SAR EVALUATION REPORT

IEEE Std 1528-2013

For
SMARTPHONE

FCC ID: BCG-E8666A

Model Name: A3083

Report Number: 14982436-S8V1
Issue Date: 7/19/2024

Prepared for
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ACCREDITED
CERT #0751.05

Revision History

Rev.	Date	Revisions	Revised By
V1	7/19/2024	Initial Issue	--

Table of Contents

1. Attestation of Test Results

Applicant Name	APPLE INC.
FCC ID	BCG-E8666A
Model Name	A3083
Applicable Standards	Published RF exposure KDB procedures IEEE Std 1528-2013
Date Tested	7/14/2024 to 7/18/2024
Test Results	Pass

This test report is supplemental to UL SAR report 14982436-S1 and UL Smart Tx report 14982436-S5 Part 1. This report contains SAR and PD test results obtained while the DUT was transmitting with a MagSafe compatible battery pack (FCC ID: BCG-A2384) attached to the DUT. Refer to § 7 for a description of the modes tested as well as Standalone SAR and PD test results from UL SAR report 14982436-S1 and UL Smart Tx report 14982436-S5 Part 1

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.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are 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 A2LA, NIST, or any agency of the U.S. Government, or any agency of the U.S. government.

Approved & Released By:	Prepared By:
Devin Chang Senior Test Engineer UL Verification Services Inc.	Coltyce Sanders Staff 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:

SAR

- 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
- SPEAG DASY 6 System Handbook; part 4 cDASY6 Module mmWave
- IEC TR 63170: 2018

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)
- **TCB workshop** April 2022; RF Exposure Procedures (Sum-Peak Location Separation Ratio)
- **TCB workshop** April 2024; RF Exposure Updates (Accessories and Peripherals to RF Devices)

PD

- 447498 D01 General RF Exposure Guidance v06
- 865664 D02 RF Exposure Reporting v01r02
- 388624 D02 Pre-Approval Guidance List v18r05
- 248227 D01 802.11 Wi-Fi SAR v02r02
- SPEAG DASY8 System Handbook; part 4 DASY8 Module mmWave
- SPEAG DASY8 Application Note: SAR, APD & PD at 6 – 10 GHz (Version 5), April 2022
- IEC TR 63170: 2018

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

- TCB workshop November 2017; RF Exposure Procedures (Power Density Evaluation)
- TCB workshop October 2018; RF Exposure Procedures (Millimeter Wave Assessment)
- TCB workshop April 2019; RF Exposure Procedures (Millimeter Wave RF Exposure Evaluation)
- TCB workshop November 2019; RF Exposure Procedures (Millimeter Wave Scan Requirements)
- TCB workshop October 2020; RF Exposure Procedures (U NII 6-7 GHz RF Exposure)
- TCB workshop October 2022; RF Exposure Policies and Procedures (f-above-6 GHz Portable Devices)

