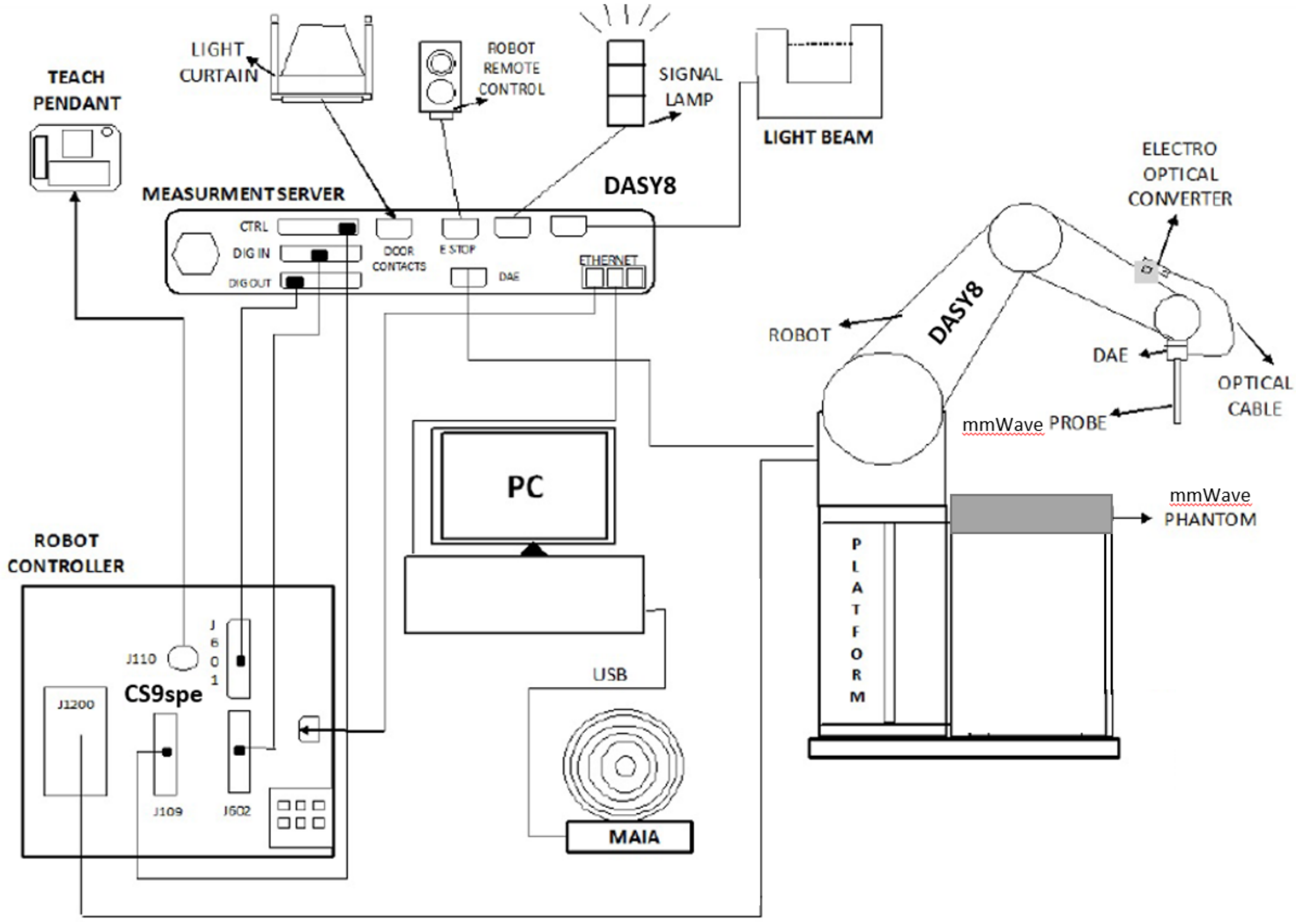
	Two dipoles optimally arranged to obtain pseudo-vector information Minimum 3 measurements/point, 120º rotated around probe axis Sensors (0.8mm length) printed on glass substrate protected by high density foam Low perturbation of the measured field Requires positioner which can do accurate probe rotation
Frequency Range	750 MHz – 110 GHz (EUmmWV4)
Dynamic Range	< 20 V/m - 10'000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm (DASY8)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm Sensor displacement to probe's calibration point: < 0.3 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 6GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction (DASY8 Module mmWave)
Compatibility	cDASY6/8 Module mmWave V3.2.2.2358