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

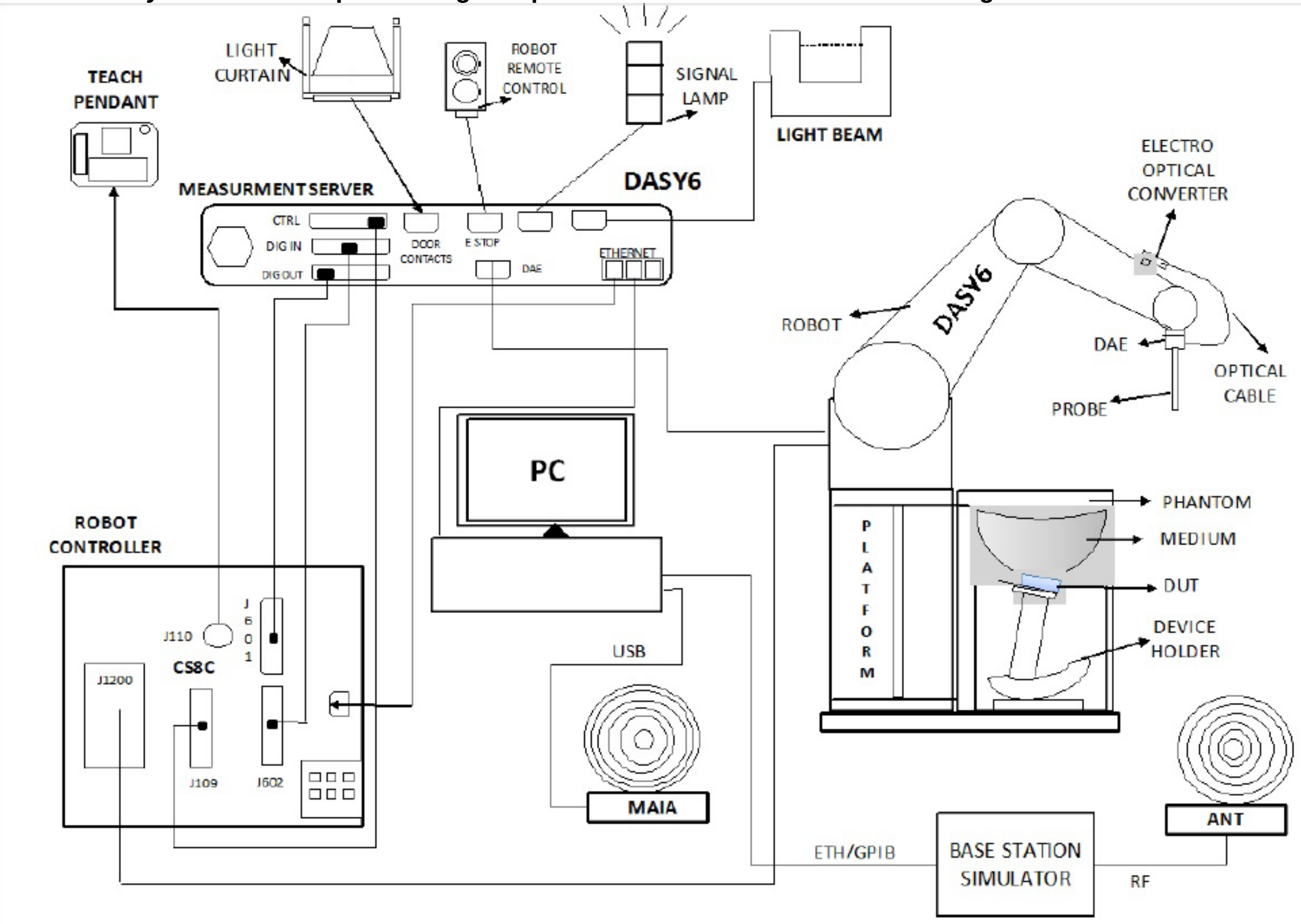
The Test Lab Conformity Assessment Body Identifier (CABID)

Location	CABID	Company Number
47173 Benicia Street, Fremont, CA, 94538 UNITED STATES	US0104	2324A
47266 Benicia Street, Fremont, CA, 94538 UNITED STATES		

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	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 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 4 – 5 GHz: ≤ 3 mm 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 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ $1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 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.

4.3. PD Measurement Procedures

4.3.1. System Verification Scan Procedures

DASY8 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 DASY8 System Handbook; part 4 DASY8 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 %, test is repeated from step1.

4.3.2. 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.

4.4. 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.

SAR

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Vector Network Analyzer	ROHDE & SCHWARZ	ZNLE6	101274-mn	2/28/2025
Vector Network Analyzer	ROHDE & SCHWARZ	ZNLE6	101273-va	2/28/2025
Vector Network Analyzer	Copper Mountain Tech	R140N	21130078	2/28/2025
Dielectric Probe kit	SPEAG	DAK-3.5	1087	11/1/2024
Dielectric Probe kit	SPEAG	DAK-3.5	1082	4/15/2025
Dielectric Probe kit	SPEAG	DAK-3.5	1103	2/12/2025
Dielectric Probe kit	SPEAG	DAK-12	1128	1/16/2025
Shorting Block	SPEAG	DAK-1.2/3.5 Short	SM DAK 200 DA	11/1/2024
Shorting Block	SPEAG	DAK-12 Short	SM DAK 220 AC	1/16/2025
Thermometer	Fisher Scientific	Traceable	122529162	1/31/2025