4.3.2. Data Acquisition Electronics(DAE)

	Serial optical link for communication with DASY embedded system (fully remote controlled) Two-step probe touch detector for mechanical surface detection and emergency robsot stop
Measurement Range	−100 – +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)
Input Offset Voltage	<5 µV (with auto zero)
Input Resistance	200 Mohm
Input Bias Current	<50 fA
Battery Power	>10 hours of operation (with two 9.6 V NiMH batteries)
Dimensions (L × W × H)	60 × 60 × 68 mm

4.3.3. Measurement System

The DASY6/8 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).
- The EUmmWVx probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse.
- 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 Win10 and the DASY6/8[2] software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom which is specialized for 5G other accessories according to the targeted measurement.

[2] DASY8 software used: DASY6/8 mmWave V3.2.2.2358 and older generations.

4.4. Power Density Measurement Procedures

4.4.1. System Verification Scan Procedures

cDASY6/8 Module mmWave supports “5G Scan”, a fine resolution scan performed on two different planes which is used to reconstruct the E- and H-fields as well as the power density; the average power density is derived from this measurement.

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 devise under test.

Step 2: 5G Scan
The steps in the X, Y, and Z directions are specified in terms of fractions of the signal wavelength, lambda. Area Scan Parameters extracted from SPEAG cDASY6 System Handbook; part 4 cDASY6/8 Module mmWave.

Recommended settings for measurement of verification sources

Frequency [GHz]	Grid step	Grid extent X/Y [mm]	Measurement points
10	0.125 $\left(\frac{\lambda}{8}\right)$	60/60	18×18
30	0.25 $\left(\frac{\lambda}{4}\right)$	60/60	26×26
45	0.25 $\left(\frac{\lambda}{4}\right)$	42/42	28×28
60	0.25 $\left(\frac{\lambda}{4}\right)$	32.5/32.5	28×28
90	0.25 $\left(\frac{\lambda}{4}\right)$	30/30	38×38

The minimum distance of probe sensors to the verification source surface, horn antenna, is 10 mm for 10 GHz and 5.55mm for 30 GHz and above.

Step 3: 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.
When the drift is larger than ± 5 %, the test is repeated from step1.

4.4.2. Scan Procedures

Step 1: Power Reference Measurement
Same as System Verification Scan Procedures step 1.

Step 2: 5G Scan
Same as System Verification Scan Procedures step 2. But measurement area is defined based on TCB workshop April 2019, “A sufficiently large measurement region and proper measurement spatial resolution are required to maintain field reconstruction accuracy”.
–Fields at the measurement region boundary should be ~20-30 dB below the peaks

Step 3: Power drift measurement
Same as System Verification Scan Procedures step 3.
When the drift is smaller than ± 5 %, it is considered in the uncertainty budget if drifts larger than 5%, uncertainty is re-calculated.

4.5. Test Equipment

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

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Vector Network Analyzer	ROHDE & SCHWARZ	ZNLE6	101274-mn	2/19/2024
Dielectric Probe kit	SPEAG	DAK-3.5	1103	2/28/2024
Shorting Block	SPEAG	DAK-1.2/3.5 Short	SM DAK 200 BA	2/28/2024
Thermometer	Fisher Scientific	Traceable	122529162	8/9/2023
Vector Network Analyzer	ROHDE & SCHWARZ	ZNLE6	101273-VA	2/19/2024
Dielectric Probe kit	SPEAG	DAK-3.5	1082	9/19/2023
Dielectric Probe kit	SPEAG	DAK-12	1128	1/16/2024
Shorting Block	SPEAG	DAK-1.2/3.5 Short	SM DAK 200 BA	9/19/2023
Shorting Block	SPEAG	DAK-12 Short	SM DAK 220 AC	1/16/2024
Thermometer	Fisher Scientific	Traceable	140493798	4/30/2024
Vector Network Analyzer	Copper Mountain Tech	R140N	21130078	4/30/2024
Dielectric Probe kit	SPEAG	DAK-3.5	1087	11/17/2023
Shorting Block	SPEAG	DAK-1.2/3.5 Short	SM DAK 200 BA	11/17/2023
Thermometer	Fisher Scientific	Traceable	170064398	4/10/2024

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Agilent	N5181A	MY50140610	1/31/2024
Power Meter	HP	437B	3125U11364	1/31/2024
Power Meter	HP	437B	3125U11347	1/31/2024
Power Sensor	HP	8481A	3318A92374	1/31/2024
Power Sensor	HP	8481A	1926A27049	1/31/2024
Amplifier	Miteq	AMF-4D-00400600-50-30P	1795093	N/A
Bi-directional coupler	Werlatone	C8060-102	2711	N/A
DC Power Supply	Sorensen	XT 15-4	1802A01877	N/A
MXG Analog Signal Generator	Agilent	N5181A	MY50140630	1/31/2024
Power Meter	Keysight	N1912A	MY55196004	1/31/2024
Power Sensor	Agilent	N1921A	MY53260010	1/31/2024
Power Sensor	Agilent	N1921A	MY52260009	1/31/2024
Amplifier	Miteq	AMF-4D-00400600-50-30P	1795092	N/A
Bi-directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	Sorensen	XT 15-4	PRE0178948	N/A
Signal Genarator	R&S	SMB 100A	171706	2/29/2024
Power Meter	Keysight	N1912A	MY55196007	1/31/2024
Power Sensor	Agilent	N1921A	MY53020038	1/31/2024
Power Sensor	R&S	NRP18A	171503	2/29/2024
Bi-directional coupler	Werlatone	C8060-102	4054	N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab D)	SPEAG	EX3DV4	7587	4/18/2024
E-Field Probe (SAR Lab 2)	SPEAG	EX3DV4	3989	1/26/2024
E-Field Probe (SAR Lab 3)	SPEAG	EUmmWV4	9589	9/20/2024
E-Field Probe (SAR Lab 8)	SPEAG	EX3DV4	7807	4/11/2024
E-Field Probe (SAR Lab 13)	SPEAG	EX3DV4	3990	2/17/2024
Data Acquisition Electronics (SAR Lab D)	SPEAG	DAE4	1239	3/16/2024
Data Acquisition Electronics (SAR Lab 2)	SPEAG	DAE4	1257	9/20/2023
Data Acquisition Electronics (SAR Lab 3)	SPEAG	DAE4	1377	9/15/2023
Data Acquisition Electronics (SAR Lab 8)	SPEAG	DAE4	1799	4/4/2024
Data Acquisition Electronics (SAR Lab 13)	SPEAG	DAE4	1545	2/14/2024
Thermometer	TRACEABLE	6530CC	170361	2/29/2024
Thermometer	TRACEABLE	6530CC	155512	2/29/2024
Thermometer	TRACEABLE	6530CC	174046	2/29/2024
System Validation Dipole	SPEAG	CLA13	1008	1/12/2024
System Validation Dipole	SPEAG	D1900V2	5d163	10/28/2023
System Validation Dipole	SPEAG	D2450V2	706	1/20/2024
System Validation Dipole	SPEAG	D2450V2	899	4/18/2024
System Validation Dipole	SPEAG	D2600V2	1036	4/11/2024
System Validation Dipole	SPEAG	D3700V2	1110	11/20/2023
5G Verification Source	SPEAG	5G Verification Source 10GHz	1015	9/13/2023