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Agilent	N5181A	MY50140610	1/31/2025
Power Meter	Keysight	N1911A	MY55196014	1/31/2025
Power Sensor	Agilent	N1921A	MY52270022	1/31/2025
Power Sensor	Agilent	N1921A	MY552260009	1/31/2025
Bi-directional coupler	Werlatone	C8060-102	4062	N/A
DC Power Supply	Sorensen	XT 15-4	1802A01877	N/A
Signal Genarator	R&S	SMB 100A	180969-yC	2/21/2025
Power Meter	Keysight	N1912A	MY55196008	1/31/2025
Power Sensor	Agilent	N1912A	MY53260001	1/31/2025
Power Sensor	Agilent	N1912A	MY52200012	1/31/2025
Bi-directional coupler	Mini-Circuits	ZUDC10-183+	1722	N/A
Signal Genarator	R&S	SMB 100A	180968-gX	2/16/2025
Power Sensor	R&S	NRP18A	100995-hs	2/28/2025
Power Meter	Keysight	N1912A	MY50001018	2/28/2025
Power Sensor	Agilent	N1912A	MY53260010	2/28/2025
Bi-directional coupler	Werlatone	C8060-102	2149	N/A
Signal Genarator	R&S	SMB 100A	180970-zC	2/28/2025
Power Sensor	R&S	NRP18A	100992-iu	2/28/2025
Power Meter	HP	437B	3125U12345	1/31/2025
Power Sensor	HP	8481A	2237A31744	1/31/2025
Bi-directional coupler	Werlatone	C8060-102	2710	N/A
MXG Analog Signal Generator	Agilent	N5181A	MY50140630	1/31/2025
Power Meter	Agilent	N1913A	MY53100006	1/31/2025
Power Meter	HP	437B	3125U11364	1/31/2025
Power Sensor	HP	8481A	3318A92374	1/31/2025
Power Sensor	HP	8487A	3318A03287	1/31/2025
Bi-directional coupler	Werlatone	C8060-102	4063	N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab 5)	SPEAG	EX3DV4	7779	5/10/2025
E-Field Probe (SAR Lab 6)	SPEAG	EX3DV4	7587	4/15/2025
E-Field Probe (SAR Lab 7)	SPEAG	EX3DV4	7501	3/14/2025
E-Field Probe (SAR Lab 15)	SPEAG	EX3DV4	7482	4/15/2025
E-Field Probe (SAR Lab 16)	SPEAG	EX3DV4	7850	10/27/2024
E-Field Probe (SAR Lab 17)	SPEAG	EX3DV4	7448	2/7/2025
Data Acquisition Electronics (SAR Lab 5)	SPEAG	DAE4	1439	4/24/2025
Data Acquisition Electronics (SAR Lab 6)	SPEAG	DAE4	1797	5/2/2025
Data Acquisition Electronics (SAR Lab 7)	SPEAG	DAE4	1357	1/9/2025
Data Acquisition Electronics (SAR Lab 15)	SPEAG	DAE4	1239	3/6/2025
Data Acquisition Electronics (SAR Lab 16)	SPEAG	DAE4	1673	5/13/2025
Data Acquisition Electronics (SAR Lab 17)	SPEAG	DAE4	1784	5/2/2025
Thermometer	TRACEABLE	6530CC	181175331	1/31/2025
Thermometer	TRACEABLE	6530CC	181073773	1/31/2025
Thermometer	TRACEABLE	6530CC	181062309	1/31/2025
Thermometer	TRACEABLE	6530CC	160643192	1/31/2025
System Validation Dipole**	SPEAG	D1900V2	5d140	4/14/2025
System Validation Dipole	SPEAG	D2300V2	1058	10/13/2024
System Validation Dipole**	SPEAG	D2450V2	706	1/20/2025
System Validation Dipole*	SPEAG	D2450V2	748	2/8/2025
System Validation Dipole**	SPEAG	D5GHzV2	1003	2/22/2025
System Validation Dipole**	SPEAG	D6.5GHzV2	1033	3/15/2025

Note(s):
**Dipole Calibration Date has been extended past 1 year. Impedance measurements have been performed to validate Dipole performance.

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Keysight	N1911A	MY55196015	1/31/2025
Power Sensor	Agilent	N1921A	MY52270022	1/31/2025
Power Meter	Keysight	N1911A	MY55196009	1/31/2025
Power Sensor	Agilent	N1921A	MY552260009	1/31/2025
Power Meter	Keysight	N1921A	MY55196007	1/31/2025
Power Sensor	Agilent	N1921A	MY53020038	1/31/2025
Power Meter	Keysight	N1911A	MY55196009	1/31/2025
Power Meter	Keysight	N1911A	MY55196009	2/28/2025
Power Sensor	Keysight	N1921A	MY55200004	1/31/2025
Wideband Radio Communication Tester	R&S	CMW500	134853-ud	2/28/2025
Wideband Radio Communication Tester	R&S	CMW500	164541-Ci	2/28/2025
Wideband Radio Communication Tester	R&S	CMW500	171875-WG	2/28/2025
Wideband Radio Communication Tester	R&S	CMW500	18172-XJ	2/28/2025
Spectrum Analyzer	Agilent	E4446A	MY45300064	2/28/2025

PD

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Signal Genarator	R&S	SMB 100A	180969-yC	2/21/2025
Power Meter	Keysight	N1912A	MY55196008	1/31/2025
Power Sensor	Agilent	N1912A	MY53260001	1/31/2025
Power Sensor	Agilent	N1912A	MY52200012	1/31/2025
Bi-directional coupler	Mini-Circuits	ZUDC10-183+	1722	N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab C)	SPEAG	EummWV4	9589	9/5/2024
E-Field Probe (SAR Lab D)	SPEAG	EummWV4	9619	3/8/2025
Data Acquisition Electronics (SAR Lab C)	SPEAG	DAE4	1621	4/12/2025
Data Acquisition Electronics (SAR Lab D)	SPEAG	DAE4	1472	1/16/2025
Thermometer	TRACEABLE	6530CC	181163673	1/31/2025
Thermometer	TRACEABLE	6530CC	181062308	12/31/2024
5G Verification Source	SPEAG	10 GHz	1015	9/5/2024
5G Verification Source	SPEAG	30 GHz	1117	9/20/2024

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Keysight	N1911A	MY55196015	1/31/2025
Power Sensor	Agilent	N1921A	MY52270022	1/31/2025
Power Meter	Keysight	N1911A	MY55196009	1/31/2025
Power Sensor	Agilent	N1921A	MY552260009	1/31/2025

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.

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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 o set	0.30	Rectangular	1.732	1	0.17	∞
PPR	Probe positioning repeatability	0.04	Rectangular	1.732	1	0.02	∞
SMO	Sensor mechanical o set	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. SAR Dielectric Property Measurements and System Checks

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

System Verification

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.