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Keysight	N1911A	MY55196015	1/31/2024
Power Sensor	Agilent	N1921A	MY52270022	1/31/2024
Wideband Radio Communication Tester	R&S	CMW500	80580	2/29/2024
Wideband Radio Communication Tester	R&S	CMW500	85780	2/29/2024
Wideband Radio Communication Tester	R&S	CMW500	208643	2/29/2024
Wideband Radio Communication Tester	R&S	CMW500	208049	2/29/2024
Wideband Radio Communication Tester	R&S	CMW500	81849	2/29/2024
Wideband Radio Communication Tester	R&S	CMW500	85781	2/29/2024

5. Measurement Uncertainty

SAR

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

Therefore, the measurement uncertainty is not required.

Power Density

a		b	c	d f(d,k)	e	f = b×*e/d*	g
Error Description		Unc.Value (±dB)	Probab. Distri.	Div.	*ci*	Std. Unc. (±dB)	vi
Uncertainty terms dependent on the measurement system							
CAL	Calibration Repeatability	0.49	Normal	1	1	0.49	∞
COR	Probe correction	0	Rectangular	1.732	1	0.00	∞
FRS	Frequency response (BW □1 GHz)	0.20	Rectangular	1.732	1	0.12	∞
SCC	Sensor cross coupling	0	Rectangular	1.732	1	0.00	∞
ISO	Isotropy	0.50	Rectangular	1.732	1	0.29	∞
LIN	Linearity	0.20	Rectangular	1.732	1	0.12	∞
PSC	Probe scattering	0	Rectangular	1.732	1	0.00	∞
PPO	Probe positioning offset	0.30	Rectangular	1.732	1	0.17	∞
PPR	Probe positioning repeatability	0.04	Rectangular	1.732	1	0.02	∞
SMO	Sensor mechanical offset	0	Rectangular	1.732	1	0.00	∞
PSR	Probe spatial resolution	0	Rectangular	1.732	1	0.00	∞
FLD	Field impedance dependance	0	Rectangular	1.732	1	0.00	∞
APD	Amplitude and phase drift	0	Rectangular	1.732	1	0.00	∞
APN	Amplitude and phase noise	0.04	Rectangular	1.732	1	0.02	∞
TR	Measurement area truncation	0	Rectangular	1.732	1	0.00	∞
DAQ	Data acquisition	0.03	Normal	1	1	0.03	∞
SMP	Sampling	0	Rectangular	1.732	1	0.00	∞
REC	Field reconstruction	0.60	Rectangular	1.732	1	0.35	∞
TRA	Forward transformation	0	Rectangular	1.732	1	0.00	∞
SCA	Power density scaling	-	Rectangular	1.732	1	-	∞
SAV	Spatial averaging	0.10	Rectangular	1.732	1	0.06	∞
SDL	System detection limit	0.04	Rectangular	1.732	1	0.02	∞
Uncertainty terms dependent on the DUT and environmental factors							
PC	Probe coupling with DUT	0	Rectangular	1.732	1	0	∞
MOD	Modulation response	0.40	Rectangular	1.732	1	0.23	∞
IT	Integration time	0	Rectangular	1.732	1	0	∞
RT	Response time	0	Rectangular	1.732	1	0	∞
DH	Device holder influence	0.10	Rectangular	1.732	1	0.06	∞
DAQ	DUT alignment	0	Rectangular	1.732	1	0	∞
AC	RF ambient conditions	0.04	Rectangular	1.732	1	0.02	∞
AR	Ambient reflections	0.04	Rectangular	1.732	1	0.02	∞
MSI	Immunity / secondary reception	0	Rectangular	1.732	1	0	∞
DRI	Drift of the DUT	0.21	Rectangular	1.732	1	0.12	∞
Combined Standard Uncertainty Uc(f) =			RSS			0.76	∞
Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence =						1.52	

6. Dielectric Property Measurements & System Check

6.1. 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.