SAR Liquid and System Check Results

Liquid Check											System Check																	
SAR Lab	Date	Tissue Type	Band (MHz)	Freq. (MHz)	Relative Permittivity (εr)			Conductivity (σ)			Date	Dipole Type & Serial Number	Dipole Cal. Due Date	Input Power (dBm)	Measured results for 1-g SAR				Measured results for 10-g SAR				Measured results for APD 4 cm^2				Plot No.
					Measured	Target	Delta	Measured	Target	Delta					Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	
SAR 5	7/18/2024	Head	2450	2450	39.78	39.20	1.48%	1.81	1.80	0.56%	7/18/2024	D2450V2 SN: 706	1/20/2025	20.0	5.36	53.6	52.3	2.49%	2.54	25.4	24.5	3.67%	N/A	N/A	N/A	N/A	1
				2400	39.82	39.30	1.33%	1.76	1.75	0.48%																	
				2500	39.68	39.14	1.39%	1.85	1.85	-0.22%																	
SAR 6	7/15/2024	Head	6500	6500	33.56	34.50	-2.72%	6.24	6.07	2.75%	7/15/2024	D6.5GHzV2 SN: 1033	3/15/2025	19.0	24.8	312	288	8.41%	4.52	56.9	53.1	7.16%	110	1385	1300	6.52%	2
				5900	34.74	35.20	-1.31%	5.50	5.38	2.29%																	
				7200	32.36	33.70	-3.98%	6.99	6.89	1.48%																	
SAR 7	7/15/2024	Head	5750	5750	33.71	35.36	-4.67%	5.04	5.21	-3.33%	7/15/2024	D5GHzV2 SN: 1003 (5.75 GHz)	2/22/2025	20.0	7.22	72.2	79.3	-8.95%	2.12	21.2	22.4	-5.36%	N/A	N/A	N/A	N/A	3
				5700	33.93	35.42	-4.21%	4.94	5.16	-4.31%																	
				5850	33.56	35.30	-4.93%	5.23	5.32	-1.69%																	
SAR 15	7/16/2024	Head	2300	2300	41.75	39.47	5.77%	1.70	1.66	2.36%	7/16/2024	D2300V2 SN: 1058	10/13/2024	20.0	4.62	46.2	48.5	-4.74%	2.22	22.2	23.6	-5.93%	N/A	N/A	N/A	N/A	4
				2350	41.66	39.38	5.78%	1.74	1.71	2.07%																	
				2400	41.57	39.30	5.78%	1.79	1.75	1.90%																	
SAR 16	7/14/2024	Head	2450	2450	38.60	39.20	-1.53%	1.81	1.80	0.28%	7/14/2024	D2450V2 SN: 748	2/8/2025	20.0	5.08	50.8	51.7	-1.74%	2.36	23.6	24.2	-2.48%	N/A	N/A	N/A	N/A	5
				2400	38.69	39.30	-1.54%	1.77	1.75	0.88%																	
				2500	38.51	39.14	-1.60%	1.84	1.85	-0.70%																	
SAR 17	7/14/2024	Head	1900	1900	40.09	40.00	0.23%	1.45	1.40	3.86%	7/14/2024	D1900V2 SN: 5d140	4/14/2025	20.0	4.08	40.8	39.4	3.55%	2.12	21.2	20.6	2.91%	N/A	N/A	N/A	N/A	6
				1850	40.20	40.00	0.50%	1.43	1.40	1.93%																	
				1920	40.05	40.00	0.12%	1.46	1.40	4.57%																	

6.2. Power Density Measurement System Validation & System 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 16% (0.66 dB) 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 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.

PD System Validation Results

SAR Lab	Test Date	5G Probe SN	Probe Cal. Due Date	DAE SN	DAE Cal. Due Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Data	Averaging Type	Measured psPDn (W/m^2) over $4cm^2$	Target psPDn (W/m^2) over $4cm^2$	Deviation (dB)	Delta	Measured psPDtot (W/m^2) over $4cm^2$	Target psPDtot (W/m^2) over $4cm^2$	Deviation (dB)	Delta
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	76.9	80.1	-0.18	-4%	78.1	80.1	-0.11	-2%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	76.5	80.1	-0.20	-4%	77.7	80.1	-0.13	-3%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	76.2	80.1	-0.22	-5%	77.3	80.1	-0.15	-3%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	76.0	80.1	-0.23	-5%	77.1	80.1	-0.17	-4%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	77.4	80.1	-0.15	-3%	78.6	80.1	-0.08	-2%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	76.2	80.1	-0.22	-5%	77.3	80.1	-0.15	-3%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	75.5	80.1	-0.26	-6%	76.7	80.1	-0.19	-4%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	75.4	80.1	-0.26	-6%	76.7	80.1	-0.19	-4%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	79.0	80.1	-0.06	-1%	80.4	80.1	0.02	0%
C	5/20/2024	9589	9/5/2024	1621	4/12/2025	30	1117	9/20/2024	Square	77.8	80.1	-0.13	-3%	79.1	80.1	-0.05	-1%
									Average	**76.7**	80.1	-0.19	-4%	**77.9**	80.1	-0.12	-3%

SAR Lab	Test Date	5G Probe SN	Probe Cal. Due Date	DAE SN	DAE Cal. Due Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Data	Averaging Type	Input Power Source Cal. (dBm)	Input Power System Cart (dBm)	Measured psPDn (W/m^2) over $4cm^2$	Normalized to Input Power Source Cal. (W/m^2)	Target psPDn (W/m^2) over $4cm^2$	Deviation (dB)	Delta	Measured psPDtot (W/m^2) over $4cm^2$	Normalized to Input Power Source Cal. (W/m^2)	Target psPDtot (W/m^2) over $4cm^2$	Deviation (dB)	Delta
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.6	58.2	56.1	0.16	4%	59.9	58.5	56.1	0.18	4%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.1	57.8	56.1	0.13	3%	59.3	58.0	56.1	0.14	3%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	58.2	56.9	56.1	0.06	1%	58.5	57.2	56.1	0.08	2%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.3	58.0	56.1	0.14	3%	59.7	58.3	56.1	0.17	4%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.3	58.0	56.1	0.14	3%	59.5	58.1	56.1	0.16	4%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	58.8	57.5	56.1	0.10	2%	59.0	57.7	56.1	0.12	3%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.0	57.7	56.1	0.12	3%	59.2	57.9	56.1	0.13	3%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	58.6	57.3	56.1	0.09	2%	58.9	57.6	56.1	0.11	3%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	59.3	58.0	56.1	0.14	3%	59.6	58.2	56.1	0.16	4%
D	5/20/2024	9619	3/8/2025	1472	1/16/2025	10	1015	9/5/2024	Square	19.9	20.00	58.2	56.9	56.1	0.06	1%	58.5	57.2	56.1	0.08	2%
											Average	58.9	**57.6**	56.1	0.11	3%	59.2	**57.9**	56.1	0.13	3%

PD System Check Results

SAR Lab	Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Date	Measured psPDn (W/m^2) over $4cm^2$	Target psPDn (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±16 %	Measured psPDtot (W/m^2) over $4cm^2$	Target psPDtot (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±16 %	Plot
C	7/15/2024	30	1117	9/20/2024	76.4	76.7	-0.02	0%	77.9	77.9	0.00	0%	7

SAR Lab	Date	Frequency (GHz)	5G Verification Source SN	Source Cal. Due Date	Input Power (dBm)	Prad (mW)	Ohmic & Mismatch Loss (dB)	Measured psPDn (W/m^2) over $4cm^2$	Normalized to dBm W/m^2	Target psPDn (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±16 %	Measured psPDtot (W/m^2) over $4cm^2$	Normalized to dBm W/m^2	Target psPDtot (W/m^2) over $4cm^2$	Deviation (dB)	Delta ±16 %	Plot
D	7/16/2024	10	1015	9/5/2024	17.00	93.30	0.30	29.2	58.2	57.6	0.05	1%	29.3	58.4	57.9	0.04	1%	8

7. Test Results

7.1. Measured and Reported (Scaled) SAR Results

The DUT supports an inductive charging system in both Tx and Rx modes. The DUT only supports Tx mode while it is connected to an external power supply via the lightning connector.

SAR testing was performed on the worst-case Head position for each supported technology in accordance with FCC guidance. Body testing was deemed unnecessary as the body-worn scenario would not be supported while the DUT is plugged in to the external power supply. SAR testing was performed while the DUT (FCC ID: BCG-E8666A) was transmitting with the MagSafe compatible battery pack (FCC ID: BCG-A2384) attached to the DUT.

Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode(s)	Dist (mm)	Test Position	Channel	Freq. (MHz)	RB Allocation	RB Offset	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	BCG-E8666A				BCG-E8666A w/ BCG-A2384				Delta %	Plot No.
															1-g Meas. (W/kg)	1-g Scaled (W/kg)	10-g Meas. (W/kg)	10-g Scaled (W/kg)	1-g Meas. (W/kg)	1-g Scaled (W/kg)	10-g Meas. (W/kg)	10-g Scaled (W/kg)	1g	
GSM	1900	ANT 4	Head	GPRS 2 Slots	Mode A	0	Left Cheek	810	1909.8				27.4	26.4	0.776	0.977	0.403	0.507	0.737	**0.928**	0.376	0.473	-5.0%	1
WCDMA	II	ANT 4	Head	Rel. 99	Mode A	0	Left Cheek	9538	1907.6				19.9	19.1	0.789	0.942	0.424	0.506	0.754	**0.900**	0.395	0.472	-4.4%	2
LTE	30	ANT 4	Head	QPSK	Mode A	0	Left Cheek	27710	2310.0	50	0		20.4	20.0	0.910	0.998	0.432	0.474	0.885	**0.970**	0.415	0.455	-2.7%	3
FR1	53	ANT 2	Head	DFT-s-OFDM π/2 BPSK	Mode A	0	Right Cheek	497860	2489.3	12	6		19.1	18.6	0.800	0.904	0.351	0.397	0.578	**0.653**	0.250	0.282	-27.8%	4
WLAN	2.4 GHz	ANT 4	Head	802.11 b	Power State 1 Mode A	0	Left Cheek	6	2437.0			99.76%	21.5	20.2	0.808	1.093	0.392	0.530	0.883	**1.191**	0.440	0.595	9.0%	5
WLAN	5.8 GHz	ANT 6	Head	802.11 ac (VHT80)	Power State 1 Mode A	0	Left Cheek	155	5775.0			94.85%	20.5	19.4	0.209	0.284	0.052	0.071	0.176	**0.239**	0.039	0.053	-15.8%	6