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

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (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

Dielectric Property Measurements

SAR Lab	Date	Band (MHz)	Tissue Type	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
					Measured	Target	Delta	Measured	Target	Delta
D	7/31/2023	2450	Head	2450	39.63	39.2	1.10%	1.79	1.80	-0.50%
				2400	39.66	39.3	0.92%	1.76	1.75	0.36%
				2500	39.52	39.1	0.98%	1.82	1.85	-1.62%
D	8/7/2023	2450	Head	2450	40.35	39.2	2.93%	1.78	1.80	-1.11%
				2400	40.42	39.3	2.86%	1.75	1.75	-0.04%
				2500	40.23	39.1	2.79%	1.81	1.85	-2.27%
8	7/31/2023	1900	Head	1900	39.30	40.0	-1.75%	1.42	1.40	1.07%
				1850	39.39	40.0	-1.53%	1.38	1.40	-1.29%
				1920	39.26	40.0	-1.85%	1.43	1.40	2.07%
8	7/31/2023	2450	Head	2450	38.51	39.2	-1.76%	1.80	1.80	-0.06%
				2400	38.59	39.3	-1.80%	1.76	1.75	0.42%
				2500	38.44	39.1	-1.78%	1.84	1.85	-0.92%
8	7/31/2023	2600	Head	2600	38.27	39.0	-1.90%	1.93	1.96	-1.89%
				2495	38.45	39.1	-1.77%	1.83	1.85	-0.90%
				2690	38.10	38.9	-2.05%	2.00	2.06	-3.03%
13	8/3/2023	3700	Head	3700	37.70	37.7	0.00%	3.13	3.12	0.41%
				3600	37.89	37.8	0.20%	3.03	3.01	0.53%
				3800	37.50	37.6	-0.23%	3.24	3.22	0.64%
2	7/20/2023	13	Head	13	55.69	55.0	1.25%	0.72	0.75	-4.32%
				12	55.86	55.0	1.56%	0.72	0.75	-4.31%
				14	55.36	55.0	0.65%	0.72	0.75	-4.32%

6.2. 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.

<u>System Check Results</u>

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. Refer to Appendix B for the SAR System Check Plots.

SAR Lab	Date	Tissue Type	Dipole Type & Serial Number	Dipole Cal. Due Date	Measured results for 1-g SAR				Measured results for 10-g SAR				Plot No.
					Zoom Scan at 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	Zoom Scan at 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	
D	7/31/2023	Head	D2450V2 SN: 899	4/18/2024	5.38	53.8	51.9	**3.66%**	2.61	26.1	24.4	6.97%	1
D	8/7/2023	Head	D2450V2 SN: 706	1/20/2024	4.99	49.9	52.3	**-4.59%**	2.40	24.0	24.5	-2.04%	2
8	7/31/2023	Head	D1900V2 SN: 5d163	10/28/2023	4.01	40.1	39.1	**2.56%**	2.10	21.0	20.4	2.94%	3
8	7/31/2023	Head	D2450V2 SN: 899	4/18/2024	5.57	55.7	51.9	**7.32%**	2.63	26.3	24.4	7.79%	4
8	7/31/2023	Head	D2600V2 SN: 1036	4/11/2024	5.97	59.7	55.4	**7.76%**	2.72	27.2	24.9	9.24%	5
13	8/3/2023	Head	D3700V2 SN: 1110	11/20/2023	6.72	67.2	64.1	**4.85%**	2.56	25.6	23.6	8.47%	6
SAR Lab	Date	Tissue Type	Dipole Type & Serial Number	Dipole Cal. Due Date	Measured results for 1-g SAR				Measured results for 10-g SAR				Plot No.
					Zoom Scan (1 W)	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	Zoom Scan (1 W)	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	
2	7/20/2023	Head	CLA13 SN: 1008	1/12/2024	0.509	0.509	0.544	**-6.43%**	0.314	0.314	0.338	-7.10%	7

6.3. Power Density System Performance Check

Per Nov 2017, TCB Workshop
System validation is required before a system is deployed for measurement.
System check is also required before each series of continuous measurement and, as applicable, repeated at least weekly.
Peak and spatially averaged power density at the peak location(s) must be compared to calibrated results according to the defined test conditions:

- the same spatial resolution and measurement region used in the waveguide calibration should be applied to system validation and system check.
- 1 cm^2 and 4 cm^2 spatial averaging have been recommended in the AHG10 draft TR with reference targets available for specific waveguide.
- power density distribution should also be verified, both spatially (shape) and numerically (level) through visual inspection for noticeable differences.
- the measured results should be within 10% of the calibrated targets.