Technology	Band	Antenna	RF Exposure Condition	Mode	Power Mode(s)	Dist (mm)	Test Position	Channel	Freq. (MHz)	Duty Cycle (%)	Max Output Pwr (dBm)	Meas. (dBm)	BCG-E8666A						BCG-E8666A w/ BCG-A2384						Delta %	Plot No.
													1-g Meas. (W/kg)	1-g Scaled (W/kg)	10-g Meas. (W/kg)	10-g Scaled (W/kg)	APD Meas. (W/m^2)	APD Scaled (W/m^2)	1-g Meas. (W/kg)	1-g Scaled (W/kg)	10-g Meas. (W/kg)	10-g Scaled (W/kg)	APD Meas. (W/m^2)	APD Scaled (W/m^2)	1g	
WLAN 6E	UNII-5	ANT 6	Head	802.11ax (HE160)	Power State 1 Mode A	0	Right Cheek	15	6025.0	93.86%	9.50	8.25	0.008	**0.011**	0.004	0.006	0.056	0.080	0.004	**0.006**	0.000	0.000	0.016	0.023	-50.0%	7

7.2. Measured and Reported (Scaled) PD Results

The DUT supports an inductive charging system in both Tx and Rx modes. The DUT only supports Tx mode while it is connected to an external power supply via the lightning connector.

PD testing was performed on the worst-case Edge position. PD testing was performed while the DUT (FCC ID: BCG-E8666A) was transmitting with the MagSafe compatible battery pack (FCC ID: BCG-A2384) attached to the DUT.

Technology	Band	Antenna	Power Mode	Test Position	Ch No.	Freq. (MHz)	Mode	Duty Cycle (%)	TuP Limit (dBm)	Meas. (dBm)	Uncertainty Scaling Factor	Grid Step Size (λ)	Dist. (mm)	BCG-E8666A				BCG-E8666A w/ BCG-A2384				psPDtot Delta (%)	Plot No.
														Meas. psPDn (mW/cm^2)	Scaled psPDn (mW/cm^2)	Meas. psPDtot (mW/cm^2)	Scaled psPDtot (mW/cm^2)	Meas. psPDn (mW/cm^2)	Scaled psPDn (mW/cm^2)	Meas. psPDtot (mW/cm^2)	Scaled psPDtot (mW/cm^2)		
WLAN 6E	UNII-7	ANT 5	Power State 1	Edge Bottom	119	6545.0	802.11ax (80 MHz)	97.68%	11.00	10.10	1.573	0.0410	2	0.112	0.217	0.166	**0.321**	0.010	0.019	0.010	**0.020**	-93.9%	8

Technology	Band	Antenna	Signal Type	Channel	Freq. (MHz)	Beam ID2	input.power.limit (dBm)	CC #	BW (MHz)	Modulation	RB #	Dist (mm)	Test Position	BCG-E8666A		BCG-E8666A w/ BCG-A2384		psPDtot Delta (%)	Plot No.
														Meas. psPDn (mW/cm^2)	Meas. psPDtot (mW/cm^2)	Meas. psPDn (mW/cm^2)	Meas. psPDtot (mW/cm^2)		
FR2	n258	BG1	CW	2025833	24800	142	-0.7	1	50	QPSK	1	2	Edge Left	0.080	**0.085**	0.060	**0.062**	-27.3%	9

Appendixes

Refer to separated files for the following appendixes.

Appendix A: Setup Photos

Appendix B: System Check Plots

Appendix C: Highest Test Plots

Appendix D: SAR Tissue Ingredients

Appendix E: Probe Certificates

Appendix F: Dipole & 5G Source Certificates

END OF REPORT