The system components, software settings and other system parameters shall be the same as those used for the compliance tests. The system check shall be performed at the closest probe calibration frequency point as in the compliance tests, e.g., if the EUT operates at 35 GHz, it is recommended to perform the validation at 30 GHz.

System Check Results

SAR Lab	Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Data	Measured psPDn (W/m^2) over $4cm^2$	Normalized to 19.9 dBm (W/m^2)	Target psPDn (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±10 %	Measured psPDtot (W/m^2) over $4cm^2$	Normalized to 19.9 dBm (W/m^2)	Target psPDtot (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±10 %	Plot
3	8/18/2023	10	1015	9/13/2023	53.9	61.2	56.0	0.38	9%	54.2	61.5	57.1	0.32	8%	8

Note(s):

- The input power level used for system performance check is the same input power level as calibration data, 19.3 dBm.
- Refer to Appendix B for the System Performance Check Plot.

7. Test Rationale

7.1. Purpose

This application for certification is leveraging the data reuse procedure from TCB workshop April 2021; RF Exposure Procedures (Remarks on Test Reductions via Data Referencing for Closely Related Products) based on reference FCC ID: BCG-E8440A (UL SAR report# 14523772-S1) and (UL PD report # 14523772-S10) to cover variants FCC ID: BCG-ECG8441A and BCG-ECG8442A. The major difference between the reference model and the variant models is that support for some LTE/5GNR bands and MSS is disabled via software in the variant models. All other circuitry and features are identical. The data reuse test plan was approved via manufacturer KDB inquiry.

7.2. Data Reuse Approach

Full RF exposure testing was performed on the reference model. The configurations with the highest SAR results for each equipment class and highest PD result were identified. These configurations were tested on the variant models.

The variation in SAR/PD results was well within the uncertainty budget of the SAR/PD test equipment. The variant SAR/PD results and worst-case reference model SAR/PD results are summarized in § 1.

For operations in the UNII bands the operating band with the highest exposure ratio across all supported UNII bands (1, 2A, 2C, 3, 5-8) was selected for the spot checks. This was UNII band 6.

8. Measured and Reported (Scaled) Results

8.1. A3106 Spot Check Results

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 1-g Meas. (W/kg)	A3105 1-g Scaled (W/kg)	A3105 10-g Meas. (W/kg)	A3105 10-g Scaled (W/kg)	A3106 1-g Meas. (W/kg)	A3106 1-g Scaled (W/kg)	A3106 10-g Meas. (W/kg)	A3106 10-g Scaled (W/kg)	Plot No.
TNE	LTE	B53	ANT 2	Body & Hotspot	QPSK	Mode B	5	Back	60197	2489.2		20.5	19.9	0.817	0.938	0.321	0.369	0.689	**0.791**	0.279	0.320	1
PCE	LTE	B41 FCC PC3	ANT 2	Body & Hotspot	QPSK	Mode B	5	Back	40185	2549.5		20.5	19.9	0.825	0.947	0.328	0.377	0.694	**0.797**	0.285	0.327	2
CBE	FR1	n48	ANT 9	Body & Hotspot	DFT-s-OFDM π/2 BPSK	Mode B	5	Back	642888	3643.3		20.8	20.1	0.808	0.949	0.949	1.115	0.725	**0.852**	0.264	0.310	3
DTS	Wi-Fi	2.4 GHz	ANT 4	Hotspot	802.11b	Power State 1 Mode B	5	Edge Right	11	2462.0	100%	19.8	18.4	0.826	1.132	0.345	0.473	0.659	**0.903**	0.277	0.379	4
DSSS	Bluetooth	(2.4 GHz)	ANT 4	Hotspot	LE (1 Mbps)	PStandalone Power Mode B	5	Edge Right	39	2441.0	76.60%	20.5	19.1	0.666	0.917	0.280	0.386	0.673	**0.927**	0.282	0.388	5

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 10-g Meas. (W/kg)	A3105 10-g Scaled (W/kg)	A3106 10-g Meas. (W/kg)	A3106 10-g Scaled (W/kg)	Plot No.
DXX	NFC	13.56MHz	Primary	Extremity	Type A		0	Edge Top		13.56				0.006		**0.004**		6

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 psPDtot Meas. (mW/cm²)	A3105 psPDtot Scaled (mW/cm²)	A3106 psPDtot Meas. (mW/cm²)	A3106 psPDtot Scaled (mW/cm²)	Plot No.
U-NII	6E	U-NII 6	ANT 6	Body & Hotspot	802.11ax (HE80)	Power State 1 & 2 & 3 Mode B	2	Back	103	6465.00	98.24%	8.75	8.25	0.615	0.702	0.498	**0.569**	7

8.2. A3108 Spot Check Results

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 1-g Meas. (W/kg)	A3105 1-g Scaled (W/kg)	A3105 10-g Meas. (W/kg)	A3105 10-g Scaled (W/kg)	A3108 1-g Meas. (W/kg)	A3108 1-g Scaled (W/kg)	A3108 10-g Meas. (W/kg)	3108 10-g Scaled (W/kg)	Plot No.
PCE	LTE	B41 FCC PC3	ANT 2	Body & Hotspot	QPSK	Mode B	5	Back	40185	2549.5		20.5	19.9	0.825	0.947	0.328	0.377	0.683	**0.784**	0.278	0.319	8
CBE	FR1	n48	ANT 9	Body & Hotspot	DFT-s-OFDM π/2 BPSK	Mode B	5	Back	642888	3643.3		20.8	20.1	0.808	0.949	0.949	1.115	0.660	**0.775**	0.251	0.295	9
DTS	Wi-Fi	2.4 GHz	ANT 4	Hotspot	802.11b	Power State 1 Mode B	5	Edge Right	11	2462.0	99.84%	19.8	18.4	0.826	1.132	0.345	0.473	0.568	**0.778**	0.238	0.326	10
DSSS	Bluetooth	(2.4 GHz)	ANT 4	Hotspot	LE (1 Mbps)	PStandalone Power Mode B	5	Edge Right	39	2441.0	76.60%	20.5	19.1	0.666	0.917	0.280	0.386	0.459	**0.632**	0.194	0.267	11

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 10-g Meas. (W/kg)	A3105 10-g Scaled (W/kg)	A3108 10-g Meas. (W/kg)	3108 10-g Scaled (W/kg)	Plot No.
DXX	NFC	13.56MHz	Primary	Extremity	Type A		0	Edge Top		13.56				0.006		**0.006**		12

Equipment Class	Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	A3105 psPDtot Meas. (mW/cm²)	A3105 psPDtot Scaled (mW/cm²)	A3108 psPDtot Meas. (mW/cm²)	A3108 psPDtot Scaled (mW/cm²)	Plot No.
U-NII	6E	U-NII 6	ANT 6	Body & Hotspot	802.11ax (HE80)	Power State 1 & 2 & 3 Mode B	2	Back	103	6465.00	98.24%	8.75	8.25	0.615	0.702	0.529	**0.604**	13

Appendixes

Refer to separated files for the following appendixes.

Appendix A: SAR Setup Photos

Appendix B: SAR System Check Plots

Appendix C: SAR Highest Test Plots

Appendix D: SAR Tissue Ingredients

Appendix E: SAR Probe Certificates

Appendix F: SAR Dipole Certificates

Appendix G: PD Verification source Certificate

END OF REPORT